WORKING GROUP FOR THE CELTIC SEAS ECOREGION (WGCSE)

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Contents

i Executive summary

In total the ICES Working Group for the Celtic Seas Ecoregion (WGCSE) is responsible for the provision of updated fisheries data, assessments and draft advice for 40 demersal fish and *Nephrops* stocks across ICES subareas 6 and 7 (with the distribution of megrim, seabass, anglerfish and saithe extending into other divisions). This includes twelve *Nephrops* stocks, five sole and plaice stocks, four cod and whiting stocks, three haddock stocks, two each of megrim and seabass, one anglerfish, one saithe and one pollack stock. As in previous years, advice for *Nephrops*, anglerfish and Rockall megrim is not issued until autumn to make use of the most up to date survey information. Advice for Rockall haddock is not issued until autumn to allow evaluation of reference points as part of a benchmark currently underway. For a number of other stocks (bss.27.6a7bj, cod.27.6b, nep.27.6aoutFU, nep.27.7outFU, ple.27.7bc, sai.27.7–10, sol.27.7bc, whg.27.6a, whg.27.6b), no new advice was provided this year. Advice on the remaining stocks was released on the 28th June.

Since the last Working Group meeting, two stocks have gone through a benchmark or Interbenchmark procedure; cod.27.6a, had.27.6b and sol.27.7fg, the results of which were presented to the group.

Update assessments were generally carried out according to the stock annexes (any deviations were detailed in the stock sections). Overall the stock status across the ecoregion is very similar to that presented last year. Of the 40 stocks assessed, 21 were fished below $F_{MSY,}$ eight stocks were fished above F_{MSY} and 11 stocks had unknown status relative to $F_{MSY;}$ 21 were above MSY $B_{trigger}$, and eight were below MSY $B_{trigger}$, with 11 unknown relative to $B_{trigger}$.

ii Expert group information

Expert group name	Working Group for the Celtic Seas Ecoregion (WGCSE)
Expert group cycle	Annual
Year cycle started	2019
Reporting year in cycle	1/1
Chairs	Sofie Nimmegeers, Belgium
	Timothy Earl, UK
Meeting venue and dates	8–17 May, 2019, Ghent, Belgium (29 participants)
	September–October, by correspondence (ten contributors)

1 Introduction

1.1 Terms of reference

1.1.1 Generic ToRs for Regional and Species Working Groups

2018/2/ACOM05 The following ToRs apply to: AFWG, HAWG, NWWG, NIPAG, WGWIDE, WGBAST, WGBFAS, WGNSSK, WGCSE, WGDEEP, WGBIE, WGEEL, WGEF, WGHANSA and WGNAS.

The working group should focus on:

a) Consider and comment on Ecosystem and Fisheries overviews where available;
b) For the aim of providing input for the Fisheries Overviews, consider and comment for the fisheries relevant to the working group on:
   1. descriptions of ecosystem impacts of fisheries;
   2. descriptions of developments and recent changes to the fisheries;
   3. mixed fisheries considerations; and
   4. emerging issues of relevance for the management of the fisheries.

c) Conduct an assessment on the stock(s) to be addressed in 2019 using the method (analytical, forecast or trends indicators) as described in the stock annex and produce a **brief** report of the work carried out regarding the stock, summarising where the item is relevant:
   1. Input data and examination of data quality;
   2. Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;
   3. For relevant stocks (i.e. all stocks with catches in the NEAFC Regulatory Area) estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2018;
   4. Estimate MSY proxy reference points for the category 3 and 4 stocks;
   5. The developments in spawning–stock biomass, total stock biomass, fishing mortality, catches (wanted and unwanted landings and discards) using the method described in the stock annex;
   6. The state of the stocks against relevant reference points;
   7. Catch scenarios for next year(s) for the stocks for which ICES has been requested to provide advice on fishing opportunities;
   8. Historical and analytical performance of the assessment and catch options with a succinct description of quality issues with these. For the analytical performance of category 1 and 2 age-structured assessment, report the mean Mohn's rho (assessment retrospective (bias) analysis) values for R, SSB and F. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose. Produce a first draft of the advice on the stocks under considerations according to ACOM guidelines.

d) Review progress on benchmark processes of relevance to the Expert Group;
e) Prepare the data calls for the next year update assessment and for planned data evaluation workshops;

f) Identify research needs of relevance for the work of the Expert Group.

Information of the stocks to be considered by each Expert Group is available here.

1.1.2 Specific ToRs

WGCSE – Working Group for the Celtic Seas Ecoregion

2018/2/ACOM13 The **Working Group for the Celtic Seas Ecoregion** (WGCSE), chaired by Timothy Earl, UK and Sofie Nimmegeers*, Belgium will meet in Ghent, Belgium, 8–17 May 2019 and by correspondence September / October 2019 to:

a) Address generic ToRs for Regional and Species Working Groups;
b) Report on reopened advice as appropriate.

The assessments will be carried out on the basis of the stock annex. The assessments must be available for audit on the first day of the meeting.

Material and data relevant for the meeting must be available to the group on the dates specified in the 2019 ICES data call.

WGCSE will report by 31 May 2019 for the attention of ACOM, and by 7 October 2019 for *Nephrops* stocks, anglerfish and megrim in Rockall. Concerning ToR b) the group will report on the ACOM guidelines on reopening procedure of the advice before 12 October and will report on reopened advice before 28 October.

1.2 Participation

The number of participants able to attend the Working Group for the full duration of the meeting has increased slightly in the last three years (Figures 1.2.1–1.2.3). The Working Group continues to welcome a number of members participating remotely, or for part of the meeting. As last year, six institutes were represented by full-time participants attending the meeting.

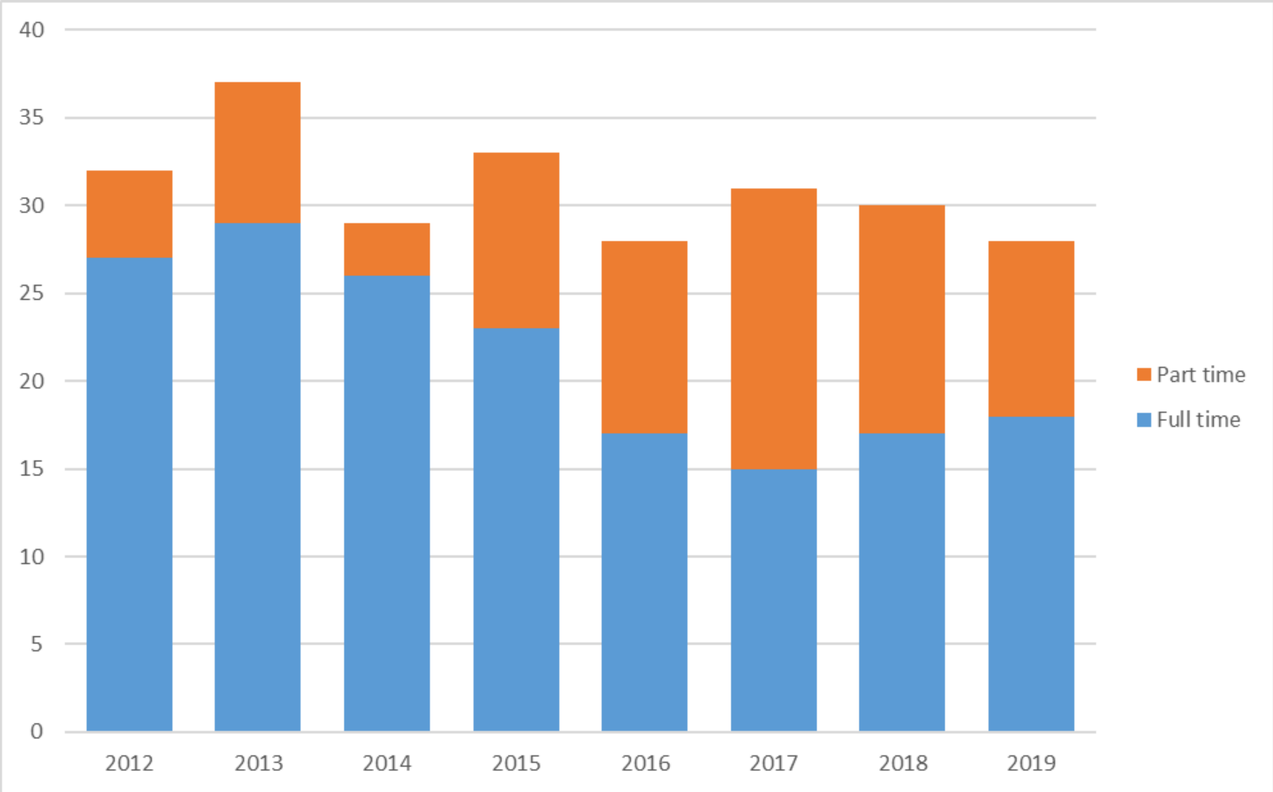


Figure 1.2.1. Numbers of WGCSE participants over time, and whether they were full-time or part-time (part-time includes working by correspondence).

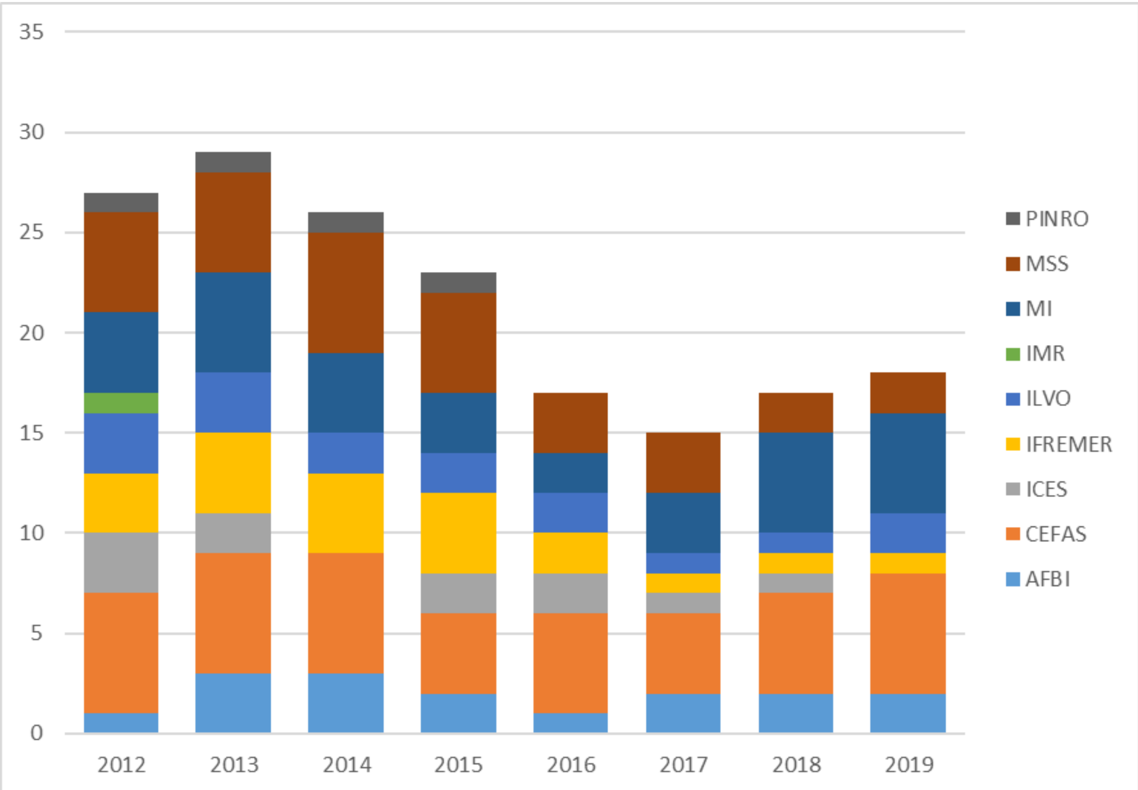


Figure 1.2.2. Number of participants from each institute attending by year.

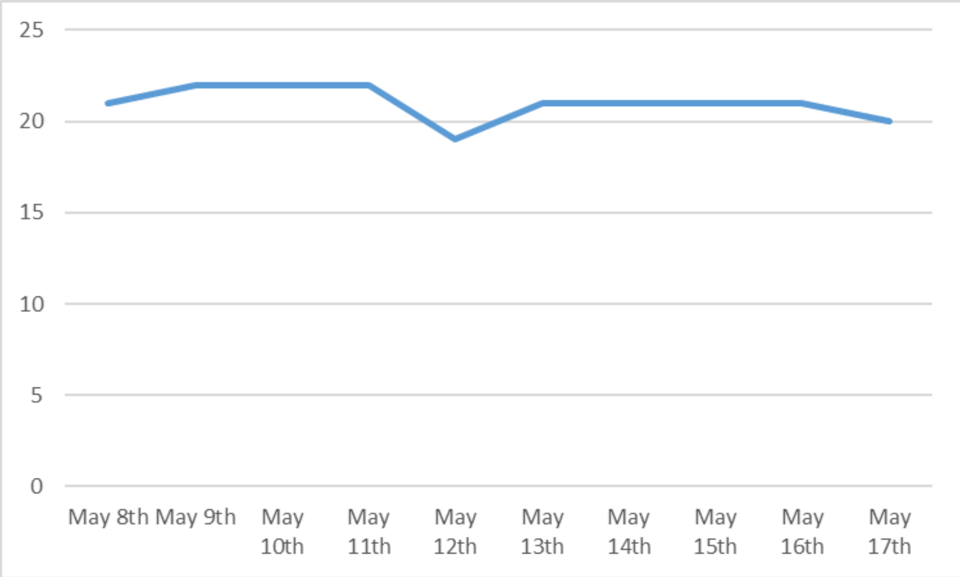


Figure 1.2.3. Number of participants attending the meeting by day. Note that no plenary session was held on Sunday 12th.

1.3 Methods

The type of final assessments presented at the WG are summarised as follows:

Category 1 age-based assessments and forecasts were conducted for bss.27.4bc7ad–h, cod.27.6.a, cod.27.7.e–k, had.27.6.b, had.27.7.a, had.27.7.b–k, ple.27.7.a, sol.27.7.a, sol.27.7.e, sol.27.7.fg, whg.27.6.a (no forecast presented as the advice published in 2018 is still valid), whg.27.7.a, whg.27.7.b–ce–k;

Category 1 Bayesian surplus production model for lez.27.4.a6.a;

Category 1: UWTV survey based assessments and advice were used for nep.fu.11, nep.fu.12, nep.fu.13, nep.fu.14, nep.fu.15, nep.fu.16, nep.fu.17, nep.fu.19, nep.fu.2021 and nep.fu.22. Fisheries data were updated at the May meeting and survey data were updated in the autumn;

Category 3: Catch-at-age based assessments with caveats i.e. used for trends only and without forecasts for ple.27.7.e, ple.27.7.h–k and sol.27.7.h–k;

Category 3: SPICT used to provide biomass trend for ple.27.7fg;

Category 3: Analysis of the trends in survey data are used as the basis for advice for anf.27.3a46, cod 27.7.a and lez.27.6b;

Category 4: Depletion corrected average catch was used for pol.27.67 and pok.27.7–10;

Category 5 & 6: No assessments were carried out in 2019 for bss.27.6bc7ad–h, cod.6b, nep.27.6aoutFU and nep.27.7outFU, ple.27.7bc, sol.27.7bc, whg.27.6b; only landings statistics were updated.

For the stocks for which a full analytical assessment was possible, the WG typically used either Extended Survivor's Analysis (XSA), Time-Series Analysis (TSA), or Age-Structured Assessment Program (ASAP). These approaches and procedures for using them are discussed in further detail in the relevant stock annexes.

1.4 Data issues

Data were generally submitted in a timely fashion through the InterCatch database for landings and discards data, and through the accessions database for other sources of data. There were no general data issues, those that affect specific stocks are discussed in the relevant section.

1.5 Transparent Assessment Framework (TAF)

TAF is a new framework, currently in development, to organize all ICES stock assessments. Using a standard sequence of R scripts, it makes the data, analysis, and results available online, and documents how the data were pre-processed. Among the key benefits of this structured and open approach are improved quality assurance and peer review of ICES stock assessments. Furthermore, a fully scripted TAF assessment is easy to update and rerun later, with a new year of data. A number of assessments are being scripted in standard TAF scripts. See http://taf.ices.dk for more information.

During the WGCSE 2019 meeting, the following stocks made progress transferring their assessments into TAF: anf.27.3a46, cod.27.6a, cod.27.6b, cod.27.7a, had.27.6b, had.27.7b–k, nep.fu.11, nep.fu.22, ple.27.7e, ple.27.7h–k, pol.27.67, sol.27.7e, sol.27.7fg, sol.27.7h–k, whg.27.6a, whg.27.6b, whg.27.7b–ce–k.

1.6 Internal auditing and external reviews

This year ICES reintroduced the external review process, establishing a Review Group (RG) with the responsibility of auditing all category 1 stocks ahead of the ADG. This review group constitutes of 20 students from the University of Maine (US) and is led by a PhD student (Mackenzie Mazur) and the faculty advisor (Yong Chen). No major errors were detected by this process, but the RG did provide some useful comments to be considered in next year's assessments.

In addition, as in previous years the WG carried out its own internal audit process using the standard ICES template. Given the workload of many of the scientists at WGCSE (sometimes with one scientist responsible for two or more stocks), many of the reports were not finalized until after the WG meeting. Audits were therefore typically carried out by correspondence after the WG and not completed for some stocks.

All stocks for which advice was provided in June and October 2019 were audited by the WG and audit reports were produced for most of these. Issues discovered during the audit process were corrected in the WG report.

1.7 Generic ToR e: WGCSE recommendations for stocks to be benchmarked

The following stocks are recommended by WGCSE to be benchmarked in 2020: cod.27.7e–k, had.27.7b–k and whg.27.7bce–k (WKCELTIC); sol.27.7fg and sol.27.7h–k together with three stocks from WGNSSK, sol.27.4, sol.27.7d and tur 27.3a (WKFlatNSCS); cod.27.6a and whg.27.6a (WKWest).

In February 2019, the first Data Evaluation Workshop in preparation of WKCELTIC was established with the focus on streamlining data compilation procedures for fishery-dependent and survey data. This will improve the transparency and diagnostics surrounding commercial tuning fleets and surveys. The second Data Evaluation Workshop is scheduled for October 2019.

WKCELTIC will revise the assessment methods and diagnostics, given the potential for changes in selectivity in the commercial fishery. Also mixed fisheries and multispecies interactions will be investigated as well as environmental drivers that may impact the growth and recruitment of all three species.

For sol.27.7fg and sol.27.7h–k (WKFlatNSCS), the focus is to examine alternative assessment models to XSA (e.g. A4A, ASAP, SAM, CASAL), explore the impact of all available tuning fleets, reconsider available life-history and catch data.

During the benchmark for cod.27.6a, the issues associated with stock structure will be addressed. A possible merge between North Sea and 27.6a cod stocks or alternatively, a split of area 27.6a in two areas North and South, will be evaluated. Furthermore, misreporting of Scottish data, fisheries selectivity pattern and alternative discard models will be explored. For whg.27.6a, the focus is to address the emergence of a trend in survey catchability.

WGCSE recommend that pol.27.67 and pok.27.7–10 should be benchmarked together in 2021. Currently, both stocks are categorized as category 4 data-limited and the DCAC method is applied to provide advice. As the DCAC method only uses long time-series of official landings, it may not reflect recent stock fluctuations or changes in the fisheries, smoothed by the length of the time-series. So new computations of DCAC are always very close to the previous year's results, even if recruitment or SSB highly fluctuate. Therefore, it is relevant to explore new assessment models. Furthermore, this is the first year advice was provided for the pok.27.7–10 stock.

WGCSE recommend that ple.27.7h–k and ple.27.7fg should be benchmarked in 2021. For those plaice stocks similar issues will be addressed as scheduled for the WKFlatNSCS in 2020.

Further details are given in the stock sections.

This year a new initiative has been approved for prioritizing the stocks that need to be benchmarked. The sum of the weighting scores (1–5) for each of the five criteria will determine the urgency for a benchmark. Those criteria are related to the quality of the previous assessments, the opportunity to improve the assessment, the management importance, the perceived stock status and the time since the previous benchmark.

To have an overview of this information, an issue list is requested for every stock. Later in the year, this prioritization exercise will be completed.

1.8 Specific ToRs

1.8.1 c(ii): Estimation of MSY proxy reference points for category 3 and 4 stocks

The Terms of Reference contained a list of six stocks for which proxy reference points should be considered. The Working Group addressed this ToR as follows.

Category 3 stocks

For four stocks (cod.27.7e–k, ple.27.7e, ple.27.7h–k and sol.27.7h–k) age-based assessments are performed, although only used as relative indicators of stock status. For these stocks, most of the reference points were estimated using the package EqSim, and the method of WKMSYREF4 at WGCSE 2017. The extra data available at this year's Working Group did not warrant recalculation of the reference points.

For ple.27.7fg, a SpiCT assessment using survey and lpue data, combined with a hind-cast of discards was used to estimate the stock status relative to reference points.

For lez.27.6b, a SpiCT assessment using survey data was used to estimate the stock status relative to reference points.

For anf.27.3a46, which was benchmarked in 2018, none of the DL approaches for estimating proxy reference points were entirely satisfactory.

The assessment of cod.27.7a was not of sufficient quality to be retained as a category 1 assessment. Therefore, the reference points previously defined for this stock are not considered appropriate for providing advice. As a result, the advice is based on the survey index as indicator of stock size and the category 3 precautionary approach.

Category 4 stocks
For pol.27.67 and pok.27.7–10, no reference points are defined.

1.8.2 c(viii): Calculation of Mohn's Rho

Through this additional ToR, the Working Group was requested to report the assessment bias statistic Mohn's rho for each of the category 1 stocks. For the following stocks the Mohn's rho data were uploaded to the "Retro-bias-2019" SharePoint: cod.27.6a, cod.27.7a, cod.27.7e–k, had.27.7b–k, lez.27.4a6a, ple.27.7a, sol.27.7a, sol.27.7e, sol.27.7fg, whg.27.7a and whg.27.7b-ce–k. The assessments of *Nephrops* stocks do not revise the perception of previous years, and so there is no retrospective assessment.

The guidance on calculating Mohn's Rho seems unclear about whether the SSB for the intermediate year should be used for the calculation of rho in XSA and ASAP models. Some members considered that the SSB in 2019 was a consequence of the known numbers and catch in 2018 and should therefore be included, while others took the view that the SSB in 2019 depends on a 2019 recruitment assumption where the recruitment has some proportion mature. Furthermore, the SSB 2019 also depends on the assumed stock weights-at-age for 2019. In the latter case, the SSB 2019 is not directly derived from the assessment model and should therefore be excluded from the Mohn's rho calculation. For most stocks that use an XSA or ASAP model, the final year was set to 2018, and in all cases we've asked for this to be made clear in the report. For cod.27.6a, that uses a TSA model, the SSB 2019 is projected by the model and thus included.

In November 2019 a workshop is planned (WKFORBIAS) to quantify the extent and possible causes for retrospective bias. However, as an interim solution for 2019, ICES has provided guidance (based on a paper of Hurtado *et al*., 2015), that suggests downgrading stocks from category 1, if the Mohn's Rho value of the SSB retro is outside the range -0.15 to 0.2.

The retrospective biases in cod.27.7e–k, cod.27.7a and had.27.7b–k were all outside the limits of the rule of thumb of Hurtado-Ferro (2015). The whg.27.7b–ce–k, assessment was also revised substantially in 2019. The choice of terminal year made no difference to which stocks had SSB retro values outside the acceptable range (in the case of whg.27.7b–ce–k the Mohn's rho with 2019 terminal year was not presented).

We dealt with these on a case-by-case basis.

For cod.27.7a, the Mohn's Rho value for SSB was 0.92 (ending in 2018). The working group considered several alternative models for catch selectivity, reduced age range, and alternative values for natural mortality, but was unable to identify a single source of the bias. As a result, advice was provided as a category 3 assessment, using the NI Groundfish Quarter 1 WIBTS Survey, as this was considered the most reliable indicator of exploitable biomass. The Working Group concluded that the fit of the model was so poor that the reference points based on it were unreliable and used a qualitative evaluation instead.

For cod.27.7e–k, the Mohn's Rho value for SSB was 0.48 (ending in 2018) and therefore the stock was moved from category 1 to category 3 (i.e. trends in the assessment). Unlike Cod.27.7a, the Working Group had enough confidence in the model outputs to determine the status relative to the reference points.

For whg.27.7b–ce–k, the Mohn's Rho value for SSB was 0.06 (ending in 2018), but the retrospective on R has a value of 0.881 due to a substantial revision downwards. The retrospective appears to be a result of very low catches in the combined EVHOE-WIBTS-Q4 (French) and IGFS-WIBTS-Q4 (Irish) at ages 1–3, which is reflected in a low level of discards in the French OTB fleet, but not in the Irish OTB fleet (predominantly sampled from 7b). The consistency of the data suggests some movement of the smaller fish in the stock, possibly related to a slightly later timing of the survey. Given the multiple sources of data revising our perception, (French survey, Irish Survey, French discards) the Working Group considered that the perception of the stock has changed due to additional data, and it was appropriate for the model to revise recruitment and SSB down in recent years. The Category 1 approach was used.

For had.27.7b–k, the Mohn's Rho value for SSB was -0.17, largely due to a change in the assessment in 2019, rather than systematic revisions. This was believed to be mainly due to revisions in stock weights in the most recent assessment. The Working Group concluded that the assessment was still suitable for providing category 1 advice.

Note that Celtic Sea cod/haddock/whiting are undergoing a benchmark in 2020, which is likely to result in a revised perception of the stocks next year.

2 Anglerfish (*Lophius budegassa, Lophius piscatorius*) in subareas 4 and 6 and in Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat)

Assessment in 2019

The last benchmark for this stock was carried out in February 2018 (ICES, 2018). The assessment carried out at the WG follows the agreed procedure for category 3.2.0 of ICES RGLIFE data-limited stock (DLS) methods as set out in the stock annex.

ICES advice applicable to 2018 and 2019

ICES advice for 2018

ICES advise that when the precautionary approach is applied, catches in 2018 should be no more than 26 408 tonnes. If discard rates do not change from the average of the last three years (2014–2016), this implies landings of no more than 25 563 tonnes.

ICES advice for 2019

ICES advise that when the precautionary approach is applied, catches in 2019 should be no more than 31 690 tonnes.

2.1 General

Stock description and management units

The anglerfish stock on the Northern Shelf is considered to occur in Division 3.a (Skagerrak and Kattegat), Subarea 4 (the North Sea) and Subarea 6 (West of Scotland plus Rockall). Anglerfish in the North Sea and Skagerrak/Kattegat were considered by this Working Group for the first time in 1999. In 2004, the WGNSDS considered the stock structure of anglerfish on a wider European scale, and found no conclusive evidence to indicate an extension of the stock area northwards to include Division 2.a. In 2013, Division 2.a was removed from WGCSE ToR.

Management applicable to 2018 and 2019

Species:	Anglerfish	Zone:	Union waters of IIa and IV
	Lophiidae		(ANF/2AC4-C)
Belgium		573 ([1])	
Denmark		1264 ([1])	
Germany		618 ([1])	
France		118 ([1])	
The Netherlands		434 ([1])	
Sweden		15 ([1])	
United Kingdom		13 203 ([1])	
Union		16 225 ([1])	
TAC		16 225	Analytical TAC

[1] Special condition: of which up to 10% may be fished in: 6; Union and international waters of 5.b; international waters of 12 and 14 (ANF/*56-14).

Species	Anglerfish	Zone:	Norwegian waters of 4
	Lophiidae		(ANF/04-N.)
Belgium		51	
Denmark		1305	
Germany		21	
The Netherlands		18	Analytical TAC
United Kingdom		305	Article 3 of Regulation (EC)
Union		1700	No 847/96 shall not apply
TAC	Not relevant	Article 4 of Regulation (EC)	
			No 847/96 shall not apply
Species	Anglerfish	Zone:	6; Union and international waters of
	Lophiidae		5.b; international waters of 7 and 14
			(ANF/56-14)
Belgium		330	
Germany		377	
Spain		353	
France		4059	
Ireland		918	
The Netherlands		318	
United Kingdom		2825	
Union		9180	
TAC		9180	Precautionary TAC

COUNCIL REGULATION (EU) No 120/2018 of 23 January 2018 fixing for 2018 the fishing opportunities available to EU vessels for certain fish stocks and groups of fish stocks which are not subject to international negotiations or agreements.

Species:	Anglerfish	Zone:	Union waters of 2.a and 4
	Lophiidae		(ANF/2AC4-C)
Belgium		715 ([1])	
Denmark		1 577 ([1])	
Germany		770 ([1])	
France		147 ([1])	
The Netherlands		541 ([1])	
Sweden		18 ([1])	
United Kingdom		16 469 ([1])	
Union		20 237 ([1])	
TAC		20 237	Analytical TAC

([1]) Special condition: of which up to 10% may be fished in: 6; Union and international waters of 5b; international waters of 12 and 14 (ANF/*56-14).

Species	Anglerfish	Zone:	Norwegian waters of 4
	Lophiidae		(ANF/04-N.)
Belgium		51	
Denmark		1 305	
Germany		21	
The Netherlands		18	Analytical TAC
United Kingdom		305	Article 3 of Regulation (EC)
Union		1700	No 847/96 shall not apply
TAC	Not relevant		Article 4 of Regulation (EC)
			No 847/96 shall not apply
Species	Anglerfish	Zone	6; Union and international waters of 5.b; international waters of 7 and 14
	Lophiidae		(ANF/56-14)
Belgium		411 ([1])	
Germany		470 ([1])	
Spain		440	
France		5067 ([1])	
Ireland		1145	
The Netherlands		396 ([1])	
United Kingdom		3524 ([1])	
Union		11 453	
TAC		11 453	Precautionary TAC

[1)] Special condition: of which up to 5 % may be fished in: Union waters of 2a and 4 (ANF/*2AC4C).

COUNCIL REGULATION (EU) No 124/2019 of 30 January 2019 fixing for 2019 the fishing opportunities available to EU vessels for certain fish stocks and groups of fish stocks which are not subject to international negotiations or agreements.

Management of Northern Shelf anglerfish is based on separate TACs for the North Sea Subarea 4 and West of Scotland Subarea 6. There is no TAC for Skagerrak and Kattegat Division 3.a. Table 4.1 summarises the ICES advice and actual management applicable for Northern Shelf anglerfish during 2003–2019.

Fishery description

A more detailed description of the fisheries can be found in the Stock Annex. The official national landings as reported to ICES are given in Table 4.2 and the breakdown by country in Tables 4.3–4.5. Minor revisions were made to tables in 2019 with updates from the ICES official and historical nominal catch statistics and the addition of the preliminary catch statistics values for 2018. Total officially reported landings of anglerfish from the Northern Shelf are shown in Figure 4.1.

The fishery in 2018

Official landings in 2018 for subareas 6 and 4 were 20 436 t (6211 t and 14 225 t), giving a 20% undershoot of the combined TAC of 25 405 t (68% and 79% TAC uptake respectively). In Subarea 6 Belgium (0%), the Netherlands (0%) and France (32%) had noticeably low uptakes. Belgium and the Netherlands were also observed to significantly undertake their quota in Subarea 4 (25% and 41%). Denmark (86%), Germany (84%), and the United Kingdom all (86%) decreased their Subarea 4 uptakes in comparison to 2017. The UK exceeded its quota in Subarea 6 (by 20%) although this was a reduction from 47% in 2017. Over quota landings by individual states are most likely due to countries obtaining additional quota from other EU member states, or carrying forward unutilised quota from 2017 and using a flexibility allowance whereby 10% of Subarea 4 TAC can be utilised to reattribute landings from Subarea 6.

Uptake of EC quota in 2018, based on the preliminary officially reported landings, was as follows:

	TAC 6	Lan-dings 6	Uptake (%)	TAC 4 (Norwegian)	TAC 2.a & 4	TAC 2.a & 4(to-tal)	Landings 4	Uptake (%)
Belgium	330	-	0%	51	573	624	156	25%
Denmark	-	-	-	1305	1264	2569	2201	86%
France	4059	1287	32%	-	118	118	142	120%
Germany	377	394	104%	21	618	639	536	84%
Ireland	918	878	96%	-	-	-	-	-
Netherlands	318	-	0%	18	434	452	187	41%
Norway	-	4	-	-	-	-	1267	-
Russia	-	-	-	-	-	-	-	-
Spain	353	261	74%	-	-	-	-	-
Sweden	-	-	-	-	15	15	25	167%
UK (total)	2825	3387	120%	305	13 203	13 508	9711	72%
Total Union TAC	9180	6207	68%	1700	16 225	17 925	12 958	72%

[1] **TAC applies to 6, 5.b (EC), and international waters of 7 and 14.**

[2] **Norwegian waters.**

Based on data submitted to ICES, the fishery was principally prosecuted by vessels using demersal trawls (Table 4.6), targeting either white fish (70% of total landings by weight) or *Nephrops* (4%). Alongside these fleets there was also a significant gillnet fishery (17%), as well as an assortment of other gears in which small quantities of anglerfish are caught as bycatch. The latter have been grouped here as miscellaneous gears (9%). Gillnets and miscellaneous gears accounted for more of the proportional split of landings across gear types in 2018 in comparison to 2017.

UK (Scottish) vessels accounted for the majority of reported anglerfish landings from the combined Northern Shelf area, taking approximately 61% of the landings overall. Scottish, Danish and Norwegian vessels took 68%, 15% and 9%, respectively, of the North Sea (divisions 4.a–4.c) landings. Scottish, French and Irish vessels took 55%, 21% and 14%, respectively, of the West Coast (Subarea 6) landings. In 2013, landings were at their lowest level since the late 1980s, well below the TAC, since then they have increased by over 70%. Anecdotal information on the fishery in 2018 from industry representatives is that there were fewer monks on the grounds with whitefish vessels more frequently targeting squid and some *Nephrops* vessels fishing central and southern North Sea grounds with lower abundances of monkfish. Port officials noted that there was a larger grade of monks being landed, as well as fewer small monks 'frogs' landed despite the low quota uptake. This is a stark change to the industry feedback of 2016–2017 where the high abundance of fish on the ground and the high-value sizeable individuals of the 2014 cohort were resulting in fishermen becoming more selective during on-board processing with suspected increased discarding and high-grading.

Landings in Division 3.a are not regulated: Table 4.5 shows the official landings which had fluctuated between 400–500 t from 2005–2015, between 2016 and 2018 they have increased significantly, on average 26% per year with the 2018 landings now at 914 t.

2.2 Data

Landings

National landings data as reported to ICES and Working Group estimates of total landings are given in Table 4.2. The working group procedures used to determine the total international landings numbers and weights-at-length are documented in the stock annex. It is acknowledged that throughout the landings time-series, there have consistently been differences between the total official landings and the landings as estimated by the WG. This is likely due to differences in the data provided to the WG by national scientists and administrators.

Due to restrictive TACs, the likelihood of misreporting and underreporting of anglerfish landings in the past is considered to have been high, particularly during the period 2003–2005. During the benchmark at WKROUND (ICES, 2013), it was agreed that recent landings are likely to be more accurate from 2006 due to, i) less restrictive TACs, ii) the introduction of buyers and sellers legislation in the UK and Ireland and iii) the offshore gillnet fishery for anglerfish historically conducted by Spanish flagged vessels and thought to under-report landings, being much reduced. Anecdotal reports from fisheries offices and catch sampling staff suggest that towards the end of 2016 and into 2017 the high abundance of anglerfish on the grounds, and the restrictive quota were leading to an increase in suspected misreporting, discarding and black landings. There was no new information in 2019 to suggest that these suspected practices continued into 2018, and the substantially lower quota uptake of 2018 may indicate that the incentives for this behaviour are no longer prevalent. During the period 2005–2010, landings data were not provided to the Working Group by some of the major nations exploiting the fishery; however, the recent data call for the WKANGLER benchmark (2018) has meant that WG estimates of Subareas 6 and 4 and Division 3.a landings have now been calculated for this period.

Discards

Prior to the recent WKANGLER benchmark (2018) discard estimates have only been available within InterCatch since 2012. Following the WKANGLER data call discard information is now available for some fleets since 2002; however, discard information from UK (Scotland) is not available before 2007. The discard estimates that are available from other nations for the 2002–2006 period are substantially higher than the later UK (Scottish) rates. Given that these fleets represent proportionally less of the landings the discards pre-2007 are considered to be non-representative of the overall fishery (WKANGLER 2018). The breakdown of landings and discards by main gear group and area for 2018 is given in Table 4.6. Discard data indicate that discarding in this fishery is relatively low due to high market value and no MLS. Overall discarding was 1.5% of total catch in 2018, a reduction on the 2017 rate of 3.4%. Demersal TR2 trawlers had the highest discard rate due to more restrictive quota share, 9.9% in 2018 down from 20.9% in 2017 and 43.9 in 2016. In comparison TR1 trawlers, gillnets and miscellaneous gear types had much lower rates of 1.0%, 1.7% and 1.5% respectively. Discards in Subarea 4 (113 t) were lower than in Subarea 6 (170 t), by weight and proportion (0.8% and 2.6%).

Figures 4.3 (a–c) show the percentage of landed weight by fleet, country and area. Length–frequency samples for catch in 2018 were submitted by Belgium, Denmark, France, Germany, Ireland, Norway, UK (England & Wales) and the UK (Scotland). There was good coverage of both the demersal TR1 and TR2 fleets in Subarea 4 and Division 6.a. However once again there were poor levels of sampling for the TR1 fleet in Division 27.6.b with only five samples for landings (Ireland: 307 fish) and 14 for discards (UK (Scotland): four samples, 167 fish and Ireland: 12 samples, 316 fish). Denmark and Norway provided samples for gillnet fleets in Subarea 4 and Division 3.a. There were no samples from UK-flag gillnet vessels which alone accounted for approximately 8% of all landings.

Discard data were used in the provision of catch advice until 2018 in line with the DLS approach (ICES, 2012). From 1 January 2019, all caught anglerfish must be retained under the discard ban of the EU landing obligation regulation.

Biological

An anglerfish ageing exchange was held in 2011 to investigate the possibility of the collation of an international landings-at-age dataset of hard structure age readings, however little agreement was found between methods or readers. This was acknowledged in the findings of the WKROUND report on current assessment and issues with data and assessment of this stock (ICES, 2013). Further to this, discussions at WKANGLER established that few countries are actively reading anglerfish hard structures, although they continue to be collected, processed and stored. It is unlikely that any developments in regards to an agreed reading criterion will be made in the near future.

Research vessel surveys

The 2019 SIAMISS-Q2 survey is described in detail in the Stock Annex and the most recent results of the 2019 SIAMISS-Q2 can be found in WDXX of the 2019 WGCSE report. This is a targeted anglerfish survey using commercial gear, covering subareas 4 and 6. The abundance and biomass estimates from the surveys are presented in Tables 4.7 and 4.8. The total biomass estimates for the Northern Shelf in 2018 and 2019 were 77 661 and 58 575 t respectively.

Total numbers of anglerfish increased in the years 2011–2015; however, from 2016 onwards there has been a fluctuating but declining trend with survey division estimates becoming more divergent (Table 4.8 and Figure 4.6). The most recent year (2019) has seen an increase in numbers driven by increases in both Subarea 4 and Division 6.a. Total biomass of anglerfish increased from 2011–2017 after which there has been two years of decline. In 2019, all surveyed divisions saw a decrease in biomass. The substantial increase in numbers (2014–2015) and biomass (2014–2017) was due to a large number of small fish having entered the stock in 2013 (Figure 4.6). The scale of this year class has not previously been seen in the SIAMISS-Q2 survey (for years for which length data are currently available 2007–2018) (Figure 4.8). Whilst this year class was clearly identifiable in 2014 and 2015, in the total survey abundance-at-length (Figure 4.8) 2016 was the first year in which the year class's contribution to total biomass-at-length is clearly observed (Figure 5.2.9). This cohort mode is less apparent in the 2019 weight-at-length (Figure 5.2.9) with the peak of the distribution now more plateaued between 65–85 cm.

After a period of low surveyed abundance in both Subarea 4 and Division 6.a for the years 2009–2012, there has been a significant increasing trend in the years following, however 2016 saw the first decline in abundance in five years. Whilst the abundance and biomass of anglerfish in Subarea 4 and Division 6.a have tracked each other relatively well over the time-series, in 2015–2016 the areas have shown divergent trends with a decline in 6.a and 4 continuing to increase. Both numbers and biomass estimates for Subarea 4 have fallen from 2018, two years after the same trend was observed in Division 6.a suggesting a possible time lag of decline. Although numbers of fish in Division 6.b have remained relatively stable since 2012 when all three surveyed areas had similar abundance estimates, the biomass in Division 6.b has increased steadily with the exception of a decline in 2017. The 2018 estimate of biomass in Division 6.b was more than double the time-series average of 11 208 kt; however the much lower estimate in 2019 is now more in line with the previous trajectory of increase.

Estimates of the ratio of survey biomass between subareas 4 and 6 have fluctuated around 1:1, (time-series average of 47% in Subarea 4, Table 4.7). The proportion of biomass in Subarea 4 had been steadily increasing since 2013; however, 2017 saw a slight decrease followed by a marked decline in 2018 to a time-series low of 37% (Figure 4.10). 2019 has seen an increase in the proportion of biomass in Subarea 4 moving back towards a 1:1 split.

Additional survey indexes were developed during the WKANGLER 2018 benchmark after revisiting the anglerfish abundance of several surveys within the stock area (ICES, 2018). Mean weight per hour for both the SCW-IBTS Q1 and Q4 surveys has declined in 2018 following recent time-series highs in 2017 and 2016 respectively (Figure 4.13) which reflects the SIAMISS-Q2 biomass trend (Figure 4.6). The ROCKALL index (Figure 4.13) shows an increasing trend since 2005 with a significant peak in 2012 followed by a short period of decline before a continuation of the increasing trajectory from 2016 to present. This increase in biomass is attributable to large fish >60 cm. Although the SIAMISS-Q2 biomass time-series for Division 6.b shows less year to year fluctuation than the Rockall index, the increasing trend and magnitude of change for the 2005–2018 period are very similar. In Subarea 4, the NS-IBTS-Q1 and Q3 indexes show declining mean weights per hour for the recent 3–4 years across all length groupings (Figure 4.14). This contradicts the SIAMISS-Q2 biomass series, which continued to increase until 2017 before a marked decline in 2018.

Commercial catch–effort data

Trends in nominal international fishing effort in the North Sea and Eastern Channel and the West of Scotland collated by STECF for the Evaluation of Fishing Effort Regimes in European Waters are shown in Figure 4.2. Since 2014, there have been slight increases in TR effort in both the North Sea and West of Scotland, with effort across all gears in the North Sea stable or reducing since

2012 and in the West of Scotland increasing in the past two years driven by marked increases in trawl fisheries. Data for 2017 has not yet been released by STECF although a significant change in the overall observed trend of anglerfish fleets is not anticipated with the introduction of 2017 data.

There is now a time-series of commercial catch-at-length data for 2002–2018 (Figure 4.4). The spread of lengths in the landings distributions are wider during the period 2012–2014 after which the distributions are steeper with singular peaks. In 2015, the strong 2013 cohort entered the fishery producing a markedly different catch composition of lengths with the bulk of landings being between 30 and 50 cm in length with steep tails either side. Discard rates are lower from 2015 onwards however, the landings of <30 cm fish were also lower, suggesting this reduction could be a combination of catch composition and the increase in quota availability. The distribution of lengths in the landings in 2018 has a wider spread to its peak than in recent years likely due to contribution of the 2014 cohort, which are now larger individuals.

2.3 Historical stock development

There has been no analytic assessment of Northern Shelf anglerfish since 2003, due to a combination of unreliable commercial data, landings misreporting, uncertain effort data and poor catchability of anglerfish in traditional research surveys. The Scottish Irish anglerfish and megrim industry science survey (SIAMISS-Q2) initiated by Marine Scotland Science in 2005, along with official logbook data and tally-book data schemes have addressed some of these issues, providing valuable information to fishery managers as well as minimum absolute abundance and biomass estimates annually. Since 2012 assessment has followed the ICES RGLIFE data-limited stock (DLS) 3.2.0 method of survey based indicative trends (ICES, 2012).

2.4 Short-term projections

In the absence of an age-based assessment, there are no short-term projections for this stock.

2.5 Biological reference points

Precautionary approach reference points.

	Type	Value	Technical basis
Precautionary approach	B_{lim}	Not defined	There is currently no biological basis for defining B_{lim}
	B_{pa}	Not defined	
	F_{lim}	Not defined	There is currently no biological basis for defining F_{lim}
	F_{pa}	0.30	$F_{35\%SPR}$ = 0.30. This fishing mortality corresponds to 35% of the unfished SSB/R. It is considered to be an approximation of F_{MSY}.
Targets	F_y	Not defined	

(unchanged since 1998).

Yield-per-recruit analysis and harvest rates

One suggested method for future assessment is a *Nephrops*-like harvest-ratio approach, which creates a catch-options table based on a range of harvest ratios. However to date no MSY reference points have been determined for Northern shelf anglerfish despite further exploration (Holah, H., 2017). Limited data, dome-shaped selectivity and uncertain life-history parameters continue to be inhibiting factors. Previous attempts to determine suitable harvesting rates, based on a yield-per-recruit analysis, estimated F_{MAX} to be 0.19 (ICES, 2004). The southern stock has recently been benchmarked and an F_{MAX} of 0.28 was adopted (ICES, 2012b). This needs to be revisited for this stock. In the case of *Nephrops* the technical basis for MSY $B_{trigger}$ is the bias-adjusted lowest observed UWTV survey estimate of abundance, however for anglerfish, whilst abundances from SIAMISS-Q2 were initially intended to be an absolute measure of abundance they are now considered to be only a relative index so this may not be appropriate.

Figure 4.11 shows mean standardised harvest rate by both weight and number of individuals, whilst there are no reference levels to relate these harvest rates to, trends can still be interpreted. In 2018, both the harvest rate of biomass and harvest rate as number of individuals have increased. The marked fall in harvest rate by number from 2013–2014 is likely due to the influx of the substantial 2013 year class and not a change in fishing behaviour. As a result of the 2013 year classes now reaching exploitable length, the harvest rate in 2016 has increased. It may be more appropriate to use a harvest rate which is measured over a given length range of commercially exploitable fish.

2.6 Management plans

There is no management plan for this stock.

2.7 Uncertainties and bias in assessment and forecast

The WGCSE has previously attempted assessments of the anglerfish stock(s) within its remit using a number of different approaches. As yet none have proved entirely satisfactory. The catch-at-length analysis used in previous years appears to have addressed a number of the suspected problems with the data due to the rapid development of the fishery, and has also provided a satisfactory fit to the catch-at-length distribution data. However, since 2003, the WG has been unable to present an analytic assessment due to the lack of reliable fishery and insufficient survey information, and in addition, it is not known to what extent the dynamic pool assumptions of the traditional assessment model are valid for anglerfish. A catch-at-age model was presented to two benchmark working groups (WKFLAT 2012 and WKROUND 2013) but was not accepted due to concerns over age reading. The SPiCT and ASPIC surplus production models were explored at the WKANGLER benchmark (2018) and whilst the models converged, the models were unstable and the uncertainty was large. This is most likely due to the lack of contrast in the catch data.

Commercial data

For a number of years the WG has expressed concerns over the quality of the commercial catch-at-length data because of:

- Accuracy of landings statistics due to species and area misreporting (historically an issue between 1998–2005 and anecdotally again in 2016).

- Lack of information on total catch and catch composition of gillnetters operating on the continental slope to the northwest of the British Isles (See the stock annex for further details of this fishery).

Survey data

There are still several factors which make the survey estimates likely to be underestimates or minimum estimates. Firstly, although experiments have been carried out to estimate escapes from under the footrope, and a model applied to account for this component of catchability, the estimates of smaller anglerfish still look to be underestimated (Figure 4.7). This could be due to either a net selectivity issue, or an availability [to the trawl] issue, as it is known that younger fish occur in shallower water (Hislop *et al*., 2001), or both. Secondly, the area considered is not complete, as the survey does not cover some of Division 4.a and none of 4.b or 4.c. However, numbers are thought to be low in these areas. A comparison of mean length in the commercial catch (Figure 4.12) and in the SIAMISS-Q2 and NS-IBTS surveys suggests that the selectivity of the commercial fleet and the angler SIAMISS-Q2 survey gear are similar (before the survey estimation procedure of corrections is applied).

Biological information

Knowledge of the biology of anglerfish has improved, with some basic biological parameters suitable for use in future assessments, such as mean weight-at-length in the stock, now available from the industry–science survey data. Difficulties still remain in finding mature females. A further discussion of the biology can be found in the stock annex.

Life-history parameters of the anglerfish species *Lophius piscatorius* and *Lophius Budegassa* in the Northeast Atlantic were reviewed at the WKANGLER benchmark (2018) with appropriate ranges of natural mortality (M) discussed and new approaches to estimating age from mixture modelling of length distributions presented (see WKANGLER 2018 report for further details).

Stock structure

Currently, anglerfish on the Northern Shelf are split into Subarea 6 (including 5.b (EC), 7 and 14) and the North Sea (and 2.a (EC)) for management purposes. However, genetic studies have found no evidence of separate stocks over these two regions (including Rockall) and particle-tracking studies have indicated interchange of larvae between the two areas (Hislop *et al*., 2001). So at previous WGs, assessments have been made for the whole Northern Shelf area combined. In fact, both microsatellite DNA analysis (O'Sullivan *et al*., 2005) and particle tracking studies carried out as part of EC 98/096 (Anon, 2001) also suggested that anglerfish from further south (Subarea 7) could also be part of the same stock.

At present, the stock is assessed for the two anglerfish species *L. piscatorius* and *L. budegassa* combined, despite differing life-history characteristics and overlap in spatial distribution. This has been the case due to the black anglerfish (*L. Budegassa*) proportionally representing only around 10% of the estimated stock biomass from the SIAMISS-Q2 survey and that the Scottish fleet land the two species for sale combined as "monkfish". Given that the proportion of black anglerfish has been as high as 28% in Division 6.a and that the Scottish market sampling programme records to species level, a splitting out of black anglerfish in this stock may be a consideration for a future benchmark.

2.8 Recommendations for next Benchmark

This stock was last benchmarked in February 2018 at WKANGLER. The recommendations to be carried forward following WKANGLER are the following tasks:

- Investigate length-based stock assessment using, for example, the SS3 approach applied to southern anglerfish stocks.
- Investigate growth models appropriate for anglerfish subareas 4 and 6.
- Investigate an age-aggregated production/depletion model.
- Determine the best way to incorporate *Lophius budegassa* into assessment and advice.

The WKANGLER data call led to the compilation of commercial sampling data (length, age, weight) previously held internationally, to construct a historical catch-at-length dataset for 2002 to present. At this stage, the focus is currently to utilise this more complete dataset to develop a suitable assessment model for this stock.

2.9 Management considerations

Up to and including 2011, ICES provided qualitative advice regarding the future exploitation of 'data-limited' stocks where there was either limited knowledge of their biology or a lack of data on their exploitation. However, in response to a strong interest from advice recipients to base advice on the information available, ICES developed the data-limited stocks (DLS) approach framework, for which anglerfish is a category 3 data-limited stock. This requires considering the application of an uncertainty cap and/or precautionary buffer to a survey adjusted *status quo* catch at each annual advice draft.

A comparison of mean biomass estimates from the SIAMISS-Q2 surveys (Table 4.9) shows that the mean biomass in subareas 4 and 6 combined has increased by 25.0% from 2014–2016 to 2017–2018. Application of the uncertainty cap implied advice for catches in 2019 to be no more than 20% greater than the previously advised catch. The stability observed in international effort time-series by the main fisheries in the stock area since 2003 meant that a precautionary buffer should not be applied.

The TACs in subareas 4 (including Norwegian waters) and 6 until 2010 were split 67:33%, since 2011 they have been split 64:36%. In 2018, 10% of the TAC for 4 and 2.a could be taken from Division 5.b, or subareas 6, 7 and 9. Over the survey time-series, the stock has been fairly evenly distributed between 4:6, the split has fluctuated around 50:50 (47% on average) (Table 4.7 and Figure 4.10) however in 2018 there was a significant decrease to 38% increasing to 40% in 2019. Note that the North Sea is only partially surveyed: however, the area covered does encompass most of the distribution of anglerfish.

Ideally, the management of the fishery should be based on a specific plan, or harvest control rule, after an evaluation of various stakeholder-led suggestions of alternative options. This still needs to be pursued in consultation with stakeholders such as the North Western Waters Advisory Council.

2.10 References

Anon. 2001. The distribution and biology of anglerfish and megrim in waters to the west of Scotland. EC Study Contract 98/096 Final Report August 2001.

Clarke, E., Buch, T., Gillsepie-Mules, R., Drewery, J., Kelly, E and Gerritsen, H. 2018. WD for WGCSE October 2018: SIAMISS Estimates of Anglerfish Biomass in subareas 4 and 6 for 2018. Working document to the *Celtic Seas Ecosystem Working Group, ICES* 2017, 14 pp.

COUNCIL REGULATION (EU). 2018. No 2018/120 of 23 January 2018 fixing for 2018 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union vessels, in certain non-Union waters, amending Regulation (EU) No 43/2014 and repealing Regulation (EU) No 2017/127.

COUNCIL REGULATION (EU). 2019. No 124/2019 of 30 January 2019 fixing for 2019 the fishing opportunities available to EU vessels for certain fish stocks and groups of fish stocks which are not subject to international negotiations or agreements.

Hislop, J. R. G., Gallego, A., Heath, M. R., Kennedy, F. M., Reeves, S. A., and Wright, P. J. 2001. A synthesis of the early life history of the anglerfish, *Lophius piscatorius* (Linnaeus, 1758) in Northern British waters. ICES Journal of Marine Science 58:70–86.

Historical Nominal Catches 1950–2010. Version 30-11-2011. Accessed 13-05-2019 via http://ices.dk/marine-data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx. ICES, Copenhagen.

Holah, H. 2017. Length based indicators and SPiCT in relation to reference points for Anglerfish in subareas 4 and 6, and in Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat) (anf.27.3a46). Working document. *Celtic Seas Ecosystem Working Group, ICES* 2017.

ICES. 2004. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks. *ICES CM 2004/**ACFM:0**1*. 558 pp.

ICES. 2012. Report of the ICES Advisory Committee on ICES implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM:68. 42 pp.

ICES. 2012b. Report of the Benchmark Workshop on Flatfish Species and Anglerfish (WKFLAT), 1–8 March 2012, Bilbao, Spain. ICES CM 2012/ACOM:46. 283 pp.

ICES. 2013. Report of the Benchmark Workshop on Roundfish Stocks (WKROUND), 4–8 February, Aberdeen. ICES CM 2013 / ACOM:47 213 pp.

ICES. 2016. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

ICES. 2018. Report of the Benchmark Workshop on Anglerfish Stocks in the ICES Area (WKANGLER), 12–16 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM:31. 177 pp.

Official Nominal Catches 2006–2014. Version 08-05-2019. Accessed 13-05-2019 via http://ices.dk/marine-data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx. ICES, Copenhagen.

O'Sullivan, M., Wright, P., Vespoor, E., Knox, D. and Piertny, S. 2005. Microsatellite DNA polymorphism indicates an absence of population structure in monkfish *Lophius piscatorius* in its northern distribution. *ICES CM2005/T:18 (poster).*

Scientific, Technical and Economic Committee for Fisheries (STECF). 2017 – Fisheries Dependent - Information – Classic (STECF-17-09). Publications Office of the European Union, Luxembourg 2017, ISBN 978-92-79-67481-5, doi:10.2760/561459, JRC107598.

Table 4.1. ICES advice and actual management applicable for Northern Shelf anglerfish for 2003 onwards.

YEAR	SINGLE STOCK EXPLOITATION BOUNDARY	BASIS	WEST OF SCOTLAND (6.a–6.b)			NORTH SEA (4.a–4.c)		
			TAC[4)]	% change in F associated with TAC	WGCSE landings	TAC[5)]	% change in F associated with TAC	WGCSE landings
2003	<6700[1)]	Reduce F	3180	49% reduction	3068	7000	49% reduction	8714
2004	<8800[2)]	Reduce F	3180	48% reduction	3130	7000	48% reduction	8532
2005	-	No effort	4686	-	3747	10 314	-	9696
2006	-	No effort	4686	-	3491	10 314	-	9564
2007	-	No effort	5155	-	4476	11 345	-	9823
2008	-	No effort	5155	-	4847	11 345	-	10 732
2009	-	No effort	5567	-	5192	11 345	-	9781
2010	-	No effort	5567	-	3912	11 345	-	7900
2011	-	Decrease	5456	-	4693	9643	-	7920
2012	-	Reduce	5183	-	4372	9161	-	6412
2013	-	20% reduc-	4924	-	4727	8703	-	6306
2014	-	20% reduc-	4432	-	5880	7833[6)]	-	8165
2015	-	20% in-	5313	-	5008[(7)]	9390[6)]	-	10 243
2016	-	20% in-	6375	-	5966	11267	-	12 854
2017	-	20% in-	7650	-	6460	13521	-	14 508
2018	-	20% in-	9180	-	6356	16225	-	14 280
2019	-	20% in-	11453	-	-	20237	-	

All values raised to nearest tonne.

[1)] Advice for Division 3.a, Subarea 4 and Subarea 6.a combined.

[2)] Advice for Division 3.a, Subarea 4 and Subarea 6 combined.

[3)] Advice for Division 2.a, Division 3.a, Subarea 4 and Subarea 6 combined.

[4)] TAC applies to 5.b(EC), 6, 7 and 14.

[5)] TAC applies to 2.a & 4 (EC).

[6)] of which up to 10% may be fished in: 5.b(EC), 6, 7 and 14.

[(7)]Landings including raised discards.

Although there is no minimum landing size for this species, there is an EU minimum weight of 500 g for marketing purposes (EC Regulation 2406/96).

An additional quota of 1500 t was also available for EU vessels fishing in the Norwegian zone of Subarea 4 in 2011–2018 which was increased to 1700 t in 2018.

Table 4.2. Anglerfish on the Northern Shelf (3.a, 4 & 6). Total official landings by area (tonnes).

	3.a	4.a	4.b	4.c	6.a	6.b	4	6	Total (3.A, 4,6)	WG Landings	WG Discards
1973	140	2085	575	41	9221	127	2701	9348	12189	-	-
1974	202	2737	1171	39	3217	435	3947	3652	7801	-	-
1975	291	2887	1864	59	3122	76	4810	3198	8299	-	-
1976	641	3624	1252	49	3383	72	4925	3455	9021	-	-
1977	643	3264	1278	54	3457	78	4596	3535	8774	-	-
1978	509	3111	1260	72	3117	103	4443	3220	8172	-	-
1979	687	2972	1578	112	2745	29	4662	2774	8123	-	-
1980	652	3450	1374	175	2634	200	4999	2834	8485	-	-
1981	549	2472	752	132	1387	331	3356	1718	5623	-	-
1982	529	2214	654	99	3154	454	2967	3608	7104	-	-
1983	506	2465	1540	181	3417	433	4186	3850	8542	-	-
1984	568	3874	1803	188	3935	707	5865	4642	11075	-	-
1985	578	4569	1798	77	4043	1013	6444	5056	12078	-	-
1986	524	5594	1762	47	3090	1326	7403	4416	12343	-	-
1987	589	7705	1768	66	3955	1294	9539	5249	15377	-	-
1988	347	7737	2061	95	6003	1730	9893	7733	17973	-	-
1989	334	7868	2121	86	5729	313	10075	6042	16451	-	-
1990	570	8387	2177	34	5615	822	10598	6437	17605	-	-
1991	595	9235	2522	26	5061	923	11790	5984	18369	17441	-
1992	938	10209	3053	39	5479	1089	13301	6568	20807	21872	-
1993	843	12309	3143	66	5553	681	15519	6234	22596	23971	-
1994	811	14505	3445	210	5273	909	18162	6182	25155	25057	-
1995	823	17891	2627	402	6354	958	20920	7312	29055	28913	-
1996	702	25176	1847	304	6408	602	27327	7010	35039	35100	-
1997	776	23425	2172	160	5330	990	25757	6320	32853	32728	-
1998	626	16859	2088	78	4506	1313	19026	5819	25471	25293	-
1999	660	13344	1517	24	4284	1401	14885	5685	21230	21854	-
2000	602	12338	1617	31	3311	1074	13986	4385	18973	19682	-

	3.a	4.a	4.b	4.c	6.a	6.b	4	6	Total (3.A, 4,6)	WG Landings	WG Discards
2001	621	12861	1832	21	2660	1309	14714	3969	19304	19157	-
2002	667	11048	1244	21	2280	718	12313	2998	15978	15067	-
2003	478	8523	847	20	2493	643	9390	3136	13004	12008	-
2004	519	8987	851	15	2453	671	9853	3124	13496	11976	-
2005	458	8424	688	5	3019	958	9117	3982	13557	13728	-
2006	426	10340	683	3	2785	915	11026	3700	15152	13292	-
2007	433	10632	749	4	3353	1261	11384	4613	16430	14564	490
2008	486	11038	769	5	3373	1246	11813	4619	16918	15878	903
2009	478	10067	651	8	2984	1820	10726	4804	16008	15372	38
2010	433	8190	615	11	3040	1606	8815	4645	13833	12136	69
2011	405	7760	764	8	2871	1871	8532	4742	13679	12902	95
2012	423	6459	714	4	2835	1831	7177	4666	12266	11143	590
2013	407	6393	546	5	2667	2123	6944	4790	12141	11375	687
2014	440	7633	820	27	2610	1754	8481	4365	13286	14406	448
2015	458	9690	985	16	3290	1723	10691	5013	16162	15663	395
2016	586	11680	1196	11	4638	1423	12887	6080	19553	19412	981
2017	742	13620	1107	7	5024	1504	14753	6528	22023	21719	756
2018*	914	13391	823	11	4292	1918	14225	6210	21350	21572	326

*Preliminary.

Table 4.3. Anglerfish in Subarea 6. Nominal landings (t) as officially reported to ICES.

Division 6.a (West of Scotland)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
Belgium	3	2	9	6	5	-	5	2	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	1	3	4	5	10	4	1	2	1	+	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Faroe Is.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	3	2	1	2	4	1	-	-	-	+	1	-	-
France	1910	2308	2467	2382	2648	2899	2058	1634	1814	1132	943	739	1212	1191	1396	1314	1764	1746	1513	1206	1168	1166	1114	1098	1107	1734	1882	1287
Germany	1	2	60	67	77	35	72	137	50	39	11	3	27	39	39	1	-	54	79	79	59	63	48	85	63	81	79	127
Ireland	250	403	428	303	720	717	625	749	617	515	475	304	322	219	356	392	470	295	328	510	488	346	336	410	446	581	579	596
Nether-	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	6	14	8	6	4	4	1	3	1	3	2	1	+	+	1	1	1	2	+	2	1	+	1	1	1	1	1	2
Spain	7	11	8	1	37	33	63	86	53	82	70	101	196	110	83	76	3	174	185	197	138	69	123	54	130	178	173	218
UK(E,W&NI)	270	351	223	370	320	201	156	119	60	44	40	32	31	30	20	24	42	5	12	3	-	12	6	-	-	-	-	-
UK(Scot.)	2613	2385	2346	2133	2533	2515	2322	1773	1688	1496	1119	1100	705	862	1127	974	1071	1096	864	1040	-	1179	1038	-	-	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1016	1191	1044	962	1643	2062	2311	2061
Total	5061	5479	5553	5273	6354	6408	5330	4506	4284	3311	2660	2280	2493	2453	3024	2785	3353	3373	2984	3040	2871	2835	2667	2610	3290	4638	5024	4292
Unallocated	296	2638	3816	2766	5112	11148	7506	5234	3799	3114	2068	-187	-2	-16	8	74	-145	-332	-190	-56	-62	-91	-115	-	-68	58	-12	-119
As used by	5357	8117	9369	8039	11466	17556	12836	9740	8083	6425	4728	2467	2495	2469	3016	2711	3498	3705	3174	3096	2933	2926	2782	4205	3358	4580	5036	4411

*Preliminary.

Table 4.3. Continued. Anglerfish in Subarea 6. Nominal landings (t) as officially reported to ICES.

Division 6.b (Rockall)/ *Preliminary.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
Faroe Is.	-	2	-	-	-	15	4	2	2	-	1	-	-	-	-	-	-	1	4	8	-	5	-	1	+	+	+	-
France	-	-	29	-	-	-	1	1	-	48	192	43	191	175	293	224	327	327	339	168	508	456	663	148	219	-	-	-
Germany	-	-	103	73	83	78	177	132	144	119	67	35	64	66	77	72	222	93	132	87	90	79	88	66	139	177	167	266
Ireland	272	417	96	135	133	90	139	130	75	81	134	51	26	13	35	53	70	76	91	107	108	235	237	162	156	160	214	282
Norway	18	10	17	24	14	11	4	6	5	11	5	3	6	5	4	6	7	5	9	12	7	5	9	3	6	11	4	1
Portugal	-	-	-	132	128	-	91	413	429	20	18	8	4	19	63	-	-	-	-	-	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	2	4	1	1	35	-	-	-	-	-	1	2	-	2	-
Spain	333	263	178	214	296	196	171	252	291	149	327	128	59	43	34	36	12	85	57	32	29	36	-	27	119	56	118	43
UK(E,W&NI)	99	173	76	50	105	144	247	188	111	272	197	133	133	54	93	46	-	1	48	15	-	120	395	-	-	-	-	-
UK(Scot)	201	224	182	281	199	68	156	189	344	374	367	317	160	294	355	477	-	624	1141	1177	-	895	732	-	-	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	622	-	-	-	1129	1015	1127	1347	1081	1018	999	1326
Total	923	1089	681	909	958	602	990	1313	1401	1074	1309	718	643	671	958	915	1261	1246	1820	1606	1871	1831	2123	1754	1723	1423	1504	1918
Unallocated	-	-	-	-132	-128	-	-91	-413	-9	17	-178	210	70	10	227	136	282	104	-198	791	111	385	178	80	74	37	80	-26
As used by WG	923	1089	681	777	830	602	899	900	1392	1091	1131	508	573	661	731	779	979	1142	2018	815	1760	1446	1945	1674	1649	1386	1424	1944

Table 4.3. Continued. Anglerfish in Subarea 6. Nominal landings (t) as officially reported to ICES.

Subarea 6 (West of Scotland and Rockall). ^ indicates landings assigned to subarea 6 but not to a division. /*Preliminary.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Belgium	3	2	9	6	5	-	5	2	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	--	-
Denmark	1	3	4	5	10	4	1	2	1	+	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Faroe Is.	-	2	-	-	-	15	4	2	2	-	1	-	-	2	2	3	2	2	6	12	1	5	-	1	+	1	+	-
France	1910	2308	2496	2382	2648	2899	2059	1635	1814	1180	1135	782	1403	1366	1689^	1537	2090	2073	1852	1374	1676	1622	1777	1246	1326	1734	1882	1287
Germany	1	2	163	140	160	113	249	269	194	158	78	38	91	105	116	73	222	146	211	166	149	142	136	151	201	258	246	394
Ireland	522	820	524	438	853	807	764	879	692	596	609	355	348	232	391	445	540	371	419	617	596	581	572	572	602	741	793	878
Nether-lands	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	24	24	25	30	18	15	5	9	6	14	7	4	6	5	5	7	8	7	9	14	7	6	10	4	8	12	5	4
Portugal	-	-	-	132	128	-	91	413	429	20	18	8	4	19	63	-	-	-	-	-	-	-	-	-	-	-		-
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	2	4	1	1	35	-	-	-	-	-	1	2	-	2	-
Spain	340	274	186	215	333	229	234	338	344	231	397	229	255	153	117^	112	15	259	242	229	167	105	123	81	149	234	290	261
UK(E,W&NI)	369	524	299	420	425	345	403	307	171	316	237	165	164	84	113	70	188	6	60	-	-	132	401	-	-	-	-	-
UK(Scot)	2814	2609	2528	2414	2732	2583	2478	1962	2032	1870	1486	1417	865	1156	1482	1451	1546	1720	2005	-	-	2073	1770	-	-	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2234	2145	2205	2171	2310	2724	3080	3310	3387
Total	5984	6568	6234	6182	7312	7010	6320	5819	5685	4385	3969	2998	3136	3124	3982	3700	4613	4619	4804	4645	4742	4666	4790	4365	5013	6060	6528	6211
Unallocated	296	2638	3816	2634	4984	11148	7415	4821	3790	3131	1890	22	68	6	235	209	137	228	388	733	49	294	63	1515	5	94	68	-145
As used by WG	6280	9206	10050	8816	12296	18158	13735	10640	9475	7516	5859	2976	3068	3130	3747	3491	4476	4847	5192	3912	4693	4372	4727	5880	5008	5966	6460	6356

Table 4.4. Nominal landings (t) of Anglerfish in the North Sea, as officially reported to ICES.

Northern North Sea (4.a). *Preliminary.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
Belgium	2	9	3	3	2	8	4	1	5	12	-	8	1	-	-	-	-	-	-	-	-	-	+	-	-	-	1	-
Denmark	1245	1265	946	1157	732	1239	1155	1024	1128	1087	1289	1308	1523	1538	1379	1311	961	1071	1134	1143	841	821	854	801	962	1506	2002	1790
Faroes	1	-	10	18	20	-	15	10	6	-	2	-	3	11	22	2	-	-	4	-	-	-	-	-	-	-	-	-
France	124	151	69	28	18	7	7	3	18	8	9	8	8	8	4	7	13	13	20	23	20	14	15	27	26	35	91	141
Germany	71	68	100	84	613	292	601	873	454	182	95	95	65	20	84	173	186	344	216	124	46	265	274	321	286	208	523	510
Netherlands	23	44	78	38	13	25	12	-	15	12	3	8	9	38	13	14	14	12	5	8	5	5	-	16	-	21	28	68
Norway	587	635	1224	1318	657	821	672	954	1219	1182	1212	928	769	999	880	1006	831	860	859	791	494	485	545	524	406	610	840	1230
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	
Sweden	14	7	7	7	2	1	2	8	8	78	44	56	8	6	5	5	20	67	-	-	-	-	-	-	6	4	8	12
UK(E, W&NI)	129	143	160	169	176	439	2174	668	781	218	183	98	104	83	34	99	303	13	320	371	-	248	550	-	-	-	-	-
UK (Scotland)	7039	7887	9712	11683	15658	22344	18783	13318	9710	9559	10024	8539	6033	6284	6003	7722	8304	8658	7509	5730	-	4622	4154	-	-	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6353	4870	4704	5943	8005	9296	10127	9638
Total	9235	10209	12309	14505	17891	25176	23425	16859	13344	12338	12861	11048	8523	8987	8424	10340	10632	11038	10067	8190	7760	6459	6393	7633	9690	11680	13620	13390

Table 4.4. Continued. Nominal landings (t) of Anglerfish in the North Sea, as officially reported to ICES.

Central North Sea (4.b). * Preliminary

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
Belgium	357	538	558	713	579	287	336	371	270	449	579	435	180	260	207	138	179	181	134	124	111	131	135	213	196	251	168	155
Denmark	345	421	346	350	295	225	334	432	368	260	251	255	191	274	237	276	173	237	248	194	286	301	192	334	369	584	565	411
Faroes	-	-	2	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	-	1	-	2	-	-	-	-	-	-	-	-	-	+	-	+	+	-	3	6	2	+-	+-	1	+	+	-	+
Germany	4	2	13	15	10	9	18	19	9	14	9	17	11	11	9	14	12	22	17	21	17	10	10	17	23	18	14	26
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	285	356	467	510	335	159	237	223	141	141	123	62	42	25	31	33	61	58	36	46	53	61	41	72	88	120	166	111
Norway	17	4	3	11	15	29	6	13	17	9	15	10	12	22	16	12	24	15	21	10	11	11	26	8	9	16	41	36
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Sweden	-	-	-	3	2	1	3	3	4	3	2	9	2	1	4	4	6	9	-	-	-	-	-	-	3	7	10	12
UK(E, W&NI)	669	998	1285	1277	919	662	664	603	364	423	475	236	167	120	96	108	-	105	85	88	-	85	70	-	-	-	-	-
UK (Scotland)	845	733	469	564	472	475	574	424	344	318	378	210	241	138	88	98	-	142	108	125	-	115	72	-	-	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	293	-	-	-	284	200	142	175	297	201	143	72
Total	2522	3053	3143	3445	2627	1847	2172	2088	1517	1617	1832	1244	847	851	688	683	749	769	651	615	764	714	546	820	985	1196	1107	823

Table 4.4. Continued. Nominal landings (t) of Anglerfish in the North Sea as officially reported to ICES.

Southern North Sea (4.c). * Preliminary.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
Belgium	13	12	34	37	26	28	17	17	11	15	15	16	9	5	4	3	3	4	6	7	6	2	2	4	5	2	1	1
Denmark	2	+	-	+	+	+	+	+	+	+	+	+	+	+		+	+	-	-	+	+	+	-	-	-	+	-	+
France	-	-	-	-	-	-	-	10	-	+	-	+	-	-	-	+	+	-	1	1	1	+	+	1	+	1	+	+
Germany	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	+	-	+	+	+	+	+	+
Netherlands	5	10	14	20	15	17	11	15	10	15	6	5	1	-	1	-	1	1	-	2	1	1	1	19	10	8	5	8
Norway	-	-	-	-	+	-	-	-	+	-		-	+	-	-	+	-	-	1	-	-	-	-	1	+	-	-	1
UK(E&W&NI)	6	17	18	136	361	256	131	36	3	1	-	-	10	3	-	+	-	+	1	1	-	-	1	-	-	-	-	-
UK (Scotland)	+	+	+	17	+	3	1	+	+	+	-	-	-	7	-	+	-	-	-	-	-	-	-	-	-	-	-	-
UK (Total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-+	-+	+	1	1	1	+	1	2	1	1	+	1
Total	26	39	66	210	402	304	160	78	24	31	21	21	20	15	5	3	4	5	8	11	8	4	5	27	16	11	7	11

Table 4.4. Continued. Nominal landings (t) of Anglerfish in the North Sea as officially reported to ICES.

Subarea 4 (North Sea).

***Preliminary./ ^ indicates landings assigned to Subarea 4 but not to a division.**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
Belgium	372	559	595	753	607	323	357	389	286	476	594	459	190	265	211	141	181	185	140	131	116	133	137	217	200	253	169	156
Denmark	1599^	1686	1293^	1509^	1027	1464	1489	1456	1496	1347	1540	1563	1714	1812	1616	1587	1134	1308	1382	1337	1127	1122	1046	1135	1331	2090	2567	2201
Faroes	1	-	12	18	20	-	15	10	6	-	2	10	3	11	22	2	-	-	4	-	-	-	-	-	-	-	-	-
France	124	152	69	30	18	7	7	13	18	8	9	8	8	8	4	7	14	13	23	30	24	15	15	30	26	36	91	142
Germany	**75**	**70**	**113**	**99**	**623**	**301**	**619**	**892**	**463**	**196**	**104**	**112**	**76**	**31**	**93**	**187**	**198**	**367**	**233**	**145**	**63**	**275**	**284**	**339**	**309**	**226**	**537**	**536**
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	313	410	559	568	363	201	260	238	166	168	132	75	52	63	45	47	76	71	41	56	59	67	42	108	98	148	199	187
Norway	604	639	1227	1329	672	850	678	967	1236	1191	1227	938	781	1021	896	1018	855	875	881	802	505	496	572	533	415	626	881	1267
Sweden	14	7	7	10	4	2	5	11	12	81	46	65	10	7	9	10	26	76	-	-	-	-	-	-	10	11	18	25
UK(E&W&NI)	804	1158	1463	1582	1456	1357	2969	1307	1148	642	658	334	281	206	130	207	425	118	406	460	-	333	621	-	-	-	-	-
UK (Scotland)	7884	8620	10181	12264	16130	22822	19358	13743	10054	9877	10402	8749	6274	6429	6091	7820	8476	8800	7617	5855	-	4736	4226	-	-	-	-	-
UK (Total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6638	5069	4847	6120	8303	9498	10270	9711
Total	11790	13301	15519	18162	20920	27327	25757	19026	14885	13986	14714	12313	9390	9853	9117	11026	11384	11813	10726	8815	8532	7177	6944	8481	10691	12887	14733	14225
Unallocated	-1224	-1573	-2441	-2732	-5126	11087	-7540	-4999	-3166	-2422	-2037	600	676	1330	-579	1462	1561	1081	945	915	612	765	638	316	448	33	225	-55
WG estimate	10566	11728	13078	15430	15794	16240	18217	14027	11719	11564	12677	11713	8714	8523	9696	9564	9823	10732	9781	7900	7920	6412	6306	8165	10243	12854	14508	14280

Table 4.5. Nominal landings (t) of Anglerfish in Division 3.a, as officially reported to ICES.

***Preliminary.**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
Belgium	15	48	34	21	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	493	658	565	459	312	367	550	415	362	377	375	369	215	311	274	227	255	287	344	270	251	307	298	309	336	389	526	597
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	1	-
Germany	-	-	1	+	-	1	1	1	2	1	-	1	-	1	1	2	1	1	1	1	2	1	1	-	1	2	1	2
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	3	4	4	3	1	3	-	5	-	-	-	4	9	17	16	16
Norway	64	170	154	263	440	309	186	177	260	197	200	242	189	130	100	139	132	144	134	158	153	115	108	127	90	124	118	204
Sweden	23	62	89	68	36	25	39	33	36	27	46	55	71	73	79	54	44	51	-	-	-	-	-	-	42	53	81	95
UK (Total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Total	595	938	843	811	823	702	776	626	660	602	621	667	478	519	458	426	433	486	478	433	405	423	407	440	478	586	742	914
Unallocated	-	-	-	-	-	-	-	-	-	-	-	288	252	197	174	189	168	187	79	109	116	63	65	78	66	-5	-9	-22
As used by WG	-	-	-	-	-	-	-	-	-	-	-	379	226	322	284	237	265	299	399	324	289	360	342	362	412	591	751	936

Table 4.6. Breakdown of WG estimates of commercial catches for 2017 and 2018 by main gear group and area.

2017	**3.a**		**4**		**6.a**		**6.b**		**Total**		**% of Total**	
Fleet	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**
Demersal trawl	86	0.56	11402	128	4271	179	779	64	16538	372	76	49
Nephrops trawl	506	11	279	118	76	99	0	0	861	228	4	30
Gillnets	100	1	2179	45	107	7	639	52	3025	105	14	14
Other/Not specified	59	0.48	648	12	582	37	5	0.43	1294	50	6	7
Total	751	13	14508	303	5036	322	1423	116	21718	754	100	100
2018												
Fleet	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**
Demersal trawl	78	2	10569	41	3501	69	982	35	15130	147	70	45
Nephrops trawl	566	28	142	40	84	19	0	0	792	87	4	27
Gillnets	198	9	2405	19	149	4	892	30	3644	62	17	19
Other/Not specified	94	4	1164	13	677	11	70	2	2005	30	9	9
Total	936	43	14280	113	4411	103	1944	67	21571	326	100	100

Table 4.7. Total biomass estimates with confidence intervals and relative standard errors from the 2005–2019 SIAMISS-Q2 surveys.

Year	Biomass (t)	Confidence Interval		RSE	Percentage Biomass in subarea 4
2005	38.617	23.479	53.755	20.0	48.27%
2006	40.985	34.478	47.492	8.1	53.49%
2007	50.392	43.676	57.108	6.8	56.62%
2008	53.546	42.421	64.671	10.6	55.51%
2009	38.060	32.987	43.133	6.8	44.82%
2010	42.279	30.429	54.129	14.3	51.90%
2011	33.254	24.846	41.662	12.9	44.96%
2012	36.325	29.704	42.946	9.3	41.59%
2013	38.395	31.020	45.770	9.8	37.04%
2014	52.884	42.769	62.999	5.2	40.25%
2015	67.915	58.782	77.047	6.9	43.66%
2016	77.946	66.831	89.060	7.275	56.39%
2017	87.896	74.222	101.569	7.937	53.47%
2018	77.661	66.258	89.064	7.491	37.80%
2019	58.575	46.189	70.962	10.789	40.49%

Table 4.8. Abundance and biomass estimates from the 2005–2019 SIAMISS-Q2 surveys by ICES subareas and divisions.

	Abundance (millions)														
ICES Subarea/Division	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Subarea 4 (partial)	11.168	12.844	15.304	12.613	8.279	7.366	5.15	5.432	8.470	17.553	18.266	21.666	23.691	11.819	14.606
Division 4.a	10.866	10.459	7.956	7.718	5.144	5.161	6.057	4.961	8.461	16.096	28.604	14.383	16.322	13.528	21.032
Division 4.b	1.8	3.174	4	3.952	3.688	3.131	3.669	5.135	4.885	6.488	5.496	4.538	4.36	6.240	3.592
Subarea 6	12.666	13.633	11.956	11.67	8.832	8.292	9.725	10.096	13.346	22.584	34.100	18.922	20.682	19.768	24.624
Northern Shelf (partial)	23.833	26.477	27.261	24.283	17.111	15.658	14.875	15.528	21.816	40.136	52.366	40.569	44.373	31.586	39.586
	Biomass (kilo tonnes)														
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Subarea 4 (partial)	18.642	21.921	28.534	29.721	17.058	21.944	14.949	15.106	14.369	21.284	29.653	43.956	46.994	29.353	23.353
Division 6.a	14.096	12.175	11.072	14.383	8.15	11.59	9.33	9.213	10.801	16.633	24.047	18.273	29.296	22.350	18.864
Division 6.b	5.879	6.889	10.786	9.442	12.852	8.745	8.974	12.005	13.626	14.967	14.215	15.717	11.604	25.958	15.992
Subarea 6	19.975	19.064	21.858	23.825	21.002	20.334	18.305	21.218	24.427	31.600	38.262	33.990	40.901	48.308	34.856
Northern Shelf (partial)	38.617	40.985	50.392	53.546	38.06	42.279	33.254	36.325	38.796	52.884	67.915	77.946	87.896	77.661	58.575

Table 4.9. Percentage change in mean stock biomass from 2015–2017 to 2018–2019 in ICES subareas 4 and 6 combined.

Average Biomass 2015–2017	Average Biomass 2018–2019	Percentage Change in Biomass
77.919	68.118	12.578%

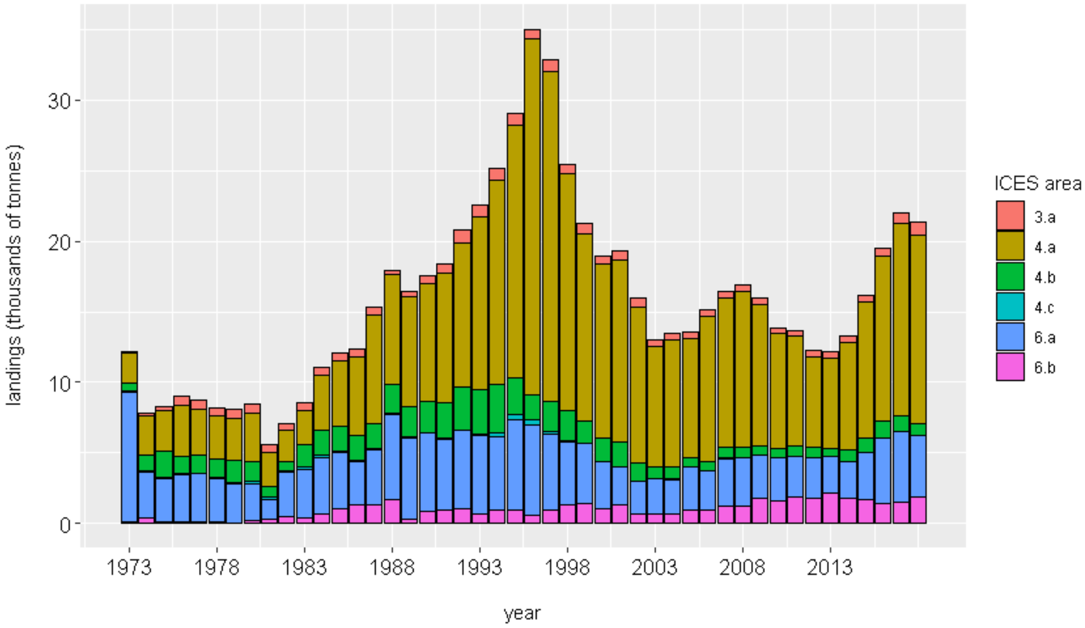
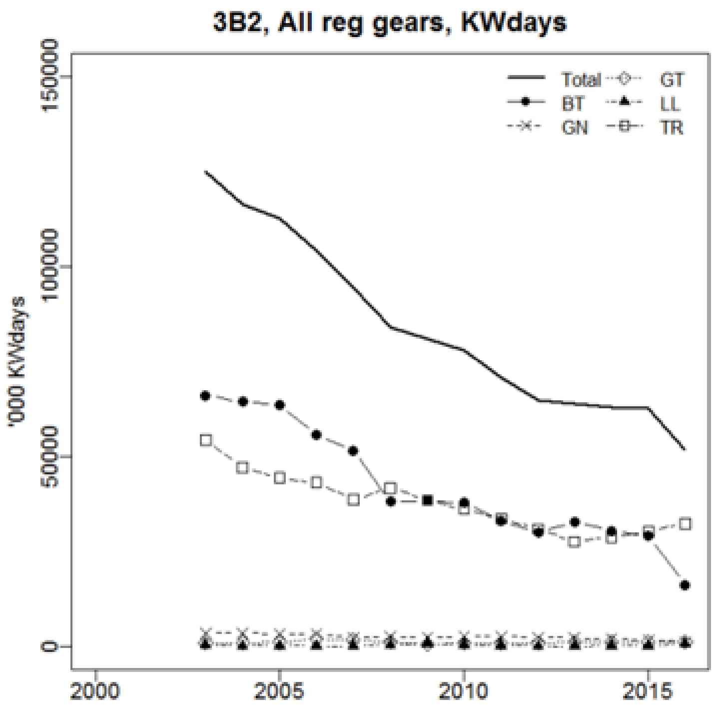


Figure 4.1. Northern Shelf anglerfish. Officially reported landings by ICES area (1973–2018).



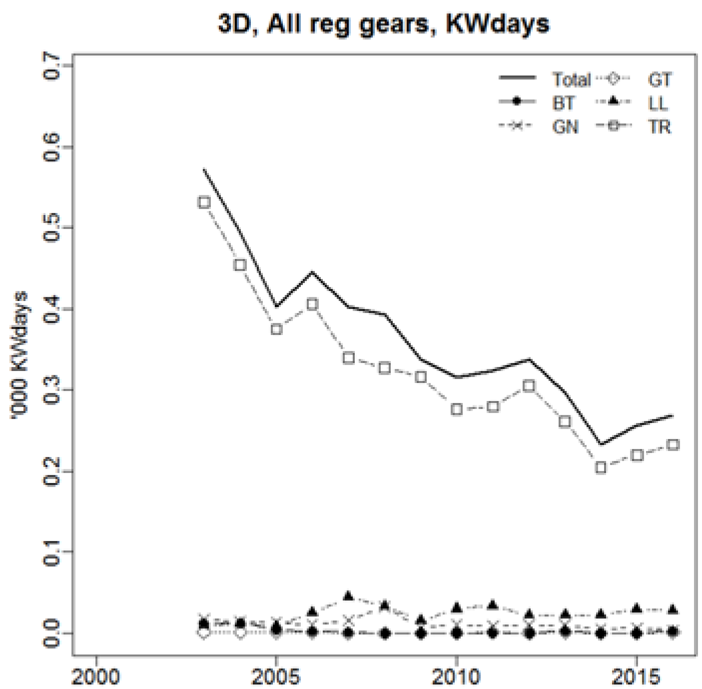


Figure 4.2. Trends in nominal international fishing effort (kW*days at sea) in North Sea and II (EU) (left) and West of Scotland (right) collated by STECF for the Evaluation of Fishing Effort Regimes in European Waters (STECF, 2017).

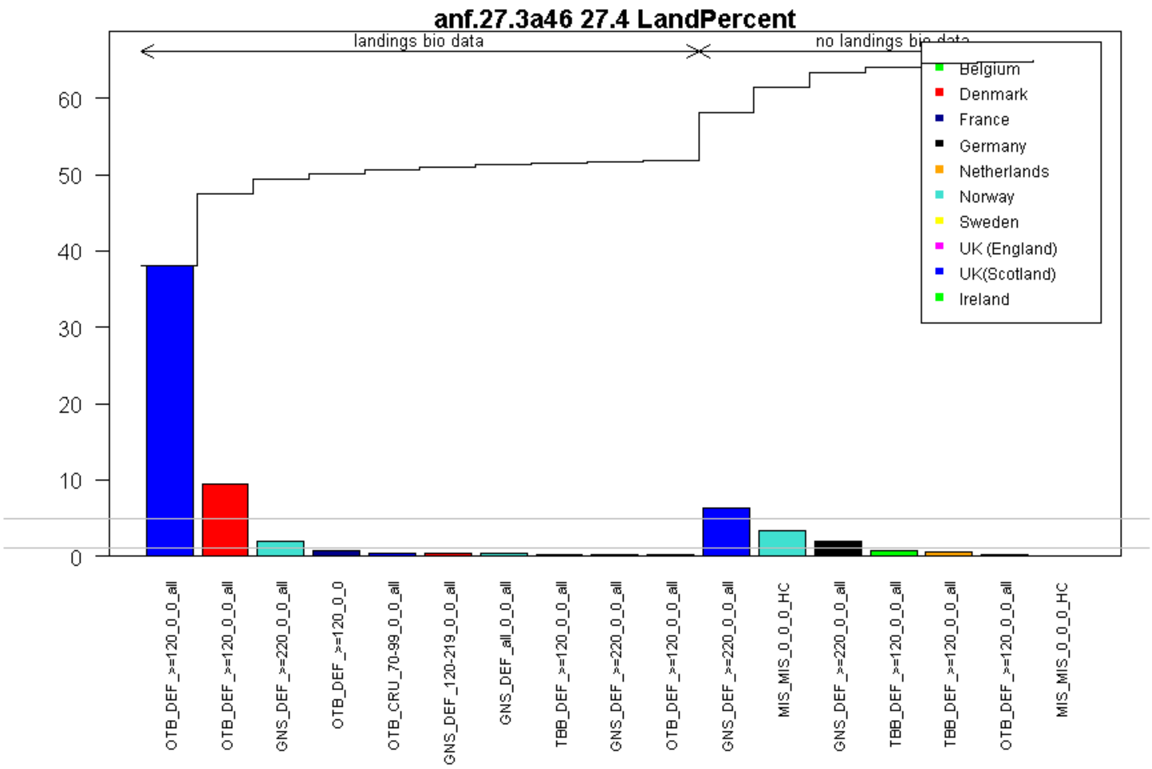


Figure 4.3a. Percentage of total landings weight by fleet and country in 2018; Subarea 4.

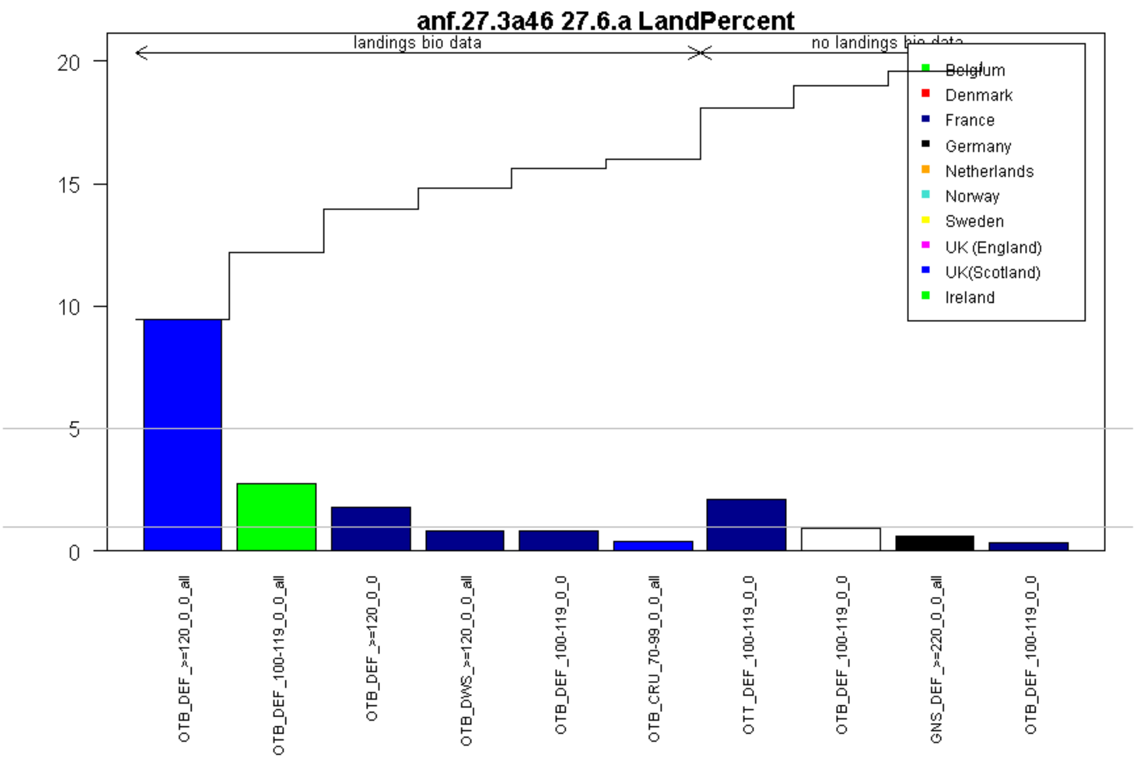


Figure 4.3b. Percentage of total landings weight by fleet and country in 2018; Division 6.a.

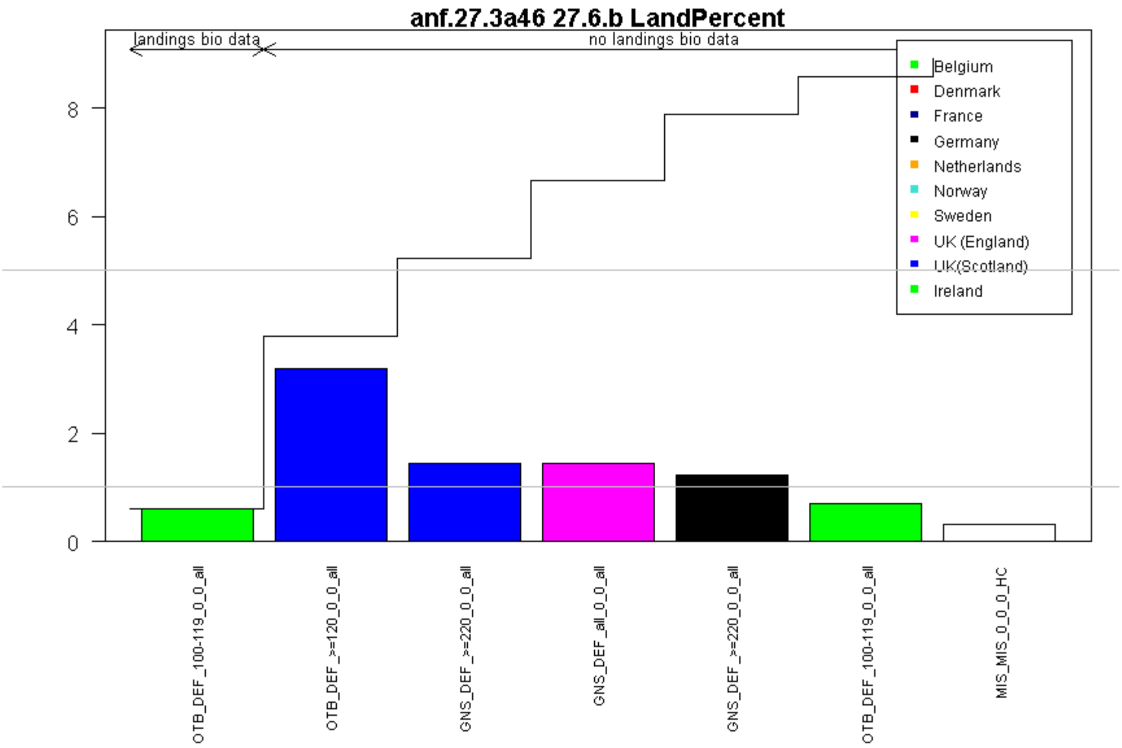


Figure 4.3c. Percentage of landings weight by fleet and country in 2018; Division 6.b.

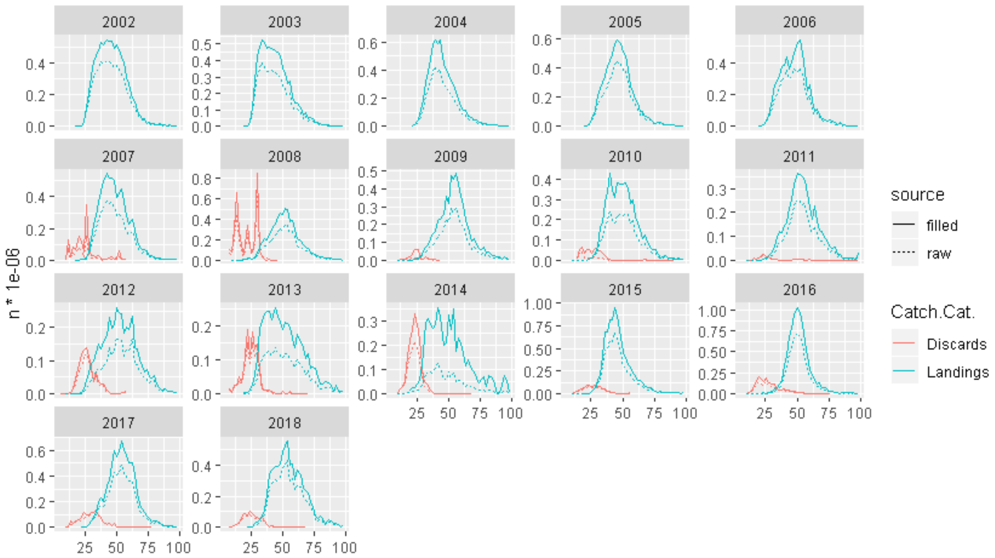


Figure 4.4. WGCSE Landed numbers ('00 thousands) at-length (cm) 2002–2018.

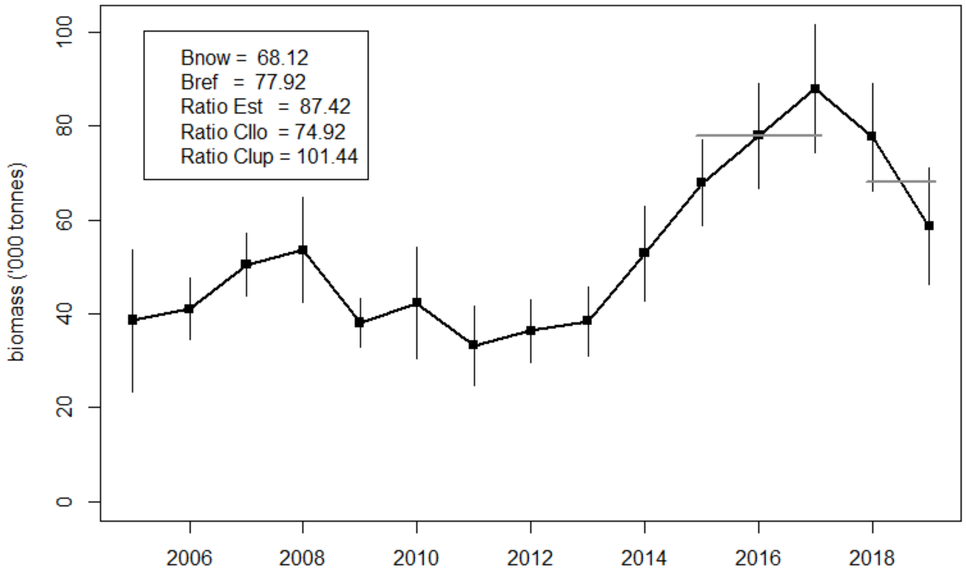


Figure 4.5. SIAMISS-Q2 estimates of total biomass, with confidence intervals, for subareas 4 and 6 combined, 2005–2019. B_{now} is the average biomass for 2018–2019, B_{ref} is the average biomass for 2015–2017; both marked on the graph in their respective years. Ratio Est is the ratio of B_{now} to B_{ref}, expressed as a percentage, with confidence intervals (Ratio CIlo, Ratio CIup).

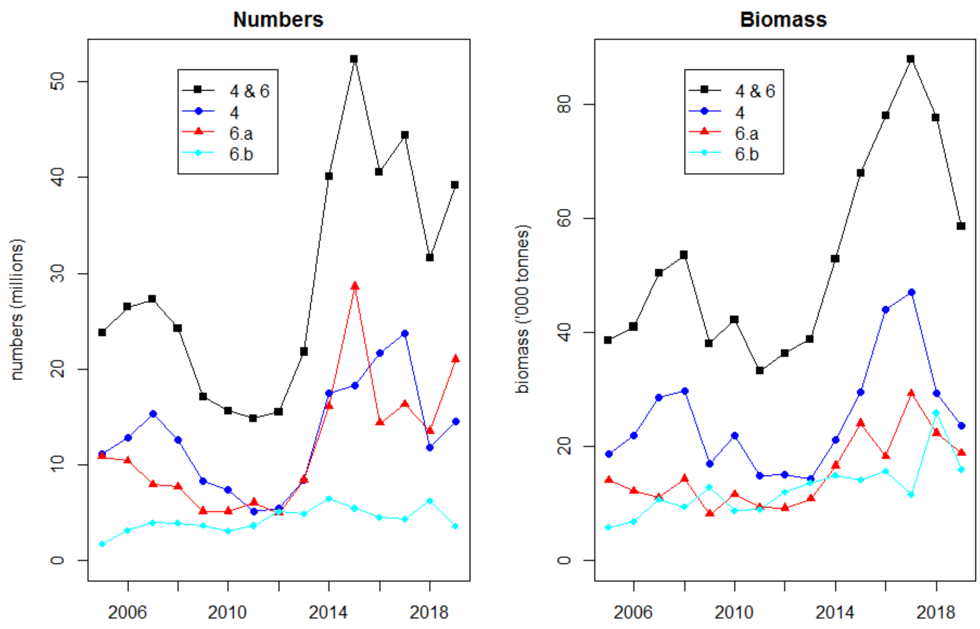


Figure 4.6. SIAMISS-Q2 estimates of total abundance (left) and biomass (right) of anglerfish for the Northern Shelf (black filled squares) 2005–2019. Estimates are also provided for ICES Subarea 4 (blue filled circles), Division 6.a (red triangles) and Division 6.b (turquoise diamonds).

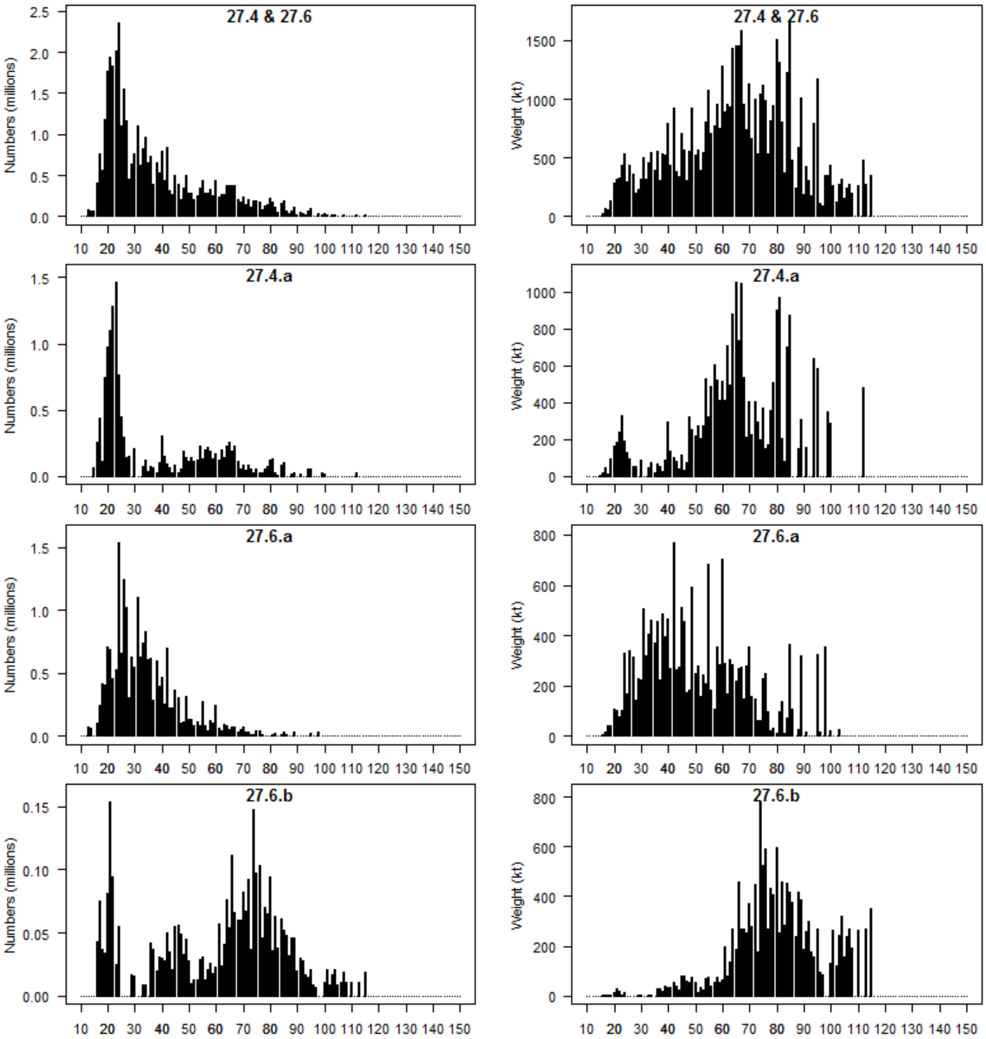


Figure 4.7. SIAMISS-Q2 estimates of total numbers (millions) at-length (cm) for subareas 4.a–c and 6.a–b, 2019.

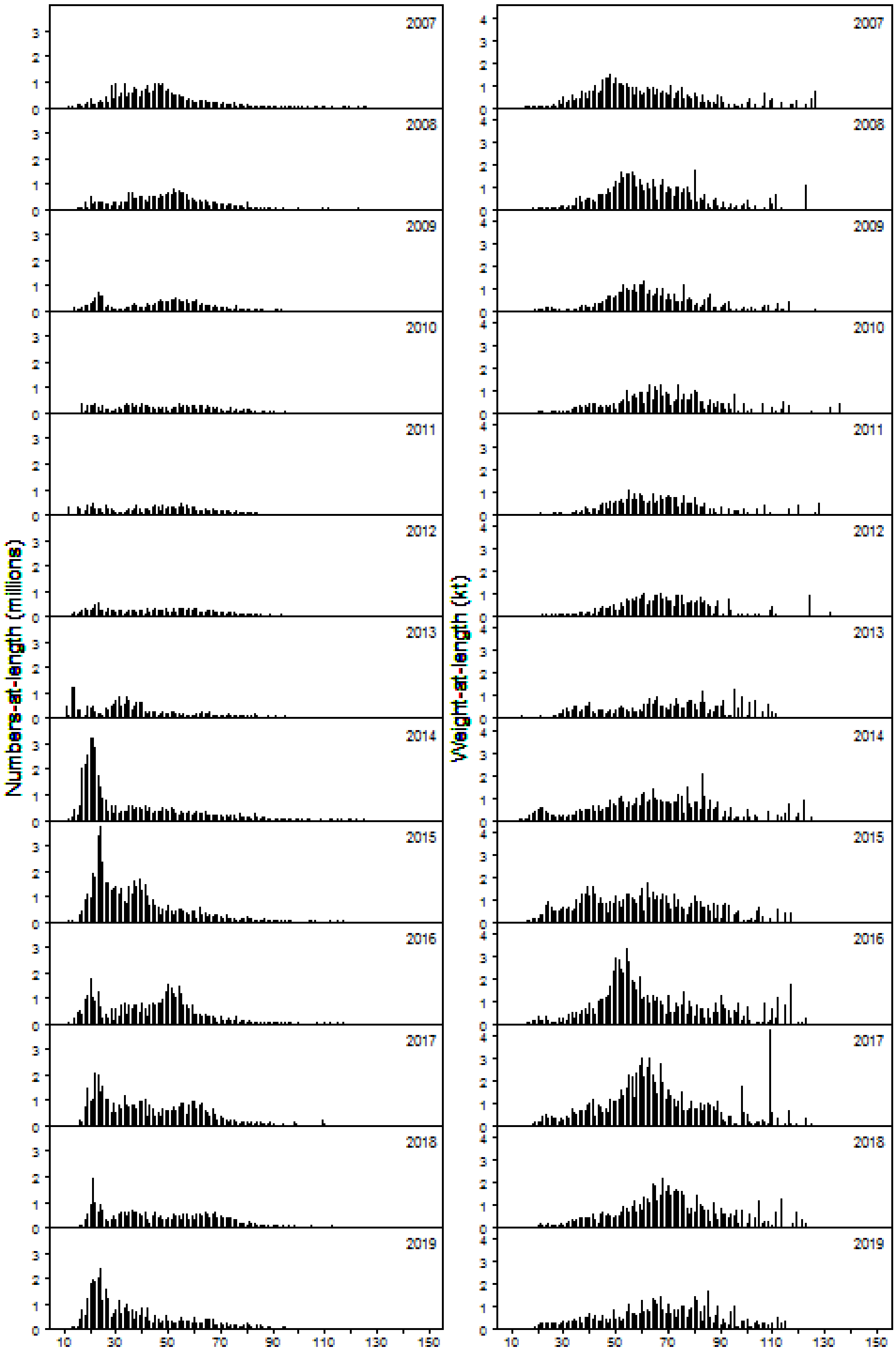


Figure 4.8. SIAMISS-Q2 estimates of total numbers (millions) at-length (cm) (left) and estimates of total biomass (kt) at-length (cm) (right) for subareas 4.a–c and 6.a–b combined, 2007–2019.

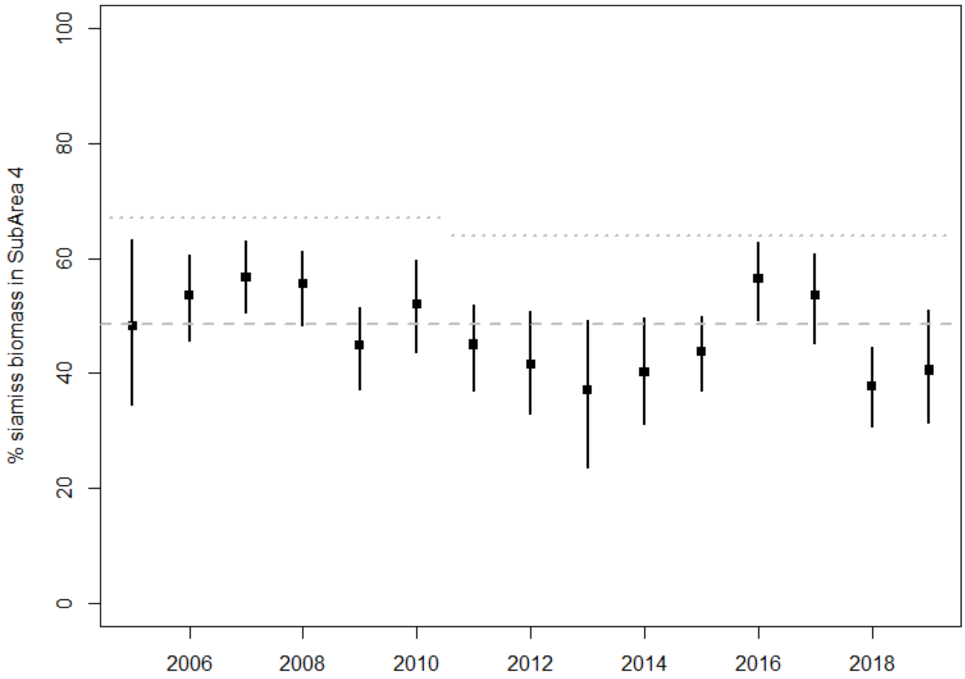


Figure 4.10. Percentage of SIAMISS-Q2 total biomass, with confidence intervals, estimated to be in subareas 4.a–c compared with subareas 4.a–c and 6.a–b combined. The full grey line represents the average of these percentages over the time-series (2005–2019) 4 (47%). The dotted grey lines represent the percentage of TAC allocated for subareas 4.a–c compared to the total of the TAC for subareas 4.a–c and 6.a–b, (67% in 2005–2010, 64% in 2011–2017).

Figure 4.11. Northern Shelf anglerfish harvest rate 2008–2018 (mean standardised WG catch total numbers of biomass)/ SIAMISS-Q2 total numbers or biomass).

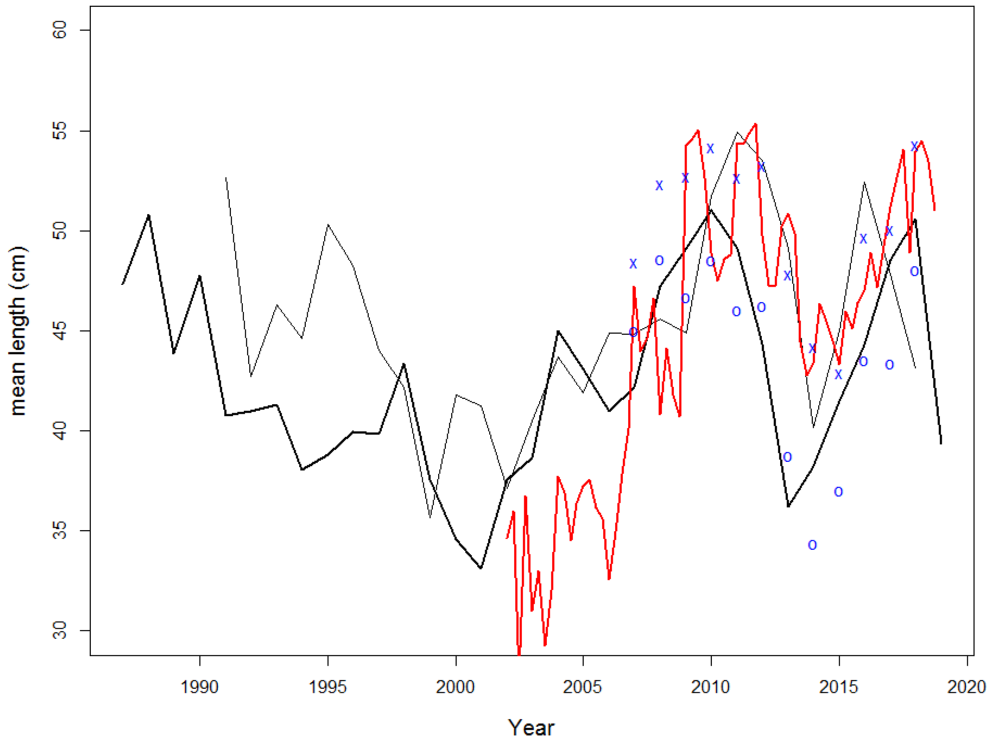


Figure 4.12. Mean length for NS-IBTS-Q1 (black bold), NS-IBTS-Q3 (black), commercial catch WKAnglerfish InterCatch estimation (red), and SIAMISS-Q2 raw catches (blue crosses) and after survey estimation procedure of corrections for footrope escapes, herding etc. (blue open circles) (see Reid *et al.*, 2007).

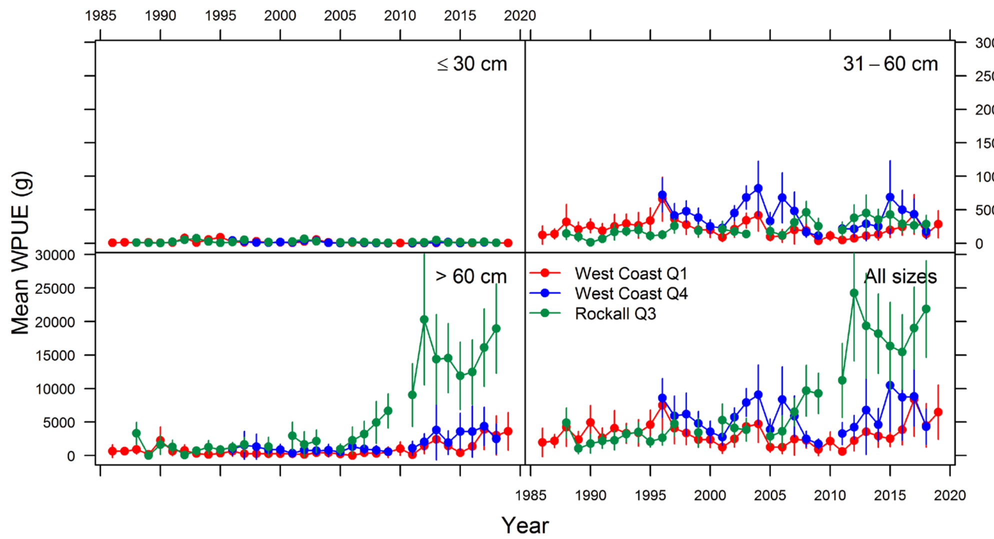


Figure 4.13. Survey indices of mean weight (g) per hour from SWC-IBTS-Q1 (blue) in 6.a, SWC-IBTS-Q4 (red) in 6.a and ROCKALL (green) in 6.b.

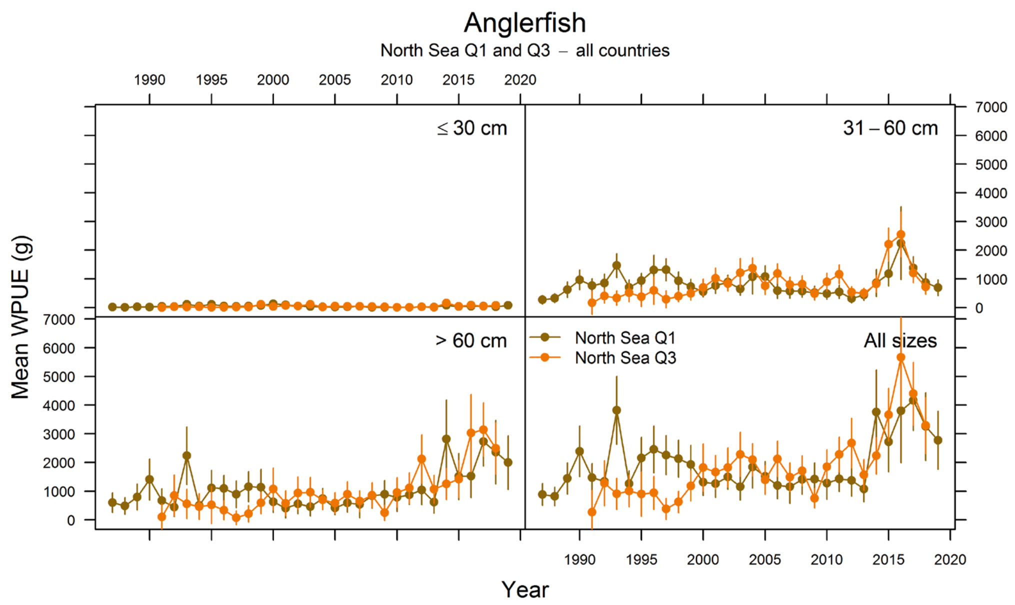


Figure 4.14. Survey indices of mean weight (g) per hour from NS-IBTS-Q1 (brown) and NS-IBTS-Q3 (orange).

3 Cod in Division 6.a

3.1 Introduction

The last benchmark for this stock was carried out in February 2012 (ICES, 2012) with subsequent inter-benchmarks in February 2015 (ICES, 2015) and February 2019 (ICES, 2019). The assessment and forecast carried out at the WG follows the procedure outlined in the stock annex developed at the benchmark and updated at the inter-benchmarks, with the exception of some minor deviations:

i. additional down-weighting of individual datapoints to improve TSA assessment model diagnostics (the stock annex acknowledges the need to allow for changes to the variance structures used in the TSA models if they improve model diagnostics);
ii. The forecast assumptions differ from those used at previous assessment WGs and those documented in the Stock Annex which have not been discussed or modified since 2008.

The deviations are explained in the relevant report section.

3.2 General

3.2.1 Advice

Biennial advice was provided for this stock in 2017. This, and advice from previous years is given below.

ICES Advice applicable for 2018 and 2019

ICES advises that when the MSY approach is applied, there should be zero catches in each of the years 2018 and 2019.

ICES Advice applicable for 2016 and 2017

ICES advises that when the MSY approach is applied, there should be no directed fisheries and all catches should be minimized in 2016 and 2017.

ICES Advice applicable for 2015

No new data are available that change the perception of the stock from the advice given in 2013. Therefore, the same catch advice is still applicable for 2015: ICES advises on the basis of the MSY and precautionary approach that there should be no directed fisheries and that bycatch and discards should be minimized.

3.2.2 Stock definition and the management unit

The assessment unit is Division 6.a although there are believed to be at least two subpopulations of cod in Division 6.a which remain geographically separated throughout the year. Further details can be found in the stock annex. The management unit is ICES Divisions 6.a plus EU and international waters of Division 5.b to the east of 12°00′W. Prior to 2009, the TAC was set for ICES Subareas 6, 12 and 14 plus Subdivision 5.b.1.

Recent management

The minimum conservation reference size of cod for human consumption in this area is 35 cm.

From 2012 to 2018 the TAC for cod in Division 6.a was set to zero with allowance for a bycatch of cod to be landed provided that it does not comprise more than 1.5% of the live weight of the total catch retained on board per fishing trip. From 2015, this provision has not been allowed for catches subject to the landing obligation.

With the full implementation of the landing obligation in 2019 for fisheries catching cod, a bycatch TAC of 1735 t has been set to allow mixed fisheries with a bycatch of cod to continue.

TAC for 2012–2014

Species: Cod *Gadus morhua*		**Zone:** VIa; Union and international waters of Vb east of 12° 00′ W (COD/5BE6A)
Belgium	0	
Germany	0	
France	0	
Ireland	0	
United Kingdom	0	
Union	0	
TAC	0 (1)	Analytical TAC

(1) By-catch of cod in the area covered by this TAC may be landed provided that it does not comprise more than 1,5 % of the live weight of the total catch retained on board per fishing trip.

TAC for 2015–2018

Species: Cod *Gadus morhua*		**Zone:** VIa; Union and international waters of Vb east of 12° 00′ W (COD/5BE6A)
Belgium	0	
Germany	0	
France	0	
Ireland	0	
United Kingdom	0	
Union	0	
TAC	0 (1)	Analytical TAC

(1) By-catch of cod in the area covered by this TAC may be landed provided that it does not comprise more than 1,5 % of the live weight of the total catch retained on board per fishing trip. This provision shall not apply for catches subject to the landing obligation.

TAC 2019

Species:	Cod *Gadus morhua*	Zone:	6a; Union and international waters of 5b east of 12° 00′ W (COD/5BE6A)
Belgium	3 (1)		
Germany	26 (1)		
France	275 (1)		
Ireland	385 (1)		
United Kingdom	1 046 (1)		
Union	1 735 (1)		
TAC	1 735 (1)		Analytical TAC Article 8 of this Regulation applies

(1) Exclusively for by-catches of cod in fisheries for other species. No directed fisheries for cod are permitted under this quota.

Technical measures applicable to the West of Scotland, including those associated with the cod recovery plan in force up to 2008 (Council Regulation No. 423/2004), the cod long-term management plan in force from 2009 (Council Regulation No. 1342/2008) were amended by Council Regulation No. 1243/2012. The management plan was further amended in 2016 by Council Regulation (EU) 2016/2094 to cover the transitional period in which preparations are ongoing towards multiannual plans for multispecies fisheries. In 2018 the cod management plan was discontinued. Cod in Division 6.a is not included in the multiannual plan for Western Waters (Council Regulation (EU) 2019/472).

3.2.3 The fishery in 2018

The table of official landings statistics is given in Table 5.1. Official landings have increased in recent years and in 2018 were 360 tonnes, more than double the 2014 value (~160 tonnes), which was the lowest of the time-series. In 2018, almost 60% of the official landings were reported by UK vessels, approximately 30% by France with smaller amounts declared by Norway, Ireland, Denmark and the Faroe Islands. The majority of reported cod landings in Division 6.a are now taken in the far north of the area (Figure 5.1 shows Scottish reported landings by statistical rectangle).

Due to restrictive TACs, seasonal/spatial closures of the fishery, and effort restrictions based on bycatch composition, the likelihood of misreporting and underreporting of cod in the past is considered to have been high. Underreporting is considered to have been reduced to low levels following the introduction of legislation in Ireland and the UK in 2006. However, area misreporting of cod landings from Division 6.a into Division 4.a (i.e. caught in Division 6.a., but declared in Division 4.a) and to a lesser extent Division 5.b, by the Scottish fleet is now believed to occur. The UK legislation introduced in 2006 is also believed to be responsible for a significant increase in discards starting in 2006.

Area-misreported landings by the Scottish fleet are considered to represent a considerable proportion of the total landings. Estimates of misreporting based on surveillance and consideration of VMS data by Marine Scotland Compliance, have been made available to the WG. Figure 5.2 shows the time-series of misreporting estimates which are assumed to come from the large mesh demersal trawl fleet. Total estimated area misreported Division 6.a cod landings in 2018 were 741 t (largely reported into Division 4.a and to a lesser extent 5.b). This represents over 65% of the total landings in 2018.

3.3 Data

Catch data

The landings uploaded into InterCatch are shown in Figure 5.3 by métier and country, and discard weights and proportions are shown in Figures 5.4 and 5.5 respectively. With the exception of the area misreported landings, the French OTB_DEF≥120 métier is the largest metier with unsampled (no age-compositions) landings (~ 9% of the total landings in 2018).

There are no age composition samples from the misreported landings. The WG this year followed the same procedure as the last two years for handling the misreported landings within InterCatch (a deviation from the Stock Annex). Previously, landings numbers-at-age from the Scottish demersal fleet (OTB_DEF>=120) were raised to the total reported plus area-misreported landings prior to uploading to InterCatch. However, the 'misreporting fleet' could potentially have a different landings age composition (as they are assumed not to discard) and the 2017 WG considered that a more appropriate approach would be to upload the misreported landings into InterCatch as a separate unsampled fleet. This allows a weighted average landings age composition (Irish and Scottish) to be applied. (The Irish landings comprise a substantially greater proportion of younger fisher than the Scottish sampled landings, although given the relative landings weights of the two fleets, the allocated proportions are similar to the Scottish sampled fleet).

It can be seen that landings by Scottish trawl ≥120 mm dominate, and total discards are also highest from this fleet (Figures 5.3 and 5.4). However, the discard proportion is higher for the Scottish trawl 70–100 mm fleet (OTB_CRU_70–99) (Figure 5.5). The discard rates observed in the Irish and French fleets are considerably lower than in the Scottish ≥120 mm demersal fleet. The proportions of the catch discarded (by weight) for the sampled fleets are given below.

Fleet	Scottish Demersal Trawl^	Scottish *Nephrops* Trawl	Irish Demersal	French Demersal trawl
Discard proportion	73%	96%	24%	38%

^ The calculation of this discard proportion excludes the area misreported component of landings as this fleet are assumed not to discard i.e. this is the discard rate of the 'reported landings fleet'.

Discard proportions and landings and discard age distributions were assigned within InterCatch to unsampled fleets on the same basis where possible (and as described in the Stock Annex). Raised discards are shown in Figure 5.6. The final mix of numbers-at-age from sampled and unsampled landings and sampled and raised (unsampled) discards is given in Figure 5.7. An extremely small amount (35 kg) of below minimum size (BMS) landings was also reported, but is not shown. The large unsampled proportion of the catch-at-ages three and above is due to the landings from the Scottish misreported fleet.

Sampling levels (number of trips) by country are given below. A limited number of Northern Irish samples are also available in some years. Sampling of the Scottish OTB_DEF landings is still relatively poor. The small sample sizes (which include a few very large fish with high raising factors) can result in a very high sum of products (SOP, landings-at-age x weight-at-age) for this fleet in some years (2015 and 2016).

	Scotland			Ireland
Year	Demersal trawl (OTB_DEF)	*Nephrops* trawl (OTB_CRU)	Total	Total
Landings	11	1	12	24
Observer	11	28	39	12

The WG estimates of total landings and discards are given in Table 5.2 and shown in Figure 5.8. These values are for fish aged 1 to 7+ which is the age range used in the assessment. Just over three tonnes of age zero fish were also estimated to have been discarded in 2018.

The total discard proportion by weight is shown in Figure 5.9. The estimate of total discards as a proportion of total catch by weight in 2018 (40%) is the lowest since 2005. However, this reduction is mostly due to the increase in the estimate of area misreported landings for 2018 which are assumed to have zero discard rate. Furthermore, the discard estimates are highly uncertain; the CV of the discard weight estimate for the large mesh Scottish demersal trawl fleet for 2018 is 51%. Given the 1.5% bycatch regulation, the landings have potentially been limited more by catch-rates of other species in the fishery. So, for example, an increase in the catch rate of anglerfish and/or haddock could have allowed for a greater proportion of cod catches to be landed by the Scottish demersal fleet in these years.

Discarding occurs across most of the age classes in the catch (Figure 5.10).

Age compositions

Raised landings numbers-at-age and discard numbers-at-age are given in Tables 5.4 and 5.6 respectively, and total catch numbers-at-age in Table 5.8. In 2018 there has been a large reduction in the catches-at-ages 1 to 3 compared to 2017. (Figure 5.11).

Weight-at-age

Annual mean weights-at-age in landings, discards and catch are given in Tables 5.5, 5.7 and 5.9. Figure 5.12 shows the mean weights-at-age in the landings and discards. The mean weight of age two and three fish in the landings has increased since the mid-2000s in line with the increase in high-grading which has occurred at these ages. Other age classes show fluctuations with a long-term downward trend particularly for ages 5 and above. Values at older age are noisy, particularly in recent years (most likely due to low sampling levels). Mean weight-at-age in the discards shows no real trend.

Survey data

All available survey data are given in Table 5.3, with the data used in the assessment highlighted in bold. Survey descriptions are given in the stock annex. Following the inter-benchmark (IBP-Cod6.a), the assessment now makes use of three additional quarter four surveys (one of which is no longer current). Survey indices for the two new Scottish surveys (UK-SCOWCGFS- Q1 and UK-SCOWCGFS- Q4) are provided with an estimate of variance.

The cpue by survey haul for the IRGFS-WIBTS-Q4 survey are shown in Figure 5.13 and in Figure 5.14 for the two Scottish surveys (UK-SCOWCGFS- Q1 and UK-SCOWCGFS- Q4). All surveys show mostly zero returns over latitudes between 56 degrees N and 58.5 degrees N (although the IRGFS-WIBTS-Q4 survey only extends to 56.5 degrees N). This pattern has been consistent in surveys since 2007. The Scottish surveys have highest catch rates to the north of 59 degrees N, in and around the 'windsock' closed area. South of 56 degrees N, the Q1 surveys catch cod in the Clyde region and the Q4 surveys catch some cod off the Northern Irish coast. From the IRGFS-WIBTS-Q4 survey there is also evidence of higher abundance in this area as well as along the shelf edge in the southern part of Division 6.a. Catch rates of age one cod are typically very low and the higher catches of older age classes that appear in the north of the region could potentially be due to overspill from the neighbouring North Sea stock which has increased in recent years. The UK-SCOWCGFS-Q1 in 2019 shows very low catch rates for ages >1 across the area, but relatively high catch rates (compared to recent years) of age 1 fish.

In 2017, the indices for age four, five and six cod in the quarter one survey show particularly high uncertainty due to a single very large haul (Figure 5.14) of large cod with most other stations having very low or zero values. In 2018, there were no large hauls and therefore the estimated variance is low. In 2019, the quarter one survey shows very low catch rates of ages >1 across the survey area, but relatively high catch rates (compared to recent years) of age 1 fish.

The quarter four survey estimates also have substantial uncertainty. This is particularly apparent in the 2018 survey with two hauls catching large numbers of individuals aged 4 to 6 and very low catches elsewhere, resulting in CVs of around 60% for these ages in this year.

A series of inshore and offshore Scottish industry–science surveys, known as the West Coast Demersal Fish (WCDF) project were conducted between December 2013 and November 2014. The initiative, funded by the Scottish Government and the European Fisheries Fund, was a joint venture between Marine Scotland Science and the Scottish Fishermen's Federation with the aim of improving the understanding of the current state of demersal stocks to the West of Scotland. The surveys show a broadly similar distribution to the UK-SCOWCGFS- Q1 and UK-SCOWCGFS-Q4 with bigger fish and increased abundance inside the Windsock compared to outside.

Biological data

Natural mortality-at-age (M) is assumed to be weight-dependent after Lorenzen (1996) but time invariant. M is calculated by finding the time-series means for stock weights-at-age before applying the Lorenzen parameters and the values are shown below.

Natural mortality (M) at-age:

Age	1	2	3	4	5	6	7+
	0.540	0.387	0.307	0.263	0.238	0.224	0.212

Figure 5.15 shows the resulting M-at-age values used in the assessment (the constant values) and the values calculated based on the annual mean weights-at-age for comparison. This suggests that in future it may be more appropriate to include time varying natural mortality given the changes in mean weight-at-age that have occurred. Proportion of fish mature-at-age are unchanged from the last meeting and is as detailed in the stock annex.

The contribution of seal predation to total cod mortality is likely to be significant and this may impair the ability of the stock to recover (Cook *et al.*, 2015). Weight dependent natural mortalities-at-age were adopted at the benchmark meeting in 2012 to take account of increased mortality at younger ages. Given the sparsity of the data, it is considered unlikely that seal consumption estimates could be incorporated into a robust annual stock assessment.

3.4 Stock assessment

This assessment uses a TSA run as outlined in the stock annex. Exploratory analysis of the input catch and survey data are also carried out.

Data screening

Catch curves from commercial catch-at-age data (landings plus discards) are shown in Figure 5.16. Although the data are noisy, there is some evidence of a flattening off of the catch curves in recent years compared to those of the cohorts spawned in the late 1990s. A plot of log catch curve gradients derived from commercial catch data (landings plus discards) over different age ranges is shown in Figure 5.17. Here too there is some evidence of a decreasing mortality in recent years, particularly over age ranges including age two. (Note that these exploratory catch data plots are based on reported landings and discards and will be influenced in part by underreporting of landings in the 1990s and early 2000s).

Figure 5.18 shows the mean standardised catch-at-age by proportion (number). It shows good tracking of the strong cohorts as recently as the 2005 year class which shows well even at age 7+. More recently the data become rather noisy and in 2015, the proportion of the catch-at-age six is high and similarly for age 7+ in 2016. Neither of these observations are supported by above average values at younger ages of the same cohort. Potentially the age 6 value in 2015 and 7+ in 2016 could be an overspill of fish from the North Sea as this coincides with the moderately strong 2009 year class in that area. In 2019, a small increase in the numbers-at-age four and older in the catch, coincidental with a large reduction in the numbers-at-age one to three results in the proportion at older ages in the catch being the highest of the time-series (Figure 5.18).

Figure 5.19 shows the log mean standardised indices from the ScoGFS-WIBTS-Q1 survey by year and by cohort. The early part of the time-series appears to track the cohorts relatively well with no obvious year effects. However in later years, the indices become more noisy and there is some evidence of year effects in the survey. The survey ended in 2010.

Figure 5.20 shows log catch curves for the ScoGFS-WIBTS-Q1 survey. It shows a strong "hook" at the younger ages, with abundance-at-age two often higher than at-age one. In later years survey abundance also shows increases from age 2 to age 3 in the same year class and the survey's ability to track recent cohorts seems poor relative to the 1990s and early 2000s. The survey scatterplots (Figure 5.21) show some consistency in the estimates of year-class strength across age classes (particularly the younger, adjacent ages), although less so at older ages. There is no trend in the log catch curve gradients derived from this survey that would be consistent with a change in mortality (Figure 5.22) for any of the age ranges considered.

Figure 5.23 shows the log mean standardised indices by cohort and year from the ScoGFS-WIBTS-Q4 survey. The survey shows reasonable tracking of cohorts at ages one to three and no particular evidence of year effects. This is also evident in the survey scatterplots which show reasonable correlation at younger ages (Figure 3.24). This survey catches very few fish at ages five and above.

Figure 5.25 shows the log mean standardised indices by cohort and year from the IRGFS-WIBTS-Q4. The log mean standardised indices plot shows consistent signals at ages 1 and 2 with no obvious year effects. The scatterplots (Figure 5.27) also show reasonable consistency between ages one and two, but the tracking at older ages is less strong. The data cover too few age classes sufficiently well to give an indication of trend in mortality through catch curve gradients (Figure 5.26).

Figure 5.28 shows log mean standardised indices by cohort and year from the UK-SCOWCGFS-Q1. There is little evidence of successful tracking of cohorts and some evidence of survey year effects (2015, 2017 and 2019, particularly for older ages). There appeared to be a general increase in the catch rates of older ages over time to 2017 (four and above), but no equivalent increase in the catch rates of younger ages (from the same cohort). These declined significantly in 2018 and 2019 although there has been an increase in the catch rate of age one in 2019.

The log catch curves from the UK-SCOWCGFS- Q1 are also very noisy (Figure 5.29) and typically do not show a decline as the cohort ages. The survey scatterplots show that even the catch rates of successive age classes (within the same cohort) are only weakly related (Figure 5.30).

Figure 5.31 shows log mean standardised indices by cohort and year from the UK-SCOWCGFS-Q4. There is some evidence of cohort tracking, but this is not consistent over time or ages and this is also apparent in the survey scatterplots shown in Figure 5.33. Figure 5.32 shows the log catch curves from the UK-SCOWCGFS-Q4, which are noisy and difficult to interpret given the short time-series and missing year of survey data.

Overall, information on mortality trends from all survey-series (including the ScoGFS-WIBTS-Q1) appears to be fairly poor due to the generally high variability and large CVs (ranging from 30% to 75% depending on age class) for the two current Scottish surveys.

Figure 5.34 shows a comparison (between surveys) of log mean standardised survey indices at-age over time (mean standardised over the common year range of all three surveys). The two quarter four surveys show some consistency over time at-age two while the two Scottish surveys show some consistency of trends at-age three. At older ages (in the Scottish surveys), there appears to be a divergence in the trend in recent years.

The inter-benchmark in 2019 agreed that all five surveys should be included in the final assessment, the basis being that the additional surveys show reasonable internal consistency and in addition, some between survey consistency. It was considered that the Irish survey could provide an additional indicator of year-class strength and could be useful as it covers the period during which there is a break in the Scottish survey indices. The lack of spatial coverage of this survey (only the southern part of Division 6.a) was deemed less important given the index is only being used to provide information on the younger ages.

Final assessment

Model settings and input parameter settings for the final run are given in Table 5.10. Input data are as agreed at the 2019 inter-benchmark and include the five surveys described above, and commercial landings- and discards-at-age (age compositions only from 1991–2005, and data excluded completely for 2006). Final parameter estimates from the TSA run are given in Table 5.11. Running the update assessment from the 2019 inter-benchmark identified a large positive residual in age one landings in 2019 in the model diagnostics (Figure 5.35), due to increased landings and lower discards at-age 1 (i.e. a lower discard rate than the recent past, which the model is unable to replicate). The only observations of age 1 landings were in the Irish sampled data (i.e. not in the Scottish) and therefore it was considered appropriate to allow additional uncertainty for this datapoint to improve model diagnostics. An alternative model run in which the 2019 discard data were down-weighted made only limited improvement to the diagnostics. (Note that the stock annex acknowledges the need to allow for changes to the variance structures (down-weighting of individual datapoints) used in the TSA models if they improve model diagnostics).

The inter-benchmark (ICES, 2019) highlighted the problems with the estimation of discards; the inability of the current discard model to reproduce the interannual variability in the discard proportions and also the influence of the proportion at-age one in recent years in the overall estimates of transitory variation in discarding. In future (requiring some bespoke changes to TSA), an assumption that all age one catch are discarded may provide a better fit to the full time-series of data (assuming that discarding practices do not change). Alternatively, an approach making use of an age-based discard ogive may be more appropriate than modelling proportions at-age as a random walk.

Figures 5.36 and 5.37 show the residuals by age class for landings and discards and the surveys respectively (based on the final smoothed model estimates). The landings and discards residuals are all reasonably small with no major outliers or particular patterns, with the exception of some indication of an underestimation of landings at-age one and overestimation of discards at-age one.

In terms of survey residuals, the two discontinued survey time-series continue to show some indication of increasing residuals over time for younger ages, most likely indicative of a mismatch in the commercial and survey data (although alternatively could be interpreted as an increase in survey catchability which is not accounted for in the model). The recent Scottish survey indices are very uncertain (and CVs are input to the assessment) while the catch data are still estimated to be comparatively more precise, resulting in a poor distribution of residuals for some ages (although the magnitude is low). Patterns are fairly consistent with fits in previous years and at the inter-benchmark.

The time-series of observed and fitted discard proportions-at-age is shown in Figure 5.38. The predictions follow the general trend in the data which are quite noisy. (See above for discussion on discard modelling).

Table 5.12 gives the TSA population numbers-at-age and Table 5.13 gives their associated standard errors. Estimated F at-age is given in Table 5.14 and standard errors of mortality on the log scale are given in Table 5.15. Full summary output is given in Table 5.16. A summary plot for this run is shown in Figure 5.39.

Retrospectives for the final assessment run are shown in Figure 5.40. Following discussion at WGCSE, the recruitment and SSB plots include the intermediate year in each of the peels (i.e. the latest assessment includes model output up to 2019 for R and SSB). There is little evidence of retrospective bias in either mean F or SSB, with respective Mohn's rho values of 0.11 and 0.03 (five year peel). Further back in time the mean F shows some evidence of underestimation which appears to be associated with the break point in the Scottish survey indices (i.e. when the current survey series begin).

The assessment appears to overestimate recruitment in the intermediate year (the estimate is based on only a single survey datapoint). The recruitment Mohn's rho is 1.71 when the intermediate year of each assessment peel is included and 0.19 when the model estimates are limited to the last year of catch data.

Stock status

Historical stock trends are shown in Figure 5.40 and the stock–recruitment relationship is shown in Figure 5.41. The estimated SSB shows a steady downward trend until 2006 and has fluctuated at a slightly higher level since then. The 2012 year class (recruitment in 2013) is estimated to be the highest since 2006 and results in a small increase in SSB in 2015 and 2016 (highest since 2003). Since then, recruitment has declined and in 2018 is estimated to be the lowest of the time-series.

Estimated SSB in the final year is well below B_{lim} (= 14 000 tonnes). Mean F is well above F_{MSY}, but has been below F_{lim} since 2012. Although the latest assessment shows an increase in mean F since 2016, there has been a clear decrease in mean F since 2005. The decline in mean F is proportionately similar (~ 50%) to the decline in STECF effort (large and small mesh demersal/crustacean trawl from both regulated and unregulated fleets), although the mean F does not start to decline until several years after the effort (Figure 5.42a). Partial mean F for landings and discards separately is shown in Figure 5.42b showing that discarding accounts for around 50% of the mean F.

3.5 Short-term stock projections

The inputs for the short-term forecast follow the specifications in the Stock Annex with the exception of the numbers-at-age one in 2019. The Stock Annex (which does not appear to have been updated since 2008 with respect to the forecast settings) states that the numbers-at-age at the start of the intermediate year ought to be the estimates from TSA. However, the retrospective plots discussed above suggest that the estimate of recruitment in the intermediate year from TSA is generally revised downwards in subsequent assessments. Therefore, in contrast to the stock annex (and previously presented forecasts) we use a short-term (ten year) geometric mean recruitment for the intermediate year onwards in the forecast.

Fishing mortality in the intermediate year (2019) was taken as a three year average over 2016 to 2018 of the exploitation pattern rescaled to the 2018 mean F as an estimate of F status quo (given that the mean F appears to be increasing). Mean weights-at-age were also averaged over the most recent three years.

In 2019 (the intermediate year), cod in Division 6.a is fully under the landing obligation and a bycatch TAC of 1735 t has been set to allow mixed fisheries with a bycatch of cod to continue. A change in discarding practices would be expected following this increase in TAC. Therefore, the forecast assumes that in 2019 and 2020, unwanted catch will be the catch below MCRS. Given that discards in recent years have been largely high grading (due to restrictive TACs), catch below MCRS is approximated by the use of historical discard proportions-at-age in the forecast (average over 1981–2000 i.e. before high-grading became an issue). This results in very low discard selectivity at all ages above age one.

The recent high-grading has resulted in landings mean weights-at-age significantly higher than catch weights-at-age. In the forecast, which assumes only below MCRS to be unwanted (i.e. no high-grading), wanted catch mean weights-at-age are assumed to be the three year average (2016–2018) of observed mean catch weights-at-age.

Variable	Value	Notes
F ages 2–5 (2019)	0.70	Average exploitation pattern (2016–2018) scaled to F ages 2–5 in 2018
SSB (2020)	2013	Tonnes; short-term forecast.
Rage1 (2019 and 2020)	2349	Thousands; GM recruitment (2009–2018)
Catch (2019)	1421	Tonnes; short-term forecast.
Wanted catch (2019)	1366	Tonnes; assuming average discard proportions-at-age (1981–2000)
Unwanted catch (2019)	55	Tonnes; assuming average discard proportions-at-age (1981–2000)

The short-term forecast inputs are shown in Table 5.17 and the outputs in Table 5.18 and 5.19. Note that the numbers-at-age in 2019 in Table 5.17 are the survivors from 2018 which differ slightly to the TSA numbers-at-age in 2019 (Table 5.12) which are smoothed estimates.

Under the forecast assumption of status quo F, wanted catch in 2019 is predicted to be 1366 t and unwanted catch to be 55 t. The SSB in 2020 is forecast to be 2013 t, which is well below B_{lim} (Table 5.18).

The forecast of landings in 2020 and SSB in 2021 in particular is sensitive to the recruitment assumptions. The assumption of GM recruitment in 2019 and 2020 contribute 41% and 28% respectively to the forecast SSB in 2021. (Figure 5.43).

3.5.1 Reference points

Both MSY and precautionary reference points were reconsidered at IBPCod.6a in February 2019 in accordance with ICES guidelines and are shown below (weights in tonnes). The final agreed reference points are given below. The estimate of F_{MSY} is greater than previous due to i) exclusion of Beverton–Holt stock–recruitment relationship and ii) choice of yield to include catch above MCRS (estimated by assuming a historical discard rate).

	Advice 2015	WKMSYREF4	IBPCod.6a	Rationale (WKMSYREF4/IBPCod.6a)
B_{lim}	14 000	14 000	14 000	B_{loss} from which the stock has increased (SSB in 1992 as estimated in 2015)
B_{pa}	22 000	20 000	20 000	1.4 x B_{lim}
F_{lim}	0.8	0.82	0.77	Based on simulation with segmented regression recruitment with B_{lim} as the breakpoint
F_{pa}	0.6	0.59	0.55	F_{lim}/1.4
F_{MSY}	0.19	0.167	0.29	F that provides max yield (calculated from EqSim using Segmented regression & Ricker stock–recruit relationship)
MSY $B_{trigger}$	22 000	20 000	20 000	B_{pa}
F_{MSY} upper		0.254	0.41	F at 95% MSY (above F_{MSY})
F_{MSY} lower		0.108	0.20	F at 95% MSY (below F_{MSY})

3.5.2 Management plans

Technical measures applicable to the West of Scotland, including those associated with the cod recovery plan in force up to 2008 (Council Regulation No. 423/2004), the cod long-term management plan in force from 2009 (Council Regulation No. 1342/2008) were amended by Council Regulation No. 1243/2012. The management plan was further amended in 2016 by Council Regulation (EU) 2016/2094 to cover the transitional period in which preparations are ongoing towards multiannual plans for multispecies fisheries. In 2018 the cod management plan was discontinued. Cod in Division 6.a is not included in the multiannual plan for Western Waters (Council Regulation (EU) 2019/472).

3.6 Uncertainties and bias in assessment and forecast

Figure 5.44 shows a comparison between this year's and last year's assessments. Following the IBP (ICES, 2019), the assessment shows a substantial downward revision of mean F, since around 2010, compared to the assessment presented last year. The 2018 assessment estimated mean F in 2017 to be 0.96 while in the current assessment this is now estimated as 0.60. There is a similar upward revision in SSB: the 2018 assessment estimated SSB in 2017 to be 3413 tonnes while this year's assessment estimates it at 4196 t. These revisions are largely the result of changes to the TSA configuration agreed at the IBP in 2019.

An upward revision of recent estimates of SSB compared with that presented last year. The 2017 assessment estimated SSB in 2016 to be 2741 t while this year's assessment estimates it at 3630 t. Mean F in that year is now estimated at 0.63 which is a significant downward revision compared to last year's assessment (0.94). The 2015 mean F has also been revised downwards.

The estimate of recruitment in 2018 is revised down from 2.826 million to 0.826 million (the lowest of the time-series) while recruitments from 2013–2015 have been revised upwards.

No forecast was conducted last year and therefore it is not possible to check the consistency of forecast SSB with current assessment estimates.

Landings

Since the early 1990s the most significant problem with the assessment of this stock is with commercial data. Incorrect reporting of landings, species, quantity and management area, is known to have occurred. Scottish landings (from 2006) are adjusted to include estimates of misreporting (in an attempt to reduce bias in the assessment) and in 2016, area misreported landings account for around 55% of the total landings. The misreporting estimates are provided by Marine Scotland Compliance based on intelligence and consideration of VMS data. Estimates based on provisional analysis of VMS data linked to landings at a trip level (conducted at the 2015 inter-benchmark (ICES, 2015)) gave somewhat higher estimates. In addition these misreported landings are unsampled and potentially have different age compositions to the rest of the Scottish demersal finfish fleet due to likely differences in discarding behaviour.

Discards

On average (over the last five years), discarding accounts for almost 70% of the total catch. Although sampling levels have improved in recent years, discard estimates are still very uncertain (approximate CV = 50% for Scottish large mesh demersal fleet in 2017) contributing to uncertainty in the estimates of mean F.

Biological factors

Assumptions on mean weight-at-length and mean maturity-at-age have remained unchanged for a long period. However, biological responses of cod in 6.a as a localised species to high exploitation and low population numbers are so far unknown to the working group.

The contribution of seal predation to total cod mortality is likely to be significant and this may impair the ability of the cod stock to recover but data is limited. Weight dependent natural mortalities-at-age have been adopted to better take account of higher natural mortality at younger ages but it is not certain these values fully accommodate the possible large source of natural mortality from seals. Regular surveys giving estimates of consumption by seals would give greater confidence in natural mortality estimates. An assessment conducted by Cook *et al.* (2015)

suggests declining fishing mortality and that seal predation may be impairing the recovery of this stock.

Stock structure

Stock structure is complex and at least two subpopulations are known to occur within this area. The survey distribution plots show that there is an almost complete absence of cod on the shelf in Division 6.a with the majority of the landings and stock concentrated in an area in the north of the region (around the 'windsock' closed area) bordering Division 4.a. It may be more appropriate to consider this component of the stock as part of the North Sea stock (or at least the northern component of this stock).

Assessment method

The input data for this cod assessment are particularly uncertain (both survey indices and commercial data) and as a result, the data can be interpreted in different ways by different assessment methods. The assessment presented by Cook (2019) shows a stock which has recovered to levels consistent with those of the 1990s, while the ICES TSA assessment shows little sign of SSB recovery. The uncertainty estimates from the final TSA assessment are therefore unlikely to adequately reflect the true uncertainty in the estimates of stock biomass and fishing mortality for this stock.

3.6.1 Recommendation for next Benchmark

problem	Solution	expertise necessary[1]	suggested time
Stock identity	Evaluate a possible merge between North Sea and 6.a cod stocks. Or as an alternative, split area 6.a in two areas North and South.	Scientists from MSS and MI	Next benchmark although would need collaboration with WGNSSK.
Misreporting of landings; does not take account of fleet components.	Further analysis of misreporting data supplied by Scotland, potentially making use of VMS data	Scientists from MSS	One year before the benchmark as it is a proceess that is time consuming.
Fishery selectivity pattern	Flat-topped & dome-shaped selectivity pattern both plausible; modelling the main fleets separately may help. Will require a longer time-series of fleet disaggregated data.	Scientists from MSS (and MI)	A data call before the data compilation workshop.
Discard proportions poorly estimated	Alternative discard models: using an age-based ogive or modelling all age one as discards	Scientists from MSS; using alternative assessment models or bespoke modifications to TSA.	Ahead of benchmark
Assessment method	Application of alternative stock assessment models and/or a multiple model approach.	Scientists from MSS	In preparation for next benchmark.

[1] **MSS = Marine Scotland Science; MI = Marine Institute Ireland.**

3.6.2 Management considerations

The fisheries for cod are fully under the landing obligation from 2019 onwards. In the past, they have been managed by a combination of landings limits, area closures and technical measures. The measures taken thus far have not recovered the stock. Although fishing mortality has reduced since 2005 (showing a proportionately similar reduction to the decline in reported effort since 2003), it remains well above F_{MSY} and showed an increase in 2019.

Cod are known to form aggregations, so it is still possible to find areas of high cod density at low stock abundance (as apparent in the Scottish Q1 survey in particular). This can lead to high caches in localized areas, generating high fishing mortality even with low fishing effort. The impact of this could potentially be reduced by the use of temporary spatial closures.

The fishing opportunities regulation explicitly made the stock a bycatch species from 2012 to 2018. Allowing landings up to 1.5% of the live weight of the total catch can cause a perverse incentive for vessels to increase catches of other species and does not inhibit the catch of cod. In fact, in recent years the landings of 6.a cod have increased.

Although the UK 'Buyers and Sellers' and Irish 'Sales Notes' legislation is considered to have reduced underreporting from 2006, discard data show increased discards at-ages one and two and a change in discard practices such that fish are discarded at older ages from this time onwards (i.e. the discards are now largely high-grading). With the full implementation of the landing obligation in 2019 for fisheries catching cod, a bycatch TAC of 1735 t has been set to allow mixed fisheries with a bycatch of cod to continue (Cf. ICES estimated catch of 1890 t in 2018 and 2363 t in 2017). It is not known how the fishery will respond to the increase in TAC. The forecast assumes that in 2019 and 2020, unwanted catch will be the catch below MCRS, which is approximated by the use of a historical discard proportion-at-age.

Estimates of misreporting (landings believed to be taken in Division 6.a and reported elsewhere) from Marine Scotland Compliance imply ICES landings estimates which are in excess of TACs during the mid-2000s. Area misreported landings account for over 60% of the total landings in 2018. Measures to reduce area misreporting should also be introduced.

Cod is taken in mixed demersal fisheries, and in Division 6.a is a bycatch species. To greatly reduce cod catch would likely result in having to greatly reduce harvesting of other stocks such as haddock, whiting and anglerfish. It is also important the bycatch from the *Nephrops* fleet is closely monitored (including discard observations). In 2018, large trawl gear vessels targeting finfish are responsible for 93% of cod catches in Division 6.a, the *Nephrops* fleet take approximately 4% and the remainder are taken by other gears, including longliners and gillnets.

A report by the Sea Mammal Research unit (Hammond and Harris, 2006) gives estimates of cod consumed by grey seals to the west of Scotland. Although highly uncertain, the estimates suggest predation mortality on cod is significant and this may impair the ability of the cod stock to recover, but data are limited (Cook *et al.*, 2015).

3.6.3 Frequency of assessment

This stock has had zero catch advice for over ten years and therefore meets the first of the criteria for consideration for biennial assessment as outlined by WGCSE in 2016.

3.6.4 References

Cook, R. M. 2019. Stock collapse or stock recovery? Contrasting perceptions of a depleted cod stock. ICES Journal of Marine Science. doi:10.1093/icesjms/fsy190.

Cook, R. M., Holmes, S. J. and Fryer, R. J. 2015. Grey seal predation impairs recovery of an over-exploited fish stock. J. Applied Ecol., 52(4), 969–979.

EU. 2008. COUNCIL REGULATION (EC) No. 1342/2008 of 18 December 2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks and repealing Regulation (EC) No. 423/2004. Official Journal of the European Union, L 348/21.

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:348:0020:0033:EN:PDF.

EU. 2016. COUNCIL REGULATION (EU) 2016/2094 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 November 2016 amending Council Regulation (EC) No 1342/2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks.

Hammond, P. S., and Harris, R. N. 2006. Grey seal diet composition and prey consumption off western Scotland and Shetland. Final report to Scottish Executive Environment and Rural Affairs Department and Scottish Natural Heritage.

ICES. 2012. Report of the Benchmark Workshop on Western Waters Roundfish (WKROUND), 22–29 February 2012, Aberdeen, UK. ICES CM 2012/ACOM:49. 283 pp.

ICES. 2015. Report of the Inter-Benchmark Protocol of West of Scotland Roundfish (IBPWSRound), February–April 2015. ICES CM 2015/ACOM:37.

ICES. 2019. Inter-benchmark Workshop on West of Scotland Cod (6.a) (IBPCod6.a). ICES Scientific Reports. 1:13. 171 pp. http://doi.org/10.17895/ices.pub.4976.

Lorenzen K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology 49, 627–647.

STECF. 2011. Scientific, Technical and Economic Committee for Fisheries. Evaluation of Fishing Effort Regimes Regarding Annexes IIA, IIB and IIC of TAC & Quota Regulations, Celtic Sea and Bay of Biscay (STECF-11–13).

STECF. 2011. Scientific, Technical and Economic Committee for Fisheries. Evaluation of Fishing Effort Regimes (STECF-13–13).

Scientific, Technical and Economic Committee for Fisheries (STECF) – Evaluation of Fishing Effort Regimes in European Waters - Part 2 (STECF-14-20). 2014. Publications Office of the European Union, Luxembourg, EUR 27027 EN, JRC 93183, 844 pp.

Table 5.1. Cod in Division 6.a. ICES official catch statistics.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Belgium	48	88	33	44	28	-	6	-	22	1	2	+	11	1	+	+	2
Denmark	-	-	4	1	3	2	2	3	2	+	4	2	-	-	+	-	-
Faroe Islands	-	-	-	11	26	-	-	-	-	-	-	-	-	-	-	-	-
France	7,411	5,096	5,044	7,669	3,640	2,220	2,503	1,957	3,047	2,488	2,533	2,253	956	714	842	236	391
Germany	66	53	12	25	281	586	60	5	94	100	18	63	5	6	8	6	4
Greenland																	
Ireland	2,564	1,704	2,442	2,551	1,642	1,200	761	761	645	825	1,054	1,286	708	478	223	357	319
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-
Norway	204	174	77	186	207	150	40	171	72	51	61	137	36	36	79	114	39
Spain	28	-	-	-	85	-	-	-	-	-	16	+	6	42	45	14	3
UK (E. W. N.I.)	260	160	444	230	278	230	511	577	524	419	450	457	779	474	381	280	138
UK (Scotland)	8,032	4,251	11,143	8,465	9,236	7,389	6,751	5,543	6,069	5,247	5,522	5,382	4,489	3,919	2,711	2,057	1544
UK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total landings	18,613	11,526	19,199	19,182	15,426	11,777	10,634	9,017	10,475	9,131	9,660	9,580	6,992	5,671	4,289	3,064	2440

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
Belgium	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.2	0.7	0.039
Faroe Islands	-	-	2	0	1	12	1	-	-	-	-	-	-	-	-	-	0.25
France	208	172	91	107	108	92	82	74	60	49	4	3	5	11.4	85.7	118.5	100.52
Germany	+	+	-	-	2	2	1	-	-	-	-	-	-	-	-	-	
Greenland			-	-				-	-	-	-	-	-	-	+	-	
Ireland	210	120	34	28	18	70	58	24	49	41	18	14	12	17.5	27.5	18.6	12.1505
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Norway	88	45	10	17	30	30	65	18	20	8	2	24	14	59	39.3	14	36.79
Spain	11	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
UK (E. W. N.I.)	195	79	46	25	14	21	6	14	4	3	2	1	9				
UK (Scotland)	1519	879	413	243	318	260	232	104	115	107	135	130	121				
UK	-	-	-	-		-	-							168	182.2	198.9	210.083
Total landings	2231	1298	596	420	491	487	445	234	248	208	161	172	161	255.9	346.7	350.7	359.8325

*** Preliminary.**

+ < 1 tonne

Table 5.2. Cod in Division 6.a. Landings (reported into 6a and area misreported), discards and catch (tonnes) estimates, as used by the WG. Values are totals for fish aged 1 to 7+.

Year	Landings		Discards	Catch
	reported	misreported		
1981	23865		303	24168
1982	21511		571	22082
1983	21305		197	21503
1984	21272		329	21601
1985	18607		963	19570
1986	11820		263	12083
1987	18971		2388	21358
1988	20413		368	20781
1989	17169		2076	19246
1990	12175		571	12746
1991	10927		622	11549
1992	9086		1779	10865
1993	10314		139	10453
1994	8928		661	9588
1995	9439		141	9580
1996	9427		63	9489
1997	7034		499	7533
1998	5714		538	6252
1999	4201		69	4270
2000	2977		821	3798
2001	2347		92	2439
2002	2243		480	2722
2003	1241		34	1275
2004	540		72	612
2005	511		41	552
2006	463	26	465	954
2007	524	70	1880	2474
2008	454	228	695	1377
2009	222	186	945	1353
2010	239	320	785	1344
2011	170	284	1670	2124
2012	174	292	1166	1632
2013	176	123	1202	1501
2014	152	205	1311	1668
2015	308	461	983	1752
2016	394	498	852	1745
2017	365	429	1569	2363
2018	388	741	760	1890

Table 5.3. Cod in Division 6.a. Survey data made available to the WG. Data used in update assessment are highlighted in bold. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

ScoGFS- WIBTS- Q1: Scottish west coast groundfish survey

1985	**2010**							
1	1	0	0.25					
1	7							
10	**1.5**	**23.7**	**8.6**	**13.6**	**3.9**	**2.5**	1.2	1985
10	**1.5**	**6.9**	**26.8**	**5.6**	**7.3**	**2.5**	1.9	1986
10	**57.4**	**16.2**	**15.3**	**22.8**	**3.0**	**2.8**	0.0	1987
10	**0.0**	**64.9**	**14.2**	**3.4**	**2.1**	**0.7**	0.2	1988
10	**4.5**	**7.2**	**45.1**	**8.6**	**1.9**	**0.5**	0.8	1989
10	**2.0**	**24.6**	**4.1**	**14.7**	**4.2**	**1.6**	0.8	1990
10	**4.8**	**5.4**	**17.4**	**5.2**	**13.4**	**2.8**	0.5	1991
10	**7.3**	**11.5**	**5.4**	**7.6**	**3.4**	**2.3**	0.5	1992
10	**1.7**	**38.2**	**12.7**	**1.7**	**1.4**	**1.1**	0.0	1993
10	**13.6**	**14.7**	**25.1**	**5.8**	**1.0**	**0.0**	0.0	1994
10	**6.4**	**23.8**	**14.0**	**16.5**	**1.2**	**1.9**	0.7	1995
10	**2.8**	**20.9**	**24.1**	**4.1**	**2.8**	**1.3**	0.0	1996
10	**11.1**	**7.7**	**11.6**	**7.9**	**4.2**	**4.7**	1.0	1997
10	**2.8**	**30.9**	**5.3**	**8.7**	**3.7**	**0.6**	2.0	1998
10	**1.5**	**8.2**	**8.2**	**1.4**	**3.2**	**0.5**	0.5	1999
10	**13.3**	**5.4**	**6.9**	**1.3**	**0.0**	**0.4**	0.0	2000
10	**2.7**	**18.4**	**5.7**	**13.2**	**19.5**	**1.1**	1.6	2001
10	**5.3**	**4.3**	**10.6**	**2.6**	**0.5**	**3.0**	0.0	2002
10	**2.7**	**16.7**	**2.0**	**4.7**	**1.8**	**0.7**	0.4	2003
10	**5.7**	**3.0**	**5.6**	**2.3**	**1.7**	**0.0**	0.0	2004
10	**1.3**	**1.5**	**1.2**	**0**	**0**	**0.4**	0	2005
10	**2.2**	**1.9**	**1.1**	**0.3**	**0**	**0**	0.3	2006
10	**2.1**	**18.8**	**3.4**	**1.2**	**0**	**0.6**	0	2007
10	**0.8**	**2.1**	**44.2**	**6.3**	**0.8**	**0**	0	2008
10	**1.8**	**2.6**	**2.3**	**0.4**	**0**	**0**	0	2009
10	**4.6**	**16.2**	**3.7**	**1.0**	**0.7**	**0**	0	2010

Table 5.3. Continued. Cod in Division 6.a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

UK-SCOWCGFS-Q1 (index)

2011	2019							
1	1	0	0.25					
1	7							
10	**0.52**	**32.95**	**21.07**	**0.93**	**0.98**	**0.74**	0.00	2011
10	**13.99**	**27.30**	**22.72**	**4.58**	**3.50**	**2.20**	4.20	2012
10	**20.03**	**40.26**	**26.38**	**36.95**	**7.76**	**0.30**	0.00	2013
10	**11.40**	**41.73**	**13.44**	**5.12**	**4.31**	**0.75**	0.00	2014
10	**8.16**	**36.40**	**70.70**	**37.74**	**23.25**	**13.00**	2.47	2015
10	**4.73**	**56.07**	**65.41**	**44.56**	**5.67**	**2.36**	2.29	2016
10	**2.92**	**33.49**	**50.58**	**49.58**	**156.64**	**10.71**	24.89	2017
10	**1.728**	**20.375**	**7.199**	**19.765**	**9.98**	**2.261**	1.092	2018
10	**9.924**	**4.173**	**6.888**	**2.031**	**3.181**	**0.318**	0.318	2019

UK-SCOWCGFS-Q1 (variance)

2011	2019							
1	1	0	0.25					
1	7							
10	**0.09**	**78.37**	**24.06**	**0.22**	**0.49**	**0.30**	0.00	2011
10	**44.18**	**120.08**	**33.73**	**2.31**	**8.34**	**4.83**	13.02	2012
10	**118.35**	**151.04**	**136.89**	**240.05**	**6.47**	**0.09**	0.00	2013
10	**20.17**	**383.27**	**12.23**	**3.04**	**5.47**	**0.28**	0.00	2014
10	**14.35**	**112.82**	**1264.73**	**602.27**	**289.82**	**98.91**	5.48	2015
10	**1.81**	**214.42**	**607.48**	**319.21**	**5.02**	**1.60**	1.85	2016
10	**1.43**	**155.67**	**498.57**	**1061.90**	**20475.95**	**84.79**	287.62	2017
10	**1**	**24.03**	**2.21**	**20.09**	**7.46**	**0.5**	0.25	2018
10	**6.79**	**2.03**	**6.12**	**0.6**	**1.98**	**0.1**	0	2019

Table 5.3. Continued. Cod in Division 6.a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

IreGFS	Irish groundfish survey			
1993	2002			
1	1	0.75	0.79	
0	3			
1849	0.0	312.0	49.0	13.0
1610	20.0	999.0	56.0	13.0
1826	78.0	169.0	142.0	69.0
1765	0.0	214.0	89.0	18.0
1581	6.0	565.0	31.0	10.0
1639	0.0	83.0	53.0	6.0
1564	0.0	24.0	14.0	3.0
1556	0.0	124.0	4.0	1.0
755	3.0	82.0	28.0	2.0
798	0.0	50.6	2.2	1.2

ScoGFS-WIBTS-Q4: Quarter 4 Scottish ground fish survey

1996	2010									
1	1	0.75	1.00							
0	8									
10	0	**0.7**	**14.4**	**5**	**3**	1.1	0.5	0	0	1996
10	1	**10.9**	**2.4**	**1.4**	**1.4**	1.4	0.2	0	0	1997
10	+	**14.8**	**9.7**	**1.1**	**0**	0	0	0	0	1998
10	2	**4**	**6**	**9.2**	**0.5**	0	0	0	0	1999
10	0	**15.8**	**2.6**	**0.4**	**0.4**	0	0	0	0	2000
10	1	**1.7**	**7.3**	**1.7**	**0.3**	0	0	0	0	2001
10	1	**10.4**	**2.8**	**6.8**	**0.6**	0	0	0	0	2002
10	1	**1.5**	**11.3**	**2.9**	**0.6**	0	0	0	0	2003
10	0	**5.1**	**3.8**	**1.4**	**0**	0.7	0	0	0	2004
10	+	**2.1**	**3**	**0**	**0.6**	0.3	0	0	0	2005
10	0	**16.9**	**5.9**	**1.4**	**0.7**	0	0	0	0	2006
10	0	**12**	**20**	**1.3**	**0.5**	0	0.3	0	0	2007
10	2	**7.7**	**5**	**7**	**1**	0	0	0	0	2008
10	2	**14.2**	**3.8**	**1.2**	**1.2**	0.3	0	0	0	2009
10	na	na	na	na	na	na	na	na	na	2010

Table 5.3. Cont. Cod in Division 6.a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

UK-SCOWCGFS-Q4 (index)

2011	2018									
1	1	0.75	1.0							
0	8									
10	0.60	**9.71**	**31.54**	**10.88**	**0.93**	**1.70**	**2.38**	0.00	0.00	2011
10	0.75	**19.78**	**7.12**	**15.43**	**13.60**	**1.02**	**0.68**	0.34	0.00	2012
Survey not completed due to mechanical issues										2013
10	1.67	**23.65**	**28.06**	**15.63**	**5.57**	**6.63**	**1.37**	0.00	0.00	2014
10	3.64	**28.17**	**52.53**	**34.22**	**10.58**	**4.24**	**5.27**	1.18	0.59	2015
10	0.374	**6.162**	**34.941**	**45.443**	**118.92**	**14.893**	**5.773**	3.176	0	2016
10	2.127	**10.024**	**6.221**	**24.427**	**10.881**	**8.538**	**0.767**	0.511	0	2017
10	0	**4.569**	**15.945**	**4.809**	**39.902**	**29.022**	**10.887**	0.829	0	2018

UK-SCOWCGFS-Q4 (variance)

2011	2018									
1	1	0.75	1.0							
0	8									
10	0.21	**31.08**	**38.07**	**5.78**	**0.19**	**1.56**	**4.79**	0.00	0.00	2011
10	0.14	**41.72**	**2.79**	**11.37**	**48.79**	**1.05**	**0.46**	0.12	0.00	2012
Survey not completed due to mechanical issues										2013
10	0.68	**132.97**	**56.62**	**44.17**	**3.87**	**4.79**	**0.39**	0.00	0.00	2014
10	5.55	**98.78**	**316.23**	**51.22**	**8.60**	**4.43**	**4.61**	0.34	0.12	2015
10	0.14	**7.394**	**419.36**	**716.38**	**7654.82**	**118.64**	**24.30**	6.08	0	2016
10	3.215	**11.252**	**3.816**	**76.154**	**14.262**	**8.928**	**0.207**	0.063	0	2017
10	0	**3.71**	**28.22**	**8.46**	**532.1**	**271.49**	**44.45**	0.39	0	2018

Table 5.3. Continued. Cod in Division 6.a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

IRGFS–WIBTS–Q4 Irish West Coast groundfish.

2003	2018					
1	1	0.79	0.92			
0	4					
1127	0	**10**	**11**	**0**	0	2003
1200	0	**24**	**10**	**1**	0	2004
960	63	**13**	**7**	**0**	2	2005
1510	0	**95**	**12**	**0**	0	2006
1173	0	**161**	**12**	**0**	1	2007
1135	0	**23**	**24**	**4**	0	2008
1378	1	**75**	**4**	**5**	0	2009
1291	0	**70**	**31**	**4**	3	2010
1287	1	**26**	**26**	**4**	0	2011
1230	0	**74**	**7**	**3**	0	2012
1295	0	**92**	**11**	**0**	0	2013
1200	0	**113**	**20**	**2**	0	2014
1213	0	**15**	**11**	**3**	0	2015
962	0	**27**	**23**	**2**	0	2016
1196	0	**2**	**17**	**7**	2	2017
966	1	**21**	**3**	**0**	1	2018

Table 5.4. Cod in Division 6.a. Landings-at-age (thousands). Values for 2006 onwards include an adjustment for area misreporting.

	1	2	3	4	5	6	7+
1978	723	1761	999	695	286	97	75
1979	929	1612	2125	682	342	134	69
1980	1195	3294	2001	796	191	77	37
1981	461	7016	3220	904	182	29	20
1982	1827	1673	3206	1189	367	111	33
1983	2335	4515	1118	1400	468	148	60
1984	2143	2360	2564	448	555	185	59
1985	1355	5069	1269	1091	140	167	79
1986	792	1486	2055	411	191	40	30
1987	7873	4837	988	905	137	56	26
1988	1008	8336	2193	278	210	39	20
1989	2017	1082	3858	709	113	69	33
1990	513	4024	432	924	170	23	11
1991	1518	1728	1805	188	266	70	23
1992	1407	1868	575	720	69	58	24
1993	328	3596	1050	131	183	24	36
1994	942	1207	1545	280	56	51	20
1995	753	2750	700	630	70	15	11
1996	341	2331	1210	247	204	31	13
1997	1414	1067	989	281	66	62	7
1998	310	3318	293	174	57	16	9
1999	132	884	1047	64	48	24	9
2000	765	532	211	231	15	12	13
2001	96	1241	155	63	52	3	4
2002	337	340	522	41	13	14	4
2003	62	516	85	107	6	2	1
2004	44	92	85	11	26	2	1
2005	31	121	43	37	7	6	0
2006	18	96	76	22	13	2	1
2007	6	187	70	37	3	4	3
2008	0	34	130	25	16	1	3
2009	2	12	11	59	8	2	0
2010	0	43	61	38	32	1	0
2011	0	11	40	34	12	13	2
2012	3	1	41	51	5	4	5
2013	0	8	9	43	10	2	1
2014	0	3	66	31	23	2	0
2015	0	53	55	41	29	27	1
2016	2	33	112	69	22	11	14
2017	1	22	62	54	52	15	3
2018	2	24	45	87	55	34	11

Table 5.5. Cod in Division 6.a. Mean weight-at-age in landings (kg).

	1	2	3	4	5	6	7+
1978	0.63	1.373	3.389	5.262	7.096	8.686	9.857
1979	0.693	1.373	2.828	4.853	6.433	7.784	9.636
1980	0.624	1.375	3.002	5.277	7.422	8.251	9.331
1981	0.55	1.166	2.839	4.923	7.518	9.314	10.328
1982	0.692	1.468	2.737	4.749	6.113	7.227	9.856
1983	0.583	1.265	2.995	4.398	6.305	8.084	9.744
1984	0.735	1.402	3.168	5.375	6.601	8.606	10.35
1985	0.628	1.183	2.597	4.892	6.872	8.344	9.766
1986	0.71	1.211	2.785	4.655	6.336	8.283	9.441
1987	0.531	1.312	2.783	4.574	6.161	7.989	10.062
1988	0.806	1.182	2.886	5.145	6.993	8.204	9.803
1989	0.704	1.298	2.425	4.737	7.027	7.52	9.594
1990	0.613	1.275	2.815	4.314	7.021	9.027	11.671
1991	0.64	1.095	2.618	4.346	6.475	8.134	10.076
1992	0.686	1.293	2.607	4.268	6.19	7.844	10.598
1993	0.775	1.316	2.94	4.646	6.244	7.802	8.409
1994	0.644	1.292	2.899	4.71	6.389	8.423	8.409
1995	0.606	1.148	2.857	4.956	6.771	8.539	9.505
1996	0.667	1.221	2.738	5.056	6.892	8.088	10.759
1997	0.595	1.21	2.571	4.805	6.952	7.821	9.63
1998	0.605	1.061	2.264	4.506	6.104	8.017	9.612
1999	0.691	1.039	2.194	4.688	6.486	8.252	9.439
2000	0.689	1.261	2.457	4.126	6.666	7.917	8.392
2001	0.654	0.988	2.679	4.568	5.86	7.741	9.386
2002	0.668	1.14	2.33	4.841	6.175	7.192	9.548
2003	0.671	1.016	2.312	3.854	6.22	8.075	8.839
2004	0.609	1.027	2.194	4.396	6.003	8.258	9.678
2005	0.776	1.172	2.624	4.118	4.908	6.753	10.24
2006	0.656	1.169	2.236	3.822	6.172	7.796	11.1
2007	0.476	0.976	2.512	4.285	6.491	7.733	8.81
2008	0.557	1.183	2.992	4.826	6.33	7.957	8.471
2009	0.988	1.961	3.132	4.759	5.904	8.171	8.646
2010	0	1.521	2.671	3.977	5.269	6.144	7.974
2011	0	1.434	3.2	4.057	5.832	6.525	9.891
2012	0.66	1.737	2.797	4.833	6.876	7.296	7.52
2013	0.993	1.372	2.966	4.073	6.141	7.158	9.849
2014	0.969	1.422	2.094	3.046	4.697	5.505	7.206
2015	0.834	2.623	2.947	3.84	5.456	5.561	8.819
2016	0.737	1.411	2.427	3.958	5.267	6.606	7.746
2017	0.814	1.172	2.087	4.539	5.63	5.142	9.241
2018	0.878	1.601	2.626	4.15	5.43	6.437	8.571

Table 5.6. Cod in Division 6.a. Discard numbers-at-age (thousands).

	1	2	3	4	5	6	7+
1978	412	26	0	0	0	0	0
1979	16	81	0	0	0	0	0
1980	1171	0	0	0	0	0	0
1981	54	907	0	0	0	0	0
1982	1808	8	0	0	0	0	0
1983	843	25	0	0	0	0	0
1984	1088	11	0	0	0	0	0
1985	5188	114	0	0	0	0	0
1986	970	14	0	0	0	0	0
1987	14358	12	0	0	0	0	0
1988	231	1059	2	0	0	0	0
1989	6243	6	0	0	0	0	0
1990	4181	41	0	0	0	0	0
1991	2518	14	2	0	0	0	0
1992	7385	143	3	0	0	0	0
1993	279	84	1	0	0	0	0
1994	2743	6	0	0	0	0	0
1995	625	56	0	0	0	0	0
1996	191	50	0	0	0	0	0
1997	1521	34	0	0	0	0	0
1998	790	972	0	0	0	0	0
1999	230	5	0	0	0	0	0
2000	2882	33	0	0	0	0	0
2001	176	115	0	0	0	0	0
2002	1051	199	0	0	0	0	0
2003	69	26	1	0	0	0	0
2004	232	21	0	0	0	0	0
2005	108	20	0	0	0	0	0
2006	1210	47	24	2	3	1	0
2007	566	1489	50	38	3	3	0
2008	68	102	281	1	0	0	0
2009	605	150	109	94	0	5	0
2010	352	392	65	7	3	0	0
2011	316	281	535	42	0	2	0
2012	374	93	383	50	0	0	0
2013	2030	321	131	103	15	0	2
2014	705	316	255	51	19	1	0
2015	161	307	217	25	6	1	0
2016	1008	209	95	46	6	0	0
2017	168	294	376	92	17	2	0
2018	93	146	60	87	17	7	2

Table 5.7. Cod in Division 6.a. Mean weight-at-age in discards (kg).

	1	2	3	4	5	6	7+
1978	0.37	0.321					
1979	0.276	0.43					
1980	0.361						
1981	0.135	0.326					
1982	0.314	0.392					
1983	0.223	0.374					
1984	0.298	0.435					
1985	0.178	0.346					
1986	0.267	0.305					
1987	0.166	0.37					
1988	0.296	0.283					
1989	0.332	0.59					
1990	0.132	0.454					
1991	0.245	0.351					
1992	0.22	1.03	2.382				
1993	0.239	0.812	3.723				
1994	0.24	0.365					
1995	0.203	0.256					
1996	0.226	0.389					
1997	0.321	0.328					
1998	0.23	0.367	0.59				
1999	0.294	0.299					
2000	0.28	0.421					
2001	0.248	0.417					
2002	0.263	1.021					
2003	0.272	0.57	0.39				
2004	0.258	0.581					
2005	0.285	0.501					
2006	0.259	1.291	2.649	3.499	6.24	5.581	11.122
2007	0.198	0.94	3.016	4.453	5.018	10.627	
2008	0.22	0.976	2.046	4.047	7.937		
2009	0.261	1.312	2.248	3.324		6.448	
2010	0.253	1.312	2.268	3.218	3.245		
2011	0.212	1.023	2.207	2.993	4.891	4.168	
2012	0.151	1.197	2.18	3.222	8.537		
2013	0.111	0.945	2.119	3.05	5.029		6.27
2014	0.145	1.124	2.415	3.066	4.007	4.731	
2015	0.344	0.994	2.32	3.409	4.414	6.103	
2016	0.205	1.111	2.228	3.759	4.435		
2017	0.261	1.013	2.174	3.486	4.397	7.714	
2018	0.235	1.002	2.222	3.657	5.47	5.967	2.118

Table 5.8. Cod in Division 6.a. Total catch-at-age (thousands).

	1	2	3	4	5	6	7+
1978	1135	1787	999	695	286	97	75
1979	945	1693	2125	682	342	134	69
1980	2366	3294	2001	796	191	77	37
1981	515	7923	3220	904	182	29	20
1982	3635	1681	3206	1189	367	111	33
1983	3178	4540	1118	1400	468	148	60
1984	3231	2371	2564	448	555	185	59
1985	6543	5183	1269	1091	140	167	79
1986	1762	1500	2055	411	191	40	30
1987	22231	4849	988	905	137	56	26
1988	1239	9395	2195	278	210	39	20
1989	8260	1088	3858	709	113	69	33
1990	4694	4065	432	924	170	23	11
1991	4036	1742	1807	188	266	70	23
1992	8792	2011	578	720	69	58	24
1993	607	3680	1051	131	183	24	36
1994	3685	1213	1545	280	56	51	20
1995	1378	2806	700	630	70	15	11
1996	532	2381	1210	247	204	31	13
1997	2935	1101	989	281	66	62	7
1998	1100	4290	293	174	57	16	9
1999	362	889	1047	64	48	24	9
2000	3647	565	211	231	15	12	13
2001	272	1356	155	63	52	3	4
2002	1388	539	522	41	13	14	4
2003	131	542	86	107	6	2	1
2004	276	113	85	11	26	2	1
2005	139	141	43	37	7	6	0
2006	1228	143	100	24	16	2	1
2007	572	1677	120	75	6	7	3
2008	68	136	411	26	16	1	3
2009	607	162	120	154	8	7	0
2010	352	436	126	45	35	1	0
2011	316	292	574	77	12	15	2
2012	377	95	424	102	5	4	5
2013	2030	329	139	146	25	2	3
2014	705	320	322	81	42	3	0
2015	161	360	272	66	35	27	1
2016	1010	242	208	115	29	11	14
2017	169	316	437	145	69	17	3
2018	96	170	105	174	72	41	13

Table 5.9. Cod in Division 6.a. Mean weight-at-age (kg) in total catch.

	1	2	3	4	5	6	7+
1978	0.536	1.358	3.389	5.262	7.096	8.686	9.857
1979	0.686	1.328	2.828	4.853	6.433	7.784	9.636
1980	0.494	1.375	3.002	5.277	7.422	8.251	9.331
1981	0.506	1.070	2.839	4.923	7.518	9.314	10.328
1982	0.504	1.463	2.737	4.749	6.113	7.227	9.856
1983	0.488	1.260	2.995	4.398	6.305	8.084	9.744
1984	0.588	1.398	3.168	5.375	6.601	8.606	10.350
1985	0.271	1.165	2.597	4.892	6.872	8.344	9.766
1986	0.466	1.203	2.785	4.655	6.336	8.283	9.441
1987	0.295	1.310	2.783	4.574	6.161	7.989	10.062
1988	0.711	1.081	2.883	5.145	6.993	8.204	9.803
1989	0.423	1.294	2.425	4.737	7.027	7.520	9.594
1990	0.185	1.267	2.815	4.314	7.021	9.027	11.671
1991	0.394	1.089	2.615	4.346	6.475	8.134	10.076
1992	0.295	1.274	2.606	4.268	6.190	7.844	10.598
1993	0.529	1.304	2.941	4.646	6.244	7.802	8.409
1994	0.343	1.287	2.899	4.710	6.389	8.423	8.409
1995	0.423	1.130	2.857	4.956	6.771	8.539	9.505
1996	0.509	1.204	2.738	5.056	6.892	8.088	10.759
1997	0.453	1.183	2.571	4.805	6.952	7.821	9.630
1998	0.336	0.904	2.264	4.506	6.104	8.017	9.612
1999	0.439	1.035	2.194	4.688	6.486	8.252	9.439
2000	0.366	1.212	2.457	4.126	6.666	7.917	8.392
2001	0.391	0.940	2.679	4.568	5.860	7.741	9.386
2002	0.361	1.096	2.330	4.841	6.175	7.192	9.548
2003	0.461	0.995	2.290	3.854	6.220	8.075	8.839
2004	0.314	0.946	2.194	4.396	6.003	8.258	9.678
2005	0.395	1.078	2.624	4.118	4.908	6.753	10.240
2006	0.265	1.209	2.335	3.799	6.183	7.071	11.102
2007	0.201	0.944	2.723	4.370	5.813	9.001	8.810
2008	0.221	1.028	2.345	4.801	6.351	7.957	8.471
2009	0.264	1.362	2.329	3.876	5.904	6.951	8.646
2010	0.253	1.333	2.462	3.856	5.095	6.144	7.974
2011	0.212	1.038	2.276	3.469	5.812	6.249	9.891
2012	0.155	1.205	2.239	4.036	6.913	7.296	7.520
2013	0.111	0.955	2.171	3.352	5.488	7.158	7.608
2014	0.145	1.127	2.349	3.058	4.379	5.358	7.206
2015	0.345	1.232	2.447	3.674	5.266	5.575	8.819
2016	0.206	1.152	2.336	3.878	5.082	6.606	7.746
2017	0.264	1.024	2.162	3.876	5.320	5.425	9.241
2018	0.251	1.086	2.396	3.902	5.440	6.359	7.739

Table 5.10. Cod in Division 6.a. TSA parameter settings for the assessment run.

Parameter	Setting	Justification
Age of full selection.	$a_m = 6$	To allow flexibility when estimating fishery selectivity.
Survey catchability model	WIBTS.Q1 & WIBTS.Q4: no transitory or persistent changes SCO.Q1, SCO.Q4 & IRGFS.Q4: transitory changes estimates	Allows for survey year effects
Multipliers on variance matrices of measurements.	$B_{landings}$(a, 1981-2005) = 2 for ages 1, 6 $B_{landings}$(a, 1981-2005) = 3 for ages 7+ $B_{landings}$(1–7+, 2007 onwards) = (15.6,9.1,3.6,1.2,1.9,3.8,7.5) $B_{discards}$(1–4, 2007 onwards) = (0.96,0.62,0.91,0.87)	Allows extra measurement variability for poorly-sampled ages (based on relative size of residuals). Allows extra measurement error post Buyers & Sellers legislation (based on external estimates of CV).
Multipliers on variances for fishing mortality estimates.	H(1) = 2 v.cvmult (1986) = 3	Allows for more variable fishing mortalities for age 1 fish. Allows for greater transitory change in fishing mortality year component.
Downweighting of particular datapoints.	Landings: Age 1 in 2019 Age 2 in 1987 age 6 in 1982 age 4 in 2004 Discards: age 1 in 1988, 1992 and 2016 age 2 in 1988, 1992,1998,2002. Survey (WCIBTS.Q1): Age 1 in 1987 age 2 in 2007 and 2010, age 3 in 2008, age 4 in 2001 and 2008, age 5 in 2001. Survey IRGFS.Q4: age 1	CV multiplier set to 3 or 5 as necessary. Large values indicated by exploratory prediction error plots. Survey downweighting in 2001 resulted from a single large haul, 24 fish >75 cm in 30 minutes. In 2008 due to v large haul near 4 degrees W line.
Discards	Discards are allowed to evolve over time constrained by a trend. Ages 1 to 4 are modelled independently. A step function is specified with the step occurring in 2006.	
Recruitment.	Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean $\eta 1\ S \exp(-\eta 2\ S)$, where S is the spawning–stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.	

Parameter	Setting	Justification
Large year classes.	The 1986 year class was large, and recruitment at-age 1 in 1987 is not well modelled by the Ricker recruitment model. Instead, N(1, 1987) is taken to be normally distributed with mean $5\eta_1 S \exp(-\eta_2 S)$. The factor of 5 was chosen by comparing maximum recruitment to median recruitment from 1966–1996 for 6.a cod, haddock, and whiting in turn using previous XSA runs. The coefficient of variation is again assumed to be constant.	

Table 5.11. Cod in Division 6.a. Comparison of TSA parameter estimates from recent assessments.

Parameter	*Notation*	Description	2018 WG	2019 IBP	2019 WG
Initial fishing mortality	F (1, 1981)	Fishing mortality-at-age a in year y	0.323	0.2507	0.264
	F (2, 1981)		0.668	0.5698	0.597
	F (a_m, 1981)		1.032	0.7805	0.753
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.152	0.1304	0.168
	σ_U	Persistent changes in selection (age effect in F)	0.009	0.0299	0.031
	σ_V	Transitory changes in the year effect in fishing mortality	0.178	0.0398	0.041
	σ_Y	Persistent changes in the year effect in fishing mortality	0.000	0.0989	0.085
Measurement CVs	$CV_{landings}$	CV of landings-at-age data	0.125	0.0881	0.067
	$CV_{discards}$	CV of discards-at-age data	0.445	0.5776	0.558
Recruitment	η_1	Ricker parameter (slope at the origin)	1.282	1.1145	1.029
	η_2	Ricker parameter (curve dome occurs at $1/\eta_2$)	0.024	0.0203	0.017
	cv_{rec}	Coefficient of variation of recruitment data	0.407	0.4213	0.459
Discards	$\sigma_{logit\ p}$	Transitory trends in discarding	0.788	0.7766	0.731
	$\sigma_{persistent}$	Persistent trends in discarding	0.296	0.2428	0.248
	Step fn age 1	Amount by which discards increase in 2006	4.058	5.9209	5.211
	Step fn age 2		5.895	6.2889	5.789
	Step fn age 3		0.985	1.1065	0.913
	Step fn age 4		-0.436	-0.1026	-0.173

Parameter	*Notation*	Description	2018 WG	2019 IBP	2019 WG
Survey selectivities WCIBTS.Q1	$\Phi(1)$	Survey selectivity-at-age *a*	0.561	0.4805	0.509
	$\Phi(2)$		2.897	2.8158	2.976
	$\Phi(3)$		6.950	6.4213	6.745
	$\Phi(4)$		10.666	9.9981	10.176
	$\Phi(5)$		15.379	12.9927	12.981
	$\Phi(6)$		20.789	15.1818	14.852
Survey CVs	σ_{survey}	CV parameter controlling gamma type dispersion	0.258	0.0393	0.014
	η_{survey}	CV parameter controlling poisson type dispersion	1.142	1.5815	1.649
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	NA	NA	NA
	σ_{β}	Persistent changes in survey catchability	NA	NA	NA
Survey selectivities UK-SCO.Q1	$\Phi(1)$	Survey selectivity-at-age *a*	0.841	0.6911	1.393
	$\Phi(2)$		20.677	23.4037	27.540
	$\Phi(3)$		40.604	37.077	39.420
	$\Phi(4)$		49.005	48.9306	48.387
	$\Phi(5)$		84.270	71.0896	71.739
	$\Phi(6)$		63.453	48.8489	35.339
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	0.388	0.3794	0.302
	σ_{β}	Persistent changes in survey catchability	NA	NA	NA
Survey selectivities WCIBTS.Q4	$\Phi(1)$	Survey selectivity-at-age *a*	NA	3.1029	3.410
	$\Phi(2)$		NA	6.2709	7.131
	$\Phi(3)$		NA	5.1223	6.019
	$\Phi(4)$		NA	1.9957	2.348
Survey CVs	σ_{survey}	CV parameter controlling gamma type dispersion	NA	0.0498	0.044
	η_{survey}	CV parameter controlling poisson type dispersion	NA	2.643	2.497

Parameter	*Notation*	Description	2018 WG	2019 IBP	2019 WG
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	NA	NA	NA
	σ_{β}	Persistent changes in survey catchability	NA	NA	NA
Survey selectivities UK-SCO.Q4	$\Phi(1)$	Survey selectivity-at-age *a*	NA	12.2388	11.239
	$\Phi(2)$		NA	23.3137	25.541
	$\Phi(3)$		NA	61.3276	58.059
	$\Phi(4)$		NA	99.2573	94.364
	$\Phi(5)$		NA	149.2903	133.958
	$\Phi(6)$		NA	125.1986	121.535
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	NA	0.142	0.000
	σ_{β}	Persistent changes in survey catchability	NA	NA	NA
Survey selectivities IRGFS.Q4	$\Phi(1)$	Survey selectivity-at-age	NA	15.3431	15.981
	$\Phi(2)$		NA	12.0422	11.947
	$\Phi(3)$		NA	3.4018	3.517
Survey CVs	σ_{survey}	CV parameter controlling gamma type dispersion	NA	0.0393	0.011
	η_{survey}	CV parameter controlling poisson type dispersion	NA	1.6476	1.591
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	NA	0.0197	0.010
	σ_{β}	Persistent changes in survey catchability	NA	NA	NA
Misreporting		Transitory changes in misreporting	0.002	0.0185	0.000
		Persistent changes in misreporting	0.258	0.1498	0.147

Table 5.12. Cod in Division 6.a. TSA population numbers-at-age (thousands).

	1	2	3	4	5	6	7
1981	11028	19248	6959	1965	433	68	48
1982	26437	5488	7166	2456	739	183	48
1983	15317	12839	2398	2647	885	268	87
1984	27103	6437	5142	806	847	295	110
1985	13406	12755	2482	1607	235	203	115
1986	23663	4839	4328	778	347	72	80
1987	57984	10899	1902	1497	252	111	52
1988	6830	19733	4131	567	368	80	52
1989	24723	2795	6630	1217	191	112	47
1990	8515	10036	1004	1631	340	53	42
1991	13386	3497	3633	363	479	118	35
1992	22922	5508	1127	1250	133	150	48
1993	9087	10350	2110	337	347	45	72
1994	18653	4156	4050	611	118	102	39
1995	14871	8100	1723	1441	179	36	40
1996	6364	6757	2696	545	439	59	26
1997	23205	2879	2111	708	155	125	21
1998	6608	10072	741	484	199	44	37
1999	4501	2691	2746	175	132	66	24
2000	16469	1937	728	666	46	37	28
2001	3566	6129	556	199	171	12	17
2002	7436	1510	1886	141	44	43	9
2003	1978	2714	425	490	34	9	11
2004	2947	766	652	108	123	10	5
2005	1660	1168	219	188	34	28	3
2006	5291	661	395	48	43	7	8
2007	2088	2332	213	109	9	10	4
2008	1424	825	775	53	28	2	3
2009	3681	639	302	237	13	9	1
2010	3642	1643	244	88	68	3	3
2011	1586	1727	665	69	23	23	2
2012	2407	716	737	164	12	7	7
2013	4986	1066	323	265	48	4	5
2014	3592	1925	467	138	100	16	3
2015	3337	1685	906	178	62	44	8
2016	1282	1655	773	379	68	21	19
2017	1579	592	813	318	161	27	15
2018	826	764	240	339	128	65	15
2019*	6404	381	345	89	121	41	27

***2019 values are TSA-derived projections of population numbers (smoothed).**

Table 5.13. Cod in Division 6.a. Standard errors on TSA population numbers-at-age (thousands).

	1	2	3	4	5	6	7
1981	1263	875	319	102	34	7	7
1982	1131	191	334	148	58	24	5
1983	1198	456	87	153	82	38	12
1984	1239	359	216	43	81	53	25
1985	1278	447	133	96	23	49	33
1986	1404	267	173	39	32	12	22
1987	6542	555	73	66	16	16	10
1988	1006	1194	150	29	28	9	9
1989	2015	148	366	47	10	13	5
1990	1320	504	54	125	22	7	8
1991	1604	364	279	25	51	12	4
1992	2008	513	122	110	11	24	8
1993	876	730	184	37	37	6	11
1994	1858	312	344	63	12	16	7
1995	1439	749	143	128	23	6	9
1996	884	566	287	52	46	10	6
1997	2004	254	229	87	18	19	6
1998	935	731	91	59	23	7	8
1999	598	309	267	21	15	7	4
2000	1633	196	87	73	6	6	4
2001	463	626	56	20	18	2	3
2002	985	160	189	15	6	6	1
2003	388	342	49	56	4	2	3
2004	526	118	97	15	15	1	2
2005	457	177	34	26	4	6	1
2006	705	180	59	12	11	2	3
2007	393	276	41	11	2	3	1
2008	246	154	89	8	3	1	1
2009	484	100	50	26	2	2	1
2010	388	207	33	13	8	1	1
2011	185	176	77	8	3	4	1
2012	389	72	74	16	1	2	2
2013	609	164	30	22	5	1	1
2014	413	223	64	10	8	3	1
2015	384	187	96	19	4	5	2
2016	210	183	87	37	8	4	4
2017	252	76	95	34	17	5	4
2018	187	110	32	40	13	9	3
2019*	1452	78	58	15	23	9	7

***2019 values are standard errors on TSA-derived projections of population numbers.**

Table 5.14. Cod in Division 6.a. TSA estimates for fishing mortality-at-age.

	1	2	3	4	5	6	7
1981	0.184	0.607	0.730	0.720	0.631	0.646	0.673
1982	0.178	0.431	0.696	0.753	0.784	0.731	0.904
1983	0.340	0.535	0.798	0.865	0.846	0.920	1.016
1984	0.210	0.591	0.866	0.954	1.050	0.999	0.937
1985	0.483	0.697	0.875	1.250	0.971	1.150	1.073
1986	0.179	0.551	0.764	0.884	0.931	0.929	0.876
1987	0.483	0.569	0.914	1.137	0.923	0.943	0.951
1988	0.381	0.713	0.905	0.836	1.001	0.815	0.819
1989	0.362	0.650	1.062	1.025	1.066	1.107	1.150
1990	0.379	0.635	0.690	0.998	0.817	0.785	0.755
1991	0.360	0.762	0.769	0.743	0.939	0.959	0.980
1992	0.233	0.576	0.922	1.039	0.855	0.803	0.880
1993	0.244	0.552	0.956	0.806	1.025	0.956	0.910
1994	0.298	0.494	0.733	0.979	0.969	1.052	1.005
1995	0.254	0.714	0.856	0.943	0.892	0.938	0.878
1996	0.296	0.783	1.009	1.016	1.040	1.187	1.110
1997	0.278	0.961	1.162	1.020	1.046	1.204	1.054
1998	0.365	0.922	1.159	1.068	0.859	1.039	0.986
1999	0.337	0.940	1.137	1.128	1.068	0.942	1.054
2000	0.451	0.878	1.016	1.122	1.121	1.086	1.235
2001	0.335	0.798	1.093	1.294	1.177	0.966	0.937
2002	0.476	0.899	1.056	1.180	1.311	1.343	1.472
2003	0.413	1.037	1.089	1.147	1.038	1.219	1.221
2004	0.386	0.880	0.958	0.877	1.255	1.428	1.302
2005	0.394	0.700	1.243	1.267	1.388	1.253	1.200
2006	0.276	0.776	0.974	1.332	1.210	1.236	1.235
2007	0.366	0.722	1.104	1.101	1.219	1.230	1.214
2008	0.264	0.620	0.895	1.142	0.994	1.124	1.162
2009	0.268	0.578	0.919	1.009	1.105	1.210	1.079
2010	0.209	0.524	0.950	1.061	0.895	0.987	0.998
2011	0.255	0.468	1.088	1.527	0.968	1.076	1.069
2012	0.254	0.394	0.711	0.992	0.839	0.902	0.932
2013	0.408	0.452	0.466	0.694	0.884	0.836	0.852
2014	0.211	0.370	0.666	0.509	0.585	0.659	0.705
2015	0.164	0.394	0.562	0.695	0.875	0.808	0.730
2016	0.220	0.332	0.580	0.598	0.682	0.767	0.764
2017	0.184	0.509	0.571	0.650	0.669	0.845	0.752
2018	0.211	0.411	0.693	0.776	0.921	0.879	0.874

Table 5.15. Cod in Division 6.a. Standard errors of TSA estimates for log fishing mortality-at-age.

	1	2	3	4	5	6	7
1981	0.028	0.039	0.043	0.050	0.075	0.095	0.110
1982	0.024	0.029	0.042	0.052	0.074	0.120	0.151
1983	0.062	0.033	0.044	0.058	0.079	0.130	0.174
1984	0.036	0.041	0.049	0.063	0.090	0.140	0.160
1985	0.075	0.038	0.054	0.070	0.088	0.148	0.177
1986	0.042	0.040	0.044	0.057	0.082	0.152	0.141
1987	0.098	0.047	0.049	0.063	0.084	0.133	0.168
1988	0.107	0.047	0.045	0.054	0.083	0.119	0.139
1989	0.075	0.044	0.063	0.061	0.101	0.152	0.206
1990	0.090	0.052	0.054	0.075	0.080	0.122	0.129
1991	0.087	0.068	0.064	0.066	0.098	0.146	0.182
1992	0.063	0.056	0.083	0.083	0.096	0.116	0.160
1993	0.064	0.051	0.078	0.082	0.108	0.164	0.151
1994	0.070	0.049	0.064	0.089	0.114	0.154	0.182
1995	0.065	0.064	0.069	0.078	0.100	0.156	0.150
1996	0.079	0.067	0.088	0.086	0.104	0.183	0.201
1997	0.066	0.076	0.091	0.095	0.111	0.160	0.192
1998	0.091	0.070	0.098	0.096	0.091	0.163	0.168
1999	0.090	0.085	0.087	0.103	0.113	0.137	0.192
2000	0.092	0.077	0.098	0.096	0.122	0.162	0.210
2001	0.091	0.072	0.088	0.104	0.115	0.163	0.156
2002	0.112	0.084	0.086	0.100	0.147	0.184	0.278
2003	0.115	0.090	0.105	0.096	0.113	0.203	0.205
2004	0.102	0.088	0.096	0.115	0.142	0.231	0.239
2005	0.111	0.099	0.165	0.188	0.256	0.236	0.243
2006	0.096	0.143	0.167	0.220	0.208	0.246	0.244
2007	0.107	0.105	0.160	0.117	0.167	0.226	0.243
2008	0.086	0.101	0.125	0.143	0.141	0.222	0.231
2009	0.082	0.099	0.143	0.118	0.156	0.226	0.222
2010	0.065	0.085	0.135	0.133	0.120	0.192	0.203
2011	0.082	0.075	0.135	0.150	0.128	0.197	0.222
2012	0.079	0.067	0.098	0.113	0.121	0.176	0.190
2013	0.107	0.077	0.072	0.081	0.120	0.166	0.177
2014	0.064	0.063	0.106	0.063	0.084	0.126	0.150
2015	0.053	0.068	0.092	0.095	0.129	0.156	0.156
2016	0.078	0.060	0.099	0.086	0.087	0.151	0.162
2017	0.060	0.090	0.100	0.094	0.085	0.146	0.161
2018	0.066	0.081	0.132	0.131	0.137	0.184	0.197

Table 5.16. Cod in Division 6.a. TSA summary table.

Year	TotalCatch (tonnes)			Landings (tonnes)			Discards (tonnes)			Mean F(2-5)		SSB (tonnes)		Recruitment (000s at age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred	SE	Estimate	SE	Estimate	SE	Estimate	SE
198	24168	2421	954	23865	2405	956	303	167	95	0.672	0.02	41750	109	11028	126
198	22082	2093	802	21511	2014	810	571	793	18	0.666	0.02	39023	114	26437	113
198	21503	2117	698	21305	2084	687	197	329	15	0.761	0.03	34821	100	15317	119
198	21601	2147	794	21272	2086	807	329	613	24	0.865	0.03	32299	108	27103	123
198	19570	1841	706	18607	1780	713	963	613	16	0.948	0.03	25558	895	13406	127
198	12083	1275	503	11820	1217	475	263	575	20	0.783	0.03	20564	629	23663	140
198	21358	1932	115	18971	1755	921	2388	1774	77	0.886	0.03	21786	568	57984	654
198	20781	2063	100	20413	2029	989	368	338	18	0.864	0.03	27998	865	6830	100
198	19246	1825	863	17169	1685	764	2076	1406	50	0.951	0.04	24102	861	24723	201
199	12746	1247	500	12175	1224	491	571	228	90	0.785	0.04	19431	902	8515	132
199	11549	1065	992	10927	1017	939	622	478	21	0.803	0.05	16143	120	13386	160
199	10865	9851	101	9086	9211	967	1779	640	26	0.848	0.06	14020	120	22922	200
199	10453	1131	106	10314	1093	103	139	385	13	0.835	0.06	17042	131	9087	876
199	9588	1111	113	8928	1043	107	661	677	24	0.794	0.06	17693	144	18653	185
199	9580	1224	126	9439	1186	123	141	380	14	0.851	0.06	18040	150	14871	143
199	9489	1215	134	9427	1191	131	63	239	89	0.962	0.06	17111	152	6364	884
199	7533	1032	119	7034	9457	110	499	872	35	1.047	0.07	12106	121	23205	200
199	6252	9253	913	5714	8928	889	538	324	12	1.002	0.07	10273	907	6608	935
199	4270	6911	795	4201	6686	769	69	225	90	1.069	0.07	9078	860	4501	598
200	3798	6056	666	2977	4978	589	821	1078	31	1.034	0.07	6338	647	16469	163
200	2439	5265	606	2347	5055	586	92	211	72	1.091	0.07	6441	607	3566	463
200	2722	5103	577	2243	4627	526	480	476	16	1.111	0.08	5995	588	7436	985

Year	TotalCatch (tonnes)			Landings (tonnes)			Discards (tonnes)			Mean F(2-5)		SSB (tonnes)		Recruitment (000s at age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred	SE	Estimate	SE	Estimate	SE	Estimate	SE
200	1275	3661	487	1241	3519	466	34	142	59	1.078	0.07	4510	507	1978	388
200	612	2204	330	540	2017	301	72	187	71	0.992	0.07	2945	370	2947	526
200	552	1828	283	511	1707	264	41	121	50	1.150	0.11	2309	281	1660	457
200	954	1579	271	488	493	114	465	1086	23	1.073	0.11	1790	219	5291	705
200	2474	1815	220	595	487	64	1880	1328	20	1.037	0.07	2299	185	2088	393
200	1377	1587	192	682	583	90	695	1004	18	0.913	0.07	2488	210	1424	246
200	1353	1506	161	408	475	48	945	1031	16	0.903	0.07	2124	169	3681	484
201	1344	1612	194	559	555	53	785	1057	18	0.858	0.06	2385	182	3642	388
201	2124	1883	203	454	474	60	1670	1409	19	1.013	0.06	2769	197	1586	185
201	1632	1528	155	466	488	49	1166	1041	15	0.734	0.05	2715	177	2407	389
201	1501	1268	118	299	392	36	1202	876	12	0.624	0.05	2347	134	4986	609
201	1668	1480	181	357	416	43	1311	1064	17	0.532	0.04	3042	205	3592	413
201	1752	2091	234	770	718	89	983	1372	20	0.631	0.05	4279	268	3337	384
201	1745	2037	216	892	805	78	852	1232	20	0.548	0.04	4642	281	1282	210
201	2363	1969	192	795	873	70	1569	1096	18	0.600	0.05	4196	274	1579	252
201	1890	1791	148	1129	1128	75	760	663	12	0.700	0.08	3478	265	826	187
201	NA	1402	198	NA	743	124	NA	659	14	0.668	0.11	2357	313	6404	145
Min	552	1268	118	299	392	36	34	121	50	0.532	0.02	1790	134	826	185
GM	4562	5501	474	3028	3681	317	466	576	16	0.852	0.05	8137	528	6374	761
AM	8113	8677	609	7367	7953	541	746	724	19	0.869	0.06	12788	684	10642	105
Max	24168	2421	134	23865	2405	131	2388	1774	77	1.150	0.11	41750	152	57984	654

***Estimates for 2019 are TSA projections.**

Table 5.17. Cod in Division 6.a.. Input values for short-term forecast. Note that LSel and LWt refer to the landings and DSel and DCWt refer to the discards. Numbers in thousands; Weights in kg.

2019

Age	N	M	Mat	PF	PM	SWt	LSel	LWt	DSel	DWt
1	2349	0.541	0	0	0	0.240	0.103	0.810	0.130	0.234
2	389	0.387	0.52	0	0	1.087	0.456	1.087	0.018	1.042
3	344	0.307	0.86	0	0	2.298	0.698	2.298	0.00028	2.208
4	88	0.263	1	0	0	3.886	0.767	3.886	0	3.634
5	120	0.238	1	0	0	5.281	0.861	5.281	0	4.767
6	40	0.224	1	0	0	6.130	0.944	6.130	0	6.841
7	27	0.212	1	0	0	8.242	0.905	8.242	0	2.118

2020

Age	N	M	Mat	PF	PM	SWt	LSel	LWt	DSel	DWt
1	2349	0.541	0	0	0	0.240	0.103	0.810	0.130	0.234
2	1083	0.387	0.52	0	0	1.087	0.456	1.087	0.018	1.042
3	165	0.307	0.86	0	0	2.298	0.698	2.298	0.00028	2.208
4	126	0.263	1	0	0	3.886	0.767	3.886	0	3.634
5	32	0.238	1	0	0	5.281	0.861	5.281	0	4.767
6	40	0.224	1	0	0	6.130	0.944	6.130	0	6.841
7	21	0.212	1	0	0	8.242	0.905	8.242	0	2.118

2021

Age	N	M	Mat	PF	PM	SWt	LSel	LWt	DSel	DWt
1	2349	0.541	0	0	0	0.240	0.103	0.810	0.130	0.234
2	1083	0.387	0.52	0	0	1.087	0.456	1.087	0.018	1.042
3	458	0.307	0.86	0	0	2.298	0.698	2.298	0.00028	2.208
4	60	0.263	1	0	0	3.886	0.767	3.886	0	3.634
5	45	0.238	1	0	0	5.281	0.861	5.281	0	4.767
6	11	0.224	1	0	0	6.130	0.944	6.130	0	6.841
7	19	0.212	1	0	0	8.242	0.905	8.242	0	2.118

Table 5.18. Cod in Division 6.a. Single-option output of the short-term forecast (F = mean F2016–2018, rescaled to 2018). Numbers in thousands, weights in tonnes.

2019

Age	F	LandNos	Yield	DF	DiscNos	DYield	StockNos	Biomass	SSNos	SSB
1	0.233	168	136	0.130	213	50	2349	565	0	0
2	0.475	119	130	0.018	5	5	389	423	202	220
3	0.699	151	348	0.00028	0	0	344	790	296	679
4	0.767	42	165	0	0	0	88	344	88	344
5	0.861	63	331	0	0	0	120	634	120	634
6	0.944	22	137	0	0	0	40	246	40	246
7	0.905	15	120	0	0	0	27	221	27	221
Total	0.700	580	1366	0.0046	218	55	3357	3223	773	2344

2020

Age	F	LandNos	Yield	DF	DiscNos	DYield	StockNos	Biomass	SSNos	SSB
1	0.233	168	136	0.130	213	50	2349	565	0	0
2	0.475	331	360	0.018	13	14	1083	1177	563	612
3	0.699	72	167	0.00028	0	0	165	378	142	325
4	0.767	60	234	0	0	0	126	489	126	489
5	0.861	16	87	0	0	0	32	167	32	167
6	0.944	22	137	0	0	0	40	245	40	245
7	0.905	12	95	0	0	0	21	175	21	175
Total	0.700	681	1216	0.0046	226	63	3816	3196	924	2013

2021

Age	F	LandNos	Yield	DF	DiscNos	DYield	StockNos	Biomass	SSNos	SSB
1	0.233	168	136	0.130	213	50	2349	565	0	0
2	0.475	331	360	0.018	13	14	1083	1177	563	612
3	0.699	202	463	0.00028	0	0	458	1052	394	904
4	0.767	29	112	0	0	0	60	234	60	234
5	0.861	23	124	0	0	0	45	237	45	237
6	0.944	6	36	0	0	0	11	65	11	65
7	0.905	11	87	0	0	0	19	160	19	160
Total	0.700	770	1318	0.0046	226	64	4025	3490	1092	2212

Table 5.19. Cod in Division 6.a. Management options table (plus table covering the interval between lower and upper bounds of F_{MSY}). Weights in tonnes.

Basis	Catch	Wanted.catch	Un-wanted.catch	Ftotal	F.wanted	F.un-wanted	SSB	Perc. SSB	Perc.TAC
F x 0	0	0	0	0	NA	NA	3765	87	-100
F x 1	1279	1216	63	0.70010	0.69552	0.00458	2212	9.9	-30
F_{MSY}	623	595	28	0.29000	0.28810	0.00190	3002	49	-66
F_{pa}	1064	1013	51	0.55000	0.54640	0.00360	2469	23	-42
F_{lim}	1371	1302	69	0.77000	0.76496	0.00504	2103	4.5	-25
$F_{msy.up}$	839	800	39	0.41000	0.40732	0.00268	2741	36	-54
$F_{MSY.low}$	446	426	20	0.20000	0.19869	0.00131	3218	60	-75
scaled.F_{MSY}	70	67	3	0.02919	0.02900	0.00019	3679	83	-96
scaled.$F_{MSY.upper}$	98	94	4	0.04127	0.04100	0.00027	3644	81	-95
scaled.$F_{MSY.lower}$	48	46	2	0.02013	0.02000	0.00013	3705	84	-97

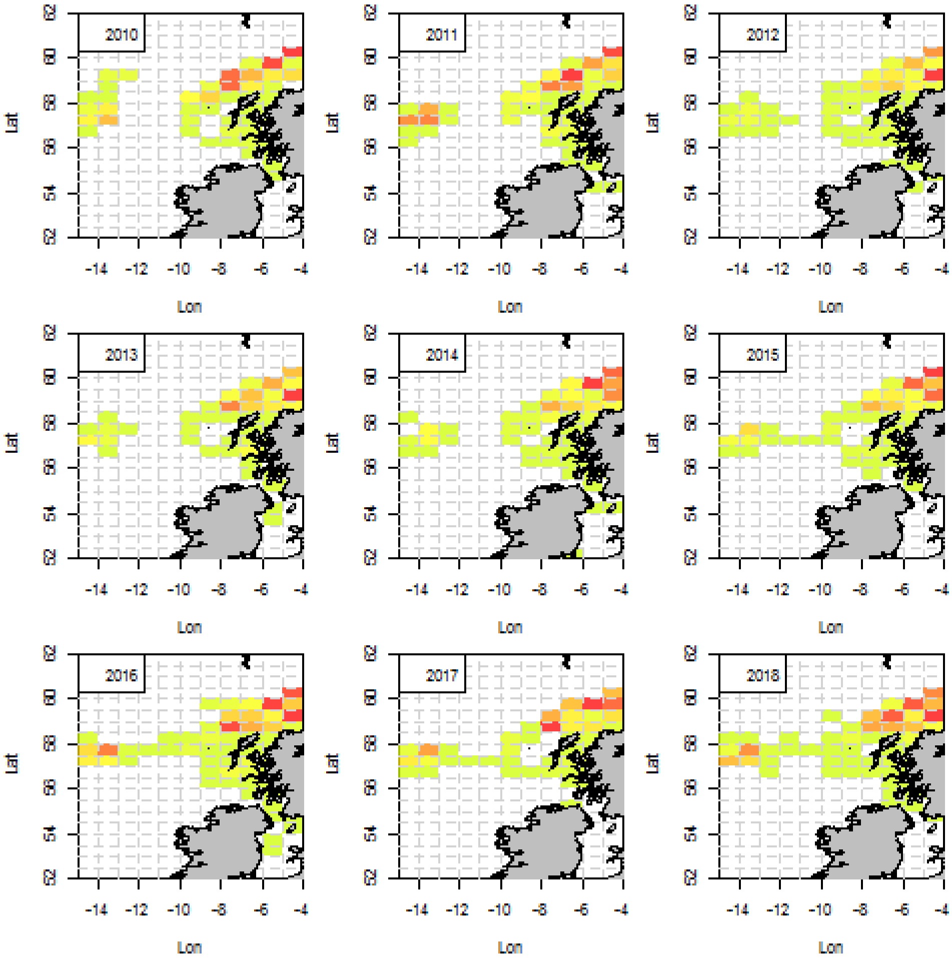


Figure 5.1. Distribution of Scottish reported landings by statistical rectangle by year.

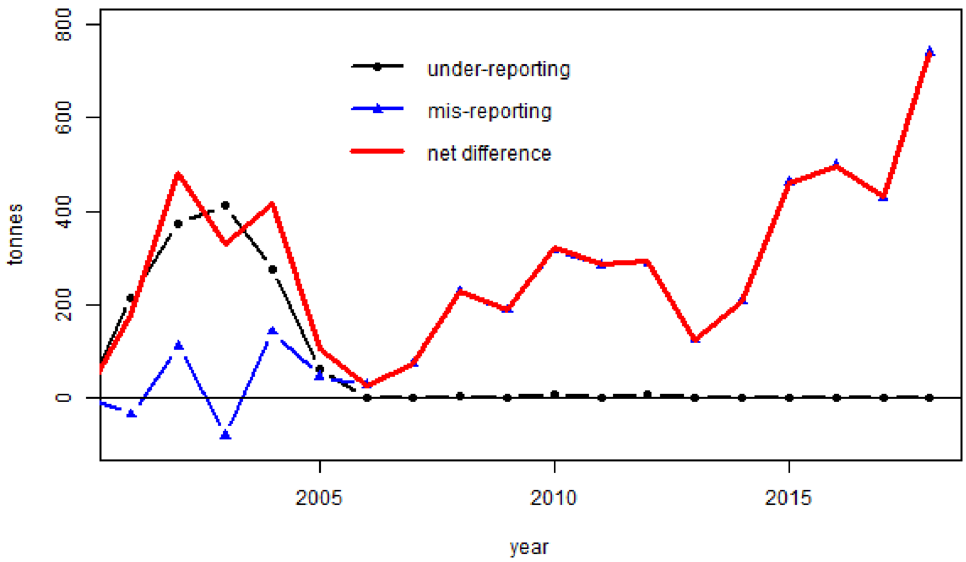


Figure 5.2. Cod in Division 6.a. Estimates of underreporting and area misreporting of cod caught in ICES Division 6.a by Scottish vessels. Negative values of area misreporting indicate a net balance of misreporting into Division 6.a from other areas.

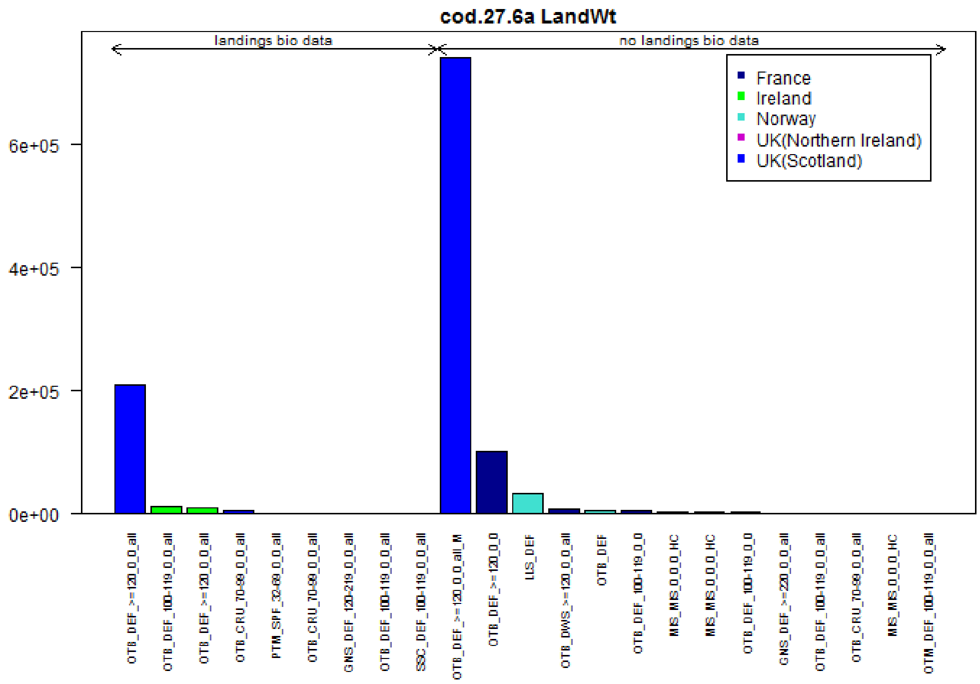


Figure 5.3. Cod in Division 6.a. Amounts landed by métier (kg) in 2018 as submitted to InterCatch.

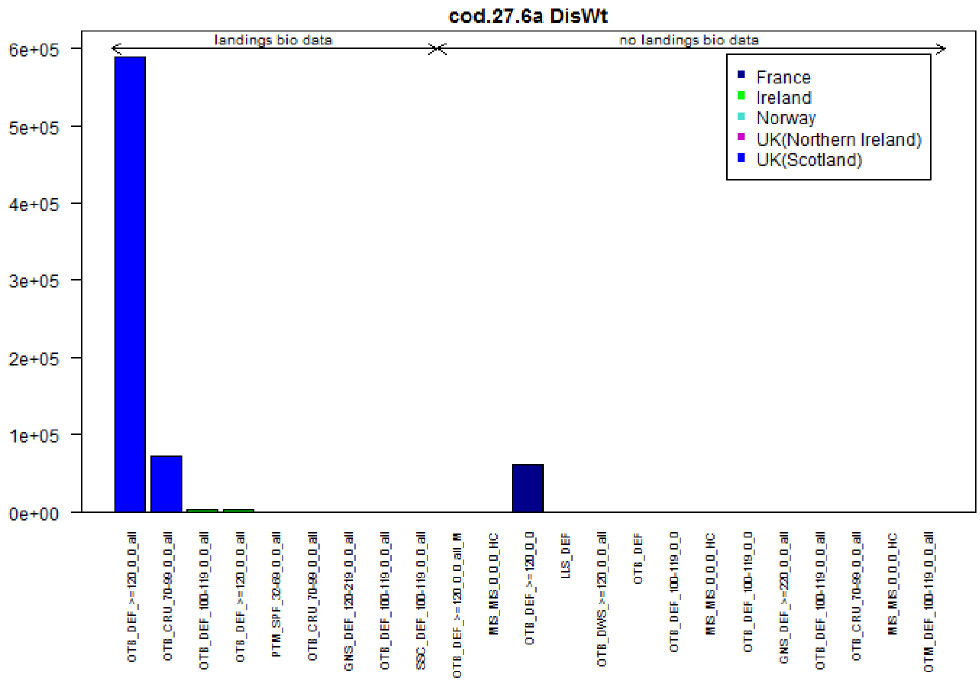


Figure 5.4. Cod in Division 6.a. Amounts discarded by métier (kg) in 2018 as submitted to InterCatch.

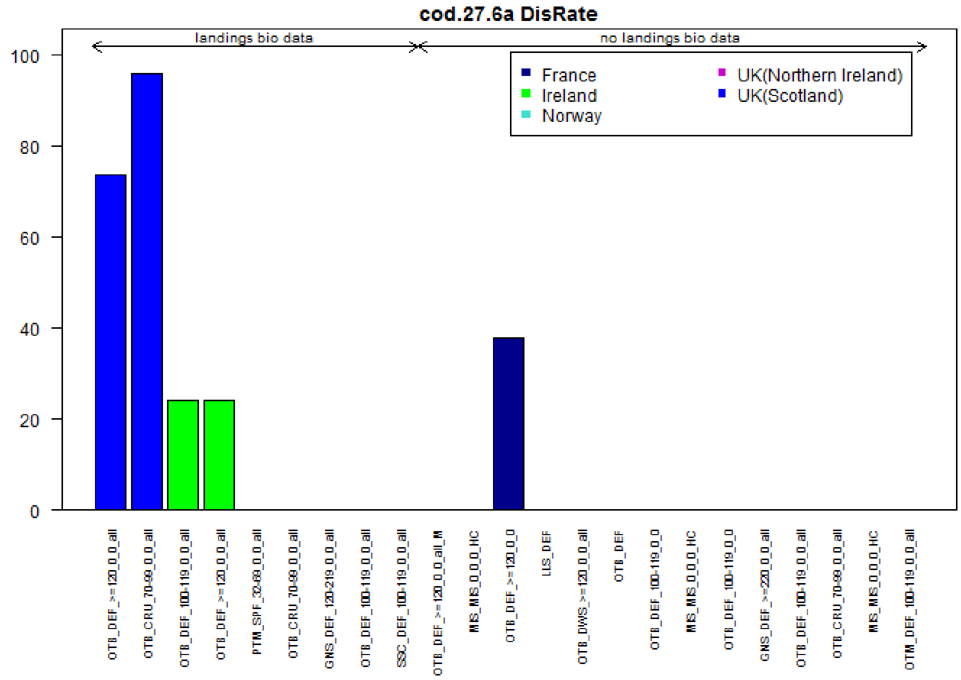


Figure 5.5. Cod in Division 6.a. Discard rates before allocations within InterCatch.

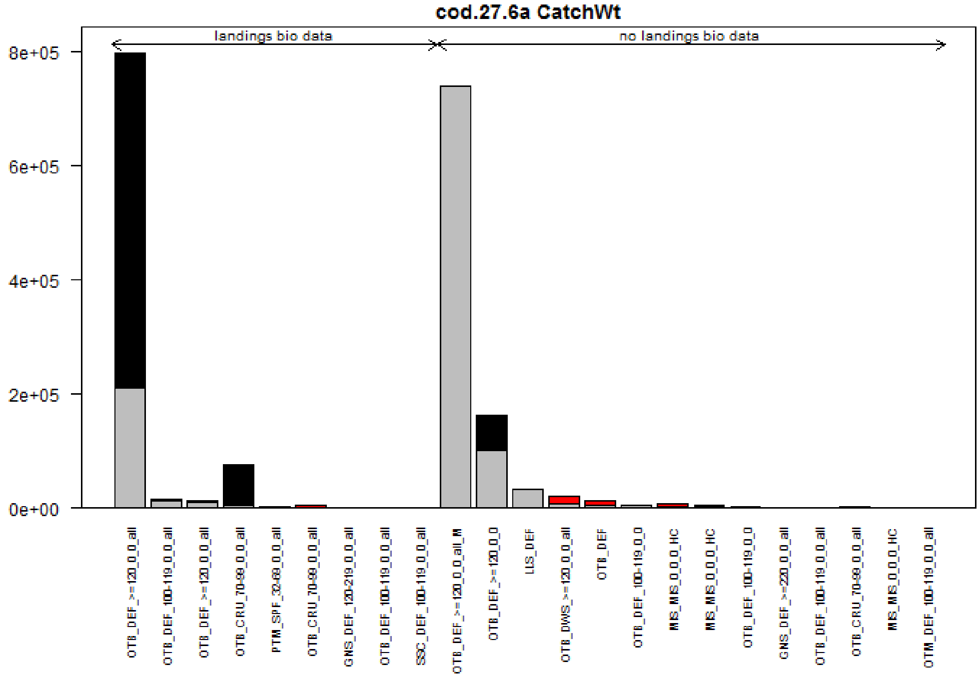


Figure 5.6. Cod in Division 6.a. Landings (grey), imported (black) and raised (red) discards of all fleets after allocations within InterCatch.

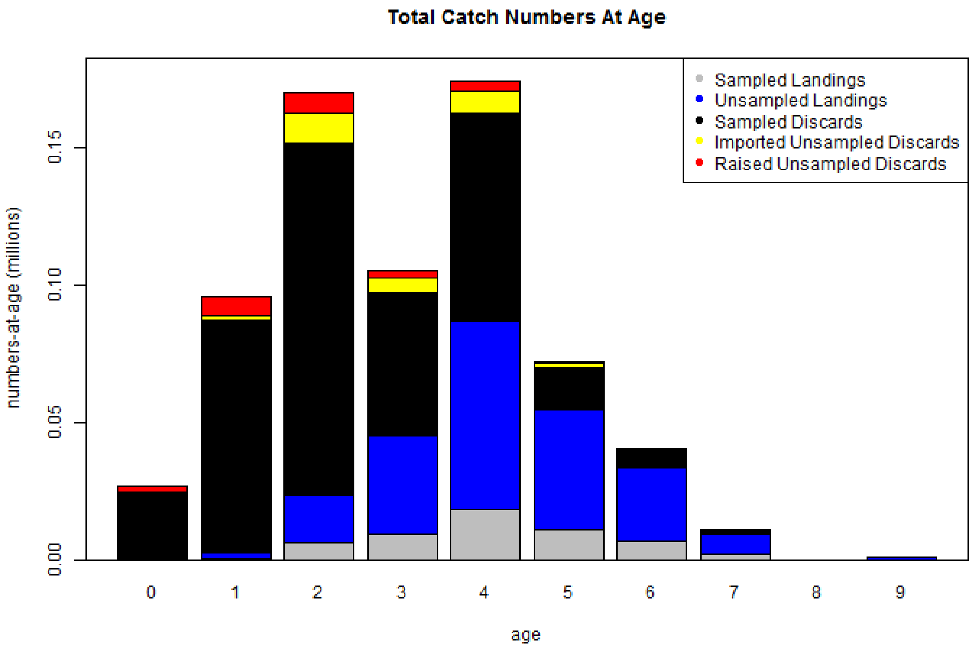


Figure 5.7. Cod in Division 6.a. Number-at-age constituted by sampled and unsampled landings and sampled and raised (unsampled) discards after allocations within InterCatch. Minor amounts (35 kg) of BMS landings were also recorded.

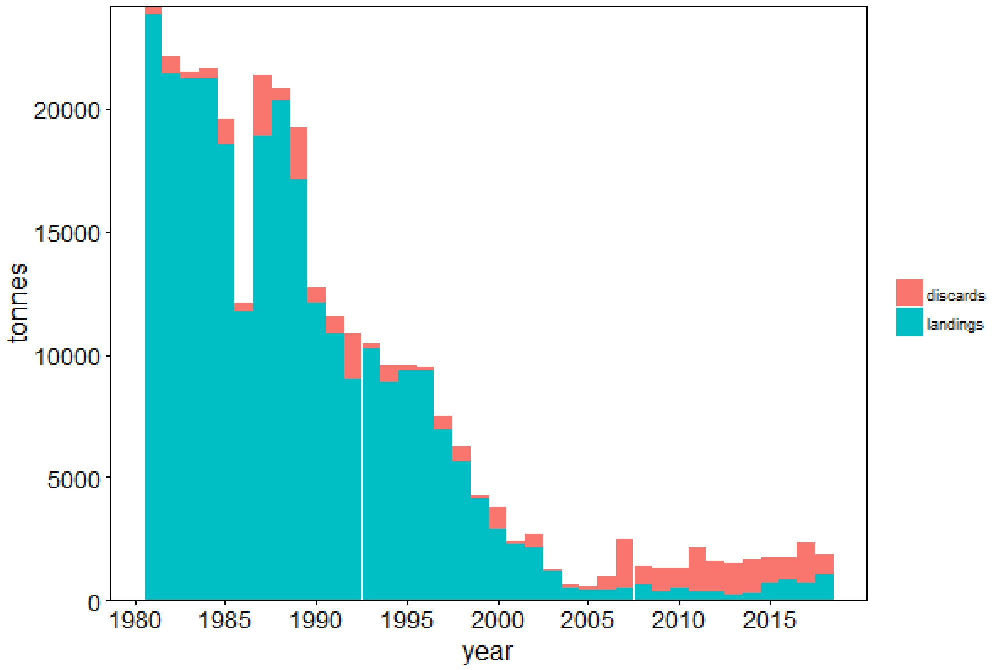


Figure 5.8. Cod in Division 6.a. Landings and discards estimates by weight, as used by the WG. Values are totals for fish aged 1 to 7+.

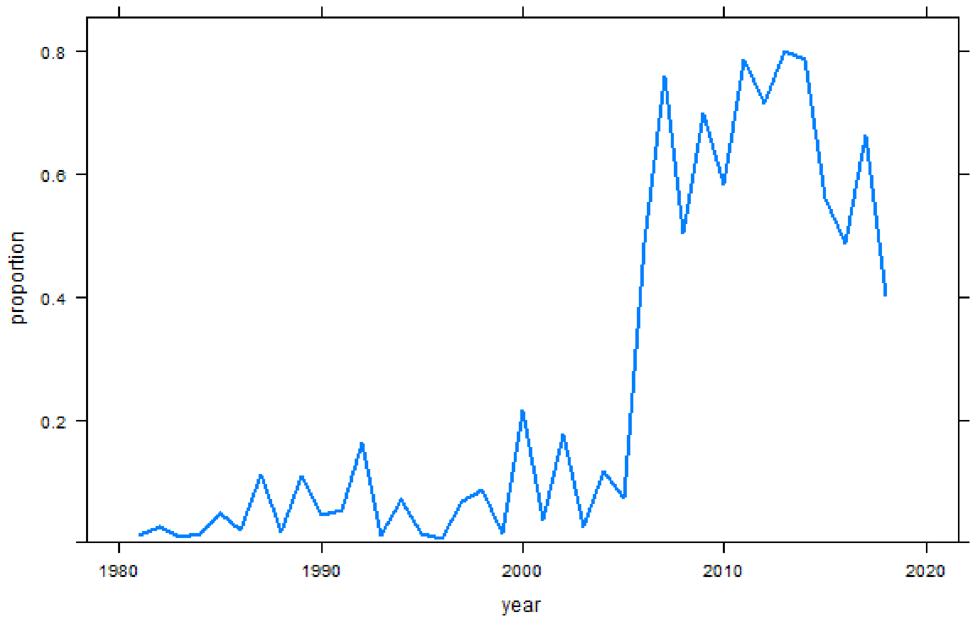


Figure 5.9. Cod in Division 6.a. Discard proportion (of total catch) by weight. Includes fish aged 1 to 7+.

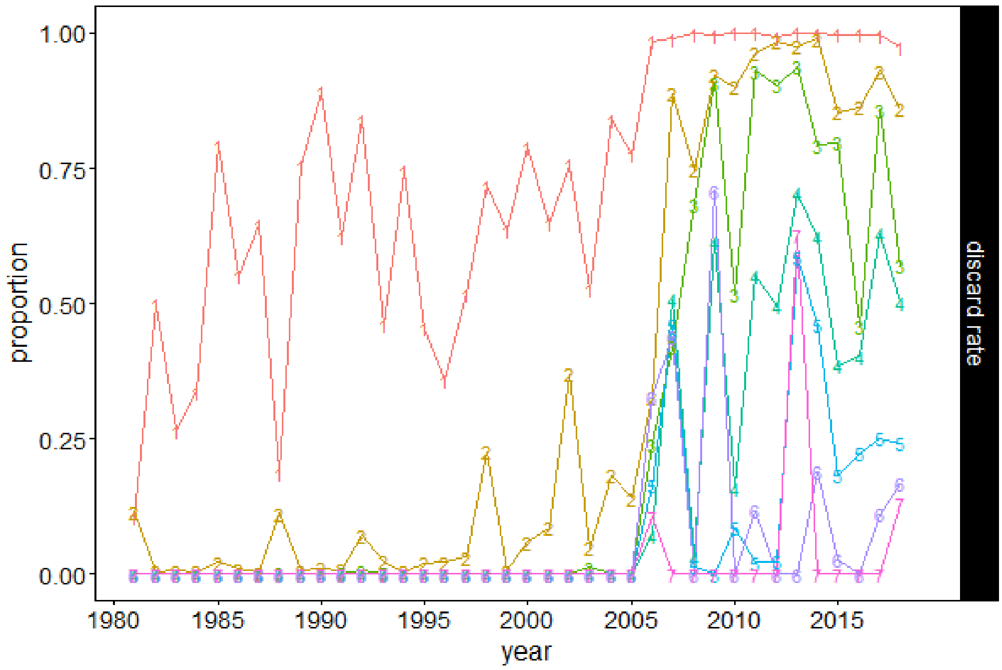


Figure 5.10. Cod in Division 6.a. Discard proportion by number.

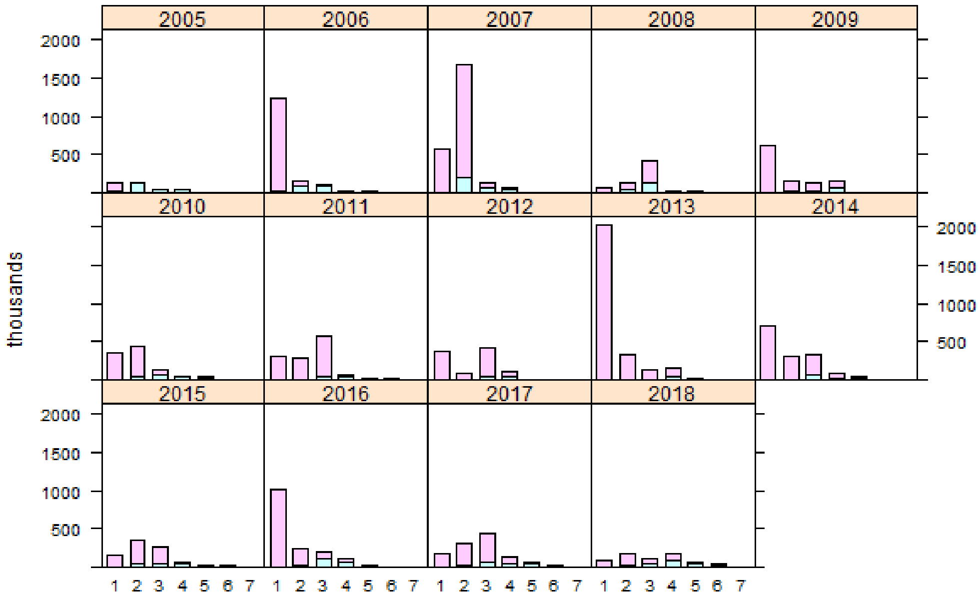


Figure 5.11. Cod in Division 6.a. Catch-at-age in numbers by year. Pink: discards, blue: landings.

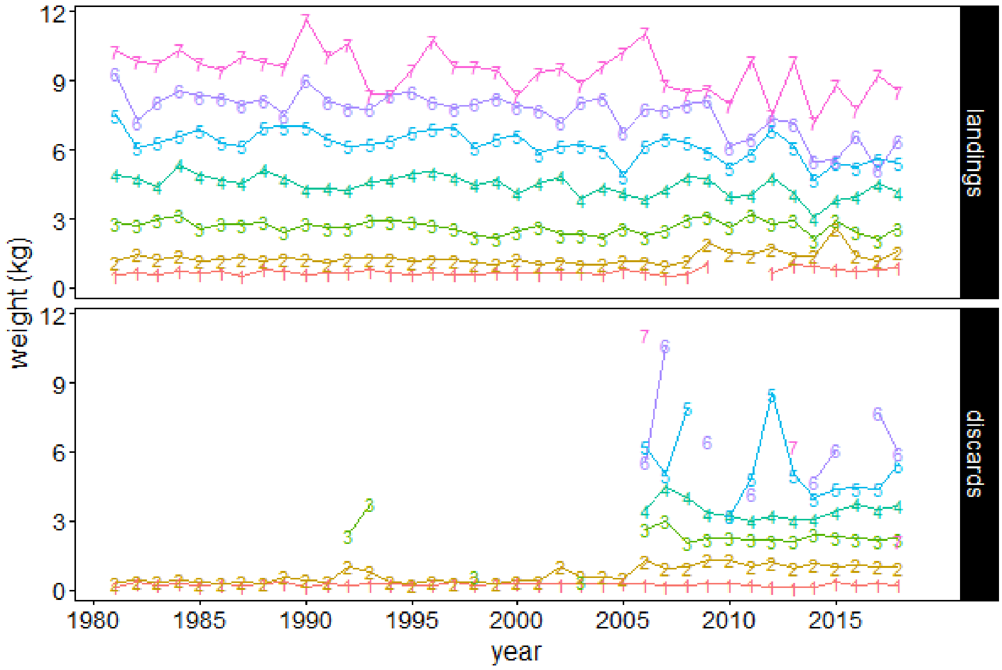


Figure 5.12. Cod in Division 6.a. Mean weights-at-age in landings and discards.

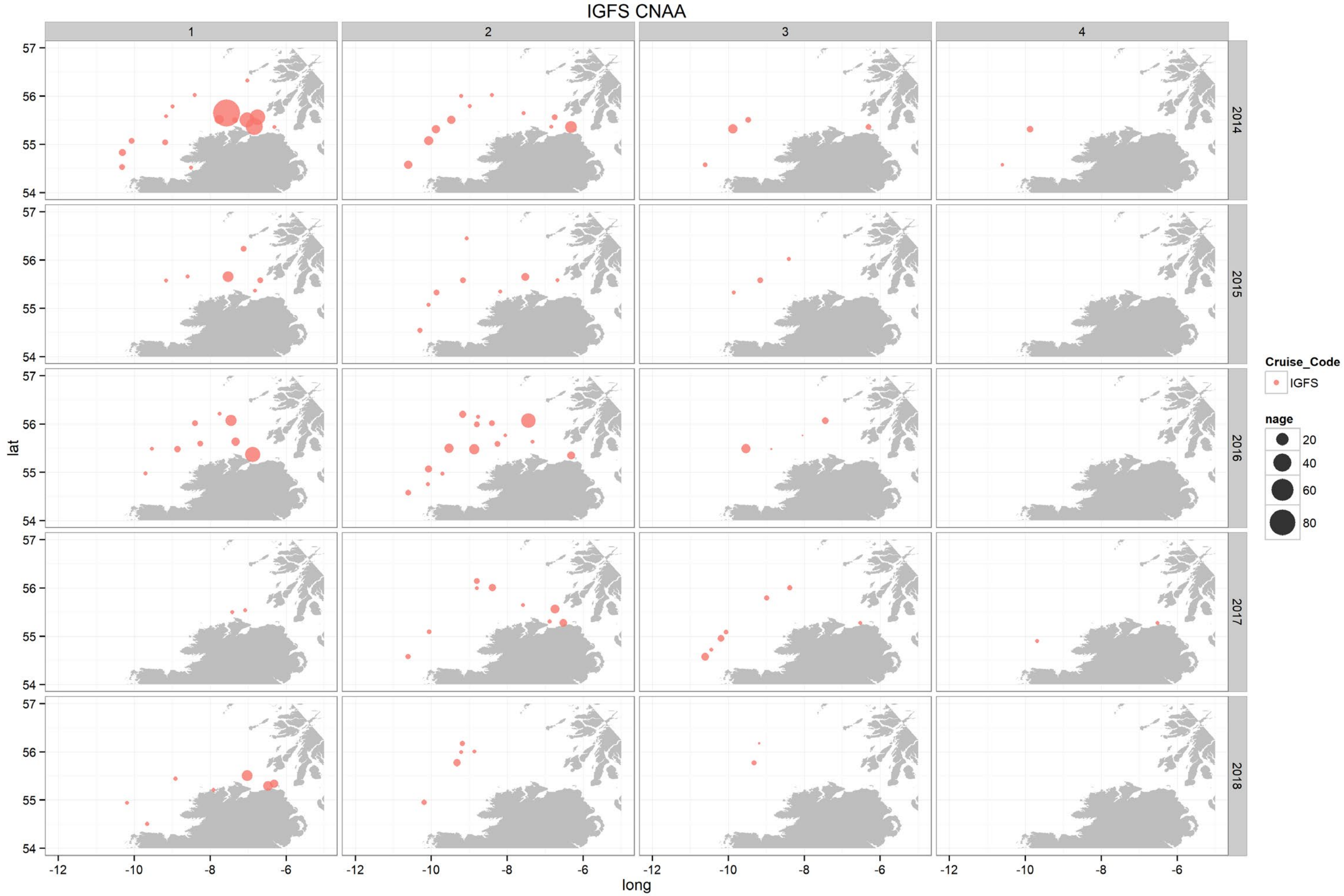


Figure 5.13. Cod in Division 6.a. Catch numbers for fish aged at 1+ per haul resulting from quarter four Irish ground fish survey (IRGFS-WIBTS-Q4). Values are standardised to 60 minutes towing. Zero shown as a black + symbol.

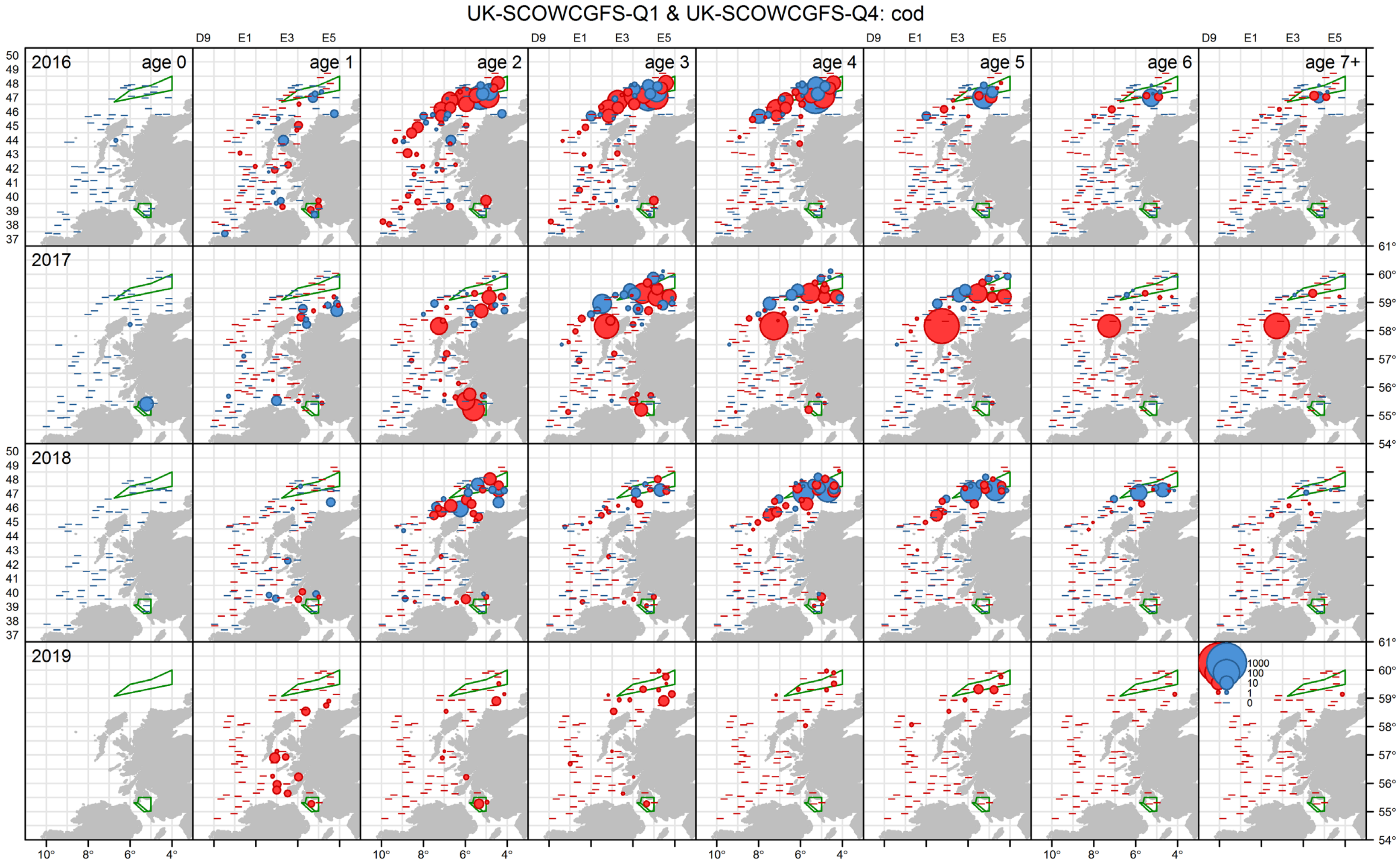


Figure 5.14. Cod in Division 6.a. Cpue numbers for fish aged at 1+ per tow resulting from Scottish quarter one survey (UK-SCOWCGFS-Q1) in red and (UK-SCOWCGFS-Q4) in blue. Numbers are standardised to 30 minutes towing. Green polygons are areas closed to fishing.

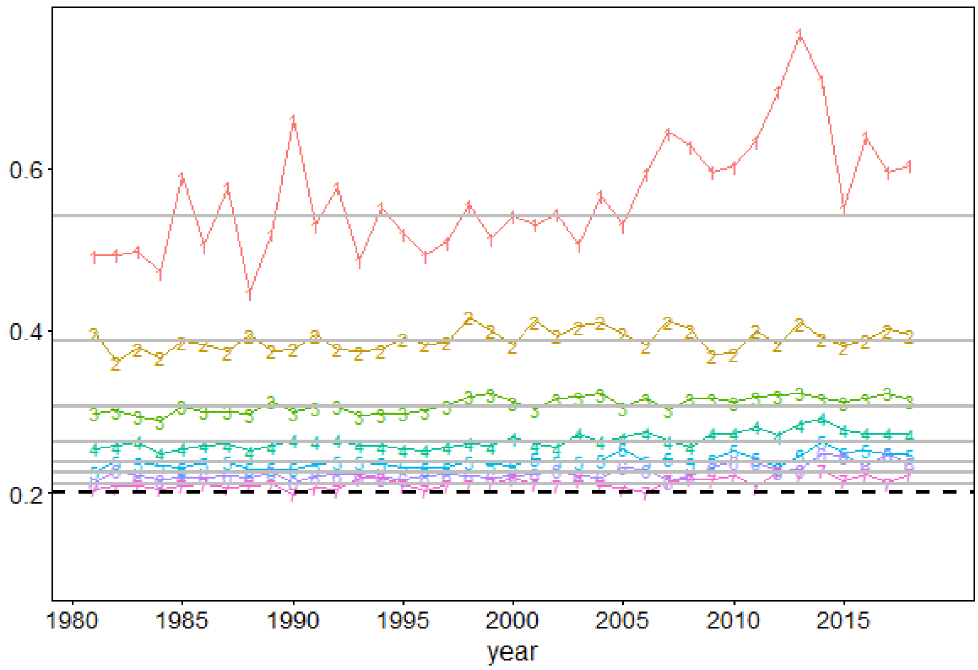


Figure 5.15. Cod in Division 6.a. Natural mortality-at-age based on mean weight-at-age and mortality–weight relationship. Solid horizontal lines show the time averaged values at each age used in the assessment. Dotted horizontal line shows value of 0.2 previously used at all ages in all years.

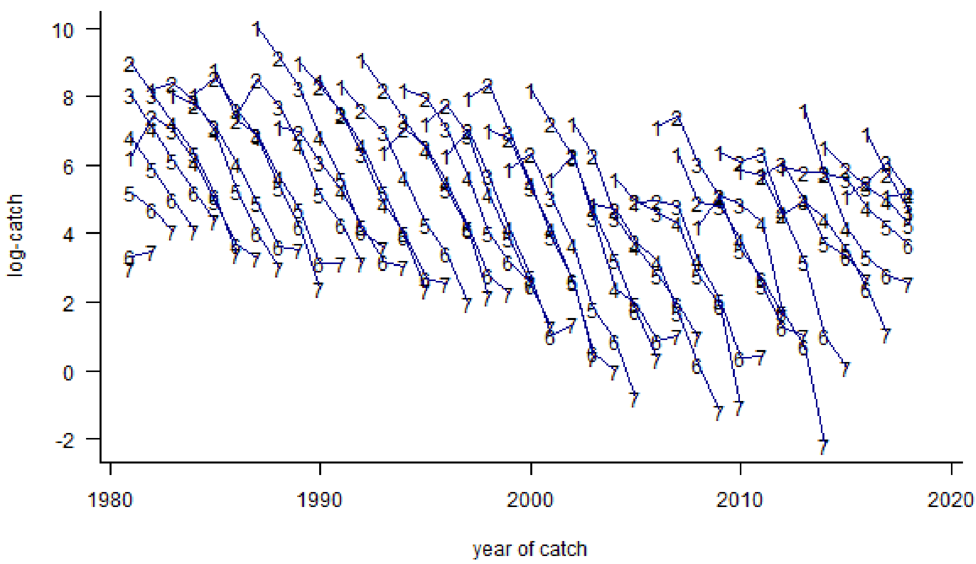


Figure 5.16. Cod in Division 6.a. Catch curves from commercial catch-at-age data.

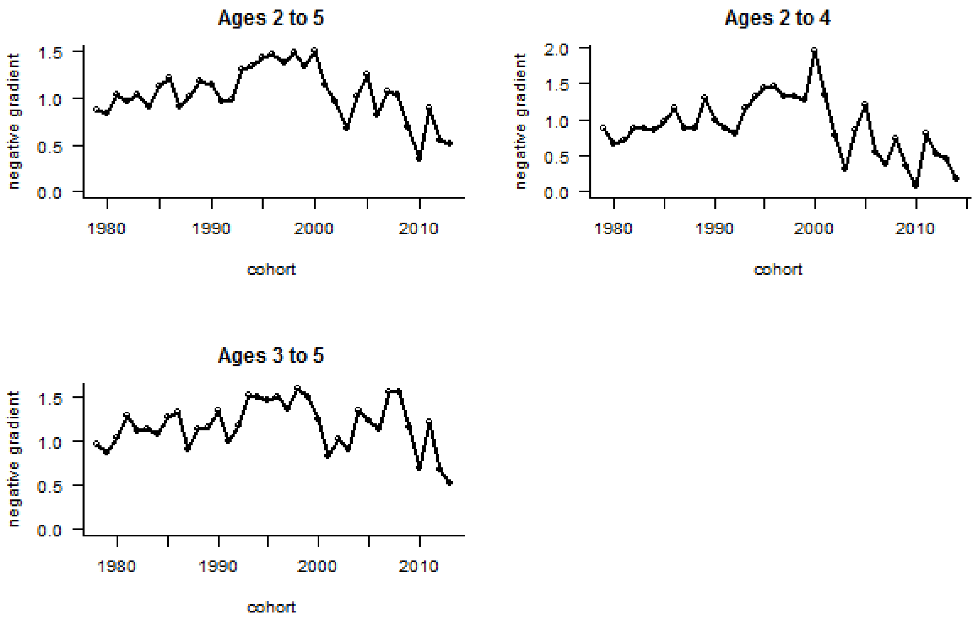


Figure 5.17. Cod in Division 6.a. Log catch (landings + discards) curve gradient plot using WG commercial catch-at-age data over different age ranges.

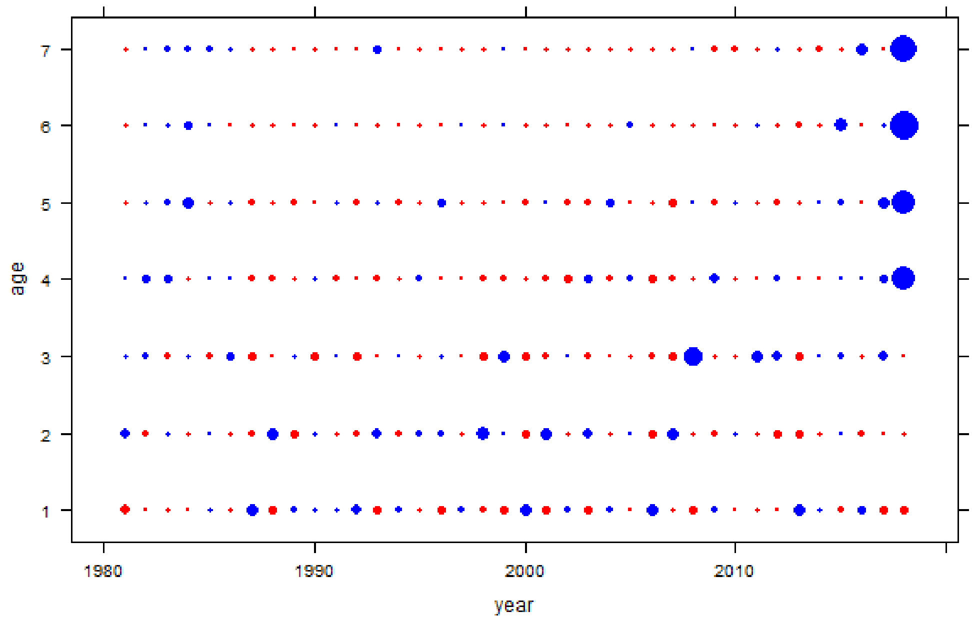


Figure 5.18. Cod in Division 6.a. Mean standardised catch-at-age proportions by number.

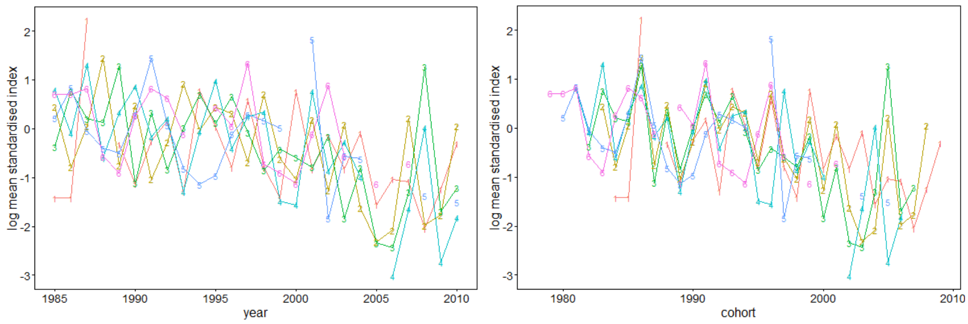


Figure 5.19. Cod in Division 6.a. Log mean standardised index values, by year, (left) and cohort (right) from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

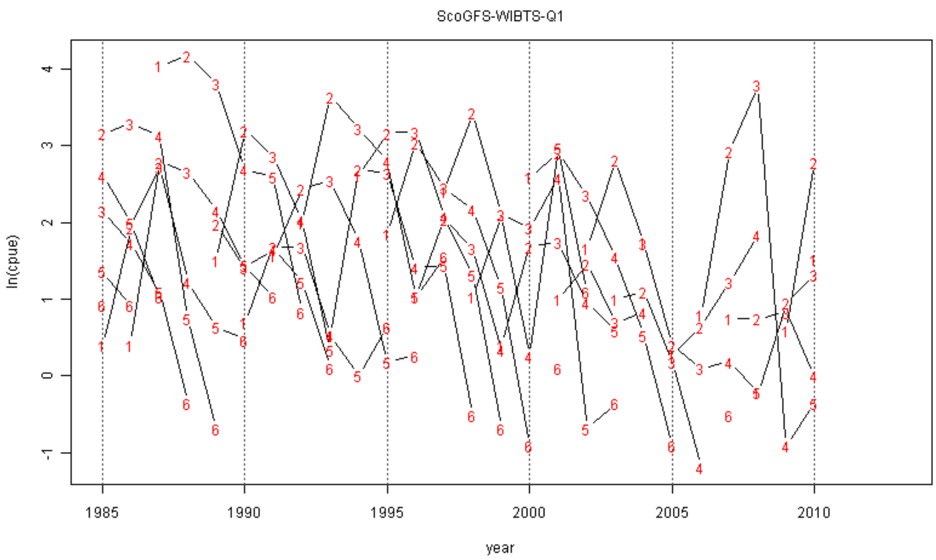


Figure 5.20. Cod in Division 6.a. Log catch curves from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

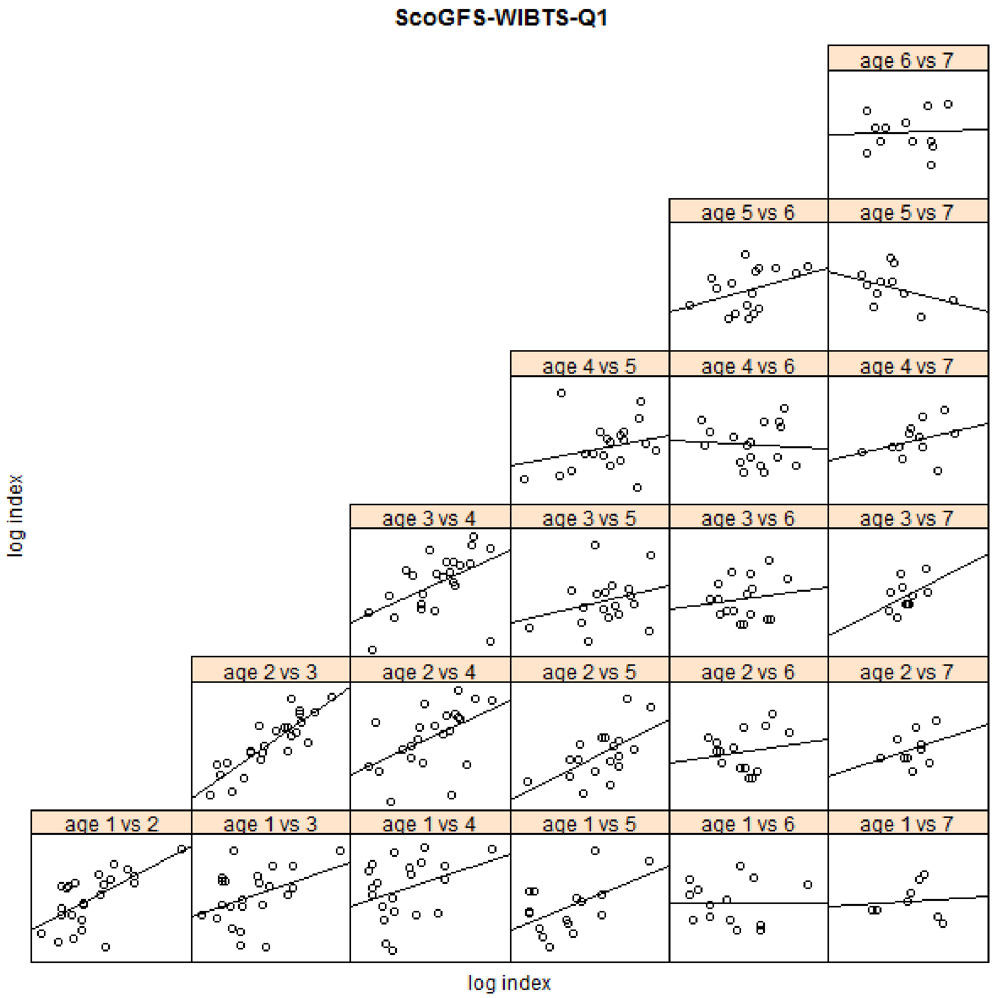


Figure 5.21. Cod in Division 6.a. Within-survey correlations for the Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1), comparing index values at different ages for the same cohorts. The straight line in a linear regression. Survey finished in 2010.

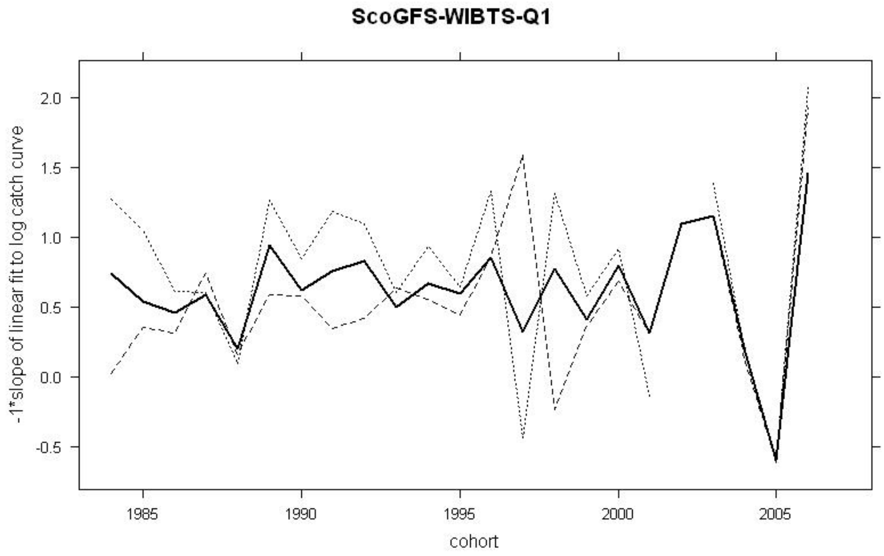


Figure 5.22. Cod in Division 6.a. Log catch curve gradient plot using ScoGFS-WIBTS-Q1 index data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. Last cohort shown was at-age 5 in 2010, the last year of the ScoGFS-WIBTS-Q1 survey.

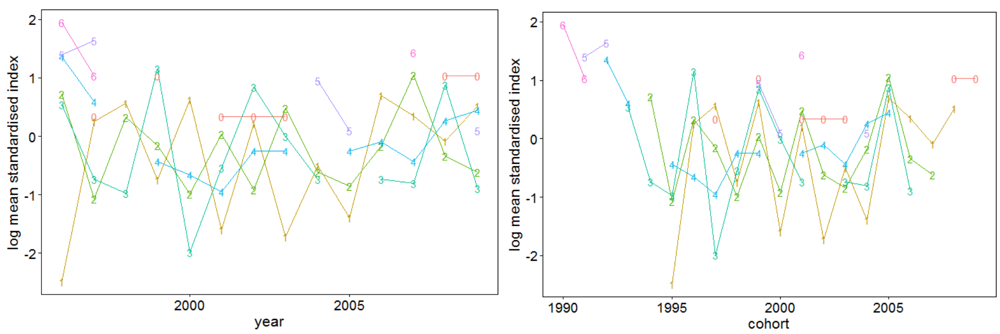


Figure 5.23. Cod in Division6a. Log mean standardised index values by year (left) and cohort (right) from ScoGFS-WIBTS-Q4.

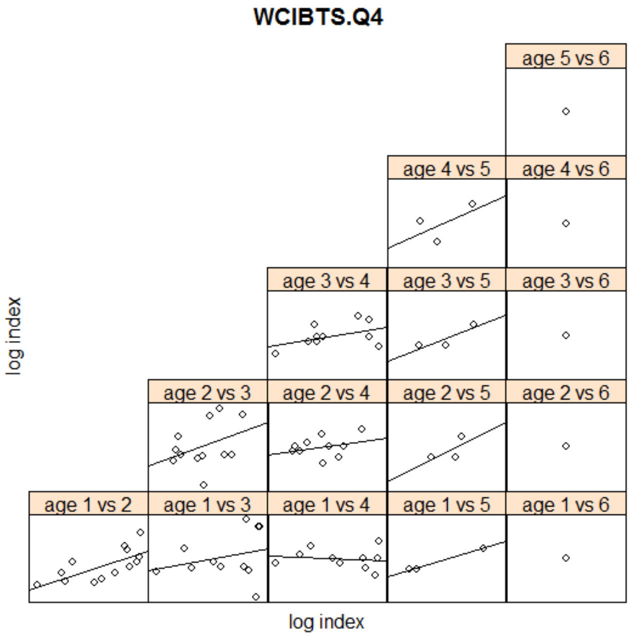


Figure 5.24. Cod in Division 6.a. Within survey correlations for ScoGFS-WIBTS-Q4 survey, comparing index values at different ages for the same cohorts. The solid line is a linear regression. Insufficient age 6 fish are caught to enable scatterplots to be constructed.

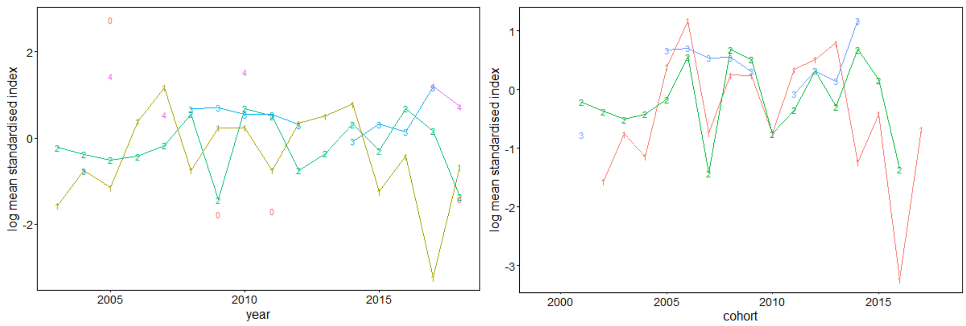


Figure 5.25. Cod in Division 6.a. Log mean standardised index values, by year (left) and cohort (right) from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 1–3. Survey started in 2003.

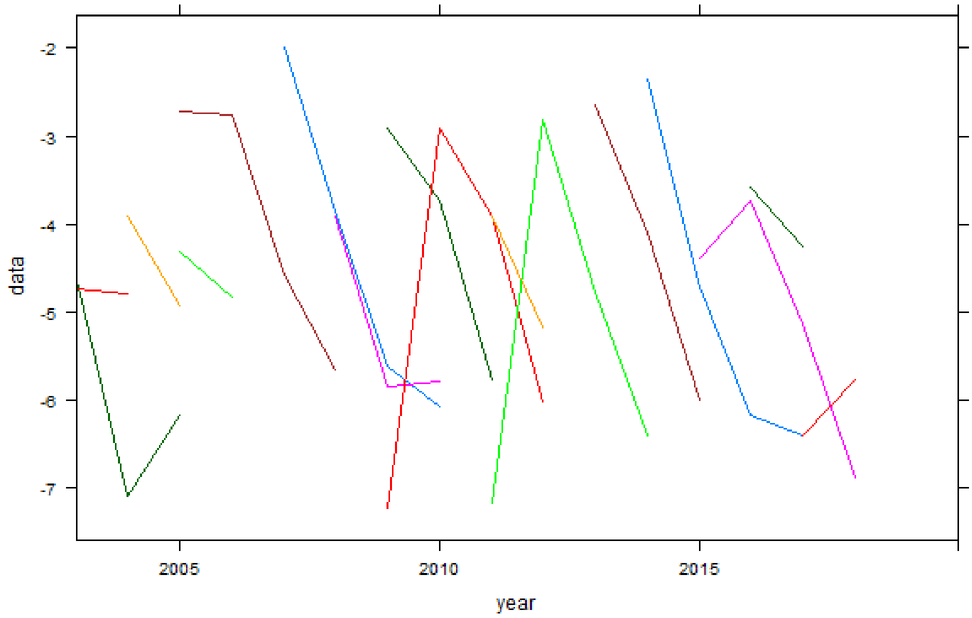


Figure 5.26. Cod in Division 6.a. Log catch curves from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 1–4. Survey started in 2003.

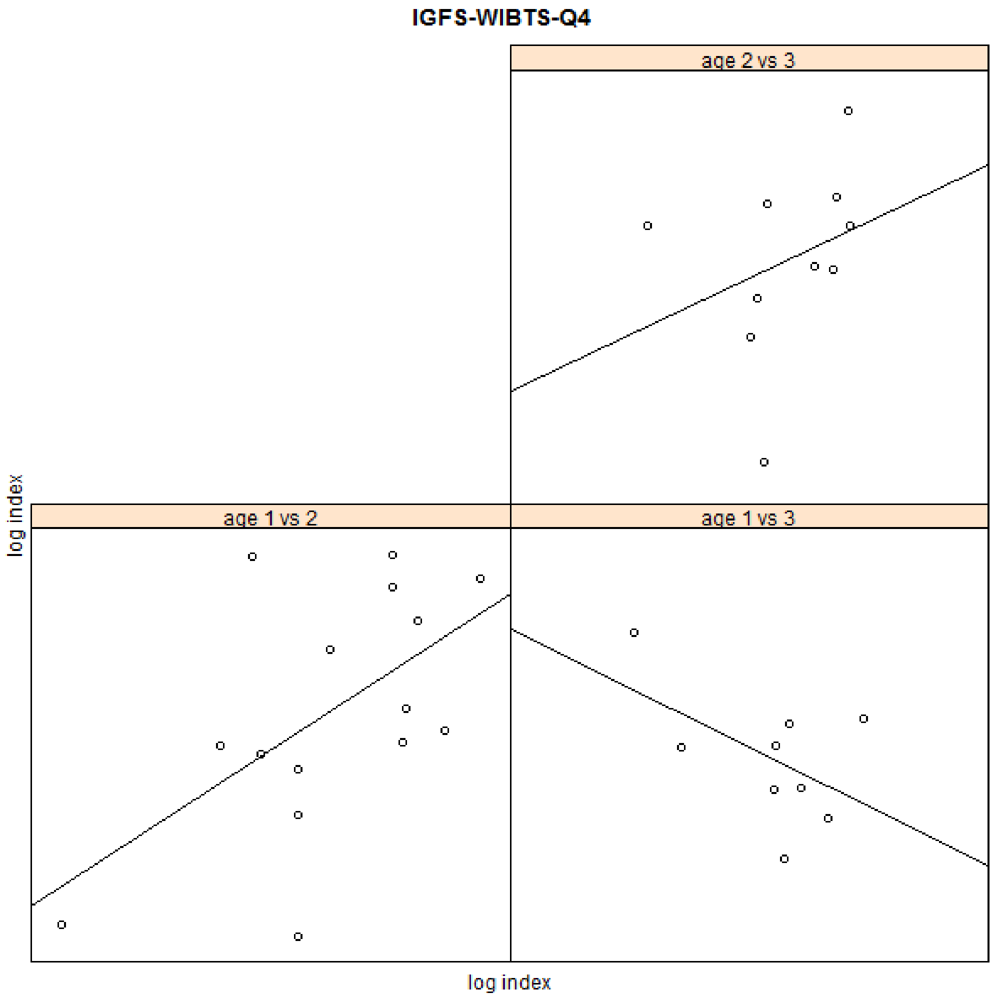


Figure 5.27. Cod in Division 6.a. Within-survey correlations for the Irish quarter four ground fish survey (IRGFS-WIBTS-Q4), comparing index values at different ages for the same cohorts. The straight line is a linear regression.

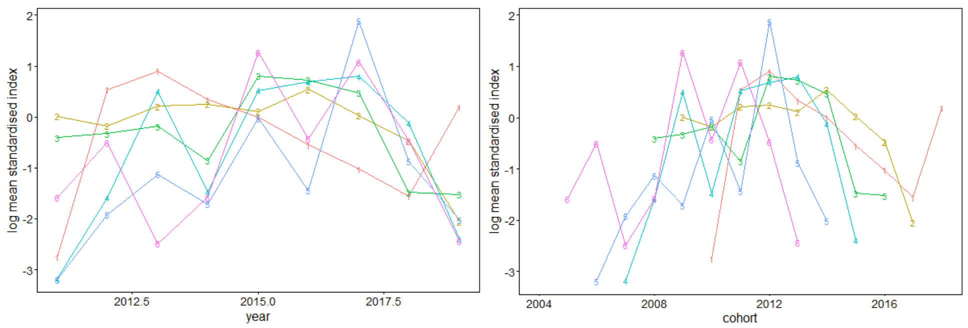


Figure 5.28. Cod in Division 6.a. Log mean standardised index values -by year (left) and cohort (right); from Scottish quarter one ground fish survey UK-SCOWCGFS-Q1; ages 1–6.

Figure 5.29. Cod in Division 6.a. Log catch curves from new Scottish quarter one ground fish survey (UK-SCOWCGFS-Q1); ages 1–7. Survey started in 2011.

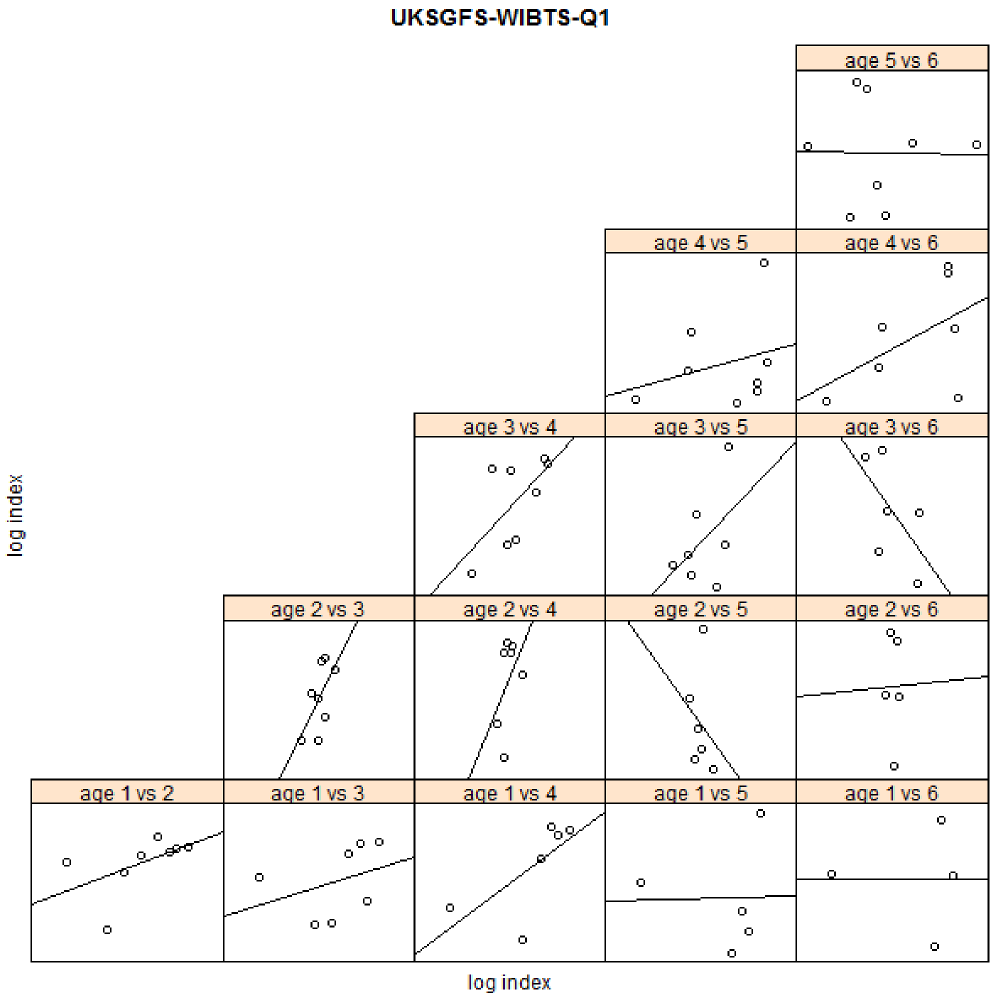


Figure 5.30. Cod in Division 6.a. Within survey scatterplots from new Scottish quarter one ground fish survey (UK-SCOWCGFS-Q1), comparing index values at different ages for the same cohorts. The straight line in a linear regression.

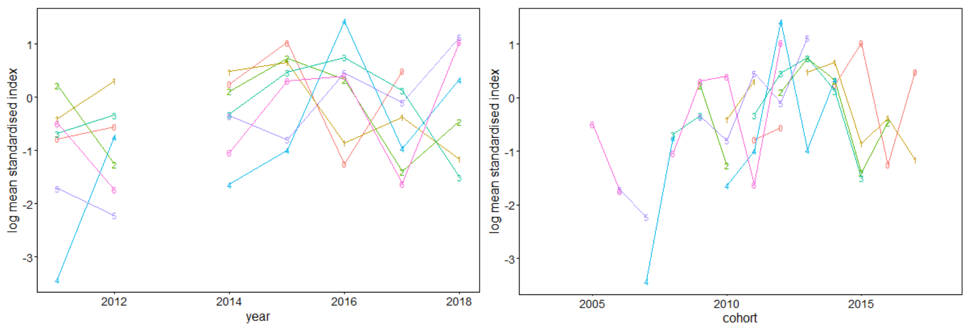


Figure 5.31. Cod in Division 6.a. Log mean standardised index values by year (left) and cohort (right) from Scottish quarter four ground fish survey UK-SCOWCGFS-Q4); ages 0–6.

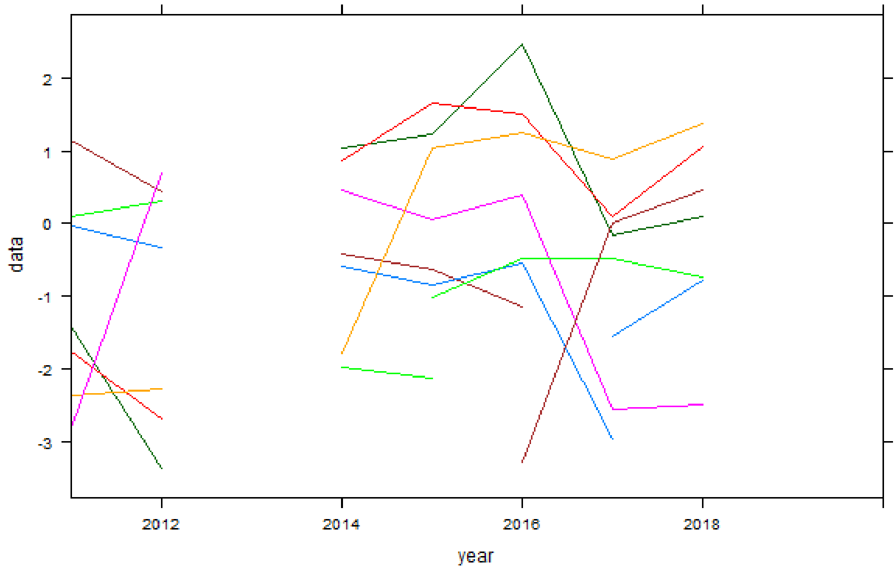


Figure 5.32. Cod in Division 6.a. Log catch curves from new Scottish quarter four ground fish survey (UK-SCOWCGFS-Q4).

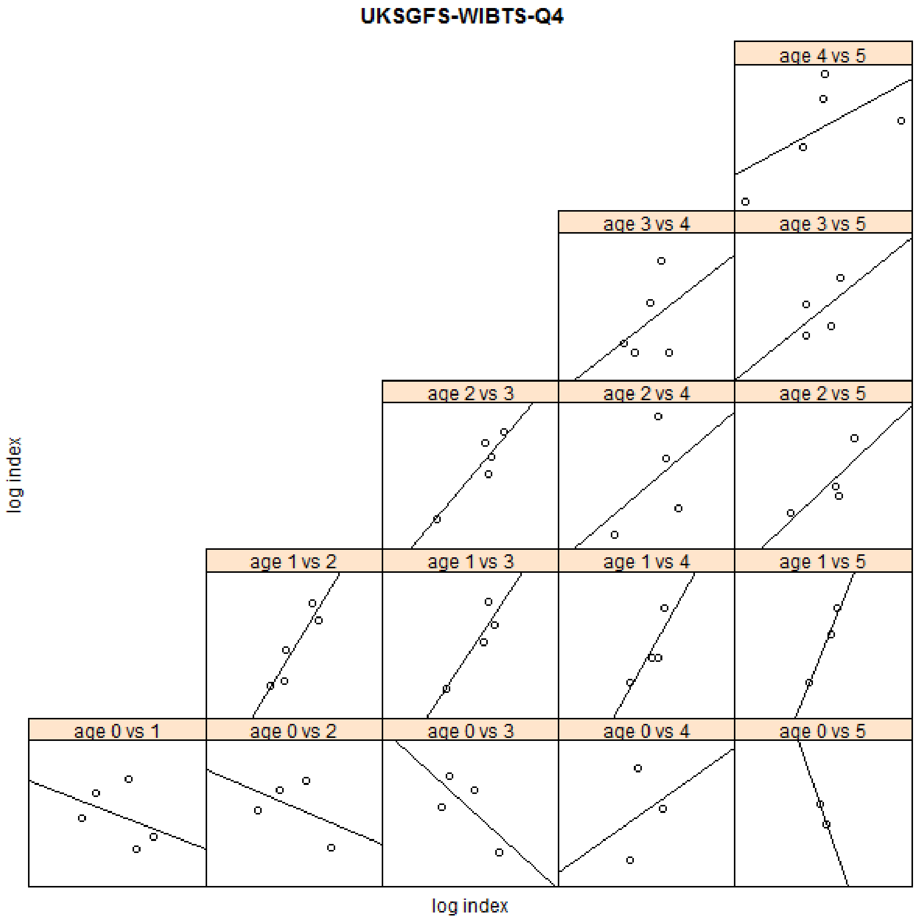


Figure 5.33. Cod in Division 6.a. Within survey scatterplots from new Scottish quarter four ground fish survey (UK-SCOWCGFS-Q4), comparing index values at different ages for the same cohorts. The straight line in a linear regression.

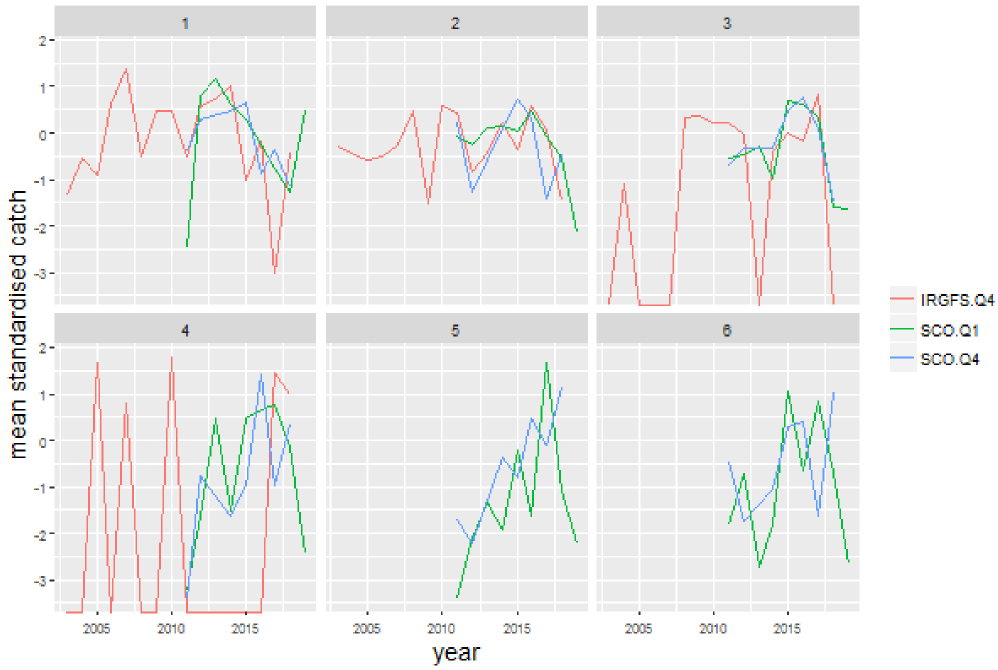


Figure 5.34. Cod in Division 6a. Comparison of survey indices by age. Irish Q4 survey (IRGFS.Q4) is compared to the current Scottish surveys. Values are mean standardised over the time period in common (2011–2018).

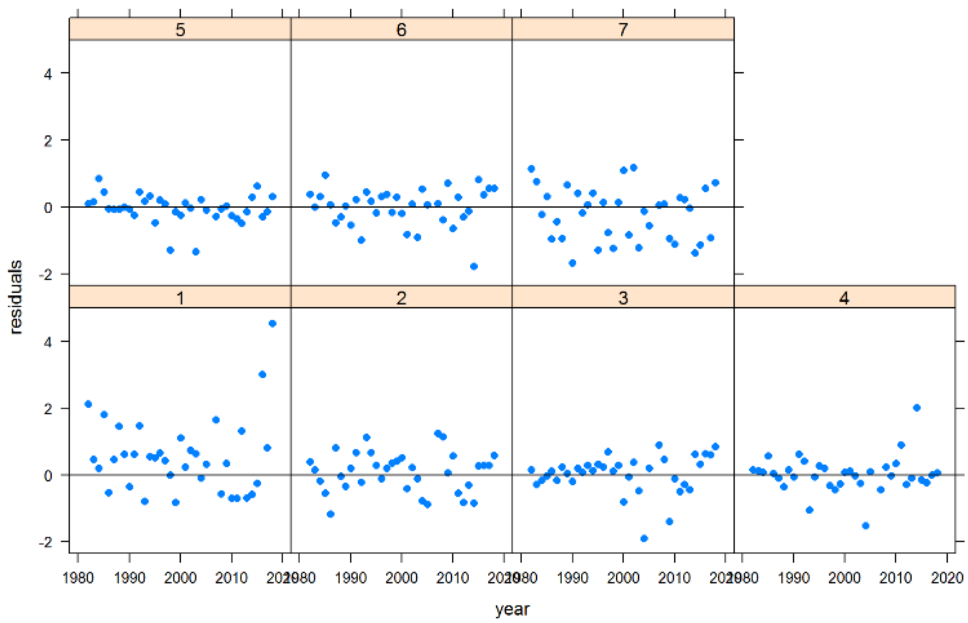


Figure 5.35. Cod in Division 6.a. TSA final run. Standardised residuals at-age for landings (update assessment).

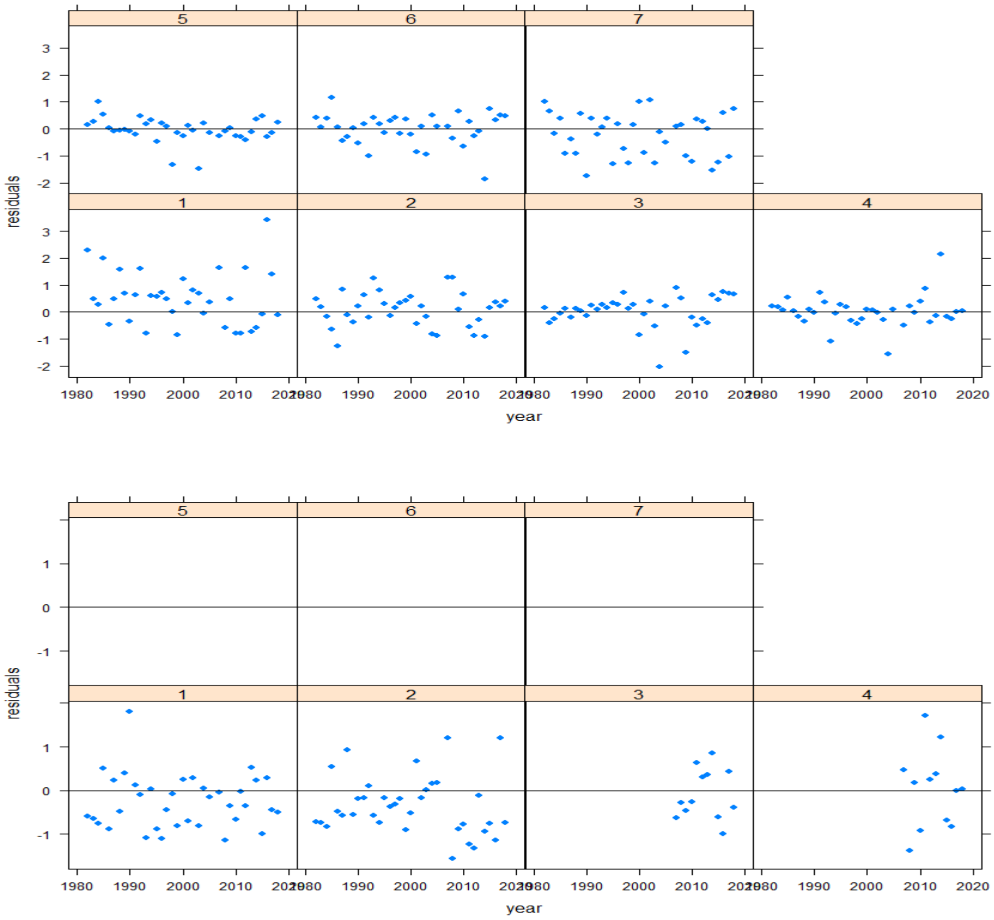


Figure 5.36. Cod in Division 6.a. TSA final run. Residuals at-age plots for landings (upper) and discards (lower). Final assessment.

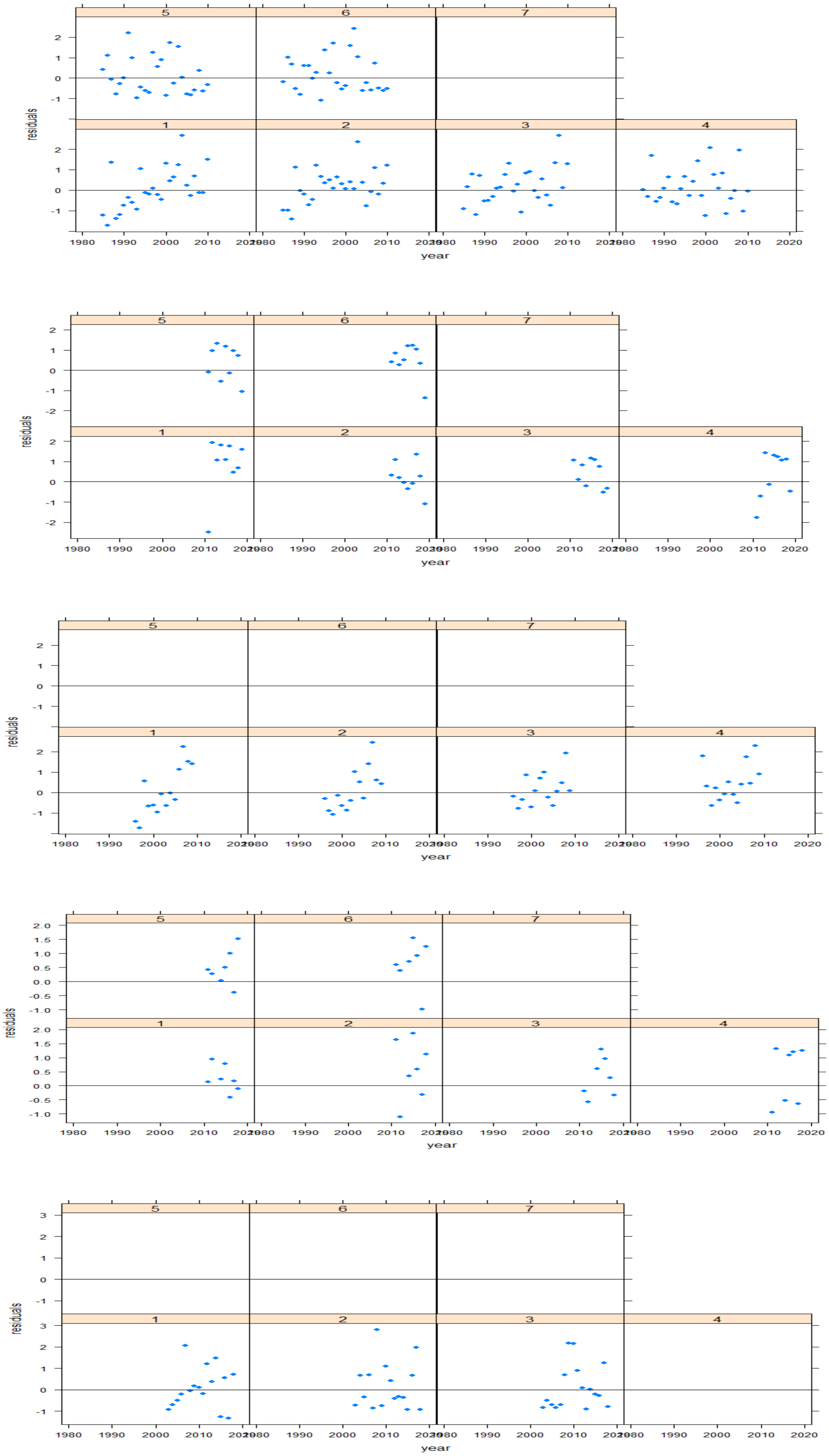


Figure 5.37. Cod in Division 6.a. TSA final run. Residuals at-age plots for ScoGFS-WIBTS-Q1, UK-SCOWCGFS-Q1, ScoGFS-WIBTS-Q4, UK-SCOWCGFS-Q4 & IRGFS-WIBTS-Q4 (upper to lower plots).

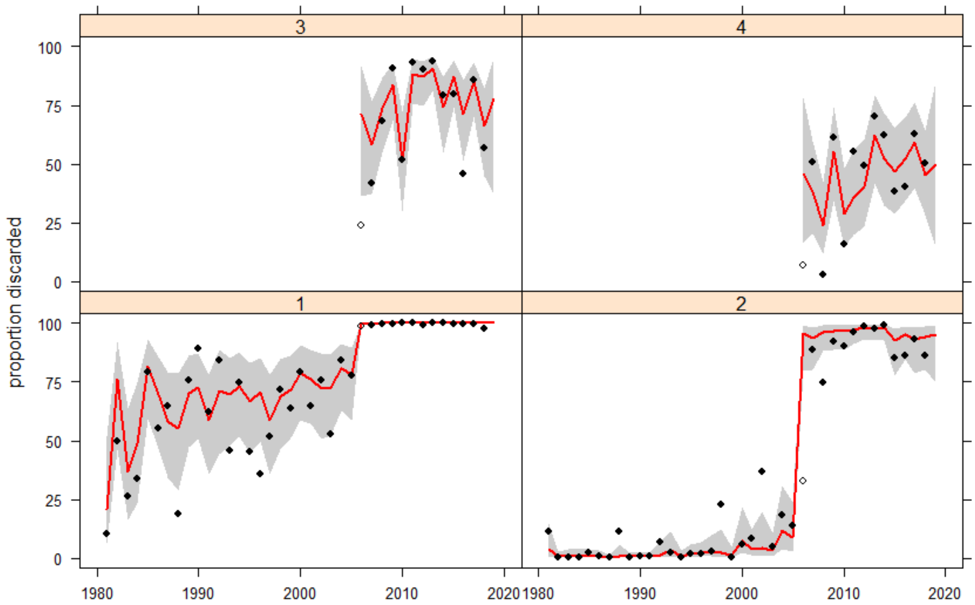


Figure 5.38. Cod in Division 6.a. Observed (points) and fitted (red lines with 95% CI indicated by grey bands) for the proportion discarded by age. Commercial data from 2006 (indicated by an unfilled circle) are not included in the assessment. Note that the plot also shows the TSA projection of discards for 2019.

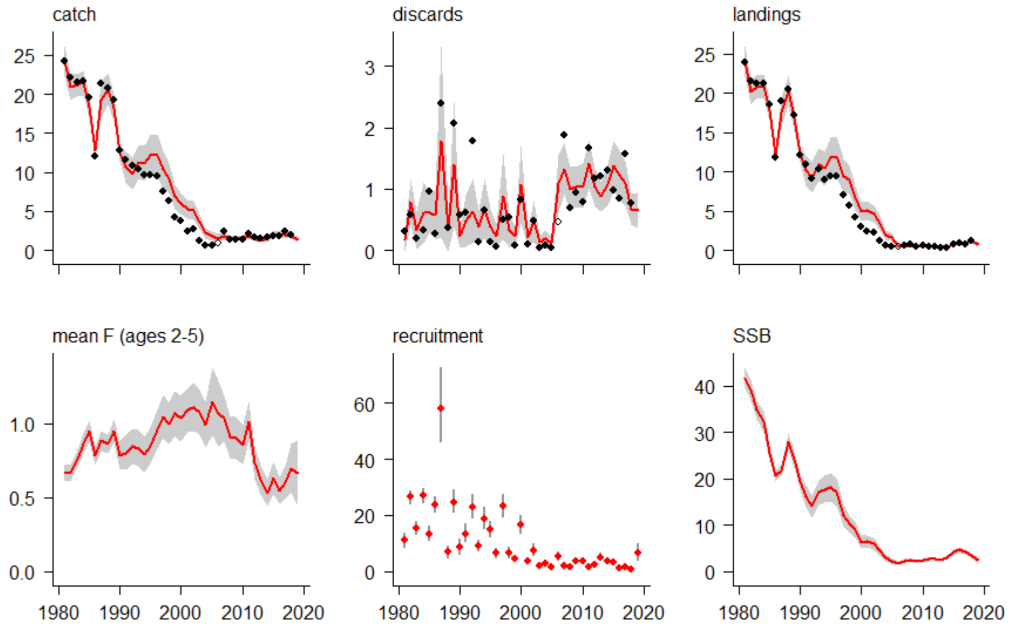


Figure 5.39. Cod in Division 6.a. Summary plot of final TSA run. Stock summary from final TSA assessment. Red lines (or points) give best estimates, grey bands (or lines) give approximate pointwise 95% confidence intervals, and black points give observed values. Commercial data from 2006 (indicated by an unfilled circle) are not included in the assessment. Note that the plot also shows the TSA projection for 2019.

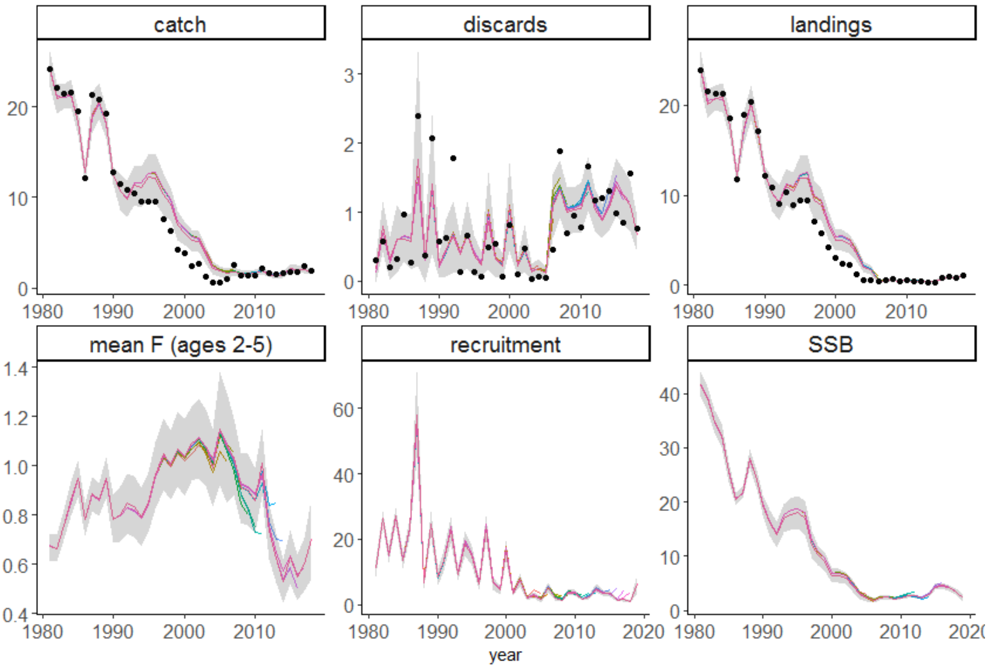


Figure 5.40. Cod in Division 6.a. Retrospective plots of final TSA run.

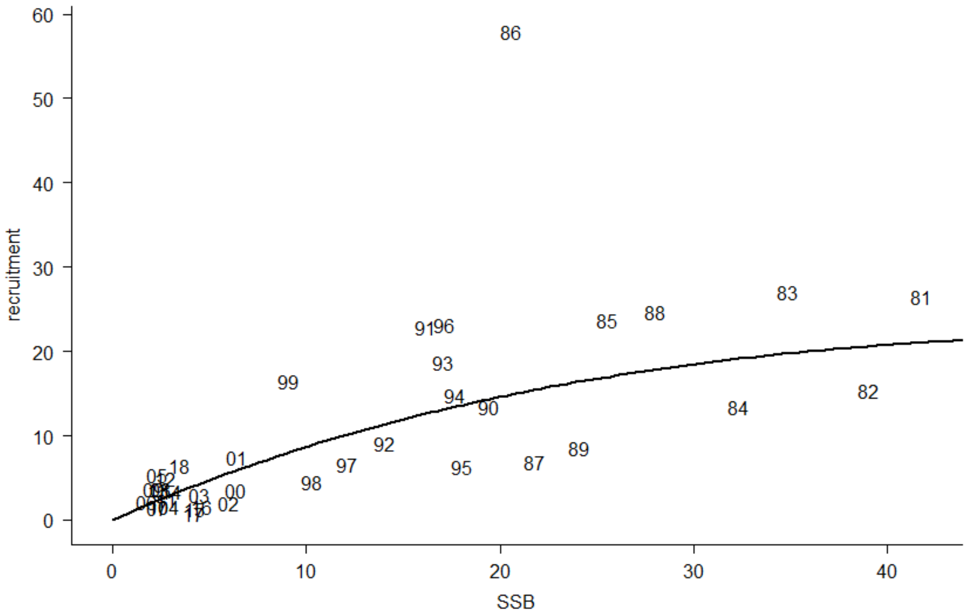
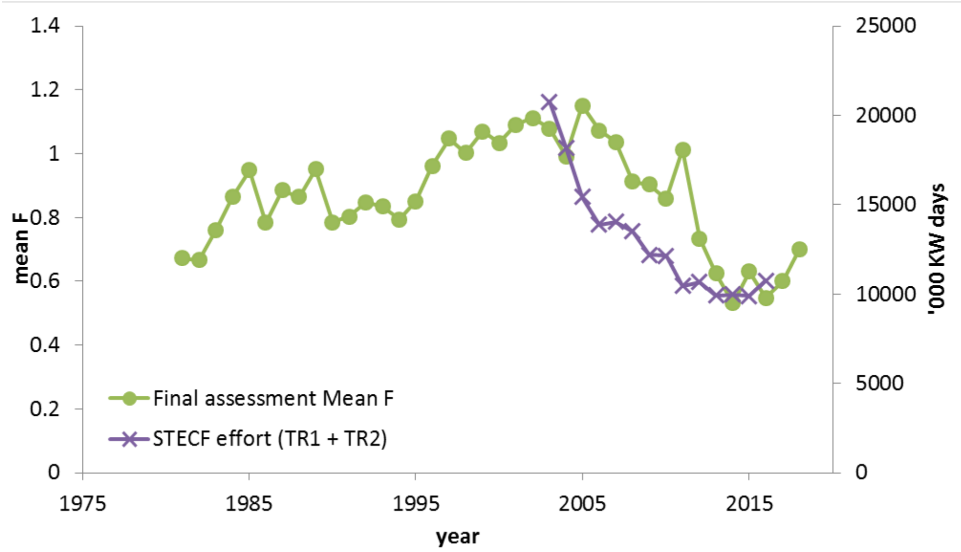


Figure 5.41. Cod in Division 6.a. TSA final run. Stock–recruit relationship. Numbers indicate year class.

a)



b)

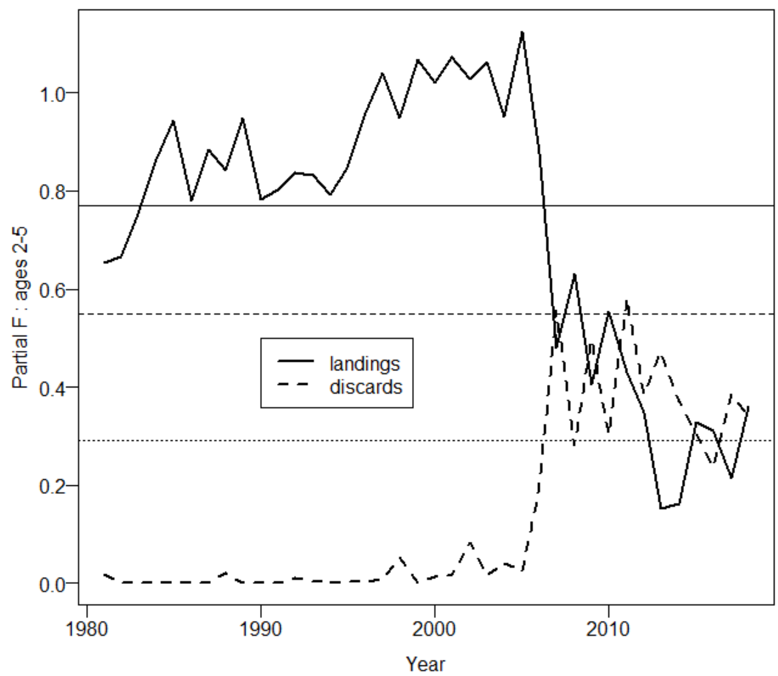


Figure 5.42. Cod in Division 6.a. a) Comparison of estimated mean F and STECF effort data; b) Partial mean F attributed to landings and discards. Horizontal lines represent F_{lim} (solid), F_{pa} (dashed) and F_{MSY} (dotted) values for the stock.

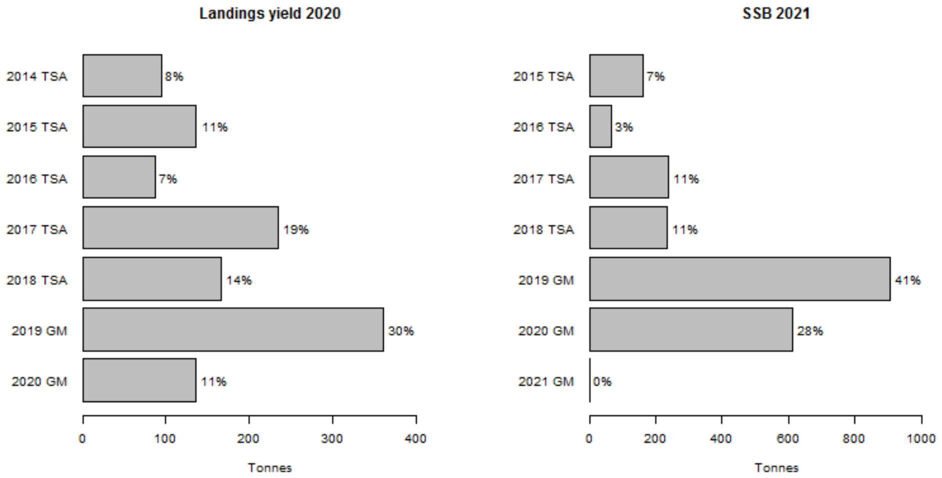


Figure 5.43. Cod in Division 6.a. Percentage contribution to landings yield in 2020 and SSB in 2021 by recruitment year (not year class).

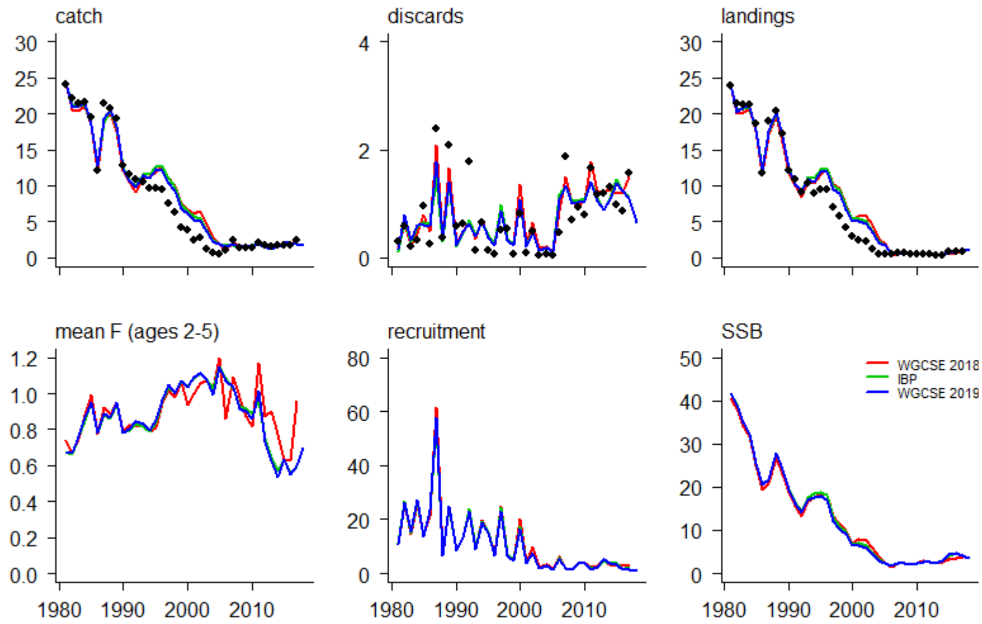


Figure 5.44. Cod in Division 6.a. Comparison of recent assessments (WGCSE 2018, IBP 2019 & WGCSE 2019).

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4 Cod (*Gadus morhua*) in Division 6.b (Rockall)

Assessment in 2017

In 2017, the update assessment and advice followed the agreed procedures for category 6.2.0 of ICES RGLIFE data-limited stock (DLS) advice rules (ICES, 2017a) as set out in the stock annex. For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented.

Given there are conflicting signals from the Irish otter-trawl and Scottish TR1 fleet effort and lpue series and that survey catch rates at Rockall remain too low to provide quantitative information on abundance the ICES advice is to apply the precautionary buffer (last applied in 2012).

ICES advice applicable in 2018–2020

ICES advises that when the precautionary approach is applied, catches should be no more than 14 tonnes in each of the years 2018, 2019, and 2020. ICES cannot quantify the corresponding landings.

ICES advice applicable in 2016–2017

ICES advises that when the precautionary approach is applied, landings should be no more than 17 tonnes in each of the years 2016 and 2017. ICES cannot quantify the corresponding total catches.

ICES approach to data-limited stocks

For data-limited stocks without information on abundance or exploitation ICES considers that a precautionary reduction of catches should be implemented, unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock.

4.1 General

Management applicable to 2018–2020

The TAC for cod at Rockall covers ICES Division 6.b, EU and international waters of Division 5.b west of 12°00′W and subareas 12 and 14. The following is applicable to 2018–2020:

Species:	Cod *Gadus morhua*	Zone:	VIb; Union and international waters of Vb west of 12° 00′ W and of XII and XIV (COD/5W6-14)
Belgium	0		
Germany	1		
France	12		
Ireland	16		
United Kingdom	45		
Union	74		
TAC	74		Precautionary TAC

The fishery in 2018

No specific information is available for 2018. Cod at Rockall are taken as a bycatch in fisheries for other species such as haddock and anglerfish.

4.2 Data

Official landings data for cod in 6.b are shown by nation in Table 4.2.1 and Figure 4.2.1. Total reported landings were 64.1 tonnes in 2018. There were minor updates to landings from previous years as well as slight modifications to the Irish effort time series due to cleaning of historic logbook data (Table 6.2). In the past, official landings have shown very high interannual variation and it is not known whether these are a true reflection of removals.

Landings data have been uploaded to InterCatch for 2018. In addition, some landings age compositions and discard data were also uploaded to InterCatch. Data uploaded to InterCatch are shown below.

Country	Discards (t)	Landings (t)
Ireland		14.2
Norway		0.6
UK (Scotland)	71.9	49.2
Grand Total		64.1

In recent years only limited discard data have been submitted to InterCatch for this stock. Discarded weight has been submitted for the Scottish demersal otter trawl fleet for the years 2014–2018 however there is high interannual variability in the estimated discard rate for this fleet (0 - 60.90%). Discard information has also been provided by Ireland in 2016 and 2017 for the demersal otter trawl fleet 100–119 mm mesh size which has more consistent discard rate estimates (2.25% and 3.68%) although no discard information was submitted for this fleet in 2018. This means that it is difficult to determine an appropriate discard rate for use in the provision of catch advice.

Irish and Scottish landings, effort and lpue are presented in Figures 6.2 and 6.3 and Tables 6.2 and 6.4. Figure 6.2 shows a large decline in the Irish lpue between 1995 and 2003 followed by relatively stable values at a level much lower than at the start of the time-series. In 2017 there was a large increase in effort for this fleet exceeding the previous time-series maximum. This has fallen in 2018 but remains above the 1995-2016 maximum. The recording of Scottish hour’s fished data is not mandatory in the log sheets and the data are incomplete. Scottish otter-trawl fleet data are therefore in units of kg/kWday. The Scottish time-series is much shorter and relatively noisier. Whilst there were marked increases in lpue in 2015 and 2016, given the magnitude of increase it seems unlikely to be completely attributable to an increase in stock size (an almost five-fold increase over two years). 2018 has seen a moderate increase in landings with no change in fishing effort which has led to an increase in lpue. The increase in Irish otter-trawl effort since 2010 has been anecdotally attributed to increases in the squid fishery in which cod is not a target or common bycatch species. This brings into question the usefulness of this lpue series as an indicator of cod abundance.

Survey catch rates of cod at Rockall remain low and are therefore unlikely to provide a reliable index of abundance (Table 6.4).

Catches of cod (both survey and commercial) are too low to support the collection of the necessary information for an assessment of stock status.

4.3 References

ICES. 2017a. Advice basis. *In* Report of the ICES Advisory Committee, 2017. ICES Advice 2017, Book 1, Section 1.2.

Table 6.1. Cod in Division 6.b (Rockall). Official catch statistics.

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Faroe Islands	18	-	1	-	31	5	-	-	-	1	-	-	-	-	-	-	-
France	9	17	5	7	2	-	-	-	-	-	-	-	-	-	-	-	+
Germany	-	3	-	-	3	-	-	126	2	-	-	-	10	22	3	11	1
Ireland	-	-	-	-	-	-	400	236	235	472	280	477	436	153	227	148	119
Norway	373	202	95	130	195	148	119	312	199	199	120	92	91	55	52	85	152
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Spain	241	1200	1219	808	1345	-	64	70	-	-	-	2	5	1	6	4	3
UK (E. & W. & N.I.)	161	114	94	69	56	131	8	23	26	103	25	90	23	20	32	22	4
UK (Scotland)	221	437	187	284	254	265	758	829	714	322	236	370	210	706	341	389	286
UK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1023	1973	1601	1298	1886	549	1349	1596	1176	1097	661	1031	775	962	661	659	572

Table 6.1. Continued. Cod in Division 6.b (Rockall). Official catch statistics.

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
Faroe Islands	-	-	-	-	-	-	-	-	3	5	-	-	-	-	-	+	-	-
France	-	+	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	40	18	11	7	12	23	24	41	20	6	12	1	2	6	5	15	17	14
Norway	89	28	25	23	7	7	12	12	25	27	49	11	3	1	18	11	3	1
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russia	26	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Spain	1	+	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E. & W. & N.I.)	2	2	3	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
UK (Scotland)	176	67	57	45	43	28	26	41	48	23	37	11	9	-	-	-	-	-
UK	-	-	-	-	-	-	-	-	-	-	-	-	-	10	18	37	38	49
Total	334	115	102	75	62	58	62	94	97	61	98	23	14	17	41	62	58	64

*** Preliminary.**

Table 6.2. Cod in 6.b. Landings, effort and lpue data from Irish otter-trawl fleet.

Year	Landings tonnes	Effort '000s Hrs	LPUE Kg/Hr
1995	414.9	9.1	45.39
1996	402	7.2	55.68
1997	130.5	7.2	18.2
1998	207.1	7.3	28.23
1999	137.8	8.79	15.88
2000	101.1	9.9	10.23
2001	33.3	7.2	4.6
2002	16.2	2.6	6.18
2003	9.9	4.5	2.18
2004	6.9	2.2	3.08
2005	8.8	3.3	2.68
2006	22.2	5.9	3.76
2007	24.2	6.6	3.68
2008	41.6	9.9	4.21
2009	21.7	4.4	4.97
2010	7.5	3.3	2.3
2011	10.2	2.5	4.01
2012	1	3.2	0.31
2013	1.8	3.8	0.46
2014	5.6	4.2	1.34
2015	5.1	4.7	1.07
2016	16.4	6.2	2.65
2017	17.3	14.9	1.16
2018	13.3	11.8	1.13

Table 6.3. Cod in 6.b. Landings, effort and lpue data from the Scottish TR1 fleet.

year	lnds(t)	eff(kwdays)	LPUE(kg/kwday)
2003	64.09	2504466	0.0256
2004	39.76	1842103	0.0216
2005	42.98	1217357	0.0353
2006	28.25	1011354	0.0279
2007	25.98	1060551	0.0245
2008	40.29	1124197	0.0358
2009	47.76	1631239	0.0293
2010	22.65	1744452	0.0130
2011	36.54	1565753	0.0233
2012	10.78	901552	0.0120
2013	9.09	532767	0.0171
2014	9.70	668665	0.0145
2015	19.92	563098	0.0354
2016	34.01	514486	0.0661
2017	37.71	794571	0.0475
2018	49.25	794017	0.062

Table 6.4. Cod in 6.b. Survey data made available to the WG: Scottish Q3 ground fish survey ((Rock-WIBTS-Q3)). Catch rates are given as number per 10 hours.

YEAR	Effort (10 Hours)	Age 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9
2011	10	0	0	0	0	0	0	0	0	0	0
2012	10	0	0	0	0	0	0	0	0	0	0
2013	10	0	0.493	0.493	0	0	0	0	0	0.403	0
2014	10	0	0.279	0.894	0	0	0	0	0	0	0
2015	10	0	0	0.922	0.307	0	0	0	0	0	0.307
2016	10	0	0	0.269	0.538	0.538	0	0	0.269	0	0
2017	10	0	0	0	0	0.922	1.062	0	0	0	0
2018	10	0	0	0.307	0.614	0.307	0.307	0	0	0	0

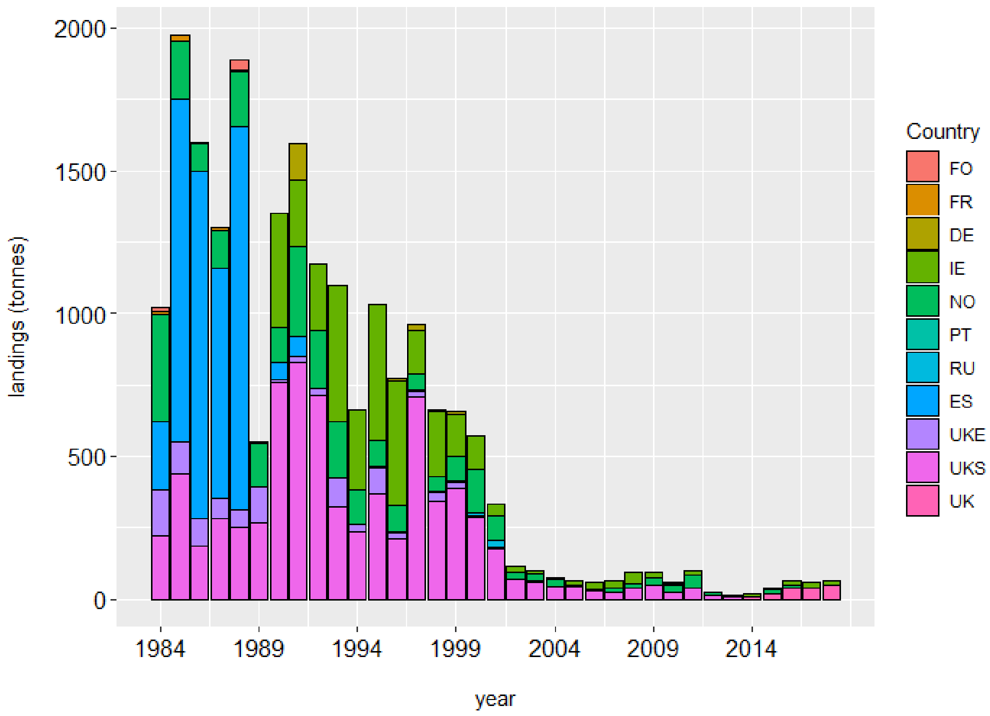


Figure 6.1. Cod in Division 6.b. Total of official catch by nation. Values for 2018 are provisional.

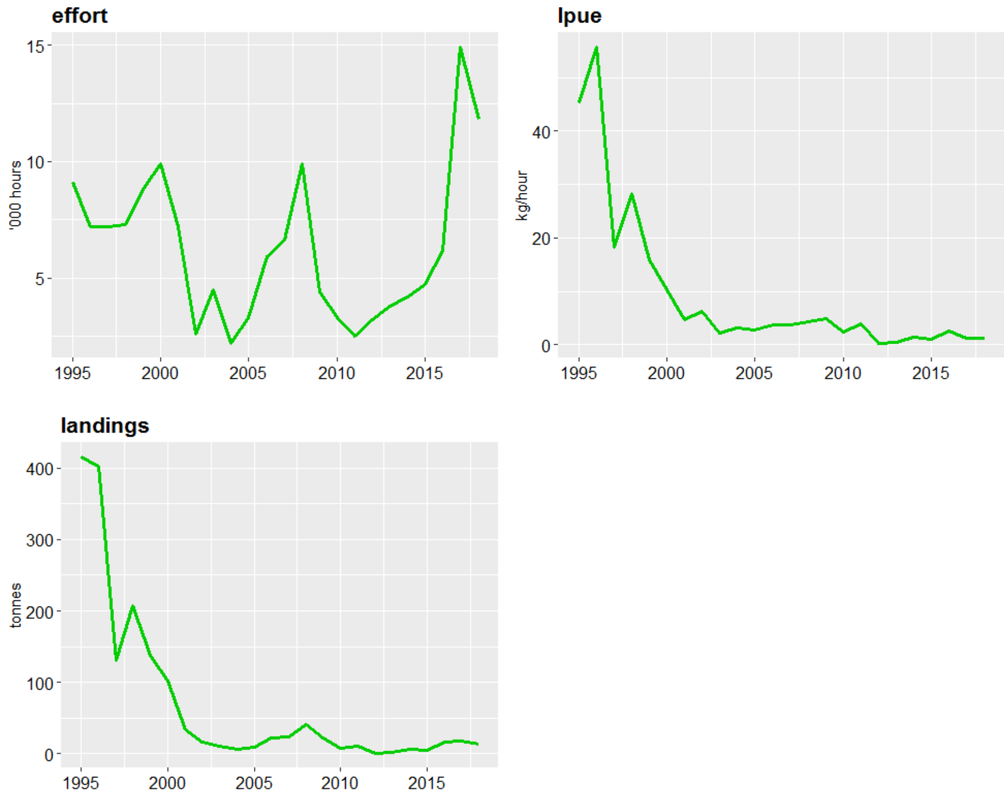


Figure 6.2. Cod in Division 6.b. Landings, effort and lpue (kg/hr) from the Irish Otter-trawl fleet.

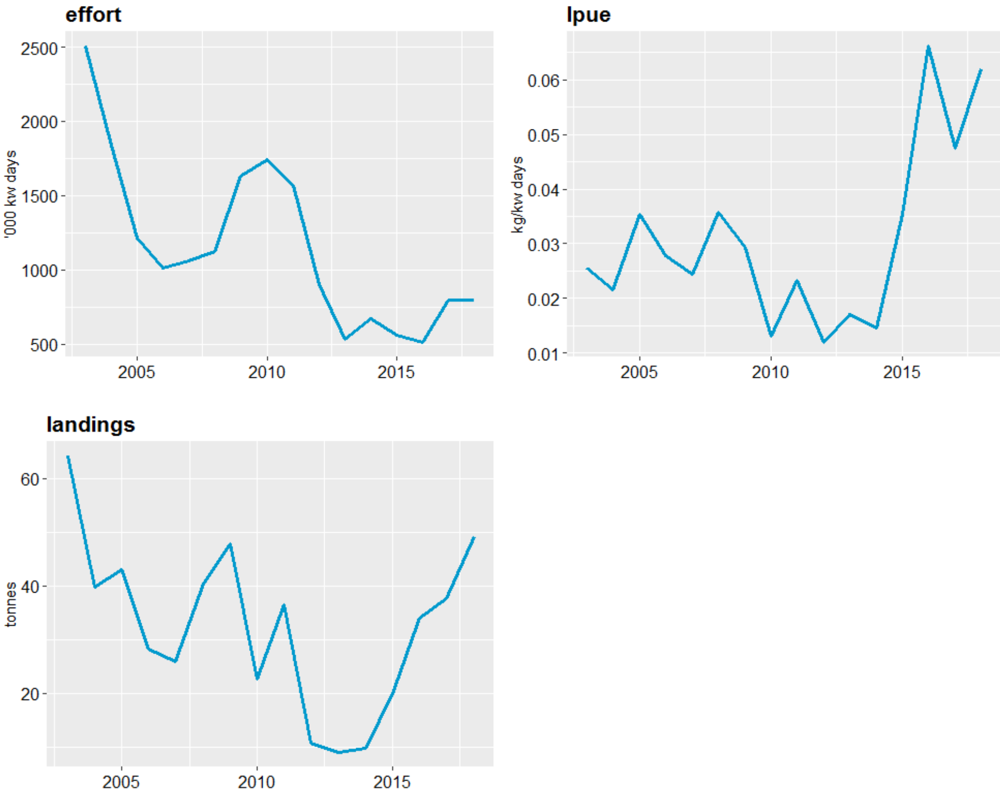


Figure 6.3. Cod in Division 6.b. Landings, effort and lpue (Kg/kWday) from the Scottish TR1 fleet.

5 Cod in 7.a (Irish Sea)

Situated between Ireland and Great Britain the Irish Sea (7.a) is connected by to the Celtic Sea (7.g) at its southern extreme by the St George's Channel and in north is linked to sea region West of Scotland (6.a) by the Northern Channel. The average depth is 50 m but the area is contrasted between a deeper channel, in the west, and shallower bays in the east. The channel has a maximum depth exceeding 275 m whilst the eastern bays have depths less than 50 m. Distinct habitat patches result from a combination of bathymetry, topographical features and hydrography. The sea bed of the eastern Irish Sea is dominated by fine sediment plains with some small areas of areas of mud habitat, the fine sediments graduate to more coarse material in central areas. A large well defined deep-water mud basin is located in the northwestern region in close to the Northern Irish and Irish coast.

Irish Sea fisheries are predominantly demersal trawling and seining with demersal trawling for *Nephrops* dominating effort with vessels using mesh in the range 70–99 mm. Effort using fishing gear with ≥100 mm mesh sizes is currently at a low level compared to historic activity, a considerable decline in effort was observed between 2003 and 2007 and has continued. The species composition of catches by vessels in using ≥100 mm mesh consists of primarily haddock, with lower quantities of hake. At present there is no commercial towed gear fishery for cod permitted. Beam trawls are operating within the Irish Sea with mesh sizes in the range 80–119 mm, targeting sole, plaice, and rays. A seasonal pelagic and gillnet herring fishery operates in late summer–early autumn in the pre and post spawning period. Dredge fisheries target king and queen scallops, with king scallops in coastal areas with the queen scallop fishery operating in the central area south of the Isle of Man, to a lesser extent queen scallops are also targeted using trawl nets, during the late summer when swimming activity is most pronounced.

Type of assessment

An ICES category 3 assessment based on a biomass trend was used as the full analytical assessment, benchmarked at ICES WKIrish3 (ICES, 2017a), did provide a retrospective bias believed to be too high.

ICES advice applicable to 2018 and 2019

ICES advised on the basis of the MSY and precautionary approaches that there should be no directed fisheries, and bycatch and discards should be minimized in 2017. A TAC based on the MSY approach was advised for 2018 and 2019.

5.1 General

Stock description and management units

The stock and the management unit are both ICES Division 7.a (Irish Sea).

Management applicable to 2018

TACs and quotas set for 2018

Zone 7a (COD/07A)	Analytical TAC	Weight tonnes	Landed
	Belgium	9	1.9
	France	25	0.05
	Ireland	459	84.6
	The Netherlands	2	0
	United Kingdom	200	128.5
	EU	695	214.9
	TAC	695	

Management of this cod fishery is by TAC, days-at-sea limits and technical measures. Technical regulations in force in the Irish Sea, including those associated with the cod recovery plan since 2000, are described in Section 7. 2 and 7.10.

Fishery in 2018

The reported landings in 2018 were 235.9 t, despite the TAC of 695 t only increased slightly from 2017 (Table 7.1). Since 2009, Irish landings of cod reported from ICES rectangles immediately north of the Irish Sea/Celtic Sea boundary (ICES rectangles 33E2 and 33E3) have been reallocated into the Celtic Sea as they represent a combination of inaccurate area reporting and catches of cod considered by ICES to be part of the Celtic Sea stock (ICES, 2009). The amount of Irish landings transferred from 7a to 7e–k by year is shown below. Total landings for this stock in 2018 were 214.9 t after this re-allocation.

Year	Tonnes
2004	108
2005	54
2006	103
2007	527
2008	558
2009	193
2010	143
2011	147
2012	130
2013	75
2014	24
2015	39
2016	40
2017	19
2018	20

The total quota uptake was less than the TAC advice for all nations. Landings by UK vessels have realised 64.3% of TAC in 2018 (Table 7.2), while the uptake of the TAC allocation in Ireland was low at 18.4% (Table 7.2). The majority of landings was taken by the TR1 fleet, followed by bycatch in *Nephrops* trawlers. Landings and discards by métier and country can be seen in Table 7.3. Total uptake of cod TAC was 31%.

A Fishery–Science Partnership Survey (FSP) was repeated in the western Irish Sea in spring 2018 in the western Irish Sea using semi-pelagic gear on commercial vessels. This survey attempts to address the lack of sampling opportunities created by the diminishing TAC for cod in the Irish Sea and the resulting significant reduction of a directed whitefish fleet targeting cod.

All sources of information on age composition in the stock, from the fishery as well as surveys using research vessels and chartered commercial vessels, started to show an increase of cod older than three years of age in the Irish Sea. However, in 2017 those fish turned up in catches at a much lower proportion than expected. Historically the proportion-at-age from the data collected during the sentinel fisheries supports a very steep age profile.

InterCatch procedure

Since 2013 international landings and discards-at-age are uploaded into InterCatch. Discards are raised for unreported strata and métiers to estimate total discards-at-age.

Landings

The input data on fishery landings and age compositions are split into four periods:

1) 1968–1990. Landings in this period, provided to ICES by stock coordinators from all countries, are assumed to be un-biased and are used directly as the input data to stock assessments.
2) 1991–1999. TAC reductions in this period caused substantial misreporting of cod landings into several major ports in one country, mainly species misreporting. Landings into these ports were estimated based on observations of cod landings by different fleet sectors during regular port visits. For other national landings, the WG figures provided to ICES stock coordinators were used.
3) 2000–2005. Cod recovery measures were considered to have caused significant problems with estimation of landings. The ICES WG landings data provided by stock coordinators for all countries are considered uncertain and estimated within an assessment model. Observations of misreported landings were available for 2000, 2001, 2002 and 2005. However, they have generally not been used to correct the reported landings but have been used to evaluate model estimates in those years.
4) 2006–2018. The introduction of the UK buyers and sellers legislation is considered to have reduced the bias in the landings data but the level to which this has occurred is unknown. Consequently comparisons were made between the fit of the model to recorded landings under an assumption of bias and unbiased information.

The annual numbers-at-age caught and the mean weights-at-age in landings (applied to the total catch) by age are given in Tables 7.2.4 and 7.2.5 and Figures 7.1 and 7.3. Weights-at-age prior to 1982 are fixed at constant values lower than estimated for subsequent years, leading to sum-of-products errors, and weights-at-ages 6+ are becoming noisy for the last few years (Figure 7.3).

Recent years' surveys and commercial data show an improvement in age structure, which resulted from very low fishing pressure since 2013 and a relatively strong 2013 cohort. However this particular cohort seems to have largely disappeared in 2017 and the very poor recruitment in 2016 results in lower landings than expected in 2018.

Discards data

Discard data (Table 7.6 a–b) have been included in the analytical assessments. Landings and discards are combined to catch weight and numbers.

The Cod 7.a Stock Annex and WKIrish3 (ICES, 2017 a, b) benchmark report gives details on historic raising to total national and international discards.

Biological data

Natural mortality

Natural mortality has been revised in WKIrish2 (ICES, 2016). M-at-age calculated following Lorenzen (1996) was considered a better representation of the natural mortality than M=0.2. Natural mortality was kept constant throughout years.

Maturity

Maturity ogive has been revised in WKIrish2 (ICES, 2016). Each year the smoother is applied to the full time-series of raw data and values are accordingly updated. Updated values after application of the smoother are in Table 7.7. Please refer to the stock annex for further information.

Survey data used in assessment

Please refer to the stock annex for a description of the surveys and survey data. For the current assessment, data for all four surveys were available (Table 7.8).

Survey	Ages	Years	
NIGFS-WIBTS-Q1	1–4	1993	2018
NIGFS-WIBTS-Q4	0–2	1993	2018
UK-FSPw	2–6	2005	2018 (except 2014)
NIMIK	0	1994	2018

Internal consistency of survey data

The survey data during spring each year are of critical importance for the fit of the assessment models as noted by WGCSE previously and evaluated by WKIrish3 (ICES, 2017a). The data for all surveys were screened by WKIrish3, and due to the number of plots produced, only few are presented here in Figures 7.4–7.7.

Commercial cpue

Commercial cpue data are available for this stock but are not currently used in the assessment.

5.2 Historical stock development

Analytical Model used: ASAP

Due to a bias in the retrospective using 5 peels of 92% and 52% for SSB and F respectively, the working group decided that an advice based on this assessment is not reliable. A number of options were investigated to improve retrospective bias, but eventually the working group concluded to change the stock category of Irish Sea cod from category 1 to category 3. The advice of the stock is now based on a trend-based assessment using a relative biomass and harvest index.

All fits for the ASAP model are supplied at the end of the chapter.

Deviations from Stock Annex

The assessment did not follow the stock annex as the model provided too great a bias. A trend based assessment was used. The analytical ASAP model is represented here nonetheless as a general trend and background for the change in category.

Software used and model options chosen

Input data types and characteristics

New data added to the ASAP assessment are the fishery catch data and survey data for 2018. Maturity ogive smoother was applied to the full NIGFS-Q1 Index maturity time-series data to produce a new maturity ogive.

ASAP model Diagnostics

The diagnostics of the update ASAP run are given in Figure 7.8–7.17.

Figure 7.8 shows the fit of observed and predicted total catches.

Figure 7.9 presents the fitted catch-at-age data for the commercial fleet and the residuals of the fit of the time-series model to the catch data for each age. The fitted values track the trends in the observations well in the early years in which there is no calibration information, with no strong pattern in the residuals. After the introduction of the tuning data, the residuals are increasingly noisy especially for age classes 1 and 2.

The diagnostics for the Indices are presented in Figures 7.10–7.12.

Figure 7.13 presents the selectivity-at-age of the fishery in two selectivity blocks. The first selectivity block represents the fishery until 1999, the dome-shaped selectivity curve from 2000, as described in the stock annex (ICES, 2107b).

Figure 7.14 presents the estimated selectivity parameters at-age for the time-series of the surveys used in the assessment.

Figure 7.16 shows the fit of the model RMSE. The fit to the total catch and MIKNET index is not perfect, however it provides a reasonable fit to the other surveys.

Retrospective summary for 2013–2018 is displayed in Figure 7.17. F_{bar} and SSB have been readjusted annually; F_{bar} is revised upwards, while SSB is revised downwards considerably.

Final assessment

A trends based analysis was eventually used to assess the stock status.

The NIGFS-Q1 survey was used to generate a biomass trend by multiplying the relative abundance-at-age/nautical miles (Table 7.8 a) by the weight-at-age (Table 7.5b) and summing within each year. This was then standardised to the mean and the average of the last two years was divided by the mean of the preceding three to generate the index of change. The rate of change (resulting from the 2 over 3 rule) (Figure 7.18, Table 7.9) was 0.57, suggesting that the biomass has been largely stable over the past few years and had a considerate drop in 2018.

The biomass index only takes into account ages 1–4, excluding the larger fish which have been responsible for the apparent increase in biomass in the ASAP assessment.

A harvest rate indicator was constructed using the ratio of biomass indicator to total catches which was then standardised to the mean.

Final assessment: long-term trends

The harvest rate indicator has been constantly declining since 2013 and only saw a slight increase in 2018 due to the landings increase in response to the higher TAC (Figure 7.18, Table 7.9) and at the same time a decline in the biomass index. The same general decline is observed in the ASAP assessment.

The biomass index shows a mostly stable biomass trend in contrast to the (biased) ASAP assessment which shows an increasing trend in SSB in recent years. The biomass trend takes into account fish from ages 1 to 4, of which not all constitute of the SSB, but largely follows the commercial exploitation pattern and is therefore considered an appropriate index for exploitable biomass.

The state of the stock from ASAP model

Spawning–stock biomass has declined ten-fold since the late 1980s and recruitment has been low since the mid-1990s, particularly since 2000. Fishing mortality has been declining in recent years and has dropped to below F_{MSY}. Since 2010 SSB has slowly recovered (Figure 7.17).

Fishing mortality throughout large parts of the assessment period has been well above the candidate reference points associated with high long-term yields and a low risk of depleting the productive potential of the stock. The assessment shows a steep decline in F from 2012 (Figure 7.17).

Recruitment has been low for the past eighteen years. 2012 and 2013 year classes have increased recruitment, but were still well below the long-term average. Recruitment in 2016 was estimated at the historically lowest point (Figure 7.17).

The status of the stock in future years is very uncertain.

Investigated options of the analytical model

A range of options were discussed during the working group meeting to decrease the retrospective bias in the model. While some of the options looked promising, further work will have to be done.

The options included:

- Changing the index selectivity pattern of Q1 survey;
- Keeping M for older ages at the level of first maturity;
- Adding a third selectivity block to commercial catches;
- Removing the final year of the FSP index, as this might have been caused by a year effect;
- Removing the Q4 survey index, since it is not tracking cohorts to a high degree;
- Curtailing the age structure of cod to age 4 (age 4+ group).

5.3 Short-term predictions

Due to the stock being re-classified as an ICES category 3 stock, no short-term forecast was carried out.

5.4 Biological reference points

No reference points available at the current time, as stock has been re-classified as category 3.

5.5 Management plans

The Irish Sea cod management plan, as described in Council Regulation (EC) 1342/2008 was evaluated independently by ICES in 2009 using the approach adopted in AGCREMP 2008 and found to be not consistent with the ICES Precautionary Approach (WGCSE 2009).

5.6 Uncertainties and bias in assessment

Landings data

The quality of the commercial landings and catch-at-age data for this stock deteriorated in the 1990s following reductions in the TAC without associated control of fishing effort. The Working Group has, since the 1990s, attempted to overcome this problem by incorporating sample-based estimates of landings from three major ports in the WG landings figures. The data for this method have been poor for the years 2003–2006, hence data for this period have been estimated by the WG using modelling approaches.

Discarding

Discarding has historically been mainly at-age 0 and 1.

The Irish Sea whitefish fleet has got good observer coverage as does the *Nephrops* fleet except for the years 2003–2006.

Strict controls on landings reporting following the introduction of the Registration of Fish Buyers and Sellers regulations has resulted in documented increases in discarding of older cod in the Irish Sea since 2012 (Figure 7.2).

Compliance with catch composition rules for some fleets, especially for those targeting *Nephrops*, could also result in increased discarding of cod.

The increased TAC for cod in the Irish Sea in 2018 will hopefully lead to lower discard rates of older cod in the *Nephrops* fleet.

Surveys

The Irish Sea has relatively good survey coverage. The surveys in general give consistent signals of fish abundance-at-age (Figure 7.6).

The UK Fisheries Science Partnership surveys (UK-FSP) of the Irish Sea cod spawning grounds in spring 2005–2018 carried out using commercial trawlers, indicated a widespread distribution of cod mostly at low density but with some localized aggregations. The time-series of SSB indices shows an upward trend similar to that shown by NIGFS-WIBTS-Q1 pointing to some recovery following the maturation of the 2012 and 2013 year classes, however there was a considerable drop in 2018. The drop resulted from the very low 2016 year class entering the fishery in 2018.

Stock structure and migrations

Stock structure and migrations have been in full discussed in the WKIrish2 report (ICES, 2016).

A tagging study of Irish Sea cod began in 2016 in part to address these issues. Up to January 2019 4238 cod were caught and tagged aboard chartered commercial fishing vessel using semi-pelagic fishing gear, FSP survey, shore angling competitions and others. Up to January 2019, 138 tagged cod were returned. The project relies on collaboration with the fishing industry to provide the data to develop a better understanding of the current behaviour, biology and stock status of Irish Sea cod. Most recent results suggest a stronger migratory behaviour of Irish Sea cod into the Celtic Sea, indicating that up to 18% of mature fish might leave the Irish Sea. This will have considerable impacts on the future management and assessment of the stock, but additional research is necessary.

5.7 Management considerations

A number of emergency and cod recovery plan measures have been introduced since 2000 to conserve Irish Sea cod. These include a spawning closure since 2000 and effort control since 2003. There have also been several vessel decommissioning schemes. As it has not been possible to provide analytical catch forecasts in recent years, the TAC has been reduced by 15–20% annually since 2006 and by 25% since 2009. In 2017 all sources of information on age composition in the stock, from the fishery as well as surveys using research vessels and chartered commercial vessels, indicated a trend towards a recovery of the stock and a decline in fishing pressure.

5.8 Future Issues and considerations

Cod in the Irish Sea and the Celtic Sea are in a highly exploited state and show historically a very steep age-profile. With the decline of the active fishery since 2000, there has been slight improvements in the stocks, however it is questionable in how far traditional analytical assessment methodologies are able to be used in the assessment.

The recent years show that a single, above average, cohort (the 2013 year class), can have a considerable impact on the SSB. However, as those fish seemed to disappear at-age 3 or 4, this resulted in the strong retrospective downwards revisions of SSB.

At the current state it is unclear as to what happened to the fish once they reached age 3 to 4, and the analytical model keeps revising the size of the year class down to fit.

It is essential to further understanding of the stock structure to improve future management, which includes the further investigation of migration and natural mortality in the Irish Sea. It might be necessary for a combined approach to manage the stocks in 7A and 7E-G, in the light of the recent tagging study results.

5.9 References

Armstrong, M. J., Gerritsen, H. D., Allen, M., McCurdy, W. J. and Peel, J. A. D. 2004. Variability in maturity and growth in a heavily exploited stock: cod (*Gadus morhua* L.) in the Irish Sea. ICES J. Mar. Sci., 61, 98–112.

Bendall, V. O., Ó´Cuaig, M., Schon, P-J., Hetherington, S., Armstrong, M., Graham, N., Righton, D. 2009. Spatio-temporal dynamics of Atlantic cod (*Gadus morhua*) in the Irish and Celtic Sea: results from a collaborative tagging programme. ICES Document CM 2009/J: 06. 35 pp.

ICES. 2016. Report of the Data Evaluation Workshop on Irish Sea Fisheries (WKIrish2), 26–29 September 2016, Belfast, UK, ICES CM 2016/BSG:02.

ICES. 2017a. Report of the Benchmark Workshop on Irish Sea fish (WKIrish3), 30 January–3 February 2017, Galway, ROI, ICES CM 2017/BSG:01.

ICES. 2107b. Stock Annex Cod27.7a.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in fish: a comparison of natural ecosystems and aquaculture. J. Fish Biol., 49: 627–647.

STECF. 2011. Scientific, Technical and Economic Committee for Fisheries. Evaluation of Fishing Effort Regimes Regarding Annexes IIA, IIB and IIC of TAC & Quota Regulations, Celtic Sea and Bay of Biscay (STECF-11-13).

STECF. 2013. Evaluation of Fishing Effort Regimes in European Waters - Part 2 (STECF-13-21). Publications Office of the European Union, Luxembourg, EUR 26327 EN, JRC86088, 863 pp.

Table 7.1. Nominal landings (t) of COD in Division 7.a as officially reported to ICES and figures used by ICES from 1999.

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017[1]	2018[1]
Belgium	150	60	283	318	183	104	115	60	67	26	19	21	36	23	13	9	12	3	5	1.9
France	n/a	53	74	116	151	29	35	18[2]	17[2]	3	12	1	3	1	<1	<1	<1	<1	<1	<1
Ireland	966	455	751	1,111	594	380	220	275	608	618[2]	323[2]	289	275	193	160	148	137	84.2	57.2	104.6
Netherlands	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (England, Wales & NI)	1,665	799	885	1,134	505	646	594	5892	423	5432	3872	282	169	109	107	79	50	35.5	41.1	113.3
UK (Isle of Man)	9	11	1	7	7	5	n/a	n/a	n/a	22	12	1	1	<1	<1	<1	<1	<1	<1	<1
UK (Scotland)	80	38	32	29	23	15	3	6	2	12	12	-	-	-	-	-	-	-	<1	<1
Total	2,875	1,417	2,026	2,715	1,477	1,179	967	948	1,117	1224	754	594	485	326	281	236	199	122.83	103.85	234.9
Unallocated	1,909	-143	226	-20	-192	-107	-57	-108	-415	-563	-286	-130	-117	-128	-75	-33	-38	-40.5	-19.4	-20
Total as used by WG	4784[3]	1274[4]	2252[4]	2695[4]	1285[4]	1072[4]	910[4]	840[4]	702[4]	661[4]	468[4]	464[4]	368	198	206	213	161	82	84	214.9

[1]Preliminary. [2]Revised. n/a = not available [3] includes sample-based estimates of landings into three ports [4] based on official data only.

Table 7.2. a)–c) Cod in 7a. Working Group figures for annual landings and TAC uptake by country since 2000 (2009).

a)

Year	NI	E & W	Scotland	Ireland	France	Belgium	Isle of Man	Netherlands	Total	TAC	% uptake
2000	638	156	39	321	52	56	11	0	1273	2100	61
2001	697	209	32	645	361	300	8	0	2251	2100	107
2002	983	171	39	953	251	294	1	2	2695	3200	84
2003	381	118	32	415	145	187	7	0	1285	1950	66
2004	539	103	15	271	37	103	5	0	1072	2150	50
2005	523	72	4	168	31	108	3	0	910	2150	42
2006	552	32	6	172	17	59	3	0	840	1828	46
2007	396	27	2	191	18	66	2	0	702	1462	48
2008	523	22	1	85	3	27	1	0	662	1199	55
2009	375	15	0	55	3	19	1	0	468	899	52
2010	274	17	0	151	1	21	1	0	465	674	69
2011	152	17	0	160	3	36	1	0	368	506	73
2012	98	14	0	63	0	23	0	0	198	380	52
2013	103	4	0	85	1	13	0	0	206	285	72
2014	72	7	0	124	0	9	0	0	213	182	117
2015	47	3	0	99	0	12	0	0	161	146	110
2016	32	3	0	45	0.4	3	0	0	82	146	56
2017	38	3	0.2	38	0.2	5	0.05	0	84	146	57
2018	113	15	<0.1	85	<0.1	2	<0.1	0	215	695	31

b)

2009	UK	Ireland	France	Belgium	Netherlands	Total
Landings	391	55	3	19	0	498
TAC	259	592	33	12	3	899
% uptake	151%	9%	9%	160%	0%	

2010	UK	Ireland	France	Belgium	Netherlands	Total
Landings	292	151	1	21	0	465
TAC	194	444	25	9	2	674
% uptake	150%	34%	4%	233%	0%	

2011	UK	Ireland	France	Belgium	Netherlands	Total
Landings	170	160	3	36	0	369
TAC	146	333	19	7	2	506
% uptake	117%	48%	16%	533%	0%	

2012	UK	Ireland	France	Belgium	Netherlands	Total
Landings	112	63	0	23	0	198
TAC	109	251	14	5	1	380
% uptake	103%	25%	0%	460%	0%	

2013	UK	Ireland	France	Belgium	Netherlands	Total
Landings	107	85	1	13	0	206
TAC	82	188	10	4	1	285
% uptake	130%	45%	10%	325%	0%	

2014	UK	Ireland	France	Belgium	Netherlands	Total
Landings	79	124	0	9	0	213
TAC	52	120	7	2	2	182
% uptake	153%	103%	0%	455%	0%	

2015	UK	Ireland	France	Belgium	Netherlands	Total
Landings	50	99	0	12	0	161
TAC	42	97	5	2	0	146
% uptake	119%	102%	0%	600%	NA	

2016	UK	Ireland	France	Belgium	Netherlands	Total
Landings	35	44	0.4	3	0	82
TAC	42	97	5	2	0	146
% uptake	83%	45%	8%	150%	0%	

2017	UK	Ireland	France	Belgium	Netherlands	Total
Landings	41	38	0.2	5	0	84
TAC	42	97	5	2	0	146
% uptake	98%	39%	4%	250%	0%	

2018	UK	Ireland	France	Belgium	Netherlands	Total
Landings	128.5	84.6	0.05	1.9	0	214.9
TAC	200	459	25	9	2	695
% uptake	64%	18%	<1%	<1%	0%	31%

c) Landings proportions by country since 2000.

Year	NI	E & W	Scotland	Ireland	France	Belgium	Isle of Man	Netherlands	Total
2000	50.1	12.3	3.0	25.2	4.1	4.4	0.9	0.0	100
2001	31.0	9.3	1.4	28.6	16.1	13.3	0.4	0.0	100
2002	36.5	6.4	1.5	35.4	9.3	10.9	0.0	0.1	100
2003	29.7	9.2	2.5	32.3	11.3	14.6	0.6	0.0	100
2004	50.3	9.6	1.4	25.2	3.5	9.6	0.4	0.0	100
2005	57.5	7.9	0.5	18.5	3.5	11.8	0.3	0.0	100
2006	65.7	3.8	0.7	20.4	2.0	7.1	0.3	0.0	100
2007	56.5	3.8	0.3	27.2	2.5	9.5	0.3	0.0	100
2008	78.9	3.4	0.2	12.8	0.5	4.0	0.2	0.0	100
2009	80.1	3.1	0.0	11.7	0.6	4.1	0.3	0.0	100
2010	41.3	4.6	0.0	43.5	0.8	9.8	0.2	0.0	100
2011	41.3	4.6	0.0	43.5	0.8	9.8	0.3	0.0	100
2015	49.5	7.1	0.0	31.8	0.0	11.6	0.0	0.0	100
2013	50.0	1.9	0.1	41.3	0.2	6.3	0.2	0.0	100
2014	33.8	3.3	0.0	58.2	0.0	4.2	0.0	0.0	100
2015	29.2	1.9	0.0	61.5	0.0	7.5	0.0	0.0	100
2016	39.0	3.7	0.0	54.9	0.5	3.7	0.0	0.0	100
2017	45.5	3.2	0.3	44.7	0.2	6	0.1	0.0	100
2018	52.7	7	<0.1	39.4	0.0	0.9	<0.1	0.0	100

Table 7.3. Landings and discard proportions by métier.

Catch (2018)	Estimated landings					
	otter trawls		Scottish seines	mid-water trawl	beam trawls	other gear types
	Nephrops directed 25%	demersal fish directed 48%	<1%	16.8%	9.1%	1.15%
	215 tonnes					
257 tonnes	Estimated discards					
	otter trawls		Scottish seines	mid-water trawl	beam trawls	other gear types
	70% *Nephrops* directed	8.3% demersal fish directed	<1%	<1%	19.5%	1.85%
	42 tonnes					

Table 7.4. Cod in 7a. Total catch numbers-at-age (thousands).

	0	1	2	3	4	5	6+
1968	17	439	1563	1003	456	177	30
1969	20	969	1481	1050	269	186	113
1970	22	1810	1385	352	204	163	71
1971	22	2835	2022	904	144	67	51
1972	26	900	3267	824	250	58	59
1973	27	2377	1091	1783	430	173	81
1974	16	601	3559	557	494	131	74
1975	26	1810	642	1407	294	249	117
1976	27	1247	3007	363	500	61	104
1977	31	946	511	1233	163	218	71
1978	40	855	1092	310	311	39	65
1979	44	1948	1288	608	127	164	71
1980	25	2636	2797	729	243	49	55
1981	38	1457	3635	1448	244	99	47
1982	46	538	2284	1455	557	102	79
1983	47	1011	932	751	499	154	46
1984	37	1733	1195	439	240	161	75
1985	34	1360	2105	703	158	84	77
1986	49	1180	2248	699	203	64	65
1987	47	4522	1793	841	252	75	43
1988	43	2971	4734	702	263	71	38

	0	1	2	3	4	5	6+
1989	41	754	2163	1886	231	86	37
1990	38	869	1075	545	372	70	30
1991	47	2169	1408	442	127	98	22
1992	37	1529	1243	664	132	42	49
1993	39	388	2907	403	119	16	13
1994	40	916	569	848	68	20	10
1995	43	678	1283	180	163	7	6
1996	88	447	1113	700	38	39	6
1997	5	651	1149.5	501	213	17	16
1998	0	231	1928	335	80	28	8
1999	141	236	843	871	66	21	7
2000	62	1107	176	107	50	4	1
2001	7	403	841	53	13	9	2
2002	0	238	564	405	7	2	3
2003	50	121	472	109	36	1	0
2004	50	161	134	174	22	6	3
2005	50	118	256	78	34	5	1
2006	50	89	174	128	17	8	3
2007	16	216	210	56	11	1	0
2008	6	77	169	87	9	3	0
2009	329	60	57	66	17	3	0
2010	49	220	188	16	7.5	2	1
2011	10	54	106	36	2	1	1
2012	8	84	135	145	10	0	0
2013	36	37	59	30	9	2	0
2014	1	41	86	26	5	1	0
2015	0	37	80	26	4	1	0
2016	0	11	25	30	2	1	0
2017	0	12	28	16	3	0	0
2018	256	95	27	36	2	2	1

Table 7.5. a) Mean weights-at-age in the landings (used for whole stock and catch).

0		1	2	3	4	5	6+
1968	0.1	0.61	1.66	3.33	5.09	6.19	6.86
1969	0.1	0.61	1.66	3.33	5.09	6.19	7.26
1970	0.1	0.61	1.66	3.33	5.09	6.19	7.17
1971	0.1	0.61	1.66	3.33	5.09	6.19	7.12
1972	0.1	0.61	1.66	3.33	5.09	6.19	7.28
1973	0.1	0.61	1.66	3.33	5.09	6.19	7.16
1974	0.1	0.61	1.66	3.33	5.09	6.19	7.34
1975	0.1	0.61	1.66	3.33	5.09	6.19	7.05
1976	0.1	0.61	1.66	3.33	5.09	6.19	7.13
1977	0.1	0.61	1.66	3.33	5.09	6.19	7.63
1978	0.1	0.61	1.66	3.33	5.09	6.19	7.19
1979	0.1	0.61	1.66	3.33	5.09	6.19	7.48
1980	0.1	0.61	1.66	3.33	5.09	6.19	6.87
1981	0.1	0.61	1.66	3.33	5.09	6.19	7.55
1982	0.1	1.01	1.52	3.49	5.57	7.59	9.11
1983	0.1	1	1.84	3.99	5.96	7.97	9.97
1984	0.1	0.68	1.81	3.81	5.87	7.48	10.05
1985	0.1	0.78	2.02	4.24	5.83	7.5	9.04
1986	0.1	0.81	1.83	3.86	5.86	7.39	8.78
1987	0.1	0.71	2.16	3.91	6.41	7.82	10.32
1988	0.1	0.61	1.56	3.76	5.67	8.02	9.88
1989	0.1	0.94	1.85	3.22	5.41	6.57	9.47
1990	0.1	0.84	1.94	3.57	5.28	7.53	9.4
1991	0.1	0.86	1.64	3.54	5.42	6.39	9.11
1992	0.1	0.81	1.96	3.99	5.98	6.92	8.67
1993	0.1	0.85	1.71	3.67	5.68	7.37	10.17
1994	0.1	0.8	1.92	3.61	6.08	7.68	8.57
1995	0.1	0.9	1.84	4.00	5.79	8.45	9.14

0		1	2	3	4	5	6+
1996	0.1	0.98	1.63	3.26	5.3	7.72	9.79
1997	0.1	0.85	1.94	3.62	5.29	6.12	9.4
1998	0.1	0.93	1.65	3.73	5.37	7.03	9.35
1999	0.1	0.85	1.62	3.18	5.51	7.52	10.25
2000	0.1	0.85	1.99	3.57	5.14	7.15	8.39
2001	0.1	0.99	1.82	4.15	5.61	7.33	9.51
2002	0.1	0.94	1.84	3.44	5.73	7.71	10.01
2003	0.1	1.21	1.66	3.29	5.43	10.2	11.09
2004	0.1	1.11	2.2	3.63	6.51	7.64	8.61
2005	0.1	0.91	1.94	3.51	5.32	7.74	8.89
2006	0.1	0.83	1.84	3.67	4.71	6.39	7.84
2007	0.1	0.83	1.85	3.78	5.35	7.99	10.04
2008	0.1	0.89	1.59	3.54	6.00	7.57	9.46
2009	0.1	1.1	2.01	3.46	5.31	7.1	6.82
2010	0.1	1.26	2.29	3.93	6.34	7.33	9.64
2011	0.1	0.95	1.88	3.75	5.54	6.75	9.04
2012	0.1	0.93	1.88	3.37	5.34	7.60	8.56
2013	0.1	0.97	2.32	4.06	5.54	7.43	10.79
2014	0.1	0.88	2.26	4.49	7.00	8.75	9.41
2015	0.1	0.83	1.79	3.69	6.49	8.55	9.95
2016	0.1	0.95	1.58	3.1	5.01	10.66	8.136
2017	0.1	0.70	1.82	3.82	5.85	7.62	9.74
2018	0.1	0.43	1.69	3.64	5.56	8.58	8.70

b) Q1 survey weights used to calculate the biomass index.

Year	1	2	3	4
1993	0.18	0.97	3.01	5.12
1994	0.14	1.25	3.06	4.82
1995	0.11	0.92	3.21	5.27
1996	0.17	1.08	2.65	7.20
1997	0.13	1.21	3.24	4.65
1998	0.19	0.91	4.01	3.96
1999	0.22	1.04	2.81	3.93
2000	0.17	1.55	3.69	4.85
2001	0.12	1.13	3.98	4.98
2002	0.15	1.20	3.11	NA
2003	0.11	1.02	2.77	5.04
2004	0.12	1.24	2.96	6.21
2005	0.12	1.50	3.67	5.52
2006	0.10	1.04	3.05	4.95
2007	0.10	1.07	3.58	7.05
2008	0.09	1.03	2.91	4.96
2009	0.18	1.26	2.82	6.50
2010	0.11	1.28	2.96	7.54
2011	0.11	0.98	3.41	4.62
2012	0.14	0.98	2.35	4.74
2013	0.11	1.12	3.51	6.09
2014	0.11	1.24	3.55	6.08
2015	0.10	0.91	3.52	7.74
2016	0.10	0.94	3.21	5.03
2017	0.09	0.92	3.06	5.63
2018	0.18	1.17	2.56	NA

Table 7.6. Cod in 7.a. Estimates of numbers discarded (a) and the discarded proportions (b) from 1968–2018. Data are total numbers ('000 fish) discarded at-age, estimated from numbers per sampled trip raised to total fishing effort by each country supplying data (UK, Ireland and Belgium) Please refer to WKIrish3 (ICES, 2017a) documents.

a)

Year	0	1	2	3	4	5	6+
1968	17.81	74.71	0	0	0	0	0
1969	20.85	87.45	0	0	0	0	0
1970	22.13	92.83	0	0	0	0	0
1971	22.94	96.2	0	0	0	0	0
1972	26.51	111.18	0	0	0	0	0
1973	27.17	113.96	0	0	0	0	0
1974	16.94	71.04	0	0	0	0	0
1975	26.38	110.62	0	0	0	0	0
1976	26.77	112.28	0	0	0	0	0
1977	31.05	130.23	0	0	0	0	0
1978	39.96	167.57	0	0	0	0	0
1979	44.35	185.98	0	0	0	0	0
1980	24.6	103.16	0	0	0	0	0
1981	37.67	157.97	0	0	0	0	0
1982	46.04	193.1	0	0	0	0	0
1983	46.98	197.05	0	0	0	0	0
1984	37.3	156.45	0	0	0	0	0
1985	33.89	142.12	0	0	0	0	0
1986	49.15	206.15	0	0	0	0	0
1987	47.38	198.69	0	0	0	0	0
1988	42.59	178.64	0	0	0	0	0
1989	41.03	172.09	0	0	0	0	0
1990	37.85	158.74	0	0	0	0	0
1991	46.64	195.61	0	0	0	0	0
1992	36.74	154.1	0	0	0	0	0
1993	39.4	165.24	0	0	0	0	0

Year	0	1	2	3	4	5	6+
1994	39.92	167.44	0	0	0	0	0
1995	42.97	180.2	0	0	0	0	0
1996	87.95	128.79	0	0	0	0	0
1997	5.28	127.79	0.5	0	0	0	0
1998	0	27.47	2	0	0	0	0
1999	141.42	165.79	0	0	0	0	0
2000	62.36	817.69	0	0	0	0	0
2001	7.22	65.15	0	0	0	0	0
2002	0	42.49	0	0	0	0	0
2003	50.43	75.68	32.62	15.83	1.25	0.13	0
2004	50.43	92.78	32.81	15.83	1.25	0.13	0
2005	50.43	76.34	32.36	15.83	1.25	0.13	0
2006	50.43	75.08	32	15.83	1.25	0.13	0
2007	16	167	4.60	0	0	0	0
2008	5.50	63.40	3.40	0	0	0	0
2009	329.30	39.80	4.40	0.1	0	0	0
2010	48.70	180	60.30	1.4	0.5	0.1	0
2011	9.70	42.70	0.90	0	0	0	0
2012	7.50	79.90	100.20	112.9	5.9	0.2	0
2013	36.10	31	26.50	11	2	0.5	0
2014	1.09	34.66	41.93	10.3	1.53	0.1	0
2015	0	37.30	45.80	6.8	1.3	0.3	0
2016	0	9.84	14.15	13.45	0.91	0.74	0
2017	0.43	9.85	7.88	8.10	0.57	0.10	0.10
2018	255.50	72.19	8.89	4.88	0.12	0.22	0

b)

Year	0	1	2	3	4	5	6+
1968	1	0.17	0	0	0	0	0
1969	1	0.09	0	0	0	0	0
1970	1	0.05	0	0	0	0	0
1971	1	0.03	0	0	0	0	0
1972	1	0.12	0	0	0	0	0
1973	1	0.05	0	0	0	0	0
1974	1	0.12	0	0	0	0	0
1975	1	0.06	0	0	0	0	0
1976	1	0.09	0	0	0	0	0
1977	1	0.14	0	0	0	0	0
1978	1	0.20	0	0	0	0	0
1979	1	0.10	0	0	0	0	0
1980	1	0.04	0	0	0	0	0
1981	1	0.11	0	0	0	0	0
1982	1	0.36	0	0	0	0	0
1983	1	0.19	0	0	0	0	0
1984	1	0.09	0	0	0	0	0
1985	1	0.10	0	0	0	0	0
1986	1	0.17	0	0	0	0	0
1987	1	0.04	0	0	0	0	0
1988	1	0.06	0	0	0	0	0
1989	1	0.23	0	0	0	0	0
1990	1	0.18	0	0	0	0	0
1991	1	0.09	0	0	0	0	0
1992	1	0.10	0	0	0	0	0
1993	1	0.43	0	0	0	0	0
1994	1	0.18	0	0	0	0	0
1995	1	0.27	0	0	0	0	0

Year	0	1	2	3	4	5	6+
1996	1	0.29	0	0	0	0	0
1997	1	0.20	0	0	0	0	0
1998	NA	0.12	0	0	0	0	0
1999	1	0.70	0	0	0	0	0
2000	1	0.74	0	0	0	0	0
2001	1	0.16	0	0	0	0	0
2002	NA	0.18	0	0	0	0	0
2003	1	0.63	0.07	0.15	0.03	0.12	NA
2004	1	0.58	0.25	0.09	0.06	0.022	0
2005	1	0.65	0.13	0.20	0.04	0.03	0
2006	1	0.84	0.18	0.12	0.07	0.02	0
2007	1	0.77	0.02	0	0	0	NA
2008	1	0.82	0.02	0	0	0	NA
2009	1	0.67	0.08	0	0	0	NA
2010	1	0.82	0.32	0.06	0.07	0.05	0
2011	1	0.80	0.01	0	0	0	0
2012	1	0.95	0.74	0.78	0.60	1	NA
2013	1	0.84	0.45	0.37	0.22	0.34	NA
2014	1	0.85	0.49	0.39	0.28	0.09	NA
2015	NA	1	0.57	0.26	0.30	0.23	NA
2016	NA	0.91	0.58	0.45	0.40	0.62	0
2017	1	0.80	0.28	0.51	0.20	0.21	0.49
2018	1	0.76	0.33	0.13	0.05	0.10	0

NA= not available.

Table 7.7. Maturity ogive updated for 2018. Prior to 1995 maturity was considered constant.

	1	2	3+
1996	0	0.28	1
1997	0	0.34	1
1998	0	0.40	1
1999	0	0.46	1
2000	0	0.53	1
2001	0	0.59	1
2002	0	0.62	1
2003	0	0.65	1
2004	0	0.68	1
2005	0	0.69	1
2006	0	0.70	1
2007	0	0.70	1
2008	0	0.70	1
2009	0	0.71	1
2010	0	0.70	1
2011	0	0.70	1
2012	0	0.70	1
2013	0	0.71	1
2014	0	0.72	1
2015	0	0.73	1
2016	0	0.74	1
2017	0	0.75	1
2018	0	0.76	1

Table 7.8. Survey catch numbers-at-age and c.v.

Northern Irish Groundfish Q1

year	c.v.	1	2	3	4
1993	0.78	138.12	648.76	44.60	10.42
1994	0.34	1380.43	109.71	120.27	8.45
1995	0.68	700.73	386.15	20.03	10.78
1996	0.42	1106.13	329.28	111.67	1.39
1997	0.64	537.30	415.84	66.72	21.39
1998	0.84	169.36	769.23	56.87	11.98
1999	0.86	49.50	253.08	241.87	15.29
2000	0.65	629.60	101.053	34.58	33.01
2001	0.89	406.68	561.44	18.44	5.78
2002	0.64	662.16	253.31	333.54	0
2003	0.54	73.87	1079.20	104.05	32.70
2004	0.75	216.96	171.96	88.62	5.38
2005	0.76	63.53	225.07	29.41	27.96
2006	0.63	169.99	130.75	58.30	2.52
2007	0.95	164.35	124.39	30.60	5.15
2008	0.90	40.66	217.15	13.02	5.17
2009	0.76	144.00	59.00	33.00	9.00
2010	0.82	1022.12	208.96	14.66	2.26
2011	0.49	353.98	414.69	46.01	2.26
2012	0.81	161.90	222.82	99.27	14.25
2013	0.81	276.59	213.68	60.08	1.49
2014	0.63	314.41	222.80	53.29	13.66
2015	0.84	78.96	719.35	69.19	8.56
2016	1.06	349.20	175.00	148.30	10.70
2017	0.77	69.8	445.20	57.80	12.60
2018	1.26	138.1	50.50	62.60	0

Northern Irish Groundfish Quarter 4

year	c.v.	0	1	2
1991	0.57	1109.37	50.06	47.60
1992	0.71	553.23	146.44	0.76
1993	0.45	1672.49	25.44	10.44
1994	0.38	1206.80	33.32	0
1995	0.60	486.65	50.15	6.54
1996	0.82	1322.20	97.19	0
1997	0.55	376.51	163.9	5.72
1998	0.75	58.47	32.48	9.49
1999	0.68	301.64	2.03	0
2000	0.72	506.79	109.91	0
2001	0.55	487.89	37.68	12.53
2002	0.86	161.45	29.4	0
2003	0.76	578.97	23.71	0
2004	0.82	706.13	107.72	17.28
2005	0.73	130.20	1.47	6.58
2006	1.22	86.99	0	2.98
2007	0.62	17.28	17.28	0
2008	1.09	213.62	6.1	0
2009	0.83	171.80	2.98	0
2010	0.82	92.48	53.86	3.05
2011	0.75	107.05	1.69	6.37
2012	0.72	321.82	32.79	20.33
2013	0.78	41.67	79.95	20.66
2014	0.78	0	55.35	39.15
2015	0.57	224.27	0	55.42
2016	0.83	14.98	0	181.79
2017	0.68	429.50	44.60	10.60
2018	1.42	68.50	112.60	0

UK FSP

year	c.v.	2	3	4	5	6+
2005	0.4	0.43	1.41	0.99	0.08	0.03
2006	0.4	0.54	2.81	0.43	0.10	0.01
2007	0.4	0.61	1.32	0.59	0.06	0.06
2008	0.4	0.22	0.82	0.15	0.08	0.02
2009	0.4	0.17	1.15	0.38	0.10	0.02
2010	0.4	0.74	0.45	0.47	0.13	0.02
2011	0.4	0.41	1.68	0.14	0.10	0.04
2012	0.4	0.36	2.30	0.80	0.07	0.02
2013	0.4	0.84	1.88	1.35	0.37	0.06
2014						
2015	0.4	0.60	2.04	1.17	0.26	0.05
2016	0.4	1.00	6.39	1.43	0.41	0.03
2017	0.4	3.06	2.85	3.84	1.01	0.23
2018	0.4	0.43	3.73	0.61	0.63	0.15

MIKNET survey

Year	c.v.	0
1994	0.7	57.4
1995	0.7	6.9
1996	0.7	66.3
1997	0.7	5.7
1998	0.7	0.1
1999	0.7	26.2
2000	0.7	6.1
2001	0.7	9.6
2002	0.7	3.4
2003	0.7	3.2
2004	0.7	25.8
2005	0.7	11.4
2006	0.7	9
2007	0.7	0.0
2008	0.7	0.8
2009	0.7	23.6
2010	0.7	5.7
2011	0.7	1.4
2012	0.7	10.6
2013	0.7	42.6
2014	0.7	8.2
2015	0.7	80.4
2016	0.7	0.0
2017	0.7	10.6
2018	0.7	20.65

Table 7.9. Relative Biomass and Harvest rate used for the advice.

Year	Relative Biomass index	Relative Harvest Rate
1993	1.26	2.9
1994	1.06	2.4
1995	0.79	2.8
1996	1.09	2.2
1997	1.26	2.2
1998	1.48	1.69
1999	1.40	1.65
2000	0.80	1.14
2001	1.16	0.93
2002	2.2	0.57
2003	2.2	0.32
2004	0.76	0.81
2005	0.73	0.71
2006	0.48	0.99
2007	0.42	0.94
2008	0.41	0.81
2009	0.36	0.72
2010	0.70	0.56
2011	0.95	0.20
2012	0.78	0.52
2013	0.82	0.20
2014	0.84	0.22
2015	1.63	0.09
2016	1.05	0.06
2017	0.97	0.07
2018	0.35	0.34

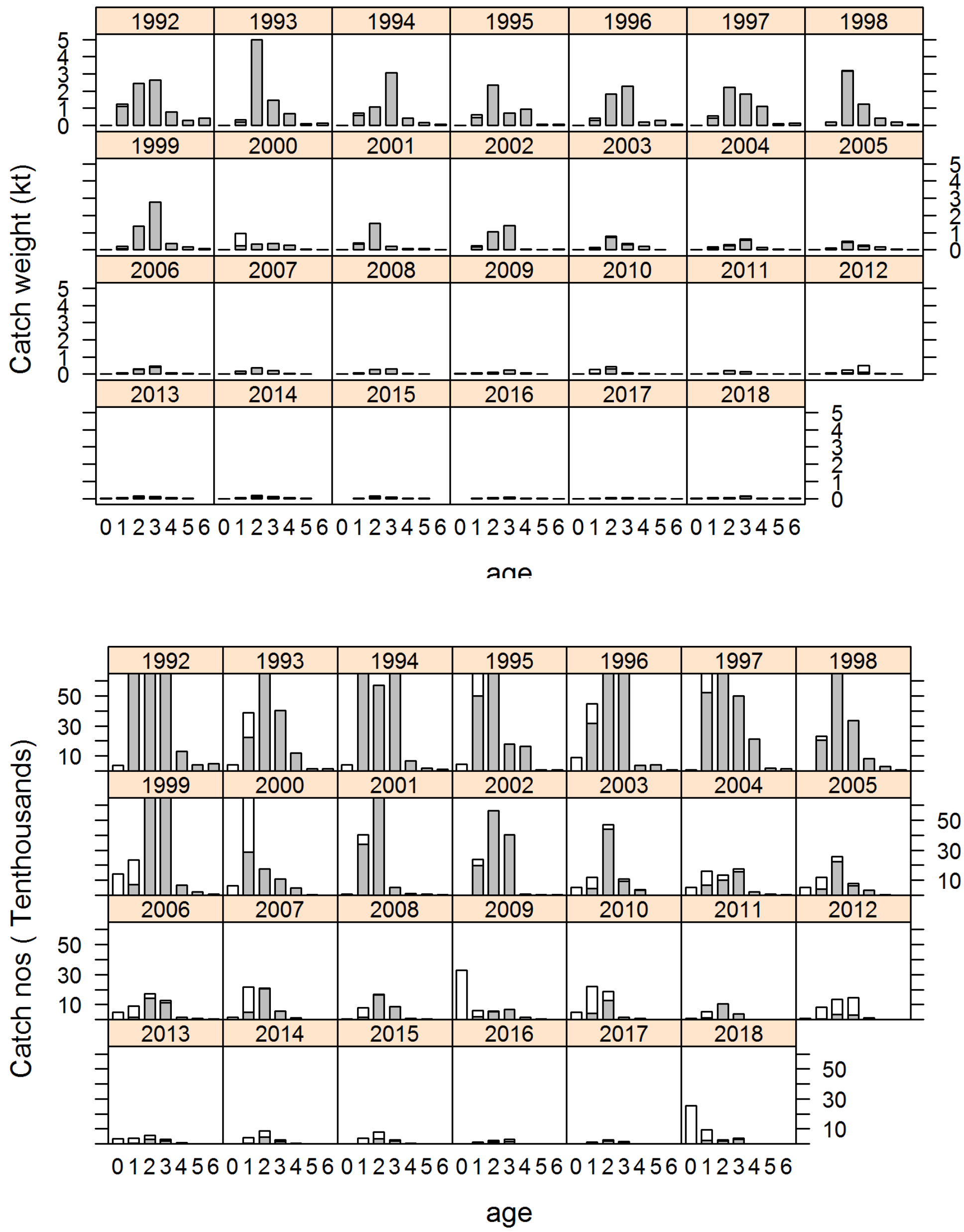


Figure 7.1. Landings (grey) and discards- (white) at-age in total weight and numbers from 1992 to 2018.

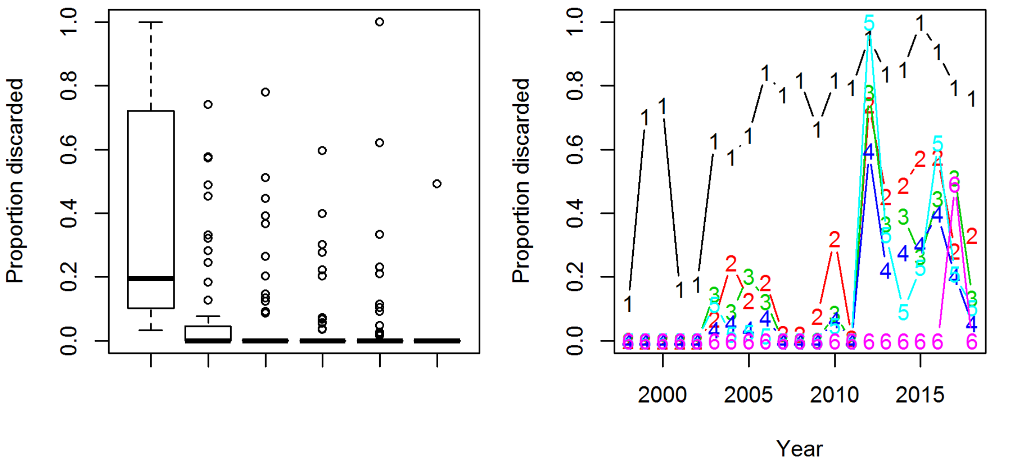


Figure 7.2. Discard proportions-at-age 1995–2018.

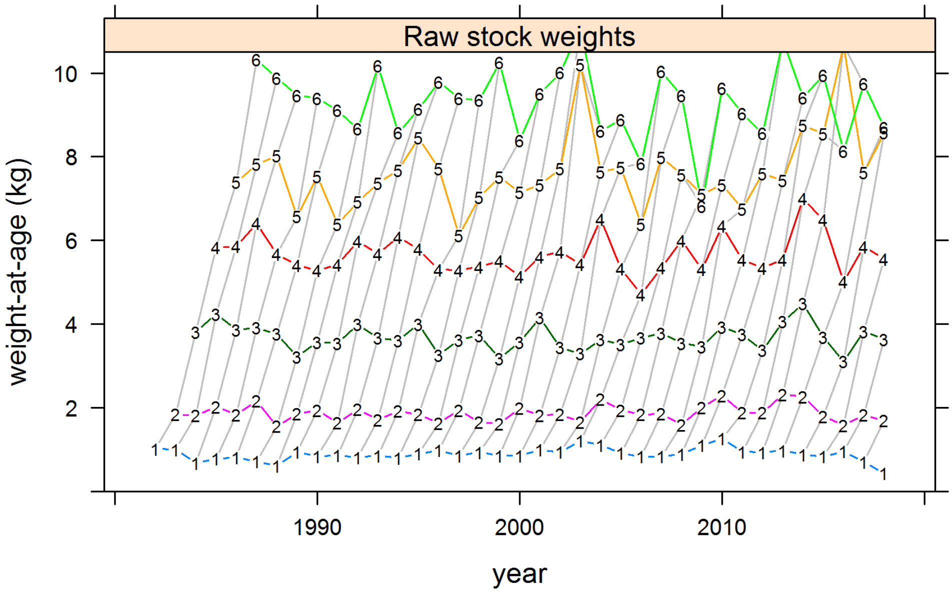


Figure 7.3. Weight-at-age, ages 1–6.

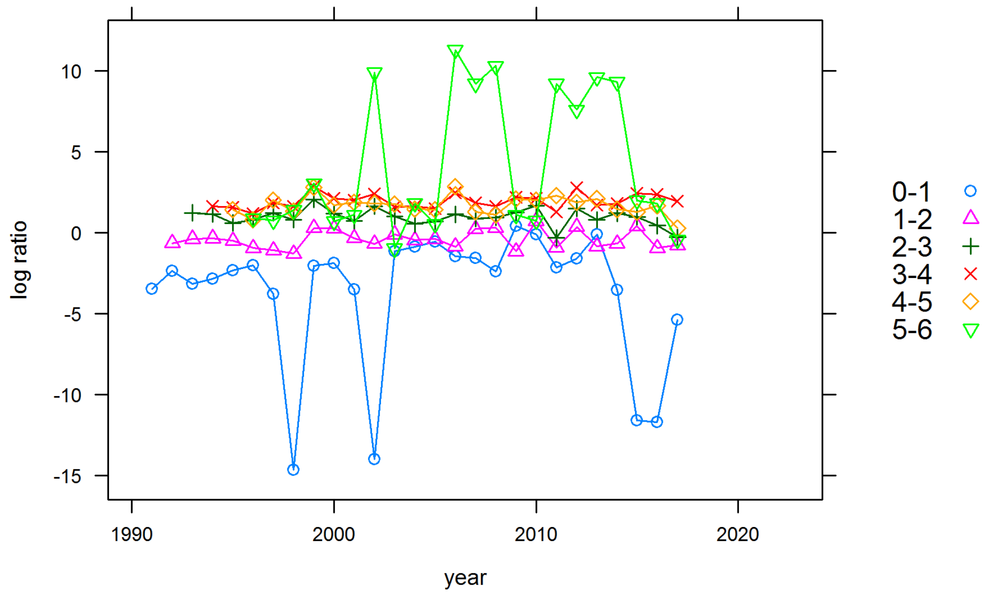


Figure 7.4. Log ratio of ages in commercial catches.

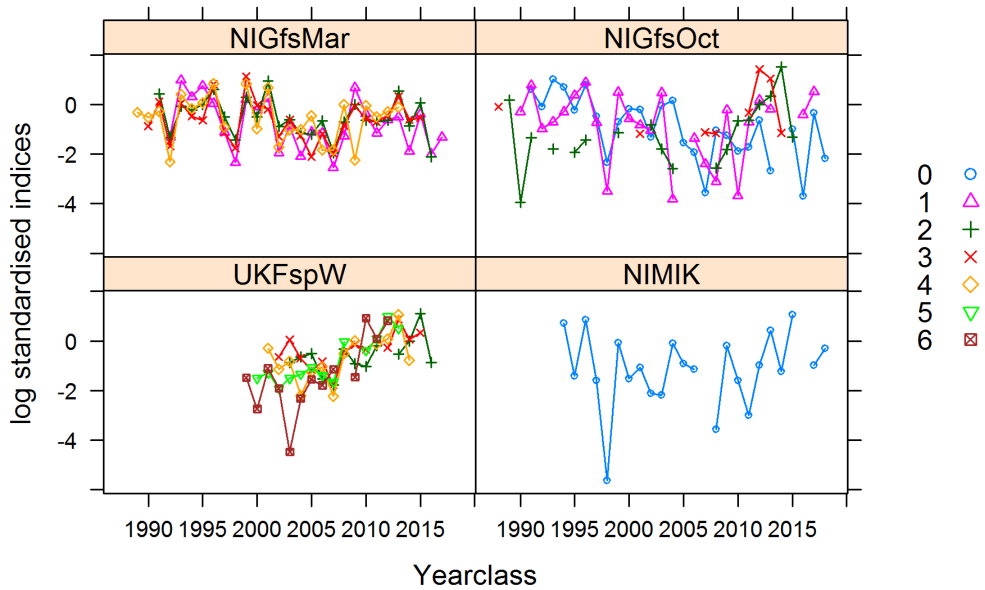


Figure 7.5. Log-standardised age distribution in survey indices.

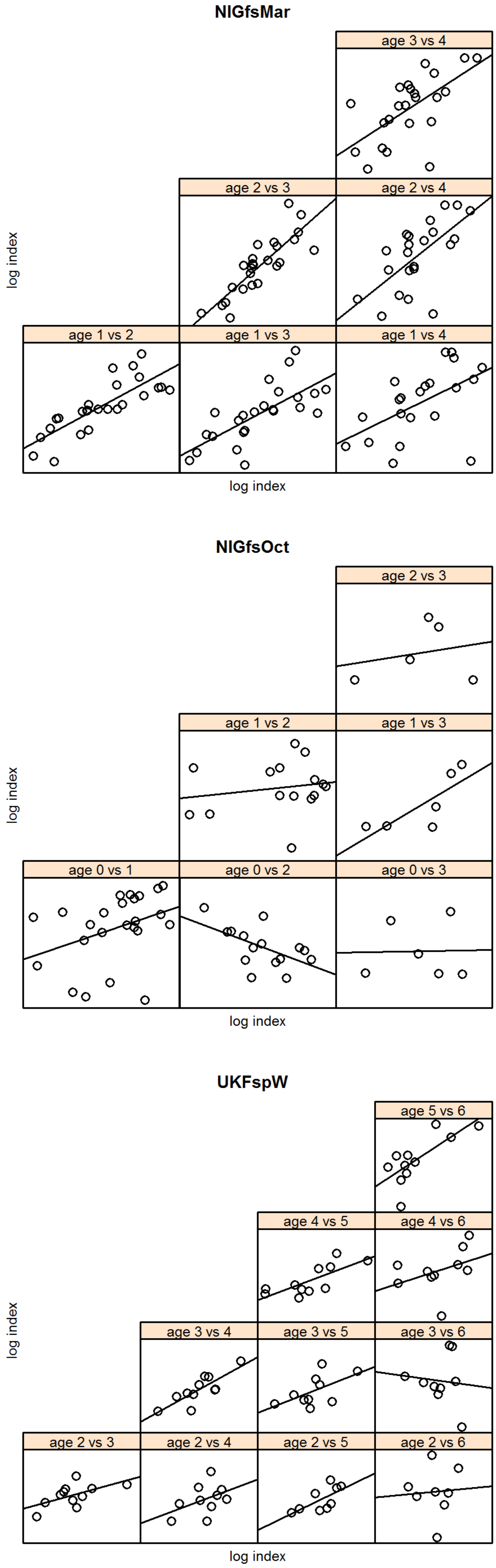


Figure 7.6. Survey age continuity.

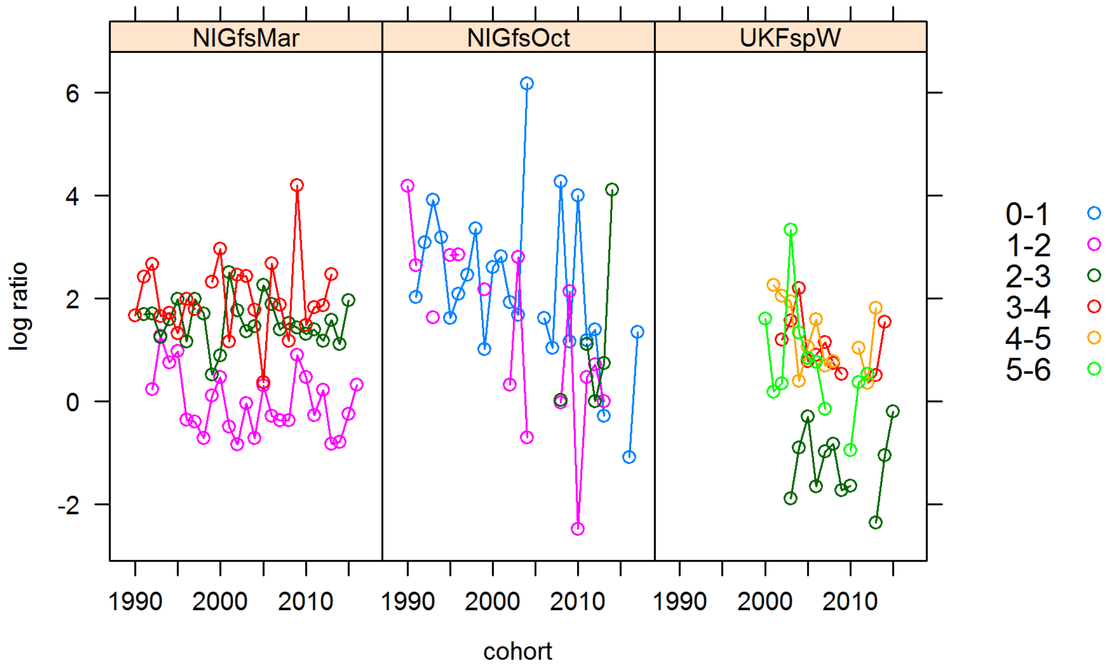


Figure 7.7. Log ratio of cohorts in surveys.

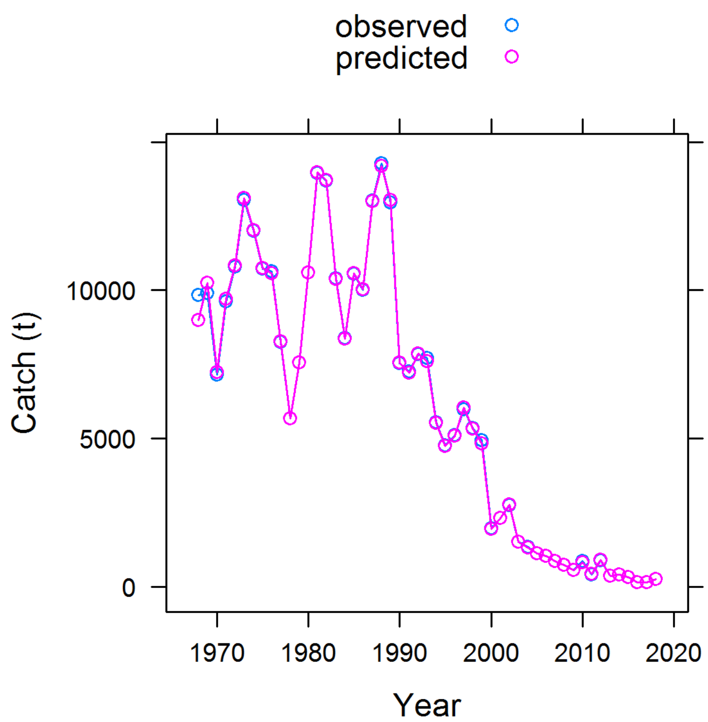
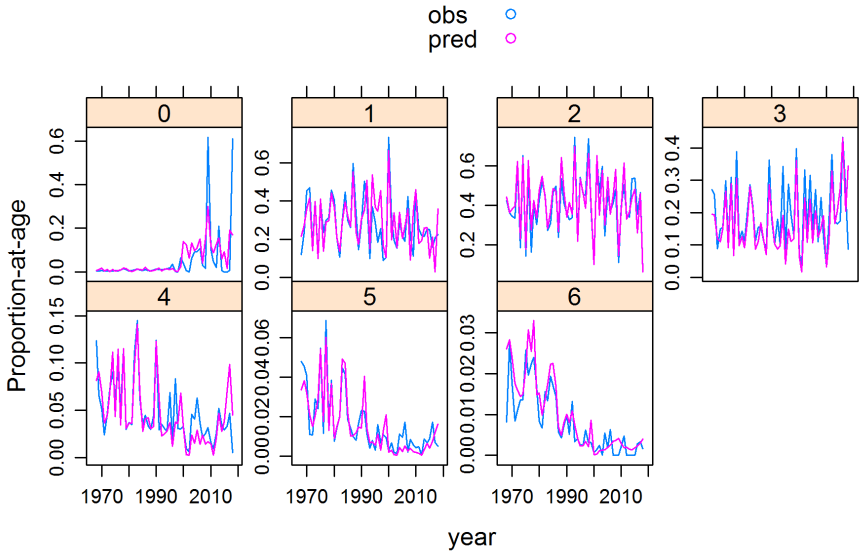
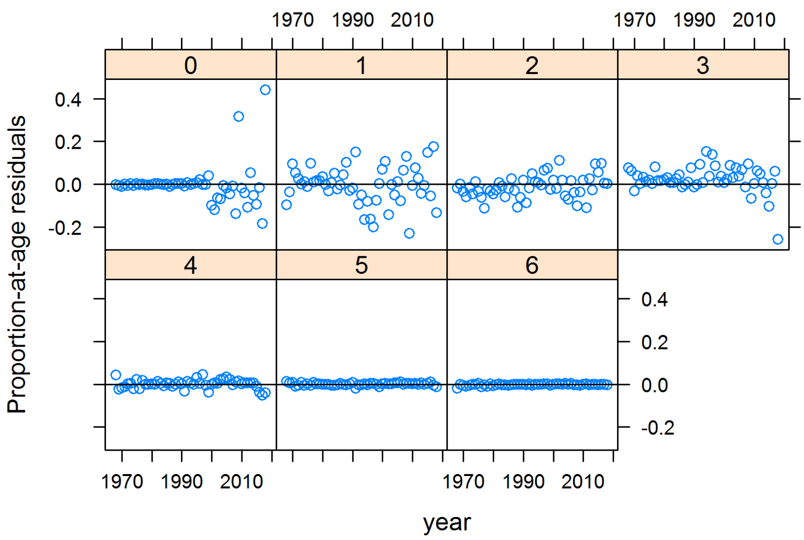


Figure 7.8. Observed and predicted catches.


obs
pred
Proportion-at-age
0
1
2
3
4
5
6
1970 1990 2010
year


Proportion-at-age residuals
0
1
2
3
4
5
6
1970 1990 2010
year

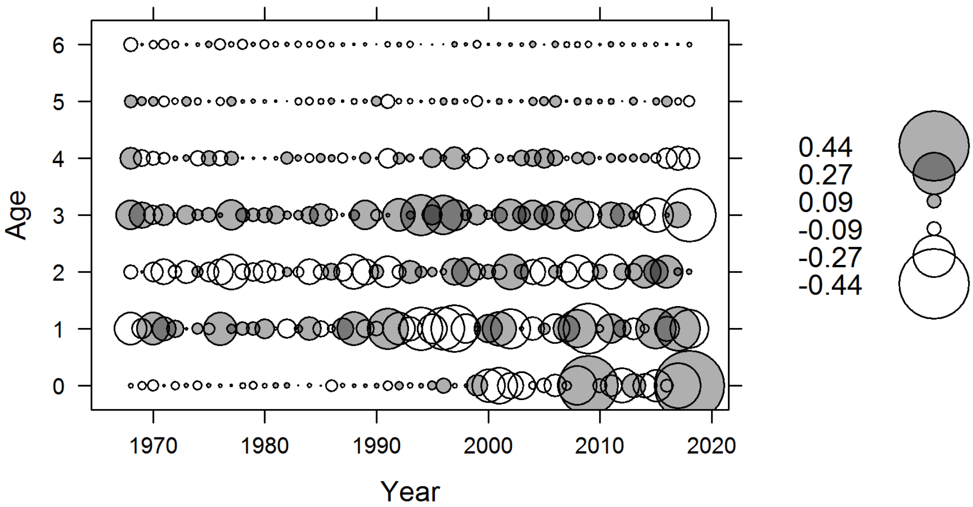


Figure 7.9. Commercial fleet catch-at-age residuals.

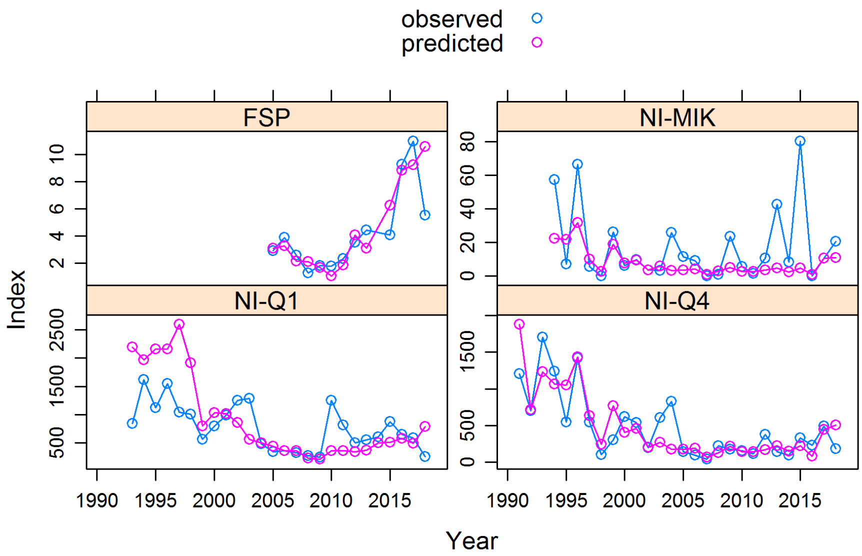


Figure 7.10. Index Fit.

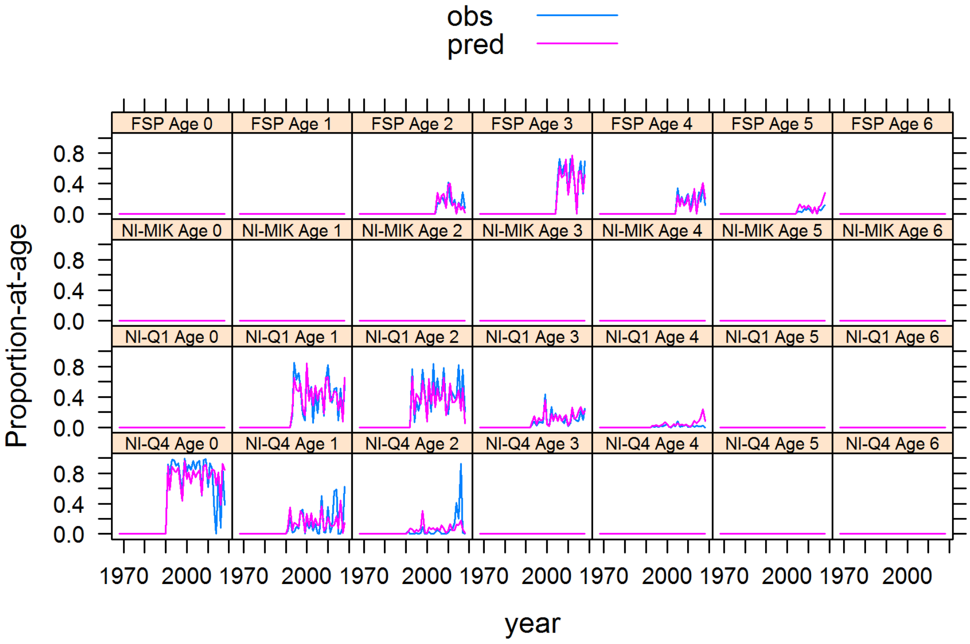


Figure 7.11. Index fit at-age.

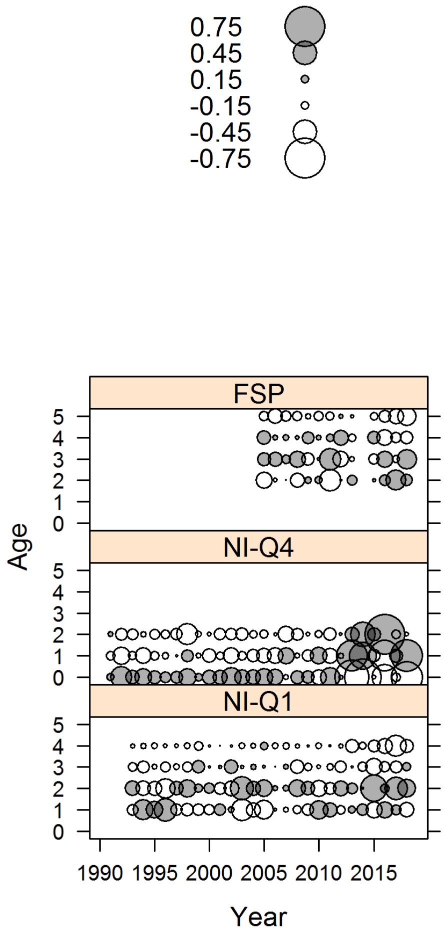


Figure 7.12. Index residuals catch-at-age (NIMIK is not included as only targets age 0 group.

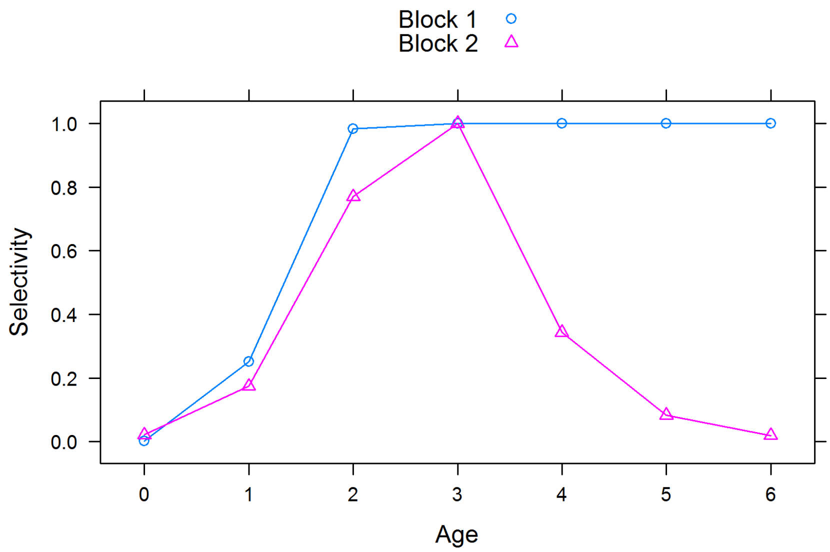


Figure 7.13. Cod in ICES Division 7.a: ASAP Fishery selectivity-at-age, Block 1: 1968–1999, Block 2: 2000–today.

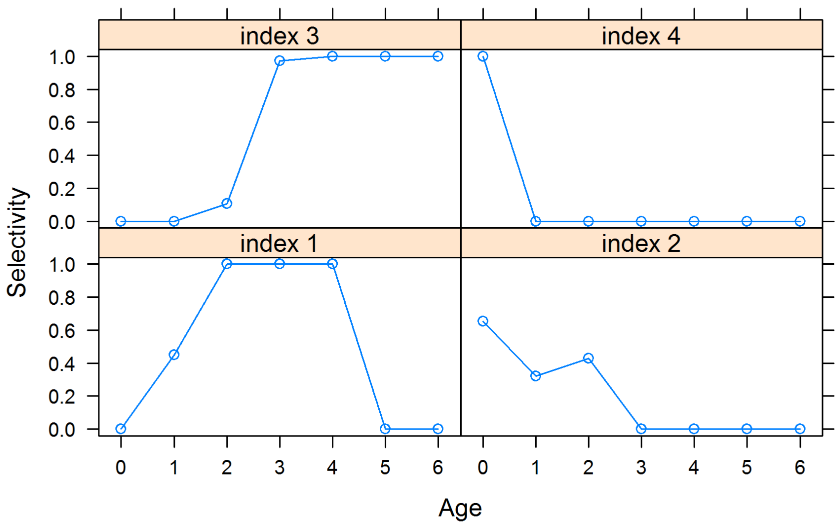


Figure 7.14. Cod in ICES Division 7.a: ASAP Index selectivity-at-age, Index1: NIGFSQ1, Index 2: NIGFSQ4, Index3: UK-FSP, Index 4: Miknet.

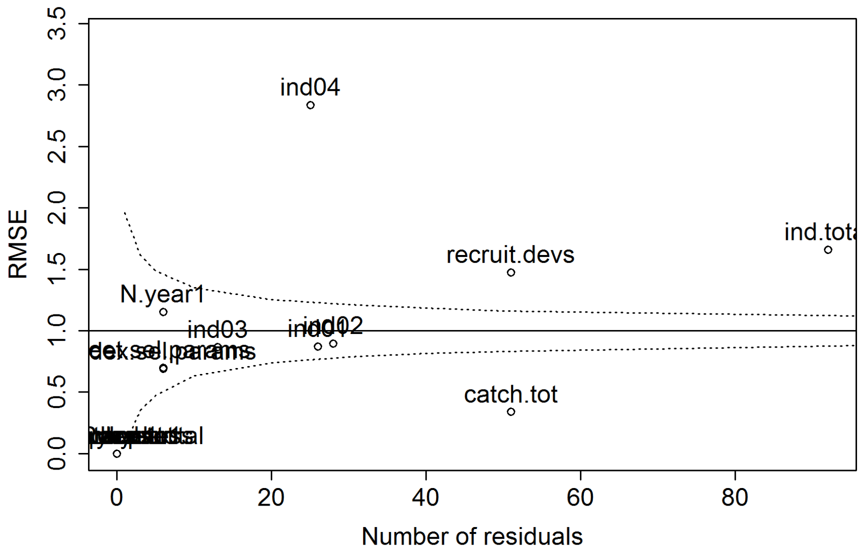


Figure 7.15. Model RMSE fit.

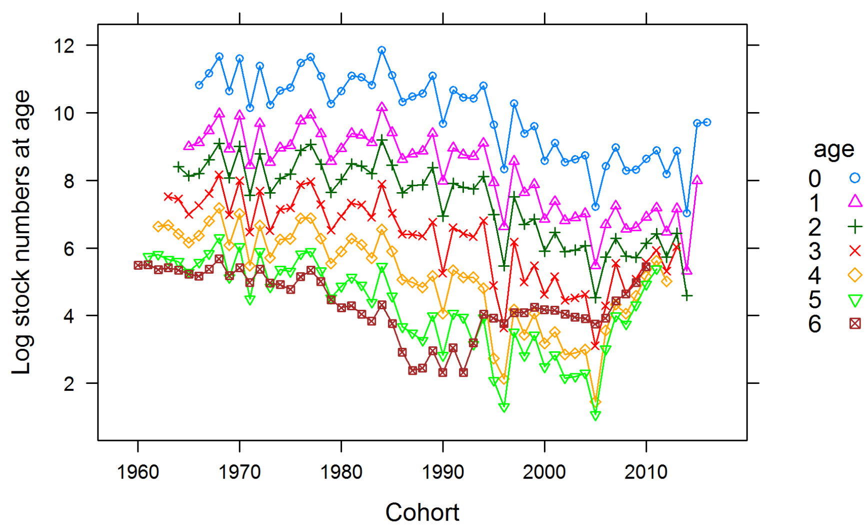


Figure 7.16. Estimated stock numbers-at-age.

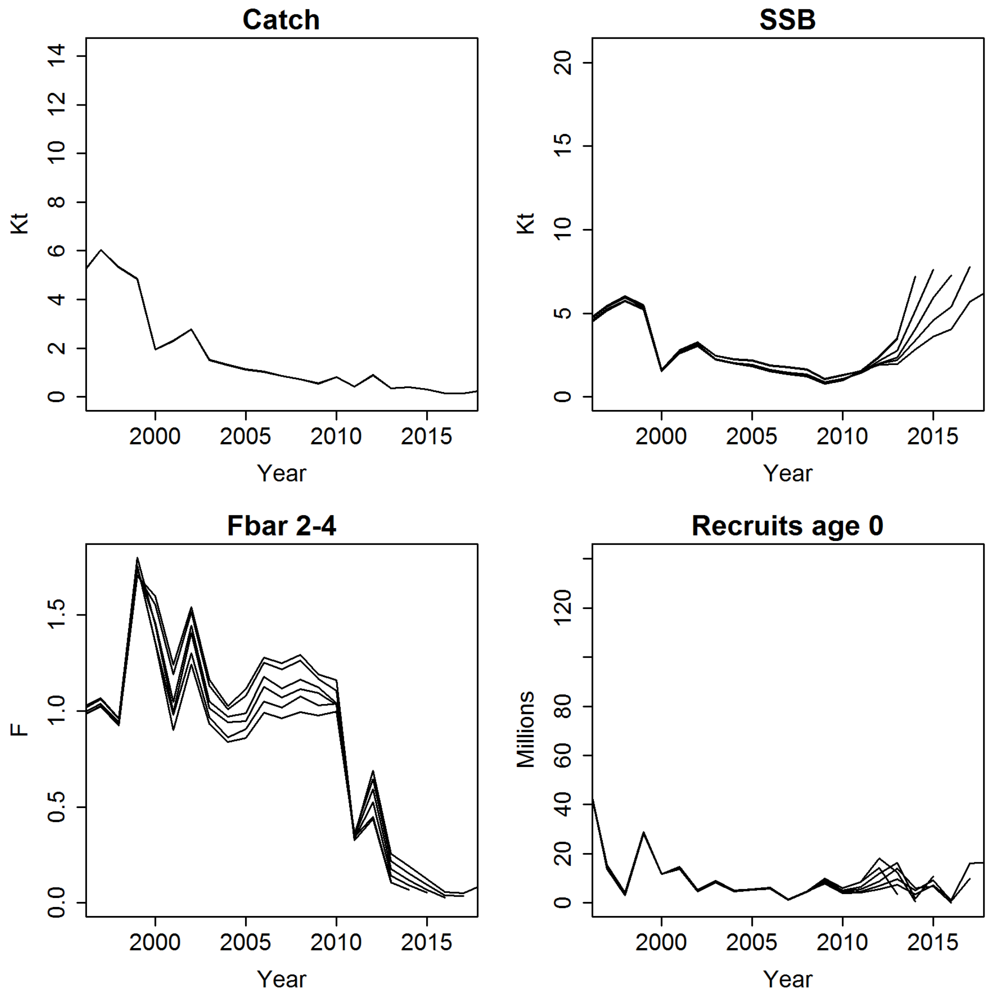


Figure 7.17. ASAP retrospective summary 2011–2017.

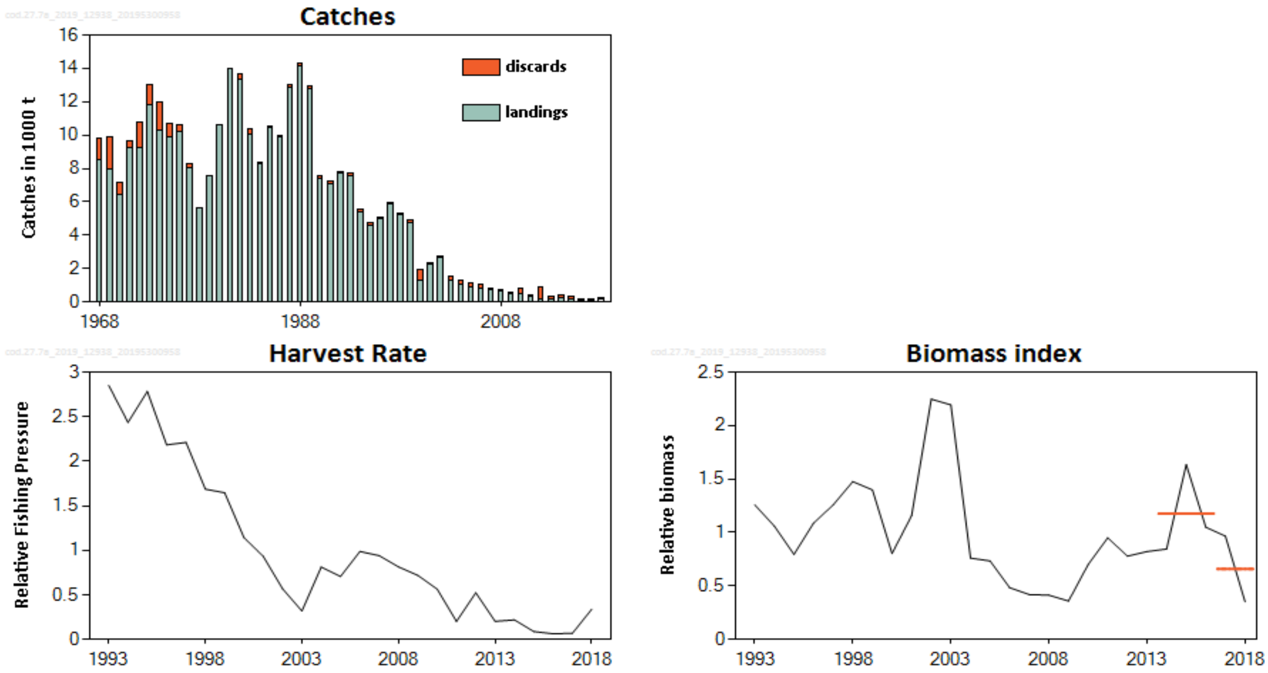


Figure 7.18. Catches and landings in tons, harvest rate and biomass index as used for the advice. The two red lines indicate the 2 over 3 rule values.

6 Cod in Divisions 7.e–k (Eastern English Channel and southern Celtic Seas)

Full analytical assessment

This stock has been benchmarked at WKROUND in February 2012. XSA was kept as the assessment model. Data, assessment and forecast procedure are detailed in the stock annex.

In 2019, the assessment was not of sufficient quality to be retained as a category 1 assessment. The basis for the advice is the ICES precautionary approach (category 3 assessment).

Latest ICES advices in 2018 and 2019

2018: "*ICES advises that when the MSY approach is applied, there should be zero catch in 2019*."
2019: "*For Cod in divisions 7.e–k, ICES advises that when the precautionary approach is applied, there should be zero catch in 2020*."

6.1 General

Stock description and management units

The TAC is set for ICES areas 7.b–c, 7.e–k, 8, 8, 10, and CECAF 34.1.1(1), excluding 7.d. This is representative of the stock area as the cod population in 7.d is more relevant to the North Sea population. However, landings from 7.bc are not included in the assessment area.

Management applicable in 2018 and 2019

TAC 2018 (Council regulation 2018/120)

Species:	Cod *Gadus morhua*	**Zone:**	7b, 7c, 7e-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	121		
France	1 984		
Ireland	757		
The Netherlands	0		
United Kingdom	214		
Union	3 076		
TAC	3 076		Analytical TAC Article 12(1) of this Regulation applies

TAC 2019 (Council regulation 2019/124)

Species:	Cod *Gadus morhua*	**Zone:**	7b, 7c, 7e-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	50 (1)		
France	822 (1)		
Ireland	650 (1)		
The Netherlands	0 (1)		
United Kingdom	88 (1)		
Union	1 610 (1)		
TAC	1 610 (1)		Analytical TAC Article 8 of this Regulation applies Article 13(1) of this Regulation applies

Since 2005, ICES rectangles 30E4, 31E4, and 32E3 have been closed during the first quarter (Council Regulations 27/2005, 51/2006, and 41/2007, 40/2008, and 43/2009).

Technical measures applied to this stock are a minimum mesh size (MMS) for beam and otter trawlers in Subarea 7 and a minimum landing size (MLS) of 35 cm.

Fishery

Landings data used by the WG are summarised in Table 8.1 and the Figure 8.1 provides historical landings by countries. In 2018, the landings are 1385 t and represent an uptake of 45% of the agreed TAC.

TAC uptake varies among countries. Belgium uses 40% of their TAC. Ireland takes 93% of its TAC. United Kingdom uses 61% of its TAC and France undershooting its TAC to only 25%. United Kingdom catches mainly comes from UK England. The low uptake rate for France is the consequence of the mixed nature of its fisheries. Cod is no longer a target species but as bycatch in haddock and whiting dedicated fisheries.

Given the rapid growth of cod in this area, discards are mostly composed of one and two year old fish. Since 2011, quotas were not restricted and the discard rate has been stable around 10–15%. Discards estimate for 2018 is 180 t, which corresponds to a discards rate of 11.5%. Discards rate by countries are 13.5%, 12.3%, 9.7% and 13% for Belgium, Ireland, France and United Kingdom respectively.

Captures (in tonnes) and TAC uptake percentage by catch category and country.

Country	CatchCategory	Tons	TAC	TAC_Uptake
Ireland	BMS landing	0	NA	NA
Belgium	Discards	7.6	NA	NA
France	Discards	53.8	NA	NA
Ireland	Discards	99.1	NA	NA
Netherlands	Discards	0.2	NA	NA
United Kingdom	Discards	19.5	NA	NA
Belgium	Landings	48.6	121	40
France	Landings	499.4	1984	25
Ireland	Landings	705.9	757	93
Netherlands	Landings	0.5	0	Inf
United Kingdom	Landings	130.1	214	61

Total catches (i.e. landings and discards), discards and discards rate by country. Total catches and discards are in tonnes.

Country	Catches (L+D)	Discards	Discard_rate
Belgium	56.2	7.6	13.5
France	553.1	53.8	9.7
Ireland	805	99.1	12.3
Netherlands	0.7	0.2	28.6
United Kingdom	149.6	19.5	13

Cod is mainly caught in area 27.7.g, followed by areas 27.7.h, 27.7.e and 27.7.j respectively. No landings are reported in 27.7.k and few in 27.7.j2 (Figure 8.2).

France is fishing in all areas but most of its landings are taking in 27.7.g. Ireland and Belgium are fishing in 27.7.g and UK in 27.7.e. For each country, landings distribution in the Celtic Sea is similar to previous years.

In Celtic Sea, cod is mainly caught by OTB_DEF_100-119_0_0_all, OTT_DEF_100-119_0_0_all and OTB_DEF_70-99_0_0_all métiers. Otter trawls landings represent 76% of the total landings. Beamers (i.e. TBB_DEF_70-99_0_0_all) also contribute to cod landings but in a lower proportion (10% of the total landings).

Discards rate in weight varies among métiers depending on gear, mesh size range and targeted species. Most of the discards are realised by otter trawlers and beamers, 60% and 22% respectively.

The group advises to follow métier definition specified in the Appendix 2 of the ICES data call to reduce the number of métier upload in InterCatch. Métier which contribute to less than 1% of the landings are included in the MIS_MIS_0_0_0_HC métier.

Captures amounts (tonnes) and percentages by catch category and métier.

Gears	Landings	Discards
Otter_trawls	1043	102
Beamers	137	37
Seiners	96	31
Gillnets	81	0
Others	10	0

Information from the Industry

No specific information was reported to the group in 2019.

6.2 Data

InterCatch procedure

Since 2013, international landings and discards data are uploaded in InterCatch. Discards are raised for unreported strata to estimate total discards in weight.

Unsampled strata of landings and discards (number-at-age) are filled in using an allocation procedure. Information on national and international assumptions made by data providers and submitters at the national level and allocation grouping used in IC are available on SharePoint To ensure the consistency of data processing at international level, the same rules are applied each year for the allocation procedure: fill unsampled strata using as much as possible the same métier and quarter, regardless of area and country. Unsampled BMS landings and Logbook Registered Discards are filled in using discards data employing as much as possible the same métier and quarter, regardless of area and country.

One of the ToRs proposed for the next benchmark is to streamlining data compilation procedures for fishery-dependent data of the three main gadoids species (cod, haddock and whiting). General raising protocol would then be added to the stock annex.

Landings

Length distributions of 2018 landings provided by countries for sampled strata and quarter are shown in Figures 8.3 a–d.

Age distribution of 2018 catches (i.e. landings and discards) is illustrated in the Figure 8.4. It is noticeable that this stock has always been composed of few age classes, even though Celtic Sea cod can live up to ten years. While the catch was mainly composed of age 2 over the period 2005–2008, the strong 2009 year class has contributed strongly to the catch at older ages in recent years: 63% in number in 2012 at-age 3, 36% at age 4 in 2013 (Table 8.2.a and 8.2.b). In 2014, high recruitment has been observed resulting in an increasing proportion of age 1 fish in the landings (53%), age 2 accounts for 22% of the landings. In 2015, landings are dominated by fish of age 2, in 2016 landings are dominated by fish of age 3 and in 2017 landings was mostly composed by cod of age 2. In 2018, 20% of the landings was fish of age 1, 35% of fish of age 2 and 31% of fish of age 3.

Discards

The landings/discards pattern is known to be strongly variable between fleets and years due to métier, recruitment intensity, TACs constraints and mixed fisheries concerns.

In 2009, age 1 individuals (30–45 cm, Mahé *et al*. 2016) were mainly discarded. In 2010, most of them were landed. In 2011, ages 1 and 2 represents respectively 51% and 46% of the total discards in numbers for all fleets. Due to the low TAC relative to the high magnitude of recruitment in 2009 and 2010, all countries had unusually high discard rates in 2011, generally 70% by weight was made up of fish above the minimum landing size (MLS, i.e. 35 cm for Celtic Sea cod). The high-graded fish from the French fishery have been added to the landings in 2003–2011. In 2014, total amount of discards was 740 t (639 t imported + 101 t raised), giving a discard rate of 19%. This discards rate was higher than the average 10% and mostly consisted of undersized fish from the strong 2013 year class (fish of age 1 in 2014). In 2015, the total amount of discard was 565 t (250 t sampled and uploaded in InterCatch and 309 t resulting from the raising procedures), giving a discard rate by weight of 12%, which is considered the usual discard rate for this species in the mixed fisheries. High-grading in 2015 (discards of fish above Minimum conservation size) was low. In 2016, the total amount of discards was 220 t (154 t sampled and uploaded in InterCatch and 52 t resulting from the raising procedures), giving a discard rate by weight of 6.3%. In 2017, the total amount of discards was 117 t (47 t sampled and uploaded in InterCatch and 62 t resulting from the raising procedures), giving a discard rate by weight of 5%, which is considered lower than average. They are mainly composed of age 1 fish (Figure 8.4).

Length distributions of 2017 discards provided by countries for sampled strata and quarter are shown Figure 8.3a–d. In recent years, due to quota constraints at vessels levels, length distribution of discards for the UK fleet have shown high-grading pattern (cod being a non-target species). However, this fleet has little contribution to both, landings and discards quantities and this was no more reported in 2017.

In 2018, discards are mostly composed of fish of 1 year (Figure 8.4).

Biological

Landings numbers-at-age (before and after the SOP correction), catch (i.e. landings) and stock weights-at-age are given respectively in Tables 8.2.a, 8.2.b, 8.3 and 8.4.

Biological parameters are described in the stock annex and are unchanged since the 2012 WKROUND benchmark. Celtic Sea cod are very fast growing and early maturing compared with more northern cod stocks.

Commercial lpue

Tables 8.5 a–c gather the values of landings, fishing effort and lpue data series for the French (a), Irish (b) and UK fleets (c). Figures 8.5 a-c illustrate the trends of lpue and effort by country.

A general decrease in the lpue trend is observed in almost all series between 1990 and 2004, where the TAC began to be constraining. From that point, the lpue seemed to stabilize, or even to increase if high-grading is taken into account. The strong 2009 year class resulted in an increase of lpue for all fleets between 2010 and 2012. Different features are observed in the effort time-series. The métiers showing the highest levels of cod directed effort have decreased significantly in the last 5–10 years until 2010. Since then, effort has gone up again until 2013 following the increased of TAC possibilities.

Since 2013, French fishing effort and lpue have decreased (Figure 8.5a). Effort of Irish fleet targeting gadoids (i.e. Otter trawl 27.7.g) remains at a high level as a consequence of mixed fisheries interaction with increased whiting and haddock fisheries opportunities (Figure 8.5b). In the meantime the spawning–stock biomass (SSB) is low, as such lpue is decreasing since 2013 (Figure 8.5b). In 2018, Otter trawl Irish 27.7.g lpue has increased. Effort of the UK trawl fleet in 27.7.e–k shows a decreasing trend (down to zero in 2016) and increases since then, while beam trawl effort in 27.7.e–k relatively stable in recent years (Figure 8.5c).

Remark: The UK English and Welsh effort data are only reliable for vessels over 12 metres registered length, and therefore has always been provided to working groups for vessels greater than 12 metres. The fleet of over 12 meter vessels has been declining gradually over the years, until in 2016 no effort recorded from this fleet. The zero figures provided for 2016 have been checked and are correct (Figure 8.5c).

Surveys and commercial tuning fleet

Table 8.6 presents the survey data series. Two ongoing surveys, both part of the DCF, IBTS Q4 (FR-EVHOE & IR-GFS7gj combined) are used to assess this stock (see details in the stock annex and modification based on 2014 WKCELT benchmark).

The historical time-series of age structure of the commercial tuning index (OTDEF French fleet for quarter 2, 3 and 4) and the survey index are shown in Table 8.6 and Figure 8.6.

In 2017, the French EVHOE survey was not conducted due to technical difficulties at the beginning of the survey. The IR-FR combined tuning index used in the assessment is only composed of Irish data for 2017. The Irish survey covered additional stations normally undertaken by the EVHOE survey.

Data issues

No important issues were reported this year.

Remark: When for a métier/strata landings are upload annually, there are is no information available in InterCatch to split the annual landings into quarterly landings and therefore the associated age composition and mean weight-at-age. As a result, when extracting quarter 1 versus quarter 2, 3 and, 4 data to inform on mean weight of the stock and the catch for the assessment, these data are not used.

6.3 Stock assessment

Model used: XSA.

Final update assessment (XSA)

The final assessment was run with the same settings as established by WKROUND 2012 and described in the stock annex. Discards are not included in the assessment.

VPA.95 software was run in parallel to the FLRXSA R script to fully validate the assessment.

XSA residuals and diagnostics do not highlight any problem regarding the input data and model fit (Table 8.7 and Figure 8.7). Outputs from the assessment are reported in Tables 8.8–10 and in Figures 8. 7–11.

The comparison of runs with and without tuning indices indicates that the majority of the information comes from the catch-at-age matrix (Figure 8.11b). The information contains in both indices seems contradictory. In recent years, survey indices contains little information due to low recruitment levels.

In 2019, the assessment shows a substantial downward revision in SSB and recruitment in recent years and substantial upward revision in F. Comparing this year's assessment results with last year and looking at the retrospective analysis, a rescaling in spawning–stock biomass (SSB), recruitment and F is evident (Figure 8.11a).

Mohn's rho analysis (i.e. a measure of the relative difference between an estimate from an assessment with a truncated time-series and an estimate of the same quantity from an assessment using the full time-series) resulted in values of -0.38 for $F_{bar(2-5)}$, 0.48 for SSB and 0.27 for recruitment. F is revised up every year of since 2012. Compared to last year results, F of age 2 to 5 was resided up by a factor of 1.6 to 2.08.

ICES considers a value greater than 0.20 to be unacceptably high. However, the stock is maintained in category 1.

The variability of cod recruitment over years is partially responsible the retrospective patterns, however, substantial changes in assessment between years may be due to strong year classes dominating the fishery in recent years, the unexpected disappearance of fish of older age, and discards being only partially included in the assessment.

State of the stock

Table 8.8 and 8.9 summarise the estimated fishing mortality-at-age and the stock numbers-at-age, respectively. The stock summary is reported in Table 8.10 and Figure 8.10.

Catches are around 5000 t since 2000 (Figure 8.10), with some higher catches following strong recruitments. Reliable discard estimates are only available since 2011 and range between 150 and 1000 t depending on the interplay between recruitment dynamics and TAC constraints.

Recruitment has been highly variable over time with occasional very high recruitment followed by period of low recruitments. Since 2012, recruitment has been very weak with the exception of the 2014 year class, which is above average (Table 8.10 and Figure 8.10). Recruitment estimated in 2017 and 2018 are remarkably low (Table 8.10 and Figure 8.10).

Spawning–stock biomass (SSB) is well below MSY $B_{trigger}$ and B_{pa} (both at 10 300 t) since 2000, with the exception of 2012 as the consequence of a very good recruitment year (Table 8.10 and Figure 8.10, ICES, 2012). Since 2004, SSB is also below B_{lim} (7300 t), except during the 2011–2013 period (Table 8.10 and Figure 8.10, ICES, 2012).

Fishing mortality has been above F_{MSY} for the entire time-series but has been decreasing between 2000 and 2010 and increased again after (Table 8.10 and Figure 8.10. Fishing mortality fluctuated around F_{lim} in recent years. In 2018, F was estimated at 0.83 that is above F_{lim} (0.80), F_{pa} (0.58) and well above F_{MSY} (0.35) (ICES, 2016a; 2016b).

6.4 Short-term projections

Assumptions made for the short-term projections are described in the table below.

Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
F ages 2–5 (2018)	0.865	$F_{sq} = F_{average}$(2016–2018)
SSB (2020)	1664 tonnes	Fishing at F= 0.865
$R_{age\ 1}$ (2019–2020)	2166 thousand	25th quantile of the recruitment time-series (1971–2018)
Catch (2019)	1321 tonnes	Landings + estimated discards
Wanted catch (2019)	1228 tonnes	Fishing at F= 0.865
Unwanted catch (2019)	93 tonnes	Average discards rate (2016–2018) = 7.58%

F-at-age (range 2 to 5) is based on the three past year average. Recruitment (age 1) is assumed as 25th quantile of the recruitment time-series (1971–2018). This option was preferred to the geometric mean in recent years as the previous year's SSB are low. Discards rate is based on the average rate of the past three years. Weights-at-age is estimated on the basis of three year average. No TAC constraint was applied.

The inputs to the short-term predictions and their outputs are presented in Table 8.11 and 8.12, respectively.

In 2019, under the forecast assumption, wanted catch (i.e. the estimated landed fish) are predicted to be 1228 t (which is less than the TAC and but higher than the 2018 ICES zero catch advice) (Table 8.13) and unwanted catch are predicted to be 93 t.

SSB is predicted to be 1664 t in 2020 which would still be above B_{lim} (7300 t), MSY $B_{trigger}$ and B_{pa} (10 300 t) (Table 8.13).

The forecasts are sensitive to the recruitment assumption that contributes to 58% of the landings in 2020 and 52% of the projected SSB in 2020 (Table 8.12 and Figure 8.13).

6.5 Medium-term projection

No medium-term projections were carried out.

6.6 Biological reference points

The reference points has been estimated using the agreed ICES guidelines (ICES, 2016).

Reference points

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	10 300 tonnes	B_{pa}	ICES (2012)
	F_{MSY}	0.35	Segmented regression with B_{lim} (EqSim)	ICES (2016)
	$F_{MSY\ lower}$	0.23	F at 95% of MSY below F_{MSY}	ICES (2016)
	$F_{MSY\ upper}$	0.55	F at 95% of MSY above F_{MSY}	ICES (2016)
Precautionary approach	B_{lim}	7300 tonnes	B_{loss}, lowest observed SSB (1976), rounded value	ICES (2012)
	B_{pa}	10 300 tonnes	B_{lim} × 1.4	ICES (2012)
	F_{lim}	0.80	Segmented regression with B_{lim} (EqSim)	ICES (2016)
	F_{pa}	0.58	F_{lim}/1.4	ICES (2016)
Management plan	SSB_{MGT}	Not applicable		
	F_{MGT}	Not applicable		

6.7 Management plans

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including cod in ICES divisions 7.e–k.

Uncertainties and bias in assessment and forecast

Cod, haddock and whiting in the Celtic Sea will be benchmarked together in 2020. The focus of the benchmark would be on streamlining data compilation procedures for fishery dependent and survey data. This will improve transparency and diagnostics surrounding commercial tuning fleets and surveys. The benchmark should also review the assessment methods and diagnostics given the potential for changes in selectivity in the commercial fishery. The benchmark should also investigate mixed fisheries and multi-species interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species.

Issues that might causes retrospectives bias are:

i. The non-inclusion of undersized discards (and high-grading in recent years) in the assessment. However, high-grading is estimated at a very low level in recent year because the TACs were not constraining (undershoot TACs).

ii. Sensitivity analysis of the assessment to commercial tuning series calculation should be investigating during the next benchmark process.

6.8 Management considerations

Management scenario are summarised in the Table 8.14.

No management scenario can bring SBB above B_{pa} in 2021 under the current recruitment assumption. The strong retrospective pattern implies that the current F estimates might be uncertain. Forecasts are sensitive to the assumption on recruitment as the landings are usually composed of a high proportion of age 2 fish (and age 1 fort discards).

The recent technical measures introduced in the Celtic Sea (square mesh panels) are not expected to significantly reduce catches of Celtic Sea cod or improved the selection pattern. This is because of the fast growth rate of Celtic Sea cod (age 2 fish range between 40 and 70 cm, Mahé *et al*., 2016).

The strong upward revision in F in previous year's assessment implies that the stock has never been fished at F_{MSY} which could explain why SSB is still below MSY $B_{trigger}$. Additionally, mixed fisheries issues could be responsible for maintaining F at high level, as other gadoids fishing opportunities are higher. In this context, cod is no longer a target species but can be considered as bycatch in the fleet targeting haddock, whiting and *Nephrophs*.

Historical information on management consideration can be found in the stock annex.

Given that SSB is estimated to be well below B_{lim} and is likely to remain so in 2019 and 2020, the ICES framework for category 3 stocks was not applied (ICES, 2012). The advice is for zero catch for 2020. Recent recruitment has been low and the short-term outlook is very dependent recent recruitment for this stock.

6.9 References

ICES. 2012. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE), 9–18 May 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:12.

ICES. 2016. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

Mahé K., Dufour J.L., Brown D., Smith J., Beattie, S. and Woods F. Working paper : Cod (*Gadus morhua*) in the Celtic Sea otolith exchange 2016.

Table 8.1. Cod in divisions 7.e–k. History of official commercial landings presented by country and used by the Working Group. All weights are in tonnes.

Year	Belgium	France	Ireland	UK	Others	Total	High-graded discard estimates	Discard estimates	Landings taken or reported in 33E2 and 33E3 ***
1971	NA	NA	NA	NA	NA	5782			NA
1972	NA	NA	NA	NA	NA	4737			NA
1973	NA	NA	NA	NA	NA	4015			NA
1974	NA	NA	NA	NA	NA	2898			NA
1975	NA	NA	NA	NA	NA	3993			NA
1976	NA	NA	NA	NA	NA	4818			NA
1977	NA	NA	NA	NA	NA	3059			NA
1978	NA	NA	NA	NA	NA	3647			NA
1979	NA	NA	NA	NA	NA	4650			NA
1980	NA	NA	NA	NA	NA	7243			NA
1981	NA	NA	NA	NA	NA	10597			NA
1982	NA	NA	NA	NA	NA	8766			NA
1983	NA	NA	NA	NA	NA	9641			NA
1984	NA	NA	NA	NA	NA	6631			NA
1985	NA	NA	NA	NA	NA	8317			NA
1986	NA	NA	NA	NA	NA	10475			NA
1987	NA	NA	NA	NA	NA	10228			NA
1988	554	13863	1480	1292	2	17191			NA
1989	910	15801	1860	1223	15	19809			NA
1990	621	9383	1241	1346	158	12749			NA
1991	303	6260	1659	1094	20	9336			NA
1992	195	7120	1212	1207	13	9747			NA
1993	391	8317	766	945	6	10425			NA
1994	398	7692	1616	906	8	10620			NA
1995	400	8321	1946	1034	8	11709			NA
1996	552	8981	1982	1166	0	12681			NA
1997	694	8662	1513	1166	0	12035			NA

Year	Belgium	France	Ireland	UK	Others	Total	High-graded discard estimates	Discard estimates	Landings taken or reported in 33E2 and 33E3 ***
1998	528	8096	1718	1089	0	11431			NA
1999	326	5488	1883	897	0	8594			NA
2000	208	4281	1302	744	0	6535			NA
2001	347	6033	1091	838	0	8309			NA
2002	555	7368	694	618	0	9235			NA
2003	136	5222	517	346	0	6221	210*	na	NA
2004	153	2425	663	282	0	3523	148*	na	108
2005	186	1623	870	309	0	2988	74*	na	54
2006	103	1896	959	368	0	3326	432*	na	103
2007	108	2509	1210	412	0	4239	592*	na	527
2008	65	2064	1221	289	0	3639	322*	na	558
2009	49	2080	870	264	0	3263	25*	na	193
2010	51	1853	1034	289	2	3229	7*	na	143
2011	124	3171	1011	414	17	4737	1828**	696	147
2012	290	5166	1536	701	0	7693	na	952	85
2013	202	4064	1478	546	0	6290	na	530	76
2014	141	2080	1159	464	1	3845	na	741	24
2015	120	2487	1126	422	2	4157	na	565	39
2016	96.8	2013.1	823.7	364.8	0.8	3299.2	na	220	40
2017	81.9	1347.5	623.5	183.8	0.1	2236.8	na	117.1	19
2018	48.6	499.4	705.9	130.1	0.5	1384.5	na	180.2	20.3

French high-grading estimates from self-sampling program. ** International high-grading estimates.

***** Included in Ireland landings estimates. Landings in the south of Division 7.a (33E2 and 33E3) are included in the assessment and are considered to be part of the stock.**

Table 8.2a. Cod in divisions 7e–k. Landings number-at-age (in thousands) (note: 2011 values represent actual catch) - InterCatch outputs before SOP correction.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1971	725	461	557	96	35	17	5	5	1	0
1972	4	774	110	205	45	26	11	5	1	0
1973	332	239	346	60	74	17	6	4	1	0
1974	1	224	40	118	38	37	18	4	14	0
1975	673	136	185	61	105	20	20	12	1	0
1976	51	1456	61	107	11	22	2	4	1	0
1977	25	416	236	15	60	2	2	5	10	0
1978	197	497	129	116	20	34	6	8	4	2
1979	438	357	263	68	104	19	24	5	2	1
1980	609	1213	285	175	52	55	14	0	0	0
1981	315	3086	811	153	41	20	10	2	0	0
1982	76	1157	888	169	36	19	4	1	0	0
1983	1285	529	540	424	77	21	5	5	1	0
1984	737	1210	134	97	94	22	3	2	0	0
1985	726	1245	465	61	40	47	12	2	1	0
1986	651	1303	673	254	30	31	17	0	0	0
1987	2741	946	448	250	62	20	11	4	0	0
1988	1830	5443	320	133	46	21	4	2	2	0
1989	666	2639	2483	149	77	18	8	2	1	0
1990	360	846	1006	663	79	21	8	6	2	0
1991	1377	1034	229	330	203	48	11	3	0	0
1992	1434	2601	329	64	70	53	16	1	0	0
1993	274	2371	928	79	24	19	14	2	0	0
1994	1340	692	1199	258	27	10	11	6	0	0
1995	823	3320	310	284	73	13	2	3	0	0
1996	617	2248	1199	134	95	43	3	1	0	0
1997	1184	1870	951	297	48	22	6	0	0	0
1998	639	2545	641	254	99	36	6	2	0	0

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1999	496	1141	756	158	59	36	9	5	0	0
2000	1693	464	419	169	44	17	12	2	0	0
2001	1091	2373	136	98	70	19	12	6	1	0
2002	210	2069	883	64	33	12	6	4	1	0
2003	103	556	827	217	15	9	6	1	0	0
2004	341	298	175	168	59	8	4	3	0	0
2005	295	664	138	52	45	11	2	0	0	0
2006	368	994	249	25	14	13	4	1	0	0
2007	491	1245	409	60	9	4	3	1	0	0
2008	123	769	312	101	24	4	3	1	0	0
2009	161	281	324	96	37	10	2	0	0	0
2010	532	434	122	91	42	9	2	0	0	0
2011	1516	3158	232	52	32	9	2	0	0	0
2012	35	489	1346	219	26	14	4	0	3	0
2013	110	195	433	451	65	21	6	0	0	0
2014	762	327	82	113	134	9	1	0	0	0
2015	37	1576	119	21	34	27	8	1	0	0
2016	137	89	579	33	6	10	17	1	0	0
2017	19	431	83	119	16	4	5	2	0	0
2018	88	152	135	12	34	3	1	1	0	0

Table 8.2b. Cod in divisions 7e–k. Landings number-at-age (in thousands) used in the assessment (note: 2011 values represent actual catch) - InterCatch outputs after SOP correction.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1971	725	461	557	96	35	17	11
1972	4	772	110	204	45	26	17
1973	331	239	345	60	74	17	11
1974	1	223	40	118	38	37	36
1975	674	136	185	61	105	20	33
1976	51	1460	61	107	11	22	7
1977	25	416	236	15	60	2	17
1978	196	496	129	116	20	34	20
1979	438	357	263	68	104	19	32
1980	609	1213	285	175	52	55	14
1981	315	3087	811	153	41	20	12
1982	77	1174	901	171	37	19	5
1983	1286	529	540	424	77	21	11
1984	736	1208	134	97	94	22	5
1985	733	1256	469	62	40	47	15
1986	651	1303	673	254	30	31	17
1987	2698	931	441	246	61	20	15
1988	1829	5441	320	133	46	21	8
1989	666	2640	2484	149	77	18	11
1990	356	838	996	656	78	21	16
1991	1377	1034	229	330	203	48	14
1992	1434	2601	329	64	70	53	17
1993	274	2373	929	79	24	19	16
1994	1340	692	1199	258	27	10	17
1995	823	3320	310	284	73	13	5
1996	617	2248	1199	134	95	43	4
1997	1185	1871	952	297	48	22	6
1998	640	2548	642	254	99	36	8

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1999	497	1143	757	158	59	36	14
2000	1692	464	419	169	44	17	14
2001	1090	2371	136	98	70	19	19
2002	210	2068	883	64	33	12	11
2003	103	556	826	217	15	9	7
2004	341	298	175	168	59	8	7
2005	296	665	138	52	45	11	2
2006	368	995	249	25	14	13	5
2007	492	1246	409	60	9	4	4
2008	123	771	313	101	24	4	4
2009	161	281	324	96	37	10	2
2010	534	435	122	91	42	9	2
2011	1515	3156	232	52	32	9	2
2012	35	490	1349	219	26	14	7
2013	110	195	434	452	65	21	6
2014	747	320	80	111	131	9	1
2015	36	1518	115	20	33	26	9
2016	132	86	558	32	6	10	17
2017	18	406	78	112	15	4	7
2018	85	146	130	12	33	3	2

Table 8.3. Cod in divisions 7e–k. Catch (landings) weight-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1971	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1972	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1973	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1974	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1975	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1976	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1977	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1978	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1979	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1980	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1981	0.945	1.549	4.385	7.565	9.060	12.750	13.822	19.232	19.232	19.232
1982	0.945	2.242	4.474	7.797	10.250	12.465	15.074	16.908	18.538	20.949
1983	0.979	2.525	4.961	7.457	9.965	12.010	14.767	17.643	19.131	19.131
1984	0.981	2.645	5.284	7.828	9.758	11.672	14.548	16.527	16.527	16.527
1985	1.001	2.637	5.521	8.082	10.407	11.469	13.448	16.658	20.853	20.853
1986	1.054	2.554	5.398	7.440	10.782	12.396	13.558	13.558	13.558	13.558
1987	0.909	2.504	5.264	8.089	10.447	13.574	15.029	16.229	16.229	16.229
1988	0.906	2.187	5.318	7.997	10.649	12.486	13.805	14.285	16.592	16.592
1989	0.844	2.013	4.706	7.638	9.438	12.917	12.479	15.407	16.683	16.683
1990	0.880	2.300	4.624	7.188	9.045	11.713	13.769	16.786	13.081	13.081
1991	0.905	2.135	4.987	6.738	8.865	10.809	13.768	15.478	15.478	15.478
1992	0.815	1.916	4.916	7.359	9.744	11.498	12.474	15.117	15.117	15.117
1993	0.871	2.043	4.508	6.866	8.431	10.942	12.147	13.646	16.530	16.530
1994	0.874	2.000	4.492	7.926	10.092	12.212	13.072	15.865	15.865	15.865
1995	0.806	1.973	4.589	7.560	9.750	11.152	13.983	14.147	14.147	14.147
1996	0.787	1.877	4.639	6.997	9.854	11.407	13.040	10.363	10.363	10.363
1997	0.771	2.039	4.516	7.389	9.719	11.820	14.367	13.687	13.687	13.687
1998	0.853	1.896	4.461	6.881	9.329	11.216	13.904	14.573	17.161	14.020
1999	0.993	2.098	4.495	7.326	8.945	11.255	13.877	15.988	15.988	17.159

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
2000	0.863	2.541	4.629	7.042	9.502	10.660	11.746	14.476	14.720	14.720
2001	0.794	2.029	5.112	7.858	9.832	11.423	13.206	14.879	16.311	16.311
2002	0.757	1.880	4.728	6.764	9.360	10.774	12.876	13.463	13.719	14.300
2003	0.889	1.844	4.274	6.667	9.506	11.064	12.040	12.762	11.139	11.139
2004	0.884	2.177	4.543	7.073	9.435	10.802	11.985	14.115	14.115	12.468
2005	0.776	2.118	3.907	6.168	9.194	11.544	10.037	12.657	13.835	13.835
2006	0.789	1.793	4.716	7.404	9.186	11.646	12.313	12.699	12.699	12.699
2007	0.772	1.657	4.276	7.463	9.697	11.863	12.441	13.953	15.046	15.046
2008	0.847	1.804	4.541	7.164	9.229	11.095	13.470	12.807	15.178	16.086
2009	0.923	2.384	4.248	6.721	8.895	10.584	10.342	10.497	16.169	14.560
2010	0.853	2.226	4.789	7.285	9.975	11.948	12.188	14.489	15.119	15.119
2011	0.532	1.449	4.551	7.745	9.524	10.597	12.749	10.595	10.595	10.595
2012	1.093	1.712	3.510	7.077	10.196	12.232	14.106	13.929	11.214	16.248
2013	0.982	2.159	4.087	6.977	8.363	10.479	11.904	16.384	12.989	12.989
2014	0.811	2.454	4.726	7.228	9.114	11.080	12.014	16.659	16.659	16.659
2015	0.915	1.838	4.144	7.980	9.539	10.719	11.891	12.416	16.165	16.165
2016	0.850	1.991	4.367	7.167	9.198	11.131	10.912	14.379	17.083	17.083
2017	0.966	2.160	3.991	7.057	8.716	9.276	10.518	11.236	12.279	12.279
2018	0.909	2.143	4.334	6.795	9.180	10.006	12.565	13.676	13.121	14.726

Table 8.4. Cod in divisions 7e–k. Stock weight-at-age =1st quarter values.

year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1971	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1972	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1973	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1974	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1975	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1976	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1977	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1978	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1979	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1980	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1981	0.460	1.549	2.284	7.806	10.544	11.439	14.464	15.354	15.354	15.354
1982	0.704	1.488	3.876	7.407	9.624	12.316	15.032	18.569	18.569	18.569
1983	0.446	1.945	4.467	7.353	9.752	11.223	15.908	18.089	21.977	21.977
1984	0.512	1.951	4.928	7.433	9.552	12.180	14.181	16.733	16.733	16.733
1985	0.581	2.070	5.333	8.376	10.851	11.585	14.247	16.399	20.853	20.853
1986	0.528	1.902	5.286	7.382	10.689	12.393	14.482	14.482	14.482	14.482
1987	0.522	1.947	4.877	7.946	10.308	14.419	15.171	16.201	16.201	16.201
1988	0.906	1.621	4.887	7.777	10.302	11.786	12.416	13.889	15.119	15.119
1989	0.844	1.463	4.514	7.615	9.438	12.692	12.788	17.794	17.794	17.794
1990	0.613	1.774	4.390	7.186	8.486	10.703	13.305	16.987	13.081	13.081
1991	0.539	1.538	4.791	6.524	8.631	10.672	13.512	14.898	14.898	14.898
1992	0.663	1.318	4.600	6.558	9.342	11.285	12.322	14.770	14.770	14.770
1993	0.703	1.385	4.278	6.574	8.066	10.815	11.945	13.421	16.530	16.530
1994	0.605	1.754	4.189	7.720	9.722	12.101	12.844	15.859	15.859	15.859
1995	0.612	1.444	4.346	7.452	9.140	10.646	13.908	14.147	14.147	14.147
1996	0.673	1.283	4.471	6.747	9.877	11.424	12.848	12.848	12.848	12.848
1997	0.470	1.410	4.079	7.112	9.044	11.156	13.730	13.623	13.623	13.623
1998	0.421	1.314	4.340	6.676	9.303	11.172	12.369	14.205	17.161	14.020
1999	0.778	1.542	4.252	7.126	8.700	11.142	13.978	17.463	17.159	17.159

year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
2000	0.561	1.696	4.223	6.627	9.326	10.505	11.115	13.566	13.566	13.566
2001	0.630	1.455	4.904	7.872	10.192	11.613	13.174	14.715	16.311	16.311
2002	0.352	1.257	4.452	7.046	9.400	10.614	12.637	14.949	14.949	14.949
2003	0.482	1.327	4.111	6.601	9.183	10.635	12.047	15.832	15.832	15.832
2004	0.591	1.258	4.053	6.759	9.372	10.158	11.680	13.850	13.850	13.850
2005	0.588	1.688	4.075	5.945	9.018	11.333	11.487	13.772	13.772	13.772
2006	0.703	1.216	4.233	6.819	8.895	11.487	11.411	12.703	12.703	12.703
2007	0.722	1.399	3.794	6.990	9.809	12.273	15.042	14.465	14.795	14.795
2008	0.869	1.449	4.188	6.896	8.881	11.543	13.624	10.045	13.763	13.763
2009	0.938	1.629	3.865	6.557	8.985	10.567	12.981	12.981	12.981	12.981
2010	0.819	1.424	4.373	6.984	9.891	11.663	12.575	13.085	13.085	13.085
2011	0.374	1.214	4.198	7.239	9.404	11.039	12.785	12.785	12.785	12.785
2012	1.005	1.224	3.534	7.333	10.404	11.702	13.727	12.663	16.045	16.174
2013	0.497	1.377	3.747	6.805	8.491	9.945	9.897	17.158	17.158	17.158
2014	0.464	1.654	3.788	6.530	9.074	10.584	11.611	12.285	12.285	12.285
2015	1.161	1.309	4.079	8.517	10.105	10.661	12.288	13.134	13.134	13.134
2016	0.647	1.310	3.683	6.700	10.573	11.453	12.928	16.875	16.435	16.435
2017	0.299	1.543	3.363	6.191	6.376	10.606	12.327	12.793	17.514	17.514
2018	0.539	1.356	3.706	5.465	9.146	10.237	12.432	14.449	16.486	16.486

Table 8.5a. Cod in divisions 7e–k. Time-series of landings, effort and lpue for French OT-DEF fleets. Units: landings in tonnes, effort in 000s hours fished and lpue in kg/hour fished.

Year	Effort	Landings	Lpue
2000	217480.1	1360798.3	6.26
2001	223428.0	2297415.3	10.28
2002	191161.1	2521943.2	13.19
2003	184878.5	1594331.4	8.62
2004	164606.5	693554.3	4.21
2005	132471.5	589933.2	4.45
2006	117258.8	571191.5	4.87
2007	115878.4	816210.8	7.04
2008	113485.2	652235.7	5.75
2009	113347.6	550405.7	4.86
2010	100331.9	635001.8	6.33
2011	101251.0	925372.7	9.14
2012	124404.4	2518809.6	20.25
2013	155301.2	1513472.3	9.75
2014	147142.9	1097602.2	7.46
2015	135732.0	1202081.0	8.86
2016	131254.0	964207.0	7.35
2017	130855.0	475897.0	3.64
2018	112660.0	154074.2	1.37

Table 8.5b. Cod in divisions 7e–k. Time-series of landings, effort and lpue for the Irish fleets. Units: landings in tonnes live weight, effort in 000s hours fished and lpue in kg/hour fished.

	Otter_trawl_27.7j			Beam_trawl_27.7j			Scottish_seiner_27.7j			Gillnet_27.7j		
X	Landing	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	339.3	93.2	3.6	0.0	0.2	0.2	75.5	5.3	14.4	178.8	21.3	8.4
1996	326.4	70.2	4.6	8.7	1.4	6.3	124.5	8.2	15.3	65.0	5.2	12.4
1997	352.7	82.7	4.3	3.4	1.7	2.0	115.8	10.7	10.8	45.5	8.3	5.5
1998	262.7	89.1	2.9	19.1	5.2	3.7	103.4	6.6	15.6	59.1	16.0	3.7
1999	76.7	40.5	1.9	27.5	7.4	3.7	9.6	1.4	6.8	24.6	8.7	2.8
2000	95.5	63.9	1.5	21.2	6.9	3.1	24.4	3.5	7.0	13.8	7.0	2.0
2001	148.5	67.4	2.2	10.7	3.0	3.6	31.3	4.4	7.1	14.8	6.6	2.3
2002	150.0	90.4	1.7	5.4	3.1	1.7	24.6	8.9	2.8	12.3	8.1	1.5
2003	73.6	107.4	0.7	8.8	9.0	1.0	12.0	7.9	1.5	6.3	11.2	0.6
2004	36.1	88.3	0.4	2.5	2.2	1.2	10.3	8.1	1.3	4.2	6.1	0.7
2005	37.8	71.3	0.5	4.7	2.4	2.0	17.5	5.8	3.0	3.4	6.1	0.6
2006	39.6	64.5	0.6	2.0	1.5	1.3	15.6	5.3	2.9	7.2	7.3	1.0
2007	35.9	78.3	0.5	7.8	2.4	3.3	9.8	3.5	2.8	6.5	10.5	0.6
2008	33.1	66.7	0.5	2.6	1.1	2.3	9.5	2.8	3.3	6.5	7.9	0.8
2009	26.6	73.0	0.4	4.7	2.8	1.7	8.9	3.3	2.7	8.0	10.9	0.7
2010	52.5	85.7	0.6	1.7	1.0	1.7	17.0	4.4	3.9	8.4	9.4	0.9
2011	57.7	62.8	0.9	1.7	0.6	2.7	21.6	4.6	4.7	16.8	8.0	2.1
2012	62.8	65.6	1.0	0.4	0.3	1.5	29.8	5.4	5.6	25.2	8.3	3.0
2013	66.1	61.3	1.1	1.8	0.6	3.3	32.5	6.6	4.9	15.4	9.8	1.6
2014	51.6	53.9	1.0	1.2	0.6	1.9	52.6	7.4	7.1	9.7	12.2	0.8
2015	63.6	46.9	1.4	0.6	0.1	6.3	38.2	5.3	7.2	18.1	14.2	1.3
2016	48.5	50.7	1.0	0.3	0.2	1.5	25.2	5.3	4.7	15.8	17.1	0.9
2017	41.3	56.4	0.7	0.0	0.0	10.0	24.0	5.3	4.5	10.4	18.0	0.6
2018	42.3	52.1	0.8	0.2	0.1	2.4	28.5	6.4	4.5	5.9	16.8	0.4

	Otter_trawl_27.7g			Beam_trawl_27.7g			Scottish_seiner_27.7g			Gillnet_27.7g		
	Landing	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	429.8	63.3	6.8	85.8	20.7	4.1	111.3	6.4	17.3	111.3	6.3	17.5
1996	569.2	60.0	9.5	112.5	26.7	4.2	164.9	9.7	16.9	164.9	6.2	26.7
1997	401.9	65.0	6.2	131.5	28.1	4.7	215.2	16.1	13.4	215.2	1.9	112.7
1998	450.5	72.3	6.2	166.8	35.2	4.7	264.1	14.9	17.7	264.1	3.4	76.8
1999	300.7	51.5	5.8	190.6	40.8	4.7	64.6	8.0	8.1	64.6	8.4	7.7
2000	279.4	60.6	4.6	180.6	36.8	4.9	106.0	9.9	10.8	106.0	10.1	10.5
2001	358.5	69.4	5.2	101.2	39.5	2.6	115.0	16.3	7.0	115.0	8.8	13.1
2002	212.9	77.2	2.8	57.9	31.5	1.8	71.0	20.9	3.4	71.0	6.4	11.0
2003	167.2	86.8	1.9	56.8	49.2	1.2	35.6	20.1	1.8	35.6	11.1	3.2
2004	190.2	97.1	2.0	74.3	54.9	1.4	54.4	18.4	3.0	54.4	13.5	4.0
2005	292.5	124.7	2.3	118.9	49.6	2.4	64.4	14.6	4.4	64.4	10.9	5.9
2006	379.4	118.0	3.2	128.6	60.5	2.1	91.0	14.8	6.2	91.0	7.8	11.6
2007	316.1	135.4	2.3	96.2	55.8	1.7	58.5	15.8	3.7	58.5	9.4	6.2
2008	344.9	125.4	2.7	85.4	37.2	2.3	55.6	11.6	4.8	55.6	14.1	3.9
2009	405.9	137.1	3.0	74.4	37.9	2.0	34.6	8.2	4.2	34.6	13.8	2.5
2010	524.8	140.8	3.7	94.7	40.2	2.4	54.3	9.7	5.6	54.3	14.0	3.9
2011	438.4	120.3	3.6	82.5	35.3	2.3	46.7	11.0	4.2	46.7	11.3	4.1
2012	780.7	127.7	6.1	161.9	40.3	4.0	111.5	14.1	7.9	111.5	15.4	7.2
2013	721.4	118.2	6.1	195.8	38.5	5.1	111.3	13.2	8.5	111.3	14.4	7.7
2014	600.1	127.3	4.7	142.9	37.8	3.8	110.5	12.5	8.9	110.5	14.1	7.8
2015	526.3	132.7	4.0	160.1	37.8	4.2	59.2	9.3	6.4	59.2	12.5	4.7
2016	418.1	148.2	2.8	106.8	39.6	2.7	51.1	10.4	4.9	51.1	13.6	3.8
2017	361.4	136.1	2.7	46.4	35.2	1.3	42.1	9.7	4.3	42.1	14.8	2.8
2018	387.6	108.2	3.6	72.6	37.4	1.9	61.1	9.7	6.3	61.1	14.0	4.4

Table 8.5c. Cod in divisions 7e-k. Time-series of landings, effort and lpue for the UK fleets. Units: landings in tonnes, effort in days fished and lpue in kg/day.

	Beam_trawl_27.7ek			Trawl_27.7ek			Trawl_27.7e		
Year	Lpue	Landing	Effort	Lpue	Landings	Effort	Lpue	Landings	Effort
1983	8.96	25.55	2853	15.91	40.93	2573	11.01	20.6	1871
1984	15.28	128.75	8427	29.12	235.68	8092	13.6	76.42	5618
1985	18.87	145.39	7706	34.88	250.67	7186	11.82	63.97	5411
1986	24.92	165.76	6651	37.61	232.19	6174	17.7	78.31	4425
1987	30.88	248.91	8060	38.63	210.36	5446	23.91	88.49	3701
1988	26.27	249.21	9487	46.53	262.68	5645	35.49	151.35	4265
1989	22.96	231.24	10071	29.53	177.12	5997	20.84	96	4607
1990	29.5	309.07	10477	45.91	305.78	6661	27	119.41	4423
1991	28.41	256.19	9017	40.81	242.33	5938	20.88	83.6	4004
1992	31.32	256.33	8183	35.7	231.85	6494	19.66	80.76	4108
1993	23.32	221.79	9511	36.21	183.05	5055	11.4	42.88	3761
1994	12.86	179.13	13925	17.67	78.23	4426	12.05	41.25	3423
1995	16.01	241.35	15076	26.12	115.05	4405	16.72	55.09	3294
1996	19.32	304.22	15748	26.91	120.46	4476	22.87	59.21	2589
1997	18.55	303.67	16373	29.48	150.01	5088	26.51	79.81	3011
1998	17.09	266.15	15574	25.28	119.56	4729	23.16	62.5	2699
1999	16.49	257.43	15614	13.66	90.68	6638	18.83	46.81	2486
2000	11.43	188.07	16456	15.71	110.79	7054	19.62	52.59	2681
2001	14.84	257.24	17335	18.68	109.75	5875	21.62	59.05	2732
2002	8.01	132.13	16503	14.62	82.7	5657	13.93	34.11	2448
2003	5.95	108.77	18285	11.48	58.8	5120	10.77	24.48	2273
2004	5.31	96.93	18250	8.36	44.06	5273	6.45	15.05	2334
2005	6.04	103.6	17157	8.15	41.13	5047	9.86	17.38	1762
2006	5.96	91.88	15412	10.43	55.43	5314	7.97	13.54	1699
2007	7.38	111.28	15085	8.74	49.65	5679	11.27	21.61	1917
2008	5.2	71.38	13734	10.53	49.34	4686	13.86	24.26	1750
2009	5.53	67.27	12170	5.59	27.56	4928	6.8	12.56	1847
2010	5.4	65.62	12150	6	31.13	5185	6.9	15.27	2213
2011	7.5	99.03	13205	10.96	47.73	4354	13.47	26	1931
2012	12.35	165.63	13411	18.33	79.03	4312	14.96	30.95	2068
2013	8.84	114.49	12950	18.52	37.3	2014	14.46	22.94	1587
2014	6.84	87.55	12807	10.63	17.07	1606	9.76	14.06	1440
2015	7	89.39	12769	15.72	16.68	1061	14.73	14.4	978
2016	5.3	73.81	13913	0	0	0	0	0	0
2017	2.49	35.49	14280	5.22	19.37	3711	3.9	9.33	2392
2018	1.87	24.41	13065	5.45	17.5	3214	2.71	5.33	1967

Table 8.6. Cod in divisions 7e–k. Time-series of survey indices scrutinized at WGCSE and used in the assessment.

Cod in divisions 7e–k, tuning fleets, WGCSE18			
102			
FR-OTDEF Q2+3+4 trawlers in 7e–k			
2000	2018		
1	1	0.25	1
1	10		

Year	Effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
2000	217479	200742	93804	59384	35784	11253	5683	3988	545	356	0
2001	223427	119879	383175	45401	44844	34907	11427	5256	2109	0	0
2002	191161	188306	472476	144332	38748	16046	9760	4317	4212	252	0
2003	184878	22380	134512	138065	59698	7928	7313	4455	847	424	0
2004	164606	12412	54908	41644	21032	13420	1720	208	0	0	208
2005	132472	13489	132632	10525	6207	8814	2861	367	54	237	0
2006	117259	24447	148506	27730	3716	1912	1282	845	0	0	0
2007	115878	265362	409573	76766	13367	2099	684	818	235	60	0
2008	113485	77385	252690	44372	16057	4178	624	236	447	0	8
2009	113348	106600	58211	46807	14017	5042	1939	894	353	0	19
2010	100332	206831	103580	15881	8766	4600	678	102	0	17	0
2011	101251	6870	1145981	92577	22801	17131	3074	551	0	0	0
2012	124404	2709	108920	463339	109825	12257	6173	1939	176	1329	0
2013	155301	41174	66032	126952	129554	21809	5676	1921	0	0	0
2014	147143	160520	70506	23843	29394	48405	2958	191	0	0	0
2015	135732	3473	409342	36700	6263	11629	7460	4640	0	0	0
2016	131254	11768	21661	149990	12802	2733	2975	6765	0	0	0
2017	130855	2135	83620	19322	23688	1831	946	1226	0	0	0
2018	112660	11660	14429	10793	1333	4676	365	198	0	0	0

IR-GFS FR-EVHOE Q4 combined indices new			
2003	2018		
1	1	0.79	0.92
0	6		

Year	Effort	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
2003	1	0.14	0.61	0.75	0.50	0.17	0.00	0.00
2004	1	0.24	0.88	0.24	0.15	0.14	0.07	0.00
2005	1	0.06	1.81	0.26	0.09	0.00	0.00	0.00
2006	1	0.04	1.39	0.67	0.08	0.00	0.00	0.02
2007	1	0.00	1.93	0.64	0.19	0.05	0.00	0.00
2008	1	0.00	0.55	0.88	0.24	0.12	0.00	0.00
2009	1	0.10	1.38	0.17	0.26	0.12	0.00	0.01
2010	1	0.12	7.34	0.76	0.04	0.06	0.07	0.00
2011	1	0.02	4.09	3.54	0.22	0.04	0.03	0.00
2012	1	0.00	0.39	1.32	0.80	0.19	0.04	0.00
2013	1	0.08	0.42	0.05	0.21	0.23	0.00	0.00
2014	1	0.00	3.64	0.27	0.12	0.15	0.20	0.00
2015	1	0.00	0.31	1.36	0.12	0.00	0.05	0.06
2016	1	0.00	2.27	0.18	0.81	0.07	0.02	0.07
2017	1	0.04	0.32	0.60	0.27	0.17	0.02	0.00
2018	1	0.05	0.48	0.09	0.04	0.04	0.12	0.00

Table 8.7. Cod in divisions 7e–k. Final XSA diagnostics (from FLR XSA).

FLR XSA Diagnostics 2019-05-10 12:51:38

Cpue data from indices

Catch data for 48 years. 1971 to 2018. Ages 1 to 7.

	fleet	first age	last age	first year	last year	alpha	beta
1	FR-OTDEF	1	6	2000	2018	<NA>	<NA>
2	IR-FR COMBINED SURVEY	1	4	2003	2018	<NA>	<NA>

Time-series weights:
Tapered time weighting not applied

Catchability analysis:
Catchability independent of size for all ages
Catchability independent of age for ages > 3

Terminal population estimation:
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1

Minimum standard error for population
estimates derived from each fleet = 0.3
prior weighting not applied

Regression weights

year										
age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	0.072	0.052	0.513	0.057	0.113	0.167	0.089	0.116	0.048	0.117
2	0.493	0.376	0.681	0.411	0.714	0.782	0.851	0.428	0.882	0.966
3	0.786	0.493	0.416	0.877	0.992	0.918	0.9	1.172	1.146	1.002
4	0.692	0.596	0.446	1.048	0.985	0.861	0.701	0.775	0.909	0.547
5	1.174	0.837	0.461	0.454	1.242	0.998	0.74	0.471	1.27	0.819
6	0.831	1.185	0.439	0.395	0.89	0.552	0.564	0.527	0.691	0.973
7	0.831	1.185	0.439	0.395	0.89	0.552	0.564	0.527	0.691	0.973

XSA population number (NA)

year	1	2	3	4	5	6	7
2009	2995	867	692	220	61	20	4
2010	13499	1670	366	233	84	15	3
2011	4874	7677	794	165	98	28	6
2012	813	1748	2688	387	81	48	24
2013	1327	460	802	825	104	40	11
2014	6277	710	156	219	235	23	3
2015	540	3184	225	46	71	68	22
2016	1561	296	941	67	17	26	47
2017	496	834	134	215	24	8	15
2018	990	284	239	31	66	5	3

Estimated population abundance at 1st January 2019

year	1	2	3	4	5	6	7
2019	0	528	75	65	14	23	2

Fleet: FR-OTDEF

Log catchability residuals.

	year					
age	2000	2001	2002	2003	2004	2005
	2006	2007	2008	2009	2010	
1	0.036	-0.354	1.628	0.037	-1.216	-1.309
	-0.678	1.932	1.551	1.229	0.497	
2	-0.421	-0.621	-0.13	0.038	-0.335	0.036
	-0.162	0.895	0.511	-0.252	-0.278	
3	-0.666	-0.244	-0.253	-0.072	0.111	-0.597
	-0.335	0.306	-0.24	-0.238	-0.731	
4	-0.592	0.141	0.86	0.27	-0.419	-0.299
	-0.313	0.027	0.004	-0.371	-0.831	
5	-0.607	0.416	0.188	0.32	0.263	0.248
	-0.117	0.112	-0.146	0.158	-0.331	
6	-0.014	0.23	0.097	0.137	-0.065	0.067
	-0.182	0.009	-0.018	0.114	-0.307	

	year	
age	2017	2018
1	-1.042	0.156
2	0.23	-0.252
3	0.583	-0.512
4	0.157	-0.855
5	-0.009	-0.202
6	0.021	-0.13

Mean log catchability and standard error of ages with catchability independent of year-class strength and constant w.r.t. time

	1	2	3	4	5	6
Mean_Logq	-8.9383	-6.6585	-6.5329	-6.5329	-6.5329	-6.5329
S.E_Logq	0.5722	0.5722	0.5722	0.5722	0.5722	0.5722

Fleet: IR-FR COMBINED SURVEY

Log catchability residuals.

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	-0.083	-0.482	-0.171	-0.517	0.043	-0.402	-0.134	0.015	0.843	-0.105	-0.474
2	0.725	-0.051	-0.686	-0.177	-0.139	0.177	-0.807	-0.065	0.209	0.471	-1.208
3	0.26	0.243	0.239	-0.77	-0.267	-0.119	-0.094	-1.58	-0.715	-0.249	-0.279
4	0.307	0.346	NaN	NaN	-0.238	0.467	0.169	-0.663	-0.853	0.368	-0.252

age	2014	2015	2016	2017	2018
1	0.177	0.101	1.053	0.181	-0.044
2	0.102	0.277	0.269	0.826	0.078
3	0.736	0.354	1.065	1.895	-0.718
4	0.539	NaN	0.883	0.725	0.894

Mean log catchability and standard error of ages with catchability independent of year-class strength and constant w.r.t. time

	1	2	3	4
Mean_Logq	-7.0498	-6.9942	-6.8614	-6.8614
S.E_Logq	0.595	0.595	0.595	0.595

Terminal year survivor and F summaries:

Age 1 Year class = 2017

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	617	1	0.116
IR-GFS FR-EVHOE Q4 combined indices new	505	1	0.720
fshk	574	1	0.163

Age 2 Year class = 2016

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	53	2	0.361
IR-GFS FR-EVHOE Q4 combined indices new	86	2	0.481
fshk	110	1	0.158

Age 3 Year class = 2015

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	49	3	0.481
IR-GFS FR-EVHOE Q4 combined indices new	100	3	0.326
fshk	61	1	0.193

Age 4 Year class = 2014

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	9	4	0.474
IR-GFS FR-EVHOE Q4 combined indices new	29	4	0.384
fshk	7	1	0.142

Age 5 Year class = 2013

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	21	5	0.677
IR-GFS FR-EVHOE Q4 combined indices new	43	4	0.135
fshk	18	1	0.188

Age 6 Year class = 2012

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	1	6	0.807
IR-GFS FR-EVHOE Q4 combined indices new	2	4	0.035
fshk	2	1	0.157

Table 8.8. Cod in divisions 7e–k. Final XSA fishing mortality-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+	F_{bar}(mean 2–5)
1971	0.219	0.685	0.635	0.550	0.359	0.519	0.519	0.557
1972	0.006	0.518	0.397	0.567	0.585	0.521	0.521	0.517
1973	0.165	0.731	0.553	0.437	0.442	0.481	0.481	0.541
1974	0.001	0.208	0.290	0.407	0.595	0.435	0.435	0.375
1975	0.156	0.367	0.313	1.160	0.871	0.791	0.791	0.678
1976	0.034	0.838	0.327	0.333	0.717	0.463	0.463	0.554
1977	0.011	0.570	0.352	0.135	0.338	0.277	0.277	0.349
1978	0.097	0.431	0.405	0.322	0.287	0.340	0.340	0.361
1979	0.089	0.340	0.512	0.433	0.585	0.515	0.515	0.468
1980	0.066	0.513	0.601	0.896	0.767	0.764	0.764	0.694
1981	0.082	0.776	0.987	0.890	0.580	0.829	0.829	0.808
1982	0.048	0.680	0.653	0.642	0.586	0.633	0.633	0.640
1983	0.274	0.747	0.987	0.861	0.741	0.874	0.874	0.834
1984	0.153	0.617	0.499	0.514	0.496	0.507	0.507	0.532
1985	0.175	0.577	0.624	0.505	0.450	0.531	0.531	0.539
1986	0.184	0.752	0.881	0.978	0.536	0.808	0.808	0.787
1987	0.148	0.596	0.757	1.165	0.726	0.894	0.894	0.811
1988	0.215	0.691	0.497	0.606	0.763	0.629	0.629	0.639
1989	0.269	0.768	1.010	0.510	0.978	0.843	0.843	0.816
1990	0.121	0.923	0.942	0.954	0.602	0.843	0.843	0.855
1991	0.170	0.865	0.869	1.173	1.018	1.034	1.034	0.981
1992	0.172	0.786	0.948	0.724	0.948	0.884	0.884	0.851
1993	0.101	0.656	0.908	0.705	0.726	0.789	0.789	0.749
1994	0.135	0.536	1.067	0.793	0.603	0.831	0.831	0.750
1995	0.116	0.811	0.588	0.920	0.585	0.706	0.706	0.726
1996	0.114	0.743	1.001	0.618	1.059	0.904	0.904	0.855
1997	0.166	0.838	1.056	0.839	0.506	0.810	0.810	0.810
1998	0.180	0.927	0.993	1.102	0.837	0.990	0.990	0.965
1999	0.319	0.795	1.009	0.817	0.927	0.930	0.930	0.887

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+	F_{bar}(mean 2–5)
2000	0.230	0.788	0.976	0.730	0.607	0.817	0.817	0.775
2001	0.174	0.825	0.676	0.723	0.858	0.612	0.612	0.770
2002	0.133	0.817	1.103	0.932	0.620	0.351	0.351	0.868
2003	0.108	0.875	1.227	1.075	0.629	0.354	0.354	0.952
2004	0.163	0.721	0.960	1.061	1.143	0.903	0.903	0.971
2005	0.096	0.771	1.155	1.017	1.065	0.706	0.706	1.002
2006	0.110	0.750	0.938	0.741	0.953	1.194	1.194	0.845
2007	0.180	0.943	1.031	0.692	0.718	0.866	0.866	0.846
2008	0.104	0.656	0.799	0.901	0.727	0.901	0.901	0.771
2009	0.072	0.493	0.786	0.692	1.174	0.831	0.831	0.786
2010	0.052	0.376	0.493	0.596	0.837	1.185	1.185	0.576
2011	0.513	0.681	0.416	0.446	0.461	0.439	0.439	0.501
2012	0.057	0.411	0.877	1.048	0.454	0.395	0.395	0.698
2013	0.113	0.714	0.992	0.985	1.242	0.890	0.890	0.983
2014	0.167	0.782	0.918	0.861	0.998	0.552	0.552	0.890
2015	0.089	0.851	0.900	0.701	0.740	0.564	0.564	0.798
2016	0.116	0.428	1.172	0.775	0.471	0.527	0.527	0.712
2017	0.048	0.882	1.146	0.909	1.270	0.691	0.691	1.052
2018	0.117	0.966	1.002	0.547	0.819	0.973	0.973	0.834

Table 8.9. Cod in divisions 7e–k. Final XSA stock number-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1971	4769	1118	1381	260	131	47	30
1972	928	2296	390	540	115	72	46
1973	2810	553	947	194	234	50	32
1974	889	1428	184	402	96	118	113
1975	6031	532	802	102	204	41	67
1976	1986	3093	255	433	24	67	21
1977	2871	1151	926	136	237	9	78
1978	2741	1701	450	480	91	132	77
1979	6630	1491	765	222	266	53	88
1980	12254	3634	734	338	110	116	29
1981	5179	6872	1506	297	105	40	24
1982	2117	2860	2189	414	93	46	12
1983	6923	1209	1003	841	167	41	21
1984	6696	3153	396	276	272	62	14
1985	5892	3443	1177	178	126	129	41
1986	5000	2964	1338	466	82	63	34
1987	25361	2493	967	409	134	37	28
1988	12239	13110	950	335	97	51	19
1989	3648	5919	4547	427	140	36	21
1990	4042	1670	1900	1221	196	41	31
1991	11365	2146	459	547	360	84	24
1992	11742	5745	625	142	129	101	32
1993	3698	5927	1812	179	53	39	32
1994	13711	2004	2128	539	67	20	33
1995	9666	7180	811	540	187	29	11
1996	7410	5156	2207	332	165	81	7
1997	9985	3963	1698	599	137	45	12
1998	5005	5067	1187	436	198	64	14
1999	2348	2504	1387	324	111	67	26

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2000	10649	1022	783	373	109	34	28
2001	8837	5072	322	218	137	47	46
2002	2182	4452	1538	121	81	46	41
2003	1298	1145	1361	376	36	34	26
2004	2925	698	331	294	98	15	13
2005	4163	1488	235	93	78	24	4
2006	4571	2266	477	55	26	21	8
2007	3850	2455	741	138	20	8	8
2008	1606	1927	662	195	53	8	7
2009	2995	867	692	220	61	20	4
2010	13499	1670	366	233	84	15	3
2011	4874	7677	794	165	98	28	6
2012	813	1748	2688	387	81	48	24
2013	1327	460	802	825	104	40	11
2014	6277	710	156	219	235	23	3
2015	540	3184	225	46	71	68	22
2016	1561	296	941	67	17	26	47
2017	496	834	134	215	24	8	15
2018	990	284	239	31	66	5	3
GMST_71_2016	4171	2186	808	273	102	41	21
AMST_71_2016	5780	2990	1049	340	124	50	29

Table 8.10a. Cod in divisions 7e–k. Final XSA summary table.

Year	Recruitment	SSB	Catch	Landings	TSB	F_{bar} (2–5)	Y/SSB
1971	4769	10093	5782	5782	15346	0.557	0.57
1972	928	9298	4737	4737	12808	0.517	0.51
1973	2810	8617	4015	4015	11700	0.541	0.47
1974	889	8327	2898	2898	10717	0.375	0.35
1975	6031	7526	3993	3993	12589	0.678	0.53
1976	1986	7316	4818	4818	12224	0.554	0.66
1977	2871	8841	3059	3059	12545	0.349	0.35
1978	2741	9689	3647	3647	13783	0.361	0.38
1979	6630	9848	4650	4650	16346	0.467	0.47
1980	12254	10347	7243	7243	22845	0.694	0.70
1981	5179	11212	10597	10597	20697	0.808	0.95
1982	2117	13547	8766	8766	18951	0.640	0.65
1983	6923	13008	9641	9641	18545	0.834	0.74
1984	6696	9568	6631	6631	17147	0.531	0.69
1985	5892	13103	8317	8317	21794	0.539	0.63
1986	5000	13692	10475	10475	20931	0.787	0.77
1987	25361	11364	10228	10228	28403	0.811	0.90
1988	12239	16606	17191	17191	41445	0.639	1.04
1989	3648	26324	19809	19809	37580	0.817	0.75
1990	4042	19126	12749	12749	25110	0.855	0.67
1991	11365	10846	9336	9336	19520	0.981	0.86
1992	11742	9073	9747	9747	21916	0.851	1.07
1993	3698	12280	10425	10425	20977	0.749	0.85
1994	13711	14357	10620	10620	26246	0.750	0.74
1995	9666	13019	11709	11709	25999	0.726	0.90
1996	7410	15899	12681	12681	26362	0.855	0.80
1997	9985	14065	12035	12035	23366	0.810	0.86
1998	5005	12522	11431	11431	19564	0.965	0.91
1999	2348	10883	8594	8594	15994	0.887	0.79

Year	Recruitment	SSB	Catch	Landings	TSB	F_{bar} (2–5)	Y/SSB
2000	10649	7548	6536	6536	15182	0.775	0.87
2001	8837	8421	8308	8308	18815	0.771	0.99
2002	2182	10738	9236	9236	15870	0.868	0.86
2003	1298	8795	6420	6420	11249	0.951	0.73
2004	2925	4596	3672	3672	7174	0.971	0.80
2005	4163	3359	3062	3062	7503	1.002	0.91
2006	4571	3739	3776	3776	8922	0.846	1.01
2007	3850	5084	4830	4830	10391	0.846	0.95
2008	1606	5402	3961	3961	8954	0.771	0.73
2009	2995	5022	3292	3292	9142	0.786	0.66
2010	13499	4875	3229	3229	17703	0.575	0.66
2011	4874	8961	7261	7261	16985	0.501	0.81
2012	813	13492	7692	7692	17047	0.698	0.57
2013	1327	9470	6290	6290	11300	0.984	0.66
2014	6277	4716	3879	3879	8523	0.890	0.82
2015	540	4501	4154	4154	7817	0.798	0.92
2016	1561	4689	3299	3299	6418	0.711	0.70
2017	496	2554	2237	2237	3639	1.052	0.88
2018	990	1783	1385	1385	2678	0.833	0.78
2019	2166	1289					

Table 8.10.b. Cod in divisions 7e–k. Final XSA summary in relative value.

Year	Relative Recruitment age 1	Relative tonnes	Landings tonnes	Discards tonnes	Relative Ages
1971	0.87	1.05	5782	0	0.75
1972	0.169	0.97	4737	0	0.70
1973	0.51	0.90	4015	0	0.73
1974	0.162	0.87	2898	0	0.51
1975	1.10	0.79	3993	0	0.92
1976	0.36	0.76	4818	0	0.75
1977	0.52	0.92	3059	0	0.47
1978	0.50	1.01	3647	0	0.49
1979	1.21	1.03	4650	0	0.63
1980	2.2	1.08	7243	0	0.94
1981	0.94	1.17	10597	0	1.09
1982	0.38	1.41	8766	0	0.86
1983	1.26	1.36	9641	0	1.13
1984	1.22	1.00	6631	0	0.72
1985	1.07	1.37	8317	0	0.73
1986	0.91	1.43	10475	0	1.06
1987	4.6	1.19	10228	0	1.09
1988	2.2	1.73	17191	0	0.86
1989	0.66	2.7	19809	0	1.10
1990	0.73	2.00	12749	0	1.15
1991	2.1	1.13	9336	0	1.32
1992	2.1	0.95	9747	0	1.15
1993	0.67	1.28	10425	0	1.01
1994	2.5	1.50	10620	0	1.01
1995	1.76	1.36	11709	0	0.98
1996	1.35	1.66	12681	0	1.15
1997	1.82	1.47	12035	0	1.09
1998	0.91	1.31	11431	0	1.30

Year	Relative Recruitment age 1	Relative tonnes	Landings tonnes	Discards tonnes	Relative Ages
1999	0.43	1.14	8594	0	1.20
2000	1.94	0.79	6536	0	1.05
2001	1.61	0.88	8308	0	1.04
2002	0.40	1.12	9236	0	1.17
2003	0.24	0.92	6420	0	1.28
2004	0.53	0.48	3672	0	1.31
2005	0.76	0.35	3062	0	1.35
2006	0.83	0.39	3776	0	1.14
2007	0.70	0.53	4830	0	1.14
2008	0.29	0.56	3961	0	1.04
2009	0.54	0.52	3292	0	1.06
2010	2.5	0.51	3229	0	0.78
2011	0.89	0.94	7261	696	0.68
2012	0.148	1.41	7692	952	0.94
2013	0.24	0.99	6290	530	1.33
2014	1.14	0.49	3879	741	1.20
2015	0.098	0.47	4154	565	1.08
2016	0.28	0.49	3299	220	0.96
2017	0.090	0.27	2237	117	1.42
2018	0.180	0.186	1385	180	1.12
2019	0.39**	0.135			

**25th quantile of the time-series (1971–2018).

Table 8.11. Cod divisions 7.e–k. Short-term forecast. Input table.

Year	Age	N	M	Mat	SWt	Sel	CWt
2019	1	2166	0.512	0.00	0.495	0.09345	0.908
2019	2	528	0.368	0.39	1.403	0.75854	2.098
2019	3	75	0.304	0.87	3.584	1.10657	4.231
2019	4	65	0.269	0.93	6.119	0.74357	7.006
2019	5	14	0.247	1.00	8.698	0.85300	9.031
2019	6	23	0.233	1.00	10.765	0.73038	10.138
2019	7	3	0.223	1.00	13.016	0.73038	11.649
2020	1	2166	0.512	0.00	0.495	0.09345	0.908
2020	2	1182	0.368	0.39	1.403	0.75854	2.098
2020	3	171	0.304	0.87	3.584	1.10657	4.231
2020	4	18	0.269	0.93	6.119	0.74357	7.006
2020	5	24	0.247	1.00	8.698	0.85300	9.031
2020	6	5	0.233	1.00	10.765	0.73038	10.138
2020	7	10	0.223	1.00	13.016	0.73038	11.649
2021	1	2166	0.512	0.00	0.495	0.09345	0.908
2021	2	1182	0.368	0.39	1.403	0.75854	2.098
2021	3	383	0.304	0.87	3.584	1.10657	4.231
2021	4	42	0.269	0.93	6.119	0.74357	7.006
2021	5	7	0.247	1.00	8.698	0.85300	9.031
2021	6	8	0.233	1.00	10.765	0.73038	10.138
2021	7	5	0.223	1.00	13.016	0.73038	11.649

Table 8.12. Cod divisions 7.e–k. Short-term forecast. Single option output table.

Year	Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
2019	1	0.09345	152	137.91	2166	1072	0	0
2019	2	0.75854	240	503.82	528	740	206	289
2019	3	1.10657	44	187.54	75	268	65	233
2019	4	0.74357	30	211.92	65	396	60	368
2019	5	0.85300	7	64.79	14	121	14	121
2019	6	0.73038	11	108.35	23	245	23	245
2019	7	0.73038	1	14.20	3	34	3	34
2019	Total	0.86500	485	1228.53	2874	2876	371	1290
2020	1	0.09345	152	137.91	2166	1072	0	0
2020	2	0.75854	538	1128.74	1182	1659	461	647
2020	3	1.10657	101	429.20	171	613	149	533
2020	4	0.74357	9	59.75	18	112	17	104
2020	5	0.85300	12	109.80	24	204	24	204
2020	6	0.73038	2	21.94	5	50	5	50
2020	7	0.73038	5	53.19	10	126	10	126
2020	Total	0.86500	819	1940.53	3576	3836	666	1664
2021	1	0.09345	152	137.91	2166	1072	0	0
2021	2	0.75854	538	1128.74	1182	1659	461	647
2021	3	1.10657	227	961.56	383	1374	333	1195
2021	4	0.74357	20	136.73	42	255	39	238
2021	5	0.85300	3	30.96	7	58	7	58
2021	6	0.73038	4	37.18	8	84	8	84
2021	7	0.73038	3	30.16	5	72	5	72
2021	Total	0.86500	947	2463.24	3793	4574	853	2294

Table 8.13. Cod divisions 7.e–k. Short-term forecast. Management options output.

2019				
tsbInt	**ssbInt**	**fmultInt**	**fInt**	**landInt**
2876	1290	1	0.8654181	1229

tsb2020	SSB_2020	F_{mult}	F_{bar}	Landings	SSB_2021
3836	1664	0.0	NA	0	4447
3836	1664	0.1	0.08654	265	4144
3836	1664	0.2	0.17308	511	3864
3836	1664	0.3	0.25963	739	3607
3836	1664	0.4	0.34617	951	3371
3836	1664	0.5	0.43271	1147	3153
3836	1664	0.6	0.51925	1329	2952
3836	1664	0.7	0.60579	1499	2767
3836	1664	0.8	0.69233	1657	2596
3836	1664	0.9	0.77888	1804	2438
3836	1664	1.0	0.86542	1941	2293
3836	1664	1.1	0.95196	2068	2159
3836	1664	1.2	1.03850	2187	2035
3836	1664	1.3	1.12504	2299	1920
3836	1664	1.4	1.21159	2403	1814
3836	1664	1.5	1.29813	2500	1716
3836	1664	1.6	1.38467	2592	1625
3836	1664	1.7	1.47121	2677	1542
3836	1664	1.8	1.55775	2758	1464
3836	1664	1.9	1.64429	2833	1392
3836	1664	2.0	1.73084	2904	1325

Table 8.14. Catch option table.

F_{mult}	Catch20	Land20	Dis20	FCatch20	FLand20	FDis20	SSB21	SSB.change20	TAC.change19	Ad-vice.change20	basis
0.0000000	0.0000	0	0.00000	0.00000	NA	NA	4447	167.20479	-100.00000	NA	f2019*0
0.1000000	285.0897	265	20.08965	0.08654	0.08654	0	4144	148.96811	-82.26909	Inf	f2019*0.1
0.2000000	549.7389	511	38.73891	0.17308	0.17308	0	3864	132.18769	-65.84147	Inf	f2019*0.2
0.3000000	795.0236	739	56.02359	0.25963	0.25963	0	3607	116.74187	-50.61118	Inf	f2019*0.3
0.4000000	1023.0953	951	72.09531	0.34617	0.34617	0	3371	102.51946	-36.48128	Inf	f2019*0.4
0.5000000	1233.9541	1147	86.95407	0.43271	0.43271	0	3153	89.41885	-23.36308	Inf	f2019*0.5
0.6000000	1429.7515	1329	100.75149	0.51925	0.51925	0	2952	77.34716	-11.17539	Inf	f2019*0.6
0.7000000	1612.6392	1499	113.63919	0.60579	0.60579	0	2767	66.21943	0.15614	Inf	f2019*0.7
0.8000000	1782.6172	1657	125.61717	0.69233	0.69233	0	2596	55.95797	10.69959	Inf	f2019*0.8
0.9000000	1940.7612	1804	136.76124	0.77888	0.77888	0	2438	46.49170	20.51736	Inf	f2019*0.9
1.0000000	2088.1472	1941	147.14721	0.86542	0.86542	0	2293	37.75553	29.66664	Inf	f2019*1
1.1000000	2224.7751	2068	156.77508	0.95196	0.95196	0	2159	29.68990	38.19985	Inf	f2019*1.1
1.2000000	2352.7965	2187	165.79647	1.03850	1.03850	0	2035	22.24028	46.16508	Inf	f2019*1.2
1.3000000	2473.2872	2299	174.28719	1.12504	1.12504	0	1920	15.35669	53.60647	Inf	f2019*1.3
1.4000000	2585.1714	2403	182.17143	1.21159	1.21159	0	1814	8.99336	60.56449	Inf	f2019*1.4
1.5000000	2689.5250	2500	189.52500	1.29813	1.29813	0	1716	3.10833	67.07633	Inf	f2019*1.5
1.6000000	2788.4995	2592	196.49952	1.38467	1.38467	0	1625	-2.33684	73.17614	Inf	f2019*1.6
1.7000000	2879.9434	2677	202.94337	1.47121	1.47121	0	1542	-7.37742	78.89528	Inf	f2019*1.7
1.8000000	2967.0840	2758	209.08398	1.55775	1.55775	0	1464	-12.04576	84.26257	Inf	f2019*1.8
1.9000000	3047.7697	2833	214.76973	1.64429	1.64429	0	1392	-16.37152	89.30452	Inf	f2019*1.9
2.0000000	3124.1522	2904	220.15224	1.73084	1.73084	0	1325	-20.38193	94.04550	Inf	f2019*2
0.0653326	189.3426	176	13.34256	0.05654	0.05654	0	4246	155.11809	-88.26193	Inf	msyap-
0.4044288	1032.7776	960	72.77760	0.35000	0.35000	0	3361	101.91623	-35.87952	Inf	msy
0.1026671	292.6203	272	20.62032	0.08885	0.08885	0	4136	148.50133	-81.81366	Inf	msy_up-
0.0429388	124.7940	116	8.79396	0.03716	0.03716	0	4314	159.18808	-92.22027	Inf	msy_lower
0.7696627	1732.0541	1610	122.05410	0.66608	0.66608	0	2646	58.98331	7.58100	Inf	TACstable
0.9341958	1991.3243	1851	140.32431	0.80847	0.80847	0	2387	43.42560	23.71815	Inf	TACplus15
0.6224737	1471.7081	1368	103.70808	0.53870	0.53870	0	2909	74.76644	-8.55615	Inf	TACmi-
0.6701963	1559.9245	1450	109.92450	0.58000	0.58000	0	2820	69.44191	-3.13567	Inf	pa
0.9244087	1977.3388	1838	139.33878	0.80000	0.80000	0	2402	44.29432	22.81017	Inf	lim
1.0000022	2088.1472	1941	147.14721	0.86542	0.86542	0	2293	37.75553	29.66664	Inf	fInt
1.0000022	2088.1472	1941	147.14721	0.86542	0.86542	0	2293	37.75553	29.66664	Inf	Btrigger
1.0000022	2088.1472	1941	147.14721	0.86542	0.86542	0	2293	37.75553	29.66664	Inf	Bli

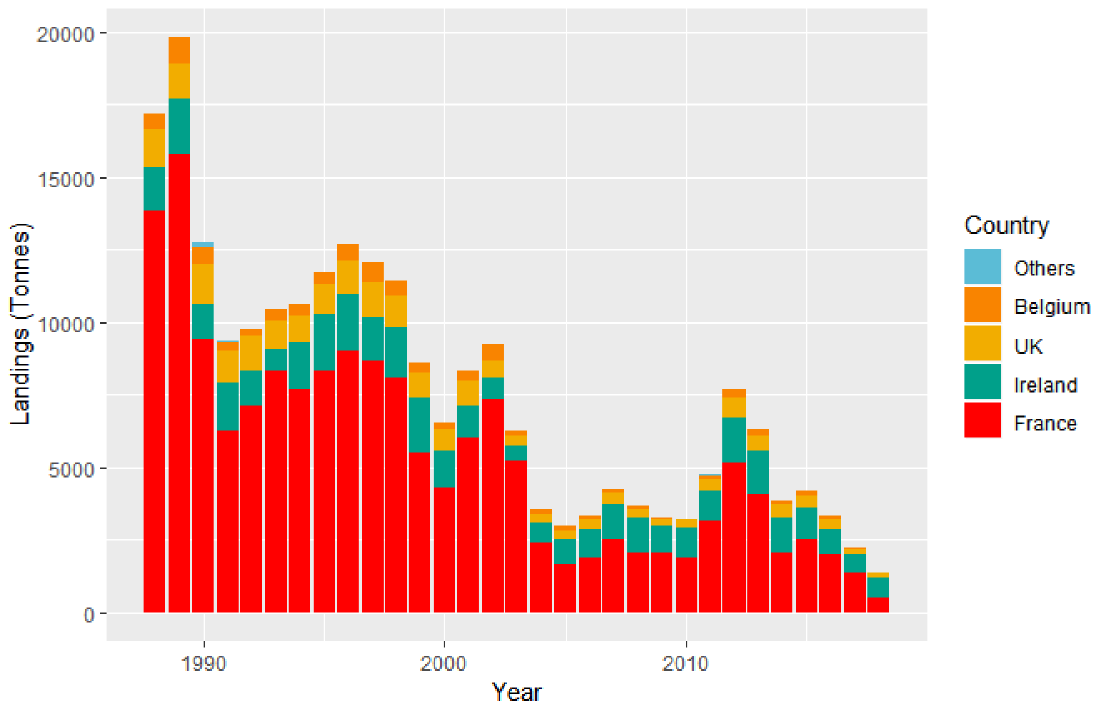


Figure 8.1. Cod in divisions 7e–k. Historical landings (in Tonnes) by country.

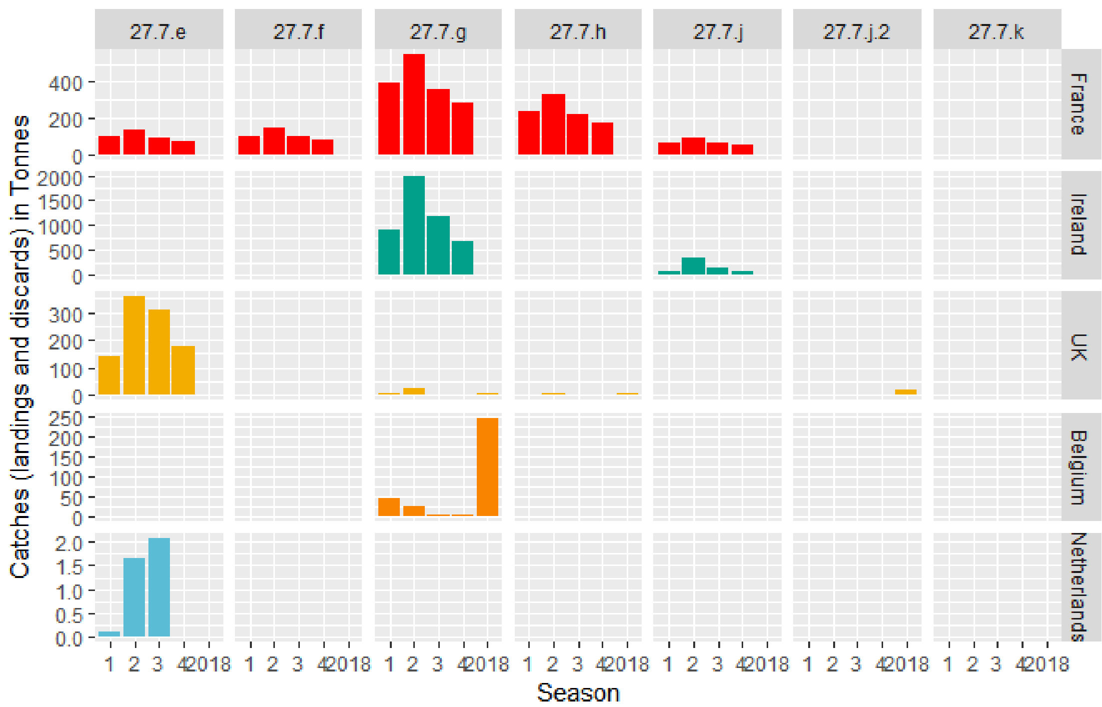


Figure 8.2. Cod in divisions 7e–k. Catches volume in Tonnes (i.e. landings plus discards) by area, season and country in 2018.

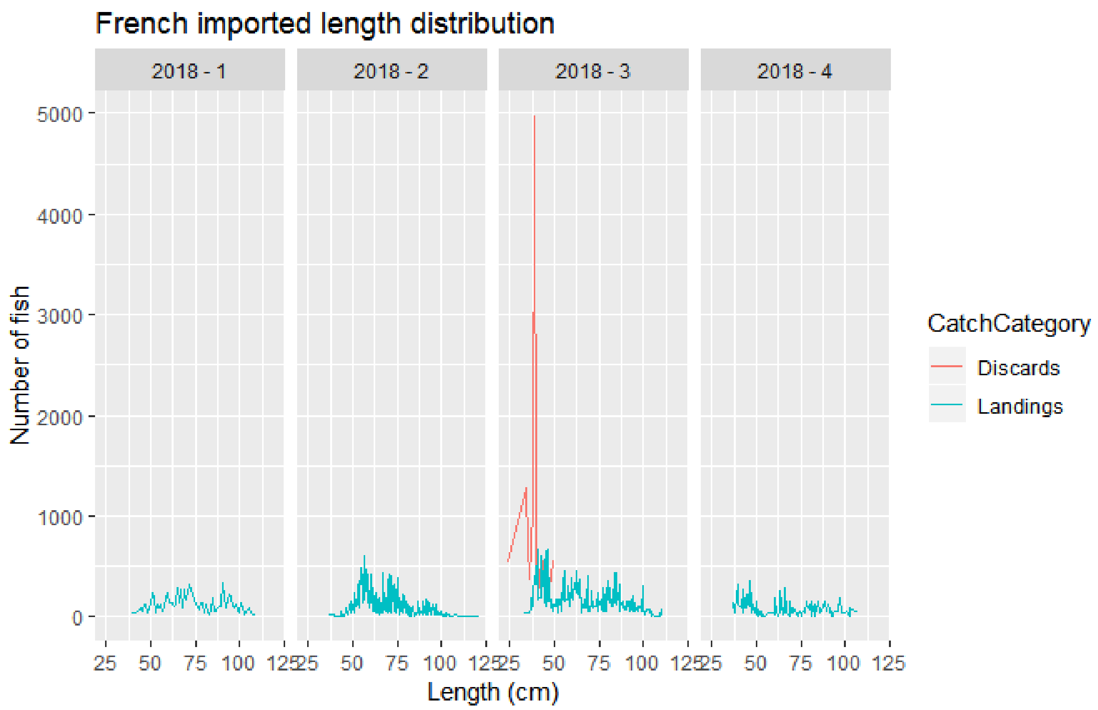


Figure 8.3.a. Cod in divisions 7e–k. Imported French 2018 landings and discards length distribution.

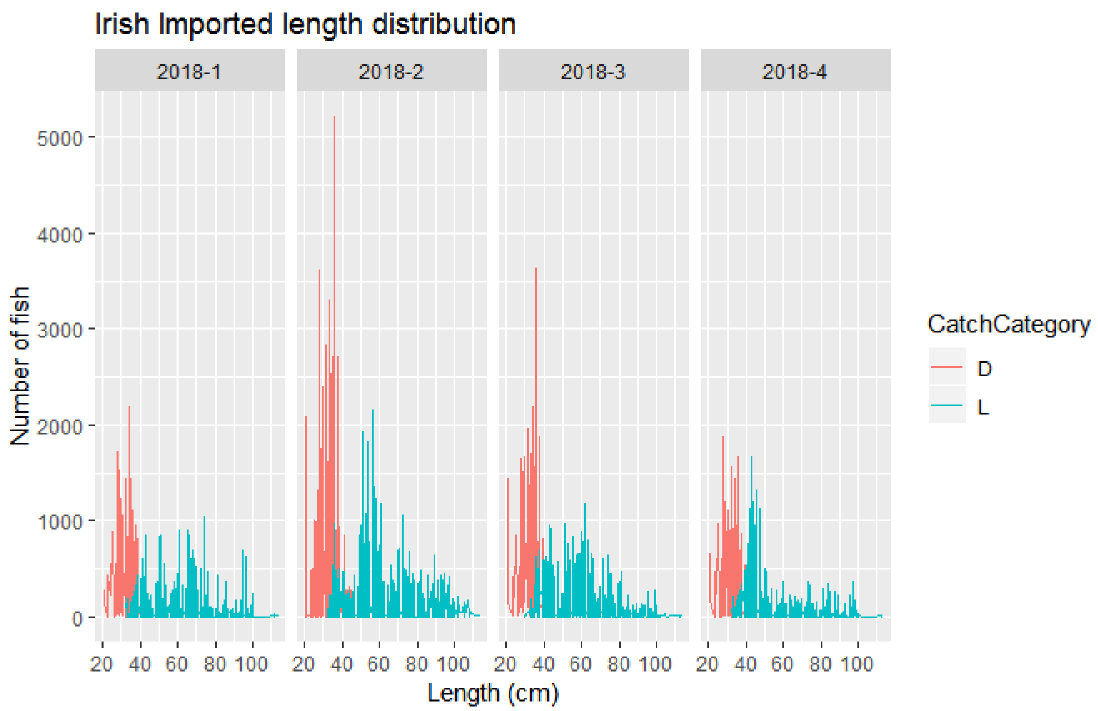


Figure 8.3.b. Cod in divisions 7e–k. Imported Irish 2018 landings and discards length distribution.

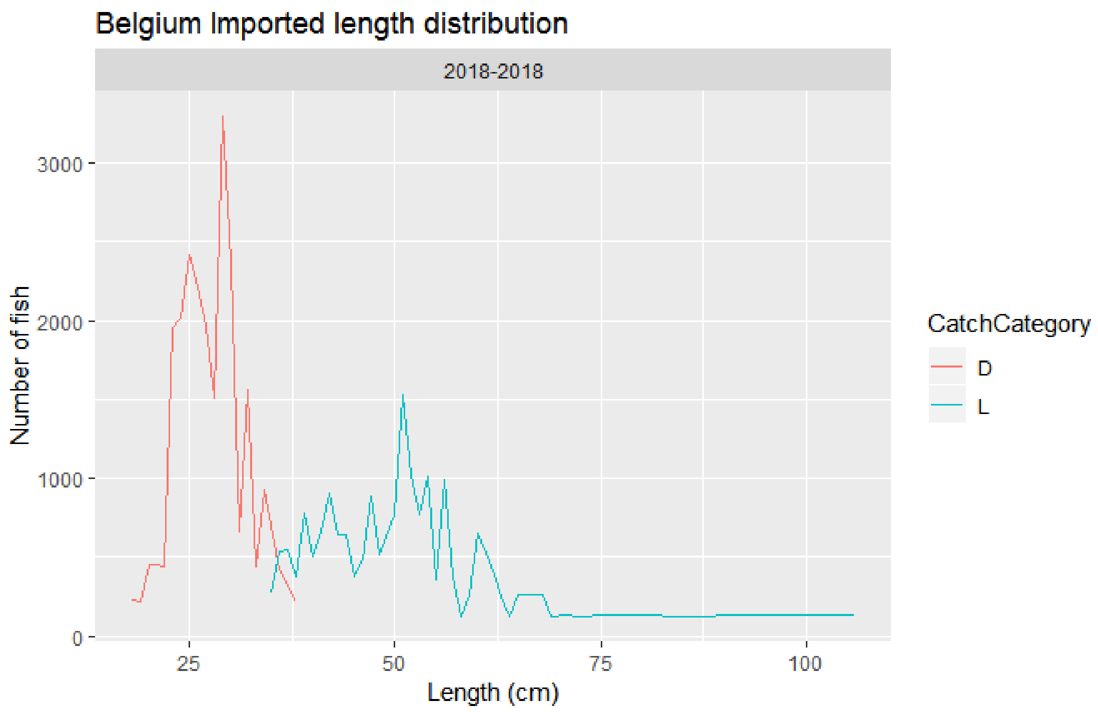


Figure 8.3.c. Cod in divisions 7e–k. Imported Belgium 2018 landings and discards length distribution.

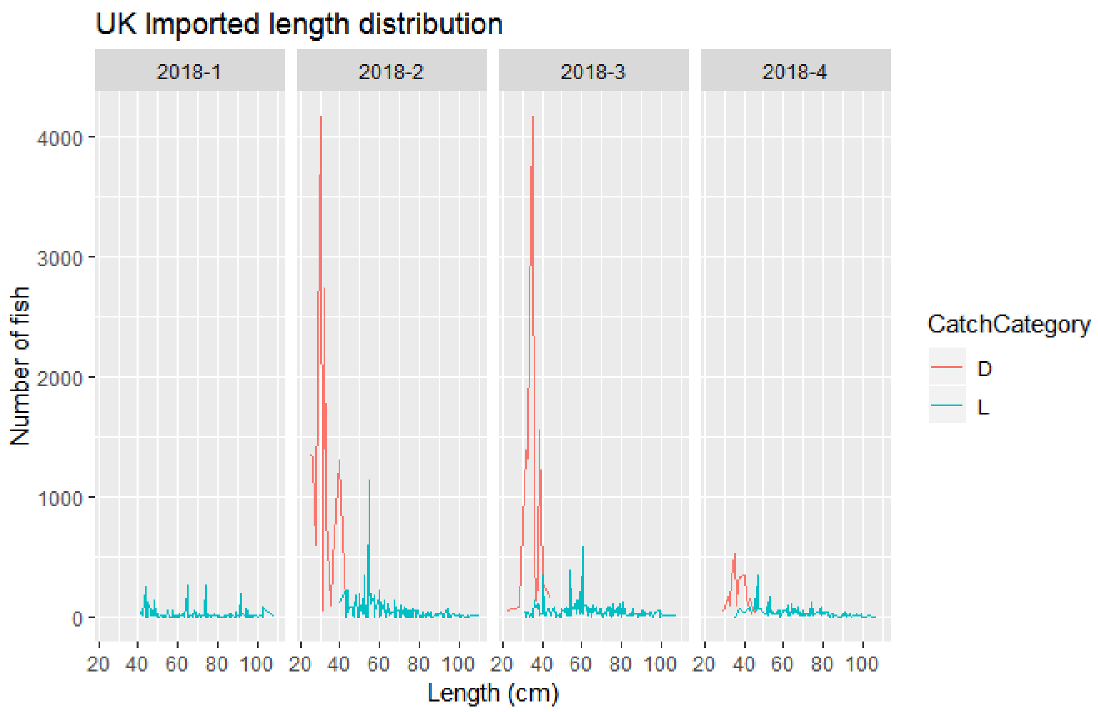


Figure 8.3.d. Cod in divisions 7e–k. Raised United Kingdom 2018 landings length distribution - Sampled strata only.

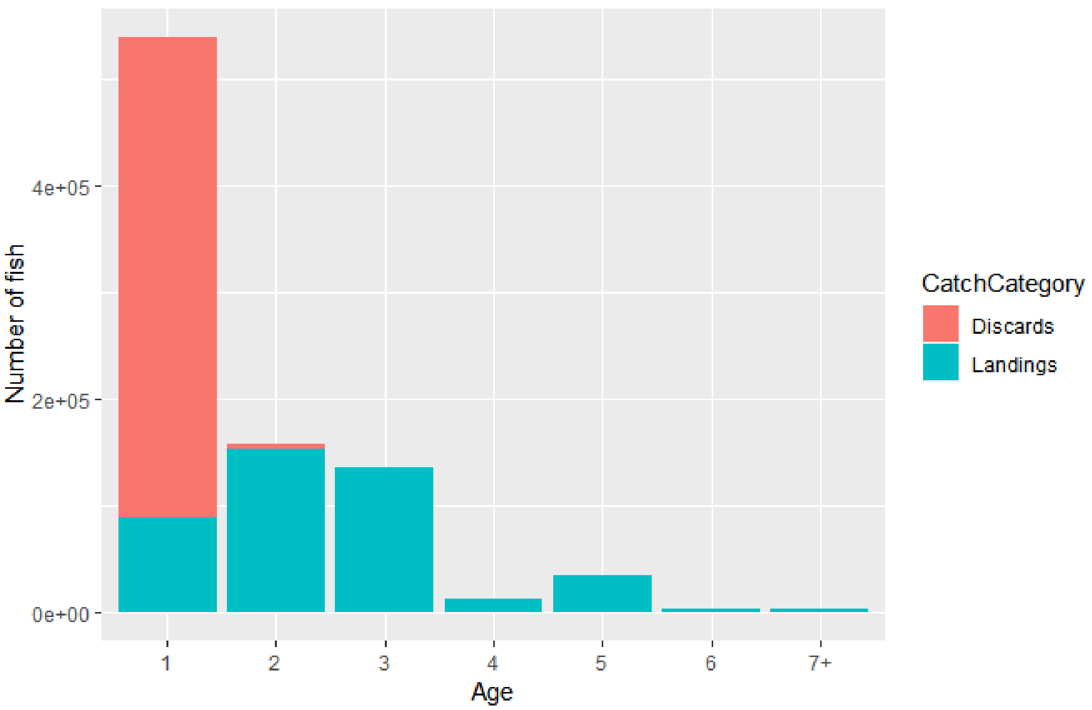


Figure 8.4. Cod in divisions 7e–k. Raised age distribution of the catches (landings and discards) in 2018.

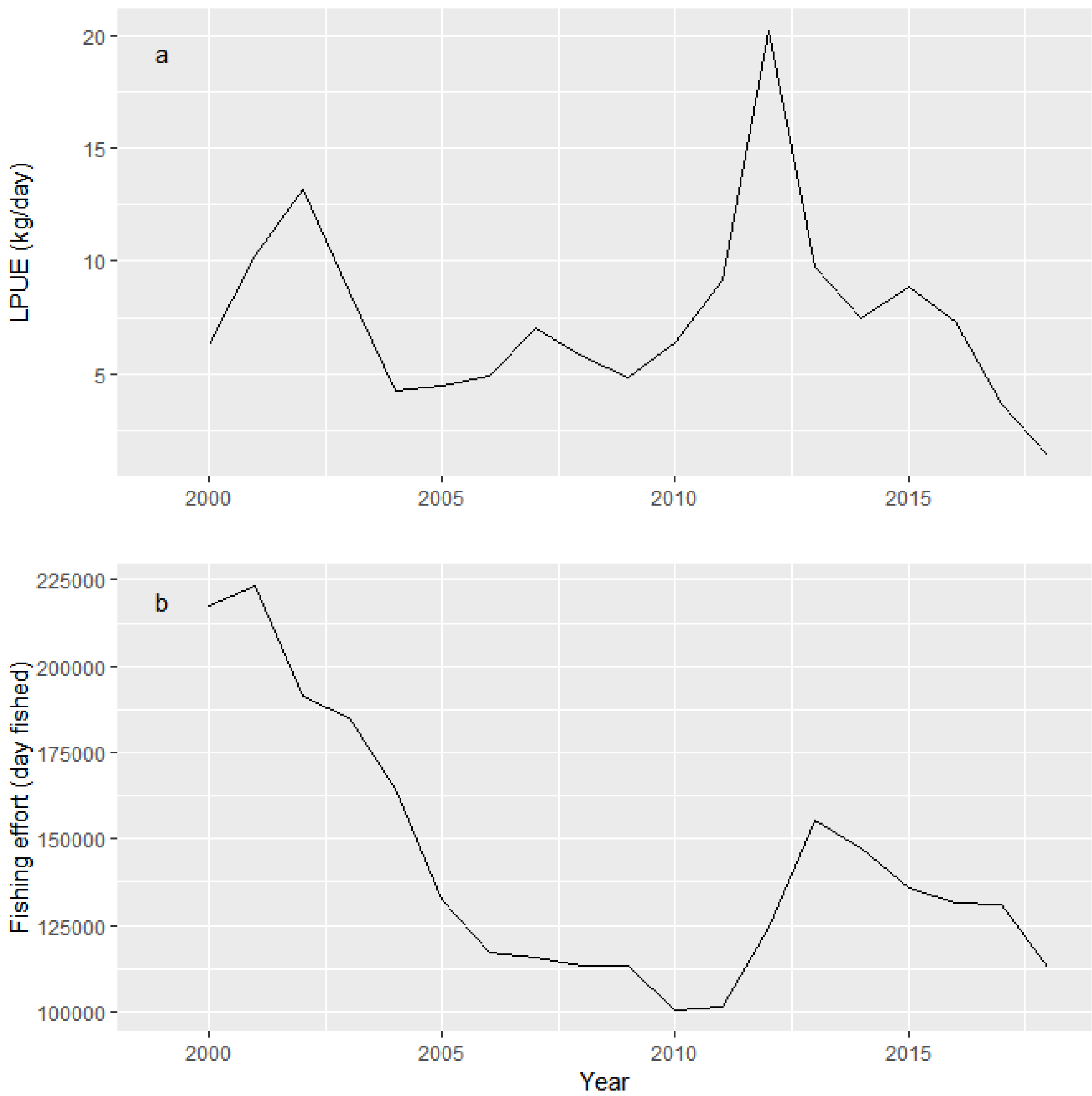


Figure 8.5a. Cod in divisions 7e–k. Time-series of (a) lpue and (b) fishing effort for the French fleets. Units: Lpue in kg/day and fishing effort in days fished.

Figure 8.5b. Cod in divisions 7e–k. Time-series of (a) Standardized lpue and (b) fishing effort for the Irish fleets. Units: lpue in kg/day fished and Effort in 000s hours fished.

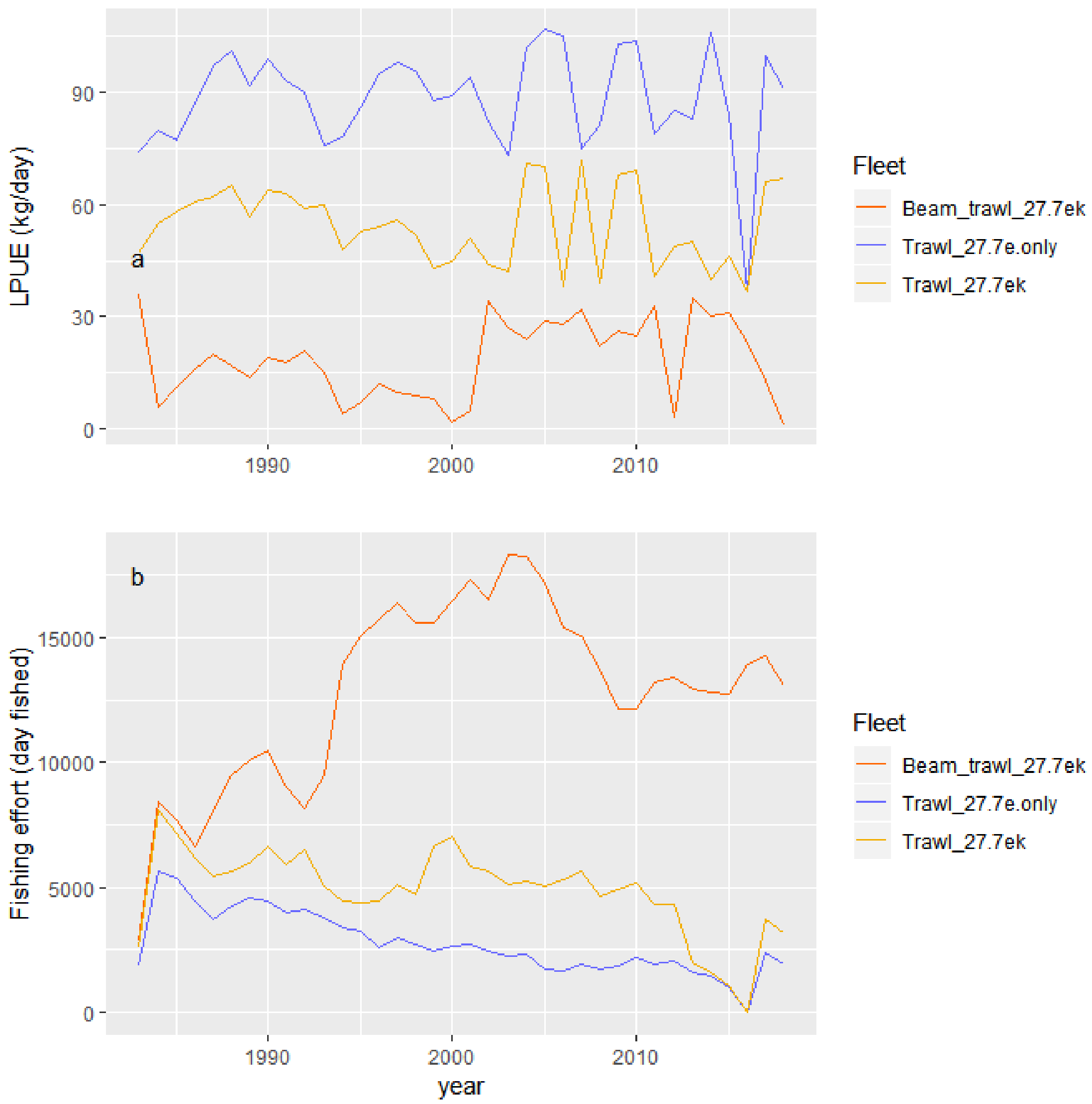


Figure 8.5c. Cod in divisions 7e–k. Time-series of (a) lpue and (b) fishing effort for the UK fleets. Units: lpue in kg/day and fishing effort in days fished.

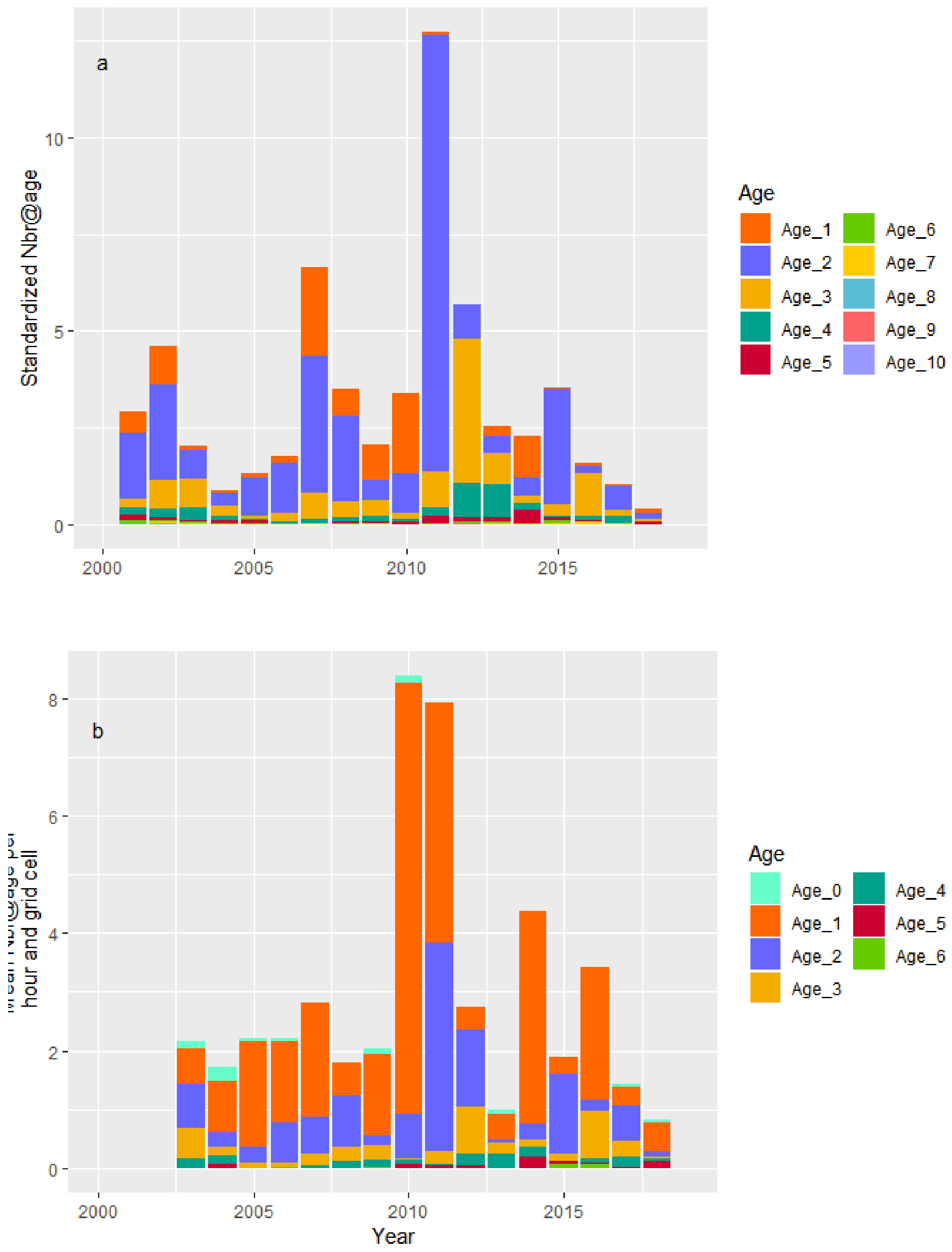


Figure 8.6. Cod in divisions 7e–k. Tuning indices used in the assessment. Commercial tuning fleet corresponds to French OTDEF Q2+3+4 where number-at-age are plotted. The survey index is a combined index based on both French IR-GFS and FR-Evhoe Q4 data where mean number-at-age per hour and grid cell are plotted.

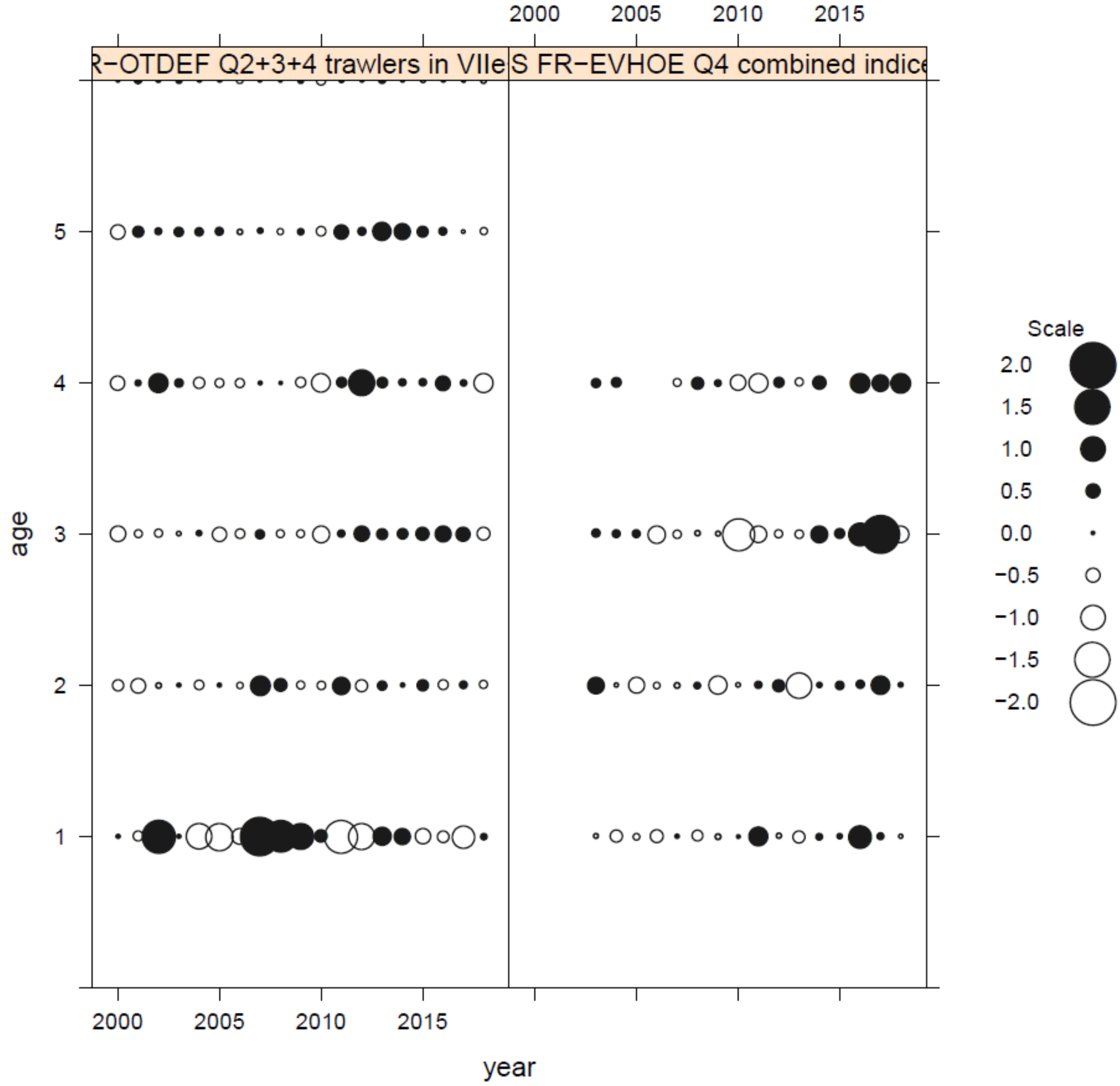


Figure 8.7. Cod in divisions 7e–k. Final assessment. Residuals (Left panel: French OTDEF demersal tuning fleet; Right Panel: Combined survey indices).

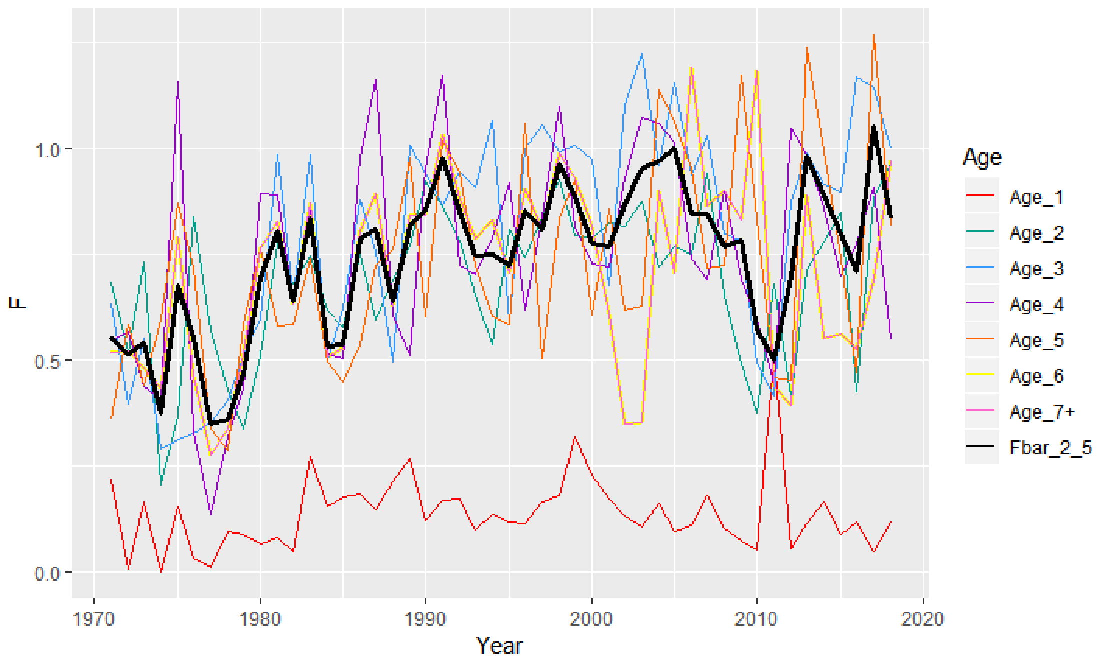


Figure 8.8. Cod in divisions 7e–k. Final XSA outputs. Fishing mortality. F_{bar}=Thick black line. Age 0 are not included in the assessment.

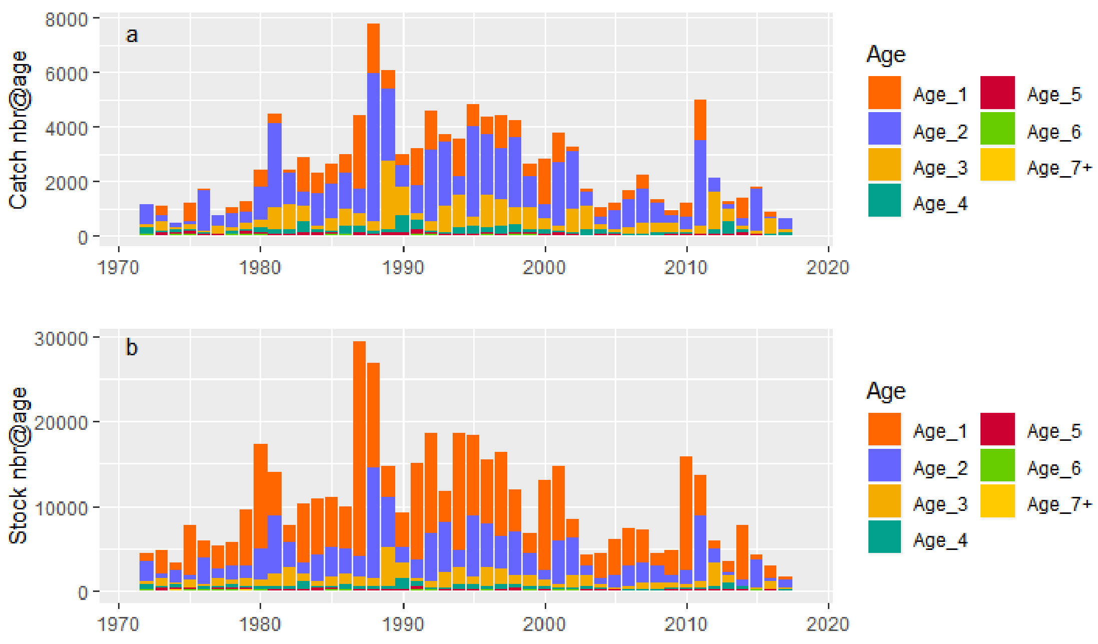


Figure 8.9. Cod in divisions 7e–k. Final XSA outputs. (a) Catch and (b) stock number-at-age. Age 0 are not included in the assessment.

Figure 8.10. Cod in divisions 7e–k. Final XSA outputs. Summary plots. Recruitment, F, and SSB values.

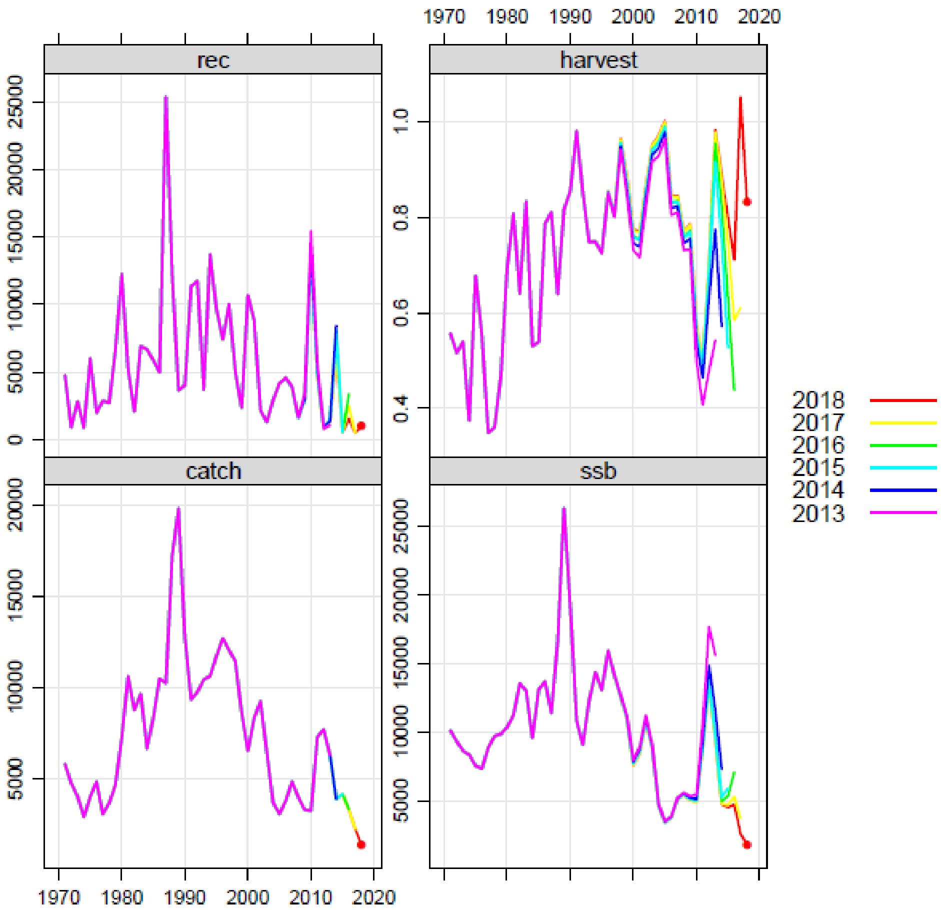
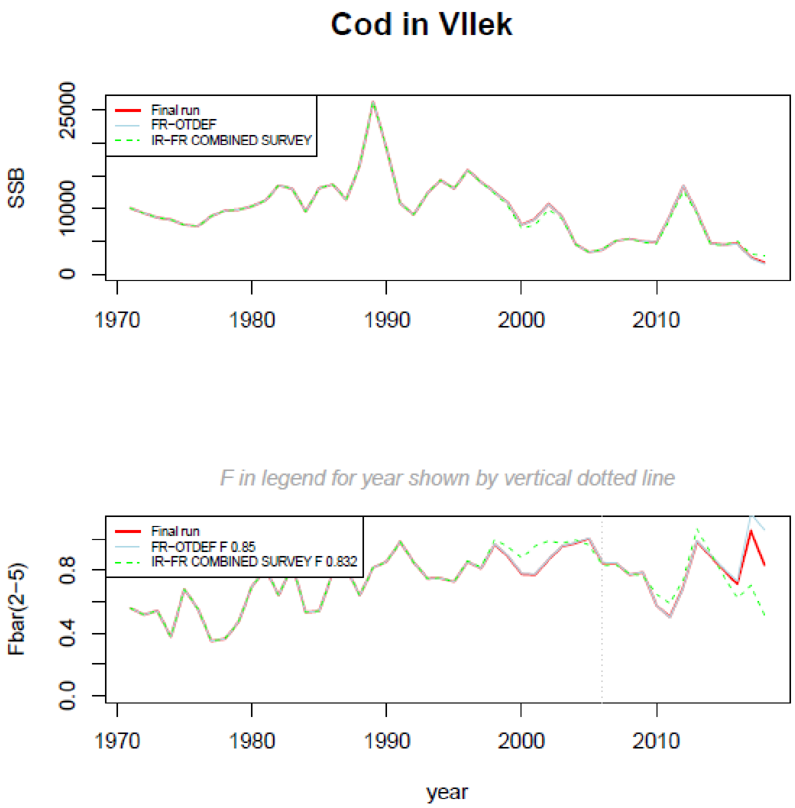


Figure 8.11a. Cod in divisions 7e–k. Final XSA. Retrospective plots.



8.11b. Cod in divisions 7e–k. Final XSA. Comparison between runs (runs with the two tuning indices, with only the survey index and with only the commercial tuning index).

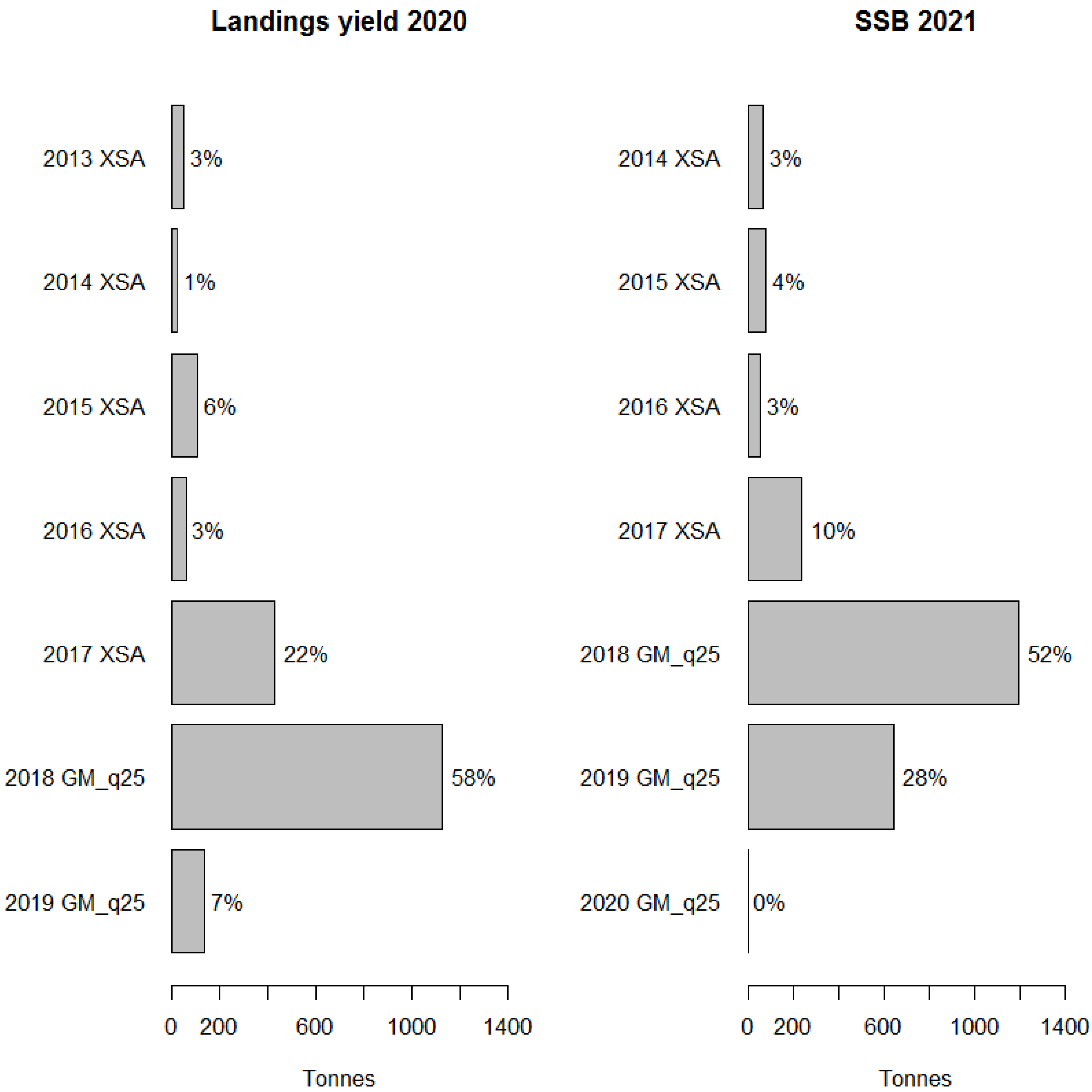


Figure 8.12. Cod in divisions 7e–k. Forecast yield in 2020 and SSB in 2021.

7 Haddock (*Melanogrammus aeglefinus*) in Division 6.b (Rockall)

Type of assessment in 2019: Update assessment taking into account the recommendations of benchmark 2019

The current assessment is an update of last year's assessment assessment taking into account the recommendations of benchmark 2019. The same approach has been used in the annual assessment since 2005 when on the recommendation of RGNSDS, adopted a new assessment approach, which allows modelling of the total catch (including discards) when no on-board observations were available (for details see the Stock Annex).

ICES advice applicable to 2019

ICES advice applicable to 2019 can be found here:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/had-rock.pdf

7.1 General

Stock description and management units

The haddock stock at Rockall is an entirely separate stock from that inhabiting the continental shelf of the British Isles. Since 2004, the EU TAC for haddock in 6.b has been included with divisions 12 and 14. For details of the earlier management units see the Stock Annex.

Management applicable to 2018 and 2019

The EU TAC for 6.b, 12 and 14was set at 5163 t in 2018 (a 10% increasing compared to TAC for 2017).

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	Union and international waters of 6b, 12 and 14 (HAD/6B1214)
Belgium	12		
Germany	40		
France	546		
Ireland	429		
United Kingdom	4 136		
Union	5 163		
TAC	5 163		Analytical TAC Article 7(2) of this Regulation applies

The EU TAC for 6.b, 12 and 14 was set at 10 469 t in 2019 (a 202 % increasing compared to TAC for 2018).

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	Union and international waters of 6b, 12 and 14 (HAD/6B1214)
Belgium	23		
Germany	28		
France	1 155		
Ireland	824		
United Kingdom	8 439		
Union	10 469		
TAC	10 469		Analytical TAC Article 7(2) of this Regulation applies

The ICES advice, agreed TAC for EU waters, and WG estimates of landings during 2002–2018 is summarised below. All values are in thousand tonnes.

YEAR	Predicted catch corresp. to advice	Predicted landings corresp. to advice#	BASIS	AGREED TAC [a]	WG LANDINGS
2002	<1300		Reduce F below 0.2		3.336
2003	-		Lowest possible F		6.242
2004	-		Lowest possible F [b]	0.702	6.445
2005	-		Lowest possible F [b]	0.702	5.179
2006	-		Lowest possible F [b]	0.597	2.765
2007	<7100		Reduce F below F_{PA} [b]	4.615	3.349
2008	<10 640		Keep F below F_{PA} [b]	6.916	4.221
2009		<4300	No long-term gains in increas-	5.879	3.445
2010		<3300	Little gain on the long-term	4.997	3.405
2011		<2700	Reduction in F is needed to	3.748	1.903
2012		<3300	MSY approach	3.300	0.710
2013	0	0	No directed fisheries, mini-	0.990	0.826
2014	<1620	<0980	MSY approch	1.210	1.675
2015	<4310	<2930	MSY approch	2.580	2.445
2016	<3932	<3225	MSY approach	3.225	2.585
2017	≤4690	≤4130	MSY approach	4.690	4.610
2018	≤5163		MSY approach	5.163	3.868
2019	≤10 469		MSY approach	10.469	

[a] Before 2014 TAC was set for Divisions 6.a and 6.b (plus 5b1, 12 and 14) combined with restrictions on quantity that can be taken in 5.b and 6.a. The quantity shown here is the total area TAC minus the maximum amount which is allowed to be taken from 5.b and 6.a. In 2004, the EU TAC for Division 6 was split and the 6.b TAC for haddock was included with XII and XIV. This value is the TAC for 6.b, 12 and 14.

[b] Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries, protecting stocks outside safe biological limits.

 # Wanted catch.

The minimum landing size of haddock taken by EU vessels at Rockall is 30 cm. There is no minimum landing size for haddock taken by non-EU vessels in international waters.

In order to protect the pre-recruit stock, the International Waters component of the statistical rectangle 42D5 has been closed for fishing since 2001 and its EU component since 2002 (see the

Stock Annex). The protected area (the whole rectangle) is referred to as Rockall Haddock Box. In order to protect cold-water corals, three further areas (North West Rockall, Logachev Mounds and West Rockall Mounds) were closed since January 2007 (see the Stock Annex). A new area to protect cold-water corals (Empress of British Banks) was established by the NEAFC in 2007 and 2012.

Since 2009 in NEAFC regulatory area, including international waters of Rockall, was established a ban on discards.

Fishery in 2018

Russian fishery in 2018

Directed fishing of haddock in Rockall by Russian vessels was not conducted in 2018.

Scottish fishery in 2018

Total Scottish haddock landings in 6.b in 2018 were estimated to be 3418 t (Table 4.3.1). Other important target species included anglerfish (*Lophius* spp.), ling, saithe and megrim. Scottish effort presented in Table 4.3.2 and 4.3.3.

Irish fishery in 2018

Irish effort in Rockall declined in 2009–2015 and increased again in 2016-2018 (Table 4.3.2 and 4.3.3).

Landings totalling 433 t haddock were reported from Irish otter trawlers in 2018 (decreased from 500 t in 2017; Table 4.3.1). Irish vessels used single otter trawls with a mesh size ranging from 100 to 120 mm together with a square mesh panel.

Norwegian fishery in 2018

In 2014–2016 Norwegian landings of haddock at Rockall 41–66 t and 26 t in 2017 were reported. Total Norwegian landings of 16 t of haddock at Rockall were reported in 2018. Norwegian demersal fleet fishing on the Rockall Bank consisted mainly of longliners targeting mainly ling and tusk.

7.2 Data

Landings

Nominal landings as reported to ICES are given in Table 4.3.1, along with Working Group estimates of total estimated landings. Revisions to official catch statistics for previous years are also shown in Table 4.3.1.

Anecdotal evidence suggests that misreporting of haddock from Rockall has occurred historically (which may have led to discrepancies in assessment), but a quantitative estimation of the degree of misreporting is not possible.

International age composition and mean weight-at-age in the landings were compiled according to the methods described in the Stock Annex.

BMS landings

In 2016 BMS (Below Minimum Size) landings which are subject EU landings obligation were only 0.4 t. In the assessment BMS landings were include in total landings. In 2017–2018 BMS landings were not reflected in the catch statistic.

Discards

Historically, the discard rate was as high as 12–87% by numbers according to the results of discards trips (see the Stock Annex). The methods used to reconstruct the historical time-series of discards is described in the Stock Annex.

The discards for 2010–2016 in the 2017 assessment were estimated from sampling aboard Scottish and Irish vessels collected in 2010–2016 (Table 4.3.4–4.3.6). On Russian vessels, the whole catch of haddock is kept on board and therefore, total catch is equivalent to landings and there is no need to calculate discards. In 2015, the discard rate was estimate at 38% and 52% by numbers on Scottish and Irish observer trips. In 2016, the level of discards has not changed significantly and was estimate at 11% and 56% by numbers on Scottish and Irish observer trips.

In 2017, the discard rate was also high and was estimated at 17% by numbers on Scottish and 39% on Irish observer trips. In 2018, discard rate was estimated at 32% by numbers on Scottish and 32% on Irish fleet (Table 4.3.4–4.3.7).

Biological

There was no change in biological parameters compared to the 2018 assessment (see the Stock Annex).

Surveys

There is only one abundance index available for this stock the Scottish Rock-IBTS-Q3 survey (Figure 4.3.1–3). The survey is coordinated by IBTS and described further in the IBTS reports and Stock Annex.

The area which was covered by the survey was not stable and moreover the survey coverage has been extended in recent years (Figure 4.3.1). The 2019 indices were obtained from the standard survey area as last year's. During the benchmark 2019, the number of different runs were conducted to explore the sensitivity of the assessment results and diagnostics to different survey indices. The correction to the survey data has little impact on the results of the stock assessment (Figure 3). In terms of diagnostics (Figure 4 and 5), the fit to the 2015 survey data at age 5 shows significant improvement in Run S1 compared to the baseline: in the baseline model run there is a large positive residual which is no longer apparent. The benchmark agreed that based on the model diagnostics, the 'standard' survey index with corrected ALK for ages 4–5 in 2015 should continue to be used in the assessment (Table 4.3.8).

Additional abundance and biomass estimates are calculated by the swept area method using three types of stratification of the survey area:

1. by geographic strata of 15' latitude wide and 15' longitude long (Figure 4.3.4);
2. by five bathymetric strata depending on depth: <150 m, 150–175 m, 176–200 m, 201–225 m and >225 m (Figure 4.3.5);
3. the whole survey area is taken for one strata without substratification (Figure 4.3.6).

All three methods show similar patterns (Figures 4.3.4–6).

In 2011, the gear was changed on the Scottish survey and an analysis showed that there was no detectable difference between the older and new survey on haddock indices in neighbouring areas (IBTSWG 2012).

The Russian trawl acoustic survey conducted in 2005 provided information on the size and biomass of the haddock stock both in the EU zone and in international waters. The acoustic survey yielded a biomass estimate of 60 000 t and an abundance estimate of 225.9 million (for the details see the Stock Annex). No such survey has been conducted in subsequent years.

Commercial Effort, Lpue and Cpue

Commercial effort series are available for Scottish trawlers, light trawlers, seiners, Irish otter trawlers and Russian trawlers fishing in Division 6.b. The effort data for these fleets are shown in Figure 4.3.7 and Table 4.3.2–4.3.3. Effort data in hours from the Scottish fleets is discontinued after 2008 and provided in KWDays after 2003 (Table 4.3.3. Effort by the Scottish and Irish fleets has been relatively stable at a low level in the last three years.

Commercial Lpue for the Irish and Scottish fleets and cpue for the Russian fleet are shown in Figures 4.3.8–4.3.9. The WG decided that the commercial cpue and lpue data, which do not include discards and have not been corrected for changes in fishing power despite known changes in vessel size, engine power, fish-finding technology and net design, were unsuitable for catch-at-age tuning.

7.3 Description of stock assessment approach

Model used:

The assessment is based on catch-at-age data and one survey index (Scottish Rock-IBTS-Q3) and conducted using the XSA method.

Software used:

In 2005–2018 same software was used as in the last year's assessment (XSA from Lowestoft suite of VPA programs). In 2019 taking into account the recommendations of benchmark 2019 FLXSA was used

Model Options chosen:

Settings for the final XSA assessment did not change compared to the previous assessment (see the Stock Annex) and were as follows:

Assessment model: XSA

Tuning indices: one survey index (Scottish Rock-IBTS-Q3)

Time-series weights: none

Catchability dependent for ages <4

Regression type: C

Minimum number of points used for regression: 10

Q plateau: 5

Shrinkage stand. error: 1.0

Shrinkage age, year: 4 years, 3 ages

Minimum stand. error: 0.3

Plus group: 7+

F_{BAR}: 2–5

Input data types and characteristics:

There were no changes in data types and characteristics compared to the previous assessment:

Year range: 1991–2018

Age range: 1–7+

For tuning data the following year and age ranges were used:

Year range: 1991–2018

Age range: 1–6

Data screening

Figures 4.3.10 and 4.3.11 as well as Tables 4.3.9 show landings, discards and total catch by number and weight. Landings, discards and total catch-at-age by number are shown in Tables 4.3.10–4.3.12.

In 2016, BMS (Below Minimum Size) landings which are subject EU landings obligation were only 0.4 t. In assessment BMS landings were include in total landings. Because BMS landings were low, this did not lead to a decrease in the average weight of landings.

For 2012 onwards, the catch-at-age data were estimated in InterCatch. The main fleets (UK(Sco) OTB_DEF_>=120 and Irish OTB_DEF_100–119) are typically sampled for both landings and discards. Discard rate allocation to other unsampled fleets consisted of:

- Manually matching annual discards to available quarterly landings by country/fleet (where necessary).
- Using a weighted average discard rate for all unsampled fleets (weighted by CATON) with the exception of the Norwegian longline fleet and the Russian fleet for which discards are both assumed to be zero..

Landings age compositions were allocated to unsampled fleets using a weighted average of all sampled fleets (excluding the Russian fleet which is likely to be less applicable given they do not discard). The weighting algorithm used is 'Mean weight weighted by numbers-at-age or length'. Discards age compositions were allocated in a similar manner.

In 2019, a benchmark assessment was conducted on this stock. During the benchmark meeting, the discards data for 2010 was also revised. Before 2019, the discards for 2010 were calculated on average discards proportion in total catch but that proportion was applied on the landings. However it is not correct because discards proportion is relative the total catch. That method not correct reflected discards because not take into account that the haddock at age 1 and age 2 mostly discarded and not reflect in landings. As result, landings in 2010 were same as in 2009 but discard in 2010 decline to much and the discards proportion in 2010 declined compare to previous years. In benchmarked assessment 2019, the discards for 2010 were calculated compared to 2009 with same proportion-at-age as proportion between landings in 2009 and 2010.

The resulting age compositions and mean weights-at-age show only minor differences to those compiled at previous assessment WG meetings (Figure 4.3.12).

Mean weights-at-age in total catch, landings, discards and stock are shown in Tables 4.3.13–4.3.16 and Figures 4.3.13–4.3.16.

Historically, stock weights-at-age have been assumed to be equal to the raw catch weights. In recent years, the number of sampled trips for both landings and discards has been very low. This lead to higher variability in the mean weight-at-age estimates. For this reason, recent years the smoothed catch weights-at-age was applied by the WGCSE.

To mitigate against variability in the mean weight-at-age since 2019 mean weights in the stock are assumed as five-year means taking into account the recommendations of benchmark 2019.

The mean weights-at-age in the total catch (including discards) and in the stock are shown in Figure 4.3.14.

There were small landings of haddock aged 1 in 2010–2012 and very few aged 2 to 6 compared to historical values. Haddock aged 7 dominated landings. However, in 2013 landings and discards of haddock aged 1 significant increased. Discarded fish are, primarily, haddock aged 1–2 (see Tables 4.3.1 and 4.3.2 in the Stock Annex). Figures of log catches by age show that these values are much less variable when discards are included (Figures 4.3.15–4.3.20). Data on catches, landings and discards-at-age are given in Tables 4.3.10–4.3.13.

The Scottish Rock-IBTS-Q3 was the only survey index available to the working group. Plots of log cpue by age, year and year class are shown in Figures 4.3.21–4.3.24.

Comparative scatter plots of log index at-age are shown in Figure 4.3.24. The survey shows relatively good internal consistency in tracking year-class strength through time.

Final update assessment

Final run

Settings for the final XSA assessment are shown in Section C of the Stock Annex. There have been no changes to assessment settings since 2013.

The diagnostics file of the final XSA run is given in Table 4.3.17 and Figure 4.3.25. Adjusted survey cpue against XSA population estimates are shown in Figures 4.3.26, 4.3.26. The analysis of residuals and retrospective analysis (Figures 4.3.25, 4.3.28) show that applying the chosen parameters for XSA (as in the Stock Annex) improves the residual patterns compared to other exploratory settings. However, the same trends are still apparent in the log catchability residuals. The results of the retrospective analysis conducted by the Working Group in 2002, 2003 and 2005 indicated that using shrinkage values of more than 0.5 improved the retrospective curves and showed convergence. In this year's analysis, only 28 years data were available for the retrospective analysis, but a good year-to-year consistency was obtained. The final XSA results are given in Tables 4.3.18–4.3.20.

Summary plots from the final XSA assessment are shown in Figure 4.3.29.

Comparison with previous assessments

The estimates from this year's assessment are reasonably consistent with the assessments carried out in previous years (Figure 4.3.30). In 2019, a benchmark assessment was conducted on this stock. The new assessment resulted in the SSB assessed for 2017 to be revised upwards by 10% and recruitment was increased by 25% compared to last year's assessment. In addition fishing mortality for 2010 been revised upwards in this year's assessment. It is result of revision of discard data for 2010. As result, total catch was estimated close to 2009 same as landings. The decline of SSB in 2010 with the same the catch gave increase F.

State of the stock

The stock summary relative to reference points is plotted in Figure 4.3.29.

The spawning–stock biomass (SSB) has increased from the lowest observed in 2014 and is estimated to be above MSY $B_{trigger}$ in 2016. Fishing mortality (F) has declined over time but has been above F_{MSY} in 2018. Recruitment during 2008–2012 is estimated to be extremely weak. Recruitment has improved in 2013–2014 and decreased again in 2015–2016 and is still lower than the values estimated at the beginning of the time-series. The 2017 year class estimated by results of survey was on high level. In 2018, recruitment has decreased again.

Statistical catch-at-age analysis (SCAA)

For Statistical catch-at-age analysis, StatCam model was used (J. Brodziak, 2005). VPA and SCAA used identical survey and catch data. For StatCam runs two scenarios were used: First scenario, non-parametric model; second, parametric model.

The StatCam model shows good conformity between observed and predicted survey index and catch biomass (Figure 4.3.31).

StatCam summary plots are shown in Figure 4.3.32.

Both Statistical catch-at-age analysis and VPA results show a similar tendency for the SSB dynamics. However, the assessment of the stock size depends on the choice of the model.

Results of stock assessment by SAM model (state–space assessment model)

For both runs of SAM and the VPA was used same input data. The summary plots for SAM assessment are shown in Figure 4.3.33.

The SAM assessment and VPA results show a similar tendency in state stock. However, recent years the SSB assessed by the SAM increased slowly compare to the VPA assessment.

The comparison of stock assessment results produced by different models

All that models results show a similar tendency for the SSB dynamics. However, there are variation in the interannual dynamics of the stock assessed by different models.

The SSB and TSB plots from the XSA, SCAA and SAM assessment are compared in Figure 4.3.34.

7.4 Short-term projections

Estimating year-class abundance

In 2007–2011, the abundance of age 0 individuals in the survey index were estimated to be extremely weak. In 2012, the observed large number 0-group. Year classes 2013 and 2014 were below average but above levels 2008–2012 (Figure 4.3.35). No significant relationship between spawning biomass and the recruitment was found. Poor year classes may be related to environmental factors including rising seawater temperatures in Rockall Bank, a reduction in zooplankton abundance (ephausiids and *Calanus finmarhicus*) and the negative impact of predation on eggs and larvae and food competition from the grey gurnard. The 2012 year class, was overestimated by the survey assessment of 0-group. It resulted in an increase of uncertainty in the assessment because more than 70% of 0-group fish were caught during a single haul (Figure 4.3.2). In 2007–2016 the recruitment (age 1) assessed by VPA was below average for full time-series 1991–2016 (Table 4.3.20).

In 2016 and 2017, a strong 0-group was observed. But a considerable number of 0-group fish were caught during a single haul (Figure 4.3.2). This increases the uncertainty of forecasting recruitment as in 2012.

VPA abundance for age 1 has been highly correlated with age 0 indices for 1993–2015 (r^2=0.75) but in 2016–2017 this correlation declined (Figure 4.3.36). The recruitment (age 1) in 2013–2017 was therefore estimated using RCT3 regression (Shepherd, 1997) relating survey indices to stock abundance. The recruitment in 2019 was estimated at 24 444 thousand.

For forecasting recruitment (age 1) in 2020 and thereafter, the WG recommended the same procedure as last year using the 25th percentile over the whole time-series.

Many definitions of how to compute the percentile may be found in the literature. The WG chose the simple rounding of the result to the nearest integer and taking the value that corresponded to that rank of percentile. The rank of percentile was determined by the following equation:

$$n = \frac{P}{100} * N + \frac{1}{2}$$

P being the percentile value (here P=28), and N the length of the time-series (here N=27). The rank of 25th percentile for the recruitment is then 8. The 7th lowest value of the time-series corresponds to a value of 14 170 thousands in 2004.

The input data for the short-term forecast can be found in Table 4.3.21.

Catch Constraint

A catch constraint is used for 2019. The assumed catch in 2019 of 9763 t is estimated based on UK (8439 t) and Irish (824 t) quotas and an estimated Russian catch 500 t. Recent UK and Irish quota up take has been high and the Russian fishery has already taken place in 2019 so the catch constraint forecast, as last year, is considered to be the best approach by the WG.

Results of forecast are shown in Tables 4.3.21–4.3.23.

Mean Weights and F pattern

In recent years, the number of sampled trips for both landings and discards has been very low. This leads to higher variability in catch and survey estimates of those year classes, increasing the uncertainty in F. Since 2015, to mitigate against this in the forecast five-year averages for weight were used in the catch options. Average of the three last years of exploitation patterns and weight-at-age in the stock were used.

Partitioning of catch into discards and landings

An important uncertainty in the assessment and forecast concerns the estimates of discards. The number of sampled discard trips in the last years has been very low. Since the discard ratio at age varies considerably from year to year a ten-year average discard proportion (2009–2018) was used for forecasting discards in the short term (Tables 4.3.7–4.3.10 and Figure 4.3.37).

STF results

Results obtained from the forecast (including discards) are given in Tables 4.3.21–4.3.23.

Stock numbers of recruits and their source for recent year classes used in the predictions and the relative (%) contributions to landings and SSB (by weight) of these year classes are shown in Table 4.3.24.

7.5 MSY evaluations and Biological reference points

ICES carried out an evaluation of MSY and PA reference points for this stock in 2019 WKROCK-MSE (ICES, 2019). The results are summarized below:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY Btrigger	3712 tonnes	Bpa	ICES (2019)
	FMSY	0.168	Segmented regression with Bloss, the lowest observed spawning–stock biomass (EqSim).	ICES (2019)
Precautionary approach	Blim	2474 tonnes	Blim = Bloss, the lowest observed spawning–stock estimated in previous assessments.	ICES (2019)
	Bpa	3712 tonnes	Bpa = Blim × 1.4. This is considered to be the minimum SSB required to obtain a high probability (95%) of maintaining SSB above Blim	ICES (2019)
	Flim	1.06	Based on a 50% probability of being above Blim in a stochastic simulation with a segmented regression using breakpoint at Blim.	ICES (2019)
	Fpa	0.710	Fpa = Flim/1.5	ICES (2019)
Management plan	SSBmgt	3712 tonnes	Bpa	ICES (2019)
	Fmgt	0.168	Based on harvest control rule evaluations.	ICES (2019)
Management plan*	MAP MSY Btrigger	3712 tonnes	MSY Btrigger	
	MAP Blim	2474 tonnes	Blim	
	MAP FMSY	0.168	FMSY	
	MAP range Flower	0.105	Consistent with ranges provided by ICES (2016a), resulting in no more than 5% reduction in long-term yield compared with MSY.	ICES (2019)
	MAP range Fupper	0.27	Consistent with ranges provided by ICES (2016a), resulting in no more than 5% reduction in long-term yield compared with MSY.	ICES (2019)

7.6 Management plans

In September 2011 and 2012 in accordance with the conclusions of the 2010–2011 Annual Meeting of the NEAFC, a delegation from the RF and EU considered the management plan. In the light of the ICES comments, the necessary adjustments required to the draft plan were considered. The revised proposal for a harvest control component of a long-term management plan for haddock at Rockall was forwarded to NEAFC at the opportunity for approval at the 2012 Annual Meeting. ICES is requested to evaluate the EU-Russia proposal for the harvest control component of the management plan for Rockall haddock and to evaluate the proposals on the protection of juvenile Rockall haddock. According the management plan the measure shall be put in place to ensure that total catch does not exceed the established TAC including measures to record and minimise discards. It is the consideration of 2004 Expert Group the basic measure to reduce discards should be effort regulation along with the biological reasonable the minimum landings size.

ICES evaluated a new HCR proposal RF and EU for the Rockall haddock stock in August 2013 (ICES, 2013) and found that a maximum F of 0.2 was required in the HCR to ensure consistency with the precautionary approach, under the low recruitment conditions observed since 2004.

The management plan additionally indicates that measures should be put in place to ensure that total catch does not exceed the established TAC, including measures to record and minimize discards. After the introduction of these measures, the human consumption TAC method currently used by ICES (advice based on landings) should not be applied.

In 2017, NEAFC again requested ICES to evaluate the following proposal for the harvest control component of a long-term management plan for Rockall haddock and in particular to consider whether the plan is consistent with the precautionary approach and will provide for the sustainable harvesting of the stock. If the plan fails to be precautionary ICES will also be asked to suggest possible options to bring the plan aligned with the precautionary approach. In 2019, ICES evaluated proposed NEAFC plan.

By NEAFC opinion the measures to reduce discards for whole area distribution of stock need to develop and to implement in practice, while also reducing the TAC to take into account any discarding that is still taking place for realization of management plan. In NEAFC regulatory area (RA) established a ban on discards. The remainder of the management plan for this species is considered to be suitable and has been agreed by the Contracting Parties (NEAFC, 2015).

7.7 Uncertainties and bias in assessment and forecast

The WG considers that the long-term trends in the XSA assessment and survey biomass estimates/indices are indicative of the general stock trends. The assessment has become increasingly uncertain in recent years as catch and sampling levels have declined to low levels. To mitigate against variability in the mean weight-at-age in the stock are assumed as five-year means. The three-year averages of exploitation patterns and five-year average catch weights and ten-year mean discard proportions were used in the catch options for forecast.

7.8 Recommendation for next benchmark

In recent years WGCSE have highlighted an increasing number of issues to be addressed when this stock is benchmarked.

1. The WG considers that a longer series of more accurate landings, discards (for non-Russian fleets) and survey data will be necessary to overcome these deficiencies.
2. There are concerns over the accuracy of landings statistics from Rockall in earlier years. There was no analysis of which method is better to use when in terms poor information by result discards trips: the method of estimating discards from survey data or the results poor discards, especially in 2010 where an average rate had to be used since the survey could not take place.
3. In 1999 and 2011, the gear and tow duration were changed on the Scottish survey. Analysis of the impact of this on the stock assessment is needed.
4. The XSA assessment shows trends in catchability, even if reduced by weak shrinkage. Diagnostics give quite large standard errors on survivors' estimates (0.3–0.4) and there are often quite different values given by Scottish Rock-IBTS-Q3, F-shrinkage and P-

shrinkage. During benchmark 2019, progress has been made but further efforts in this direction are needed.

5. The survey covers only part of the currently known distribution area of haddock that raises uncertainty in the assessment.
6. The indices obtained from the standard survey area must be used for the next assessment on account of the heterogeneity in the abundance and length–age composition of the haddock stock in different parts of the bank. New survey indexes from whole area will be used for the assessment once the time-series for the whole area of haddock distribution is of sufficient length.
7. Analysis of possibility improving relationship between the survey assessed 0-group and the recruitment-at-age 1 assessed by VPA need for the short-term forecast.
8. There are doubts on the level of agreement of age reading by international experts.
9. Finally, it would be beneficial to develop and introduce standardization methods for reading the age for haddock.

7.9 Management considerations

The new F_{MSY} estimate is consistent with the F in the management plan previously evaluated by ICES. The stock appears to be recovering after a period of very low recruitment. Incoming recruitment is still not as strong as it was historically. So a sudden expansion of the fishery at Rockall should be avoided.

A discards ban has been in place in the NEAFC regulatory area since 2009. Haddock in 6.b have not yet been included under the EU landings obligation in 2016 (EC, 2015). However, the discard rate has not changed significantly and remains at a high level. Since 2017, basis for the ICES advice for haddock 6.b was changed from landings advice to catch advice as a result of a high level of discards not being accounted for. As result, ICES advice has become increasingly. It would be beneficial to develop and introduce measures aimed at preventing discards of haddock into fisheries practice. Elaboration of such measures complies with recommendations under the UNGA Resolution 61/105 that urges states to take action to reduce or eliminate fish discards (UNGA Resolution 61/105, 2007, Chapter VIII, item 60).

7.10 References

Blacker R.W. 1982. Rockall and its fishery. Laboratory Leaflet, Lowestoft. No 55. 23 pp.

Brodziak J. 2005. Technical Description of STATCAM Version 1.2. Northeast Fisheries Science Center 166 Water Street Woods Hole, MA 02543. 39 pp.

Chuksin, Yu. V. and Gerber, E. M. 1976. Soviet fishery in the Rockall and Porcupine areas. Zaprybpromrazvedka. Kaliningrad, 8 pp.

EC. 2015. Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters

Finina E.A., Khlivnoy V.N., Vinnichenko V.I. 2009. The Reproductive Biology of Haddock (*Mellanogrammus aeglefinus*) at the Rockall Bank. Journal of Northwest Atlantic Fishery Science, Vol. 40: pp. 59–73.

ICES. 2004. Report of an Expert Group on Rockall Haddock Recovery Plans following a request for advice made on behalf of the European Community and the Russian Federation. 13–15 January 2004. Galway, Ireland. ICES/ACFM. 300 p.

ICES. 2013. ICES Advice 5.3.2.2. Special request Advice August 2013. Request from NEAFC to evaluate the proposals for the harvest control components of the management plan for Rockall haddock fisheries. ICES CM 2013/ACOM. 8 p.

ICES. 2016. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4). ICES CM 2015/ACOM:58. 183 p.

ICES. 2019. Report of the benchmark workshop (WKROCK) for Rockall haddock. ICES CM 2017/ACOM:58. 61 p.

Khlivnoy V.N., Sentiabov E.V. 2009. Influence of environmental factors on formation of year classes of haddock (*Melanogrammus aeglefinus*) at the Rockall Bank. Theses and reports of X All-Russian conference on problems of fishery forecasting, Murmansk: PINRO. pp. 137.

Newton, A. W., Peach, K. J., Coull, K. A., Gault, M. and Needle, C. L. 2008. Rockall and the Scottish haddock fishery. Fisheries Research, 94: pp.133–140.

Shestov, V. P. 1977. Rockall haddock. Fishery biological resources of the North Atlantic and adjacent seas of the Arctic Ocean. Moscow, pp.344–346.

Sonina M.A. 1976. The condition of the Arcto-Norwegian haddock stock and the factors determining the population size. // The Edition of the PINRO works. Vol. 37. pp. 129–150.

Tormosova I.D. 1978. The survival of North Sea haddock eggs at different stages of development and its determining factors. // The Edition of the AtlantNIRO works. Vol. 81. pp. 7–18.

Table 4.3.1. Nominal catch (tonnes) of haddock in Division VIb, 1998–2018, as officially reported to ICES.

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018[1]
Faroe Islands	-	-	n/a	n/a	-	-	-	-	2	2	16	-	42	2	53	-	<1	<1	-		
France	-		5	2	-	1	-	-	-	-	-	-	-	<1	-	-	<1	-	-		
Iceland	-	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Ireland	704	1,021	824	357	206	169	19	105	41	338	721	352	169	123	31	105	94	190	362	500	433
Norway	40	61	152	70	49	60	32	33	123	84	36	71	65	40	48	121	41	66	63	26	16
Portugal	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Russian Feder-ation	-	458	2,154	630	1,630	4,237	5,844	4,708	2,154	1,282	1669	55	198	-	1	4	388	136	-	153	-
Spain	21	25	47	51	7	19	-	-	5	-	-	-	-	-	-	-	-	-	-	-	
UK (E, W & NI)	561	288	36	-	-	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
UK (Scotland)	3,768	3,970	2,470	1,205	1,145[3]	1,607	411[3]	332[3]	440[3]	1,643[3]	1,779[3]	2,951[3]	2,931[3]	1,738[3]	577[3]	596[3]	1,152[3]	2,052[3]	2,160[3]	3,930[3]	3,418
Total	5,098	5,990	5,688	2,315	3,037	6,148	6,306	5,178	2,765	3,349	4,221	3,429	3,405	1,903	710	826	1,675	2,445	2,585	4,610	3,868
Unallocated catch	-599	-851	-357	-279	299	94	139	1	0	0	0	-192	0	0	0	0	0	0	0	0	0
WG estimate	4,499	5,139	5,331[4]	2,036[4]	3,336[4]	6.242[4]	6,445	5,179	2,765	3,349	4,221	3,237	3,405	1,903	710	826	1,675	2,445	2,585	4,610	3,868

[1]Preliminary.

[2]Included in Division 6.a.

[3]Includes Scotland, England, Wales and NI landings

[4]Includes the total Russian catch.

n/a = not available.

Table 4.3.2. Details of Scottish and Irish effort (in hours) from 1985–2015 (preliminary data, no data for 2016–2018).

Year	Scottish fleet			Irish fleet
	SCOTRL*	SCOLTR*	SCOSEI*	IROTB*
1985	8421	3081	1677	
1986	7465	4783	507	
1987	8786	9737	402	
1988	12450	5521	261	
1989	10161	11946	1411	
1990	3249	5335	4552	
1991	2995	11464	6733	
1992	2402	9623	3948	
1993	1632	11540	1756	
1994	2305	15543	399	
1995	1789	13517	1383	9142
1996	1627	17324	952	7219
1997	563	16096	1061	7169
1998	1332	12263	456	7461
1999	11336	9424	456	8680
2000	12951	8586	80	9883
2001	7838	1037	42	7244
2002	8304	1100	0	2626
2003	15000	500	50	4618
2004	15200	300	50	2070
2005	7788	32	0	2693
2006	9990	231	0	5903
2007	4534	319	44	6589
2008	2497	1016	82	9740
2009	NA	NA	NA	4354
2010	NA	NA	NA	3280
2011	NA	NA	NA	2495
2012	NA	NA	NA	3291
2013	NA	NA	NA	2947
2014	NA	NA	NA	3159
2015	NA	NA	NA	3053
2016	NA	NA	NA	NA
2017	NA	NA	NA	NA
2018	NA	NA	NA	NA

SCOTRL* – Scottish Heavy Trawl, SCOLTR* – Scottish Light Trawl, SCOSEI* – Scottish Seine, IROTB* – Irish bottom otter trawl.

Table 4.3.3. Effort from the Scottish TR1 fleet and Irish otter-trawl fleet at Rockall (see the Section Cod VIb).

year	Scottish TR1 fleet effort(kwdays)	Irish otter-trawl fleet Effort '000s Hrs
2003	2504466	4.542
2004	1842103	2.233
2005	1217357	3.283
2006	1011354	5.9
2007	1060551	6.587
2008	1124197	9.898
2009	1631239	4.353
2010	1744452	3.28
2011	1565753	2.534
2012	901552	3.248
2013	532767	3.809
2014	668665	4.2
2015	563098	4.7
2016	514486	6.2
2017	794571	14.9
2018	NA	NA

Table 4.3.4. Discards and retained catches of haddock (number per trip) by Irish discard trips in the Rockall area from 2007–2009 and 2011–2012.

Year	2007		2008		2009		2011		2012	
Length (cm)	Discards	Retained Catch	Discards	Retained Catch	Discards	Retained Catch	Dis-cards	Re-tained Catch	Dis-cards	Re-tained Catch
10									1	
11									1	
12									1	
13									1	
14										
15										
16										
17										
18										
19	1.3									
20										
21										
22	1.6		14.8							
23	4.6		66.2				13.1			
24	7.3		183.8				98.9	5.7		
25	22.7		576.9		15.6		53.9	5.7		
26	54.2		1424.9		30.4		75.3	11.4		
27	104.6		3024.6		25.2		121.3	34.3	2	
28	256.9		6274.7		228.2		96.4	108.5		
29	386.5	7.9	7193.3		180.6		33.6	62.8		
30	533.4	17.6	7813.5	13.9	573.2	9.9	73.9	5.7	3	2
31	462.6	47.2	7573.7	40.6	1338.1	9.9	28.6	17.1	6	3
32	298.8	88.3	4639.0	77.8	1762.8	57.8	46.9	125.3	7	4
33	227.3	99.4	3664.7	126.8	2256.5	235.9	20.7	92.4	9	5
34	120.8	139.2	2391.8	277.4	1496.5	397.3	16.0	196.8	7	7
35	78.3	118.8	1590.1	503.6	656.6	614.8	4.8	118.6	6	8

Year	**2007**		**2008**		**2009**		**2011**		**2012**	
Length (cm)	Discards	Retained Catch	Discards	Retained Catch	Discards	Retained Catch	Dis-cards	Re-tained Catch	Dis-cards	Re-tained Catch
36	27.4	187.0	871.7	580.5	423.5	567.1	0.3	340.4	2	6
37	26.1	139.8	280.3	640.9	66.9	526.8	0.0	235.8	1	11
38	24.3	142.7	78.3	581.9	57.4	421.4	0.0	632.2		8
39	3.4	162.5	206.6	443.0	23.1	346.9	4.8	312.7		11
40	8.7	119.4	37.5	535.6		281.4		158.9		9
41	1.3	133.8	5.2	310.7		197.9		203.4		12
42	4.6	133.1	5.2	334.7		155.7		348.1		13
43	3.2	109.3		333.5		195.1		225.4		11
44		118.6		291.1		201.7		305.4		13
45		97.9		253.6		149.9		226.0		10
>45 cm		574.5	0.0	1791.2	0.0	1001.7		2490.8	1	144
Total	2659.9	2436.9	47916.8	7136.8	9134.4	5371.3	688.6	6263.7	48.0	277.0
Discard rate, %	52.2		87.0		63.0		10.0		14.8	

Table 4.3.5. Length composition of Irish discards and landings of haddock (number) by results of Irish discard trips in the Rockall area in 2014–2015.

Year	2014		2015	
Length (cm)	Discards	Landings	Discards	Landings
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20	508.86			
21	1249.21		68.03	
22	3757.56		136.45	
23	9882.93		548.57	
24	17742.15		2466.15	
25	26690.88		5489.88	
26	29456.22	206.22	8664.85	
27	27737.04	1787.22	17011.27	
28	28506.24	4605.52	23581.32	
29	23556.01	5224.18	28730.09	
30	22791.88	4261.83	33689.11	274.85
31	25734.19	4330.57	32838.74	742.11
32	25404.86	3436.96	33210.44	1044.45
33	17211.02	4880.48	25934.47	2308.78
34	8877.72	6392.74	17534.75	2666.09
35	4733.26	7217.61	7589.53	8300.60
36	2034.38	6324.00	4142.17	9702.36

Year	**2014**		**2015**	
Length (cm)	Discards	Landings	Discards	Landings
37	918.99	5774.09	854.19	16628.69
38	77.02	4674.26	110.53	10636.86
39	153.20	3780.65	88.60	13495.35
40	0.00	4949.22		14787.16
41	39.00	4949.22		12808.21
42	51.67	7011.39		17425.77
43	12.67	4743.00		14732.19
44	12.67	4055.61		11488.91
45	25.34	2680.83		11186.57
>45 cm	290.53	30520.19		77254.68
Total	277455.52	121805.80	242689.10	225483.63
Discard rate, %	69.5		51.8	

Table 4.3.6. Discards and retained catches of haddock (number per trip) by Scottish discard trips in the Rockall area in 2009 and 2011–2015.

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
9					1.0							
10					3.0							
11					5.2							
12					66.5							
13					233.3							
14					313.0							
15					842.8							
16					516.7		226		1493			
17					247.3		0		7817		138	
18					341.7		0		22709		957	
19					81.5		135		39126		4591	
20					4.7		39		37513		9278	
21							357		25979		15194	
22							1322		8774		16591	
23					4.0		2201		14104		19529	

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
24					23.0		3665		28818		42079	
25					18.9		6643		64709		122065	
26			3.8		36.4		6714		118616		206928	
27			3.8		15.9		6424		164637		254254	
28	24.2		17.4		22.6		5018		142534		305155	
29	14.7		78.6		53.4		3599		121740	1422	342216	
30			53.0		77.9	37.3	2326		78972	7965	330023	10543
31	5.3	26.4	17.4		126.6	76.1	1286	894	58592	25316	178402	31628
32	12.0		35.2	317.1	119.9	161.9	1181	2682	31670	30389	94018	84630
33	20.1	47.1	28.0	463.7	160.4	464.8	643	6454	13957	33340	23867	195299
34		201.7		637.4	71.0	1093.8	208	18902	10246	52890	9191	271402
35		220.2	139.8	1171.2	25.6	1366.4	101	23579	3404	47790		328955
36		269.0	139.8	1709.7	42.0	1872.7	39	34036		60976		241848
37		296.5		1668.7	10.1	2164.3		35748		57701		277221
38		353.1	139.8	2032.6	17.5	1917.5		33986		57472		197661
39		193.2		1927.7		2393.7	39	27892		61971		256136
40		237.9	139.8	1233.5		2091.6		36058		45808		188271

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
41		131.7		1020.3	1.5	1876.3		23821		42575		189250
42		107.9		959.1		1247.9		18935		50824		123229
43		181.9		641.2	118.0	1416.8		23001		48330		150363
44		96.8	139.8	406.0	118.0	1288.2		20654		48019		108077
45		72.1		233.1		1326.8		22804		40359		75009
46		82.4	139.8	138.1	2.1	1252.9		22272		34162		78581
47		46.8		122.2	193.5	1023.0		22565		36909		39233
48		47.0	139.8	55.9		833.8		17565		33530		43136
49		33.3	1.0	49.9	194.5	711.7		18802		29220		48753
50		19.3		36.2	1.0	651.6		17499		28263		42833
51		8.9		37.5		410.3		12020		22682		50870
52		4.8		14.7		315.2		14866		23089		72142
53		5.1		20.5		206.1		12313		27292		40558
54		3.2		8.4		210.4		18722		34873		9895
55		2.3		5.4		98.8	26	11861		23816		34552
56		4.6		3.4		203.3		19573		18753		12660
57		2.7		1.6		408.4		14254		17896		9895

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
58		1.9		3.1		404.8		8962		16511		9506
59		1.7		9.1		87.8		6702		21930		7518
60		1.2				189.9		9813		20822		2765
61		1.7		2.7		190.7		5851		12248		
62		1.1		1.3		213.7		6436		20519		5531
63		0.5		2.4		210.2		4016		9150		
64		1.3				97.7		6675		7792		1166
65				1.1		45.1		5212		9321		
66				1.1		105.2		2314		13225		
67						45.0		3830		14393		
68				1.0		24.3		1649		9712		3154
69						63.1		1649		3359		
70				0.9		58.0		1915		4556		
71						47.9		665		2406		
72						42.2		1782		190		
73						20.1		1117		1102		2765
74						20.6		133		2181		

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
76						5.7						
77						8.6				71		
78				0.7		4.1				759		
82				0.6								
Total	76.3	2705.3	1216.8	14939.0	4110.5	29006.3	42218	600479	995410	1214092	1974476	3245035
Discard rate, %	2.7		7.5		12.4		6.6		45.0		37.8	

***Retained discards and landings**

Table 4.3.7. Discards and retained catches of haddock (number) by Scottish and Irish discard trips in the Rockall area in 2013–2018.

Year	Country		Age						
			1	2	3	4	5	6	7+
2013	Scotland	Landings	116013	9886	1154	33064	4373	33020	3387
		Discards	4666330	28973	0	0	0	0	11791
	Ireland*	Landings	-	-	-	-	-	-	-
		Discards	55362	5189	9389	3816	31041	35875	0
	Ireland**	Landings	-	-	-	-	-	-	-
		Discards	3061	2869	5192	2110	1716	1984	0
2014	Scotland	Landings	-	577684	2252	213	87220	18169	528556
		Discards	142263	853148	-	-	-	-	-
	Ireland	Landings	4188	58642	2353	1277	21085	7630	26631
		Discards	15651	261804	-	-	-	-	-
2015	Scotland	Landings	-	464407	2679182	1620	1171	24139	88332
		Discards	70129	1935829	45431	-	-	-	-
	Ireland	Landings	-	2277	159849	3767	3662	42685	13244
		Discards	-	149261	93428	-	-	-	-
2016	Scotland	Landings	127	580	1991	590	0	0	2891
		BMS landings	1271	356	51	-	-	-	

Year	Country		Age						
			1	2	3	4	5	6	7+
		Discards	163346	153742	88894	402	-	-	-
	Ireland	Landings	-	27955	138593	278405	3345	2294	8634
		BMS landings	-	-	-	-	-	-	-
		Discards	23629	177594	287589	108446	-	-	-
2017	Scotland	Landings	340	955346	1401088	1606845	821574	2851	12316
		BMS landings	-	-	-	-	-	-	
		Discards	747839	245953	1073	201	268	-	-
	Ireland	Landings	24	166140	75380	217982	125193	4364	9657
		BMS landings	-	-	-	-	-	-	-
		Discards	314743	43494	19349	12118	-	-	-
2018	Scotland	Landings		3116059	456039	2052985	533709	191175	8853
		BMS landings	-	-	-	-	-	-	-
		Discards	87472	2906183	2033	38342	458	431	
	Ireland	Landings							
		BMS landings		33562.58	6180.39	4416.73	17015.94	13023.1	3205.62
		Discards	219.48	42390.14	790.51	1315.76			

*** Mesh size 110–119 mm.**

**** Mesh size 70–99 mm.**

Table 4.3.8. Haddock in 6.b. Tuning data available from the Scottish groundfish survey conducted in September. In bold, the data used in the assessment.

HADDOCK WGCSE 2017 ROCKALL
101
SCOGFS
1991 2018
1 1 0.66 0.75
0 6

1	14458	**16398**	**4431**	**683**	**315**	**228**	**37**	64	3
1	20336	**44912**	**14631**	**3150**	**647**	**127**	**200**	4	32
1	15220	**37959**	**15689**	**3716**	**1104**	**183**	**38**	73	21
1	23474	**13287**	**11399**	**4314**	**969**	**203**	**30**	12	4
1	16923	**16971**	**6648**	**5993**	**1935**	**483**	**200**	16	-1
1	33578	**19420**	**5903**	**1940**	**1317**	**325**	**69**	6	1
1	28897	**10693**	**2384**	**538**	**292**	**281**	**71**	9	1
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	10178	**9969**	**2410**	**708**	**279**	**172**	**90**	64	32
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	31813	**7455**	**521**	**284**	**154**	**39**	**14**	12	14
1	11704	**20925**	**2464**	**173**	**105**	**65**	**20**	10	15
1	2526	**10114**	**10927**	**1656**	**138**	**97**	**100**	26	6
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	24452	**4082**	**920**	**1506**	**2107**	**231**	**33**	13	7
1	3570	**18715**	**2562**	**256**	**1402**	**1694**	**349**	16	6
1	558	**2671**	**6019**	**570**	**254**	**516**	**367**	28	2
1	85	**560**	**966**	**3813**	**182**	**41**	**282**	249	49
1	132	**139**	**323**	**488**	**1651**	**40**	**9**	54	17
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	13	**17**	**96**	**22**	**42**	**88**	**607**	4	4
1	39619	**4**	**12**	**73**	**14**	**75**	**50**	635	9
1	6035	**14179**	**5**	**8**	**8**	**9**	**11**	23	166
1	3044	**7232**	**4692**	**5**	**0**	**13**	**0**	11	10
1	1997	**2908**	**5635**	**3357**	**0**	**0**	**16**	2	20
1	67096	**1576**	**1483**	**2064**	**1526**	**11**	**1**	5	2
1	30130	**29449**	**956**	**909**	**1389**	**663**	**5**	1	2
1	10008	**4170**	**10535**	**308**	**773**	**967**	**358**	0	0

Table 4.3.9. Haddock in 6.b. International landings, discards and total catch.

Year	Num (*1000)			Weight, tonnes		
	Landings	Discards	Total Catch[1]	Landings	Discards	Total Catch[1]
1991	12302	65832	78134	5655	13229	18884
1992	11418	55964	67383	5320	11873	17192
1993	8767	44656	53423	4784	9856	14639
1994	11400	46628	58028	5733	11027	16761
1995	11784	35467	47251	5587	9170	14758
1996	14066	41506	55572	7075	9356	16432
1997	9965	26980	36945	5166	5893	11059
1998	9034	47831	56865	4984	10863	15847
1999	12931	52881	65812	5358	11065	16423
2000	16000	26033	42033	5445	6611	12056
2001	5069	9222	14291	2020	1536	3556
2002	11168	21899	33067	3116	4153	7269
2003	24542	25087	49629	5967	5521	11488
2004	22706	3989	26695	6437	883	7321
2005	19505	1877	21382	5238	505	5742
2006	9605	1667	11273	2756	386	3142
2007	8936	12300	21236	3348	2242	5590
2008	10209	7603	17812	4221	2104	6325
2009	6709	4765	11474	3242	1556	4798
2010	5264	3242	8506	3404	907	4311
2011	3082	248	3331	1861	152	2013
2012	631	49	680	686	26	712
2013	829	5039	5868	889	1065	1954
2014	3114	1634	4748	1845	332	2177
2015	4327	2397	6724	2510	554	3064
2016	3733	1333	5068	2504	401	2905
2017	6629	1552	8181	4431	379	4810
2018	6985	3087	10072	3850	788	4638

[1] **Landings and discards.**

Table 4. 3.10. Haddock in 6.b. International catch (landings and discards) numbers (*103) at-age.

	Age						
Year	1	2	3	4	5	6	7
1991	21 186	33 847	15 189	5 341	1 704	346	522
1992	16 084	24 711	18 584	5 361	1 761	676	206
1993	11 178	19 375	15 494	4 938	1 617	461	359
1994	8 170	20 623	17 868	8 209	2 449	476	232
1995	2 749	9 831	21 584	9 756	2 464	787	79
1996	12 096	18 811	10 911	9 612	3 299	751	92
1997	9 957	10 535	5 388	4 098	5 002	1 758	206
1998	14 224	19 807	10 173	4 763	3 740	2 767	1 391
1999	17 282	21 949	12 203	5 499	3 419	2 684	2 776
2000	8 222	12 581	10 698	4 917	2 050	1 498	2 066
2001	7 669	2 013	1 699	821	1 041	477	570
2002	13 363	11 119	4 537	2 445	898	260	444
2003	6 576	23 606	14 568	2 065	1 286	927	602
2004	932	4 112	10 282	9 212	1 386	296	474
2005	1 061	3 723	7 420	8 124	753	109	193
2006	2 880	1 475	1 626	2 414	2 291	436	151
2007	1 489	9 829	3 630	1 514	2 227	1 827	720
2008	476	2 207	11 437	1 291	507	964	930
2009	223	707	1 237	8 046	495	263	504
2010	152	534	1 064	2 087	4 096	276	296
2011	4	59	75	183	181	2 579	249
2012	5	6	144	58	3	35	428
2013	4 896	98	101	86	39	84	565
2014	406	3 008	418	52	138	47	679
2015	80	2 973	3 387	104	7	61	112
2016	374	1 051	2 639	988	3	2	11
2017	1 194	1 670	1 802	2 191	1 207	58	59
2018	88	6373	504	2273	598	222	13

Table 4.3.11. Haddock in 6.b. International landings numbers (*10³) at-age.

	Age						
Year	1	2	3	4	5	6	7
1991	87	6807	3011	1344	558	32	464
1992	86	3642	5623	964	580	364	160
1993	28	1919	4740	1157	489	144	290
1994	30	1160	5299	3665	1039	66	141
1995	1	146	5205	4791	1319	279	43
1996	2	5149	1861	4149	2347	473	85
1997	0	319	2102	2155	3658	1540	192
1998	4	392	1815	1340	1898	2284	1301
1999	245	2600	2994	1972	1228	1600	2291
2000	33	3446	5081	3006	1296	1176	1963
2001	402	994	1116	555	991	462	549
2002	657	2983	3998	2111	809	217	392
2003	920	8103	11010	1848	1189	879	593
2004	197	1765	9502	9119	1364	286	472
2005	887	2835	6866	7913	725	98	182
2006	2344	768	1290	2356	2269	428	150
2007	31	1220	2709	1074	1550	1634	719
2008	17	749	6191	1164	479	761	848
2009	5	11	244	5243	460	261	486
2010	0	71	196	352	4078	274	294
2011	2	23	71	177	181	2405	222
2012	0	0	134	51	0	35	410
2013	162	14	2	46	6	46	553
2014	226	1553	418	52	138	47	679
2015	9	820	3214	104	7	61	112
2016	127	612	2137	842	3	2	11
2017	7	1336	1783	2179	1207	58	59
2018	0	3418	502	2233	598	222	13

Table 4.3.12. Haddock in 6.b. International discards numbers (*10³) at age.

YEAR	AGE						
	1	2	3	4	5	6	7
1991	21099	27040	12178	3998	1146	313	58
1992	15998	21069	12961	4397	1181	312	46
1993	11151	17456	10755	3781	1128	317	69
1994	8140	19464	12570	4545	1409	410	91
1995*	2748	9685	16379	4965	1145	508	36
1996	12094	13662	9051	5463	952	278	7
1997*	9957	10216	3286	1944	1344	218	15
1998*	14220	19415	8357	3423	1842	483	91
1999*	17037	19348	9209	3526	2191	1084	485
2000*	8189	9136	5616	1912	755	322	103
2001*	7268	1019	583	266	50	15	21
2002	12706	8136	539	334	89	43	51
2003	5655	15503	3558	217	97	48	8
2004	735	2346	781	93	22	10	2
2005	174	888	554	210	28	11	11
2006	536	707	336	58	22	8	1
2007	1458	8609	921	440	678	193	0
2008	458	1458	5246	128	28	203	82
2009	218	696	993	2803	35	2	18
2010*	152	463	868	1736	19	2	2
2011*	2	36	4	6	0	174	27
2012*	5	6	10	7	3	0	18
2013*	4733	84	99	40	33	38	12
2014*	179	1454	0	0	0	0	0
2015*	71	2153	173	0	0	0	0
2016*	245	439	503	146	0	0	0
2017*	1187	334	20	12	0	0	0
2018*	88	2955	3	40	0	0	0

*** data calculated using estimates from discard observer trips.**

Table 4.3.13. Haddock in 6.b. International catch (landings and discards) weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.142	0.240	0.291	0.378	0.469	0.414	0.681
1992	0.133	0.239	0.318	0.362	0.423	0.567	0.852
1993	0.137	0.238	0.335	0.400	0.493	0.503	0.882
1994	0.153	0.233	0.319	0.420	0.469	0.477	0.740
1995	0.118	0.222	0.309	0.401	0.501	0.460	0.870
1996	0.136	0.278	0.314	0.396	0.553	0.575	0.762
1997	0.136	0.240	0.322	0.381	0.512	0.634	0.940
1998	0.141	0.250	0.308	0.354	0.436	0.546	0.663
1999	0.138	0.208	0.272	0.334	0.379	0.483	0.619
2000	0.189	0.250	0.267	0.321	0.382	0.451	0.709
2001	0.133	0.264	0.326	0.447	0.427	0.520	0.683
2002	0.135	0.239	0.237	0.325	0.509	0.579	0.755
2003	0.153	0.203	0.256	0.349	0.384	0.424	0.604
2004	0.147	0.198	0.244	0.294	0.444	0.609	0.753
2005	0.114	0.197	0.235	0.311	0.459	0.600	1.062
2006	0.093	0.198	0.245	0.329	0.441	0.595	0.787
2007	0.114	0.186	0.265	0.294	0.386	0.496	0.578
2008	0.199	0.241	0.291	0.437	0.571	0.669	0.937
2009	0.248	0.288	0.339	0.391	0.668	0.513	1.012
2010	0.141	0.247	0.333	0.327	0.590	0.977	1.464
2011	0.198	0.280	0.596	0.449	0.695	0.603	0.748
2012	0.263	0.295	0.622	0.784	0.372	1.411	1.219
2013	0.211	0.368	0.236	0.704	0.423	0.827	1.261
2014	0.140	0.286	0.268	0.545	1.000	1.036	1.370
2015	0.104	0.254	0.601	0.354	1.178	0.948	1.439
2016	0.298	0.449	0.600	0.711	1.556	1.808	2.650
2017	0.219	0.430	0.586	0.691	0.944	0.780	1.270
2018	0.088	0.298	0.563	0.700	0.935	1.233	1.928

Table 4.3.14. Haddock in 6.b. International landings weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.302	0.402	0.444	0.592	0.724	0.963	0.704
1992	0.136	0.366	0.455	0.658	0.612	0.759	0.954
1993	0.305	0.402	0.503	0.701	0.830	0.820	0.972
1994	0.314	0.356	0.452	0.558	0.638	1.224	0.890
1995	0.377	0.311	0.414	0.479	0.640	0.699	1.236
1996	0.327	0.436	0.501	0.487	0.627	0.709	0.783
1997	0.300	0.315	0.401	0.444	0.564	0.661	0.973
1998	0.256	0.344	0.494	0.517	0.542	0.591	0.678
1999	0.085	0.177	0.326	0.417	0.495	0.595	0.662
2000	0.111	0.206	0.242	0.328	0.413	0.483	0.720
2001	0.094	0.281	0.344	0.497	0.427	0.522	0.690
2002	0.107	0.196	0.227	0.323	0.521	0.627	0.804
2003	0.100	0.164	0.246	0.350	0.387	0.423	0.606
2004	0.142	0.172	0.241	0.293	0.446	0.617	0.754
2005	0.103	0.184	0.230	0.310	0.461	0.614	1.095
2006	0.084	0.167	0.223	0.327	0.440	0.598	0.789
2007	0.096	0.238	0.275	0.322	0.449	0.521	0.578
2008	0.125	0.197	0.302	0.444	0.583	0.752	0.984
2009	0.300	0.346	0.420	0.416	0.692	0.512	1.031
2010	0.052	0.420	0.517	0.457	0.591	0.980	1.473
2011	0.214	0.329	0.613	0.454	0.694	0.594	0.780
2012	0.189	0.368	0.632	0.850	0.898	1.412	1.238
2013	0.510	0.554	0.713	0.972	1.361	0.948	1.267
2014	0.186	0.351	0.268	0.545	1.000	1.036	1.370
2015	0.107	0.327	0.615	0.354	1.178	0.948	1.439
2016	0.409	0.574	0.664	0.767	1.576	1.808	2.650
2017	0.173	0.460	0.587	0.692	0.944	0.780	1.270
2018	-1	0.332	0.564	0.705	0.935	1.235	1.928

Table 4.3.15. Haddock in 6.b. International discards weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.142	0.199	0.253	0.306	0.345	0.358	0.499
1992	0.133	0.217	0.258	0.298	0.330	0.342	0.499
1993	0.137	0.220	0.260	0.307	0.346	0.359	0.504
1994	0.153	0.226	0.263	0.308	0.345	0.356	0.508
1995	0.118	0.220	0.276	0.325	0.341	0.329	0.438
1996	0.136	0.218	0.276	0.326	0.370	0.348	0.515
1997	0.136	0.238	0.272	0.312	0.372	0.442	0.512
1998	0.141	0.248	0.267	0.291	0.327	0.336	0.451
1999	0.139	0.212	0.255	0.288	0.313	0.318	0.417
2000	0.189	0.267	0.289	0.311	0.330	0.334	0.484
2001	0.135	0.247	0.294	0.344	0.412	0.440	0.513
2002	0.137	0.254	0.308	0.335	0.398	0.338	0.382
2003	0.161	0.223	0.287	0.342	0.337	0.440	0.487
2004	0.148	0.218	0.282	0.343	0.324	0.371	0.449
2005	0.171	0.240	0.298	0.357	0.387	0.473	0.511
2006	0.132	0.233	0.334	0.420	0.495	0.435	0.423
2007	0.115	0.179	0.233	0.227	0.243	0.280	0.420
2008	0.202	0.264	0.279	0.370	0.351	0.358	0.446
2009	0.247	0.287	0.319	0.343	0.360	0.662	0.507
2010	0.141	0.220	0.292	0.301	0.322	0.534	0.250
2011	0.178	0.248	0.300	0.302	0.795	0.727	0.481
2012	0.263	0.295	0.488	0.319	0.339	0.733	0.797
2013	0.201	0.337	0.228	0.397	0.247	0.679	0.980
2014	0.082	0.218	-	-	-	-	-
2015	0.104	0.227	0.334	-	-	-	-
2016	0.240	0.276	0.325	0.393	-	-	-
2017		0.308	0.482	0.520	0.726	-	-
2018	0.088	0.258	0.361	0.422	0.479	0.536	-1

Table 4.3.16. Haddock 6.b. Stock weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.142	0.240	0.291	0.378	0.469	0.414	0.681
1992	0.133	0.239	0.318	0.362	0.423	0.567	0.852
1993	0.137	0.238	0.335	0.400	0.493	0.503	0.882
1994	0.153	0.233	0.319	0.420	0.469	0.477	0.740
1995	0.137	0.234	0.314	0.392	0.471	0.484	0.805
1996	0.136	0.242	0.319	0.396	0.488	0.516	0.821
1997	0.136	0.242	0.320	0.399	0.506	0.530	0.839
1998	0.137	0.245	0.314	0.390	0.494	0.538	0.795
1999	0.134	0.240	0.305	0.373	0.476	0.540	0.771
2000	0.148	0.245	0.297	0.357	0.452	0.538	0.739
2001	0.148	0.242	0.299	0.368	0.427	0.527	0.723
2002	0.147	0.242	0.282	0.356	0.426	0.516	0.686
2003	0.150	0.233	0.272	0.355	0.416	0.491	0.674
2004	0.151	0.231	0.266	0.347	0.429	0.517	0.701
2005	0.136	0.220	0.260	0.345	0.444	0.546	0.771
2006	0.128	0.207	0.243	0.322	0.447	0.561	0.792
2007	0.124	0.197	0.249	0.315	0.423	0.545	0.757
2008	0.134	0.204	0.256	0.333	0.460	0.594	0.823
2009	0.154	0.222	0.275	0.352	0.505	0.574	0.875
2010	0.159	0.232	0.295	0.355	0.531	0.650	0.956
2011	0.180	0.248	0.365	0.380	0.582	0.651	0.948
2012	0.210	0.270	0.436	0.477	0.579	0.834	1.076
2013	0.212	0.295	0.425	0.531	0.550	0.866	1.141
2014	0.191	0.295	0.411	0.562	0.616	0.971	1.212
2015	0.183	0.297	0.465	0.567	0.734	0.965	1.207
2016	0.203	0.330	0.465	0.619	0.906	1.206	1.588
2017	0.195	0.357	0.458	0.601	1.020	1.080	1.598
2018	0.170	0.343	0.524	0.600	1.123	1.161	1.731

Table 4.3.17. XSA diagnostics from the assessment of Haddock in 6.b. Final runs.

FLR	XSA	Diagno	22/08/19	15:12:57								
CPUE	data	from	had.tun									
Catch	data	for	28	years.	1991	to	2018	Ages	1	to	7	
	fleet	first	age	last	age	first	year	last	year	alpha	beta	
1	SCOGF	1	6	1991	2018	0.66	0.75					
	Time	series	weights	:								
	Tapere	time	weighting	not	applied							
Catcha	analysi	:										
	Catcha	indepe	of	size	for	ages	>	3				
	Catcha	indepe	of	age	for	ages	>	4				
Termin	popula	estima	:									
	Survivo	estima	shrunk	towards	the	mean	F					
	of	the	final	4	years	or	the	3	oldest	ages.		
	S.E.	of	the	mean	to	which	the	estima	are	shrunk	=	1
	Minimu	standa	error	for	population							
	estima	derive	from	each	fleet	=	0.3					
	prior	weight	not	applied								
Regres	weights											
	year											
	age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
	all	1	1	1	1	1	1	1	1	1	1	
	Fishing	mortalities										
	year											
	age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
	1	0.17	0.111	0.012	0.004	0.16	0.012	0.004	0.04	0.017	0.006	
	2	0.286	0.78	0.057	0.026	0.101	0.139	0.11	0.072	0.254	0.117	
	3	0.272	0.935	0.227	0.192	0.698	0.818	0.23	0.135	0.169	0.113	
	4	0.365	1.038	0.394	0.276	0.168	1.01	0.485	0.097	0.159	0.333	
	5	0.583	0.321	0.215	0.009	0.3	0.444	0.328	0.022	0.164	0.059	
	6	1.182	0.776	0.343	0.059	0.405	0.735	0.36	0.15	0.763	0.041	
	7	1.182	0.776	0.343	0.059	0.405	0.735	0.36	0.15	0.763	0.041	

Table 4.3.17. Continued.

XSA	popula	number	(Thousand)								
age											
year	1	2	3	4	5	6	7				
2009	1576	3146	5730	29052	1239	419	786				
2010	1606	1089	1936	3573	16506	566	598				
2011	343	1177	409	622	1036	9807	940				
2012	1370	278	910	267	344	684	8262				
2013	36658	1117	221	615	166	279	1857				
2014	38814	25584	827	90	426	100	1422				
2015	20623	31411	18225	299	27	224	407				
2016	10472	16812	23027	11856	151	16	83				
2017	79118	8235	12813	16465	8813	121	121				
2018	17509	63696	5232	8860	11498	6123	360				
Estima	popula	abundance	at	1st	Jan	2019					
age											
year	1	2	3	4	5	6	7				
2019	0	14256	46384	3827	5198	8873	4813				
Fleet:	SCOGFS										
Log	catchal	residuals.									
year											
age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.296	0.179	-0.005	-0.103	0.062	0.181	-0.235	NA	0.121	NA	-0.49
2	-0.411	0.369	0.301	-0.048	0.087	0.164	-0.343	NA	-0.265	NA	-0.601
3	-0.485	0.36	0.419	0.316	0.347	-0.015	-0.739	NA	-0.276	NA	-0.402
4	-0.19	0.587	0.478	0.487	0.809	-0.007	-1.155	NA	-0.339	NA	-0.723
5	-0.221	0.094	0.512	-0.452	0.856	-0.046	-0.757	NA	-0.439	NA	-0.503
6	0.028	0.218	-0.036	-0.153	0.158	-0.173	-0.398	NA	-0.193	NA	-0.456
year											
age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	-0.175	0.029	NA	0.383	-0.15	0.26	0.264	0.308	NA	0.29	-1.393
2	-0.636	0.14	NA	0.165	0.632	-0.287	0.219	0.408	NA	0.346	0.206
3	-0.813	-0.231	NA	0.019	-0.045	0.422	-0.003	0.309	NA	0.299	0.464
4	-0.843	-0.554	NA	0.553	0.572	0.681	0.25	-0.046	NA	0.146	-0.189
5	-1.059	0.29	NA	-0.474	0.868	0.112	-0.179	-0.458	NA	0.249	1.048
6	-0.058	0.284	NA	0.089	0.285	-0.145	0.015	-0.444	NA	0.023	-0.011
year											
age	2013	2014	2015	2016	2017	2018					
1	0.371	-0.051	-0.057	0.129	0.142	0.235					
2	-1.363	0.326	0.264	-0.067	0.299	0.095					
3	0.331	-1.06	0.69	0.096	0.021	-0.025					
4	-1.66	0	0	0.582	0.203	0.36					
5	-0.137	-0.612	0	-0.037	0.092	0.13					
6	-0.383	0	0.181	-0.095	-0.081	-0.247					

Table 4.3.17. Continued.

	Mean	log	catchability	and	standa	error	of	ages	with	catchability		
	indepe	of	year	class	strengt	and	constai	w.r.t.	time			
	4	5	6									
Mean_	-2.423	-2.423	-2.4228									
S.E_Log	0.625	0.521	0.2161									
	Regres	statistics										
	Ages	with	q	depender	on	year	class	strength				
	slope	intercept										
Age	1	0.701	4.162033									
Age	2	0.773	3.847961									
Age	3	0.847	3.495144									
	Termir	year	survivor	and	F	summaries:						
	Age	1	Year	class	2017							
source												
	scaled\	survivc	yrcls									
SCOGF	0.698	19930	2017									
fshk	0.215	4312	2017									
nshk	0.088	18472	2017									
	Age	2	Year	class	2016							
source												
	scaled\	survivc	yrcls									
SCOGF	0.712	52415	2016									
fshk	0.288	37156	2016									
	Age	3	Year	class	2015							
source												
	scaled\	survivc	yrcls									
SCOGF	0.746	3716	2015									
fshk	0.254	1126	2015									
	Age	4	Year	class	2014							
source												
	scaled\	survivc	yrcls									
SCOGF	0.616	7448	2014									
fshk	0.384	3711	2014									
	Age	5	Year	class	2013							
source												
	scaled\	survivc	yrcls									
SCOGF	0.759	10102	2013									
fshk	0.241	1989	2013									
	Age	6	Year	class	2012							
source												
	scaled\	survivc	yrcls									
SCOGF	0.914	3760	2012									
fshk	0.086	1090	2012									

Table 4.3.18. Haddock in 6.b. Final XSA runs. Fishing mortality-at-age.

table	4.3.18	.	HADDOCK	LANDISC	2014	ROCKALL	.	harvest	
	22/08/19	15:13:10	units=	f					
	age								
year	1	2	3	4	5	6	7		
	1991	0.24	0.61	0.901	0.948	0.46	0.695	0.695	
	1992	0.178	0.49	0.829	0.994	1.011	0.332	0.332	
	1993	0.107	0.337	0.662	0.543	0.986	0.82	0.82	
	1994	0.142	0.293	0.601	0.935	0.573	0.926	0.926	
	1995	0.051	0.253	0.572	0.797	0.836	0.362	0.362	
	1996	0.241	0.573	0.496	0.545	0.701	0.667	0.667	
	1997	0.167	0.342	0.316	0.349	0.617	1.081	1.081	
	1998	0.248	0.581	0.656	0.512	0.625	0.859	0.859	
	1999	0.501	0.754	0.898	0.948	0.881	1.434	1.434	
	2000	0.39	0.863	1.107	1.259	1.273	1.414	1.414	
	2001	0.115	0.154	0.256	0.21	1.057	1.31	1.31	
	2002	0.152	0.243	0.611	0.721	0.375	0.852	0.852	
	2003	0.167	0.438	0.579	0.632	1.134	0.854	0.854	
	2004	0.075	0.149	0.346	0.932	1.284	0.9	0.9	
	2005	0.084	0.482	0.438	0.509	0.167	0.289	0.289	
	2006	0.037	0.162	0.401	0.246	0.259	0.137	0.137	
	2007	0.133	0.17	0.75	0.823	0.378	0.34	0.34	
	2008	0.128	0.299	0.305	0.664	0.739	0.278	0.278	
	2009	0.17	0.286	0.272	0.365	0.583	1.182	1.182	
	2010	0.111	0.78	0.935	1.038	0.321	0.776	0.776	
	2011	0.012	0.057	0.227	0.394	0.215	0.343	0.343	
	2012	0.004	0.026	0.192	0.276	0.009	0.059	0.059	
	2013	0.16	0.101	0.698	0.168	0.3	0.405	0.405	
	2014	0.012	0.139	0.818	1.01	0.444	0.735	0.735	
	2015	0.004	0.11	0.23	0.485	0.328	0.36	0.36	
	2016	0.04	0.072	0.135	0.097	0.022	0.15	0.15	
	2017	0.017	0.254	0.169	0.159	0.164	0.763	0.763	
	2018	0.006	0.117	0.113	0.333	0.059	0.041	0.041	

Table 4.3.19. Haddock in 6.b. Final XSA runs. Stock numbers ($*10^3$) at-age.

table	4.3.19	.	HADDOCK	LANDISC	2014	ROCKALL	.	stock.n	
	22/08/19	15:13:10	units=	NA					
	age								
year	1	2	3	4	5	6	7		
	1991	109540	81935	28277	9640	5108	762	1136	
	1992	109143	70515	36457	9407	3059	2640	799	
	1993	121862	74805	35373	13033	2852	911	699	
	1994	68327	89657	43714	14941	6202	871	418	
	1995	61262	48549	54745	19623	4805	2862	285	
	1996	62439	47669	30854	25291	7238	1704	206	
	1997	71687	40176	22007	15388	12009	2941	339	
	1998	71695	49683	23361	13143	8890	5306	2626	
	1999	48472	45829	22755	9921	6450	3894	3930	
	2000	28158	24048	17661	7588	3148	2187	2944	
	2001	78115	15614	8305	4780	1763	722	844	
	2002	104614	57015	10962	5262	3171	502	842	
	2003	47320	73559	36619	4870	2095	1784	1140	
	2004	14170	32792	38866	16799	2119	552	869	
	2005	14506	10758	23128	22517	5418	480	845	
	2006	88242	10917	5440	12222	11084	3755	1297	
	2007	13174	69641	7603	2982	7822	7002	2739	
	2008	4368	9438	48124	2940	1072	4389	4208	
	2009	1576	3146	5730	29052	1239	419	786	
	2010	1606	1089	1936	3573	16506	566	598	
	2011	343	1177	409	622	1036	9807	940	
	2012	1370	278	910	267	344	684	8262	
	2013	36658	1117	221	615	166	279	1857	
	2014	38814	25584	827	90	426	100	1422	
	2015	20623	31411	18225	299	27	224	407	
	2016	10472	16812	23027	11856	151	16	83	
	2017	79118	8235	12813	16465	8813	121	121	
	2018	17509	63696	5232	8860	11498	6123	360	

Table 4.3.20. Haddock in 6.b. Final XSA run. Summary table.

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	Yield/SSB	Fbar(2-5)
1991	109540	50576	15357	5656	0.3683	0.7295
1992	109143	49840	18471	5321	0.2881	0.8308
1993	121862	54043	19544	4781	0.2446	0.6318
1994	68327	55199	23854	5732	0.2403	0.6005
1995	61262	48513	28760	5587	0.1943	0.6148
1996	62439	44403	24438	7072	0.2894	0.5785
1997	71687	40589	21117	5167	0.2447	0.4058
1998	71695	43790	21795	4986	0.2288	0.5936
1999	48472	36338	18844	5356	0.2842	0.8703
2000	28158	22789	12730	5445	0.4278	1.1255
2001	78115	21243	5981	2020	0.3377	0.4194
2002	104614	36331	7155	3118	0.4357	0.4875
2003	47320	38443	14205	5968	0.4201	0.6958
2004	14170	27686	17971	6434	0.3581	0.6776
2005	14506	21446	17107	5239	0.3063	0.3988
2006	88242	26901	13346	2756	0.2065	0.2671
2007	13174	27314	12031	3347	0.2782	0.5302
2008	4368	22368	19862	4222	0.2126	0.5018
2009	1576	14298	13357	3241	0.2427	0.3766
2010	1606	12056	11548	3404	0.2947	0.7683
2011	343	8628	8274	1860	0.2248	0.2233
2012	1370	10547	10184	686	0.0674	0.1257
2013	36658	10975	2872	889	0.3096	0.3171
2014	38814	17434	2474	1845	0.7458	0.6028
2015	20623	22474	9371	2510	0.2679	0.2883
2016	10472	26020	18346	2504	0.1365	0.0815
2017	79118	43365	25077	4430	0.1767	0.1865
2018	17509	53527	28703	3850	0.1341	0.1556

Table 4.3.21. Haddock in 6.b. Detailed short-term forecast output.

MFDP version 1a												
Run: FMSY1												
Time and date: 01:32 04.09.2019												
Fbar age range (Total) : 2-5												
Fbar age range Fleet 1 : 2-5												
Year:	2018	F multipli	1	Fleet1 HC	0.1085	Fleet1 DF	0.047					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.001	16	3	0.005	79	7	17509	2977	0	0	0	0
2	0.0397	2167	719	0.0773	4220	1089	63696	21848	0	0	0	0
3	0.0793	356	201	0.0337	151	55	5232	2742	5232	2742	5232	2742
4	0.2672	1835	1294	0.0658	452	191	8860	5316	8860	5316	8860	5316
5	0.0479	485	454	0.0111	112	54	11498	12912	11498	12912	11498	12912
6	0.0388	211	261	0.0022	12	6	6123	7109	6123	7109	6123	7109
7	0.0401	13	25	0.0009	0	0	360	623	360	623	360	623
Total		5083	2957		5027	1401	113278	53526	32073	28702	32073	28702
Year:	2019	F multipli	1.1476	Fleet1 HC	0.1065	Fleet1 DF	0.0555					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.004	88	19	0.0201	440	65	24444	4620	0	0	0	0
2	0.0574	684	280	0.112	1334	343	14250	4902	0	0	0	0
3	0.1119	4360	2354	0.0476	1856	642	46392	22361	46392	22361	46392	22361
4	0.1807	563	345	0.0445	139	57	3826	2322	3826	2322	3826	2322
5	0.0761	343	386	0.0177	80	41	5199	5283	5199	5283	5199	5283
6	0.3454	2342	2721	0.0195	132	85	8874	10197	8874	10197	8874	10197
7	0.3571	1390	2406	0.0078	30	18	5095	8350	5095	8350	5095	8350
Total		9770	8512		4011	1251	108080	58034	69386	48513	69386	48513
Year:	2020	F multipli	1.4	Fleet1 HC	0.13	Fleet1 DF	0.0677					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0049	62	14	0.0245	310	46	14170	2678	0	0	0	0
2	0.07	1124	460	0.1366	2193	564	19537	6721	0	0	0	0
3	0.1365	1111	600	0.0581	473	164	9849	4747	9849	4747	9849	4747
4	0.2205	5684	3479	0.0543	1400	574	32382	19656	32382	19656	32382	19656
5	0.0928	199	224	0.0216	46	24	2501	2541	2501	2541	2501	2541
6	0.4214	1204	1399	0.0238	68	44	3876	4453	3876	4453	3876	4453
7	0.4357	2549	4413	0.0095	56	34	7940	13014	7940	13014	7940	13014
Total		11933	10587		4547	1448	90254	53809	56547	44411	56547	44411
Year:	2021	F multipli	1.4	Fleet1 HC	0.13	Fleet1 DF	0.0677					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0049	62	14	0.0245	310	46	14170	2678	0	0	0	0
2	0.07	648	265	0.1366	1265	325	11265	3875	0	0	0	0
3	0.1365	1467	792	0.0581	625	216	13009	6270	13009	6270	13009	6270
4	0.2205	1165	713	0.0543	287	118	6638	4029	6638	4029	6638	4029
5	0.0928	1604	1808	0.0216	373	193	20142	20464	20142	20464	20142	20464
6	0.4214	567	659	0.0238	32	21	1826	2098	1826	2098	1826	2098
7	0.4357	1990	3445	0.0095	43	26	6198	10159	6198	10159	6198	10159
Total		7503	7695		2935	944	73248	49573	47812	43020	47812	43020
Input units are thousands and kg - output in tonnes												

Table 4.3.22. Haddock in 6.b. Input data for the short-term forecast.

MFDP version 1a						
Run: FMSY1						
Time and date: 01:32 04.09.2018						
Fbar age range (Total) : 2-5						
Fbar age range Fleet 1 : 2-5						
2018						
Age	N	M	Mat	PF	PM	SWt
1	17509	0.2	0	0	0	0.17
2	63696	0.2	0	0	0	0.343
3	5232	0.2	1	0	0	0.524
4	8860	0.2	1	0	0	0.6
5	11498	0.2	1	0	0	1.123
6	6123	0.2	1	0	0	1.161
7	360	0.2	1	0	0	1.731
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.000989	0.219	0.005	0.087		
2	0.0397	0.332	0.0773	0.258		
3	0.0793	0.564	0.0337	0.361		
4	0.2672	0.705	0.0658	0.422		
5	0.0479	0.935	0.0111	0.479		
6	0.0388	1.235	0.0022	0.536		
7	0.0401	1.928	0.0009	0.603		
2019						
Age	N	M	Mat	PF	PM	SWt
1	24444	0.2	0	0	0	0.189
2	.	0.2	0	0	0	0.344
3	.	0.2	1	0	0	0.482
4	.	0.2	1	0	0	0.607
5	.	0.2	1	0	0	1.016
6	.	0.2	1	0	0	1.149
7	.	0.2	1	0	0	1.639
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0035	0.219	0.0175	0.147		
2	0.05	0.409	0.0976	0.257		
3	0.0975	0.54	0.0415	0.346		
4	0.1575	0.612	0.0388	0.41		
5	0.0663	1.127	0.0154	0.517		
6	0.301	1.162	0.017	0.642		
7	0.3112	1.731	0.0068	0.603		
2020						
Age	N	M	Mat	PF	PM	SWt
1	14170	0.2	0	0	0	0.189
2	.	0.2	0	0	0	0.344
3	.	0.2	1	0	0	0.482
4	.	0.2	1	0	0	0.607
5	.	0.2	1	0	0	1.016
6	.	0.2	1	0	0	1.149
7	.	0.2	1	0	0	1.639
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0035	0.219	0.0175	0.147		
2	0.05	0.409	0.0976	0.257		
3	0.0975	0.54	0.0415	0.346		
4	0.1575	0.612	0.0388	0.41		
5	0.0663	1.127	0.0154	0.517		
6	0.301	1.162	0.017	0.642		
7	0.3112	1.731	0.0068	0.603		
2021						
Age	N	M	Mat	PF	PM	SWt
1	14170	0.2	0	0	0	0.189
2	.	0.2	0	0	0	0.344
3	.	0.2	1	0	0	0.482
4	.	0.2	1	0	0	0.607
5	.	0.2	1	0	0	1.016
6	.	0.2	1	0	0	1.149
7	.	0.2	1	0	0	1.639
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0035	0.219	0.0175	0.147		
2	0.05	0.409	0.0976	0.257		
3	0.0975	0.54	0.0415	0.346		
4	0.1575	0.612	0.0388	0.41		
5	0.0663	1.127	0.0154	0.517		
6	0.301	1.162	0.017	0.642		
7	0.3112	1.731	0.0068	0.603		
Input units are thousands and kg - output in tonnes						

Table 4.3.23. Haddock in 6.b. Short-term forecast output.

MFDP version 1a								
Run: FMSY								
Time and date: 08:19 26.08.2019								
Fbar age range (Total) : 2-5								
Fbar age range Fleet 1 : 2-5								
2018								
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
53526	28702	1	0.1085	2957	0.047	1401		
2019								
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
58034	48513	1.1476	0.1065	8512	0.0555	1251		
2020							2021	
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
53809	44411	1.1	0.1021	8614	0.0532	1165	52364	45786
.	44411	1.13	0.1049	8818	0.0546	1194	52076	45500
.	44411	1.16	0.1077	9020	0.0561	1223	51790	45217
.	44411	1.19	0.1105	9221	0.0575	1251	51506	44936
.	44411	1.22	0.1132	9420	0.059	1280	51224	44656
.	44411	1.25	0.116	9618	0.0604	1308	50945	44379
.	44411	1.28	0.1188	9815	0.0619	1337	50667	44103
.	44411	1.31	0.1216	10010	0.0633	1365	50390	43830
.	44411	1.34	0.1244	10204	0.0648	1393	50116	43558
.	44411	1.37	0.1272	10396	0.0662	1420	49844	43288
.	44411	1.4	0.13	10587	0.0677	1448	49573	43020
.	44411	1.43	0.1327	10777	0.0691	1476	49305	42754
.	44411	1.46	0.1355	10965	0.0706	1503	49038	42489
.	44411	1.49	0.1383	11152	0.072	1530	48773	42227
.	44411	1.52	0.1411	11338	0.0735	1558	48510	41966
.	44411	1.55	0.1439	11522	0.0749	1585	48248	41707
.	44411	1.58	0.1467	11705	0.0764	1612	47989	41450
.	44411	1.61	0.1494	11886	0.0778	1638	47731	41194
.	44411	1.64	0.1522	12067	0.0793	1665	47475	40941
.	44411	1.67	0.155	12246	0.0807	1691	47220	40689
.	44411	1.7	0.1578	12423	0.0822	1718	46967	40438
Input units are thousands and kg - output in tonnes								

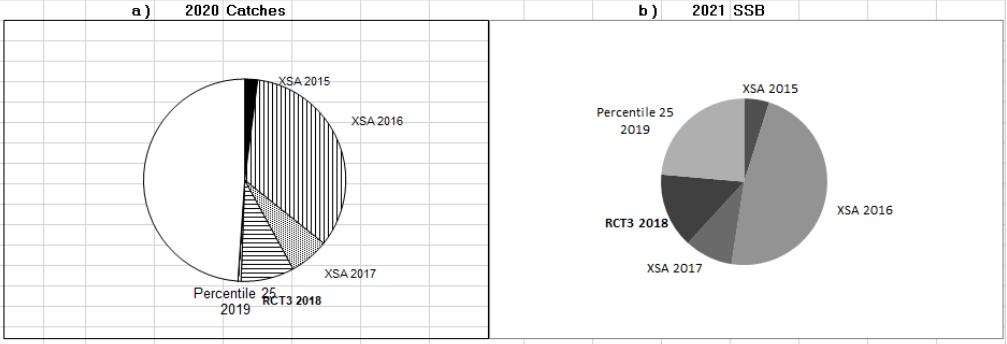
Table 4.3.24. Haddock 6.b. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class			2015	2016	2017	2018	2019
Stock No. (thousands)			10472	79118	17509	24444	14170
of	1	year-olds					
Source			XSA	XSA	XSA	RCT3	Percentile 25
F2017 = 0.31, F 2018=0.2:							
% in	2019	landings	4.1	30.7	6.4	0.9	-
% in	2020	landings	2.1	33.7	6.3	8.5	0.5
% in	2019	SSB	4.8	46.1	0.0	0.0	-
% in	2020	SSB	5.7	44.3	10.7	0.0	0.0
% in	2021	SSB	4.9	47.6	9.4	14.6	0.0

GM : geometric mean recruitment

Haddock VIb : Year-class % contribution to

a) 2020 Catches | **b) 2021 SSB**



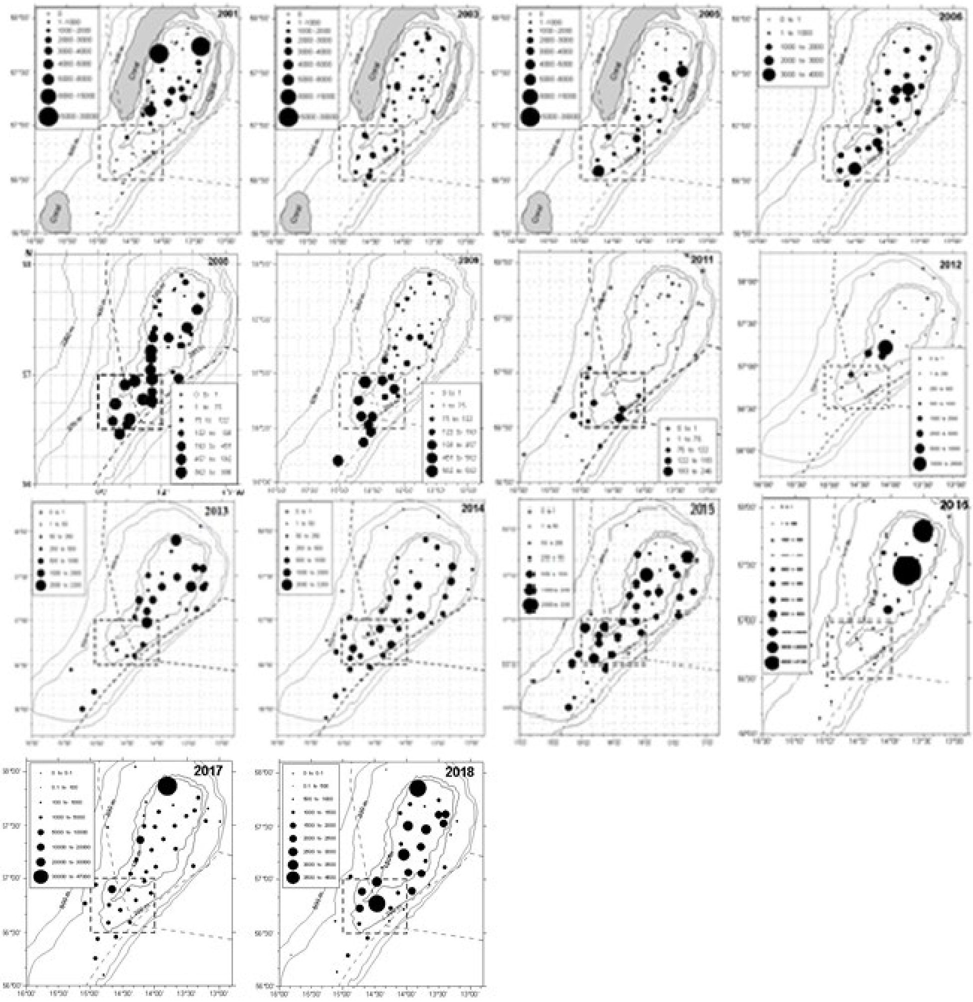


Figure 4.3.1. Distribution of haddock (catch N per 30 minutes) on the Rockall Bank in 2001–2017 from the Scottish trawl survey (Scottish Rock-IBTS-Q3).

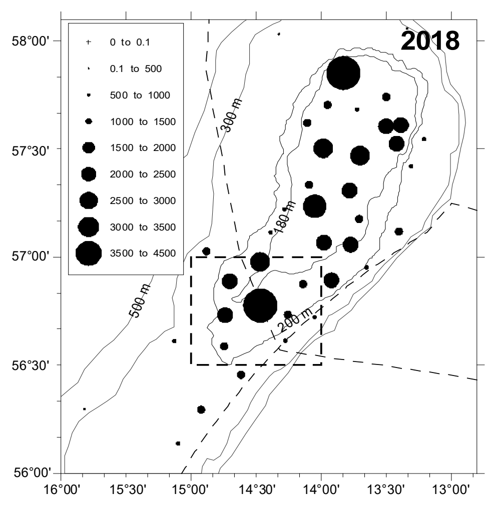


Figure 4.3.2. Haulings pattern during bottom survey by RV 'Scotia' in September 2017.

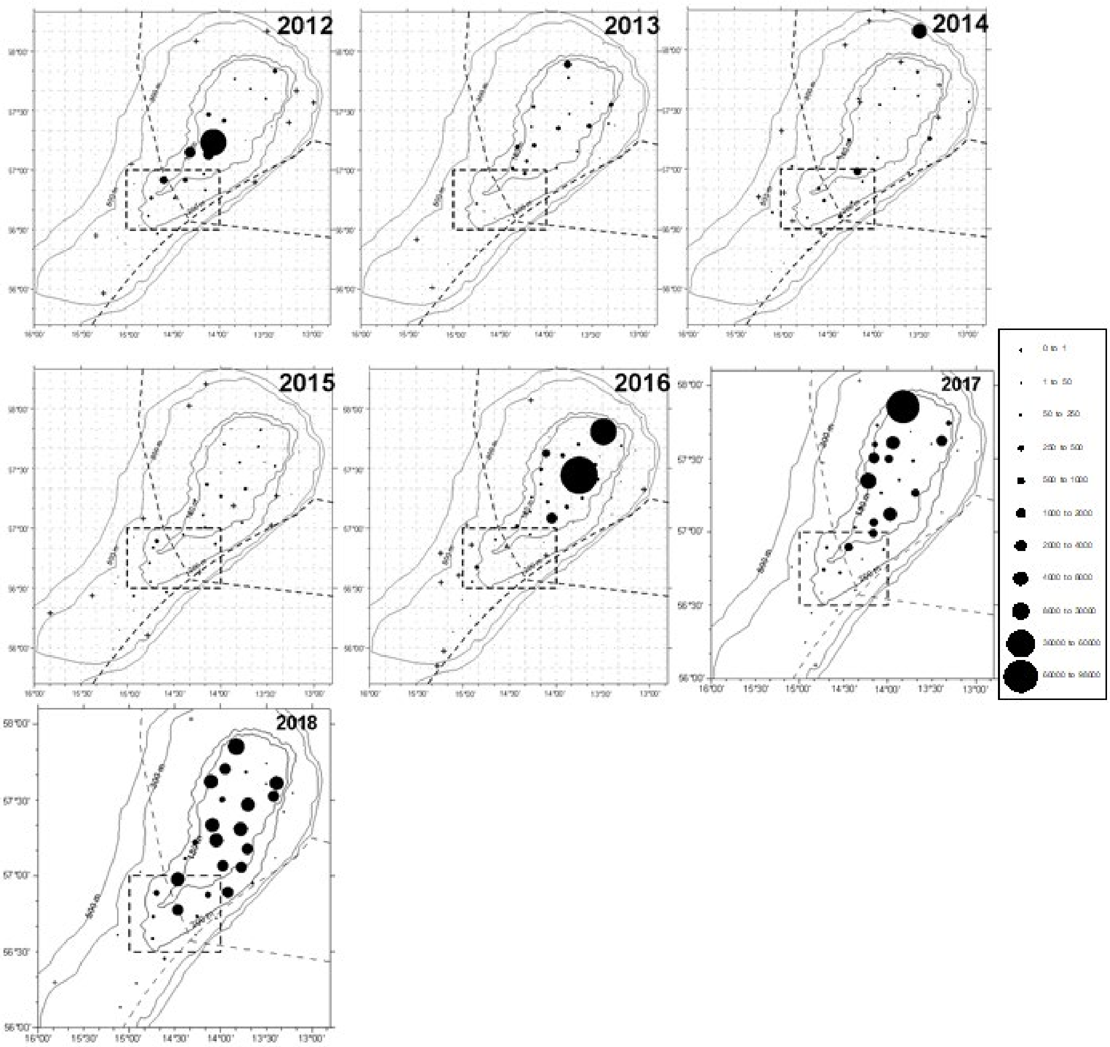


Figure 4.3.3. Distribution of 0-group haddock (number per 30 minutes) on the Rockall Bank in 2012–2018 from the Scottish trawl survey.

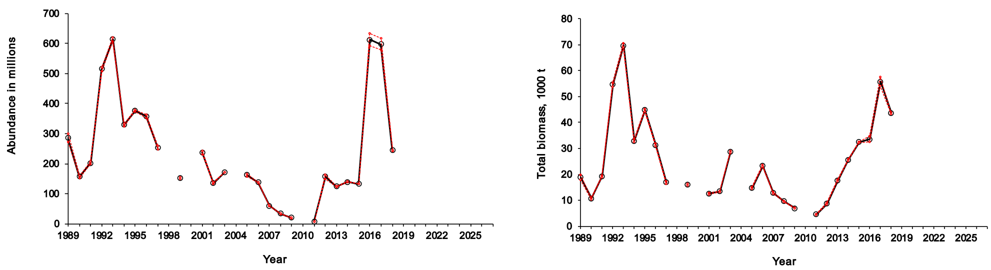


Figure 4.3.4. Abundance (a) and biomass (b) of haddock, assessed with the trawl survey method with geographical stratification based on rectangles of 15′ latitude and 15′ longitude by RV 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

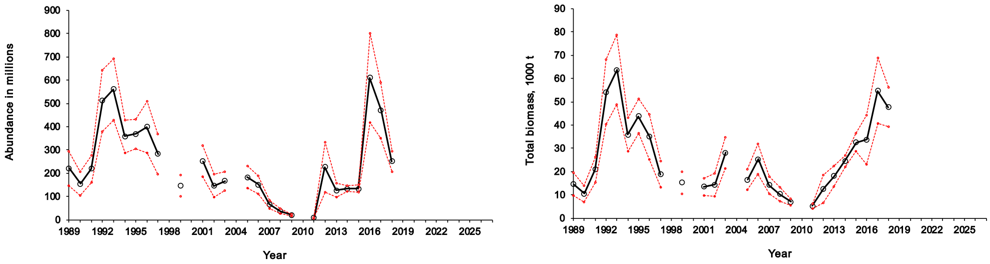


Figure 4.3.5. Abundance (a) and biomass (b) of haddock, assessed with the trawl survey method with geographical stratification based on bathymetry by RV 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

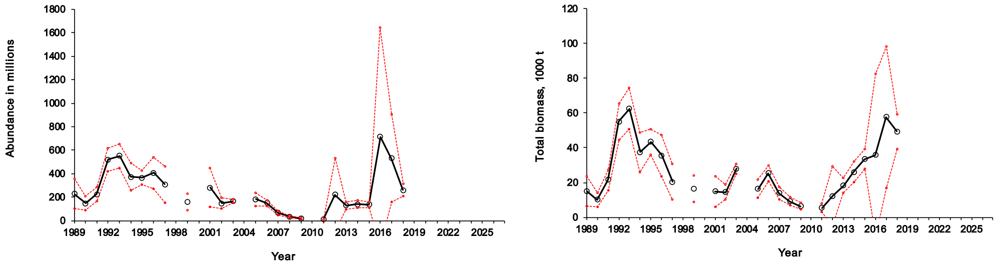


Figure 4.3.6. Abundance (a) and biomass (b) of haddock, assessed with the trawl survey method without geographical stratification by RV 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

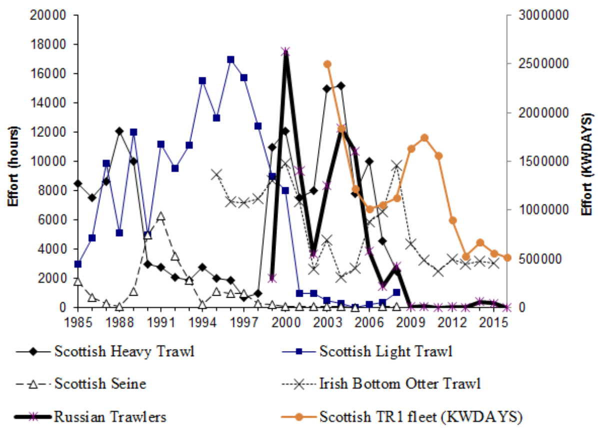


Figure 4.3.7. Rockall haddock in 6.b. Scottish, Irish effort in 1985–2016 and Russian effort in 1999–2016. Data for 2017–2018 are not available.

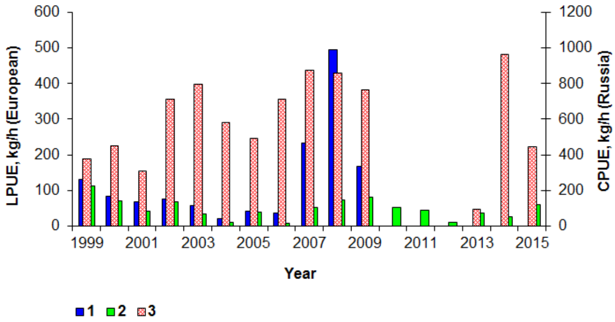


Figure 4.3.8. Lpue and cpue of the fleets fishing for Rockall haddock. Note that Scottish and Irish effort data are not reliable because reporting is not mandatory (data for 2016–2018 are not available).
1 – Scottish lpue (all gears).
2 – Irish trawlers lpue.
3 – Cpue of Russian trawlers (BMRT type, tonnage class 10 in 1999–2007, and tonnage class 9 in 2008–2009, 2013–2015).

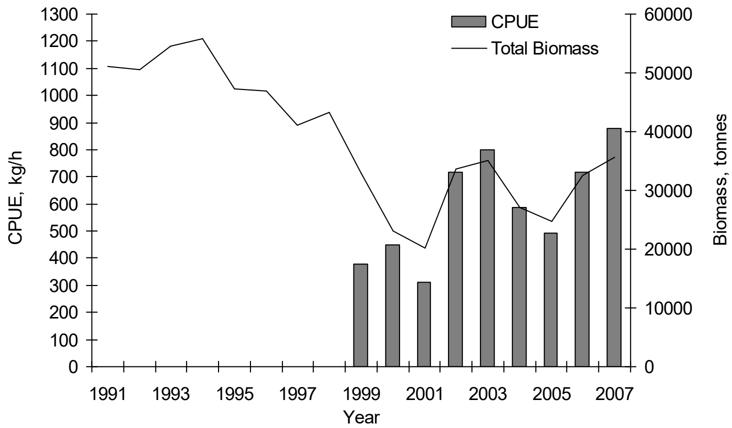


Figure 4.3.9. Dynamics of haddock total biomass (ICES, 2008a; ICES, 2008b) and directed fishing efficiency (t per a trawling hour) for tonnage class 10 vessels in 1999–2007.

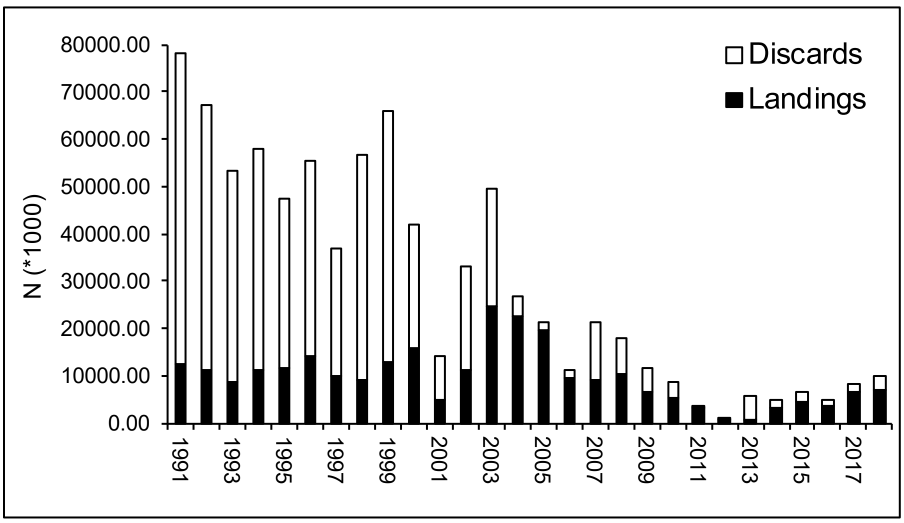


Figure 4.3.10. Total landings and discards of Rockall haddock ('000 individuals).

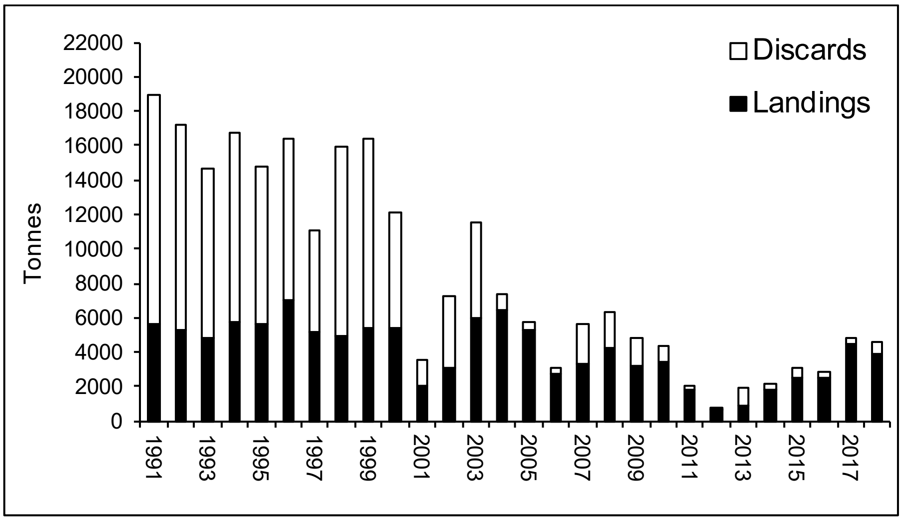


Figure 4.3.11. Total landings and discards of Rockall haddock (tonnes).

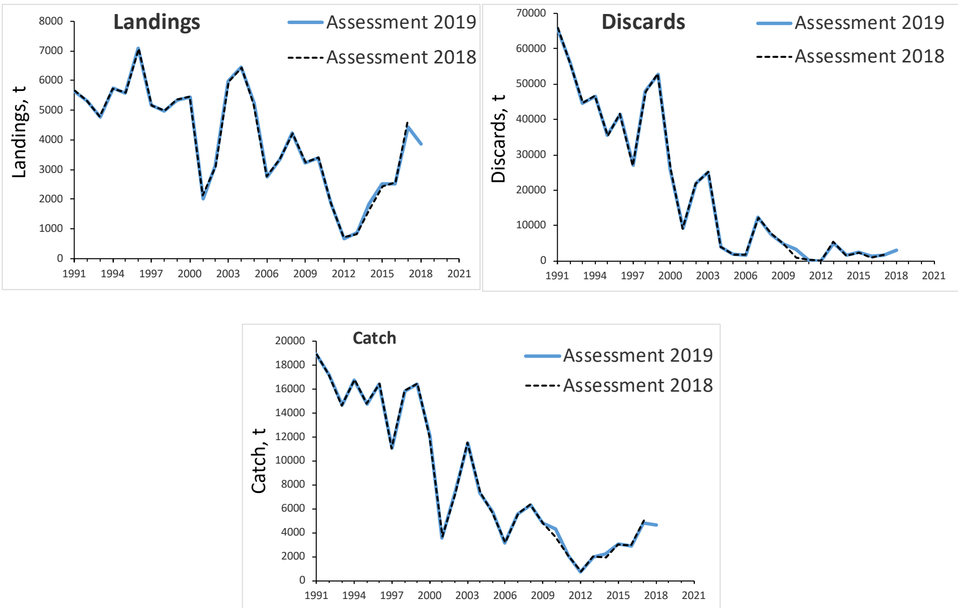


Figure 4.3.12. Comparison the landings, discards and catch of Rockall haddock from assessments 2018 and 2019.

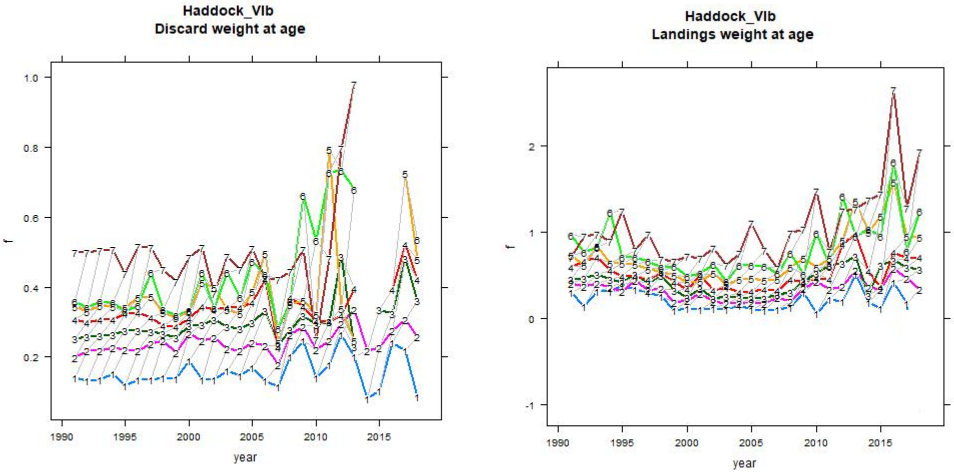


Figure 4.3.13. Haddock in 6.b. Mean weights-at-age in discards (left) and in landings (right).

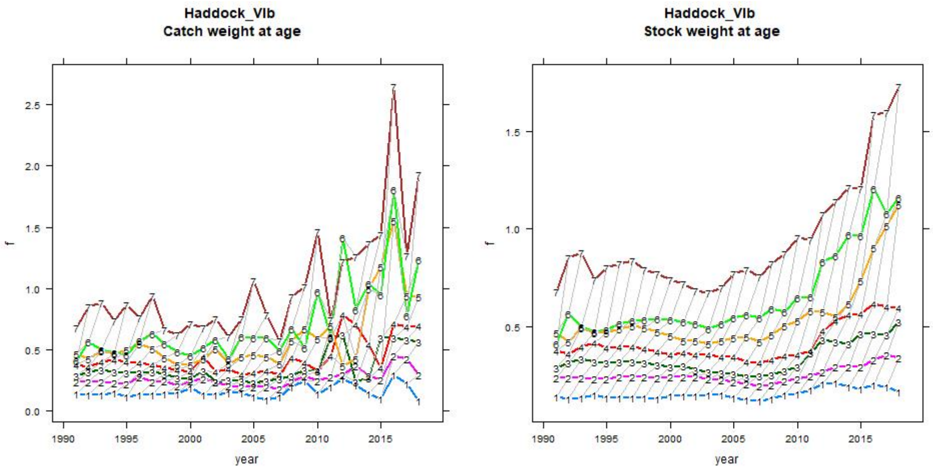


Figure 4.3.14. Haddock in 6.b. Mean weights-at-age in catch (left) and in stock (right)

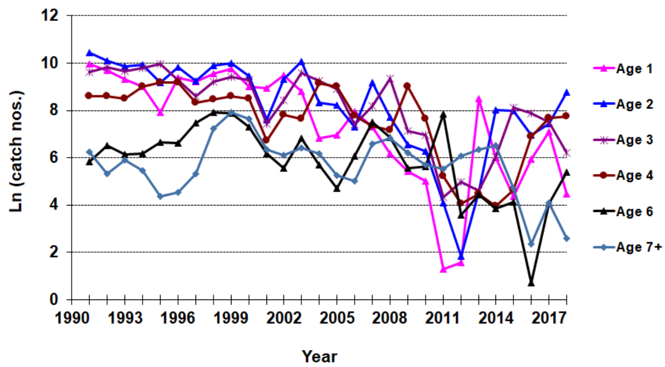


Figure 4.3.15. Haddock in 6.b. Log catch (with discards in numbers)-at-age by year.

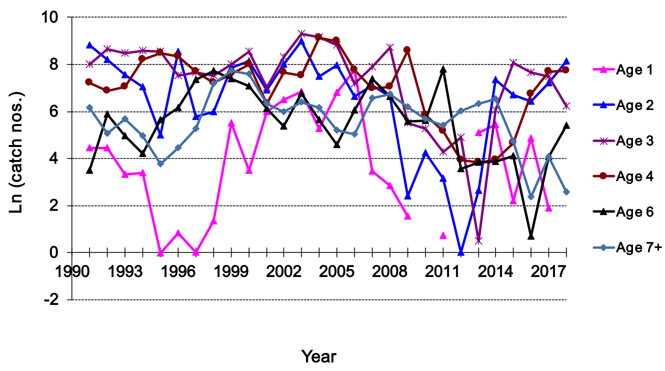


Figure 4.3.16. Haddock in 6.b. Log landings (in numbers) at age by year.

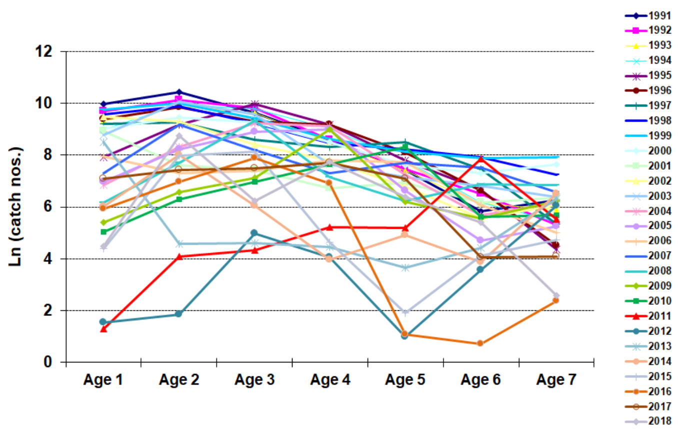


Figure 4.3.18. Haddock in 6.b. Catch curves (with registered discards).

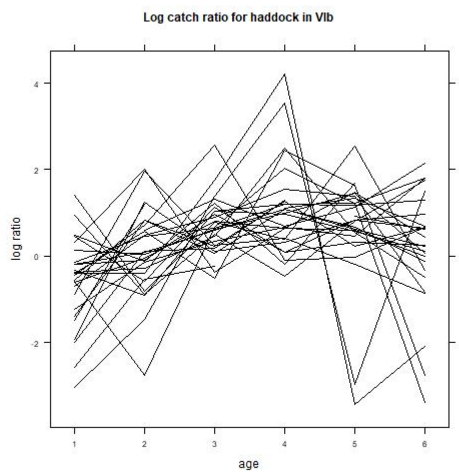


Figure 4.3.19. Haddock in 6.b. Catch curves (with registered discards).

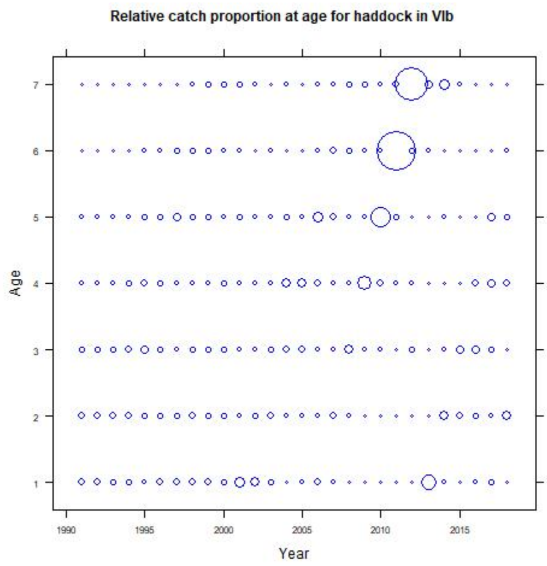


Figure 4.3.20. Haddock in 6.b. Relative catch proportion-at-age.

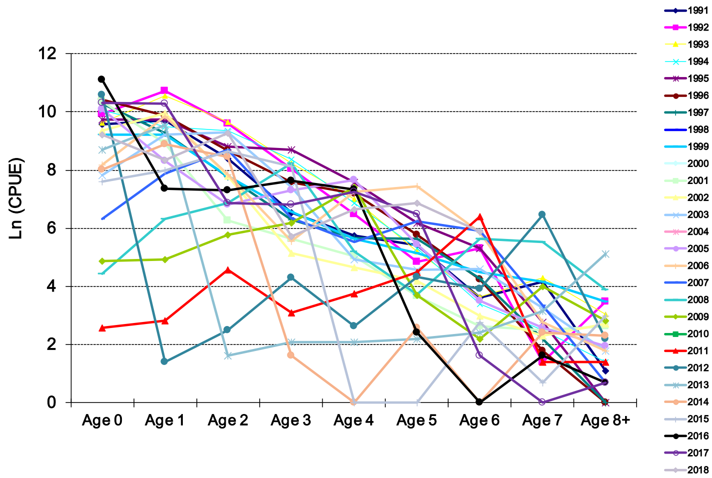


Figure 4.3.21. Haddock in 6.b. Log survey cpue at-age by year.

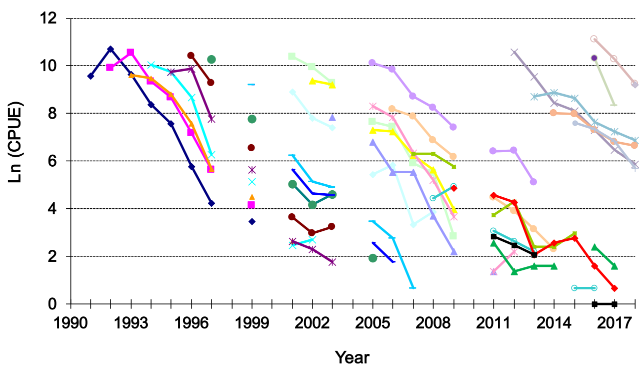


Figure 4.3.22. Haddock in 6.b. Final XSA run. Log survey cpue by year class.

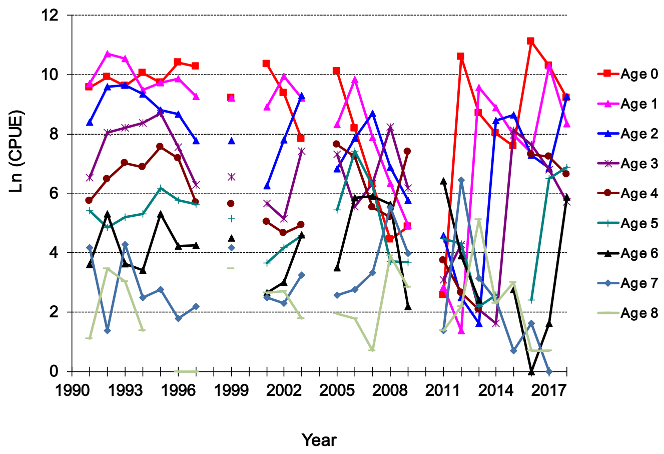


Figure 4.3.23. Haddock in 6.b. Log survey cpue-at-age.

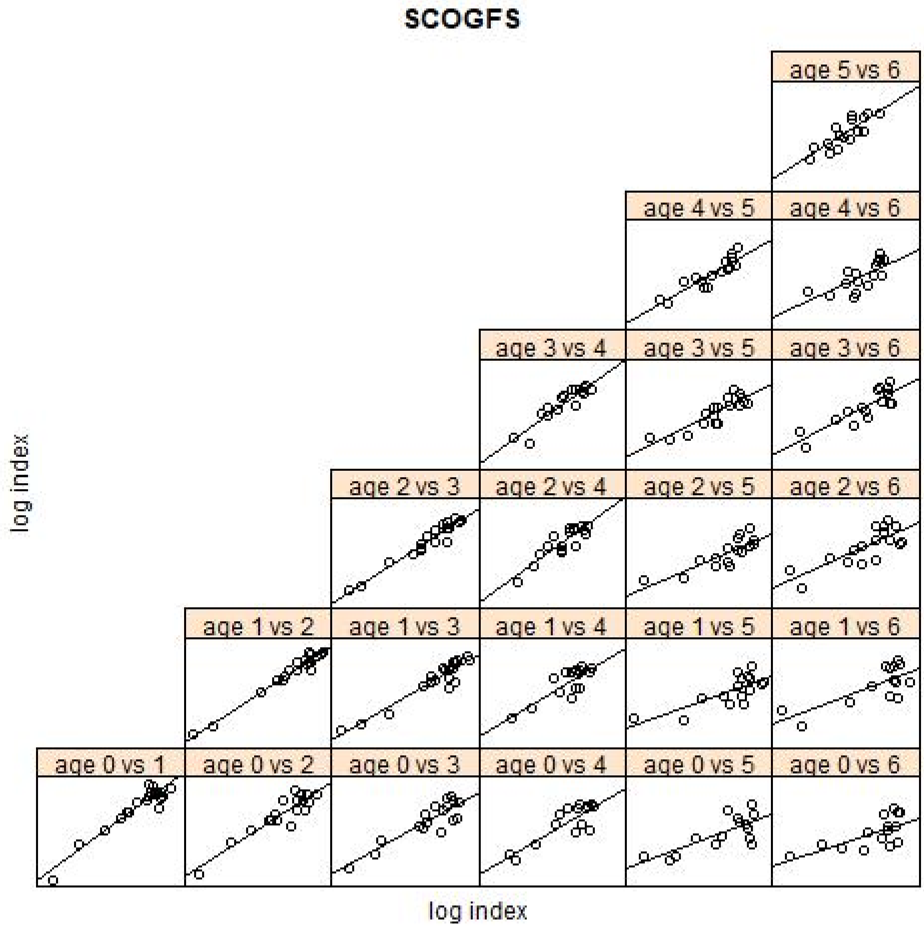


Figure 4.3.24. Haddock in 6.b. The analysis of survey data. Pairwise plots of age.

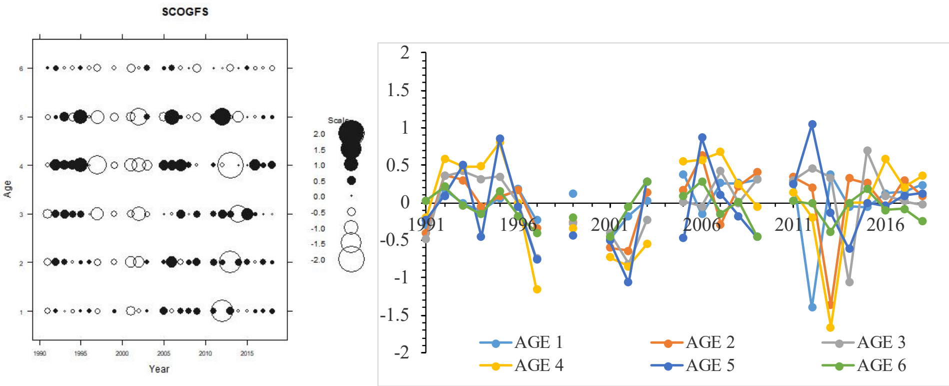


Figure 4.3.25. Haddock in 6.b. Log catchability residual plots (shrinkage 1.0, catchability dependent on stock size at-ages <4). Final XSA.

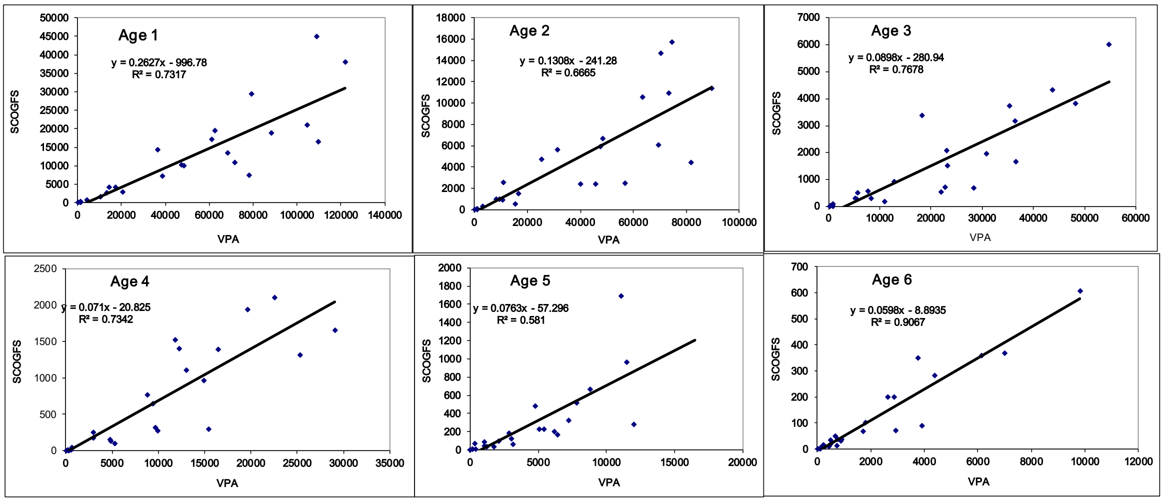


Figure 4.3.26. Haddock in 6.b. Adjusted Scottish groundfish survey cpue from the final XSA run plotted against VPA numbers-(shrinkage 1.0) at-age. Catchability dependent on stock size at-ages <4.

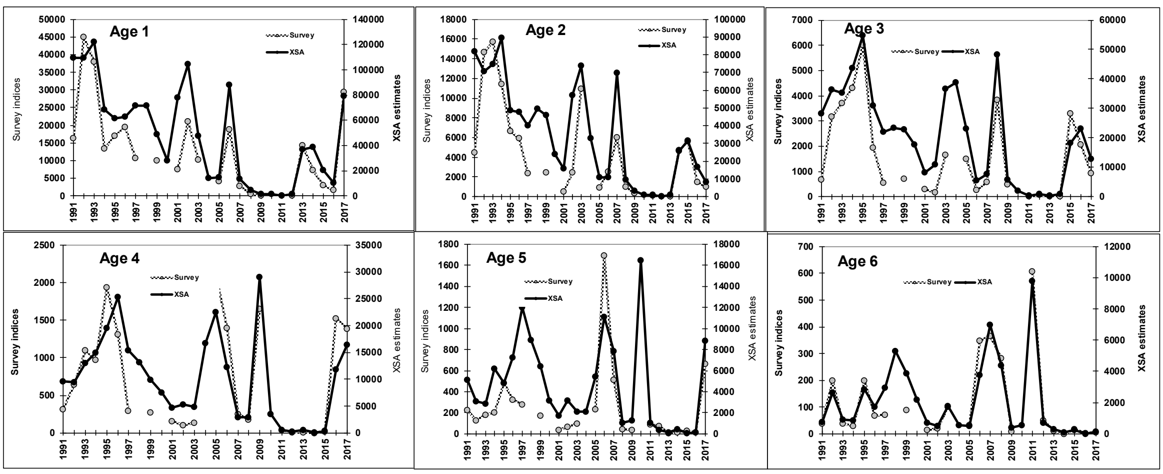


Figure 4.3.27. Haddock in 6.b. Survey indices and XSA estimates (shrinkage 1.0) at-age. Final XSA: catchability dependent on stock size at-ages <4.

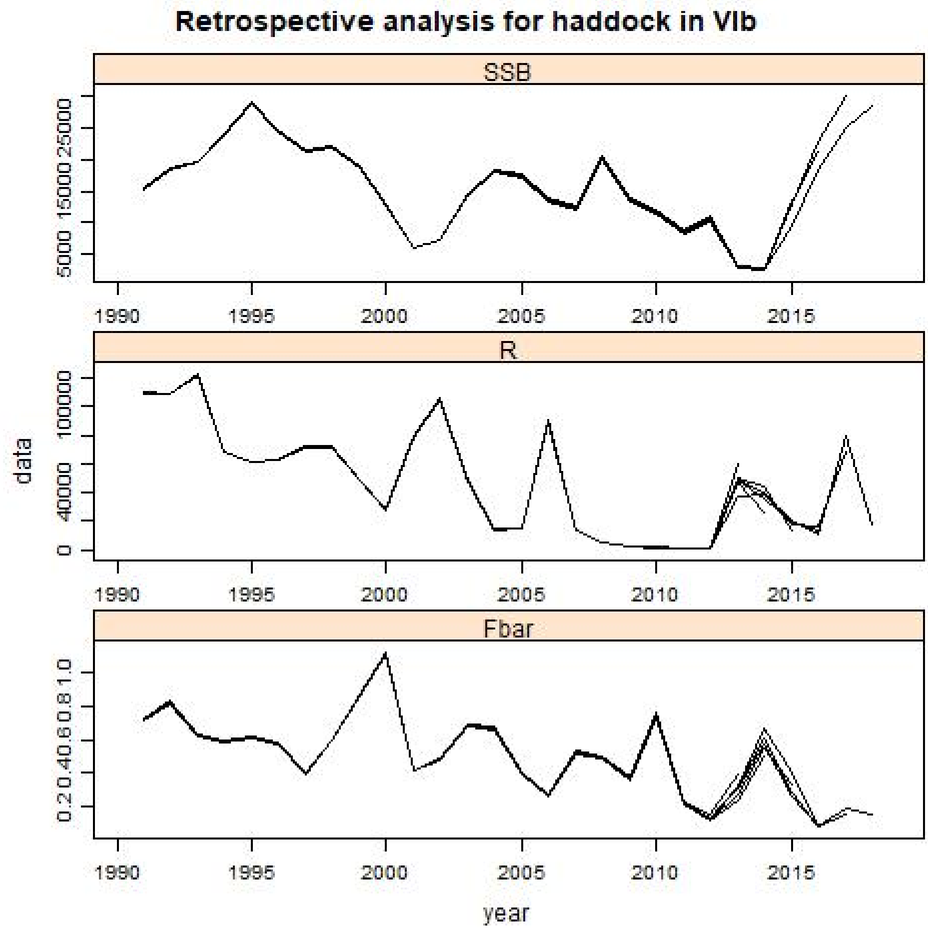


Figure 4.3.28. Haddock in 6.b. Retrospective analyses (F shrinkage 1.0).

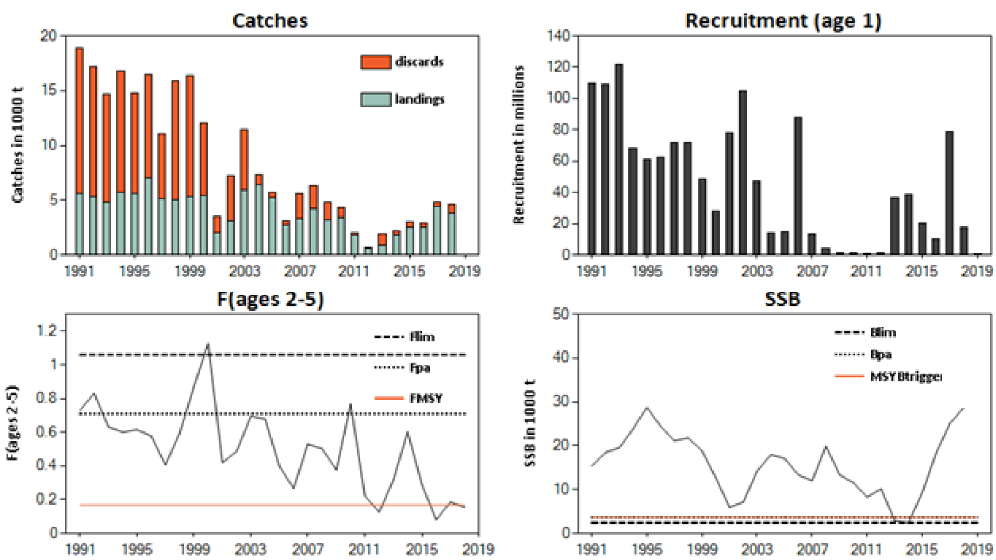


Figure 4.3.29. Haddock in 6.b. XSA assessment. Summary plots.

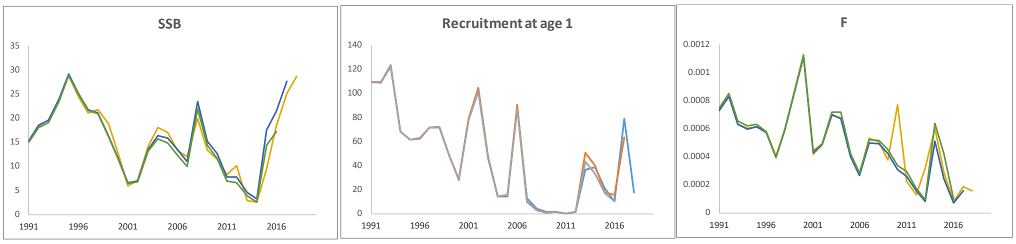


Figure 4.3.30. Haddock in 6.b. Comparison of the current final assessment (in red) with the previous one (in black). In the SSB plot, the solid blue line indicates B_{PA} and the dotted blue line refers to B_{lim}. In the fishing mortality plot, the solid blue line signifies F_{PA}.

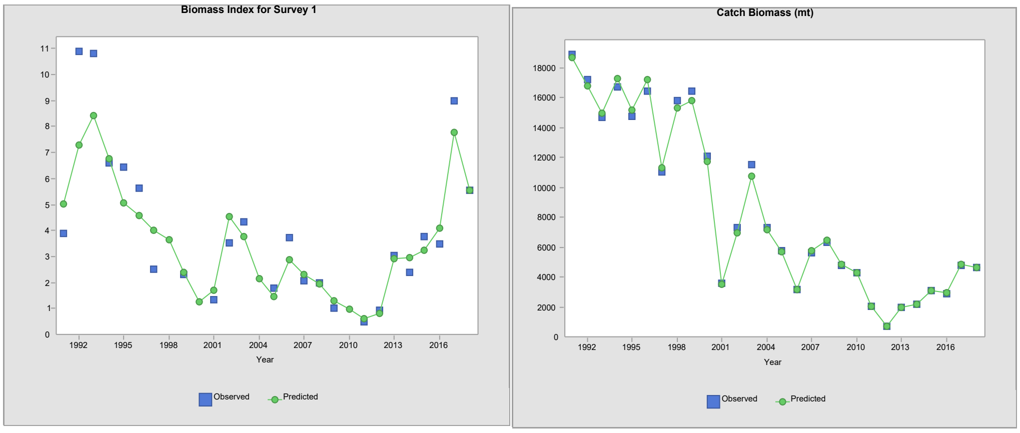


Figure 4.3.31. Haddock in 6.b. Comparison of observed and predicted survey and catch biomass derived from StatCam. The parametric model (scenario 2).

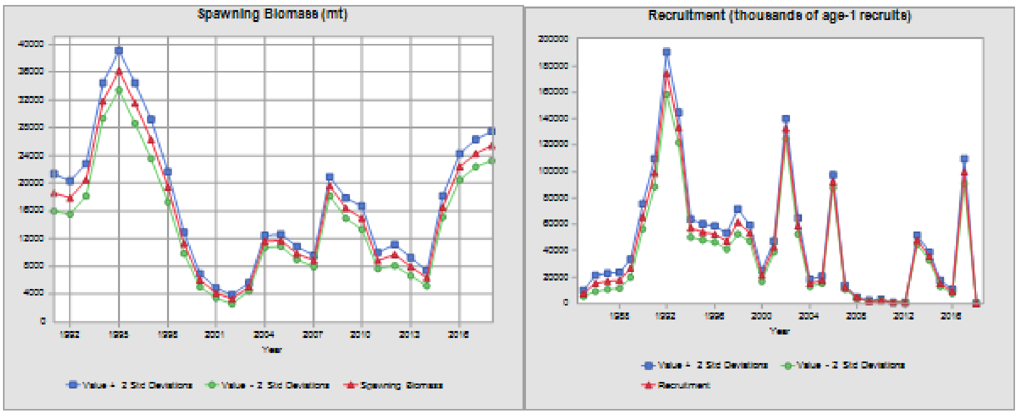


Figure 4.3.32. Haddock in 6.b. The SSB and recruitment by StatCam estimation. The parametric model (scenario 2).

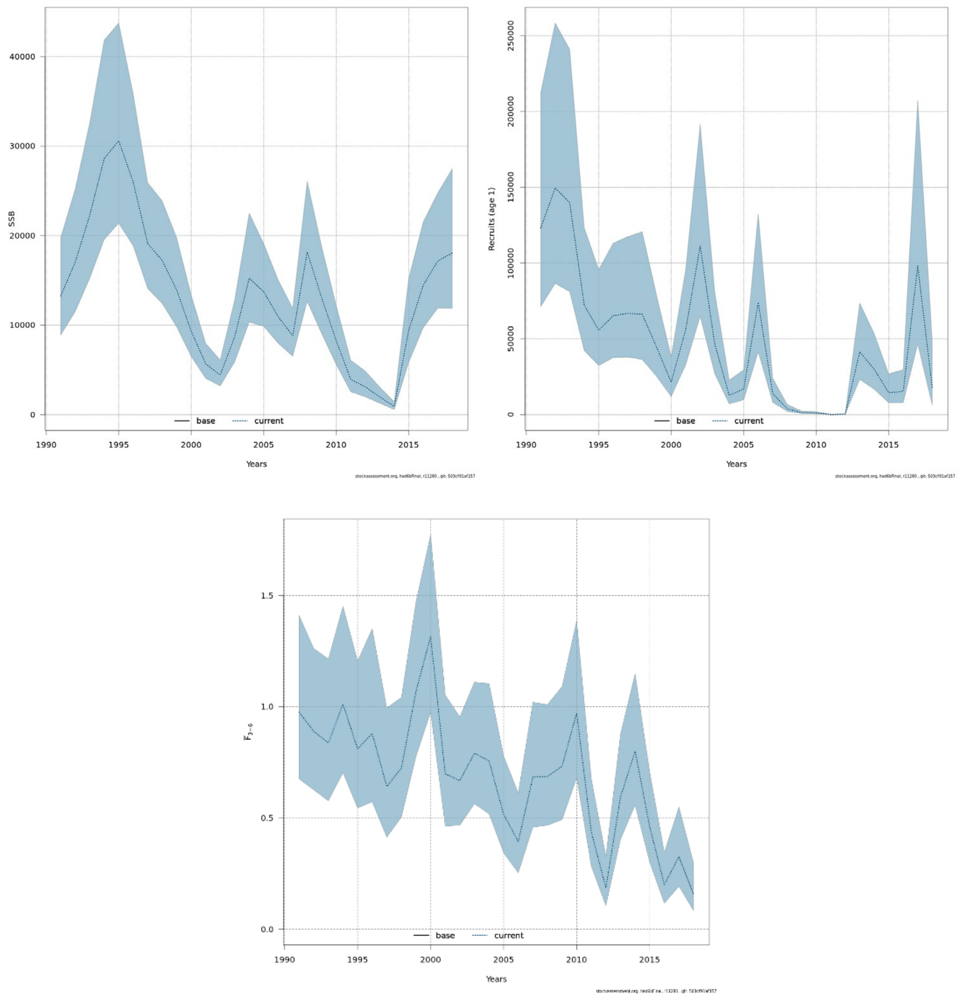


Figure 4.3.33. Haddock in 6.b. The SSB, recruitment and fishing mortality by SAM estimation.

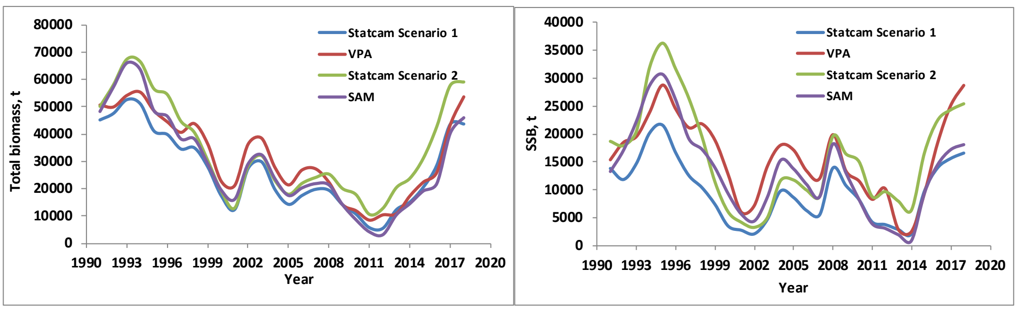


Figure 4.3.34. Haddock in 6.b. Comparison of the final XSA (VPA) assessment with the statistical catch-at-age model StatCam and SAM assessments.

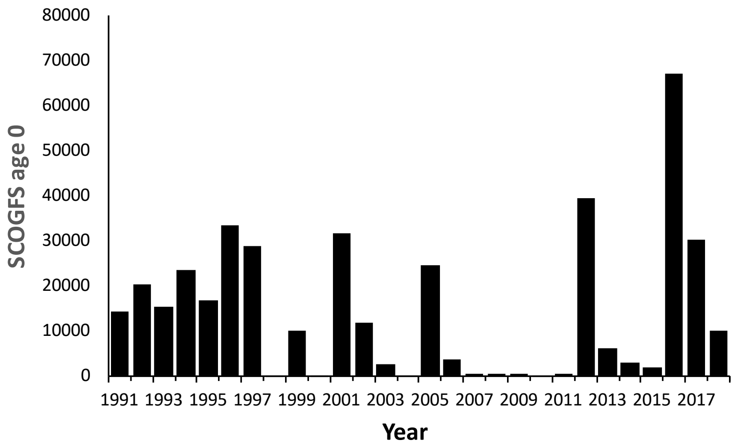


Figure 4.3.35. Haddock in 6.b. Scottish Groundfish survey indices of haddock abundance-at-age 0.

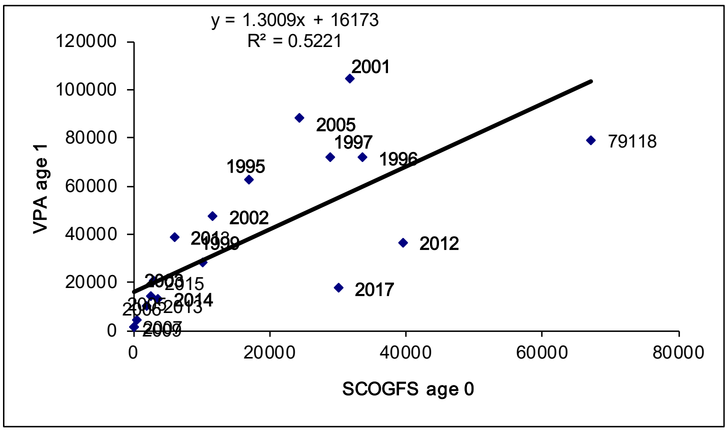


Figure 4.3.36. Haddock in 6.b. VPA numbers-at-age 1 from XSA plotted against Scottish Groundfish survey indices of haddock at-age 0.

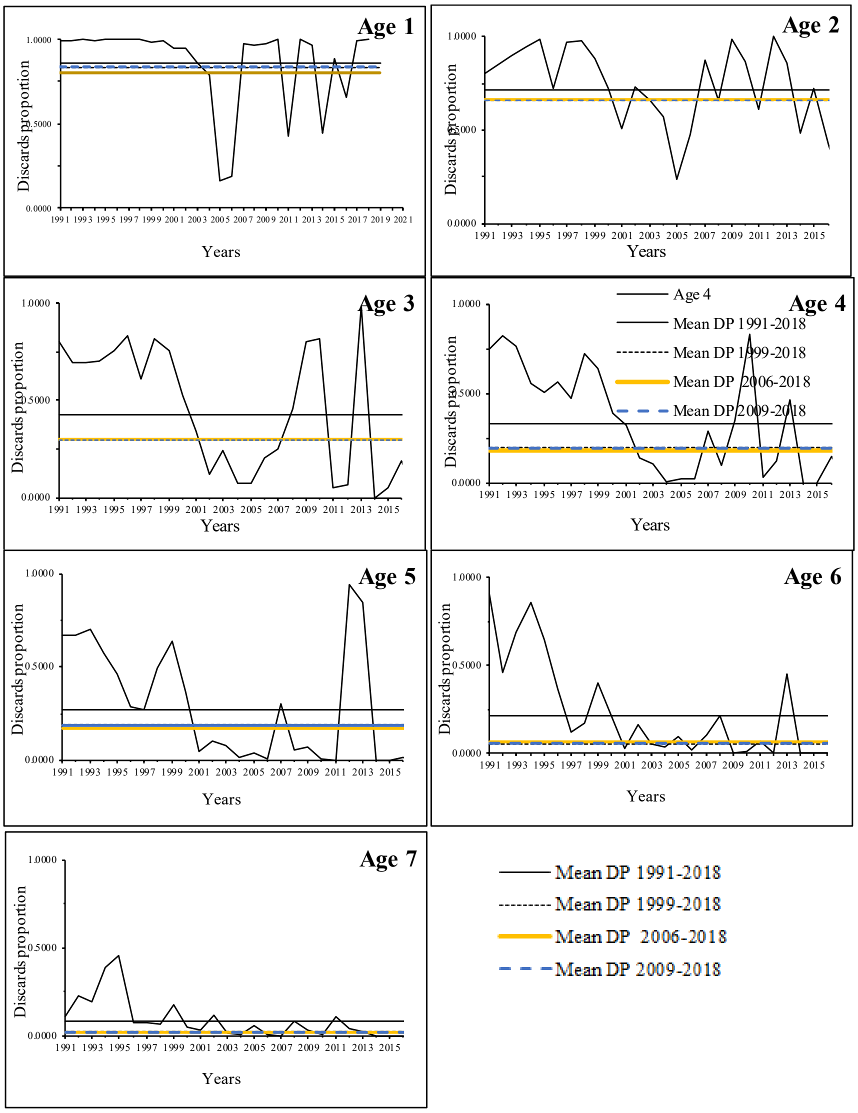


Figure 4.3.37. Haddock in Division 6.b. Discard proportion-at-age by year, and mean discard proportion-at-age for periods: 1991–2018, 1999–2018, 2006–2018 and 2009–2018.

8 Haddock (*Melanogrammus aeglefinus*) in Division 7.a (Irish Sea)

Type of assessment

Age-structured assessment model using Age Structured Assessment Program (ASAP).

ICES advice applicable to 2018

ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 3444 tonnes.

ICES advice applicable to 2019

ICES advises that when the MSY approach is applied, catches in 2019 should be no more than 3739 tonnes.

8.1 General

Stock descriptions and management units

The stock and management units are both ICES Division 7.a (Irish Sea). Landing taken or reported by Irish vessels in the southern most rectangles of 7.a have been reassigned to the 7.b–k stock since 2003 because they are believed to be part of the Celtic Sea stock.

Management applicable to 2019

Management measures include TAC and effort restrictions as well as technical measures. Due to the bycatch of cod in the haddock fishery, the regulations affecting Irish Sea haddock remain linked to those implemented under the cod recovery plan. From 1st January 2019, all fleets catching haddock are subject to the landing obligation.

TAC regulations for 2018 and 2019 are given below:

2018 management (Council Regulation (EU) 2018/127)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	7a (HAD/07A.)
Belgium	51		
France	232		
Ireland	1 388		
United Kingdom	1 536		
Union	3 207		
TAC	3 207		Analytical TAC Article 7(2) of this Regulation applies

2019 management (Council Regulation (EU) 2019/124)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	7a (HAD/07A.)
Belgium	59		
France	271		
Ireland	1 619		
United Kingdom	1 790		
Union	3 739		
TAC	3 739		Analytical TAC Article 7(2) of this Regulation applies

The minimum landing size for haddock in the Irish Sea is 30 cm.

Landings obligation

Since 2017 the landings obligation has applied to the stock. According to the delegate regulation (EC, 2015) vessels where more than 25% of their landings using trawls and seines in the reference years (2013 and 2014) and area were specified gadoids (cod, haddock, whiting and saithe) were covered by the Landings Obligation. This implies that all catches of haddock in the Irish Sea by those vessels must be landed. From the 1st January 2019, all fleets catching haddock will be subject to the landings obligation.

Fishery in 2018

The characteristics of the fishery are described in the stock annex.

The fishery in 2018 was prosecuted by a similar fleet and gears as in recent years, with directed fishing prevented inside the cod closure in spring. The targeted whitefish fishery that developed during the 1990 using semi-pelagic trawls was in decline underwent but since 2014 there has been a slight increase in activity due to abundance of the haddock stock and increased fishing opportunity. However, this continues to be pursued by a small number of vessel (<15). A proportion of the TAC is taken as bycatch in the *Nephrops* fishery in a mixed fishery.

In 2018, the uptake of TAC was 79%. The primary two nations exploiting the stock are the UK and Ireland. The UK used 102% of quota allocation whilst Ireland used 69%. ICES catch estimates are adjusted for reallocation of Irish landings from southern rectangles of 7.a to 7.g, as it is believed that these fish do not belong to the 7.a stock. Table 11.1 gives nominal landings of haddock from the Irish Sea (Division 7.a) as reported by each country to ICES since 1984.

8.2 Data

All required to perform the assessment were supplied as required. Data submitted to InterCatch was used for allocation and raising of unsampled fleets. The unsampled fleets for discard estimates 19.5% of the total discard estimate. Age sampling was carried out on those fleets contributing >95% of the international landings and >80% of the international discards total in 2018. The assessment uses landings and discard information, updated proportion mature-at-age estimates and updated tuning indices.

Landings

Table 11.2 gives the long-term trend of nominal landings of haddock from the Irish Sea (Division 7.a) as reported to ICES since 1972, together with Working Group estimates. The 1993–2005 WG estimates includes sampled-based re-estimates of landings into the main Irish Sea ports. Sample-based evidence suggests that WG estimates are similar to reported landings since 2006. Following the benchmark (WKROUND 2013) the landings have been revised since 1993, and exclude landings from the southern rectangles in the Irish Sea, as they not are believed to be part of this stock.

The methods for estimating quantities and composition of haddock landings from 7.a, used in previous years, are described in the stock annex (see Annex 2). The series of numbers-at-age in the international commercial catch is given in Table 11.3. Sampling levels were not considered adequate to derive catch age compositions in 2003. The time-series mean weight-at-age in the catch is given Table 11.4.

Discards

Annual discard data were updated for Ireland and Northern Ireland. Historic discard numbers-at-age for the different sampled fleets are given in the stock annex (see Annex 2). Issues relating to the reliability and confidence in the data were addressed at the benchmark assessment for this stock (WKROUND 2013; WKIrish3 2017).

Methods for estimating quantities and composition of discards from UK (NI) and Irish *Nephrops* trawlers are described in the stock annex. Sampling levels have increased in recent years. The large estimates of discarding for *Nephrops* fleets observed by previous WG are still evident. A historic time-series of discard numbers-at-age was constructed at the benchmark. Discard rates are very variable between fleets.

Biological data

The derivation of biological parameters and variables is described in the stock annex (see Annex 2). Natural mortality-at-age was calculated using the methods proposed by Lorenzen (1996) at WKIrish2 (2016). The proportions mature-at-age was also recalculated at the benchmark, and based on the mean proportion observed during the NIGFS-WIBTS-Q1 survey with a smoother fitted this is updated annually.

There is evidence of trends in mean length-at-age over time (Figure 11.1), which needs to be reflected in the stock weights-at-age. Since 2001, the WG calculated stock weights by fitting a von Bertalanffy growth curve to survey estimates of mean length-at-age in March, described in the stock annex. The procedure was updated this year using NIGFS-WIBTS-Q1 (2018) and quarter one commercial landings data for 2018. The time-series of length–weight parameters indicate a reduction in expected weight-at-length since 1996, although this strength of this decline has reduced in recent years (see stock annex for historical data):

	Length–weight parameters		Expected weight-at-length	
Year	A	B	30 cm	40 cm
2006	0.00506	3.165	239	595
2007	0.00469	3.194	244	612
2008	0.00523	3.159	242	601
2009	0.00431	3.224	249	629
2010	0.00413	3.238	250	635
2011	0.00457	3.207	250	629
2012	0.00499	3.174	243	606
2013	0.00451	3.208	247	622
2014	0.00591	3.121	241	591
2015	0.00423	3.232	251	637
2016	0.00420	3.233	250	634
2017	0.004144	3.235	249	631
2018	0.006453	3.108	252	614

The following parameter estimates were obtained:

Mean LI_{yc} = 45.4 cm; K = 0.428; t_0 = -0.092

Year-class effects giving estimates of asymptotic length relative to the mean were as follows:

Year class	Effect	Year class	Effect
1990	0.949	2004	0.983
1991	0.979	2005	0.989
1992	0.954	2006	0.953
1993	1.045	2007	0.986
1994	1.092	2008	0.961
1995	1.018	2009	1.002
1996	1.049	2010	1.058
1997	0.968	2011	1.074
1998	1.024	2012	1.106
1999	1.004	2013	1.014
2000	0.995	2014	1.019
2001	0.971	2015	0.943
2002	0.971	2016	0.920
2003	0.998	2017	1.001

The year-class effects show a smooth decline from the mid-1990s coinciding with the rapid growth of the stock and may represent density-dependent growth effects, although other environmental factors may contribute. There is evidence in a reversal of this trend in recent years.

The resultant stock weights-at-age are given in Table 11.3. The weight-at-age in the stock shows a decreasing trend over time, which appears to have reversed in recent years.

Surveys

The survey data considered in the assessment for this stock are given in Table 11.5. All survey series data for haddock available to the Working Group are described in the stock annex (see Annex 2). The following age-structured abundance indices were used in the assessment:

- UK (NI) groundfish survey (NIGFS) in March (age classes 1 to 4, years 1992–2018). Acronym NIGFS-WIBTS-Q1.
- UK (NI) groundfish survey (NIGFS) in October (age classes 0 to 3; years 1991 to 2018). Acronym NIGFS-WIBTS-Q4.
- UK (NI) Methot–Isaacs–Kidd (NI-MIK) net survey in June (age 0; years 1994–2018).
- UK Fishery Science Partnership (UKFspW) western Irish Sea roundfish survey (age classes 2 to 5, years 2004–2018, the survey was not conducted in 2014).

The relative log standardised indices for cohorts are plotted against time in Figure 11.2. Whilst ages 2 to 4 appear to show strong signal in the UKFspW the ability to detect the year class in age 5 haddock is less clear. The strong 2013 year class continues to be tracked in all indices, indicating that the different surveys are capturing the prominent year-class signals in this stock (Figure 11.2). Correlation between survey indices by age is positive for all surveys and show high consistency within each survey (Figure 11.3). The indices from the UKFspW survey in the western Irish Sea also show similar year-class signals to the other survey-series, but are noisy with strong year effects (Figure 11.2).

8.3 Assessment

Deviation from stock annex

The assessment presented is the single fleet ASAP model. Recent changes in targeted fishing activity were accounted for with the inclusion of an additional selectivity pattern (2013–2017) in the 2018 assessment. In 2019, there was an apparent poor fit of the model to tuning series age structure and catch-at-age data, in particular for age 0 haddock. Figure 11.4A shows the residuals of the model-fit to catch-at-age data. A pattern of large negative residuals was observed for age ‘0’ haddock 2013–2018. It was considered that the selectivity block introduced to the model in 2018 (2013–present) may be fitted to over select age 0 fish in the catch-at-age data, resulting in here a biased prediction this age class compared to the observed catch data.

The assessment model estimated selectivity of age 0 haddock in the 2019 assessment was compared to that estimated in 2018. In 2019, it was estimated as 0.19 compared to 0.08 in 2018. Within the model setup, the initial starting value of the selectivity pattern is set as 0.3. The model fit when provided with a lower starting value of 0.1 was compared to the update assessment. The lower starting value improved the model fit with a reduced objective function from 1673 to 1654. The estimated selectivity of age 0 haddock was re-estimated by the model as 0.08 in the 2013–2018 selectivity block. The observed residual pattern was improved (Figure11.4) with overall reduction in the residuals and reduction of the bias in the final selectivity block.

ASAP was used for the assessment and model settings:

Option	Setting
Use likelihood constant	Yes
Mean F (F_{bar}) age range	2–4
Fleet selectivity block 1	Asymptotic
Fleet selectivity block 2	Age coefficients (age 0–5) (0.2;0.5;0.8;1;0.7;0.5)
Fleet selectivity block 3	Age coefficients (age 0–5) (0.3;0.6;0.7;0.7;0.4;0.2)
*Fleet selectivity block 4	Age coefficients (age 0–5) (0.1;0.6;0.8;0.9;1.0;1.0)
Discards	Included in catch (not specified separately from landings)
Index units	4 (numbers)
Index month	NIGFS-Q1 (3); NIGFS-Q4 (10); NIMIK (7); UKFSPW(3)
Index selectivity linked to fleet	-1 (not linked)
Index age range	NIGFS-Q1 (1–4); NIGFS-Q4 (0–3); NIMIK (0); UKFSPW(2–5)
Index Selectivity (NIGFS-Q1)	Double logistic
Index Selectivity (NIGFS-Q4)	Asymptotic
Index Selectivity (NIMIK)	NA (age 0 only)
Index Selectivity (UK-FSPW)	Asymptotic
Index CV & ESS (NIGFS-Q1)	Observed strata CV (lower limit 0.1); ESS = 50
Index CV & ESS (NIGFS-Q4)	Observed strata CV (lower limit 0.1); ESS = 50
Index CV & ESS (NIMIK)	Observed station CV (lower limit 0.1); ESS = 50
Index CV & ESS (UK-FSPW)	CV = 0.7; ESS = 10
Phase for F-Mult in 1st year	1
Phase for F-Mult deviations	2
Phase for recruitment deviations	3
Phase for N in 1st Year	1
Phase for catchability in 1st Year	3
Phase for catchability deviations	-5 (Assume constant catchability in indices)
Phase for unexploited stock size	1
Phase for steepness	-5 (Do not fit stock–recruitment curve)
Catch total CV	1993–2000 (0.175); 2003–2006 (0.2); 2007–present (0.15)

Option	Setting
Catch effective sample size	1993–2000 (50); 2003–2006 (1); 2007–present (50)
Lambda for recruit deviations	0 (freely estimated)
Lambda for total catch	1
Lambda for total discards	NA (discards included in catch)
Lambda for F-Mult in 1st year	0 (freely estimated)
Lambda for F-Mult deviations	0 (freely estimated)
Lambda for index	1 for both indices in the model
Lambda for index catchability	0 for all indices (freely estimated)
Lambda for catchability devs	NA (phase is negative)
Lambda N in 1st year deviations	0 (freely estimated)
Lambda devs initial steepness	0 (freely estimated)
Lambda devs unexpl stock size	0 (freely estimated)

***Changed in 2019 compared to 2018.**

Final update assessment

The final assessment was run with the same settings as established by WKIrish 2017 and described in the stock annex, with the addition of a new selectivity pattern 2013–2017, as applied in 2018 and with a the lower starting value for selection of age 0 haddock in the final selectivity block. Discards were combined with the landings as catch in the model.

Figure 11.5 shows the predicted and observed catch. The catch information from 2007 to present is regarded as the most confident, during 2003–2006 it is regarded that catch and sampling information is of relatively lower quality due to lack of sampling opportunity. Before 2003, the catch series is regarded as of intermediate confidence. The model has close fit to the current observed catch 2011–present. Before this time, there is consistent over estimation of the catch 2000–2011 following a period of consistent underestimation of catch 1993–2000. Figure 11.6 shows the residuals of the catch proportions-at-age. For all ages there appears to good fit with no consistent pattern, however, there are some large deviations from observed and predicted for age 5 fish across the series. Figure 11.7 shows that the catch is dominated by fish <4 years, therefore the large residuals for fish of age 5 are likely to result from low sampling and small contribution of 5+ fish to the stock. The fishing pressure (F)-at-age is shown in Table 11.6.

The residuals of the index are shown in Figure 11.7. A good fit to the NI-MIK index is seen across the series, although some single year events are observed with a strong deviation in the last two years of the index. For the UKFsPW survey a poor fit to the 2009, 2017 and 2018 is evident. This suggests an inability of the model to track the large survey index values, this should be investigated further to explore the method of index calculation. During the most recent two years of the index, when the stock biomass has been high the UKFspW survey appears to tend of overestimated compared to the model fit. There is strong tracking of the both NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 index in general patterns, however, a general trend to under estimate the NIGFS-WIBTS-Q4 index by the model is observed whilst the NIGFS-WIBTS-Q1 shows an initial period of over estimation 1993–2000, followed by a period of under estimation 2002–2013.

Figure 11.9 shows the residuals of the survey proportions-at-age. For all indices, there is close fit between the observed and model predicted fit for fish up to four years old. The largest deviations occur in five year old fish in the UKFspW survey, which under reported five year old fish prior to 2014.

Figure 11.10 shows the retrospective analysis. The predicted catch shows no obvious retrospective pattern, neither does the recruitment estimate or fishing pressure. However, the SSB has a tendency to be revised downwards. The historic widely splayed retrospective runs are caused by re-estimation of selectivity patterns with a short terminal selectivity blocks (four years) and the influence of decreasing UK-FspW tuning series length with each retro peel. The results of the assessment are given in Table 11.8.

Comparison with previous assessments

Figure 11.11 shows the comparison of the current assessment with previous ASAP and model. There is close agreement with the stock trends of the current assessment and the previous assessment. Mohn's Rho values were calculated for 5 retrospective runs 2018: 2013 for F_{bar} (-0.034), SSB (0.155) and recruitment (-0.266).

State of the stock

Following a period of sustained decline, since 2008, SSB increased during 2010–2013. Since 2014, the SSB has increased markedly. The stock is characterized by highly variable recruitment. The model indicates above average recruitment for the 2009–2011 year class after below average recruitment for the 2007 and 2008 year classes. Recruitment in 2013 is amongst the highest observed in the time-series and has been followed by strong recruitment in 2014 and 2015. The current SSB is predicted to exceed any previously observed level.

8.4 Short-term projections

Short-term projections were performed using FLR libraries. Recruitment for 2019–2021 was estimated at (GM 1994–2016; 357 134 thousands). The F used in the forecast was derived as the F related to the TAC for 2019. The TAC for 2018 (3739 t) was however, adjusted to account for the predicted landings that would be taken in rectangles 33E2 and 33E3 calculated as the average annual reallocation within the preceding ten years (430 t) suggesting that landings in 2018 would be approximately 3309 equating to an F = 0.253.

Catches were split into landings and discards using the proportions of the catch that were discarded over the full the last three years. Input data for the short-term forecast are given in Table 11.7. The management options output is given in Table 11.9.

Estimates of the relative contribution of recent year classes to the 2020 landings and 2021 SSB are shown in Figure 11.12. As the very strong 2013 year class moves through the fishery the contribution to landings in 2020 is comprised of mainly the 2015 cohort (77%), with the SSB in 2021 largely be dependent on a the 2016 cohort, comprising 62% of the biomass.

8.5 Biological reference points

MSY evaluations

In response to an EU special request to provide plausible and updated F_{MSY} ranges for Irish Sea haddock the management reference points for the stock were re-estimated (Table 11.10; ICES 2018). The B_{lim} was set as the lowest SBB at which above recruitment in the upper quartile has been observed (2994 t). The S–R plot for Irish Sea haddock shows no obvious S–R relationship mainly because the recruitment is highly variable. B_{lim} was estimated as 2994 t. MSY $B_{trigger}$ is set to 4281 t as the stock has been fished at or below F_{MSY} for more than five years. F_{MSY} median point estimates is 0.28. The upper bound of the F_{MSY} range giving at least 95% of the maximum yield was estimated to 0.35 and the lower bound at 0.20. F_{lim} is estimated to be 0.50 as F with 50% probability of SSB <B_{lim} with F_{pa} as 0.38 calculated as F_{lim} combined with the assessment error; F_{lim} x exp(-1.645 x σ); σ = 0.20.

Yield and biomass-per-recruit

Not available for this stock, previous explorations are detailed in the stock annex.

8.6 Management plans

There is no specific management plan for haddock in the Irish Sea. The regulations affecting Irish Sea haddock remain linked to those implemented under the cod management plan due to potential for bycatch of cod in a fishery targeting haddock (Council Regulation (EC) 1342/2008).

8.7 Uncertainties and bias in assessment and forecast

Landings

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment. However, within the assessment there is relocation of reported landings in rectangles 33E2 and 33E3, which are not considered part of the stock. Historic misreporting estimates are considered in the assessment and accounted for, current misreporting is not considered to be a factor within the fishery.

Discards

Sampling levels of discarding at sea remains high. For Northern Irish vessels targeting haddock 20.2% of trips are observed and 2.6% of the main *Nephrops* targeted fishery trips observed.

Selectivity

A breakpoint in selectivity is applied in 2000, associated with management measures to reduce fishing mortality on cod. The model included three selectivity blocks in fishery-dependent data, reflecting bycatch and targeted fishery until the year 2000 (asymptotic). After 2007, a fleet selectivity pattern without targeted fishing of older fish (dome-shaped) is applied. During 2000–2007 a transition between a fully selected stock to a regime without targeted fishing of older fish is fitted. The use of current specified selectivity blocks may require review at annual at regular intervals. In the current assessment a new selectivity pattern for the fishery was added 2013–2018 with full selection of fish older than three years. With advice and management for haddock or other species, it is possible that the character of the fishery may change. A retrospective analysis demonstrated a consistent historic downward revision of the perceived SSB trend, however, there is consistent estimation of F. The initial two years of the retrospective plot show significant deviations. This was considered due to the model having a selectivity block, beginning in 2007, with reduced selection for older fish and the introduction of the UKFspW, with an asymptotic selectivity pattern, starting in 2007. The short period to estimate the selectivity parameters for both the fishery and survey index are considered to contribute to the instability of the model during this time.

Surveys

The survey indices used in the model have spatial coverage of the assessment area. The combination of a recruitment index (NI-MIK), juvenile fish survey indices (NIGFS-WIBTS-Q1 & NIGFS-WIBTS-Q4) and the UKFspW survey aimed at older fish using commercial fishing gear means that the full age range of the stock is covered by survey information.

8.8 Recommendations for next benchmark assessment

This stock was be benchmarked through the WKIrish process in 2016–2017.

8.9 References

EC. 2015. Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters.

Table 11.1. Landings (t) of HADDOCK in Division 7.a, 1984–present, as officially reported to ICES. (Working Group figures are given in Table 11.2).

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	3	4	5	10	12	4	4	1	8	18
France	38	31	39	50	47	n/a	n/a	n/a	73	41
Ireland	199	341	275	797	363	215	80	254	251	252
Netherlands	-	-	-	-	-	-	-	-	-	-
UK(E&W)[1]	29	28	22	41	74	252	177	204	244	260
UK (Isle of Man)	2	5	4	3	3	3	5	14	13	19
UK (N. Ireland)	38	215	358	230	196	…	…	…	…	…
UK (Scotland)	78	104	23	156	52	86	316	143	114	140
Total	387	728	726	1,287	747	560	582	616	703	730

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	22	32	34	55	104	53	22	68	44	20
France	22	58	105	74	86	n/a	49	184	72	146
Ireland	246	320	798	1,005	1,699	759	1,238	652	401	229
Netherlands	-	-	1	14	10	5	2	-	-	-
UK(E&W)[1]	301	294	463	717	1,023	1,479	1,061	1,238	551	248
UK (Isle of Man)	24	27	38	9	13	7	19	1	-	-
UK (N. Ireland)	…	…	…	…	…	…	…	…	…	…
UK (Scotland)	66	110	14	51	80	67	56	86	47	31
Total	681	841	1,453	1,925	3,015	2,370	2,447	2,229	1,115	674

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Belgium	15	22	23	30	15	7	9	16	13	6.2
France	20	36	20	11	6	3	2	8	3	.7
Ireland	296	139	184	477	319	388	333	434	561	492
Netherlands	-	-		-	-	-	-	-	-	-
UK (England & Wales)[1]	421	344	419	559	521	446	593	355	236	154
UK (Isle of Man)	-	-	-	-	1	1	-	-	<1	<.1
UK (N. Ireland)	…	…	…	…	…	…	…	…	…	…
UK (Scotland)	9	6	9	1	17	1	2			-
United Kingdom									236	154
Total	761	547	655	1078	879	846	939	813	813	654

Country	2014	2015	2016*	2017	2018
Belgium	7	7	5	5	4
France	0	7	1	5	0
Ireland	541	507	632	114	949
Netherlands	-	-		-	-
UK (England & Wales)[1]	-	-		-	-
UK (Isle of Man)	<1	<1		-	-
UK (N. Ireland)	…	-		-	-
UK (Scotland)	-	-		-	-
United Kingdom	426	634	825	1240	1580
Total	974	1154	1463	2363	2532

* **Preliminary.**

[1] **1989–2015 Northern Ireland included with England and Wales.**

n/a = not available.

Table 11.2. Haddock in 7.a. Total international landings of haddock from the Irish Sea, 1972–present as officially reported to ICES. Working Group figures, assuming 1972–1992 official landings to be correct, are also given. The 1993–2005 WG estimates include sampled-based estimates of landings at a number of Irish Sea ports. Sample-based evidence confirms more accurate catch reporting since 2006. Landings in tonnes live weight. Since 1993, the landings have been corrected to exclude catches from the southernmost rectangles, which are not considered part of this stock.

Year	Official landings	WG landings	ICES discards**	ICES catch	% Discard	Landings taken or reported in rectangles 33E2 and 33E3
1972	2204	2204				
1973	2169	2169				
1974	683	683				
1975	276	276				
1976	345	345				
1977	188	188				
1978	131	131				
1979	146	146				
1980	418	418				
1981	445	445				
1982	303	303				
1983	299	299				
1984	387	387				
1985	728	728				
1986	726	726				
1987	1287	1287				
1988	747	747				
1989	560	560				
1990	582	582				
1991	616	616				
1992	703	656				
1993	730	813				
1994	681	1042				
1995	841	1736	780	2516	31%	16
1996	1453	2981	709	3690	19%	33

Year	Official landings	WG landings	ICES discards**	ICES catch	% Discard	Landings taken or reported in rectangles 33E2 and 33E3
1997	1925	3547	895	4442	20%	36
1998	3015	4874	1015	5889	17%	28
1999	2370	4095	634	4729	13%	34
2000	2447	1357	802	2159	37%	11
2001	2229	2246	269	2515	11%	74
2002	1115	1817	387	2204	18%	82
2003	674	659	-	-	-	64
2004	761	1217	392	1609	24%	53
2005	547	666	551	1217	45%	35
2006	655	633	306	939	33%	26
2007	1078	886	722	1608	45%	222
2008	879	786	643	1429	45%	194
2009	846	581	579	1160	50%	285
2010	939	679	508	1187	43%	267
2011	813	446	307	753	41%	374
2012	n/a	343	599	942	64%	473
2013	654	254	283	537	53%	410
2014	953	518	488	1006	49%	444
2015	1154	833	652	1451	44%	322
2016	1463	1008	298	1306	23%	455
2017	2363	1662	333	1995	17%	715
2018	2532	1993	568	2561	22%	532

Table 11.3. Haddock in 7.a: stock weights-at-age.

	Age					
	0	1	2	3	4	5
1993	0.02	0.095	0.42	1.043	1.759	2.563
1994	0.02	0.083	0.338	0.968	1.999	3.028
1995	0.02	0.085	0.347	0.785	1.708	3.219
1996	0.02	0.083	0.359	0.788	1.319	2.718
1997	0.022	0.07	0.357	0.863	1.435	2.391
1998	0.018	0.06	0.253	0.743	1.384	2.165
1999	0.016	0.057	0.226	0.561	1.294	2.262
2000	0.017	0.048	0.23	0.51	0.966	2.123
2001	0.018	0.051	0.201	0.548	0.93	1.822
2002	0.017	0.056	0.215	0.472	0.983	1.637
2003	0.017	0.05	0.229	0.485	0.798	1.52
2004	0.017	0.041	0.199	0.509	0.816	1.306
2005	0.018	0.031	0.165	0.459	0.902	1.347
2006	0.014	0.033	0.128	0.378	0.803	1.435
2007	0.019	0.034	0.136	0.299	0.68	1.402
2008	0.014	0.037	0.139	0.31	0.515	1.167
2009	0.025	0.042	0.153	0.326	0.563	0.98
2010	0.017	0.04	0.176	0.357	0.58	0.945
2011	0.018	0.052	0.167	0.407	0.624	0.937
2012	0.012	0.057	0.209	0.375	0.688	0.96
2013	0.023	0.059	0.233	0.491	0.673	1.115
2014	0.022	0.038	0.238	0.512	0.812	1.04
2015	0.017	0.046	0.153	0.577	0.97	1.371
2016	0.021	0.047	0.192	0.354	1.015	1.533
2017	0.022	0.054	0.137	0.347	0.809	1.476
2018	0.023	0.068	0.196	0.472	0.601	0.987

Table 11.4. Haddock in 7.a: Catch numbers-at-age.

	Age					
	0	1	2	3	4	5
1993	790	1568	2066	19	1	1
1994	16857	821	258	922	3	2
1995	950	8079	1587	107	220	5
1996	15171	1380	5510	728	16	30
1997	347	8828	1528	2388	201	16
1998	4209	4642	10532	252	488	42
1999	4944	3200	3436	4773	25	57
2000	287	11118	1771	466	457	418
2001	7883	425	3246	1074	30	89
2002	2105	8229	789	2063	142	18
2003	2000	2000	400	800	50	25
2004	10797	2056	421	827	46	78
2005	6048	4342	1416	285	193	34
2006	5334	2971	656	524	63	51
2007	2282	3537	3371	671	60	47
2008	2158	4569	2052	837	242	36
2009	4327	2490	2021	629	121	36
2010	3933	4058	834	464	309	59
2011	5669	2324	942	239	97	52
2012	6235	2799	774	201	27	28
2013	4525	1162	558	156	41	17
2014	1392	3854	1265	189	17	10
2015	518	1915	3087	324	63	5
2016	512	1845	907	1079	109	108
2017	231	783	2234	829	1096	78
2018	56	1039	5325	2845	426	526

Table 11.5. Haddock in 7.a: Available tuning data.

```
IRISH SEA haddock, 2013 WG,ANON,COMBSEX,TUNING DATA(effort, nos-at-age)
104
NIGFS-WIBTS-Q1
1992 2018
1 1 0.21 0.25
0 5
```

1	0	139	569	31	0	0
1	0	644	58	183	0	0
1	0	24823	437	0.1	43	0
1	0	1065	3743	67	3	1.1
1	0	25118	474	1457	44	2.1
1	0	3913	8694	70	105	1.1
1	0	6058	680	2072	16	11.1
1	0	14028	1853	64	147	5
1	0	3277	6990	770	40	20.1
1	0	28755	842	1059	78	1.1
1	0	6966	14162	341	356	26.1
1	0	19945	2379	2206	45	35.1
1	0	24488	6454	406	234	15
1	0	13444	12721	2194	91	33.1
1	0	20918	11325	3661	240	27
1	0	7480	12009	2559	495	48.1
1	0	9345	3888	2877	163	42
1	0	17058	1765	524	239	27
1	0	17278	5543	299	67	50
1	0	13509	5266	1095	38	13
1	0	8245	5202	751	119	20
1	0	33807	2260	773	108	22
1	0	15495	22420	1297	407	44
1	0	14418	9109	5594	205	38
1	0	4321	18887	5524	323	33
1	0	7897	4683	7086	1709	1369

```
NIGFS-WIBTS-Q4
1991 2018
1 1 0.83  0.88
0 4
```

1	36.127	0.716	3.965	0	0
1	2.042	151.766	1.171	0.959	0
1	15.289	101.536	0.753	0	0.045
1	1067.99	13.327	13.2	0.092	0.001
1	160.434	398.722	1.81	0.886	0.04
1	365.679	10.521	39.889	0.08	0.034
1	685.913	28.002	0.527	1.633	0.001
1	59.867	93.66	5.533	0.125	0.104
1	584.902	19.354	28.408	0.947	0
1	146.491	105.115	1.18	3.372	0
1	552.309	59.354	30.746	0.295	0.27
1	666.652	167.224	7.422	4.911	0.001
1	476.2	122.094	12.378	0.264	0.052
1	387.556	111.692	35.717	2.228	0.441
1	94.667	102.086	37.1	11.654	0.375
1	88.61	46.338	23.832	1.991	0.33
1	451.303	45.695	6.139	4.891	0.23
1	219.533	82.392	5.858	1.752	0.973
1	207.925	42.145	7.808	1.044	0.093
1	165.294	79.593	12.05	1.275	0
1	1004.22	8.279	1.531	0.179	0
1	339.218	311.607	68.768	3.016	0.423
1	455.385	81.189	108.663	2.309	0.362
1	99.046	154.865	52.207	4.273	0.281
1	191.946	42.885	90.324	15.934	6.202
1	690.663	167.338	12.891	16.507	2.003

```
NIMIK
1994 2018
1 1 0.38 0.47
0 0
```

1	47000
1	1700
1	47800
1	14500
1	2500
1	15400
1	1700
1	17100
1	1200
1	4250
1	25970
1	8250
1	40240
1	3820
1	6638
1	18540
1	4532
1	6606
1	9818
1	28325
1	12892
1	48463
1	1800
1	26900
1	30954

```
FSP Haddock: Tuning data
101
UKFspW
2005 2018
1 1 0.15 0.25
0 5
```

1	0	0	1.774	1.506	4.981	0.291
1	0	0.308	7.749	7.336	0.546	1.115
1	0	0.208	42.727	37.286	6.289	0.697
1	0	0	4.657	12.836	7.213	0.794
1	0	0	0.662	3.99	1.443	0.541
1	0	0.627	1.422	3.78	2.753	0.866
1	0	0.048	0.598	1.976	1.121	0.81
1	0	0.27	4.135	4.772	0.79	0.226
1	0	0.035	3.684	7.674	1.742	0.176
1	NA	NA	NA	NA	NA	NA
1	0	0.437	31.2	19.349	5.051	0.554
1	0	0	0	59.769	12.592	6.205
1	0	0	19.748	85.536	246.488	10.838
1	0	0	0	36.397	62.861	55.448

Table 11.6. Haddock in 7.a: F-at-age.

	Age					
	0	1	2	3	4	5
1993	0.023	0.227	0.614	0.698	0.704	0.705
1994	0.024	0.236	0.639	0.726	0.733	0.734
1995	0.031	0.312	0.846	0.961	0.970	0.971
1996	0.025	0.250	0.675	0.767	0.775	0.775
1997	0.031	0.312	0.844	0.959	0.968	0.969
1998	0.033	0.327	0.886	1.007	1.016	1.017
1999	0.048	0.483	1.308	1.486	1.500	1.501
2000	0.034	0.342	0.926	1.053	1.063	1.063
2001	0.124	0.422	0.753	0.803	0.562	0.401
2002	0.159	0.539	0.961	1.026	0.717	0.513
2003	0.128	0.435	0.776	0.828	0.579	0.414
2004	0.123	0.416	0.743	0.792	0.554	0.396
2005	0.100	0.341	0.609	0.649	0.454	0.325
2006	0.057	0.195	0.347	0.371	0.259	0.185
2007	0.095	0.324	0.578	0.616	0.431	0.308
2008	0.144	0.512	0.578	0.545	0.299	0.145
2009	0.111	0.393	0.444	0.419	0.230	0.112
2010	0.162	0.574	0.648	0.611	0.335	0.163
2011	0.085	0.302	0.341	0.322	0.176	0.086
2012	0.088	0.314	0.354	0.334	0.183	0.089
2013	0.009	0.064	0.112	0.107	0.112	0.112
2014	0.011	0.086	0.150	0.144	0.150	0.150
2015	0.010	0.077	0.134	0.128	0.134	0.134
2016	0.007	0.053	0.093	0.089	0.093	0.093
2017	0.009	0.068	0.118	0.113	0.118	0.118
2018	0.012	0.089	0.156	0.149	0.156	0.156

Table 11.7. Forecast input data.

Variable	Value	Source	Notes
F ages 2–4 (2019)	0.253	ICES (2019a)	F in 2017 predicted for TAC, adjusted for annual reallocation of landings from rectangles 33E2 and 33E3 (ten year average value)
SSB (2020)	14 160	ICES (2019a)	Short-term forecast
$R_{age\ 0}$ (2019 and 2020) (thousand)	357 134	ICES (2019a)	Geometric mean (2006–2016)
Catch (2019)	3746	ICES (2019a)	Short-term forecast
Wanted catch * (2019)	3310	ICES (2019a)	Average discard pattern (2016–2018)
Unwanted catch *(2019)	437	ICES (2019a)	Average discard pattern (2016–2018)

*** "Wanted catch" is used to describe fish that would be landed in the absence of the EU landing obligation.**

Table 11.8. Haddock in Division7.a. Assessment results. All weights are in tonnes. Low and high refer to 1 std confidence limits.

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Landings tonnes	Discards tonnes	F Ages 2-4	High	Low
1993	153743	172355	135131	2391	2725	2058	813	365	0.67	0.81	0.53
1994	527015	578308	475722	2234	2631	1838	1042	468	0.70	0.86	0.54
1995	62874	75047	50701	2376	2810	1941	1736	780	0.93	1.14	0.71
1996	1357285	1488285	1226285	4879	5497	4262	2981	709	0.74	0.88	0.60
1997	210990	241958	180022	4066	4758	3374	3547	895	0.92	1.11	0.74
1998	344353	386475	302231	8209	9089	7329	4874	1015	0.97	1.12	0.82
1999	677646	745127	610165	5648	6411	4885	4095	634	1.43	1.68	1.18
2000	98299	115777	80821	2727	3195	2260	1357	802	1.01	1.24	0.79
2001	709368	784132	634604	3873	4440	3305	2246	269	0.71	0.83	0.58
2002	134462	155680	113244	2938	3454	2421	1817	387	0.90	1.08	0.72
2003	424040	480565	367515	3518	4085	2951	1517	390	0.73	0.88	0.57
2004	646527	719493	573561	2636	3184	2088	1217	392	0.70	0.86	0.54
2005	496007	550841	441173	2547	3052	2041	666	551	0.57	0.71	0.44
2006	566750	622671	510829	3288	3853	2723	633	306	0.33	0.40	0.25
2007	224231	250795	197667	4298	4926	3669	886	722	0.54	0.65	0.44
2008	158495	179166	137824	4416	5103	3730	786	643	0.47	0.57	0.38
2009	336811	374765	298857	3848	4571	3125	581	579	0.36	0.44	0.29
2010	252631	283537	221725	3344	4027	2661	679	508	0.53	0.65	0.42
2011	314140	352344	275936	3037	3697	2376	446	307	0.28	0.34	0.22
2012	308690	352445	264935	3345	4028	2662	343	599	0.29	0.35	0.23
2013	1458723	1627793	1289653	4287	5135	3439	254	282	0.110	0.135	0.085
2014	648601	736419	560783	5958	6982	4934	518	488	0.148	0.179	0.116
2015	943094	1075454	810734	12058	13782	10335	833	652	0.132	0.159	0.105
2016	287929	337962	237896	15894	18152	13636	1008	298	0.091	0.110	0.073
2017	279938	335044	224832	20049	22931	17168	1662	333	0.117	0.141	0.092
2018	281126	367573	194679	20241	23324	17159	1993	568	0.154	0.188	0.120
2019	357134*			18945							

Table 11.9 Haddock in Division 7.a. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2020)	Wanted catch * (2020)	Un-wanted catch * (2020)	F_{total} (2020)	F_{wanted} (2020)	$F_{unwanted}$ (2020)	SSB (2021)	% SSB change **	% Advice change ^
ICES advice basis									
EU MAP ^^: F_{MSY}	3156	2667	489	0.28	0.19	0.086	10493	−26	−15.6
F = MAP $F_{MSY\ lower}$	2333	1975	358	0.20	0.14	0.061	11317	−20	−38
F = MAP $F_{MSY\ upper}$	3830	3232	598	0.35	0.24	0.11	9824	−31	2.4
F = 0	0	0	0	0	0	0	13678	−3.4	−100
F_{pa}	4106	3463	644	0.38	0.26	0.12	9550	−33	9.8
Flim	5141	4324	817	0.50	0.35	0.15	8533	−40	38
$SSB_{2020} = B_{lim}$	11133	9142	1991	1.64	1.14	0.50	2994	−79	198
$SSB_{2021} = B_{pa}$	9788	8099	1690	1.28	0.89	0.39	4160	−71	162
SSB_{2021} = MSY $B_{trigger}$	9653	7992	1661	1.24	0.86	0.38	4281	−70	158
F = F_{2019}	2887	2441	446	0.25	0.18	0.07	10762	−24	−23

*** "Wanted" and "unwanted" catch are used to describe fish that would be landed and discarded in the absence of the EU landing obligation, based on discard rate estimates for 2016–2018.**

**** SSB 2021 relative to SSB 2020.**

***** Total catch in 2020 relative to TAC in 2019 (3739 tonnes).**

^Advice value for 2020 relative to advice value for 2019 (3739 tonnes).

Please check years are correct.

^^ EU multiannual plan (MAP) for the Western Waters (EU, 2019).

Table 11.10. Haddock in 7.a Management reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	4281 tonnes	5th percentile of BMSY; Irish Sea haddock has been fished at, or below F_{MSY} for >five years.	ICES (2018a)
	F_{MSY}	0.28	Median point estimates of EqSim with segmented regression stock–recruitment relationship	ICES (2018a)
	$F_{MSYLower}$	0.20	F at 95% of MSY below F_{MSY}	ICES (2018a)
	$F_{MSYUpper}$	0.35	F at 95% of MSY above F_{MSY}	ICES (2018a)
Precautionary approach	B_{lim}	2994 tonnes	Lowest observed SSB with >75th percentile recruitment	ICES (2018a)
	B_{pa}	4160 tonnes	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.20$	ICES (2018a)
	F_{lim}	0.50	F with 50% probability of SSB <B_{lim}	ICES (2018a)
	F_{pa}	0.38	F_{lim} combined with the assessment error; $F_{lim} \times \exp(-1.645 \times \sigma)$; $\sigma = 0.2$	ICES (2018a)
Management plan	SSB_{MGT}	Not applicable		
	F_{MGT}	Not applicable		

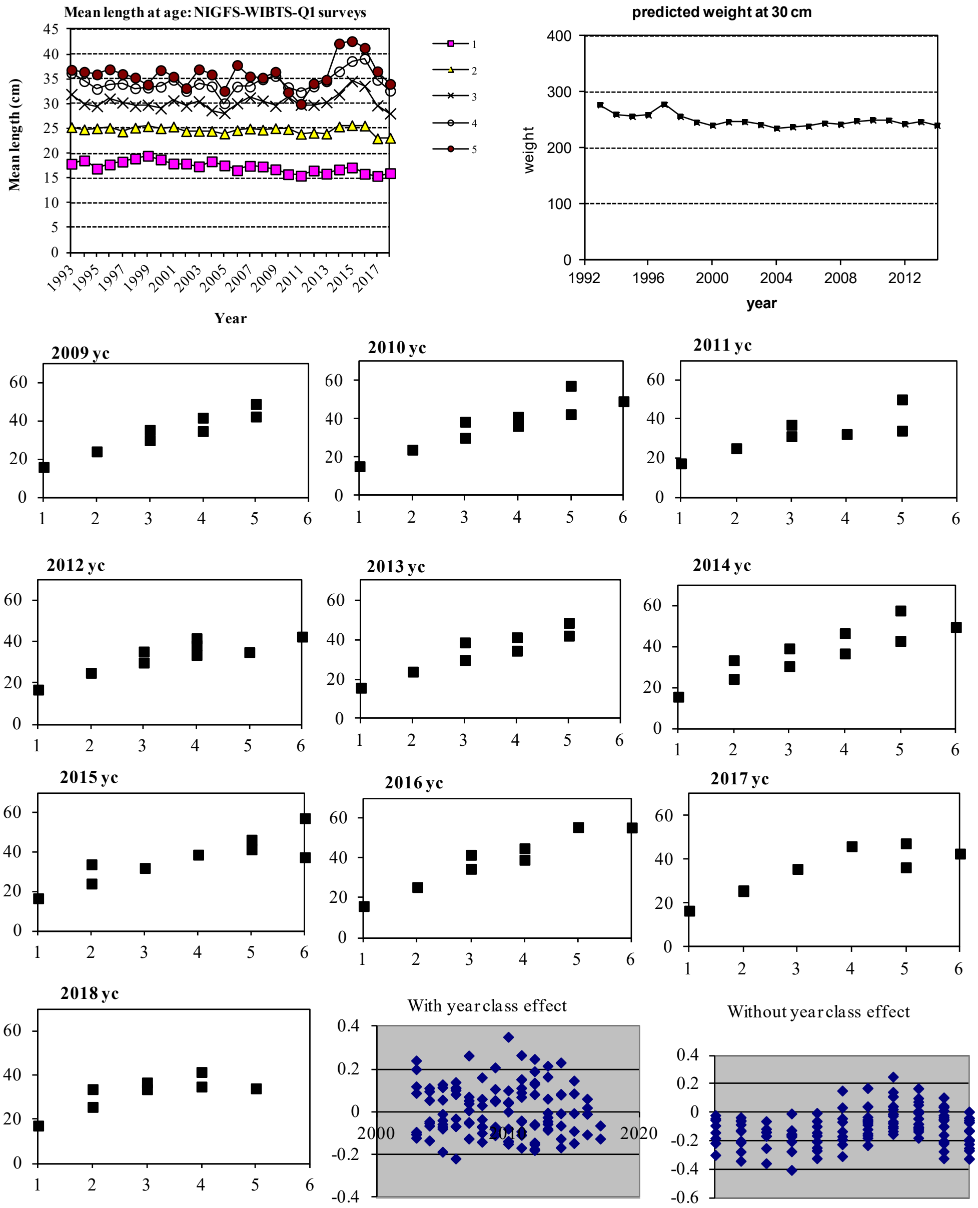


Figure 11.1. Haddock in 7.a: Growth of haddock in the Irish Sea. Top two panels: mean length-at-age in UK(NI) groundfish surveys in March (NIGFS-WIBTS-Q1), by year and age, and expected mean weight-at-length based on length–weight parameters from each survey. Lower panels: mean length-at-age from March surveys, and from Quarter 1 commercial landings at-age 3 and over, by year class. Lines are von Bertalanffy model fits with year-class effect included. Model residuals are shown for the fit without year-class effects, and for the fit with year-class effects.

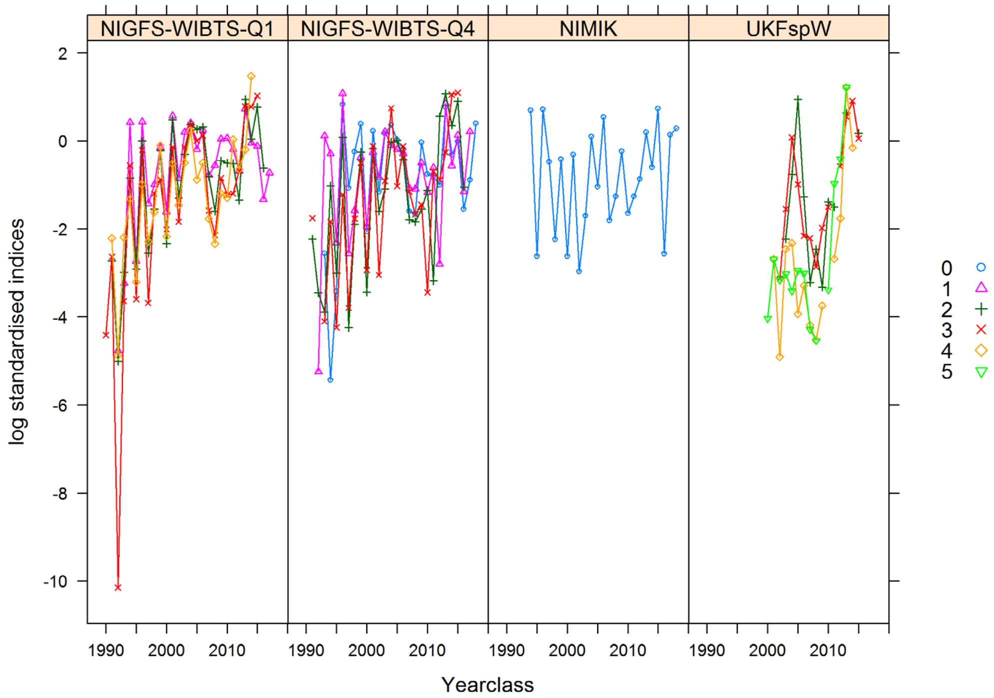
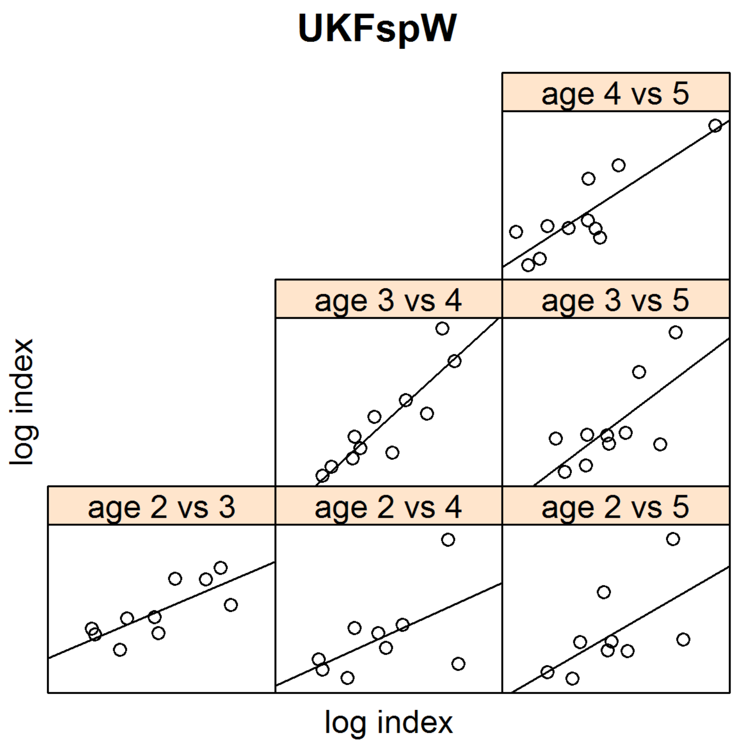
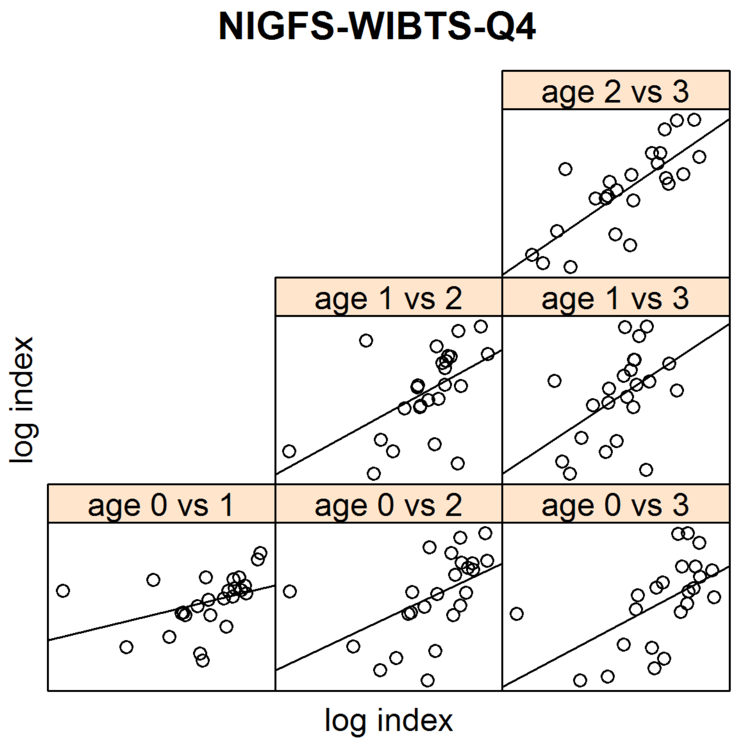


Figure 11.2. Haddock in 7.a: Trends in log-standardised survey indices.


UKFspW
age 4 vs 5
age 3 vs 4
age 3 vs 5
age 2 vs 3
age 2 vs 4
age 2 vs 5
log index
log index


NIGFS-WIBTS-Q4
age 2 vs 3
age 1 vs 2
age 1 vs 3
age 0 vs 1
age 0 vs 2
age 0 vs 3
log index
log index

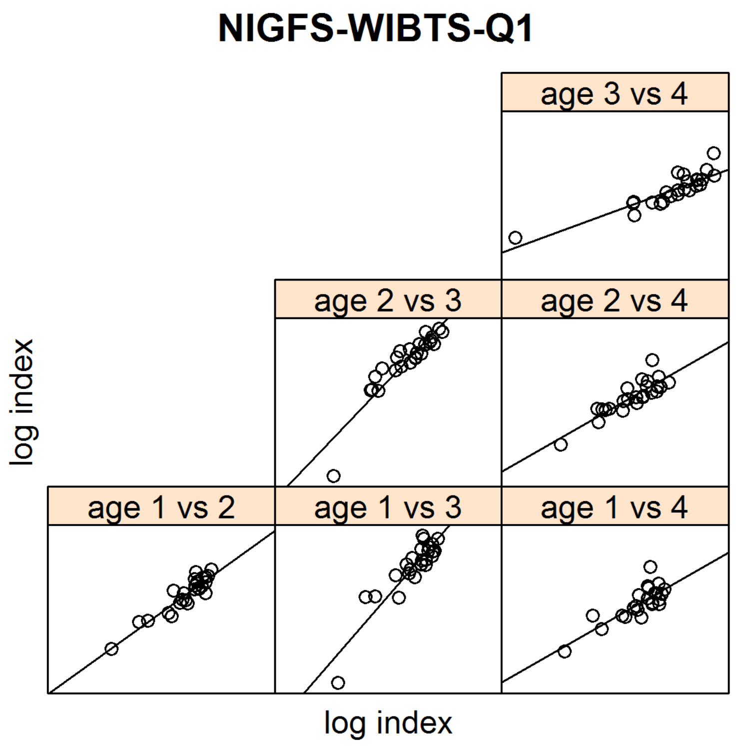


Figure 11.3. Haddock in 7.a: Scatterplot matrix of log indices of cohorts at different ages.

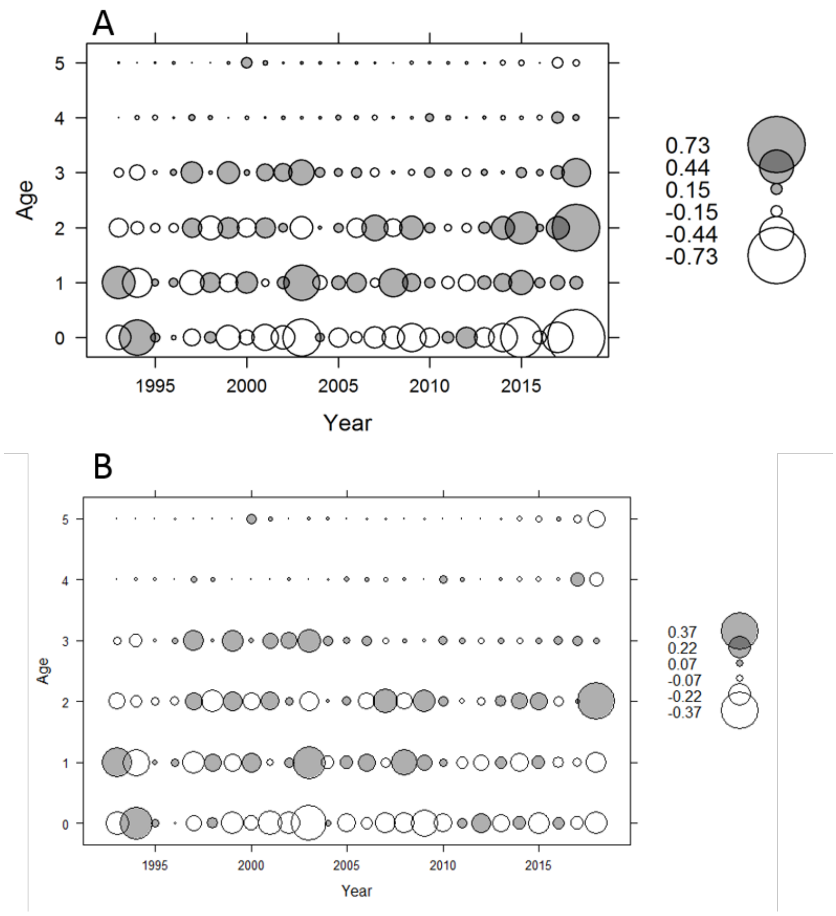


Figure 11.4 Residuals from fitted and observed catch age proportions from update assessment as applied in 2018 (A) and with new starting estimate for selectivity of 0 age haddock from 2013–2018 (B).

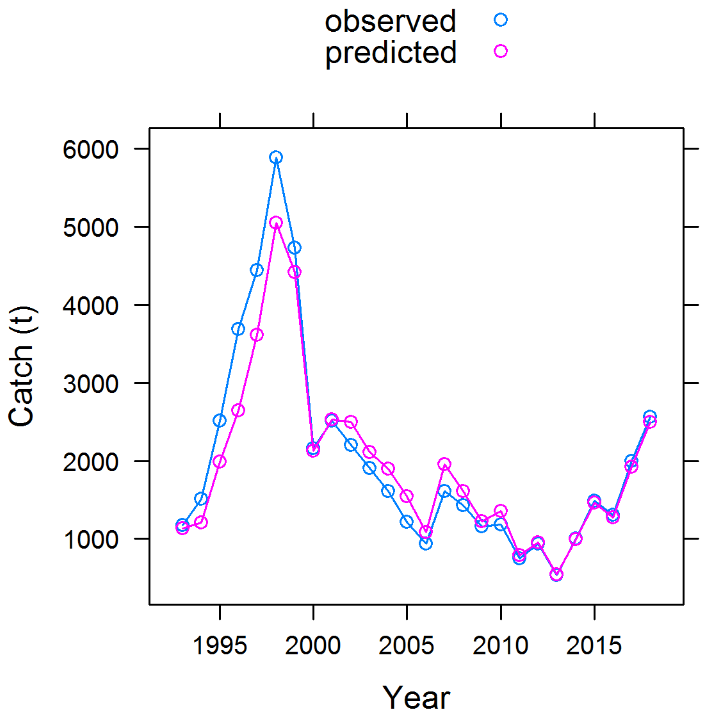


Figure 11.5. Fitted and observed catch from update assessment.

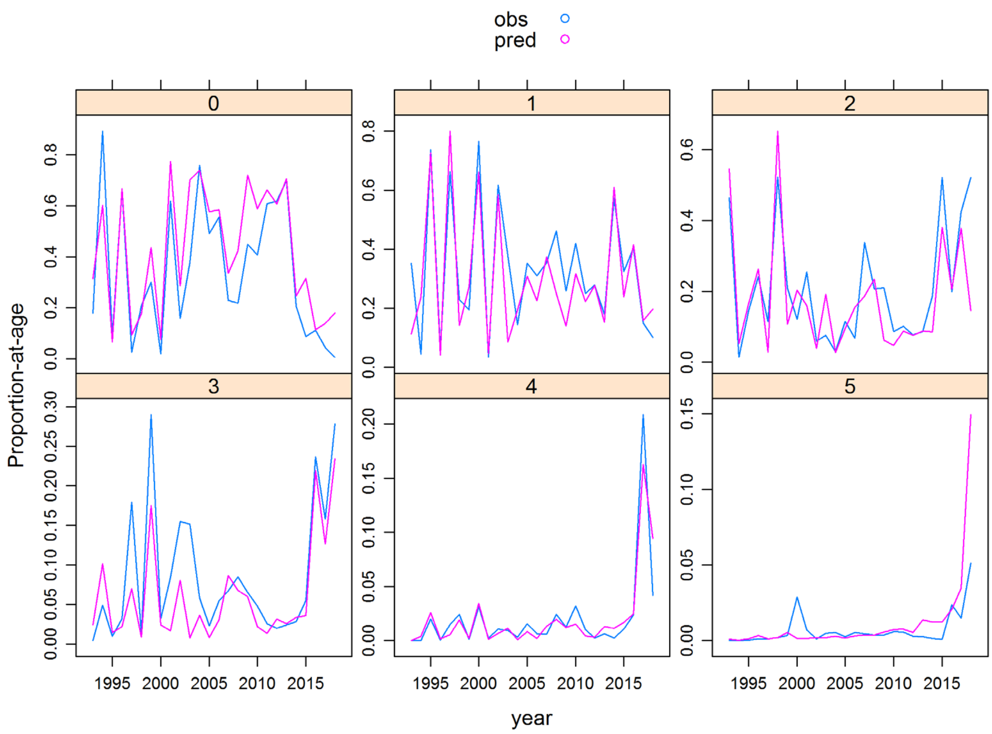


Figure 11.6. Fitted and observed catch age proportions from update assessment.

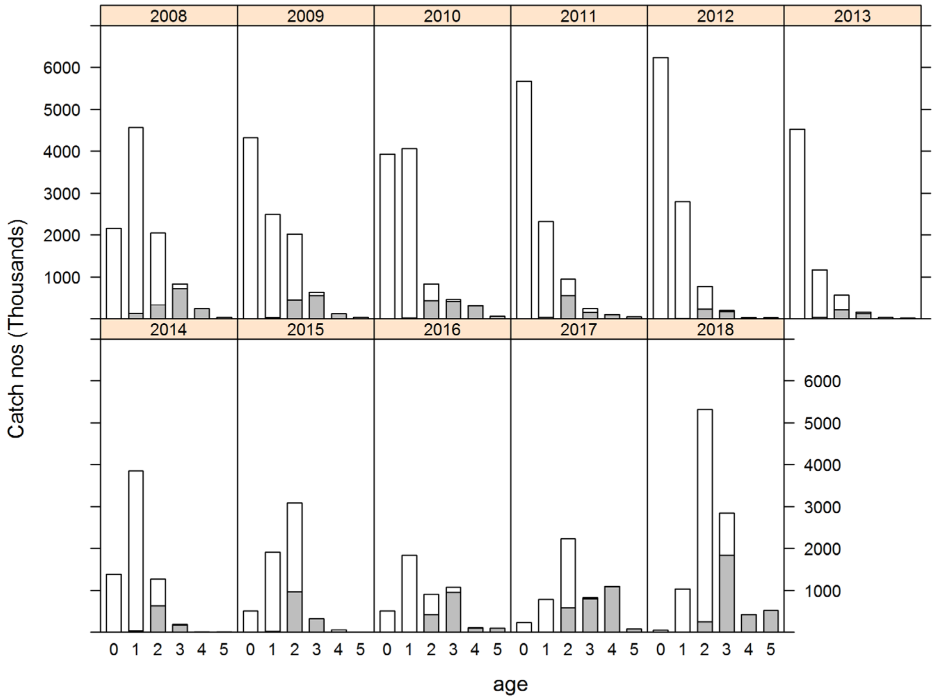


Figure 11.7. Observed catch numbers 2005–present.

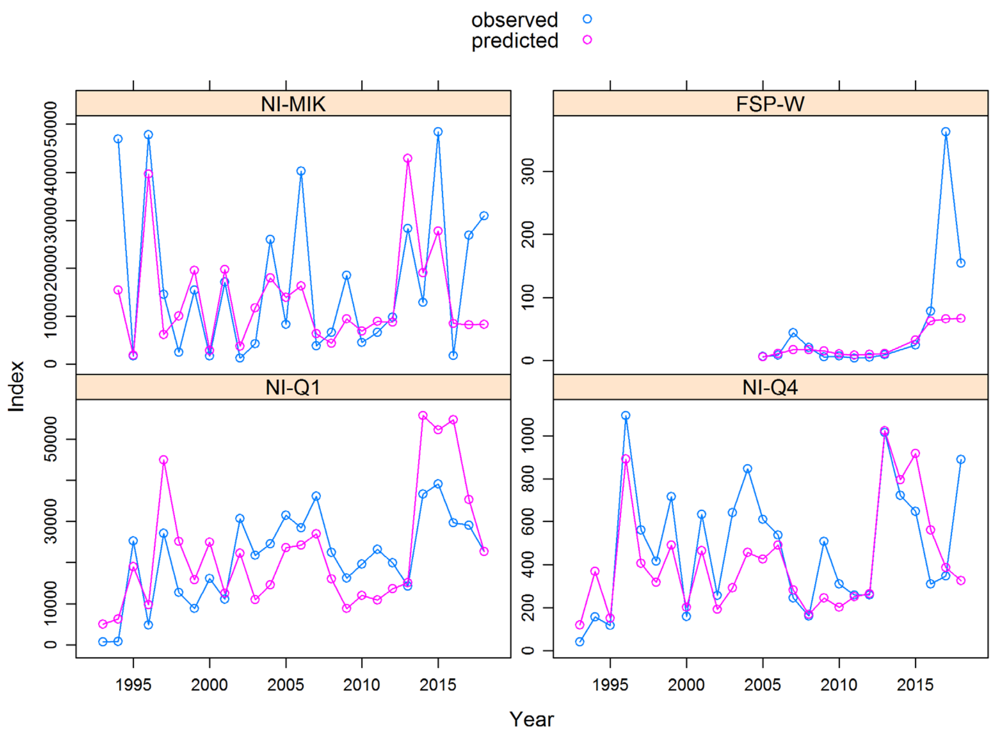


Figure 11.8. Fitted and observed index series from update assessment.

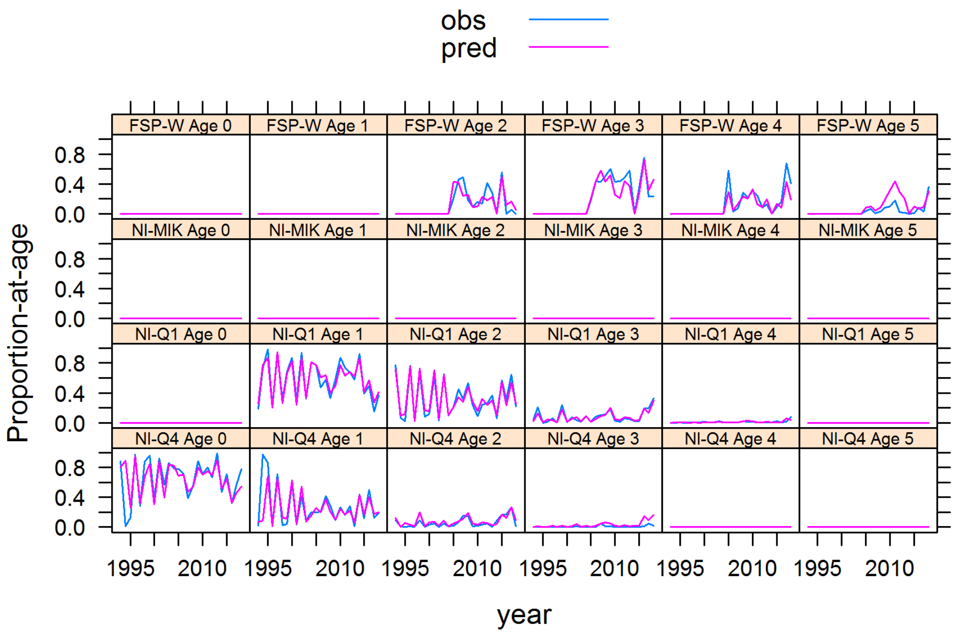


Figure 11.9. Fitted and observed index age proportions from update assessment.

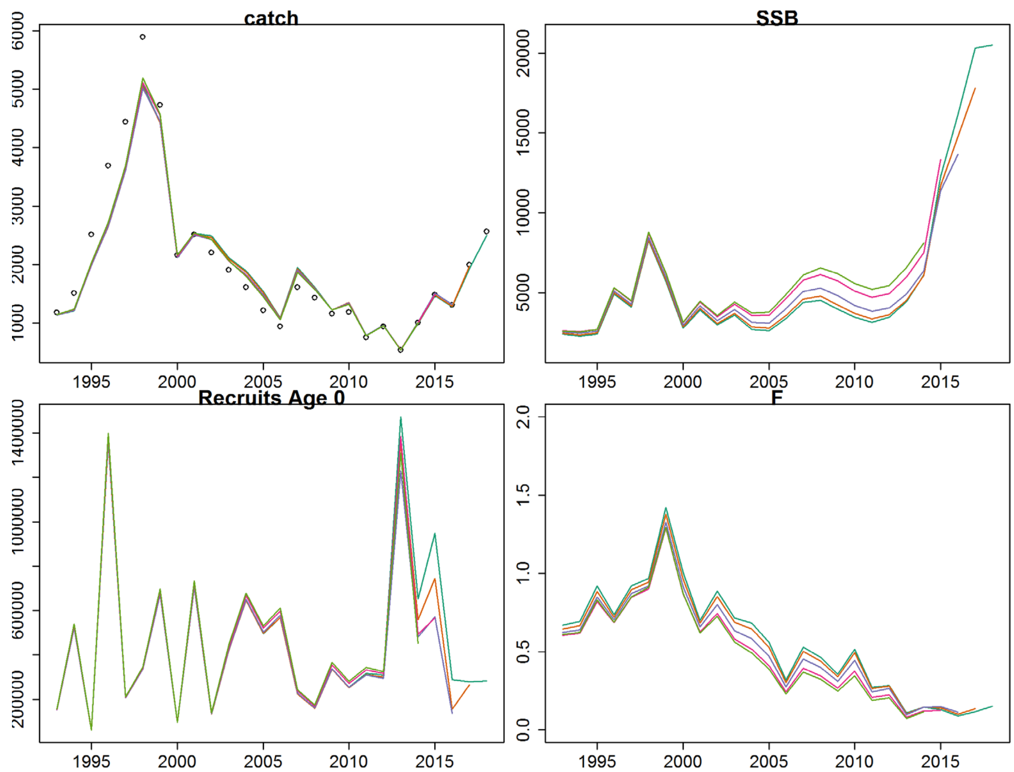


Figure 11.10. A retrospective plot the final update model.

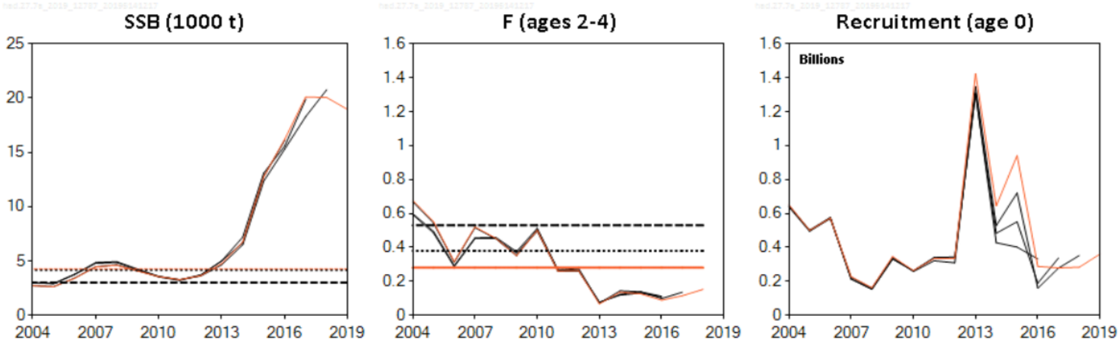


Figure 11.11. Haddock in Division7.a. Historical assessment results.

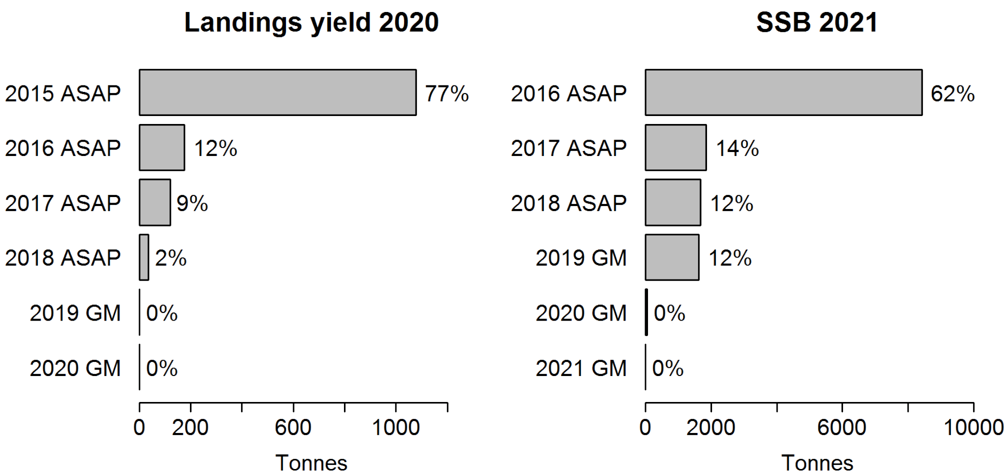


Figure 11.12. Haddock in 7a. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

9 Haddock in divisions 7.b,c,e–k

Type of assessment in 2019

The 2019 assessment followed the Stock Annex 5 procedure performed in the preceding year.

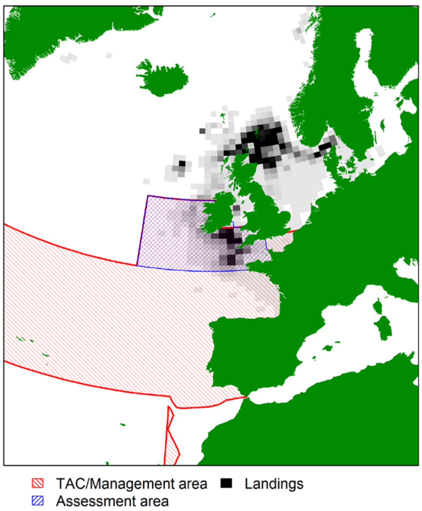
ICES advice applicable to 2018

Last year's full advice is available in the ICES Advice 2018, Book 5. The headline advice was as follows:

"For haddock in Division 7.b–k, ICES advises that when the EU multiannual plan (MAP) is applied, catches in 2020 that correspond to the F ranges in the MAP are between 11 418 and 23 262 tonnes. According to the MAP, catches higher than those corresponding to F_{MSY} (16 671 tonnes) can only be taken under conditions specified in the MAP, whilst the entire range is considered precautionary when applying the ICES advice rule."

9.1 General

Stock description and management units



The basis for the stock assessment area 7.b,c,e–k is described in detail in the stock annex.

Figure 7.4.1 shows the spatial distribution of international haddock landings in the NE Atlantic for 2016. It is clear from the figure that the stock extends into Area 8 and it could be argued that landings from 8 should be included in the stock area. In recent years these landings varied between 20 and 300 t which is up to 4% of the total landings in the stock area.

The TAC for haddock is set for the combined Areas 7.b–k, 8, 10 and 10 and EU waters of CECAF 34.1.1. This does not correspond to the stock assessment area (7.b–k).

2018 management (Council Regulation (EU) 2018/120)

Species:	Haddock *Melanogrammus aeglefinus*	**Zone:**	7b-k, 8,9 and 10; Union waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	77		
France	4 606		
Ireland	1 536		
United Kingdom	691		
Union	6 910		
TAC	6 910		Analytical TAC Article 7(2) of this Regulation applies Article 12(1) of this Regulation applies

2019 management (Council Regulation (EU) 2019/124)

Species:	Haddock *Melanogrammus aeglefinus*	**Zone:**	7b-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	93		
France	5 552		
Ireland	1 851		
United Kingdom	833		
Union	8 329		
TAC	8 329		Analytical TAC Article 7(2) of this Regulation applies Article 13(1) of this Regulation applies

Since 2009, a separate TAC is set for 7.a haddock; previously a separate allocation for 7.a existed within the TAC for 7, 8, 9 and 10.

During the 2011 December fisheries council meeting, Ireland, UK and France agreed to introduce additional technical measures to reduce the high levels of gadoids discards recently observed in the Celtic Seas. In consultation with national governments and the NWWRAC it was agreed to introduce the mandatory use of a 110 mm square mesh panel in *Nephrops* trawls and a 100 mm panel in gadoid fisheries. While the regulation was not introduced until 14th August 2012 (EC Regulation 737/2012), it is understood that for both French and Irish fleets, the technical measures were in practice introduced much earlier in the year by the national administrations.

9.2 The fishery

The official landings reported to ICES and Working Group estimates of the landings and discards are given in Table 7.4.1. The historic landings are also shown in Figure 7.4.2.

Before 2002, the TAC was well in excess of the landings in the TAC area (Table 7.4.1a). The TAC appeared to become restrictive for France in 2003–2004 and Ireland in 2001–2003 and perhaps after (Table 7.4.1a and Figure 7.4.2b). (WGSSDS05 provided some qualitative evidence that mis-reporting was a problem). During 2005–2008 landings were well below the TAC. In 2009 and 2010 the total landings were still below the TAC, but the quota appeared to become restrictive again for Ireland and Belgium. Since 2011 the TAC has been close to the total landings and can be assumed to be restrictive for all countries.

Figure 7.4.2a gives a long-term overview of the landings of haddock. The time-series is characterized by a number of peaks with rapid increases in the landings, mostly followed by rapid decreases within a few years, suggesting the fishery was taking advantage of sporadic events of very high recruitment. During the 1960s and 1970s, three such peaks in landings occurred: the landings increased from less than 4000 t to 10 000 t or more. During the 1980s and early 1990s, landings were relatively stable around 2000–4000 t. During the mid-1990s the haddock landings increased again to over 10 000 t, mirroring increased landings in the Irish Sea in that period. Since the late 1990s the landings have varied between 7000 and 10 000 t and in 2012, the landings were the highest on record at more than 18 000 t.

The discard estimate for 2010 was the highest on record at 16 547 tonnes (Table 7.4.1b), this was mainly a consequence of the 2009 cohort entering the fishery.

Table 7.4.2 and Figure 7.4.3 show that Irish commercial lpue was relatively low between 2003 and 2007 after which it increased. Effort in the French gadoid fleet has declined considerably since the early 2000s as the result of a decommissioning scheme. The French and Irish 7.fgh fleets both showed an increase in lpue as the strong 2009 cohort entered the fishery. These data are presented for auxiliary information only; these fleets are not used directly in the assessment.

9.2.1 Information from the Industry

The French and Irish fishing industry have reported that the abundance and distribution of haddock increased in 2016 and that this continued into 2018. Due to the restrictive TAC the industry have reported to national scientists that there is increased discarding of haddock.

9.3 Data

9.3.1 Landings and discard numbers-at-age

Discard and retained catch–age distributions for 2013 and 2018 are shown in Figure 7.4.4. Many of the discarded fish will be above the MLS, which is likely to be the result of restrictive quota.

Figures 7.4.5 and 7.4.6 shows the available time-series of catch (discards and retained catch) and age distributions.

The historic approach to raising the catch numbers-at-age is given in the stock annex. France and Ireland had allocated age distributions to most unsampled catches before uploading to InterCatch. For métiers where discards were not provided, the discards were estimated from the discard rate of métiers that had both landings and discards. Sampled and unsampled métiers, by country and age class, are shown in Figure 7.4.7.

Landings numbers-at-age are given in Table 7.4.3a and discard numbers-at-age are given in Table 7.4.3b. Despite some uncertainty about the quality of the discard data, it is possible to track strong year classes in both the discards and the landings-at-age matrices. Discards account for a large proportion of the catch numbers up to age 3. Figure 7.4.6 shows the proportions-at-age that are discarded; over the last ten years 97% of one year-olds, 80% of two year-olds and 40% of three-year olds have been discarded. By number, 77% of the total catch was discarded (46% by weight; average last ten years). There is a trend for increasing proportions of two and 3-year olds to be discarded, in the mid-nineties around half of the 2-year olds were discarded and around 10% of 3-year olds while in recent years around 80% of 2-year olds and 30% of 3-year olds were being discarded.

Catch and stock weights-at-age are given in the ASAP input file (Table 7.4.4). Figure 7.4.8 shows that the raw stock weights-at-age which are fairly noisy, a 3-year running average was applied to the stock weights used in the assessment. There appear to be cyclical trends in the weights-at-age that follow cohorts (rather than year-effects).

9.3.2 Biological

The assumptions of natural mortality and maturity are described in the stock annex. The maturity ogive used in the assessment is knife-edged at-age 2. Recent Irish maturity data from 2004–2014 (working document to WGCSE15) suggested a similar maturity ogive for females, but also indicated that a significant number of males mature before the age of two.

9.3.3 Surveys and commercial tuning fleets

The available surveys and commercial tuning fleets are described in detail in the stock annex. One survey index is used in the assessment: the FR-IRL-IBTS index, which is a combined index from the French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS surveys. Additionally one commercial tuning fleet is used: the IR-GAD index, which is the Irish gadoid fleet in selected rectangles of 7.gj. The index data are given in the ASAP input file (Table 7.4.4). The standardised indices are given by year in Figure 7.4.9 and by cohort in Figure 7.4.10. Figure 7.4.11 shows the scatterplot matrices of the log indices. These plots indicate that the internal consistency of the indices is robust. The IR-GAD index (Figure 7.4.9) shows an increasing trend over time, mainly as a result of the relatively strong 2002 and 2009 cohorts.

9.4 Historical stock development

Model used: ASAP; (XSA is also used for quality control purposes).

Software used: ASAP V3.0.17 NOAA Fisheries toolbox (http://nft.nefsc.noaa.gov)

FLR with R version 3.1.2 with packages FLCore 2.5.20150116, FLAssess _2.5.20130716, FLXSA 2.5. 20140808 and FLEDA 2.5 (http://flr-project.org/)

9.4.1 Data screening

The general approach to data screening and analysis was followed in addition to the data exploration tools available in the FLR package FLEDA. The results of the data screening are fully documented using R markdown and are available in the folder 'Data\Stock\had-7bce–k' on the ICES SharePoint.

9.4.2 Final update assessment

The final assessment was run with the same settings as established by WKROUND 2012 and described in the stock annex. Discards were combined with the landings and not supplied separately to the model.

Figure 7.4.12 shows the residuals of that catch proportions-at-age. For age classes where discards dominate, the residuals are relatively large. There is no obvious pattern in the younger ages but the residuals in the older ages at the start of the time-series are mostly positive. The 2010 year class has the strongest residuals in later year (ages of 4 and above) with the signal continuing with the year class as they age, indicating that the model does not 'believe' the 2010 cohort is as strong as the index suggests. The observed and predicted catches are shown in Figure 7.4.12. The predicted catches were generally slightly lower than observed in most recent years while they were generally higher than observed from 2002–2006.

In the proportions-at-age residual plots of the survey (FRA-IRL-IBTS) commercial (IRL-GAD) indices (Figure 7.4.14) there are no consistent patterns, with only minor differences between observed and predicted values. The observed and predicted index cpue values are shown in Figure 7.4.15. The model closely follows the survey index, though in 2012 and 2016 the predicted index in the IRL-GAD index was above the observed, as the assessment balanced the observed catch in the FRA-IRL scientific survey indices. The scientific survey index also observed a notable increase in the 2018 survey, which follows through the assessment as a notable 2018 recruitment event, and is shown in Figure 7.4.14 to comprise age 0 recruits.

The selectivity of the catch data was freely estimated for ages 1 and 2 by the model. For the other ages, selectivity was fixed. Table 7.4.5 shows the model estimates for ages 1 and 2. Selectivity of the FR-IR-IBTS index was fixed at 1 for all ages that were included and selectivity (exploratory data analysis shows that log catch numbers of those ages decline in straight lines) of the IRL-GAD index was freely estimated for age 3 and fixed at one for older ages. (Discards are not included in this commercial fleet therefore selectivity was not assumed to be the same as that of the catch data).

The ASAP assessment is shown in Figure 7.4.16, detailing catch, landings, SSB F and recruits with stdev.

9.4.3 Comparison with previous assessments

Figure 7.4.16 shows the comparison of the current assessment with an XSA assessments. The two assessment models mirror catch, SSB and recruitment well, with estimates of F being of a similar range if dissimilar in precision in the recent time period.

9.4.4 State of the stock

Table 7.4.6 shows the estimated fishing mortality-at-age and Table 7.4.7 shows the stock numbers-at-age. The stock summary is given in Table 7.4.8.

The spawning–stock biomass (SSB) peaked in 2011 as the very strong 2009 year class matured; this cohort was followed by three years of below-average recruitment which led to a rapid decline in SSB after 2011. Recent recruitment has varied around the average, with a notable peak in 2009 and in 2018. SSB appears to have stabilised, while fishing mortality (F) has been above F_{MSY} for the entire time-series but shows a declining trend.

9.5 Short-term projections

Because recruitment of haddock is characterised by sporadic events, the assumed geometric mean (GM) recruitment for the intermediate year introduces significant uncertainty for the SSB estimate in 2019. The short-term predictions are expected to give a reasonably reliable estimate of landings in 2019 (assuming average F 2015–2017), which are largely based on the estimates of the 2016 and 2018 recruitments. In the past, recruitment has generally been accurately estimated.

Short-term projections were performed using FLR libraries. Recruitment for 2019–2021 was estimated at 252 713 (GM 1993–2016; thousands). Three year averages were used for F (unscaled) and weights-at-age. Catches were split into landings and discards using the proportions of the catch that were discarded over the full time-series. This was done because the discard pattern over the last four years are unlikely to persist: the proportion of discards in the 2013–2014 was considerably lower than the historic proportion of discards.

Input data for the short-term forecast are given in Table 7.4.9. The single option output is given in Tables 7.4.10 and 7.4.11 gives the management options.

Intermediate year assumptions for the catch advice were as follows:

Variable	Value	Notes
$F_{ages\ 3–5}$ (2019)	0.77	$F_{sq} = F_{Average}$(2015–2018), rescaled to 2018
SSB (2020)	49 821	tonnes; F_{sq} = 0.77
R_{age} 0 (2019–2020)	252 713	thousands; Geometric mean (1993–2016)
Catch (2019)	20 457	tonnes; F_{sq} = 0.77
Wanted catch (2019)	6963	tonnes; Average discard rate (1993–2018)
Unwanted catch (2019)	13 494	tonnes; Average discard rate (1993–2018)

Estimates of the relative contribution of recent year classes to the 2020 landings and 2021 SSB are shown in Figure 7.4.17. The extremely high recruitment observed in 2018 accounts for over 77% of the projected landings in 2020 while the GM 2019 assumption only accounts for 3% of 2020 landings. The 2018 cohort also contributes largely to the estimated SSB in 2021 (58%) with a second, large proportion coming from the 2019 GM assumption. At GM recruitment and *status quo* F, SSB will remain well above $B_{trigger}$.

9.6 MSY evaluations and biological reference points

ICES carried out and evaluation of MSY and PA reference points for this stock at WKMSYREF4 (ICES, 2016a). The results have been published earlier this year (ICES, 2016b) are summarized below:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	10 000 t	B_{pa}	ICES (2016a)
	F_{MSY}	0.40	Median point estimates of EqSim with a segmented regression stock–recruitment relationship.	ICES (2016a)
Precautionary approach	B_{lim}	6700 t	Lowest observed SSB	ICES (2016a)
	B_{pa}	10 000 t	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.26$	ICES (2016a)
	F_{lim}	1.41	F with 50% probability of SSB< B_{lim}	ICES (2016a)
	F_{pa}	0.89	F_{lim} combined with the assessment error; $F_{lim} \times \exp(-1.645 \times \sigma)$; $\sigma = 0.28$	ICES (2016a)
Management plan*	MAP MSY $B_{trigger}$	10 000 t	MSY $B_{trigger}$	
	MAP B_{lim}	6700 t	B_{lim}	
	MAP F_{MSY}	0.40	F_{MSY}	
	MAP range F_{lower}	0.26	Consistent with ranges provided by ICES (2016b), resulting in no more than 5% reduction in long-term yield compared with MSY.	
	MAP range F_{upper}	0.60	Consistent with ranges provided by ICES (2016b), resulting in no more than 5% reduction in long-term yield compared with MSY.	

9.7 Management plans

The EU multiannual plan (MAP) for the Western Waters (EU, 2019), incorporating the stock haddock 7.b,c,e–k has been agreed. This MAP "establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks", under article 17 states that "It is appropriate to establish the target fishing mortality (F) that corresponds to the objective of reaching and maintaining MSY as ranges of values which are consistent with achieving MSY(F_{MSY}). Those ranges, based on best available scientific advice, are necessary in order to provide flexibility to take account of developments in the scientific advice, to contribute to the implementation of the landing obligation and to take into account the characteristics of mixed fisheries."

9.8 Uncertainties and bias in assessment and forecast

9.8.1 Landings

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches, although the assessment is contingent on the accuracy of the landings statistics.

9.8.2 Discards

Irish discards have been monitored since 1995. The number of trips sampled has varied considerably over time (between three and 62 trips per year). Sample numbers were particularly low in 1995, 1999–2002 and 2006. During the remaining years, the number of sampled trips was considered sufficient to give reliable estimates of discards.

French discard data exist from 2004 onwards but the data are not considered to be reliable before 2008. The time-series of French discards was reconstructed by assuming that 90% of one-year olds, 50% of two-year olds and 10% of three year olds were discarded throughout the time-series. These proportions were estimated from the available discard and retained catch data provided by France. Because French discards are estimated to account for 80–86% of the international discards (by weight; 2008–2012), there is considerable uncertainty around the historic discard estimates. However WKROUND (2012) concluded that the ASAP assessment is relatively robust to the uncertainty in the discard estimates.

Although recent discard estimates are considered to be more reliable, the problem remains that the number of observer trips is very small compared to the total number of trips (typically <1% of all trips are sampled). The level of uncertainty owing to the small sample sizes is likely to be high but the cost of increasing discard coverage would be considerable.

9.8.3 Selectivity

As a consequence of the introduction of square-mesh panels in the Celtic Sea, the selectivity of the fleet might be expected to change. The regulations were introduced in the second half of 2012 (although many vessels had already voluntarily fitted panels earlier that year). STECF (PLEN-13-03) investigated the efficiency of the introduction of the square-mesh panel in the Celtic Sea and did not find evidence for a change in selectivity in 2012 or 2013. A possible change in selectivity was investigated using a number of different approaches:

- There is no evidence of a ‘block’ of negative residuals of young fish in recent years from the catch proportions-at-age residuals (Figure 7.4.12).
- An exploratory ASAP run with two selectivity blocks (1993–2011 and 2012–2015) estimated slightly higher lower selectivity for 1-year olds but slightly higher selectivity for 2-year olds since the introduction of the panels. The assessment results were otherwise nearly identical.
- The XSA assessment (which does not have a fixed selectivity pattern) does not show clear reductions in F for younger ages relative to the older ages since 2012.
- A change in selectivity may also be detected from a change in mean weight-at-age for young fish (within an age class the smaller, lighter fish should escape). The average catch weight of 1-year olds has shown minor increases since the late 2000s (Figure 7.4.8). The catch weights of 2-year-olds increased between 2011 and 2018, while three-year-olds have also shown an increasing trend, and this age class is not expected to be affected by square-mesh panels.

Therefore there is no clear evidence that selectivity has changed significantly and the assumption of constant selectivity in ASAP appears to be valid. In future assessments a separate selectivity block for the last three years should continue to be considered.

9.8.4 Assessment bias

Figure 7.4.18 shows the retrospective of the ASAP analysis. The predicted catch shows little retrospective pattern, neither does the recruitment estimate. The SSB however, has a tendency to be revised upwards as another year of data is added. F has been overestimated and revised downwards since approximately 2008 in the assessment, caused by the strong 2009 cohort for which caused a conflict between the catch data, and being most pronounced in 2011 and 2012, becoming less with the addition of another year. This retrospective bias appears to become more aligned form 2013–2014 onwards.

Assessment bias (Figure 7.4.19) is more apparent for SSB in the most recent year, being revised up, while F and recruitment showed little revision historically, and only recruitment showing any marked change, in the 2018 value owing to the large recruitment observed in the surveys. Mohn's rho was calculated for the assessment, comparing the yearly estimates with proceeding years' assessment estimates, with comparisons lagged to remove the last year value from each assessment, as this value will have been influenced by recruitment, which was set to the geometric mean of the proceeding time-series values. The averages of the proceeding five years' Mohn's rho were calculated, for SSB (-0.172) F (0.113) and recruitment (0.003). In line with Figure 7.4.19, values for F and recruitment were low. The value for SSB was strongly influenced by the upward shift in the most recent years' assessment, with proceeding years' assessments agreeing well. The increase in SSB observed in the most recent year's assessment is attributable to the observed 2018 large recruitment event, being well above recent and average level of recruitment in the stock. ICES recommendations for Mohn's rho is a range within 0.20 and -0.15. The SSB value in this case falls outside this range, however owing to the bias being a response to an observed, unusual recruitment even it is considered that on this occasion the resulting advice is still fit for purpose.

9.9 Surveys

The combined French/Irish survey has nearly full spatial coverage of the assessment area. The survey has good internal consistency. The commercial tuning fleet only covers a small part of the stock area but WKROUND (2012) decided to include this fleet due to the short time-series of the survey.

9.9.1 Forecast

The 2018 cohort accounts for over 77% the projected landings in 2020, with recruitment of this cohort estimated with a CV of 21%, which is reasonably precise and recruitment estimates have tended to be accurate in the past with little retrospective bias. The strong cohort was picked up by both the Irish and French quarter 4 surveys in 2018.

The 2018 GM recruitment assumption does not contribute much to the forecasted landings in 2020 (3% contribution), however it contributes 35% to the 2021 SSB estimate; this adds considerable uncertainty to the 2021 SSB forecast.

The large recruitment event seen in 2018 surveys is expected to contribute significantly to the realised 2019 catch and 2020 catch, (Figure 7.4.20, Table 7.4.11 & 7.4.12).

9.10 Recommendation for next benchmark

9.10.1 Stock audit

The audit of the 2019 report did not raise any concerns.

9.10.2 Recommendations for future work

WGCSE recommend that cod, haddock and whiting in the Celtic Sea will be benchmarked together in 2019–2020. The focus of the benchmark will streamlining data compilation procedures for fishery-dependent and survey data. This will give improved transparency and diagnostics surrounding commercial tuning fleets and surveys. The benchmark will also re-examine the assessment methods and diagnostics given the potential for changes in selectivity in the commercial fishery. The benchmark should also consider mixed fisheries and multispecies interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species.

Catch data should continue to be monitored for indirect evidence of improved selection patterns due to the augmented TCMs in the Celtic Sea. Direct monitoring of escapement through SMPs would also be useful.

It would be desirable to include discards separately in the assessment model in order to specify greater precision for the discard numbers-at-age than for the landings numbers-at-age. However WKROUND (2012) concluded that this resulted in undesirable residual patterns. The benchmark workshop did not have sufficient time to fully evaluate this problem.

It would be worth investigating the value of the commercial tuning fleet. If this fleet is to be retained it would be useful to apply a method of standardisation to account for possible changes in the fleet.

9.11 Management considerations

The stock size fluctuates strongly over the time. The size of the stock is determined to a large extent by recruitment, which has been erratic and in 2018 is shown to have been large. There is no discernible relationship between stock size and recruitment, as is the case with most haddock stocks.

Fishing mortality has been consistently above F_{MSY}, but this has not led to a decreasing trend in stock size, which suggests that the stock is robust to overfishing, however F has been increasing since 2015 and at current levels the SSB could quickly fall below $MSY_{Btrigger}$ if recruitment were to be low for three or four years. Recent high 2018 recruitment is not yet appearing in the SSB estimates, which continues to fall.

The variable recruitment has also resulted in substantial short-term variability in TACs and high discards have occurred when a strong year class occurs, this is expected to be the case in 2019 and 2020 (Figure 7.4.19). Discarding of under-size as well as marketable fish is a serious problem for this stock, with approximately $^2/_3$ in catch numbers and almost half the catch weight has been discarded on average over the past decade. Alternative or complimentary approaches to managing such strong, recruit-driven fluctuations are required, especially with regard to the EU landings obligation.

The minimum landing size of haddock is 30 cm, which is approximately the same as the mean length of two-year old haddock in the Celtic sea. Because gadoids are caught in a mixed fishery, restrictive quota in recent years have led to increased discarding of marketable fish as well as already considerable discarding of undersized fish. Technical measures have been introduced to reduce discards of undersize gadoids (110 mm square-mesh panel in the *Nephrops* fisheries and 100 mm in the gadoid fisheries). It is not clear whether this is sufficient to reduce discard mortality of future cohorts. It is important that technical measures are fully implemented and their effectiveness in reducing discards and impact on commercial catches are monitored and evaluated.

9.12 References

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008.

ICES. 2016a. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2016b. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. ICES Advice 2016 Book 5, ICES Special Request Advice, Published 5 February 2016.

Table 7.4.1.a. Haddock in 7.bc–ek. Official landings (quota uptake in brackets).

Year	BEL	ESP	FRA	IRL	UK*	Others	Total	TAC**
1994	123	0	2788	908	240	17	4076	
1995	189 (28%)	19	2964 (74%)	966 (72%)	266 (44%)	64	4468	6000
1996	133 (9%)	48	4527 (49%)	1468 (47%)	439 (31%)	38	6653	14000
1997	246 (16%)	54	6581 (71%)	2789 (90%)	569 (41%)	31	10270	14000
1998	142 (6%)	260	3674 (28%)	2788 (63%)	445 (22%)	52	7361	20000
1999	51 (2%)	88	2725 (19%)	2034 (42%)	278 (13%)	71	5247	22000
2000	90 (5%)	110	3088 (28%)	3066 (83%)	289 (17%)	13	6656	16600
2001	165 (12%)	646	4842 (61%)	3608 (135%)	422 (35%)	19	9702	12000
2002	132 (128%)		4348 (70%)	2188 (106%)	315 (34%)	106	7089	9300
2003	118 (130%)		5781 (106%)	1867 (103%)	393 (48%)	82	8241	8185
2004	136 (127%)		6130 (96%)	1715 (80%)	313 (33%)	159	8453	9600
2005	167 (130%)		4166 (54%)	2037 (80%)	292 (25%)	197	6859	11520
2006	99 (77%)		3190 (42%)	1875 (73%)	274 (24%)	209	5647	11520
2007	119 (93%)		4142 (54%)	1930 (75%)	386 (34%)	52	6629	11520
2008	108 (84%)		3639 (47%)	1800 (70%)	566 (49%)	121	6234	11579
2009	131 (102%)		5429 (70%)	2983 (116%)	716 (62%)	48	9307	11579
2010	170 (132%)		6240 (81%)	2609 (101%)	852 (74%)	128	9999	11579
2011	211 (143%)		8388 (94%)	3322 (112%)	1659 (125%)	129	13709	13316
2012	231 (125%)		11793 (106%)	4130 (112%)	1901 (114%)	167	18222	16645
2013	173 (110%)		8748 (93%)	2699 (86%)	1455 (103%)	21	13096	14148
2014	99 (94%)		6374 (101%)	2092 (99%)	785 (83%)	18	9368	9479
2015	117 (126%)		5681 (102%)	1656 (89%)	759 (91%)	4	8217	8342
2016	88 (102%)		4487 (87%)	1713 (99%)	692 (89%)	27	7007	7751
2017	111 (144%)		4615 (100%)	1256 (82%)	690 (100%)	13	6685	6910
2018	89 (96%)		4478 (81%)	1434 (77%)	581 (70%)	8	6590	8329

*** UK Includes Channel Islands.**

**** TAC Applied to subareas 7–10 from 1995 to 2008 and to 7b–k, 8, 9 and 10 from 2009 onwards.**

Table 7.4.1.b. Haddock in 7.bc–ek. ICES estimate of the landings (lan) and discards (dis).

Year	BEL Lan	ESP Lan	FRA Lan	IRL Lan	UK Lan	Others Lan	Total Lan	FRA Dis*	IRL Dis**	Others Dis***	Total Dis
1993							3348	505	594	109	1208
1994							4131	1116	594	176	1886
1995							4470	730	1221	267	2218
1996							6756	3170	713	426	4309
1997							10827	2129	502	253	2883
1998							7928	680	140	114	934
1999							4970	477	54	55	586
2000							7499	1587	727	189	2503
2001							9278	2234	743	441	3418
2002	134	85	3878	2070	301	21	6488	871	5651	552	7073
2003	116	82	5960	1731	362	41	8292	1835	6941	680	9456
2004	137	143	6336	1785	303	73	8777	1108	5156	486	6750
2005	165	197	4096	2026	282	21	6787	762	3933	496	5191
2006	98	185	3151	1883	262	14	5593	1061	1167	256	2484
2007	118	49	4073	2135	383	23	6781	1268	1241	230	2739
2008	109	121	4587	2032	545	61	7455	7608	2153	1427	11187
2009	131	47	5455	3271	703	1	9608	6064	2143	873	9080
2010	170	127	6267	2876	789	34	10262	11396	3246	1905	16547
2011	212	94	7365	3697	1511	0	12879	9320	2913	2145	14378
2012	232	105	11793	4608	1637	0	18376	7221	1678	1293	10191
2013	174	40	8622	3109	1480	0	13424	1103	727	255	2085
2014	99	3	6376	2529	848	0	9855	1793	992	392	3177
2015	118	0	5679	1978	766	4	8545	2798	2785	1110	6693
2016	88	0	4487	1713	692	26	7574				
2017	111	0.180	4896	2379	699	0	8086	4357	1597	2021	7975
2018	89	0	4446	1986	578	7	7109	2733	1133	1570	5436

*** For 1993–2007 fixed discard ratios were used to estimate French discards.**

**** For 1993–1994, the mean Irish discards over 1995–1999 were used.**

***** Estimated from the proportion of the landings of `Others' between 1993 and 2012.**

Table 7.4.2. Haddock in 7.bc–ek. Lpue (kg/hour fishing) of haddock and effort (hours fishing x 1000) for Irish Otter trawls in 7.bc, 7.fgh and 7.jk, the French demersal fleet in 7.bc–ek and effort only for the UK trawl fleets (excluding beam trawls) in 7.e–k (effort in fishing days).

	FR GAD 7ek effort	FR GAD 7ek lpue	IRL OTB 7bc effort	IRL OTB 7bc lpue	IRL OTB 7fgh effort	IRL OTB 7fgh lpue	IRL OTB 7jk effort	IRL OTB 7jk lpue	UK Trawl 7e–k effort
1983	NA	NA	NA	NA	NA	NA	NA	NA	51.5
1984	NA	NA	NA	NA	NA	NA	NA	NA	161.8
1985	NA	NA	NA	NA	NA	NA	NA	NA	143.7
1986	NA	NA	NA	NA	NA	NA	NA	NA	123.5
1987	NA	NA	NA	NA	NA	NA	NA	NA	108.9
1988	NA	NA	NA	NA	NA	NA	NA	NA	112.9
1989	NA	NA	NA	NA	NA	NA	NA	NA	119.9
1990	NA	NA	NA	NA	NA	NA	NA	NA	133.2
1991	NA	NA	NA	NA	NA	NA	NA	NA	118.8
1992	NA	NA	NA	NA	NA	NA	NA	NA	129.9
1993	NA	NA	NA	NA	NA	NA	NA	NA	101.1
1994	NA	NA	NA	NA	NA	NA	NA	NA	88.5
1995	NA	NA	78	5.77	64	1.48	106	2.20	88.1
1996	NA	NA	47	4.16	60	5.35	73	3.24	89.5
1997	NA	NA	63	4.36	65	5.83	92	8.23	101.8
1998	NA	NA	79	5.71	72	4.09	99	5.88	94.6
1999	NA	NA	77	5.27	51	2.35	52	3.53	132.8
2000	306	6.12	74	4.73	61	10.43	72	4.25	141.1
2001	333	10.57	78	4.30	69	8.69	81	7.41	117.5
2002	289	10.63	63	2.81	79	3.22	108	5.50	113.1
2003	264	15.15	81	2.09	87	3.26	123	3.88	102.4
2004	217	19.39	82	2.51	97	3.49	108	3.35	105.5
2005	175	14.67	69	2.45	127	4.53	93	3.70	100.9
2006	167	10.64	60	2.56	119	4.19	89	3.59	106.3
2007	160	14.97	60	3.31	136	4.01	103	3.66	113.6
2008	148	19.60	48	4.36	127	4.56	84	4.60	93.7
2009	150	22.65	48	5.47	141	9.25	82	7.09	98.6
2010	131	30.83	54	4.36	144	7.33	101	5.15	103.7
2011	216	22.90	40	6.39	129	10.51	84	5.58	87.1
2012	188	45.03	44	4.93	135	13.17	84	6.58	86.2
2013	215	27.40	42	5.38	126	8.69	80	4.92	40.3
2014	203	19.81	46	5.22	142	5.11	77	3.91	32.1
2015	NA	NA	31	4.42	150	4.95	78	2.91	21.2
2016	NA	NA	39	2.41	164	4.94	83	3.09	NA
2017	NA	NA	36	2.25	151	5.10	92	2.43	NA
2018	NA	NA	46	2.19	125	5.33	93	1.70	NA

Table 7.4.3a. Haddock in 7.bc–ek. Landings numbers-at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	0	491	3291	948	810	255	129	129	45
1994	0	1277	5223	674	302	94	24	35	16
1995	0	4275	1622	1327	270	245	46	0	0
1996	0	3693	15998	818	313	93	32	10	9
1997	0	1353	9645	5553	716	354	139	144	110
1998	0	167	3184	7403	1443	307	178	86	61
1999	0	476	654	1464	2425	307	18	19	6
2000	0	2197	2996	784	741	1250	205	35	28
2001	0	4297	8638	1131	303	317	321	54	39
2002	0	879	4274	3400	765	39	89	74	26
2003	0	703	8791	2160	1226	116	43	49	51
2004	0	125	5948	4663	928	589	51	12	20
2005	0	786	863	4366	1983	450	115	4	17
2006	0	852	3393	1500	2219	400	67	7	1
2007	0	707	6404	2687	532	864	155	29	5
2008	0	1637	4034	4422	987	235	382	70	13
2009	0	795	7010	3394	1939	489	145	110	27
2010	0	1291	4814	6091	901	494	162	68	62
2011	0	170	11164	3359	3249	606	200	55	43
2012	0	61	787	18587	2352	1319	212	60	54
2013	0	24	244	2071	11007	764	444	87	47
2014	0	284	719	309	1632	5587	272	108	19
2015	0	111	4775	552	215	946	1896	165	23
2016	0	58	312	5543	202	95	402	476	45
2017	0	21	1808	960	3874	113	57	191	203
2018	0	156	715	3347	728	1435	40	38	102

Table 7.4.3b. Haddock in 7.bc–ek. Discard numbers-at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	0	7617	2816	160	6	0	0	0	0
1994	0	15120	3069	170	5	0	0	0	0
1995	0	32830	1977	91	4	0	0	0	0
1996	0	20734	8976	187	9	0	0	0	0
1997	0	12613	10022	493	5	0	0	0	0
1998	0	3580	2348	445	5	0	0	0	0
1999	0	3742	1562	100	10	0	0	0	0
2000	0	29015	2521	64	3	0	0	0	0
2001	0	25234	6772	219	2	0	0	0	0
2002	0	21624	20729	249	7	0	0	0	0
2003	0	52412	11075	352	8	0	0	0	0
2004	0	11733	21598	1395	61	0	0	0	0
2005	0	15904	10766	4315	149	0	0	0	0
2006	0	9377	4130	381	33	0	0	0	0
2007	0	6387	7066	662	34	0	0	0	0
2008	0	48764	15658	5492	330	0	0	0	0
2009	0	23561	27015	873	581	0	0	0	0
2010	0	98400	23292	2133	131	0	0	0	0
2011	0	16081	47971	1831	665	0	0	0	0
2012	0	7056	22315	12250	115	0	0	0	0
2013	0	1645	1187	1339	1899	0	0	0	0
2014	0	13089	3385	449	176	155	0	0	0
2015	0	2806	17841	550	14	103	134	15	1
2016	0	22590	4116	6993	80	4	33	311	0
2017	0	4389	12077	1279	2268	40	3	12	6
2018	0	4487	4277	4073	384	318	3	2	5

Table 7.4.4. Haddock in 7.bc–ek. ASAP input data.

```
# ASAP VERSION 3.0
# Had7b-k
#
# ASAP GUI 15 AUG 2012
#
# Number of Years
26
# First Year
1993
# Number of Ages
9
# Number of Fleets
1
# Number of Sensitivity Blocks
1
# Number of Available Survey Indices
2
# Natural Mortality
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
# Fecundity Option
0
# Fraction of year that elapses prior to SSB calculation (0=Jan-1)
0
# Maturity
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
```

```
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
# Number of Weights at Age Matrices
2
# Weight Matrix - 1
0 0.09 0.257 0.524 0.848 1.402 1.693 2.13 2.573
0 0.1 0.358 0.614 0.987 1.456 1.745 2.014 2.536
0 0.089 0.388 0.875 1.321 1.188 1.746 0 0
0 0.13 0.275 0.576 0.799 1.181 1.369 1.828 1.827
0 0.097 0.305 0.743 1.205 1.362 1.268 1.412 1.176
0 0.103 0.296 0.611 0.938 0.956 1.086 1.292 1.453
0 0.129 0.299 0.848 1.072 1.186 1.223 0.908 1.708
0 0.091 0.452 1.19 1.463 1.719 1.627 1.163 1.459
0 0.122 0.384 0.971 1.857 1.783 1.705 2.297 1.612
0 0.095 0.295 0.791 1.03 1.733 1.678 1.505 1.569
0 0.133 0.353 0.804 1.238 1.441 1.818 1.704 1.709
0 0.136 0.285 0.654 1.135 1.378 1.876 1.84 2.084
0 0.136 0.211 0.499 0.971 1.252 1.942 2.667 1.949
0 0.162 0.348 0.504 0.925 1.47 2.091 2.59 4.022
0 0.168 0.34 0.566 0.855 1.2 1.642 1.507 2.837
0 0.13 0.287 0.461 0.74 1.159 1.282 1.685 1.926
0 0.118 0.291 0.618 0.846 1.311 1.547 1.653 2.441
0 0.114 0.268 0.653 1.072 1.754 1.845 1.738 1.673
0 0.155 0.278 0.59 0.928 1.623 2.116 1.888 1.478
0 0.127 0.248 0.543 1.041 1.443 2.022 2.278 2.203
0 0.151 0.298 0.587 0.832 1.422 1.611 2.209 1.86
0 0.142 0.372 0.63 0.911 1.179 1.654 1.965 2.576
0 0.155 0.403 0.667 1.02 1.233 1.478 1.859 2.462
0 0.2 0.3 0.7 1.022 1.448 1.709 1.566 2.017
0 0.214 0.41 0.673 1.086 1.318 1.998 2.013 2.023
0 0.267 0.42 0.692 1.056 1.464 1.673 1.765 2.026
# Weight Matrix - 2
0.041 0.093 0.277 0.641 0.824 1.804 2.089 2.407 2.647
0.042 0.093 0.29 0.756 1.138 2.36 2.163 2.407 2.647
0.045 0.102 0.295 0.715 1.232 2.174 1.972 2.169 2.386
0.046 0.1 0.313 0.719 1.246 2.046 1.773 1.95 2.145
0.043 0.098 0.287 0.579 0.904 1.144 1.261 1.631 1.794
0.037 0.096 0.274 0.655 0.87 1.005 1.016 1.251 1.376
0.028 0.103 0.265 0.791 0.962 1.148 1.203 1.348 1.483
0.027 0.109 0.306 0.93 1.326 1.548 1.605 1.765 1.942
0.022 0.102 0.312 0.926 1.33 1.634 1.672 1.84 2.024
0.021 0.11 0.312 0.841 1.399 1.676 1.888 2.076 2.284
0.023 0.119 0.275 0.725 1.189 1.601 1.938 2.132 2.345
0.032 0.133 0.248 0.623 1.207 1.662 2.308 2.538 2.792
0.037 0.139 0.252 0.523 1.056 1.587 2.159 2.409 2.65
0.043 0.148 0.265 0.49 0.922 1.417 2.062 2.537 2.79
0.041 0.145 0.282 0.481 0.799 1.313 1.763 2.168 2.385
0.048 0.135 0.267 0.505 0.759 1.148 1.611 1.838 2.022
0.048 0.119 0.252 0.522 0.804 1.252 1.519 1.775 1.952
0.041 0.128 0.256 0.55 0.861 1.331 1.732 2.036 2.24
0.043 0.13 0.251 0.52 0.913 1.439 1.896 2.268 2.495
0.044 0.142 0.263 0.512 0.87 1.445 1.95 2.514 2.765
0.054 0.137 0.291 0.55 0.886 1.407 1.867 2.384 2.622
0.055 0.147 0.333 0.604 0.894 1.4 1.695 2.167 2.384
0.064 0.164 0.336 0.642 0.957 1.407 1.727 1.924 2.116
0.063 0.189 0.351 0.656 1.016 1.45 1.848 2.033 2.236
0.061 0.225 0.36 0.665 1.03 1.53 1.918 2.11 2.321
0.05 0.238 0.394 0.659 1.047 1.503 1.964 2.16 2.376
# Weights at Age Pointers
1
1
1
1
2
2
# Selectivity Block Assignment
# Fleet 1 Selectivity Block Assignment
1
1
1
1
1
```

```
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
# Selectivity Options for each block 1=by age, 2=logisitic, 3=double logistic
1
# Selectivity Block #1 Data
0 -1 0 1
0.5 1 0 1
1 1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 1 0 1
1 1 0 1
1 1 0 1
1 1 0 1
1 1 0 1
1 1 0 1
# Fleet Start Age
1
# Fleet End Age
9
# Age Range for Average F
4 6
# Average F report option (1=unweighted, 2=Nweighted, 3=Bweighted)
1
# Use Likelihood constants? (1=yes)
0
# Release Mortality by Fleet
1
# Catch Data
# Fleet-1 Catch Data
0 8107 6107 1108 816 255 129 129 45 4556
0 16396 8292 844 307 94 24 35 16 6017
0 37105 3599 1419 273 245 46 0 0 6688
0 24428 24973 1005 321 93 32 10 9 11065
0 13965 19667 6046 722 354 139 144 110 13710
0 3747 5531 7848 1448 307 178 86 61 8862
0 4218 2217 1564 2435 307 18 19 6 5556
0 31212 5517 848 744 1250 205 35 28 10002
0 29531 15409 1350 304 317 321 54 39 12696
0 22503 25003 3650 772 39 89 74 26 13561
0 53115 19866 2512 1234 116 43 49 51 17748
0 11858 27546 6058 989 589 51 12 20 15527
0 16690 11629 8681 2133 450 115 4 17 11978
0 10229 7524 1881 2252 400 67 7 1 8077
0 7094 13470 3350 566 864 155 29 5 9520
0 50401 19692 9913 1317 235 382 70 13 18642
0 24356 34025 4267 2519 489 145 110 27 18688
0 99691 28106 8225 1033 494 162 68 62 26809
0 16252 59134 5190 3914 606 200 55 43 27257
0 7116 23102 30837 2467 1319 212 60 54 28567
0 1669 1431 3410 12906 764 444 87 47 15509
```

```
0 13372 4103 758 1808 5741 272 108 19 13031
0 2918 22616 1102 229 1049 2029 180 24 15239
0 22477 4503 13233 312 100 443 803 46 17931
0 4410 13885 2239 6141 153 60 203 211 16072
0 4644 4992 7420 1112 1753 43 41 106 12546
# Discards
# Fleet-1 Discards Data
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
# Release Proportion
# Fleet-1 Release Data
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
# Survey Index Data
# Aggregate Index Units
2 2
# Age Proportion Index Units
2 2
# Weight at Age Matrix
2 2
# Index Month
11 7
# Index Selectivity Link to Fleet
-1 -1
# Index Selectivity Options 1=by age, 2=logisitic, 3=double logistic
1 1
```

```
# Index Start Age
1 4
# Index End Age
6 8
# Estimate Proportion (Yes=1)
1 1
# Use Index (Yes=1)
1 1
# Index-1 Selectivity Data
1 1 1 1e-04
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
-1 -1 0 1
-1 -1 0 1
-1 -1 0 1
1 1 0 1
1 1 0 1
0 -1 0 1
0.001 -1 0 1
1 1 0 1
1 1 0 1
# Index-2 Selectivity Data
-1 -1 0 1
-1 -1 0 1
-1 -1 0 1
0.8 1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
-1 -1 0 1
1 1 0 1
1 1 0 1
3 -1 0 1
1 -1 0 1
8 -1 0 1
1 -1 0 1
# Index-1 Data
1993 0 0 0 0 0 0 0 0 0 0 0 0
1994 0 0 0 0 0 0 0 0 0 0 0 0
1995 0 0 0 0 0 0 0 0 0 0 0 0
1996 0 0 0 0 0 0 0 0 0 0 0 0
1997 0 0 0 0 0 0 0 0 0 0 0 0
1998 0 0 0 0 0 0 0 0 0 0 0 0
1999 0 0 0 0 0 0 0 0 0 0 0 0
2000 0 0 0 0 0 0 0 0 0 0 0 0
2001 0 0 0 0 0 0 0 0 0 0 0 0
2002 0 0 0 0 0 0 0 0 0 0 0 0
2003 707.4 0.2 157 508.3 32.6 7 2.4 0.1 0 0 0 40
2004 517.7 0.2 385.7 49.1 70.9 7.9 2.7 1.4 0 0 0 40
2005 310.7 0.2 193.5 85.7 9.9 19.4 1.9 0.3 0 0 0 40
2006 176.9 0.2 110.2 39.7 19 4.5 3.2 0.4 0 0 0 40
2007 670.6 0.2 610.8 38.6 9.9 5.8 2.8 2.7 0 0 0 40
2008 424 0.2 271.5 143.3 5.6 1.6 1.3 0.7 0 0 0 40
2009 1562.4 0.2 1428.4 67.1 62 2.1 1.9 0.8 0 0 0 40
2010 823.4 0.2 89.7 686 33 13.6 0.4 0.8 0 0 0 40
2011 317.8 0.2 69.2 45.3 193.9 7.2 2.1 0.2 0 0 0 40
2012 113.9 0.2 21.4 23.1 13.4 52.4 2.2 1.3 0 0 0 40
2013 705.9 0.2 666 10.5 8.9 5.2 14.3 0.8 0 0 0 40
2014 279.9 0.2 91.3 177.2 2.4 1.9 2.1 5.1 0 0 0 40
2015 476.7 0.2 355.6 74.1 42.7 0.9 1.2 2.2 0 0 0 40
2016 248.6 0.2 43.1 155.7 39.3 9.3 0.9 0.3 0 0 0 40
2017 146.6 0.2 71.4 25.4 40.5 6.7 2.4 0.2 0 0 0 40
2018 733.8 0.2 696.5 16.5 4.9 7.2 6.5 2.2 0 0 0 40
# Index-2 Data
1993 0 0 0 0 0 0 0 0 0 0 0 0
1994 0 0 0 0 0 0 0 0 0 0 0 0
1995 0.826 0.3 0 0 0 0.751 0.06 0.015 0 0 0 40
1996 1.031 0.3 0 0 0 0.675 0.226 0.096 0.035 0 0 40
1997 3.578 0.3 0 0 0 3.086 0.339 0.115 0.019 0.019 0 40
1998 6.695 0.3 0 0 0 5.811 0.824 0.033 0.008 0.018 0 40
```

```
1999 3.047 0.3 0 0 0 1.147 1.735 0.149 0.005 0.011 0 40
2000 4.103 0.3 0 0 0 1.618 1.077 1.204 0.204 0 0 40
2001 3.47 0.3 0 0 0 2.926 0.293 0.148 0.093 0.009 0 40
2002 3.996 0.3 0 0 0 3.657 0.266 0.02 0.021 0.034 0 40
2003 2.075 0.3 0 0 0 1.267 0.703 0.082 0.009 0.015 0 40
2004 4.594 0.3 0 0 0 3.368 0.858 0.351 0.01 0.008 0 40
2005 7.108 0.3 0 0 0 4.707 2.085 0.268 0.048 0 0 40
2006 7.058 0.3 0 0 0 2.976 3.523 0.484 0.062 0.012 0 40
2007 4.706 0.3 0 0 0 2.664 0.674 1.219 0.136 0.012 0 40
2008 5.48 0.3 0 0 0 3.56 1.17 0.258 0.404 0.088 0 40
2009 5.872 0.3 0 0 0 2.952 1.822 0.569 0.307 0.223 0 40
2010 9.978 0.3 0 0 0 8.297 0.964 0.506 0.154 0.057 0 40
2011 9.597 0.3 0 0 0 3.939 4.592 0.705 0.301 0.06 0 40
2012 17.739 0.3 0 0 0 13.829 1.746 1.787 0.285 0.092 0 40
2013 9.851 0.3 0 0 0 0.796 7.03 0.989 0.891 0.145 0 40
2014 4.997 0.3 0 0 0 0.225 0.972 3.584 0.155 0.061 0 40
2015 3.055 0.3 0 0 0 0.378 0.166 0.521 1.901 0.089 0 40
2016 5.165 0.3 0 0 0 4.305 0.126 0.049 0.254 0.431 0 40
2017 3.721 0.3 0 0 0 0.953 2.586 0.069 0.031 0.082 0 40
2018 5.614 0.3 0 0 0 3.383 0.752 1.377 0.064 0.037 0 0
# Phase Control
# Phase for F mult in 1st Year
1
# Phase for F mult Deviations
2
# Phase for Recruitment Deviations
3
# Phase for N in 1st Year
1
# Phase for Catchability in 1st Year
3
# Phase for Catchability Deviations
-5
# Phase for Stock Recruitment Relationship
1
# Phase for Steepness
-5
# Recruitment CV by Year
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
# Lambdas by Index
1 1
# Lambda for Total Catch in Weight by Fleet
1
# Lambda for Total Discards at Age by Fleet
1
# Catch Total CV by Year and Fleet
0.2
0.3
0.3
```

```
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
# Discard Total CV by Year and Fleet
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
# Catch Effective Sample Size by Year and Fleet
25
25
25
25
25
25
25
25
25
50
50
50
50
50
50
50
50
50
50
50
50
50
50
```

```
50
50
50
# Discard Effective Sample Size by Year and Fleet
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
# Lambda for F Mult in First year by Fleet
0
# CV for F Mult in First year by Fleet
0.5
# Lambda for F Mult Deviations by Fleet
0
# CV for F Mult Deviations by Fleet
0.5
# Lambda for N in 1st Year Deviations
0
# CV for N in 1st Year Deviations
1
# Lambda for Recruitment Deviations
0
# Lambda for Catchability in First year by Index
0 0
# CV for Catchability in First year by Index
1 1
# Lambda for Catchability Deviations by Index
0 0
# CV for Catchability Deviations by Index
1 1
# Lambda for Deviation from Initial Steepness
0
# CV for Deviation from Initial Steepness
1
# Lambda for Deviation from Unexploited Stock Size
0
# CV for Deviation from Unexploited Stock Size
1
# NAA Deviations Flag
1
# Initial Numbers at Age in 1st Year
40000 20000 10000 4000 2000 1000 500 250 100
# Initial F Mult in 1st Year by Fleet
0.7
# Initial Catchabilty by Index
1 1
# Stock Recruitment Flag
0
# Initial Unexploited Stock
1000
# Initial Steepness
1
```

```
# Maximum F
2.5
# Ignore Guesses (Yes=1)
0
# Projection Control
# Do Projections (Yes=1)
0
# Fleet Directed Flag
1
# Final Year in Projection
2019
# Projection Data by Year
2019 -1 3 -99 1
# Do MCMC (Yes=1)
0
# MCMC Year Option
0
# MCMC Iterations
1000
# MCMC Thinning Factor
200
# MCMC Random Seed
1415963
# Agepro R Option
0
# Agepro R Option Start Year
1993
# Agepro R Option End Year
2005
# Export R Flag
1
# Test Value
-23456
######
###### FINIS ######
# Fleet Names
#$LAND+DIS
# Survey Names
#$FR-IRL-IBTS
#$IR-GAD
#
```

Table 7.4.5. Haddock in 7.bc–ek. Selectivity of the catches and indices. Catch selectivity was fixed at zero for age 0 and at one for ages 3–8; it was freely estimated for ages 1–2. For the FR_IR_IBTS survey the selectivity was fixed at 1 for all ages and for the IR_GAD commercial fleet selectivity was freely estimated for age 3 and fixed at 1 for the older ages. Catch and index selectivity were not allowed to vary over time.

Age	Catch	FRA.IRL.IBTS	IRL.GAD
0	0.000	1	NA
1	0.364	1	NA
2	0.980	1	NA
3	1.000	1	0.781
4	1.000	1	1.000
5	1.000	1	1.000
6	1.000	NA	1.000
7	1.000	NA	1.000
8	1.000	NA	NA

Table 7.4.6. Haddock in 7.bc–ek. Fishing mortality- (F) at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	0	0.398	1.037	1.094	1.094	1.094	1.094	1.094	1.094
1994	0	0.388	1.011	1.067	1.067	1.067	1.067	1.067	1.067
1995	0	0.306	0.797	0.841	0.841	0.841	0.841	0.841	0.841
1996	0	0.303	0.790	0.833	0.833	0.833	0.833	0.833	0.833
1997	0	0.256	0.667	0.704	0.704	0.704	0.704	0.704	0.704
1998	0	0.275	0.715	0.754	0.754	0.754	0.754	0.754	0.754
1999	0	0.189	0.492	0.519	0.519	0.519	0.519	0.519	0.519
2000	0	0.240	0.624	0.658	0.658	0.658	0.658	0.658	0.658
2001	0	0.254	0.661	0.697	0.697	0.697	0.697	0.697	0.697
2002	0	0.455	1.184	1.249	1.249	1.249	1.249	1.249	1.249
2003	0	0.237	0.618	0.652	0.652	0.652	0.652	0.652	0.652
2004	0	0.283	0.736	0.777	0.777	0.777	0.777	0.777	0.777
2005	0	0.299	0.777	0.820	0.820	0.820	0.820	0.820	0.820
2006	0	0.187	0.487	0.513	0.513	0.513	0.513	0.513	0.513
2007	0	0.149	0.388	0.409	0.409	0.409	0.409	0.409	0.409
2008	0	0.265	0.689	0.727	0.727	0.727	0.727	0.727	0.727
2009	0	0.208	0.542	0.572	0.572	0.572	0.572	0.572	0.572
2010	0	0.216	0.562	0.593	0.593	0.593	0.593	0.593	0.593
2011	0	0.169	0.439	0.463	0.463	0.463	0.463	0.463	0.463
2012	0	0.209	0.544	0.574	0.574	0.574	0.574	0.574	0.574
2013	0	0.180	0.468	0.494	0.494	0.494	0.494	0.494	0.494
2014	0	0.184	0.478	0.504	0.504	0.504	0.504	0.504	0.504
2015	0	0.167	0.435	0.459	0.459	0.459	0.459	0.459	0.459
2016	0	0.211	0.550	0.581	0.581	0.581	0.581	0.581	0.581
2017	0	0.222	0.577	0.609	0.609	0.609	0.609	0.609	0.609
2018	0	0.275	0.715	0.755	0.755	0.755	0.755	0.755	0.755

Table 7.4.7. Haddock in 7.bc–ek. Stock numbers-at-age (start of year) (`1000).

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	112280	50443	11948	2819	801	254	254	223	74
1994	384344	41721	16486	2324	572	174	57	59	70
1995	534466	142813	13773	3292	485	128	40	14	31
1996	151443	198595	51188	3407	861	136	37	12	14
1997	77087	56273	71376	12754	898	244	40	11	8
1998	160867	28644	21198	20098	3825	289	81	14	7
1999	424334	59775	10595	5692	5733	1170	91	26	7
2000	400838	157672	24084	3554	2054	2219	467	37	14
2001	456207	148942	60395	7083	1116	692	770	167	19
2002	803719	169516	56246	17116	2139	362	231	265	65
2003	220145	298643	52370	9451	2977	399	69	46	66
2004	284915	81801	114638	15488	2985	1009	139	25	41
2005	274362	105868	30010	30132	4320	893	311	44	21
2006	202585	101946	38230	7570	8047	1237	264	95	20
2007	712753	75276	41164	12898	2748	3133	496	109	48
2008	371945	264842	31573	15333	5197	1187	1395	228	73
2009	1755911	138206	98929	8697	4494	1634	385	466	102
2010	219614	652455	54638	31589	2979	1651	618	150	224
2011	57933	81604	255899	17089	10585	1071	611	236	146
2012	41955	21527	33558	90543	6523	4333	452	266	169
2013	573690	15590	8501	10686	30922	2389	1635	176	172
2014	130438	213170	6340	2922	3956	12278	978	690	150
2015	387698	48468	86356	2157	1070	1554	4970	408	355
2016	75598	144060	19963	30681	827	440	658	2170	339
2017	79577	28091	56762	6319	10412	301	165	254	982
2018	873064	29569	10955	17494	2085	3684	110	62	477
2019	253861	324410	10935	2940	4987	637	1161	36	180

Table 7.4.8. Haddock in 7.bc–ek. Stock Summary: weights in tonnes; CatchPred is predicted catch from ASAP; recruitment at age zero (`1000); F_{bar} ages 3–5.

Year	Lan	Dis	Cat	CatPred	Tsb	Ssb	SsbCv	Recr	RecrCv	Fbar	FbarCv
1993	3348	1208	4556	4675	16818	7550	0.210	111802	0.211	1.087	0.246
1994	4131	1886	6017	5398	28097	8114	0.219	383799	0.182	1.064	0.236
1995	4470	2218	6688	6455	46077	7509	0.193	533832	0.160	0.838	0.259
1996	6756	4309	11065	12205	46746	19979	0.180	150687	0.196	0.830	0.258
1997	10827	2883	13710	13620	37906	29116	0.156	76803	0.221	0.703	0.256
1998	7928	934	8862	9988	31453	22775	0.157	160517	0.192	0.746	0.245
1999	4970	586	5556	6042	32454	14458	0.157	423278	0.181	0.513	0.290
2000	7499	2503	10002	10870	45714	17833	0.165	397699	0.204	0.655	0.279
2001	9278	3418	12696	16561	54818	29759	0.165	453878	0.174	0.696	0.304
2002	6488	7073	13561	23529	72031	36655	0.201	801131	0.138	1.238	0.236
2003	8292	9456	17748	17458	66415	25954	0.164	219000	0.154	0.653	0.268
2004	8777	6750	15527	21918	63781	43868	0.139	284062	0.129	0.774	0.246
2005	6787	5191	11978	15012	55040	30228	0.150	274063	0.123	0.814	0.232
2006	5593	2484	8077	10523	47753	23989	0.135	202132	0.138	0.508	0.287
2007	6781	2739	9520	8670	65604	25527	0.127	711866	0.105	0.406	0.268
2008	7455	11187	18642	15521	77948	24448	0.127	370642	0.129	0.724	0.177
2009	9608	9080	18688	16111	137393	36875	0.106	1752675	0.088	0.570	0.186
2010	10262	16547	26809	25630	130467	38136	0.116	218799	0.136	0.591	0.182
2011	12879	14378	27257	27938	99511	86470	0.089	57476	0.189	0.463	0.190
2012	18376	10191	28567	25780	74114	69258	0.097	41446	0.201	0.572	0.160
2013	13424	2085	15509	13459	75657	43200	0.108	562000	0.099	0.491	0.180
2014	9854	3177	13031	12104	65868	28258	0.133	125695	0.156	0.509	0.196
2015	8545	6694	15239	14627	76360	43106	0.104	399920	0.114	0.478	0.200
2016	7594	10337	17931	16555	66624	33794	0.119	75314	0.198	0.619	0.183
2017	8097	7975	16072	15819	49119	38018	0.113	78760	0.223	0.627	0.201
2018	7109	5436	12546	12209	74659	24239	0.152	869103	0.216	0.773	0.286
2019*	NA	NA	NA	NA	NA	14205	NA	252713	NA	0.773	NA

*** GM recruitment and mean F last over the three years.**

Table 7.4.9. Haddock in 7.bc–ek. Input values for short-term forecast. Note that Sel and CWt refer to the landings and DSel and DCWt refer to the discards. Numbers in thousands; Weights in kg.

2019

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	252713	0.99	0	0	0	0.058	0.000	0.000	0.000	0.061
1	322939	0.72	0	0	0	0.217	0.013	0.453	0.231	0.224
2	10758	0.60	1	0	0	0.368	0.202	0.688	0.433	0.335
3	2872	0.50	1	0	0	0.660	0.483	0.899	0.190	0.527
4	4916	0.43	1	0	0	1.031	0.608	1.212	0.065	0.770
5	569	0.40	1	0	0	1.494	0.657	1.465	0.016	1.118
6	1038	0.37	1	0	0	1.910	0.666	1.816	0.007	1.534
7	32	0.36	1	0	0	2.101	0.657	1.905	0.016	1.658
8	164	0.34	1	0	0	2.311	0.669	2.007	0.004	2.817

2020

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	252713	0.99	0	0	0	0.058	0.000	0.000	0.000	0.061
1	93902	0.72	0	0	0	0.217	0.013	0.453	0.231	0.224
2	118710	0.60	1	0	0	0.368	0.202	0.688	0.433	0.335
3	2848	0.50	1	0	0	0.660	0.483	0.899	0.190	0.527
4	804	0.43	1	0	0	1.031	0.608	1.212	0.065	0.770
5	1476	0.40	1	0	0	1.494	0.657	1.465	0.016	1.118
6	176	0.37	1	0	0	1.910	0.666	1.816	0.007	1.534
7	331	0.36	1	0	0	2.101	0.657	1.905	0.016	1.658
8	64	0.34	1	0	0	2.311	0.669	2.007	0.004	2.817

2021

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	252713	0.99	0	0	0	0.058	0.000	0.000	0.000	0.061
1	93902	0.72	0	0	0	0.217	0.013	0.453	0.231	0.224
2	34518	0.60	1	0	0	0.368	0.202	0.688	0.433	0.335
3	31432	0.50	1	0	0	0.660	0.483	0.899	0.190	0.527
4	798	0.43	1	0	0	1.031	0.608	1.212	0.065	0.770
5	242	0.40	1	0	0	1.494	0.657	1.465	0.016	1.118
6	457	0.37	1	0	0	1.910	0.666	1.816	0.007	1.534
7	56	0.36	1	0	0	2.101	0.657	1.905	0.016	1.658
8	128	0.34	1	0	0	2.311	0.669	2.007	0.004	2.817

Table 7.4.10. Haddock in 7.bc–ek. Single-option output of the short-term forecast (F = mean F2013–2015). Numbers in thousands, weights in tonnes.

2019

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0.000	0	0	0.000	0	0	252713	14657	0	0
1	0.015	3041	1376	0.266	54257	12136	322939	70185	0	0
2	0.232	1379	948	0.497	2959	990	10758	3962	10758	3962
3	0.555	902	810	0.218	354	187	2872	1896	2872	1896
4	0.698	1996	2419	0.075	213	164	4916	5068	4916	5068
5	0.754	253	371	0.018	6	7	569	851	569	851
6	0.765	473	859	0.008	5	8	1038	1982	1038	1982
7	0.754	14	28	0.019	0	1	32	67	32	67
8	0.768	76	153	0.005	0	1	164	379	164	379
Total	1.000	8134	6964	0.000	57794	13494	596001	99047	20349	14205

2020

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0.000	0	0	0.000	0	0	252713	14657	0	0
1	0.015	884	400	0.266	15777	3529	93902	20408	0	0
2	0.232	15214	10462	0.497	32657	10929	118710	43725	118710	43725
3	0.555	894	804	0.218	351	185	2848	1880	2848	1880
4	0.698	327	396	0.075	35	27	804	829	804	829
5	0.754	656	961	0.018	16	18	1476	2206	1476	2206
6	0.765	80	146	0.008	1	1	176	337	176	337
7	0.754	149	285	0.019	4	6	331	695	331	695
8	0.768	30	60	0.005	0	0	64	148	64	148
Total	1.000	18234	13514	0.000	48841	14695	471024	84885	124409	49820

2021

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0.000	0	0	0.000	0	0	252713	14657	0	0
1	0.015	884	400	0.266	15777	3529	93902	20408	0	0
2	0.232	4424	3042	0.497	9496	3178	34518	12714	34518	12714
3	0.555	9868	8868	0.218	3872	2042	31432	20745	31432	20745
4	0.698	324	393	0.075	35	27	798	822	798	822
5	0.754	107	157	0.018	3	3	242	361	242	361
6	0.765	208	378	0.008	2	3	457	873	457	873
7	0.754	25	48	0.019	1	1	56	118	56	118
8	0.768	59	119	0.005	0	1	128	295	128	295
Total	1.000	15899	13405	0.000	29186	8784	414246	70993	67631	35928

Table 7.4.11. Haddock in 7.bc–ek. Management options table. Weights in tonnes.

Fmult	Catch20	Land20	Dis20	FCatch20	FLand20	FDis20	SSB21	Change SSB2019 %	Change TAC 2019 to Catch 2020 %	Change TAC 2019 to Land 2020 %	Change-Advice 2019 to 2020 %
0.0	0	0	0	0.00	NA	NA	65183	31	-100	-100	-100.0
0.1	3641	1778	1863	0.08	0.07	0	61296	23	-56	-79	-42.0
0.2	7067	3444	3623	0.16	0.13	0	57665	16	-15	-59	11.9
0.3	10291	5004	5287	0.23	0.20	0	54271	9	24	-40	63.0
0.4	13326	6466	6860	0.31	0.27	0	51098	3	60	-22	111.0
0.5	16185	7836	8349	0.39	0.33	0	48131	-3	94	-6	156.0
0.6	18879	9121	9759	0.46	0.40	0	45356	-9	127	10	199.0
0.7	21419	10325	11093	0.54	0.47	0	42760	-14	157	24	240.0
0.8	23814	11456	12359	0.62	0.54	0	40331	-19	186	38	280.0
0.9	26075	12517	13558	0.70	0.60	0	38057	-24	210	50	310.0
1.0	28208	13513	14696	0.77	0.67	0	35929	-28	240	62	350.0
1.1	30224	14448	15776	0.85	0.74	0	33935	-32	260	73	380.0
1.2	32128	15327	16801	0.93	0.80	0	32067	-36	290	84	410.0
1.3	33928	16153	17776	1.00	0.87	0	30316	-39	310	94	440.0
1.4	35631	16929	18702	1.08	0.94	0	28675	-42	330	103	460.0
1.5	37243	17659	19583	1.16	1.00	0	27136	-46	350	112	490.0
1.6	38769	18347	20422	1.24	1.07	0	25692	-48	370	120	510.0
1.7	40214	18993	21221	1.31	1.14	0	24338	-51	380	128	540.0
1.8	41585	19603	21982	1.39	1.20	0	23066	-54	400	135	560.0
1.9	42884	20177	22708	1.47	1.27	0	21872	-56	410	142	580.0
2.0	44117	20718	23400	1.55	1.34	0	20750	-58	430	149	600.0

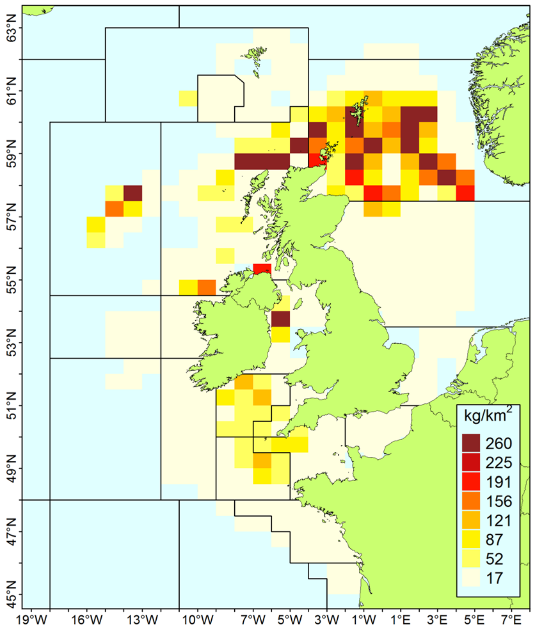


Figure 7.4.1. International haddock landings by ICES rectangle (all gears; 2016; data from https://stecf.jrc.ec.europa.eu/data-dissemination).

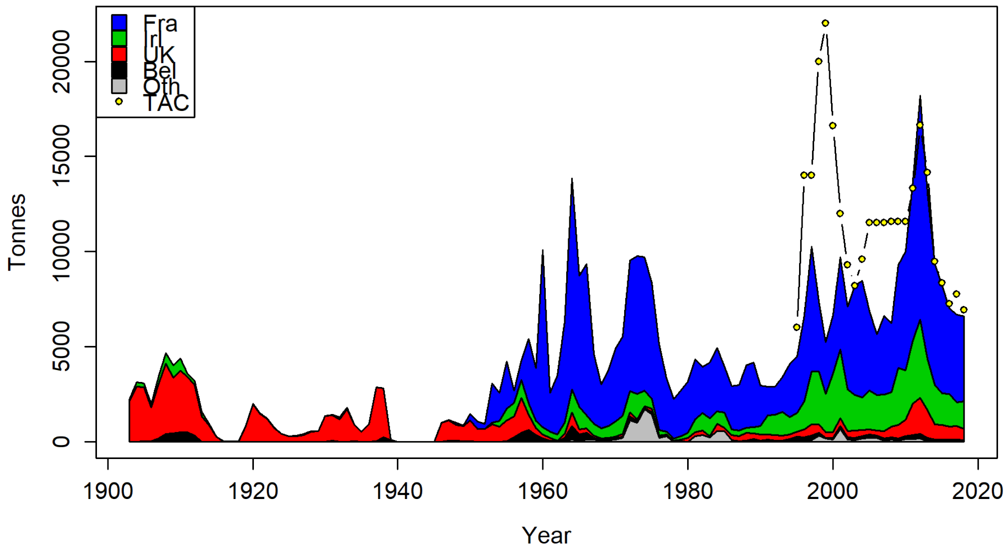


Figure 7.4.2. a. Haddock in 7.bc–ek. Official Ices landings and TAC of haddock in 7.b–k.

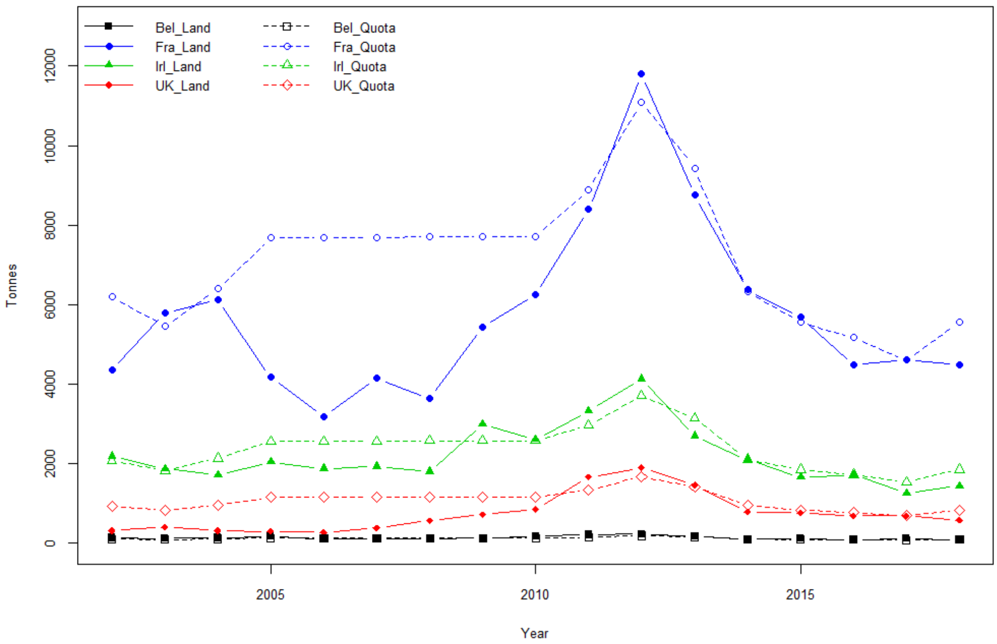


Figure 7.4.2 b. Haddock in 7.bc–ek. Recent working group landings and quota by country.

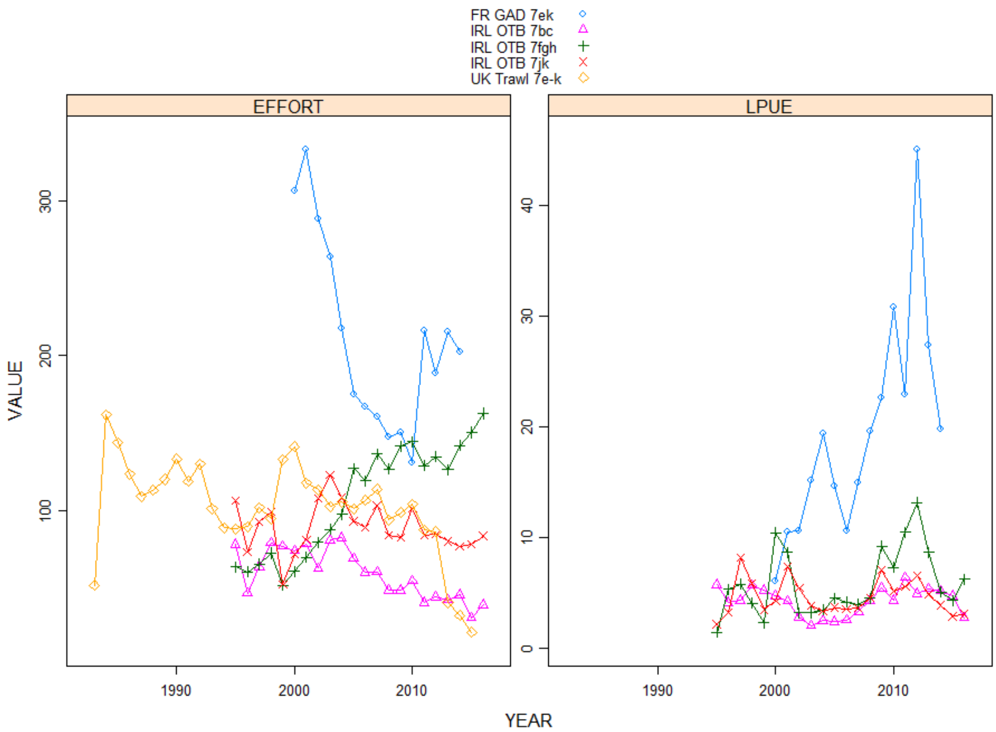


Figure 7.4.3. Haddock in 7.bc–ek. Effort ('1000h) of the Irish Otter trawl fleets, the French demersal otter trawl fleet and for UK trawl fleet (effort in fishing days, rescaled to other fleets) and lpue (kg/h) for the Irish and French fleets.

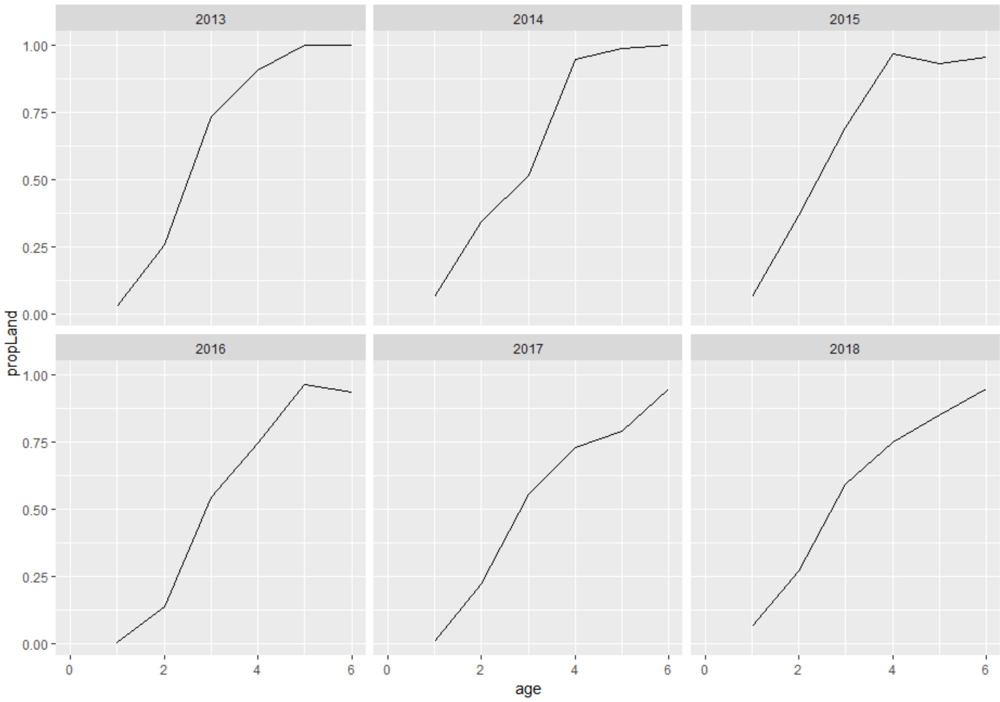


Figure 7.4.4 Proportional representation of landings relative to catch (discards + landings) by age, 2013–2018.

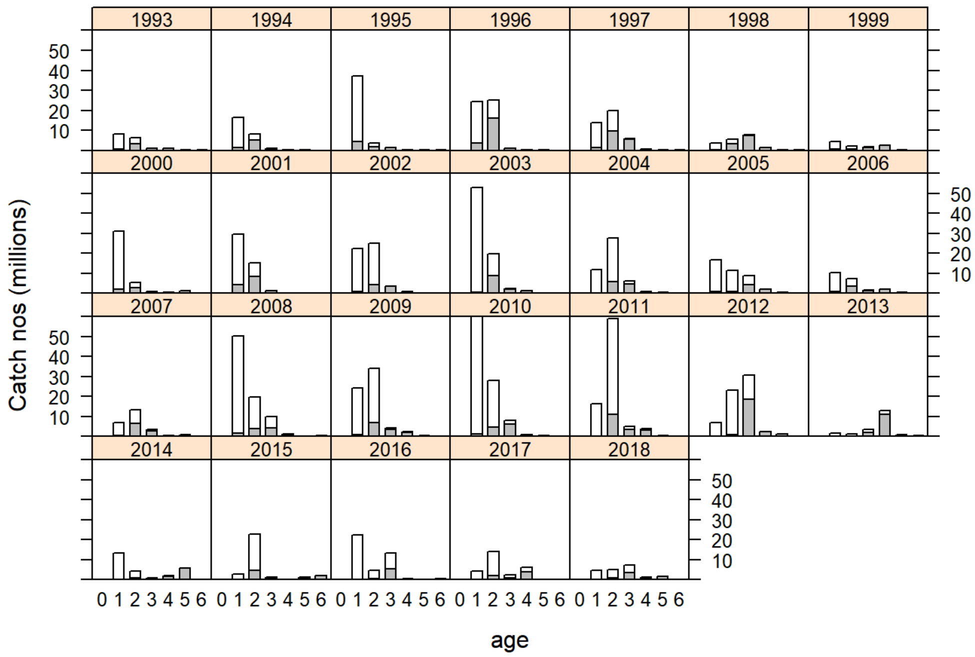


Figure 7.4.5. Haddock in 7.bc–ek. Discarding by number by age class 2000–2018 (grey = landings, white = discards).

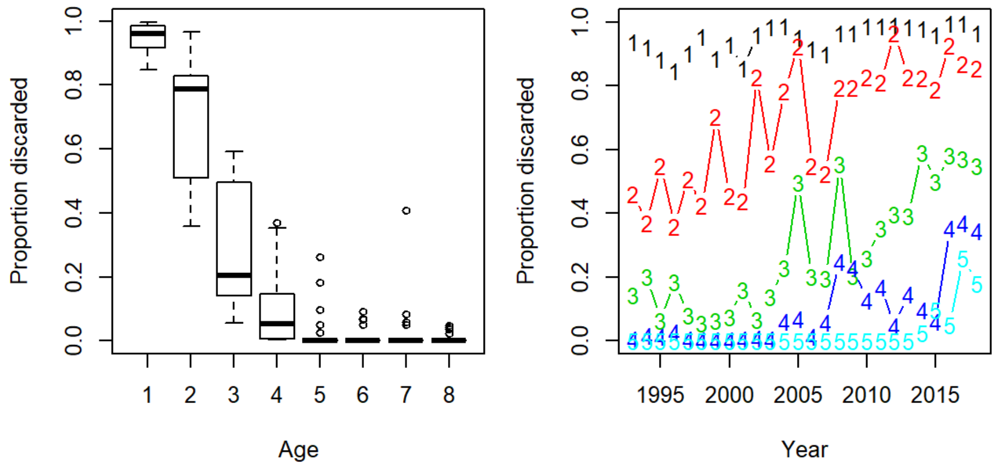


Figure 7.4.6. Haddock in 7.bc–ek. Proportion of discards by age (left) and year (right).

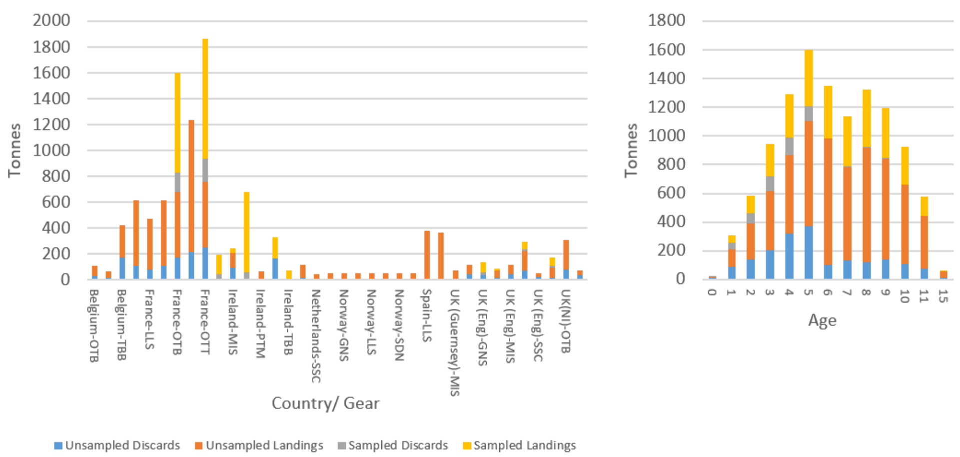


Figure 7.4.7. Haddock in 7bc–ek. Distribution sampled and unsampled the catches by country and gear (left) and by age (right). Note that both France and Ireland allocated age data to most unsampled strata before uploading to InterCatch.

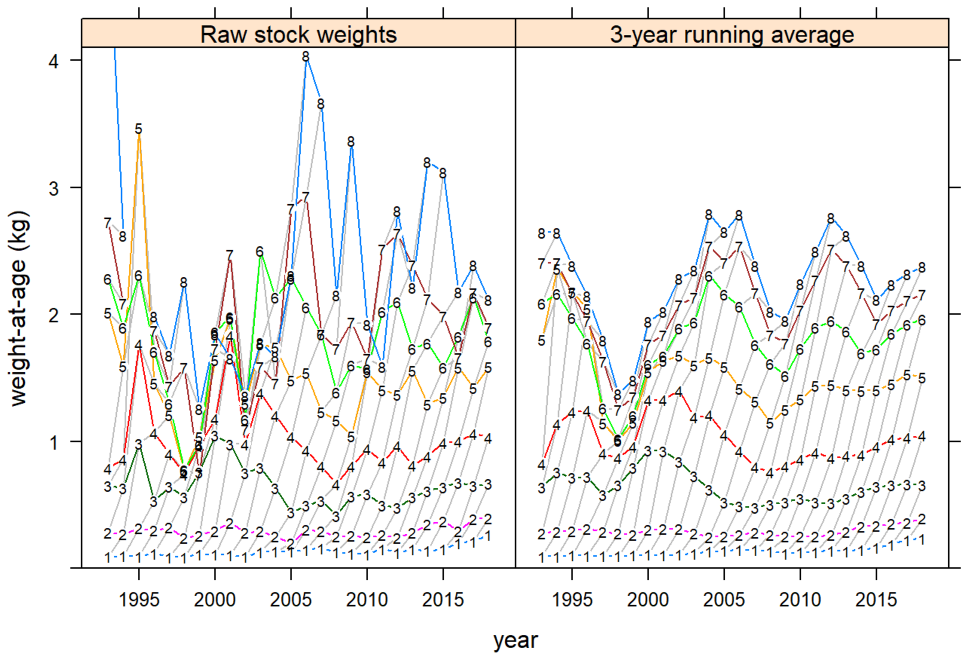


Figure 7.4.8. Haddock in 7.bc–ek. Raw stock weights-at-age (left) and the three-year running average stock weights (right).

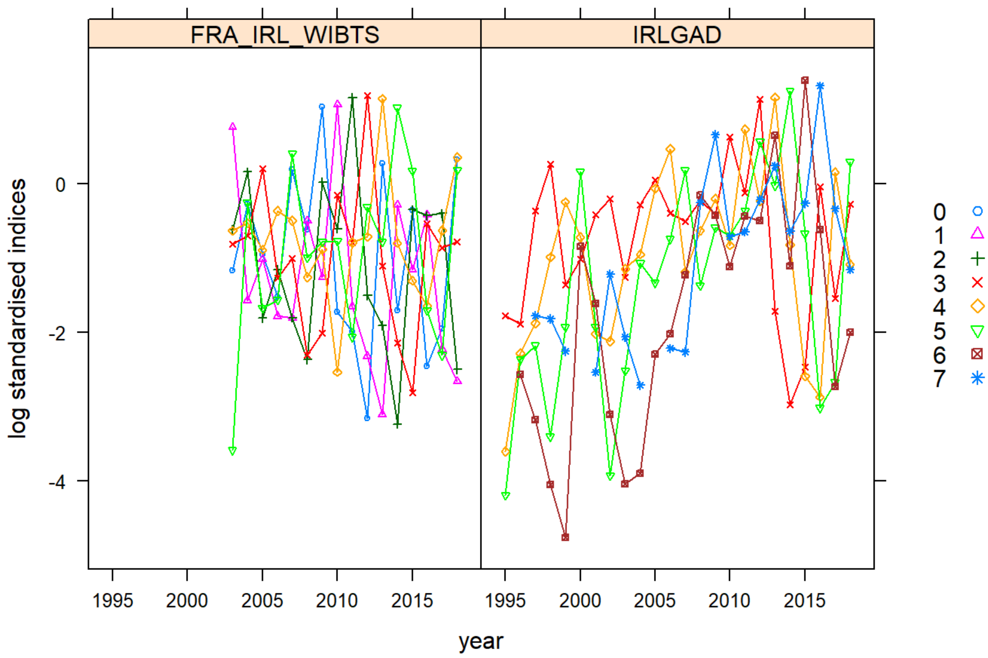


Figure 7.4.9. Haddock in 7.bc–ek. Log standardised indices of tuning fleets by year. The FRA-IRL-IBTS survey is the combined French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS survey. The IRL-GAD commercial tuning fleet is the Irish gadoid fleet in 7.gj.

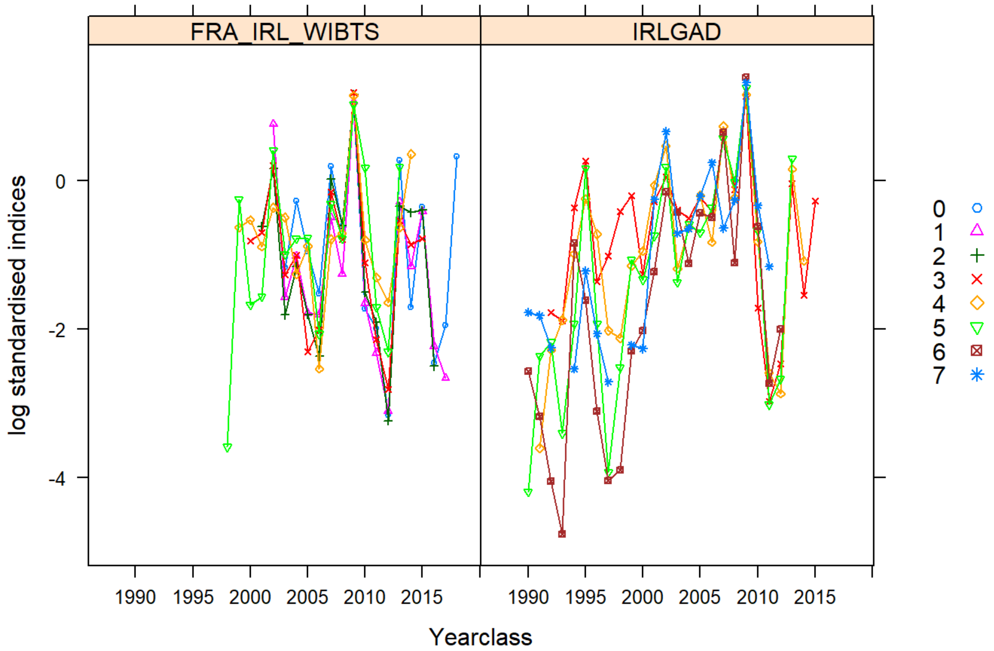
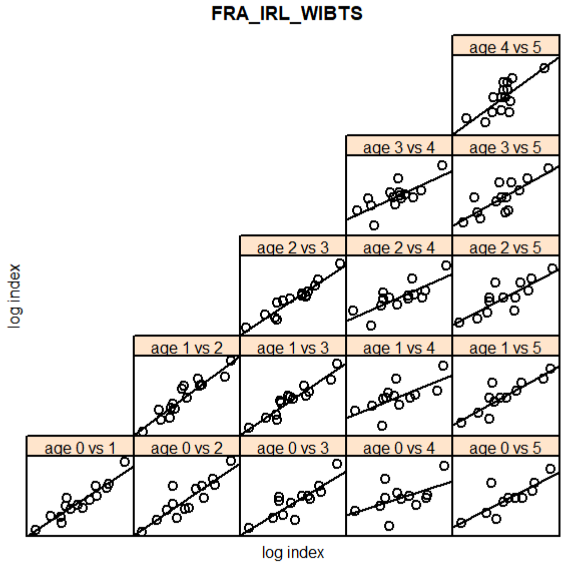


Figure 7.4.10. Haddock in 7.bc–ek. Log standardised indices of tuning fleets by cohort.



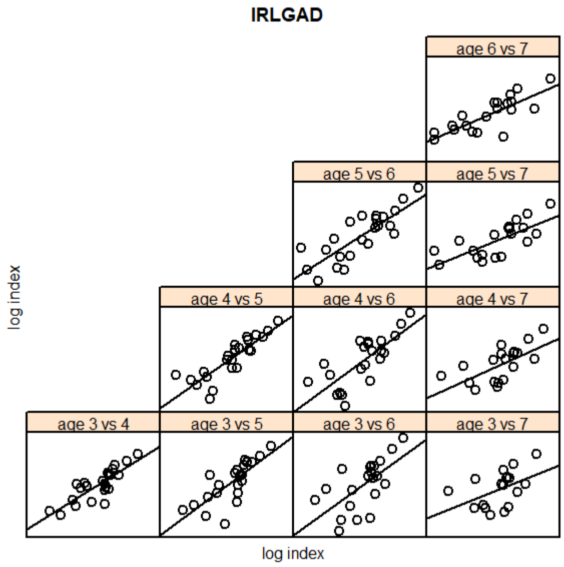


Figure 7.4.11. Haddock in 7.bc–ek. Scatterplot matrix of log indices of cohorts at different ages.

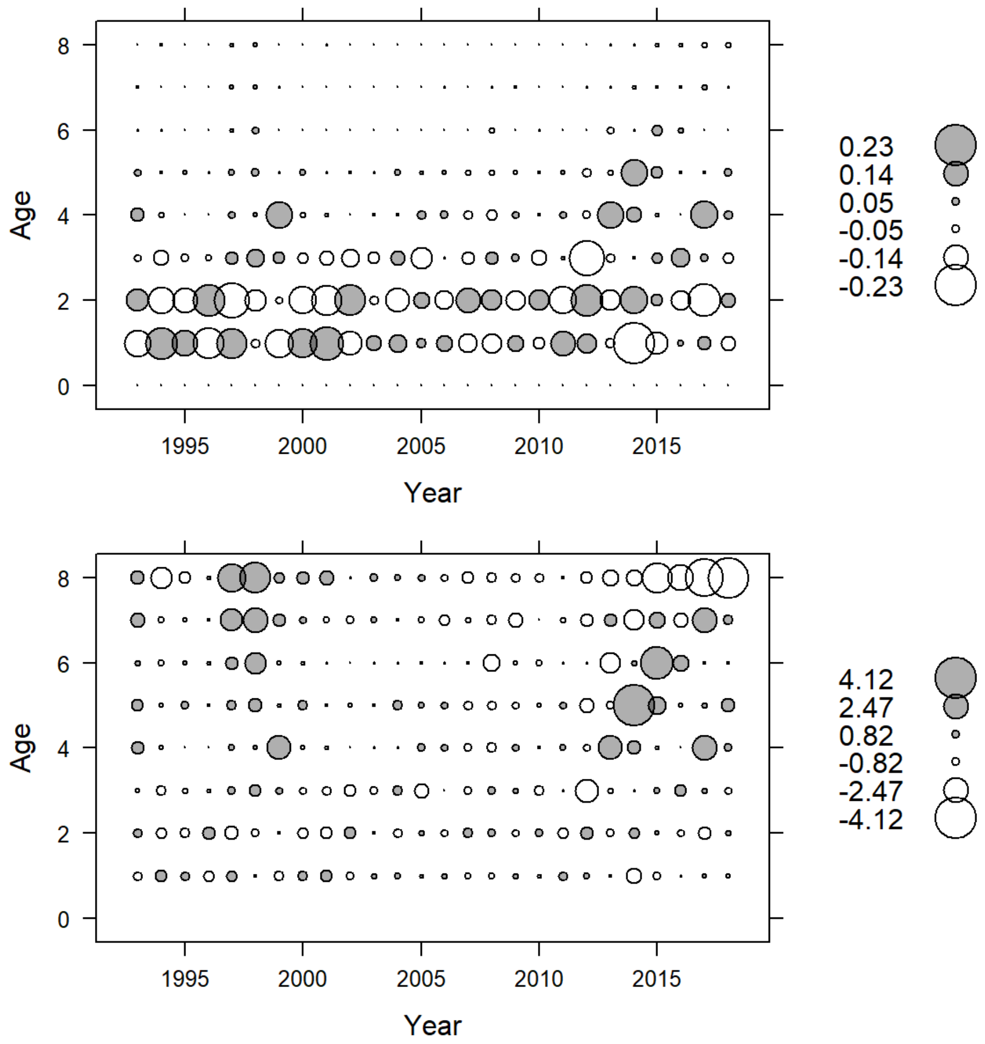


Figure 7.4.12. Haddock in 7.bc–ek. Residuals of the proportions-at-age index observed to predicted, (upper) and standardised relative to predicted (lower).

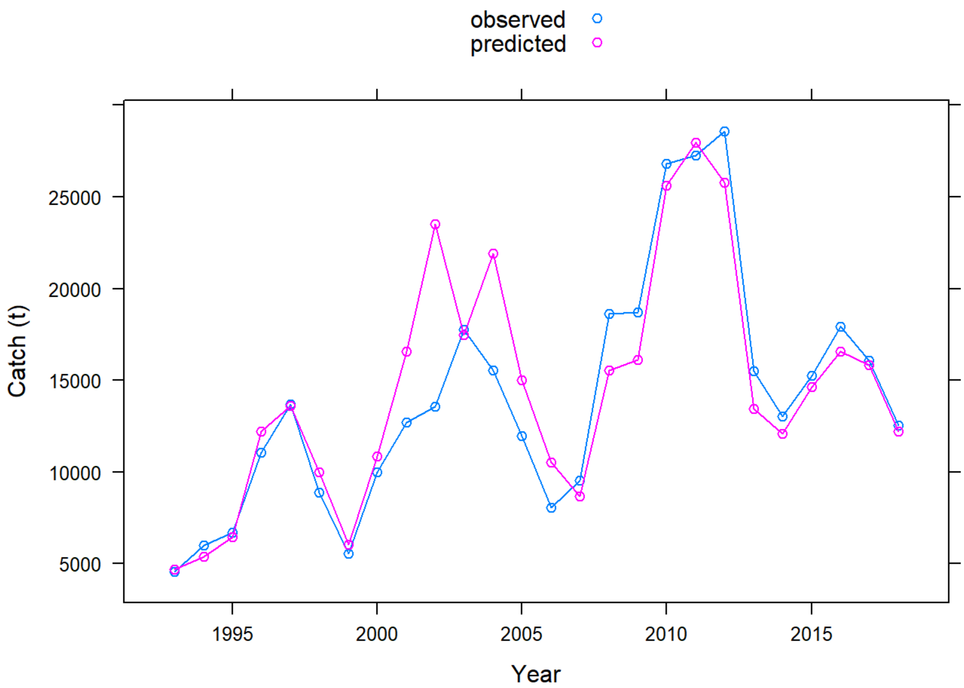


Figure 7.4.13. Haddock in 7.bc–ek. Observed and predicted catches.

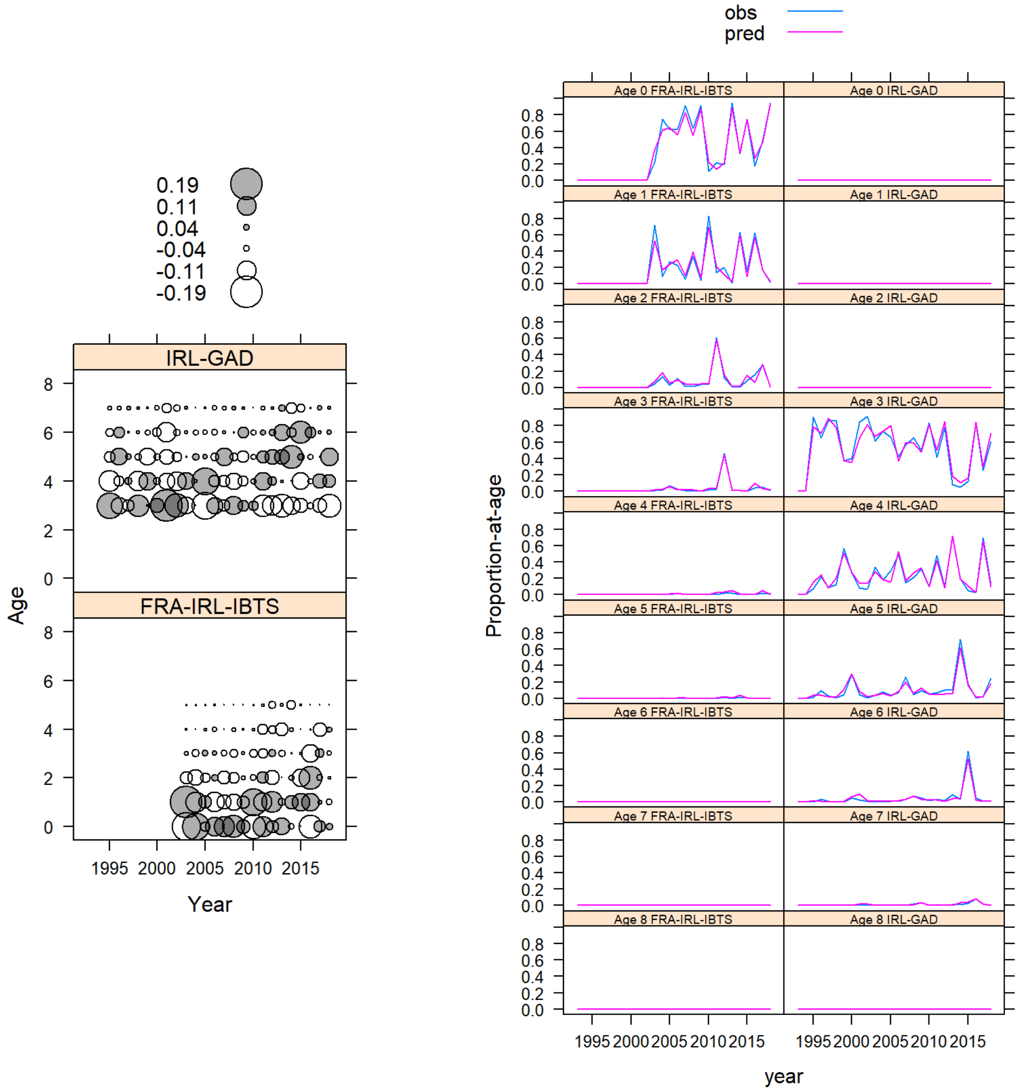


Figure 7.4.14. Haddock in 7.bc–ek. Index proportions-at-age residuals (observed and predicted).

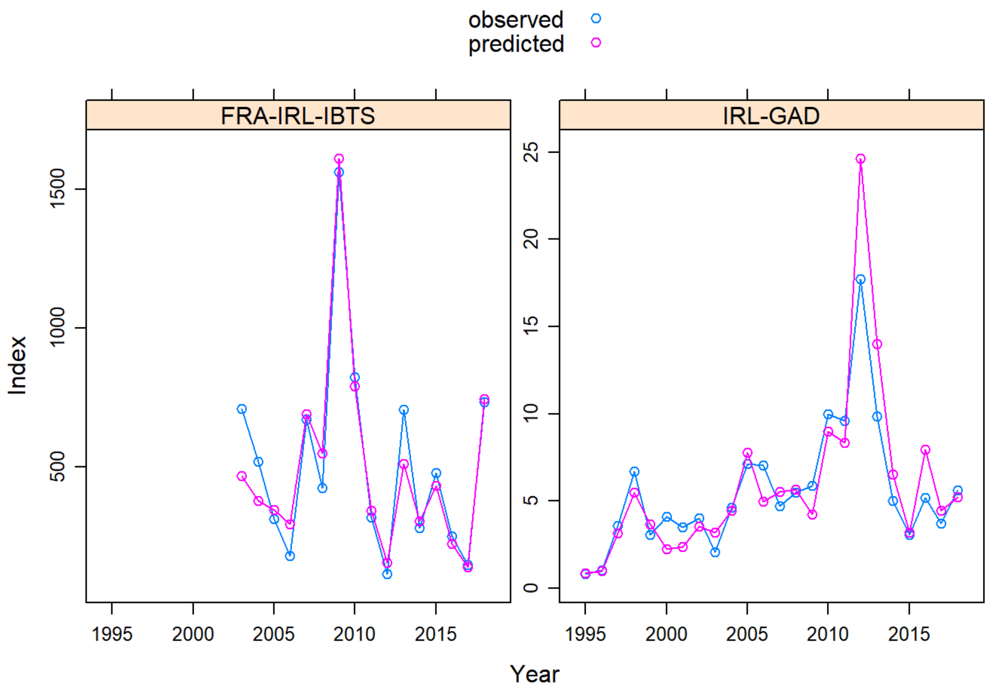


Figure 7.4.15. Haddock in 7.bc–ek. Observed and predicted index cpue.

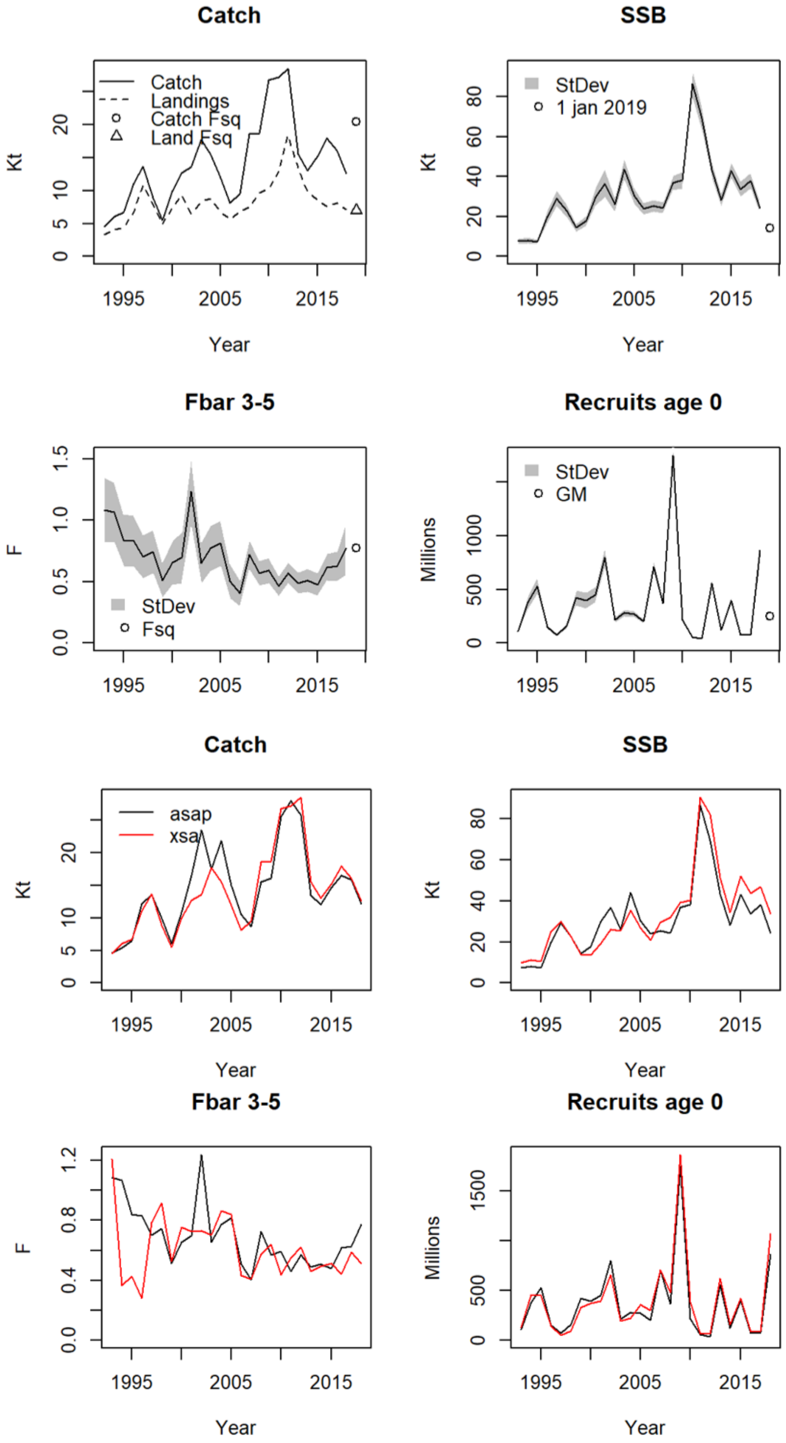


Figure 7.4.16. Haddock in 7.bc–ek. ASAP assessment stock summary plots.

- Top four plots: Lines represent the ASAP assessment with standard deviation shaded. Forecast/ assumed values are given by open circles.
- Bottom four plots: Comparison of ASAP (black) and XSA (red) assessments. For ASAP the F_{bar} range was 3–5 while for XSA 2–5. The natural mortality assumption for the ASAP is much higher for young ages than the assumed M for the historic XSAs, resulting in a higher estimate of recruitment.

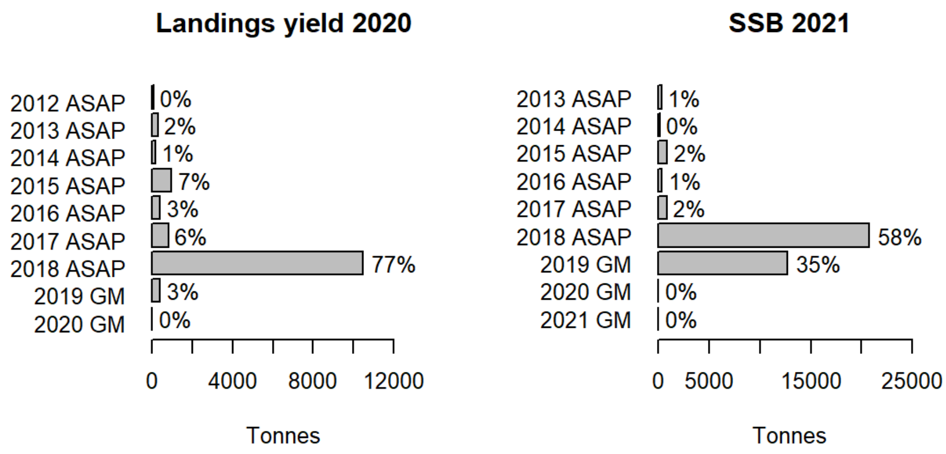


Figure 7.4.17. Haddock 7bc–ek. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

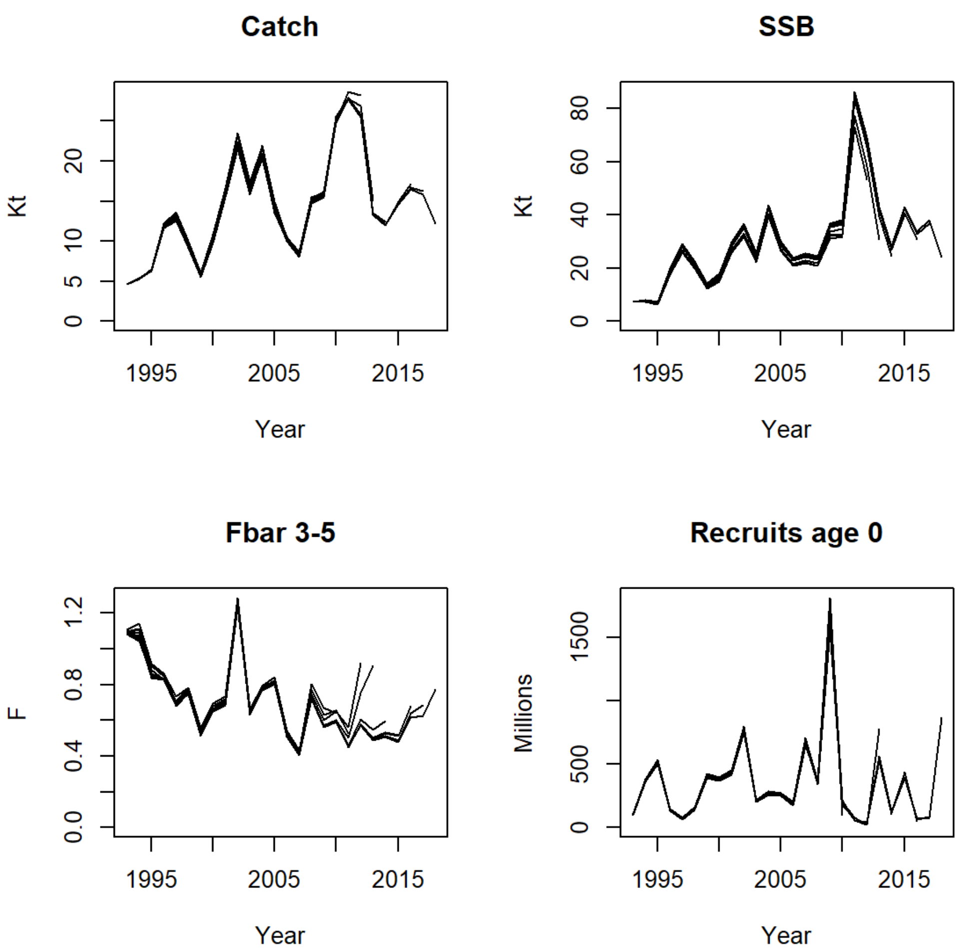


Figure 7.4.18. Haddock in 7.bc–ek. Retrospective analysis of the final ASAP run. Note that the survey index only started in 2003.

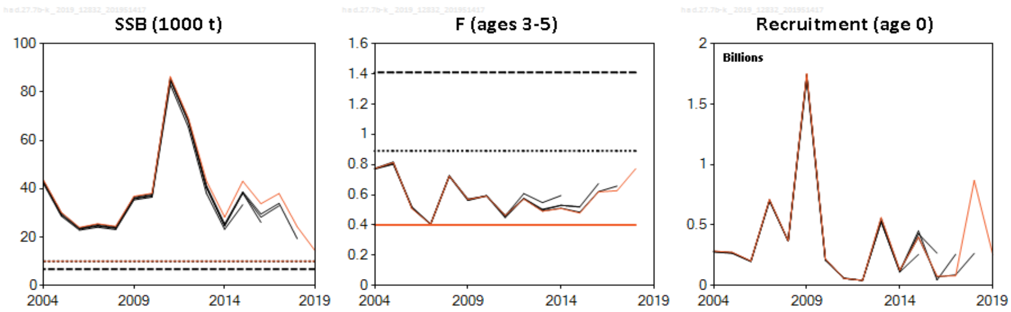


Figure 7.4.19. Haddock 7bc–ek. Retrospective analysis of the stock assessment, comprising the ASAP assessment of the stock status up to the most recent catch year (2018) and current year stock status made on the intermediate year assumptions (Section 12.13) . Note that the survey index only started in 2003.

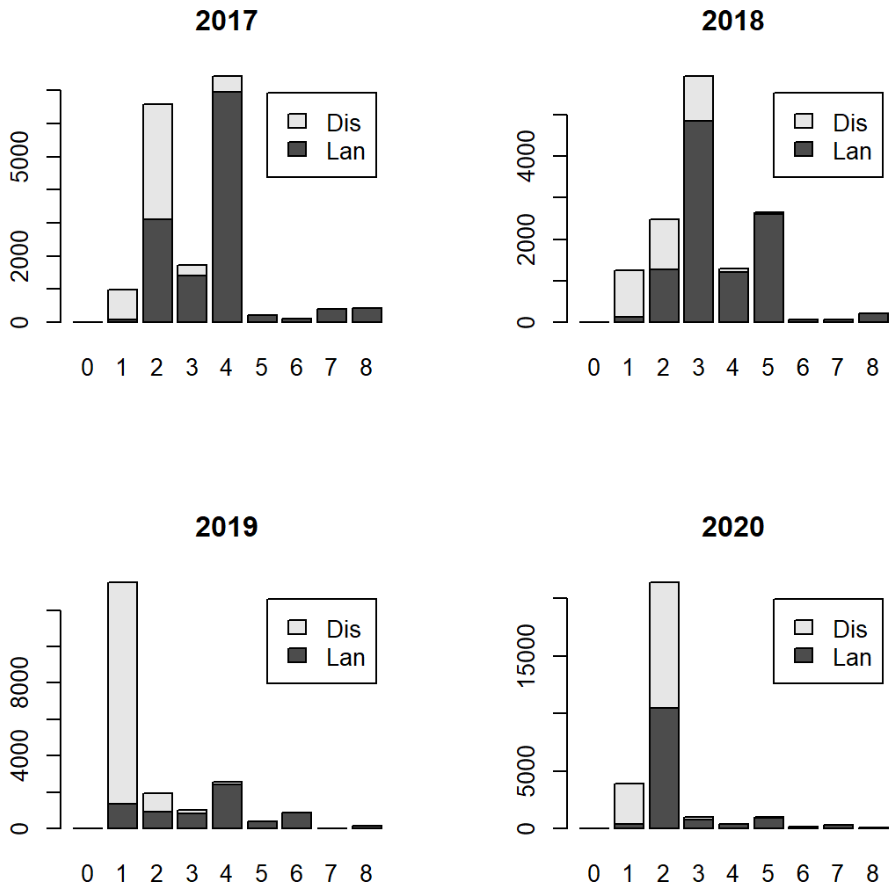


Figure 7.4.20. Haddock 7bc–ek. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

10 Megrim (*Lepidorhombus* ssp.) in divisions 4.a and 6.a (northern North Sea, West of Scotland)

Type of assessment in 2018

Update of 2018 assessment with new landings and survey data. The model used to carry out the assessment is the Schaefar Surplus production process model in R and Winbugs.

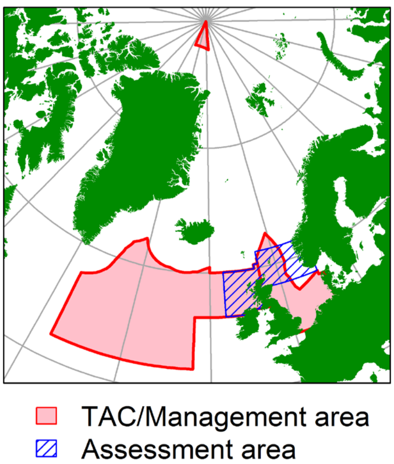
ICES advice applicable to 2019 and 2020

ICES advises that when the EU multiannual plan (MAP) is applied, catches in 2019 that correspond to the F ranges in the plan are between 6450 tonnes and 8350 tonnes.

10.1 General

Stock description and management units

Megrim stock structure is uncertain and historically the Working Group has considered megrim populations in 6.a and 6.b as separate stocks. The review group questioned the basis for this in 2004. Data collected during an EC study contract (98/096) on the 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' showed significantly different growth parameters and significant population structure difference between megrim sampled in 6.a and 6.b (Anon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear. As noted by WGNSDS (2008), megrim in 4.a has historically not been considered by ICES and WGNSDS (2008). Since 2009, data from 4 and 2.a are included in this report, but international catch and weight-at-age data for 4, prior 2006 were not available to the working group or WKFLAT (2011). Given that there is little evidence to suggest that megrim in 6.a and 4.a are separate stocks, based on a visual inspection of the spatial distribution of commercial landings and fishery-independent survey data, WKFLAT (2011) concluded that megrim in 6.a and 4.a should be considered as a single stock. This has subsequently been supported through recent genetic studies (MacDonald and Prieto, 2012) indicating that there is one stock consisting of divisions 4.a (northern North Sea) and 6.a (West of Scotland) and another separate stock in Division 6.b (Rockall).



Management area (red boxes) and assessment area (blue hatched boxes).

Species:	Megrims *Lepidorhombus* spp.	Zone:	Union waters of 2a and 4 (LEZ/2AC4-C)
Belgium	8		
Denmark	7		
Germany	7		
France	41		
The Netherlands	33		
United Kingdom	2 430		
Union	2 526		
TAC	2 526		Analytical TAC Article 7(2) of this Regulation applies

Species:	Megrims *Lepidorhombus* spp.	Zone:	Union and international waters of 5b; 6; international waters of 12 and 14 (LEZ/56-14)
Spain	617		
France	2 407		
Ireland	704		
United Kingdom	1 704		
Union	5 432		
TAC	5 432		Analytical TAC Article 7(2) of this Regulation applies

2018 TAC for 6, EC waters of 5.b and International waters of 12 and 14 (lower) and TAC for 4 and 2.a (upper).

Species:	Megrims *Lepidorhombus* spp.	Zone:	Union waters of 2a and 4 (LEZ/2AC4-C)
Belgium	9		
Denmark	7		
Germany	7		
France	47		
The Netherlands	37		
United Kingdom	2 780		
Union	2 887		
TAC	2 887		Analytical TAC Article 7(2) of this Regulation applies

Species:	Megrims *Lepidorhombus* spp.	Zone:	Union and international waters of 5b; 6; international waters of 12 and 14 (LEZ/56-14)
Spain	657		
France	2 563 ([1])		
Ireland	749		
United Kingdom	1 813 ([1])		
Union	5 782		
TAC	5 782		Analytical TAC Article 7(2) of this Regulation applies

2019 TAC for 6, EC waters of 5.b and International waters of 12 and 14 (lower) and TAC for 4 and 2.a (upper).

The uptake of the 2018 TAC for ICES Division 6 and EU waters of 5.b was 33%. Uptake varied considerably between countries. The UK, which holds much of the quota allocation, utilised only 23% of its allocation.

In ICES areas 4 and 2.a, the TAC was overshot by 13% in 2018. The majority of available TAC (96%) is allocated to the UK, who take 87% of it.

Fishery in 2018

Landings

Official landings data for each country together with Working Group best estimates of landings from 6.a are shown in Table 13.2 and for 4.a in Table 13.3. To estimate ICES landings we take InterCatch estimates and, if unavailable, we use official estimates. There are a few discrepancies with the estimates, for example there are no Danish data in InterCatch for 2017 and 2018. There are often minor differences between official data and InterCatch for most countries.

Catches of megrim comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al*., 1995; Anon, 2001). Commercial catches are dominated by female megrim, typically 90% of the total catch.

The InterCatch catch estimate is 3258 tonnes, and the ICES catch estimate for 6.a and 4.a. is 3003 tonnes. The total ICES landings are well below the total TAC covering the fished areas of 4.a–6.a.

Discards

Raised discard data were made available by Scotland, France, Spain and Ireland (6.a and 4.a) and Scotland and Ireland (6.a). Scottish data give a discard rate of 7.9%, Irish discards were 10.2%, Spanish discards were 0.3%, and French discards were 13.9% by weight. Total discards were estimated to be 255 t or 7.8% by weight for the stock area in 2018. We assume no discards for Denmark, Netherlands, and Germany.

A linear decline in discards from 30 to 15% over time between 1985 and 2012 is assumed in the stock assessment. From 2013 onwards discard data have taken from InterCatch, there is no deviation from the agreed stock annex (see Annex 2).

Catch

A breakdown of 2018 catch by main gear type in InterCatch is given below:

Catch	Landings			Discards		
3258 tonnes	Finfish trawls	*Nephrops* trawls	Other Gears	Finfish trawls	*Nephrops* trawls	Other Gears
	96.6%	0.52%	2.9%	96..5%	3.4%	0.029%
	3003 tonnes			255 tonnes		

Surveys

Indices from six fishery-independent surveys are used in the assessment. The surveys are outlined in Table 13.1 below and details can be viewed in the stock annex.

Table 13.1. Summary indices used for surplus production model.

NUMBER	SURVEY	NATIONALITY	AREA	TIME-SERIES	DEPTH RANGE(M)
1	Sco-IBTS-Q3	Scotland	4.a	1987–2017	50–250
2	Sco-IBTS-Q1	Scotland	4.a	1987–2017	50–250
3	ScoGFS-WIBTS-Q1	Scotland	6.a	1986–2010	40–400
4	ScoGFS-WIBTS-Q4	Scotland	6.a	1986–2010	50–300
5	SAMISS-Q2	Scotland	6.a/4.a	2005–2017	50–1050
6	IAMISS-Q2	Ireland	6.a	2005–2017	50–850

The SAMISS and IAMISS surveys were combined for assessment purposes.

Figures 13.1 to 13.5 present the megrim biomass maps for the AMISS and IBTS surveys. The AMISS bubble plots show and increasing abundance over time throughout the area over the time-series. The abundance in 6.a was particularly high in 2013 and a similar high abundance occurred in 4.a in 2014 (Figure 13.1). Figures 13.2. (Sco-IBTS-Q3 4.a) and 13.3 (Sco-IBTS-Q1 4.a) show the large increase in biomass over time in the northern North Sea. Biomass in the southern North Sea remains quite low.

Figures 13.4 (Sco-GFS-Q1 4.a) and 13.5 (Sco-GFS-Q4 4.a) also show an increase in biomass over the time-series. However, the survey design and ground gear changed after 2010 so this should be taken into account when interpreting the plots. Data from these data were truncated from the time-series going into the assessment.

10.2 Estimation of survey cpue indices

Cpue trends of survey data

The data from the IBTS surveys exhibit a relatively large proportion of zeros, therefore the delta method of Stefánsson (1996) was used to generate indices. This method (delta-gamma model) comprises fitting two generalized linear models. The first model (binomial GLM) is used to obtain the proportion of non-zero tows, and is fit to the data coded as 1 or 0, if the tow contained a positive or zero cpue, respectively. The second model is fit to the positive only cpue data using a gamma or lognormal GLM.

At WGCSE 2017, it was discovered that previous delta-gamma cpue estimations had included the full time-series for the 6.a surveys, when fitting the model to those surveys. In 2019, these again generate a slightly different cpue index Figure 13.6. The truncated series was used in the 2019 assessment since fitting to the full series would be inappropriate.

The biomass trend for the AMISS survey is shown in Figure 13.7. There is a weakly increasing trend over time with year effects evident in 6.a in 2013 and 4.a in 2014, while a notable increase in 2016 and 2017 was followed by a decrease in 2018. The biomass trends for the four IBTS surveys are shown in Figure 13.8.

Commercial cpue

Commercial cpue data have not been updated compared to last year and are not used in the assessment.

10.3 Stock assessment

The input data for the stock assessment are given in Table 13.4 this comprises of a time-series from all six surveys and ICES catch estimates for this stock.

2019 Final run

The Pearson residuals diagnostic plots for the final assessment are shown in Figure 13.9. The residuals for the two 6.a surveys and the AMISS survey are fairly randomly dispersed around zero. A trend in the residuals is evident for the two 4.a surveys is evident with increasing positive residuals in the last decade.

The prior and posterior distributions for the parameters in the final model fit, are shown in Figure 13.10. The priors are given in Table 13.5. The posterior distributions are similar to previous years' assessments. The posterior parameter estimates for the final assessment model are given in Table 13.6. These are similar to recent assessments.

Figure 13.11 shows the final model fits to the cpue series and the estimates of total biomass and harvest ratio. The fits to the 6.a and AMISS surveys are reasonable. The fits to the 4.a surveys show that the model is not fitting well to those surveys in recent years. This issues needs to be examined further in the next benchmark.

Figure 13.12 compares the assessment results of the model fitted with to a cpue generated using the full time-series of the 6.a surveys and a model with the truncated cpue series. This indicates that the impact of fitting the model to the full time-series of delta-gamma cpues for 6.a instead of the truncated time-series was minimal, mainly effecting the early part of the time-series.

The time-series of B/B_{MSY} and F/F_{MSY} landings and discards used in the final assessment are given in Table 13.7.

Comparison with previous assessments

Figure 13.13 compares the final assessment with those conducted by WGCSE at previous meetings. The 2019 assessment revised down recent biomass estimates and up recent fishing mortality estimates. There is also some deviations in the historic estimates of F and Biomass around 2000. This is linked to the use of the truncated 6.a surveys to derive the delta-gamma cpues to input to the assessment model.

To evaluate evidence of possible bias in the assessment population metrics, a Mohn's Rho analysis resulted in values of -0.092 for F_{bar} and 0.088 for biomass. ICES considers a value greater than 0.20 to be unacceptably high.

State of the stock

The state of the stock has not changed since last year. Fishing mortality has been below F_{MSY} for almost the full time-series and has an overall declining trend since the late 1990s. Biomass has consistently been above MSY $B_{trigger}$ and shows an increasing trend since 2005. The stock in 2018 is estimated to be 1.7 times B_{MSY}. The fishing mortality in 2018 is estimated to be have been 35% of F_{MSY}.

10.4 Short-term projections

Short-term projections have been updated according to the method set out in the stock annex. The basis for the catch options is given in Table 13.8.

The management option table is given in Table 13.9. Fishing at F_{MSY} in 2019 is projected to result in total catches of 8350 t (landing of 7684 t and discards of 666 t) and a Biomass of 1.4 times B_{MSY} in 2021.

10.5 Biological reference points

Precautionary approach reference points

F_{MSY}, B_{MSY} and the yield at MSY are all directly estimated in the model. It should be noted that these will vary when new survey and catch information is added. B_{pa} and B_{lim} are defined as 50%B_{MSY} and 30%B_{MSY} respectively. F_{lim} is defined as 1.7 F_{MSY} and is the F that drives the stock to B_{lim} assuming B_{lim}=30%B_{MSY}. The derivation is given below:

$P=rB(1-B/K)$

The surplus productivity associated with B_{lim} *is:*

$P_{lim}=rB_{lim}(1-B_{lim}/K)$

The corresponding F is:

$F_{lim}=rB_{lim}(1-B_{lim}/K)/B_{lim} = r(1-B_{lim}/K)$

$B_{lim}=0.3B_{MSY} = 0.3K/2$

$F_{lim} = r(1-0.3K/(2K)) = r(1-0.3/2) =0.85r$

$F_{MSY}=r/2$, *let x denote the proportionality between* F_{MSY} *and* F_{lim}

$xF_{MSY}=F_{lim}$

$x(r/2)=0.85r$

$x=2*0.85$

$x=1.7$

MSY reference points

In 2015, ICES provided precautionary F_{MSY} ranges that are derived to deliver no more than a 5% reduction in long-term yield compared with MSY. Details of this analysis are given in WKMSYREF3 (ICES, 2015) and the derivations are given below.

	MSY F_{lower} [b)]	F_{MSY} [b)]	MSY F_{upper} [b)] with AR	MSY $B_{trigger}$
Megrim in divisions 4.a and 6.a	0.39 × r [d)]	r/2 [d)]	r/2 [d)]	K [d)]

Because the stock has been fished below F_{MSY} for more than ten years the WG considered it appropriate to set the MSY $B_{trigger}$ = B_{MSY} according to the ICES guidelines (ICES, 2017).

Uncertainties and bias in assessment and forecast

The model estimates of B and F have large uncertainty. Despite this, there is a low probability that SSB is below MSY $B_{Trigger}$ and a high probability that F is below F_{MSY}.

The reference points are re-estimated within the assessment. The change between 2017 and 2018 reference points is less than has been previously seen, and results in a notable rescaling of relative stock status. However, in absolute terms, stock trends are consistent with those of previous years.

The biomass time-series from surveys has increasing uncertainty boundaries as the index increases. This results in uncertainty bounds in the model estimates show a contraction from the 2018 assessment.

Owing to incomplete discard data, historical discard rates (1985–2012) are assumed to have declined, from 30% at the beginning of the time-series, to an estimate of 15% in 2012. The evaluation of current stock status is robust to this assumption. Estimates since 2013 are based on observed discards.

Recommendation for next benchmark

This stock was subject to an inter-benchmark in 2012 (IBP-MEG, 2012). Due to incomplete age data, particularly for 4.a, a Bayesian state–space surplus production model was chosen as the final assessment model. Subsequent update assessments have highlighted a problem fitting to the 4.a surveys which needs to be examined in a future benchmark.

WGCSE recommends the following explorations:

- The AMISS survey should be merged into one continuous index. The length data for the index should also be examined.
- The Sco 6.a Q1/Q4 WIBTS 2011+: the Sco 6.a Q1/Q4 WIBTS survey time-series should also be examined for re-introduced into the assessment as a new time-series. There may also be scope to integrate the IGFS.
- Available length and age-structured data should be compiled for this stock.
- Length or age-structured assessment models could be explored.

Once sufficient progress has been made on the points above, WGCSE will suggest a benchmark schedule.

Management considerations

Megrim is a bycatch species in the mixed demersal trawl in divisions 6.a and 4.a. Management measures for other species have constrained the fishery and reduced effort and fishing mortality on megrim. The general increase in mesh size in 6 and 4 since 2010 has also benefited the stock.

The TAC in 6 has not been fully utilised. However, the uptake rate is country specific, with some Member States reporting landings above their quota in the North Sea. Partial quota uptake by individual Member States may be linked to reduction in effort rather than reflective of a reduction in biomass. The TAC and assessment area are incompatible. There are two separate TAC areas covering ICES areas 6 and 4, whereas the assessment covers ICES divisions 6.a and 4.a combined. Due consideration of the inconsistency between management and assessment area is required when setting fishing opportunities for this stock and the separate 6.b Rockall stock. ICES (2013) have advised the EC that the TAC areas should be consistent with the assessment area and that ICES has no basis on how to split the catch advice so that it is consistent with the TAC areas.

10.6 References

ICES. 2015. Report of the Joint ICES-MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 156 pp.

ICES. 2012. Report of the Inter-benchmark Protocol for Megrim in Subarea IV and Division IVa (IBPMeg), 2–6 April 2012. By correspondence. ICES CM 2012/ACOM:67. 23 pp.

ICES. 2011. Report of the Benchmark Workshop on Flatfish (WKFLAT), 1–8 February 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:39. 257 pp.

ICES. 2011. Report of the Working Group for Celtic Seas Ecoregion (WGCSE), 11–19 May 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:12. 1573 pp.

Kunzlik, P. A., A. W. Newton and A. W. Jermyn. 1995. Exploitation of monks (*Lophius* spp.) and megrims (*Lepidorhombus* spp.) by Scottish fishermen in ICES Division VIa (West of Scotland). Final report EU FAR contract MA-2-520.

Laurenson, C. and MacDonald, P. 2008. Collection of fisheries and biological data on megrim in ICES Sub-area IVa. Scottish Industry Science Partnership Report No 05/08.

Meyer and Millar. 1999. BUGS in Bayesian stock assessments. Canadian Journal of Fisheries and Aquatic Sciences; Jun 1999; 56, 6; Canadian Periodicals. pp. 1078.

Reid, D.G., Allen, V.J., Bova, D.J., Jones, E.G., Kynoch, R.J., Peach, K.J., Fernandes, P.G. and Turrell, W.R. 2007. Angler fish catchability for swept area abundance estimates in a new survey trawl. ICES J. Mar. Sci. 64.

Stefánsson, G. 1996. Analysis of groundfish survey abundance data: combining the GLM and delta approaches. *ICES Journal of Marine Science*, 53, 577–588.

Table 13.2. Megrim in Subarea 6.a. Nominal catch (t) of Megrim West of Scotland, as officially reported to ICES and WG best estimates of landings. The shaded cells show updates in official data compared with last year.

Year	Belgium	France	Ireland	Netherlands	Spain	UK – Eng, Wales & N.Irl.	UK – Scotland	UK	Official Total	ICES landings**
1990	0	398	317	0	91	25	1093	-	1924	2210
1991	1	455	260	0	48	167	1223	-	2154	2432
1992	0	504	317	0	25	392	887	-	2125	2549
1993	0	517	329	0	7	298	896	-	2047	2721
1994	1	408	304	0	1	327	866	-	1907	2693
1995	0	618	535	0	24	322	952	-	2451	3498
1996	0	462	460	0	22	156	944	-	2044	4054
1997	0	192	438	1	87	123	954	-	1795	3272
1998	0	172	433	0	111	65	841	-	1622	2705
1999	0	0	438	0	83	42	831	-	1394	2648
2000	0	135	417	0	98	20	754	-	1424	2247
2001	0	252	509	0	92	7	770	-	1630	2473
2002	0	79	280	0	89	14	643	-	1105	1828
2003	0	92	344	0	98	13	558	-	1105	1642
2004	0	50	278	0	45	17	469	-	859	1328
2005	0	48	156	0	69	10	269	-	552	561
2006	0	53	221	0	52			346	672	875
2007	0	104	191	0	5			667	967	1301
2008	0	92	172	0	149			874	1287	1545
2009	0	174	188	0	112			953	1427	1387
2010	0	271	318	0	288			822	1699	1698
2011	0	153	227	0	217			715	1312	1297
2012	0	140	214	0	142			590	1086	1132
2013	0	105	203	0	213			470	991	949
2014	0	126	246	0	57			465	894	948
2015	0	140	311	0	140			520	1110	1110
2016	0	189	408	0	146			694	1437	1437
2017	0	132	336	0	313			579	1359	1359
2018*	0	119	301	0	289			683	1392	1392

*** Preliminary. ** Historical landings data have been adjusted for area misreporting, mainly from Division 4.a to Division 6.a.**

Table 13.3. Megrim in Subarea 4 and 2.a. Nominal catch (t) of Megrim North Sea, as officially reported to ICES and WG best estimates of landings.

Country	Belgium	Denmark	France	Germany	Germany, Fed. Rep. of	Ireland	Netherlands	Norway	Spain	Sweden	UK – Eng, Wales & N.Irl	UK – England & Wales	UK N. Ireland	UK – Scotland	UK	Official total	ICES landings**
1990	4	2	-	-	3	-	24	-	-	-	17	-	-	1126	-	1176	837
1991	3	1	-	6	-	-	28	-	-	-	9	-	-	1169	-	1216	878
1992	2	4	36	3	-	-	27	-	-	-	47	-	-	1372	-	1491	1025
1993	7	6	25	4	-	-	30	-	-	-	8	-	-	1736	-	1816	1081
1994	2	1	27	1	-	-	28	-	-	-	19	-	-	2000	-	2078	1207
1995	7	2	24	2	-	-	26	-	-	-	44	-	-	2193	-	2298	1172
1996	5	7	14	1	-	-	9	-	-	-	4	-	-	3221	-	3261	1199
1997	3	5	16	2	-	-	20	-	-	-	3	-	-	3091	-	3140	1584
1998	5	18	14	4	-	-	30	-	-	-	5	-	-	2628	-	2704	1548
1999	4	21	.	1	-	-	26	-	-	-	4	-	-	2121	-	2177	1111
2000	10	29	7	3	-	-	20	-	-	-	2	-	-	2044	-	2115	1247
2001	2	52	5	1	-	-	11	-	-	-	2	-	-	1854	-	1927	1098
2002	5	8	6	-	-	-	9	-	-	-	3	-	-	1675	-	1706	975
2003	3	11	11	2	-	1	7	<0.5	-	-	1	-	-	1235	-	1271	727
2004	-	7	9	2	-	-	11	<0.5	-	-	1	-	-	1130	-	1160	739
2005	-	1	3	4	-	-	19	<0.5	-	-	1	-	-	958	-	986	n/a
2006	0	3	4	1		0	6	1	0	0					1342	1357	1179
2007	0	11	18	4		0	1	1	0	0					1437	1472	1047
2008	0	31	20	1		0	1	4	0	0					1524	1581	1349
2009	0	54	9	0		0	0	6	0	0					1474	1543	1484
2010	0	22	1	0		0	1	2	0	0					1440	1466	1499
2011	0	23	10	3		0	0	1	0	0					1394	1431	1421
2012	0	35	5	3		0	0	1	0	0					1397	1441	1458
2013	0	48	7	3		0	0	17	0	0					1690	1765	1788
2014	0	35	7	1		0	0	12	0	0					1475	1530	1551
2015	0	26	1437	0		0	0	8	0	0					1175	1217	1230
2016	0	46	13	2		0	2	21	0	0					1278	1362	1361
2017	0	0	36	0		0	0	29	0	0					1171	1235	1235
2018*	0	0	66	0		0	0	0	0	0					1545	1611	1611

*** Preliminary.**

**** Historical landings data have been adjusted for area misreporting, mainly from Division 4.a to Division 6.a.**

Table 13.4 Time-series of megrim survey indices in ICES Area 6.a and Division 4 as used in the surplus production model.

year	sco.6.a.q1	sco.6.a.q4	sco.4.a.q1	sco.4.a.q3	monk.6.a	monk.4.a
1985	2.587277	NA	NA	NA	NA	NA
1986	1.687998	NA	1.329749	NA	NA	NA
1987	1.370928	NA	1.537833	NA	NA	NA
1988	2.008519	NA	1.748567	NA	NA	NA
1989	1.161744	NA	1.426951	NA	NA	NA
1990	1.072564	1.589121	0.7735	NA	NA	NA
1991	0.79324	1.273655	0.505929	0.350627	NA	NA
1992	0.958432	1.885181	0.698599	0.335977	NA	NA
1993	1.013121	2.058297	1.134466	0.324729	NA	NA
1994	1.589026	3.246435	0.271782	0.407895	NA	NA
1995	1.555855	1.862839	0	0.408543	NA	NA
1996	1.939844	1.94602	0.524468	0.653647	NA	NA
1997	1.100464	1.081142	0.447485	0.458213	NA	NA
1998	1.094432	1.892789	0.834695	0.247146	NA	NA
1999	1.322173	1.360191	1.043853	0.251712	NA	NA
2000	1.140297	1.18569	0.885684	0.28164	NA	NA
2001	0.997603	0.967749	0.292969	0.091139	NA	NA
2002	0.760004	1.857327	1.244472	0.361805	NA	NA
2003	1.271763	1.204998	0.533176	0.34784	NA	NA
2004	1.244469	1.063918	0.279859	0.503955	NA	NA
2005	0.690391	1.012593	0.599738	0.894977	1660.379	4753.223
2006	0.916576	1.120885	0.821337	1.046429	2688.942	3344.997
2007	0.90675	1.198995	0.895681	1.502491	3380.351	6347.544
2008	1.253294	0.956626	1.636657	1.286277	2467.076	7754.143
2009	1.572727	1.396689	1.989926	1.160419	3830.668	5946.946
2010	1.170501	NA	1.798376	1.874144	3312.129	5394.946
2011	NA	NA	2.025557	1.720147	2501.99	4683.594
2012	NA	NA	2.663022	1.621436	3450.807	4839.468
2013	NA	NA	2.840508	1.481465	6174.864	6460.015
2014	NA	NA	2.251962	1.367421	3033.072	11970.3
2015	NA	NA	3.122434	1.398177	2563.105	4986.899
2016	NA	NA	1.527182	1.357468	3027.648	8207.787
2017	NA	NA	1.852547	1.025582	6508.563	10238.94
2018	NA	NA	NA	NA	3364.165	7154.307

Table 13.5. ***Lepidorhombus whiffiagonis*** **in ICES areas 6.a and 4.a. Prior distributions on parameters.**

Parameter	Symbol	Prior distribution	Notes
Intrinsic rate of population growth	r	$\text{Uniform}(0.001, 2.0)$	
Carrying capacity	K	$\text{Uniform}\left(\ln(\max(C)), \ln\left(10 \times \sum_{t=1985}^{2010} C_t\right)\right)$	From the maximum catch to ten times the cumulative catch across all years assuming uniform distribution on the logarithmic scale
Catchabilities	$\log(q_j)$	$\text{Uniform}(-11.0, 0.0)$	Uniformly distributed on log-scale. See catchability sensitivity in Section 2.2.3.1
Process error variance	$\frac{1}{\sigma_u^2}$	$\text{Gamma}(\text{shape} = 0.001, \text{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Measurement error variances	$\frac{1}{\sigma_{\varepsilon,j}^2}$	$\text{Gamma}(\text{shape} = 0.001, \text{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Proportion of *K* in 1985	a	$\text{Uniform}(0.01, 2.0)$	

Table 13.6. Parameter estimates for final assessment outputs.

Parameter	Estimates 2013	Estimates 2014	Estimates 2015	Estimates 2016	Estimates 2017	Estimates 2018	Estimates 2019
r.hat	0.67	0.55	0.51	0.51	0.507507	0.466	0.50
K.hat	39346	43134	47216	46840	42681	55129	44116
MSY	6037	5660	5612	5362	5072	5362	5123
F_{MSY}	0.33	0.28	0.26	0.26	0.253753	0.233	0.25
B_{MSY}	19673	21567	23608	23420	21340	27565	22058
B	3624	4109	42416	42356	37610	38057	37062
F	0.09	0.08	0.07	0.07	0.07291	0.081	0.08
B_{lim}	5902	6470	7082	7026	6402	8269	6617
B_{trig}	9837	10783	11804	11710	10670	13782	11029

Table 13.7. Time-series of B/BMSY and F/FMSY estimates and landings and discards in tonnes for the final assessment.

Year	B/B_{MSY}	$B/B_{MSY\ High}$	$B/B_{MSY\ Low}$	Landings	Discards*	F/F_{MSY}	$F/F_{MSY\ High}$	$F/F_{MSY\ Low}$
1985	2.093	3.699	0.438	4499		0.783	1.655	0.357
1986	1.514	2.286	0.399	2858		0.589	1.096	0.300
1987	1.414	2.075	0.383	4614		1.033	1.925	0.543
1988	1.344	2.119	0.369	5212		1.254	2.287	0.577
1989	1.077	1.609	0.326	3451		0.961	1.781	0.463
1990	0.979	1.430	0.309	3047		0.907	1.740	0.437
1991	0.916	1.330	0.318	3310		1.050	1.997	0.535
1992	0.978	1.430	0.330	3574		1.061	1.924	0.536
1993	1.058	1.555	0.338	3802		1.049	1.949	0.520
1994	1.169	1.855	0.354	3900		0.978	1.811	0.447
1995	1.189	1.863	0.353	4670		1.169	2.189	0.540
1996	1.148	1.841	0.338	5253		1.383	2.530	0.604
1997	0.958	1.421	0.307	4856		1.485	2.702	0.698
1998	0.920	1.423	0.277	4253		1.331	2.450	0.599
1999	0.890	1.387	0.265	3759		1.195	2.214	0.527
2000	0.827	1.286	0.249	3494		1.172	2.137	0.512
2001	0.765	1.181	0.237	3571		1.289	2.411	0.582
2002	0.775	1.195	0.241	2803		0.964	1.770	0.446
2003	0.808	1.330	0.236	2369		0.769	1.418	0.338
2004	0.808	1.240	0.245	2067		0.652	1.196	0.304
2005	0.796	1.168	0.237	1527		0.468	0.910	0.241
2006	0.898	1.289	0.263	2054		0.567	1.111	0.297
2007	1.021	1.473	0.312	2348		0.575	1.087	0.299
2008	1.131	1.619	0.330	2894		0.647	1.248	0.334
2009	1.245	1.807	0.381	2871		0.582	1.112	0.301
2010	1.265	1.757	0.392	3197		0.635	1.145	0.344
2011	1.302	1.849	0.426	3257		0.626	1.133	0.341
2012	1.422	2.060	0.466	2545		0.472	0.849	0.258
2013	1.617	2.491	0.526	2737	327	0.407	0.733	0.214
2014	1.624	2.346	0.519	2500	309	0.367	0.646	0.203
2015	1.506	2.094	0.495	2471	152	0.361	0.616	0.208
2016	1.608	2.261	0.586	2792	167	0.386	0.642	0.222
2017	1.782	2.709	0.664	2594	193	0.333	0.560	0.178
2018	1.681	2.198	1.154	3003	255	0.4	0.59	0.24

*** The discards are extrapolated form 30% of catch in 1985 to 15% of catch in 2012. Estimates from 2013 onwards are derived from data submitted to InterCatch.**

Table 13.8. Basis for the catch options.

Variable	Value	Source	Notes
F (2018)/F_{MSY}	0.402038	ICES (2018a)	F (average 2015–2018)
B (UPDATE)/B_{MSY}	1.681026	ICES (2018a)	Short-term forecast
Catch (2019)	3258	ICES (2018a)	Short-term forecast
Landings (2019)	3003	ICES (2018a)	Assuming discard rate of 7.98%in total weight of catch (average 2015–2017)
Discards (2019)	255	ICES (2018a)	Assuming discard rate of 7.98% in total weight of catch (average 2015–2017)

Table 13.9. The management option table.

Basis	Total catch (2020)	Wanted catch* (2020)	Unwanted catch* (2020)	Fishing mortality F_{2019}/F_{MSY}	Stock size B_{2021}/B_{MSY}	Probability** of Biomass $_{2021}$ falling below MSY $B_{trigger}$	Probability** of Biomass $_{2021}$ falling below B_{lim}	% B change ***	% TAC change ^	% Advice change^^
ICES advice basis										
MSY approach: F_{MSY}	8350	7684	666	1.00	1.42	0.057	0.01	-15	4	1
$F_{MSY\ LOWER}$	6450	5935	515	0.77	1.52	0.030	0.01	-10	-26	-22
$F_{MSY\ UPPER}$	8350	7684	666	1.00	1.42	0.06	0.01	-15	4	1
Other options										
F = 0	0	0	0	0.00	1.83	0.02	0.01	9	-100	-100
B (2021) = B_{lim}	27350	25168	2182	3.27	0.50	0.50	0.30	-70	215	232
B (2021) = B_{pa}	16700	15368	1332	1.99	1.01	0.50	0.01	-40	92.6	102.4
B (2021) =MSY $B_{trigger}$	16700	15368	1332	1.99	1.01	0.50	0.01	-40	92.6	102.4
F = F_{2018}	3258	2998	260	0.40	1.68	0	0	0	-62	-61

* "Wanted" and "unwanted" catch are used to describe fish that would be landed and discarded in the absence of the EU landing obligation (for Division 6.a only), based on discard rate estimates for 2014–2017.

**Probabilities are based on bootstrap sampling and based on a two- and three-year projection of F and B, respectively.

***B 2021 relative to B 2010.

^ Total catch in 2020 relative to TAC in 2019 (8669 t, which corresponds to the 2019 TAC for subareas 4 and 6).

^^ Advice value 2020 relative to advice value 2019 (8250 t).

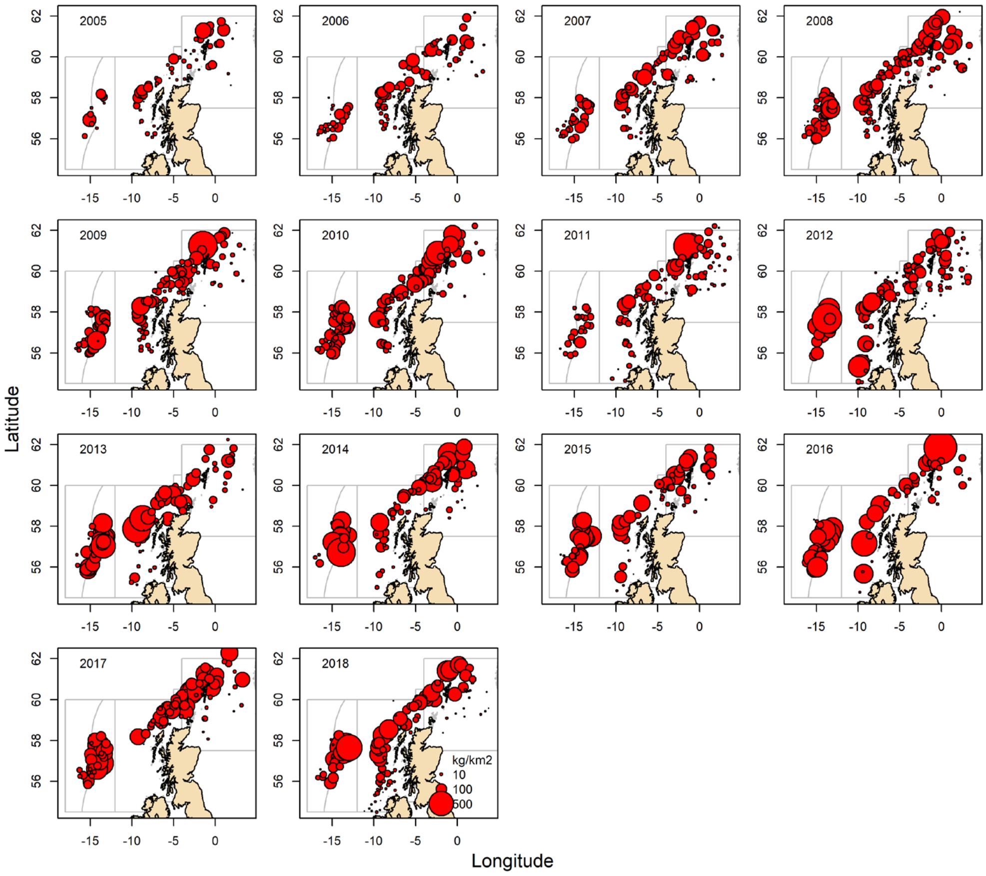


Figure 13.1. Maps of the northern continental shelf around the British Isles showing the biomass of megrim during the anglerfish surveys (SAMISS and IAMISS) 2005–2017.

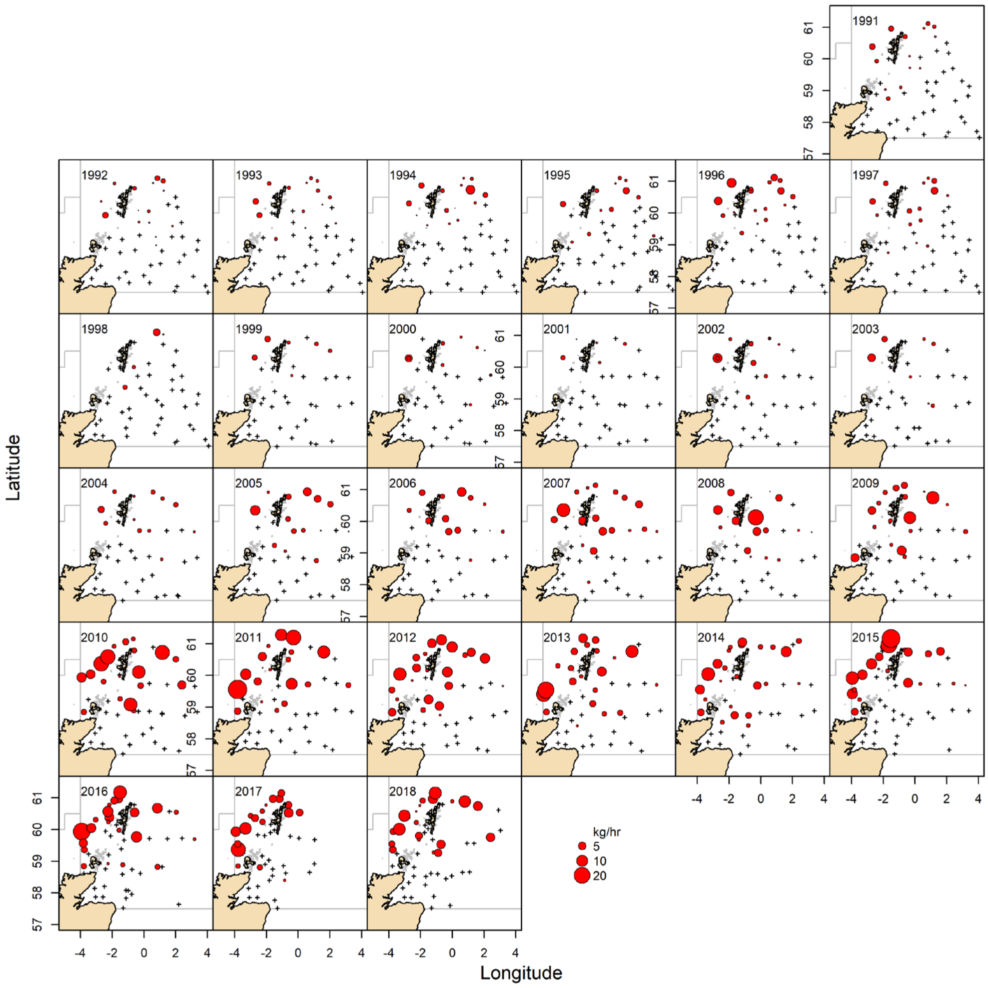


Figure 13.2. Scottish IBTS Q3 4.a megrim biomass maps.

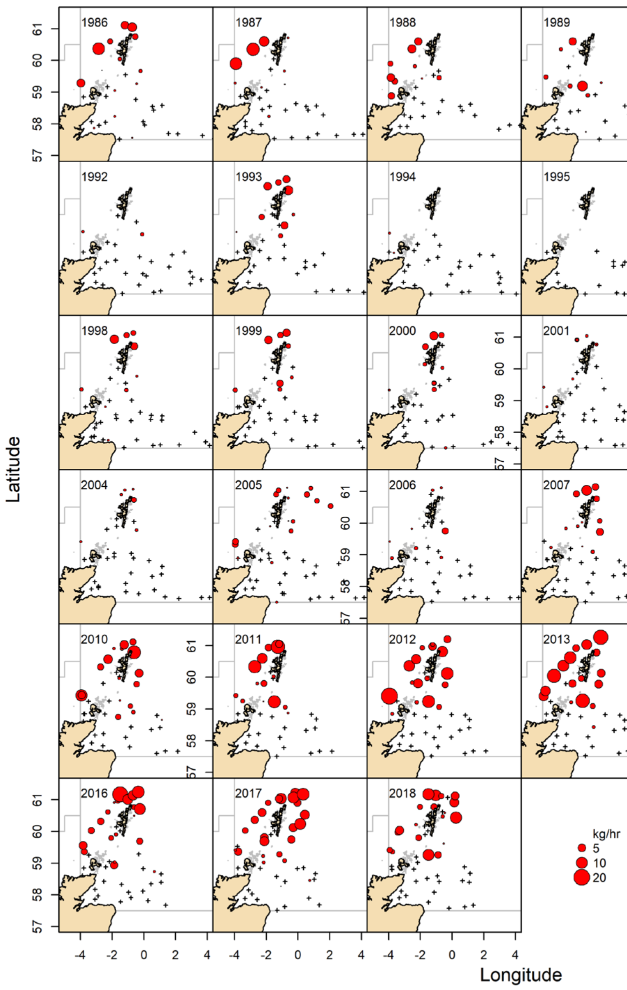


Figure 13.3. Scottish IBTS Q1 4.a megrim biomass maps.

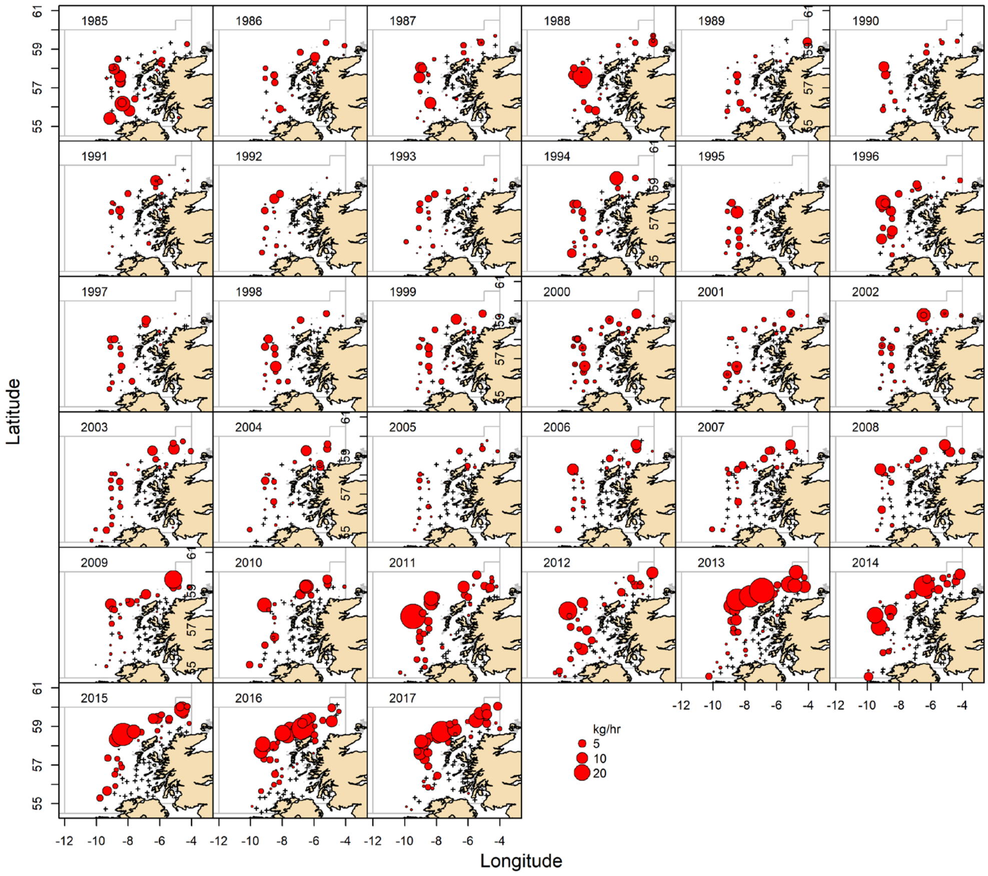


Figure 13.4 Scottish IBTS Q1 4.a megrim biomass maps.

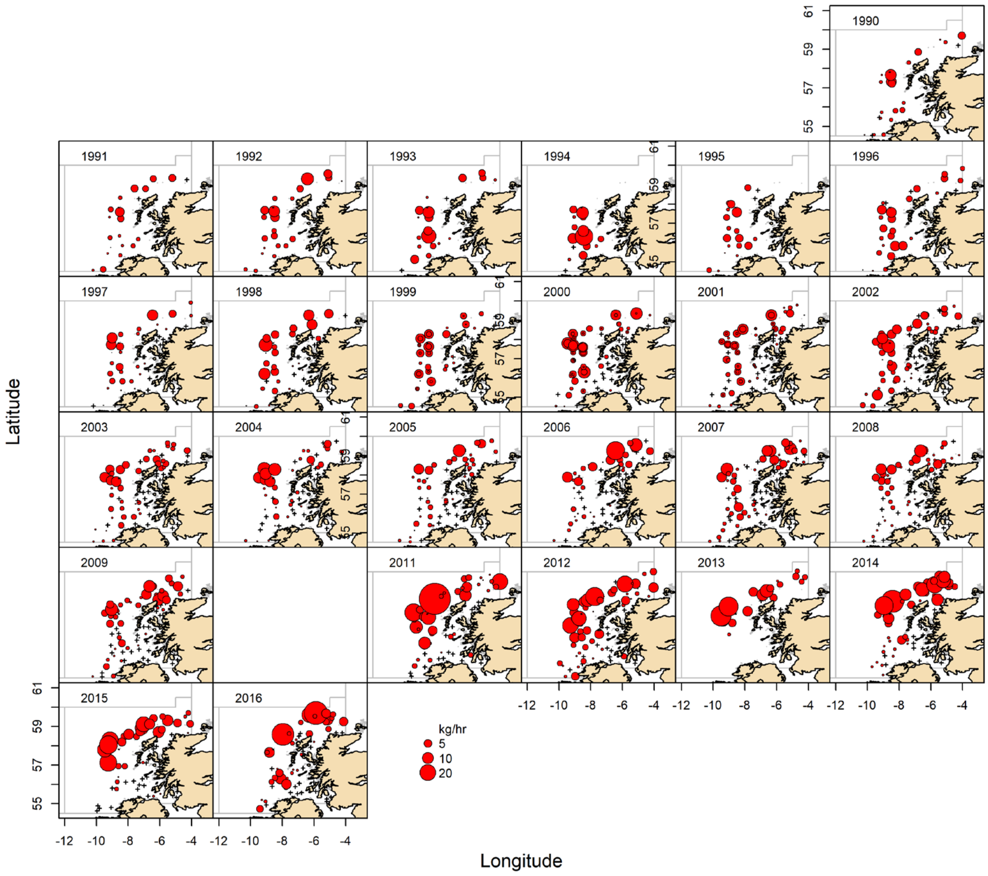


Figure 13.5. Scottish IBTS Q4 6.a megrim biomass maps.

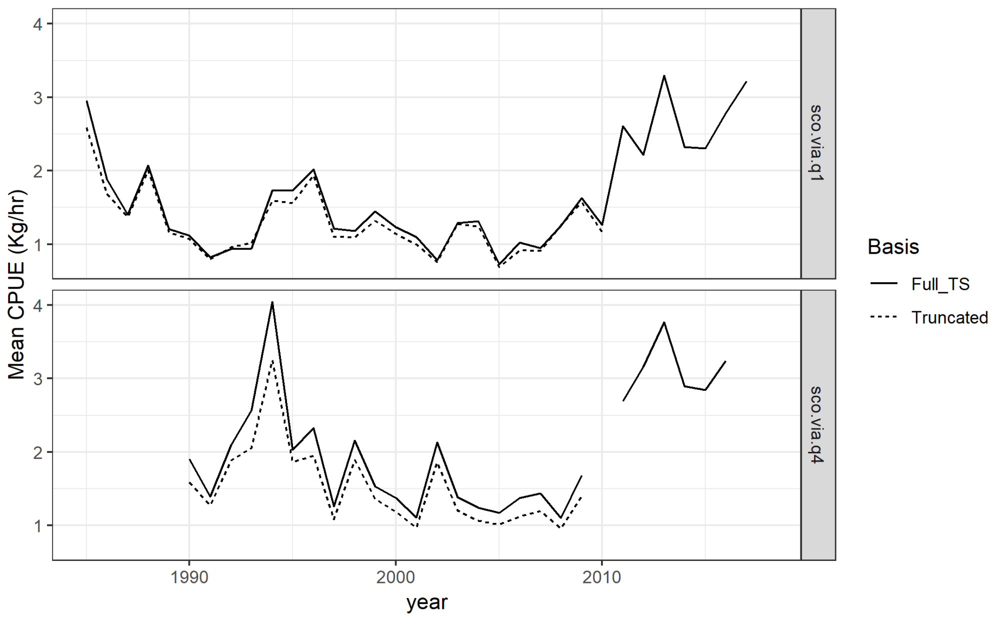


Figure 13.6. Comparison of the delta-gamma cpue estimates for the two 6.a Scottish IBTS surveys using the full time-series or truncating the series to 2010 after which the survey design and ground gear was changed.

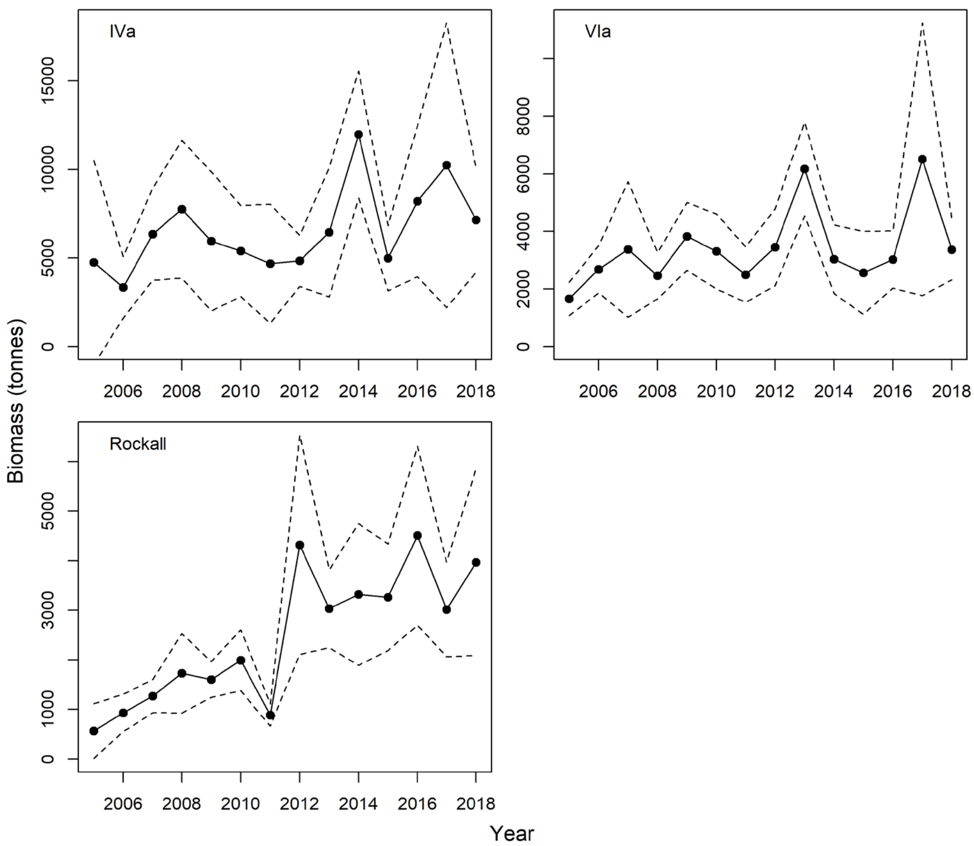


Figure 13.7. Megrim biomass estimates in ICES divisions 4, 6.a and 6.b from the anglerfish (AMISS) survey with 95%cls.

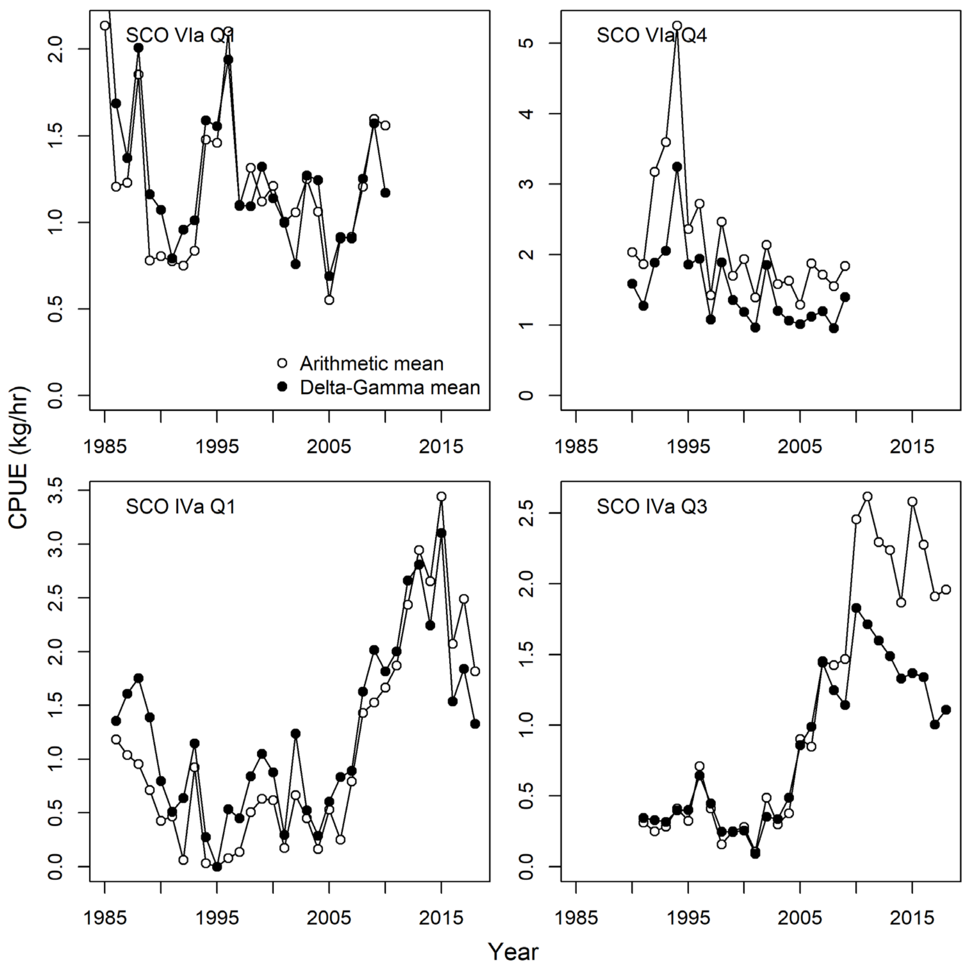


Figure 13.8. Megrim cpue estimates in ICES division 6.a Q1 top left panel and 6.a Q4.

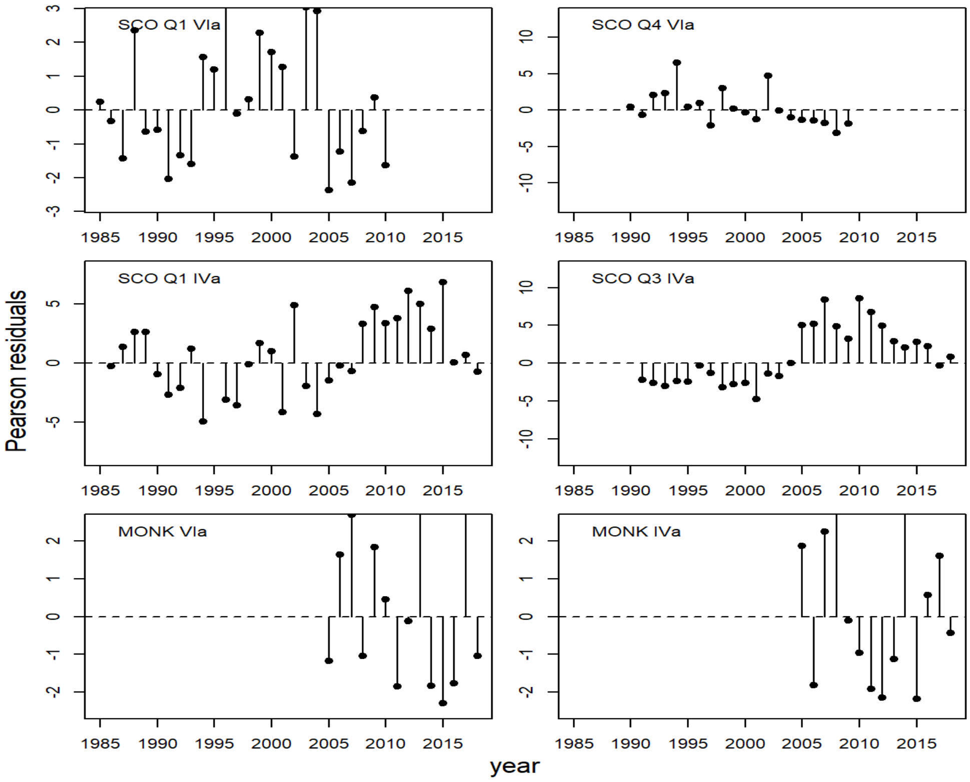


Figure 13.9. Pearson residuals for the six survey indices.

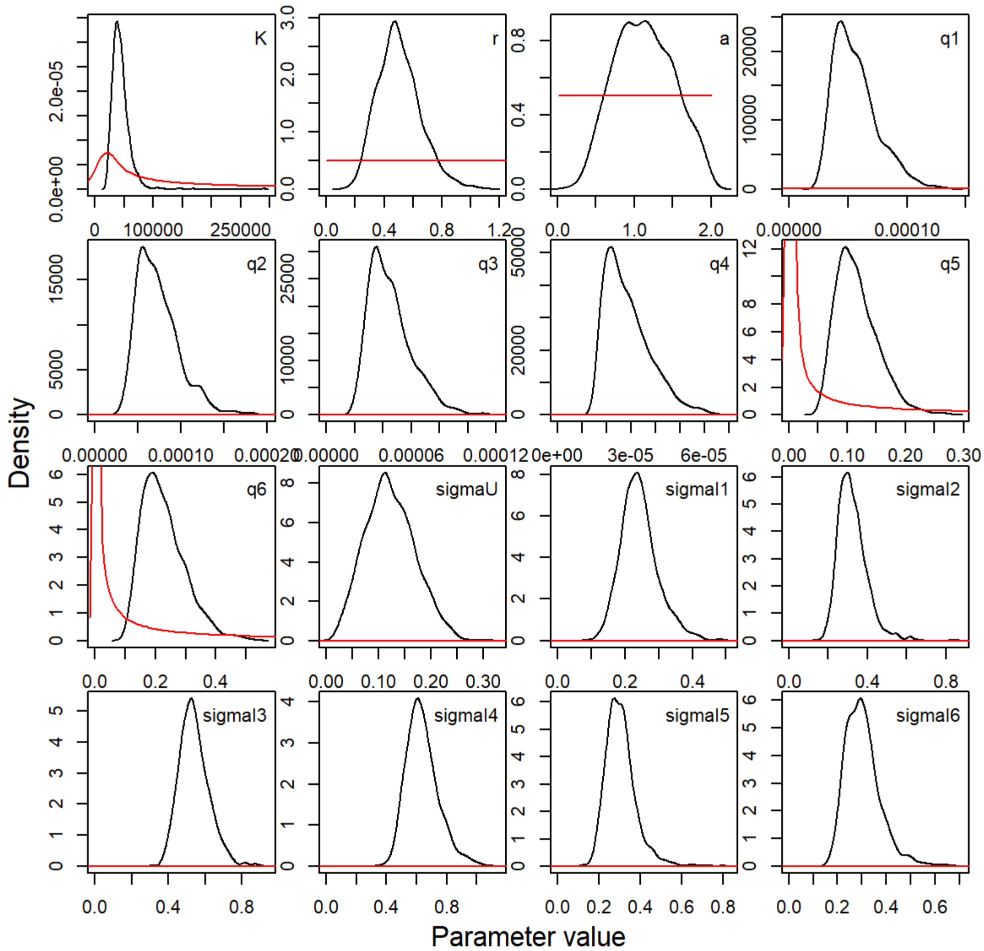


Figure 13.10. Prior (red line) and posterior distributions (black line) for the parameters in the model.

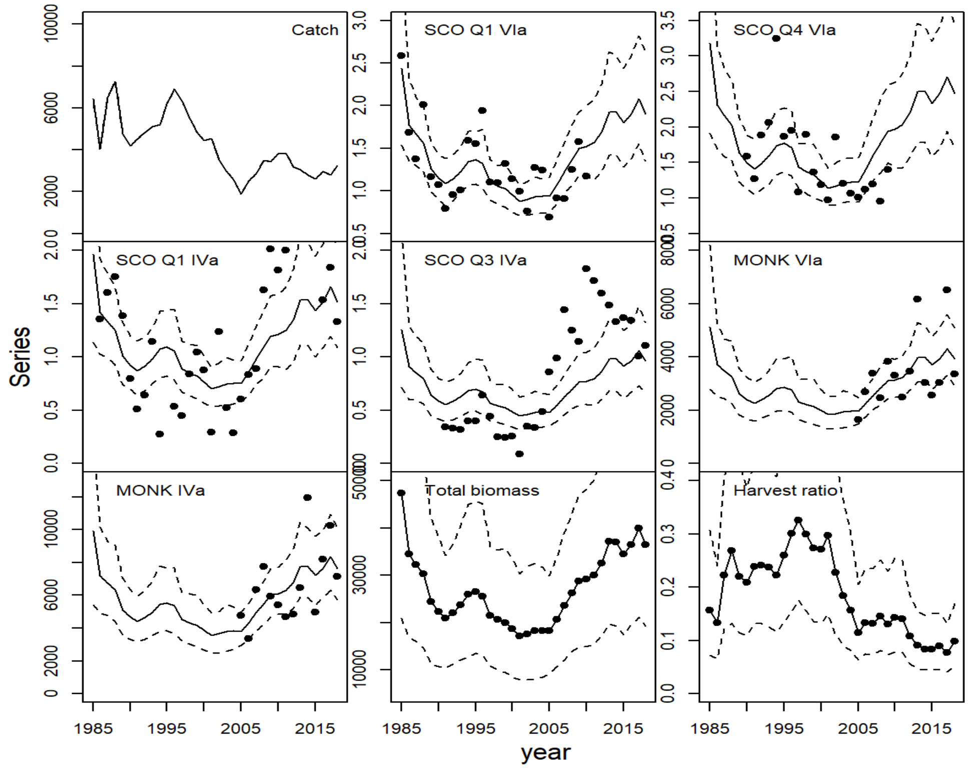


Figure 13. 11. Time-series of catch and model estimates of total biomass and exploitation rate (median values are shown as solid lines and 95% confidence intervals shown as broken lines). The model fits to the various cpue series is also shown (observations dots, median fit solid line and 95% confidence intervals shown as broken lines).

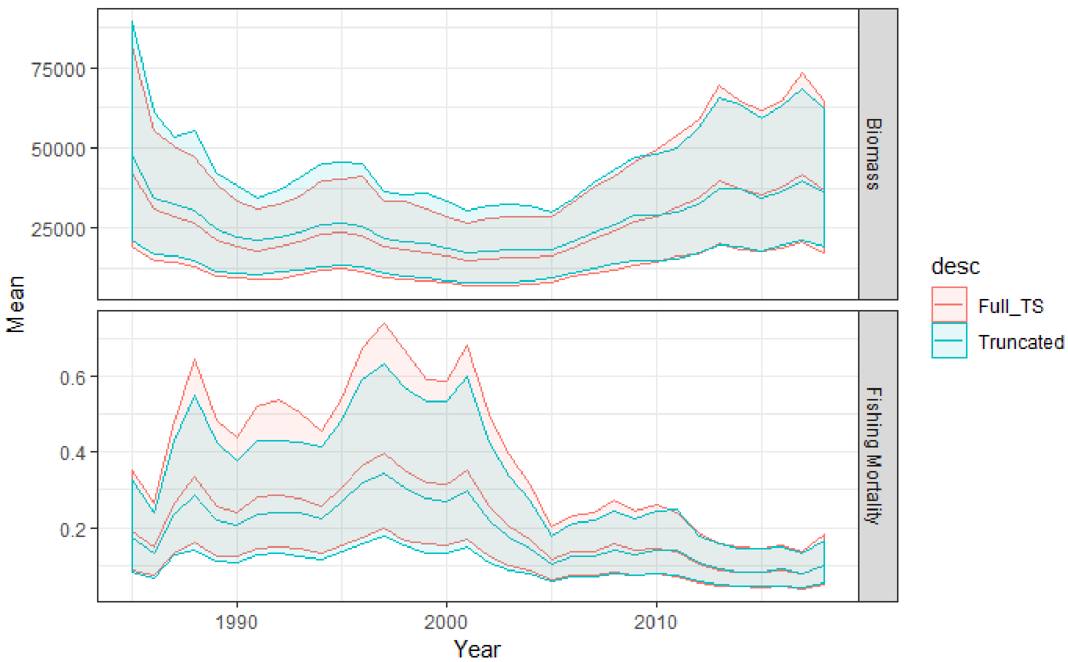


Figure 13.12. Comparison of assessment results models fitted to a cpue generated using the full time-series of the 6.a (red) and a truncated time-series (blue).

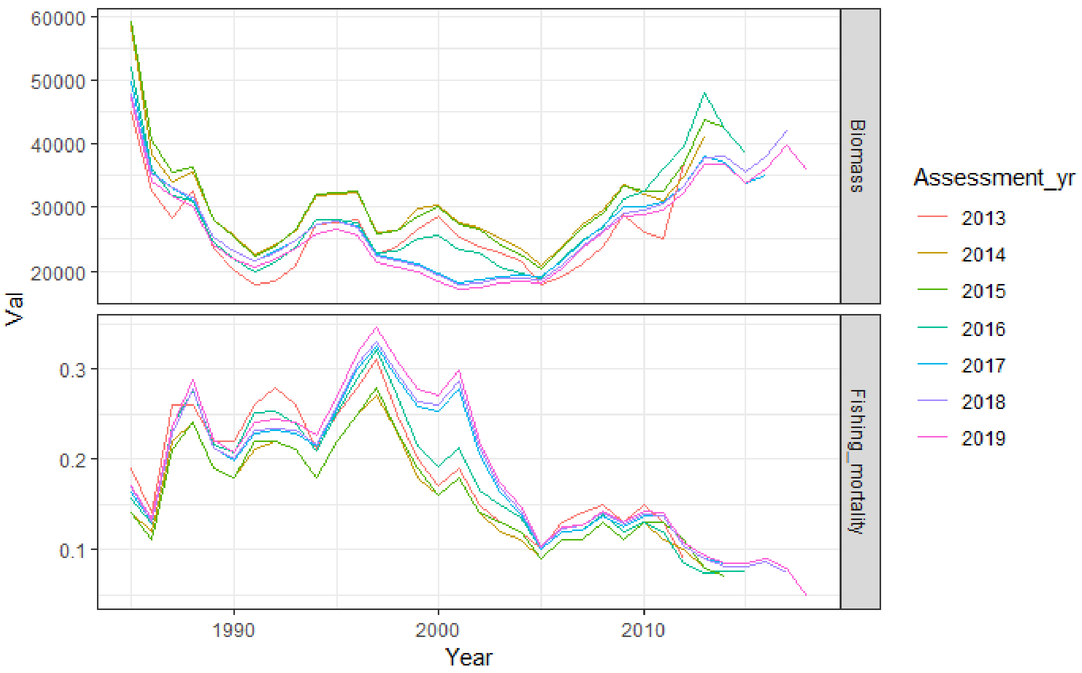


Figure 13.13. Comparison with previous assessments.

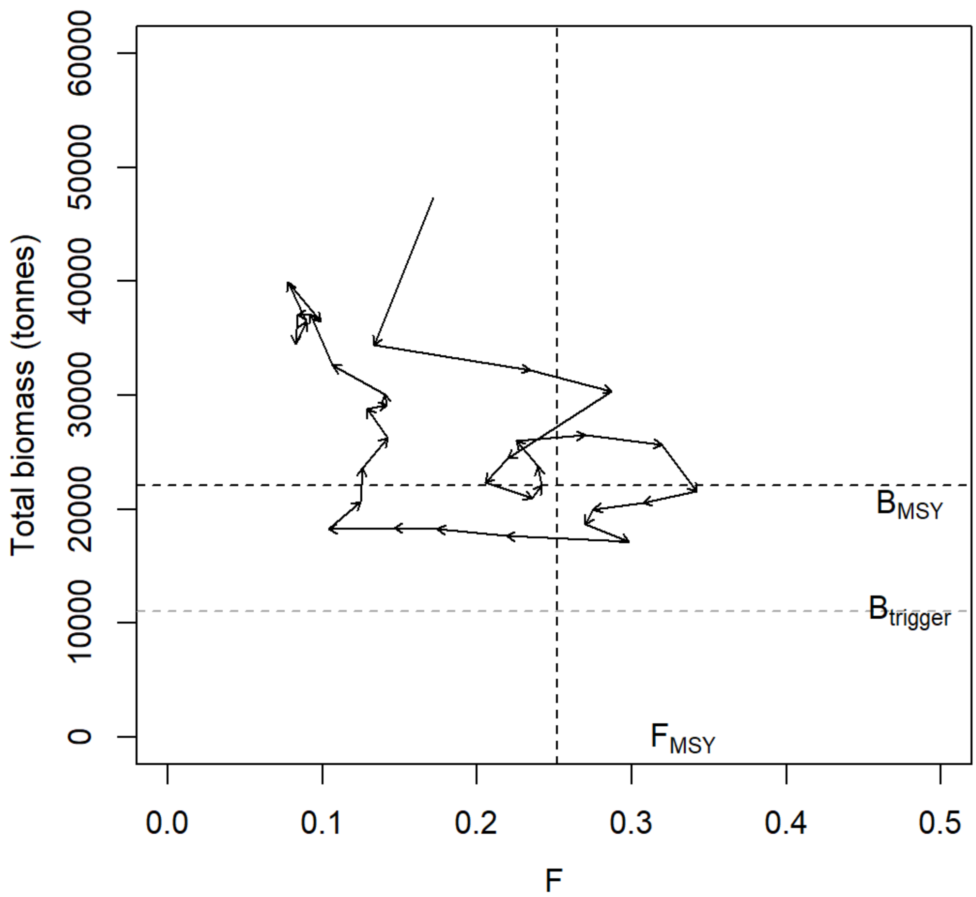


Figure 13.14. Kobe plot of stock status.

11 Megrim (*Lepidorhombus* spp.) in Division 6.b (Rockall)

Type of assessment in 2019

The current assessment is based on survey trends in relative biomass from the ISP-Anglerfish survey conducted annually in 6.a, 4.a and 6.b.

ICES advice applicable to 2018

Based on ICES approach to data-limited stocks, ICES advises that landings and catches should be no more than 339 t and 443 t respectively in 2018.

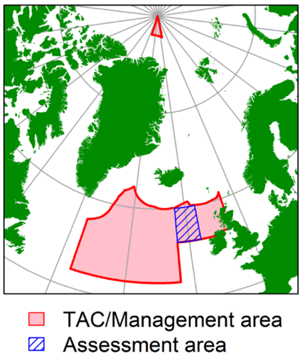
ICES advice applicable to 2019

ICES advises that when the EU multiannual plan (MAP) is applied, catches in 2019 that correspond to the F ranges in the plan are between 354 tonnes and 473 tonnes.

General

Stock description and management units

Megrim stock structure is uncertain. Data collected during an EC study contract (98/096) on the 'Distribution and biology of anglerfish and megrim in the waters to the west of Scotland,' showed significantly different growth parameters and significant population structure difference between megrim sampled in 6.a and 6.b (Anon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear. WKFLAT (2011) concluded that megrim in 6.b should continue to be considered as a separate stock until further information is available.



Management area (red box) and assessment area (blue hatched area).

The recent TACs are presented above in Section 5.3.1.1.

Fishery in 2018

Ireland had the highest catches in 2018 followed by Scotland and Spain (Table 14.1). The majority of the landings and catches are from otter trawlers.

Landings			Discards		
Nephrops trawls	Other Gears	Finfish trawls	*Nephrops* trawls	Other Gears	Finfish trawls
0.00%	8.00%	92.00%	0.00%	0.00%	100%

Data

As part of the 2011 benchmark, landings-at-age data was compiled from 1990 to 2010. However; available age data from 6.b prior to 2002 was sparse. A common Subarea 6 ALK was applied to megrim from 6.a and 6.b, which allowed area-specific age data from the anglerfish survey to be collected from 2012.

Landings

Official landings data for each country together with Working Group best estimates of landings from 6.b are shown in Table 14.1. The WG best estimates of landings are the same as the official statistics.

Catches of megrim comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al*., 1995; Anon, 2001). It is not clear to the WG whether landings of other countries are accurately partitioned by megrim species. Megrim are caught in association with anglerfish by some fleets and are area-misreported along with anglerfish. However, it is unknown whether misreporting from Division 6.b is an issue.

Discards

Discard data from Ireland and Scotland were available in InterCatch from 2016. The discard estimates for Scotland decreased in 2018. Discard data for 2014 were available for Ireland in InterCatch, but the estimate for Scotland based on discard rates in Area 6 were as reported to STECF and landings of 95 t. Total discard estimates were available from 2005–2018. To estimate catches prior to 2005, for the SPiCT analysis; a catch over landing ratio of 1.2 was used (derived from that observed ratio between 2015–2019). In 2018 discards represented approximately 21% of catch; decreasing from 233 to 203 tonnes (Figure 14.1, Table 14.2).

Surveys

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish. Fourteen years of survey data are available and these cover the main distribution of the anglerfish fishery. The survey is also considered to have greater spatial coverage for megrim, and as such was recommended by WKAGME (2008) as the main source of data of megrim relative biomass, for all megrim stocks in the Northern Shelf.

The survey index for 6.b is presented in Table 14.2. Biomass and abundance recovery have continued in 2019 after prior reduction in 2017. The stock has displayed a largely increasing abundance and biomass trend since 2005. The area-stratified survey provides a minimum estimate of absolute biomass; survey catches are raised based on swept area and weighted by area. The survey assumes that all megrim in the trawl path are retained e.g. q=1. Assuming full retention is overly optimistic, therefore the minimum estimate of stock biomass was provided.

The biomass dynamic model used in the Lez.27.4a6a assessment, provided megrim catchability estimates of 0.2–0.3 for SAIMISS-Q2/IAMISS-Q2 6.a and 4.a surveys. The upper q estimate of 0.3 is used in combination to scale the survey biomass estimate. This provides an absolute biomass and catch estimate offering a relatively broad harvest ratio approximation of megrim in 6.b (Table 14.2). This indicates the harvest ratio for megrim ranges from 2 to 25% over the time-series; however in recent years, this value has typically been less than 10%.

Historical stock development

No analytical assessment has been agreed for this stock since 1999.

State of the stock

The state of the stock is unknown.

Short-term projections

There is no accepted analytical assessment for this stock.

Biological and MSY reference points

Precautionary approach reference points

No precautionary reference points have been defined for this stock.

MSY evaluations

Proxy reference points (F_{MSY} and $B_{trigger}$) were explored for the stock at WKProxy (ICES, 2016) and WGCSE 2016 (ICES, 2016). A biomass dynamic model (SPiCT-Stochastic Production model in Continuous Time) was used to explore these reference points. This analysis was updated again by WGCSE 2017 using the SPiCT r package (Pedersen and Berg, 2016). The summary plots are shown in Figure 14.4. The stochastic reference point estimates are shown below. These are not significantly different to the results obtained by WGCSE last year.

Reference point	estimate	cilow	ciupp	est.in.log
B_{MSY}s	3582	2170	5914	8.2
F_{MSY}s	0.216	0.144	0.323	-1.5
MSYs	774	460	1305	6.6

The general conclusion of WKProxy and WGCSE in 2016 is still valid; that the stock is currently exploited below F_{MSY} proxy reference points and B_{MSY} is above the proxy for MSY $B_{trigger}$.

Yield-per-recruit analysis

It was not possible to define $F_{0.1}$ and F_{MAX} values for this stock due to the lack of international catch-at-age data and recent changes in fleet selectivity due to likely changes in targeting behaviour and recent changes in mesh selectivity, which, if fully implemented, will result in a significant change in age selectivity of the gear.

11.1 Uncertainties and bias in assessment and forecast

There is no accepted analytical assessment for this stock.

11.2 Recommendation for next Benchmark

This stock was subject to benchmark in 2011. WGCSE should review the available data, discuss assessment options and schedule a benchmark as soon as is practical.

Management considerations

The TAC in 6 has not been fully utilised. However, the uptake rate is country specific, with full uptake being reported by some Member States. Partial quota by individual Member States may be an artefact of reduction in effort rather than reflective of a reduction in biomass. The TAC and assessment area are incompatible.

11.3 References

Kunzlik, P. A., A. W. Newton and A. W. Jermyn. 1995. Exploitation of monks (*Lophius* spp.) and megrims (*Lepidorhombus* spp.) by Scottish fishermen in ICES Division VIa (West of Scotland). Final report EU FAR contract MA-2-520.

Laurenson, C. and MacDonald, P. 2008. Collection of fisheries and biological data on megrim in ICES Sub-area IVa. Scottish Industry Science Partnership Report No 05/08.

ICES. 2016. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

ICES. 2016a. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 4–13 May 2016, ICES Headquarters, Copenhagen, Denmark. ICES CM 2016/ACOM:13. 1031 pp.

Pedersen, M. W. and Berg, C. W. 2017. A stochastic surplus production model in continuous time. Fish Fish, 18: 226–243. doi:10.1111/faf.12174.

Table 14.1. Megrim in Subarea 6.b. Nominal catch (t) of Lez.27.6b, as officially reported to ICES and WG best estimates of landings (tonnes).

Year	Belgium	France	Ireland	Spain	UK – Eng+Wales+N.Irl.	UK – England & Wales	UK – Scotland	UK	Official total	ICES landings	ICES Discards
1991			240	587	14		204		1045	1045	
1992			139	683	53		198		1073	1073	
1993			128	594	56		147		925	925	
1994			176	574	38		258		1046	1046	
1995			117	520	27		152		816	816	
1996			124	515	92		112		843	843	
1997			141	628	76		164		1009	1009	
1998			218	549	116		208		1091	1091	
1999			127	404	57		278		866	866	
2000		4	167	427	57		309		964	964	
2001		< 0.5	176	370	42		236		824	824	
2002		< 0.5	87	120	41		207		455	455	
2003			83	93	74		382		632	632	
2004			43	71	42		372		528	528	
2005			68	88	19		207		382	382	87
2006			95	59	9		181		344	344	75
2007			87	19					106	106	22
2008			68	84		1	141		294	294	59
2009			48	0			178		226	226	44
2010			47	0				92	139	139	26
2011			72	17				66	155	155	7
2012			120	15				89	224	224	21
2013			181	39				58	278	278	15
2014			230	18				95	343	343	15
2015			256	67				130	453	453	85
2016			272	27				106	405	405	145
2017			358	46	15		167		586	586	233
2018			438	62	14		249		263	763	203

Table14.2. Estimates of Lez.27.6b biomass and harvest ratio from SAMISS surveys.

Year	Survey Biomass (tonnes)	Survey q	Raised Biomass (tonnes)	Landings (tonnes)	Discards (tonnes)	Catch (tonnes)	Harvest Ratio
2005	566	0.3	1886	382	87	469	0.25
2006	929	0.3	3098	344	75	419	0.14
2007	1267	0.3	4224	106	22	128	0.03
2008	1728	0.3	5759	294	59	353	0.06
2009	1605	0.3	5349	226	44	270	0.05
2010	1991	0.3	6636	139	26	165	0.02
2011	885	0.3	2949	155	7	162	0.05
2012	4320	0.3	14 401	224	21	245	0.02
2013	3030	0.3	10 101	278	15	293	0.03
2014	3318	0.3	11 060	343	15	358	0.03
2015	3262	0.3	10 872	453	85	538	0.05
2016	4507	0.3	15 024	405	145	550	0.04
2017	3015	0.3	10 067	586	233	819	0.08
2018	3984	0.3	13 280	763	203	967	1.13
2019	4150	0.3	13835	–	–	–	–

Table14.3. SPICT results for Lez.27.6b.

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 33.5910069
Euler time step (years): 1/16 or 0.0625
Nobs C: 28,  Nobs I1: 15

Priors
    logn  ~  dnorm[log(2), 2^2]
 logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]

Model parameter estimates w 95% CI
          estimate        cilow        ciupp    log.est
 alpha     7.3755203    0.9510703 5.719693e+01   1.9981664
 beta      0.6823274    0.2629204 1.770767e+00  -0.3822456
 r         0.6141472    0.0381455 9.887847e+00  -0.4875206
 rc        0.4343541    0.2894908 6.517080e-01  -0.8338953
 rold      0.3359916    0.0846066 1.334297e+00  -1.0906690
 m       780.7226300  458.3001577 1.329975e+03   6.6602199
 K      6348.4804684 3477.4518751 1.158987e+04   8.7559708
 q         0.8318326    0.4372011 1.582671e+00  -0.1841240
 n         2.8278645    0.2030382 3.938578e+01   1.0395219
 sdb       0.0470530    0.0063377 3.493384e-01  -3.0564800
 sdf       0.3093946    0.1638362 5.842726e-01  -1.1731379
 sdi       0.3470406    0.2347785 5.129820e-01  -1.0583136
 sdc       0.2111084    0.1299810 3.428713e-01  -1.5553835

Deterministic reference points (Drp)
        estimate        cilow       ciupp    log.est
 Bmsyd 3594.867478 2180.0272728  5927.940602   8.187262
 Fmsyd    0.217177    0.1447454    0.325854  -1.527043
 MSYd   780.722630  458.3001577  1329.975159   6.660220
Stochastic reference points (Srp)
         estimate        cilow        ciupp    log.est rel.diff.Drp
 Bmsys 3582.3010157  2170.0597438  5913.6070350   8.183761  -0.003507930
 Fmsys    0.2161803     0.1445486     0.3233096  -1.531642  -0.004610626
 MSYs   774.4104634   459.6670714  1304.6650567   6.652102  -0.008150931

States w 95% CI (inp$msytype: s)
                  estimate        cilow        ciupp    log.est
 B_2019.00        4401.2470131 2599.6929166  7451.2551643   8.3896432
 F_2019.00           0.2014333    0.0942929     0.4303121  -1.6022972
 B_2019.00/Bmsy      1.2286089    0.8477088     1.7806585   0.2058826
 F_2019.00/Fmsy      0.9317835    0.4116918     2.1089092  -0.0706548

Predictions w 95% CI (inp$msytype: s)
```

	prediction	cilow	ciupp	log.est
B_2019.00	4401.2470131	2599.6929166	7451.2551643	8.3896432
F_2019.00	0.2014333	0.0942929	0.4303121	-1.6022972
B_2019.00/Bmsy	1.2286089	0.8477088	1.7806585	0.2058826
F_2019.00/Fmsy	0.9317835	0.4116918	2.1089092	-0.0706548
Catch_2019.00	872.0600054	494.1873654	1538.8670499	6.7708582
E(B_inf)	3784.2003438	NA	NA	8.2385899

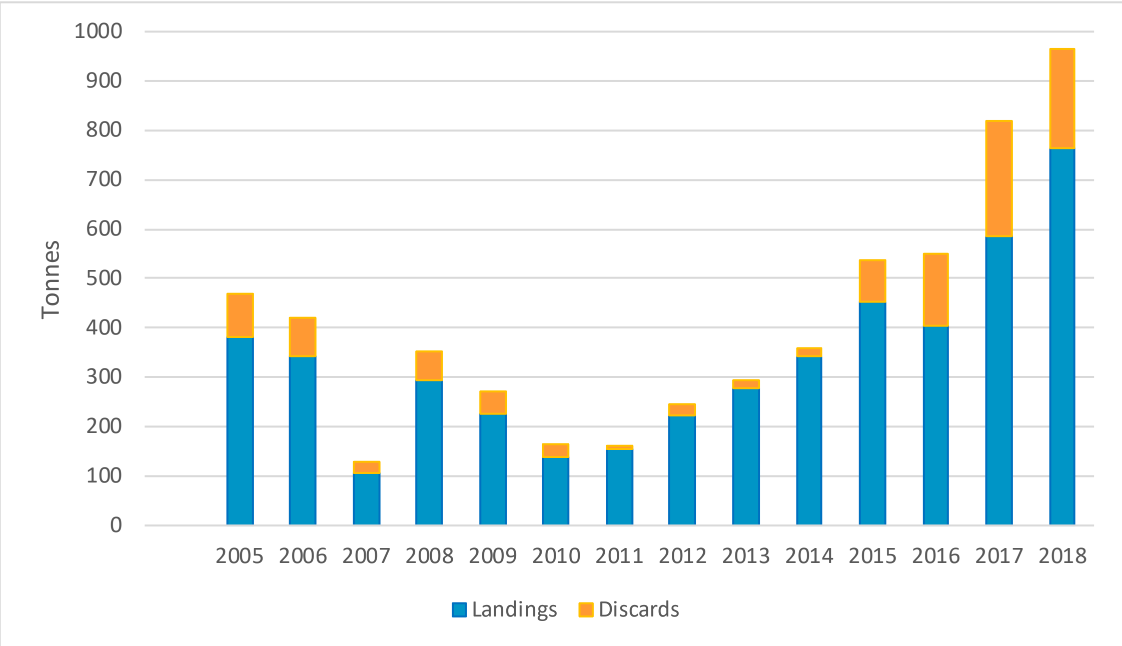


Figure 14.1. Lez.27.6b reported catch (landings and discards).

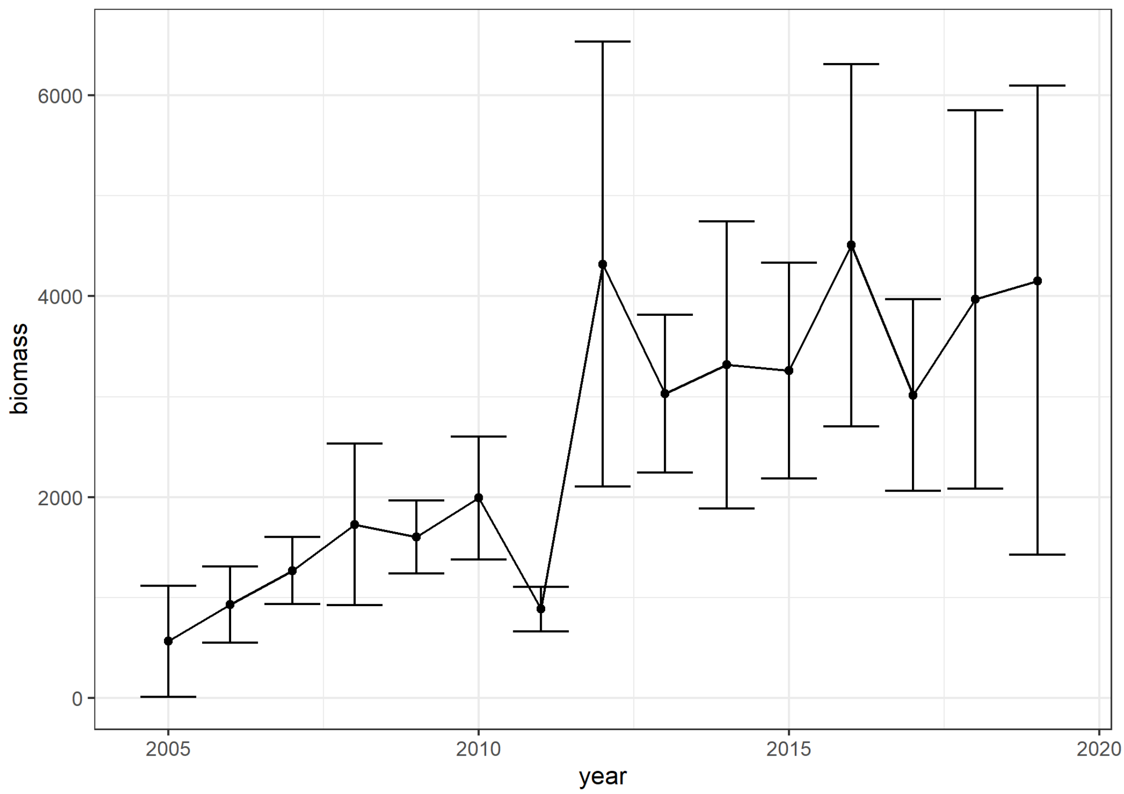


Figure 14.2 Lez.27.6b estimate biomass time-series.

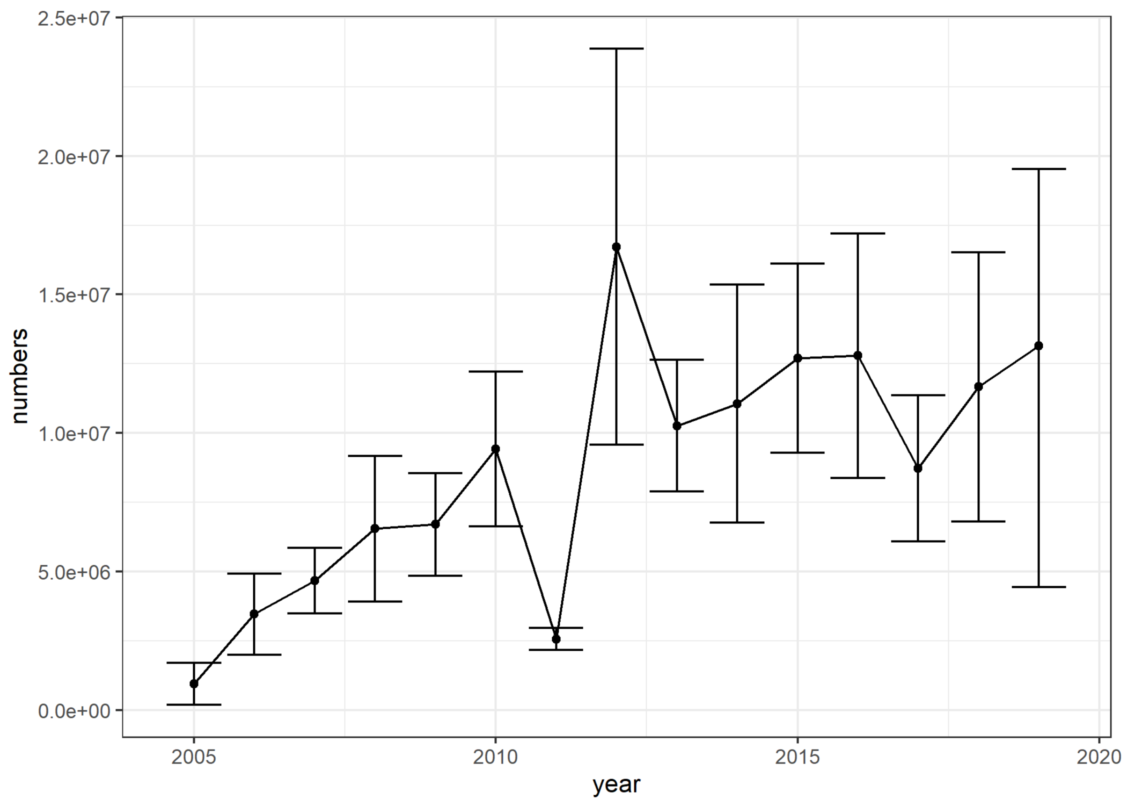


Figure 14.3 Lez.27.6b estimate abundance time-series.

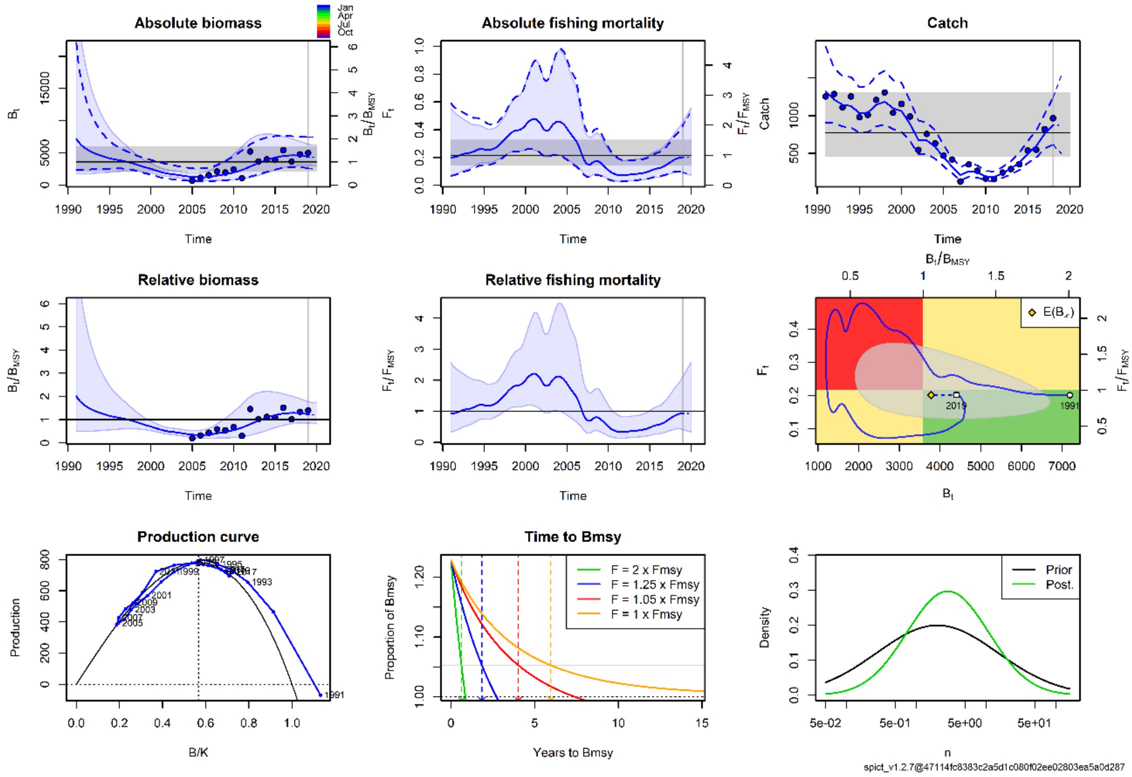


Figure 14.4. Lez.27.6b SPiCT model output. Top right: observed and fitted catch with 95 ci. Centre left: Biomass relative to B_{MSY}. Centre: F relative to F_{MSY}. Corresponding MSY quantities are shown in each plot as horizontal lines (0.5 B_{MSY} in the case of the relative biomass plot). Centre right Kobe plot of stock trajectory.

12 Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 11 (West of Scotland, North Minch)

Nephrops stocks have previously been identified by WGNEPH on the basis of population distribution, and defined as separate Functional Units. The Functional Units (FU) in ICES Division 6.a (of which there are three) are defined by the groupings of ICES statistical rectangles given in Table 14.1 and illustrated in Figure 14.1. The functional unit is the level at which the WG collates fishery data (quantities landed and discarded, fishing effort and length distributions) and at which it performs assessments.

Type of assessment in 2019

The assessment of North Minch *Nephrops* in 2019 is based on a combination of examining trends in fishery indicators and abundance estimated by underwater TV survey, both of which comprise an extensive dataseries for this FU. The assessment follows the process defined by the benchmark WG (WKNEPH 2009 and WKNEPH 2013). Further details on the assessment and catch options are provided in the stock annex.

ICES advice applicable to 2018

'ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should be no more than 2819 tonnes.

To ensure that the stock in functional unit (FU) 11 is exploited sustainably, management should be implemented at the functional unit level.'

ICES advice applicable to 2019

'ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2015–2017, catches in 2019 should be no more than 3270 tonnes.

To ensure that the stock in functional unit (FU) 11 is exploited sustainably, management should be implemented at the functional unit level.'

12.1 General

Nominal landings as reported to ICES for divisions 6.a and 6.b are presented in Table 14.1.1. Total official landings from Division 6.a were 8914 tonnes in 2018, mostly reported by the UK with only 65 tonnes reported from Ireland. Table 14.1.2 and Figure 14.1.1 shows WG estimates of landings in Division 6.a broken down by FU. *Nephrops* landings are also made from outside the functional units, from statistical rectangles where small pockets of suitable sediment exist, although these are generally small amounts. In 2018, 160 tonnes of landings were reported from outside the FUs which is lower than the long-term average (Table 14.1.2). The main areas of activity outside FUs are the Stanton Bank (to the west of the South Minch) and areas of suitable sediment along the shelf edge and slope to the west of the Hebrides. There are no functional units in Division 6.b and only very small quantities of *Nephrops* are landed (Table 14.1.1(b)).

Stock description and management units

The North Minch (FU11) is located at the northern end of the west coast of Scotland (Figure 14.1). Owing to its burrowing behaviour, the distribution of *Nephrops* is restricted to areas of mud, sandy mud and muddy sand. Within the North Minch functional unit these substrates are distributed according to prevailing hydrographic and bathymetric conditions. The area is characterised by numerous islands of varying size and sea lochs, which occur along the mainland coast. These topographical features create a diverse habitat with complex hydrography and a patchy distribution of soft sediments. Results from work on mapping the spatial extent of *Nephrops* habitat in the North Minch sea lochs indicate that the muddy habitat in these areas is only a very small proportion of the total *Nephrops* grounds in the North Minch (WKNEPH 2013).

Management applicable to 2018 and 2019

The management unit is Subarea 6 and EU and international waters of 5.b. The TAC for this area is 15 092 tonnes in 2019, up from 12 129 tonnes in 2018.

Since 2016, fisheries catching *Nephrops* in Division 6.a have been covered by the EU landing obligation (EU, 2015a). Creel fisheries are exempt from the landing obligation due to high survivability of discards. Dermersal trawlers using a codend between 80mm–110mm and within 12 miles of shore are also exempt from the landings obligation.

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex if available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland compliance officers.

The fishery in 2018 followed a similar pattern to 2017. The fishery started slowly before a good summer fishery developed from May to August. The fishery the tailed off in September, similar to the situation in 2017. This was said to be a seasonal occurrence rather than being caused by bad weather. The majority of the Western Isles trawl fleet then relocated to the east coast and to the fishing grounds in the Firth of Forth/Eyemouth/Shields for the winter months. Trawls activity in the winter months was at a very low level. Activity in the *Nephrops* creel sector was slightly down on 2017, a high price for crab encouraged some vessels to target crab.

The largest part of the North Minch fleet is still based at Stornoway, numbering approximately 220 vessels in 2018. The majority of the Stornoway vessels (175) are below 10 m in length. Trawlers targeted *Nephrops* year round whereas some creelers targeted *Nephrops* in the winter and shifted to lobster and crab over the summer months.

The number of trawlers reduced at the end of 2017 and into 2018 due to vessels being sold to elsewhere in the UK and others licences were removed and sold on, leaving the vessels tied up.

The fleet were targeting the same areas in the North Minch as previous years. The notable changes were that the fleet went to the East coast from September on. This reduced activity meant that static gear vessels, set *Nephrops* creels on area of the North Minch that would have, otherwise been trawled.

This area had the normal increase in fishing activity in the spring/summer caused by non-local visiting vessels from the east coast.

No major changes in gear use were reported. Since 2009, vessels have been required to fit 120 mm square meshed panels, in accordance with the west coast emergency measures (Council Reg. (EU) 43/2009). Large SMPs (200 mm) are also widely used in the North Minch and have been mandatory for all TR2 vessels with power >112 kW fishing under the Scottish Conservation Credits scheme.

In 2018, there was a large reduction in landings and effort (Figure 14.2.1) in all three functional units on the west coast. This reduction was partly explained by the migration of the west coast fleet to the east coast to take advantage of improved *Nephrops* fishing opportunities in 4.a. Anecdotal information from the fishing industry suggests that an additional factor contributing to the migration of the fishing fleet was an issue with foreign crew being unable to work in the inshore grounds of the west coast therefore moved to the offshore grounds of the east coast. Further general information on the fishery can be found in the stock annex.

12.2 Data available

InterCatch

Data for 2018 were successfully uploaded into InterCatch prior to the 2019 WG meeting. Uploaded data were worked up in InterCatch to generate 2018 raised international length–frequency distributions. Allocation schemes for any unsampled fleets are described in the stock annex. Data exploration in InterCatch has previously shown that outputs of raised data were very close to those generated by the previous method applied internally with differences being <0.1%. As such, InterCatch length–frequency outputs have been used in the stock assessment since 2012.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Tables 15.1.1(a) and 15.1.1(b); these relate to the whole of 6.a of which the North Minch is a part. Landings by gear category for FU11 provided by country have been reported since 1981 and are presented in Table 14.2.1. Landings from this fishery are usually only reported from Scotland; but between 2012 and 2014 2 tonnes of *Nephrops* were reported by Ireland and 1 tonne reported in 2017. Total reported Scottish landings in 2018 were 1961 tonnes, consisting of 1599 tonnes landed by trawlers targeting *Nephrops* (~81%), 329 tonnes landed by creel vessels (~17%) and 30tonnes by other trawlers. In 2018 there were no reports of *Nephrops* landed in the below minimum size (or more properly minimum conservation reference size) category in accordance with the EU landing obligation (EU, 2015b).

Effort data

In 2015, WGCSE agreed that effort should be reported in kW days as this is likely to be more informative about changes in the actual fleet effort. Reported effort by Scottish trawlers targeting *Nephrops* (Métiers: OTB_CRU – Bottom Otter Trawls Targetting Crustaceans and OTT_CRU – Multirig Otter Trawls Targeting Crustaceans) has shown a decreasing trend since 2000 (Figure 14.2.1) but in 2012 the effort increased by 20% due to the influx of vessels from the North Sea during the first quarter of the year. Since then, effort has declined although there was a small increase in 2016. In 2018, there was a 17% decline in effort from 2017, which was attributed to the majority of the North Minch fleet moving to the east coast in the winter months. Note that the year range in effort time-series (2000–2018) does not match with the more extensive year range available for landings, due to a lack of reliable effort data in the MSS in-house database. The effort is also slightly inconsistent with the landings data in that effort is provided for TR2 vessels while the '*Nephrops* trawl' landings additionally includes landings by large mesh trawlers targeting *Nephrops*.

Sampling levels

Length compositions of landings and discards are obtained during market and on-board observer sampling respectively. These sampling levels are shown in Table 14.2.2. Length compositions for the creel fishery are available for landings only as the small numbers of discards survive well and are not considered to be removed from the population. There was a decrease in sampling for this FU in 2018 due to a change in the sampling design that divides the discard sampling by east and west coast rather than by functional unit. This change was a trail and has since been reverted to the previous design due to the negative effect on sample numbers. This change had no effect on mean weights in landings and discards, these figures fell well within normal ranges.

Length compositions

Figure 14.2.2 shows a series of annual length–frequency distributions for the period 2000 to 2018. Catch (removals) length compositions are shown for each sex along with the mean length for both. In both sexes the mean sizes fluctuate over time and has generally remained stable since 2012. This parameter might be expected to reduce in size if overexploitation were taking place. In 2018, the mean size was within the normal range of variation seen in this functional unit in recent years.

Sex ratio

Males consistently make the largest contribution to the landings, although the proportion of males does vary between years (Figure 14.2.3(a)). This is likely due to the varying seasonal pattern in the fishery and associated relative catchability (due to different burrow emergence behaviour) of male and female *Nephrops.* Males are available throughout the year and the fishery is prosecuted in all quarters (although effort is usually reduced during the winter months when the weather is poor). Females are mainly taken in the summer when they emerge after egg hatching. The seasonal change in proportion of males to females is evident in Figure 14.2.3(b) in 2018 the normal trend where males dominate in quarters one and four but the ratio is more even (or often female dominated) in quarters two and three was not seen. Instead, males dominate the catch in quarters one, two and four however this is well within ranges observed in the past.

Mean weights

The mean weight in the landings (trawls and creels combined) shows substantial interannual variation (Figure 14.2.4 and Table 14.2.3) decreasing between 2010 and 2012, followed by an increase in 2013–2015 and a decrease again in 2016 and stable in 2017 with a increase in 2018. Given the relatively larger size of creel caught *Nephrops* (compared to trawl) the proportion of creel landings has a substantial effect on overall size composition. The increases in mean weight to 2010 (and also size, Figure 14.2.2) in particular are due to a higher proportion of creel landings. Figure 14.2.5 shows the mean weight by sample and gear type over the period 2009–2018. There is no obvious trend in North Minch trawl-caught mean weights, a slight increasing trend previously detected in these landings from 2009 to 2015 is no longer visible on inclusion of the 2016, 2017 and 2018 data. A decrease in the mean weight of creel caught males is still obvious, although this is largely driven by the cluster of high values from the start of 2010. The mean weight in the landings has a significant impact on the catch forecast. Due to the high interannual variability in mean weights it was considered more appropriate to use a full time-series average, from 1999 (first year with creel and trawl length distributions combined) until 2018 for producing the catch options.

Discarding

Discarding of undersized and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discard rates fluctuate in this FU and averaged ~8.6% by number in the last three years (Table 14.2.4). In 2018, the discard rate increased to 6.7% by number (from 5.2% in 2017).

It is likely that some *Nephrops* survive the discarding process. An estimate of 25% (Charuau *et al.*, 1982; Sangster *et al.*, 1997; Wileman *et al.*, 1999) survival is assumed for this FU in order to calculate removals (landings + dead discards) from the population. The discard survival rate for creel caught *Nephrops* has been shown to be high (ICES, 2013) and a value of 100% is used. The discard rate (adjusted for survival) which will be used in the provision of landings options for 2020 is 6.6% based on a three-year average of 2016–2018.

Abundance indices from UWTV surveys

Underwater TV surveys are available for this stock since 1994 (missing surveys in 1995 and 1997). The stock area for this FU was updated in 2013 to 2908 km^2 (see stock annex for further details).

In 2019, an error in the analysis of the 2018 TV survey for FU11 was noticed, this error was an incorrect camera angle. The analysis was redone with the corrected camera angle. The corrected abundance estimate for 2018 is 1188 million which is a change of -2.22% from 1215 million original estimate. The corrected results are presented in this report.

In 2019, 47 valid stations were used in the survey final analysis (Table 14.2.5).Table 14.2.6 shows the basic analysis for the most recent TV survey conducted in FU11. At the 2012 SGNEPS meeting (ICES, 2012) it was decided that a CV (relative standard error) of <20% was an acceptable precision level for UWTV survey estimates of abundance. The CV for the most recent TV survey was 10.5%, lower than the precision level agreed (Table 14.2.6).

Figure 14.2.6 shows the distribution of stations in recent TV surveys (2014–2019), with the size of the symbols reflecting the *Nephrops* burrow density. Table 14.2.5 and Figure 14.2.7 show the time-series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates.

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009; ICES, 2013). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative relative to absolute conversion factor estimated for FU11 was 1.33 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 33%.

12.3 Assessment

Comparison with previous assessments

The assessment is the same as last year and is based on a combination of examining trends in fishery indicators and underwater TV abundance estimates. Landings predictions are derived by applying a harvest rate to the UWTV survey estimate of abundance and assuming a length composition derived from recent fishery data (including data from both trawl and creel fisheries).

No internal audit was conducted last year.

State of the stock

The assessment summary is provided in Table 14.2.4. The underwater TV survey is presented as the best available information on the North Minch *Nephrops* stock. The surveys provide a fishery-independent estimate of *Nephrops* abundance. At present, it is not possible to extract any length or age-structure information from the survey and therefore it only provides information on abundance over the area of the survey.

TV survey estimated stock abundance in 2019 was 1232 million individuals, a 3.7% increase from the 2018 estimate. The stock is still well above the MSY $B_{trigger}$ value of 541 million, or the rounded value of 540 million individuals used in the provision of advice (Figure 14.2.7).

The calculated harvest rate in 2018 (dead removals/TV abundance = 6.4%) is below the F_{MSY} proxy for this stock (the value associated with high long-term yield and low risk depletion) of 10.8%.

12.4 Catch option table

Landings predictions at various harvest rates (based on principles established at WKNEPH (ICES, 2009)), including a selection of those equivalent to the per-recruit reference points, will be made on the basis of the 2019 UWTV survey conducted in June and presented in October 2019 for the provision of advice.

The table below shows the agreed inputs to the catch options table.

Input	Data	2019 assessment
Survey abundance (millions)	UWTV 2019	1232
Mean weight in wanted catch (g)	1999–2018	25.9
Mean weight in Unwatched catch (g)	1999–2018	10.99
Unwanted catch	average 2016–2018	8.6%
Discards survival	Proportion by number	25%
Dead discard rate	average 2016–2018	6.6%

Due to the high interannual variability in mean weights it was considered more appropriate to use a full time-series average, from 1999 (first year with creel and trawl length distributions combined) until 2018 for producing the catch options.

12.5 Reference points

New reference point F_{MSY} were derived for this stock at WKMSYRef4 (ICES, 2016). This was updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values a five-year average was chosen. Similarly, the five-year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five-year average of the F above F_{MAX} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy, which occasionally appear. For this stock, the F_{MSY} proxy has been revised from 10.9% to 10.8%.

WKFMSYRef4 did not update the MSY $B_{trigger}$ except for rounding to tens of millions. MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased (ICES, 2013) and is calculated as 541 million individuals and rounded to 540 million for use as MSY $B_{trigger}$ in the advice. Full details are contained in the stock annex.

These reference points should remain under review by WGCSE and may be revised should improved data become available.

Table 14.2.4 and Figure 14.5.1 show the harvest rates for FU11. From 2006–2009 there was a sustained period of high, above F_{MSY} proxy, harvest rates followed by two years of low harvest rates of around 6–7%. There was a sudden increase in 2012, following this the harvest rate declined and has remained below the F_{MSY} proxy. In 2018, the harvest rate has decreased to 6.4%. It is likely that prior to 2006, the estimated harvest rates may not be representative due to underreporting of landings.

12.6 Management strategies

Scotland has recently established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

On the 8th of February 2016, phase 1 of the fisheries management measures for inshore MPAs in Scottish waters came into force (SG, 2016). These measures relate to both NCMPA (Marine (Scotland) Act and the UK Marine and Coastal Access Act) and SACs (EC Habitats Directives – Council Directive 92/43/EEC) both of which have the aim of conserving biological diversity in Scottish waters and contribute to Scotland's MPA network (SG, 2017a). Although not specific to the management of the *Nephrops* fishery, they will influence spatial patterns of fishing for *Nephrops* where controls on the two main gear types, demersal trawls and creels are implemented on *Nephrops* habitat. Within the North Minch functional unit, two MPAs are covered by fisheries management measures. Specifically the Wester Ross NCMPA where fishing activity is banned for dermersal gears for vessels over 500 kW in power and banned in certain areas for vessels below 500 kW. North of the main *Nephrops* ground is the Loch Laxford SAC where demersal trawling is banned (SG, 2016). The areas of the SAC and NCMPA relative to the estimated *Nephrops* habitat within the North Minch functional unit are displayed in Figure 14.6.1.

12.7 Quality of assessment and forecast

The length and sex composition of the landings data is considered to be well-sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the fishery adequately. The length compositions from 1999 onwards, are derived from both creel and trawl samples. The creel fishery accounted for greater than 20% of landings from 2009 to 2011, although this has decreased to 17% in 2018. This part of the fishery exhibits a length composition composed of larger animals.

There were concerns over the accuracy of historical landings and effort data prior to 2006 when Buyers and Sellers legislation was introduced and the reliability began to improve. Because of this, the final assessment adopted is independent of historical landings data. Harvest rates since 2006 are also considered more reliable due to more accurate landings data reported under this legislation. Incorporation of creel length compositions (since the 2010 WG) has also improved estimates of harvest rates. Underwater TV surveys have been conducted for this stock since 1994, with a continual annual series available since 1998. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals around the abundance estimates are relatively small for this functional unit. In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. A three-year average (2016–2018) of discard rates (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options.

The cumulative absolute conversion factor estimates for FU11 are largely based on expert opinion (see stock annex). The precision of these bias corrections cannot yet be characterised. The method to derive landings for the catch options is sensitive to the input dead discard rate and mean weight in landings and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The stock area was revised in 2013 (ICES, 2013) using integrated VMS-logbook data to more accurately estimate the spatial extent of *Nephrops* catches. Two other factors however, have the potential to increase the fished area further. Firstly, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations and secondly, it is known that most of the sea lochs have areas of mud substrate and are typically fished by creel boats. In recent years, a number of TV surveys have taken place in the major North Minch sea lochs in an attempt to improve estimates of the ground area and *Nephrops* abundance. Work presented at the WKNEPH 2013 (ICES, 2013) showed that the total area of the sea lochs is 105 km^2, which is considerably smaller than the offshore VMS area estimated to be 2908 km^2. Therefore, it is unlikely that the exclusion of these inshore areas from the survey have an impact in the mean densities and overall abundance of *Nephrops* in the North Minch.

12.8 Recommendation for next benchmark

This stock was last benchmarked in 2013 (ICES, 2013). WGCSE will keep the stock under close review and recommend a future benchmark as required.

12.9 Management considerations

The WG, ACOM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level and management at the functional unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

Creel fishing takes place in this area but overall effort by this fleet in terms of creel numbers is not known, and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the North Minch and STECF estimates that discards of whiting and haddock are high in 6.a generally. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Efforts to reduce discards and unwanted bycatches of cod include the implementation of large square meshed panels (SMPs) of 120 mm under the west coast emergency measures, and SMPs of 200 mm which were introduced under the Scottish Conservation Credits scheme.

12.10 References

Council Reg. (EU) 43/2009.

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea, ICES-CM-1982/B:13.

Dobby H. 2009. F_{MSY} proxies for *Nephrops* stocks. Working document for WGNSSK, 5–11 May 2010 and WGCSE, 12–20 May, 2010.

ESRI. 2014. ArcGIS. Version 10.2.1. Environmental Systems Research Institute, Inc.: Redlands, CA.

EU. 2015a. COMMISSION DELEGATED REGULATION (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters. Official Journal of the European Union, L 336/29. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R2438&from=EN> [Accessed: 2016].

EU. 2015b. REGULATION (EU) 2015/812 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 May 2015. Official Journal of the European Union, L 133/1. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R0812&from=EN> [Accessed: 14/05/2017].

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L 83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9–11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22. 95 pp.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2013 Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2013/45. 230 pp.

ICES. 2015. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4). ICES CM 2015/ACOM:58. 185 pp.

ICES. 2016. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.4.1.

ICES. 2017. ICES Statistical Rectangles. International Council for the Exploration of the Sea: Copenhagen, Denmark. Available at: <http://geo.ices.dk/index.phpSource> [Accessed: 16/03/2017].

Sangster, G.I., Breen, M., Bova, D.J., Kynoch, R., O'Neill, F.G., Lowry. N., Moth-Poulsen, T. Hansen, U.J., Ulmestrand, M., Valentinsson, D., Hallback, H., Soldal, A.V., and Hoddevik, B. 1997. *Nephrops* survival after escape and discard from commercial fishing gear. Presented at ICES FTFB Working Group, Hamburg, Germany 14–17 April, 1997, ICES CM 1997 CM/B.

SG. 2016. Simple guide to fisheries management measures in Marine Protected Areas. Marine Scotland (The Scottish Government): Edinburgh. Available at: <http://www.gov.scot/Resource/0049/00498320.pdf> [Accessed: 16/05/2017].

SG. 2017a. Marine Protected Areas in Scotland's Seas - Guidelines on the selection of MPAs and development of the MPA network. Marine Scotland (The Scottish Government): Edinburgh. Available at: <http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/mpaguidelines> [Accessed: 16/05/2017].

SG. 2017b. Marine conservation orders (MCOs) and fisheries management measures (MPAs and SACs) - with effect May 2017. Marine Scotland (The Scottish Government): Edinburgh. Available at: <https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?availablelayers=838> [Accessed: 31/05/2017].

SNH. 2015. Nature Conservation Marine Protected Areas. Scottish Natural Heritage (Scottish Government): Inverness. Available at: <https://gateway.snh.gov.uk/natural-spaces/index.jsp> [Accessed: 03/04/2017].

SNH. 2016. Special Areas of Conservation. Scottish Natural Heritage (Scottish Government): Inverness. Available at: <https://gateway.snh.gov.uk/natural-spaces/index.jsp> [Accessed: 03/04/2017].

Wessel, P. and Smith, W.H.F. 2016. GSHHG version 2.3.6 - A Global Self-consistent, Hierarchical, High-resolution Geography Database. National Centers for Environmental Information, National Oceanic and Atmospheric Administration: Boulder, CO. <https://www.ngdc.noaa.gov/mgg/shorelines/gshhs.html> [Accessed: 31/05/2017].

Wileman, D.A., Sangster, G.I., Breen, M., Ulmestrand, M., Soldal, A.V. and Harris, R.R. 1999. Roundfish and *Nephrops* survival after escape from commercial fishing gear. EU Contract Final Report. EC Contract No: FAIR-CT95-0753.

Table 14.1. *Nephrops* functional units and descriptions by statistical rectangle.

Functional Unit	Stock	Division	ICES Rectangles
11	North Minch	6.a	44–46 E3–E4
12	South Minch	6.a	41–43 E2–E4
13	Clyde	6.a	39–40 E4–E5

Table 14.1.1(a). Nominal landings (tonnes) of *Nephrops* in Division 6.a, 1980–2018, as officially reported to ICES.

	France	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	UK	TOTAL
1980	5	1	-	-	7422	-	7428
1981	5	26	-	-	9519	-	9550
1982	1	1	-	1	9000	-	9003
1983	1	1	-	11	10 706	-	10 719
1984	3	6	-	12	11 778	-	11 799
1985	1	1	28	9	12 449	-	12 488
1986	8	20	5	13	11 283	-	11 329
1987	6	128	11	15	11 203	-	11 363
1988	1	11	7	62	12 649	-	12 730
1989	-	9	2	25	10 949	-	10 985
1990	-	10	4	35	10 042	-	10 091
1991	-	1	-	37	10 458	-	10 496
1992	-	10	-	56	10 783	-	10 849
1993	-	7	-	191	11 178	-	11 376
1994	3	6	-	290	11 047	-	11 346
1995	4	9	3	346	12 527	-	12 889
1996	-	8	1	176	10 929	-	11 114
1997	-	5	15	133	11 104	-	11 257
1998	-	25	18	202	10 949	-	11 194
1999	-	136	40	256	11 078	-	11 510
2000	1	130	69	137	10 667	-	11 004
2001	9	115	30	139	10 568	-	10 861
2002	-	117	18	152	10 225	-	10 512
2003	-	145	12	81	10 450	-	10 688
2004	-	150	6	267	9941	-	10 364
2005	-	153	17	153	7616	-	7939
2006	-	133	1	255	13 419	-	13 808

	France	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	UK	TOTAL
2007	-	155	-	2088	14 120	-	16 363
2008	-	56	1	419	14 795	-	15 271
2009	-	53	-	1226	11 462	-	12 741
2010	-	45	1	1962	10 250	-	12 258
2011	-	38	-	2517	10 419	-	12 974
2012	-	28	-	2502	11 807	-	14 337
2013*	-	5	-	-	-	12866	12871
2014	-	51	-	-	-	12760	12811
2015**	-	75	-	-	-	11653	11728
2016**	-	107	0	-	-	14600	14707
2017	-	114	-	-	-	11442	11557
2018	-	65	0	-	-	8849	8914

Table 14.1.1(b). Nominal landings (tonnes) of *Nephrops* in Division 6.b, 1980–2018, as officially reported to ICES. There are no Functional Units in ICES Division 6.b but occasional small landings are made.

	France	Germany	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	TOTAL
1980	-	-	-	-	-	-	0
1981	-	-	-	-	-	-	0
1982	-	-	-	-	-	-	0
1983	-	-	-	-	-	-	0
1984	-	-	-	-	-	-	0
1985	-	-	-	-	-	-	0
1986	-	-	-	8	-	-	8
1987	-	-	-	18	11	-	29
1988	-	-	-	27	4	-	31
1989	-	-	-	14	-	-	14
1990	-	-	-	10	1	-	11
1991	-	-	-	30	-	-	30
1992	-	-	-	2	4	1	7
1993	-	-	-	2	6	9	17
1994	-	-	-	5	16	5	26
1995	1	-	-	2	26	1	30
1996	-	6	-	5	65	5	81
1997	-	-	1	3	88	23	115
1998	-	-	1	6	46	7	60
1999	-	-	-	5	2	5	12
2000	2	-	8	3	4	4	21
2001	1	-	1	14	2	7	25
2002	1	-	-	7	3	7	18
2003	-	-	1	5	6	18	30
2004	-	-	-	2	7	13	22
2005	3	-	1	1	5	7	17
2006	-	-	-	-	1	3	4

	France	Germany	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	TOTAL
2007	-	-	-	2	3	-	5
2008	-	-	-	-	-	-	0
2009	-	-	-	-	-	-	0
2010	-	-	-	-	-	-	0
2011	-	-	-	-	-	-	0
2012	-	-	-	-	-	-	0
2013	-	-	-	-	-	-	0
2014	-	-	-	-	-	-	0
2015	-	-	-	-	-	-	0
2016	-	-	-	-	-	0	0
2017	-	-	-	-	-	2	2
2018	-	-	-	-	-	0	0

Table 14.1.2. ***Nephrops*, Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981–2018.**

Year	FU11	FU12	FU13	Other	Total
1981	2861	3652	2968	39	9520
1982	2799	3552	2620	27	8998
1983	3197	3413	4076	34	10720
1984	4143	4300	3310	36	11789
1985	4060	4008	4286	104	12458
1986	3381	3484	4341	89	11295
1987	4084	3892	3009	257	11242
1988	4035	4473	3664	529	12701
1989	3205	4745	2812	212	10974
1990	2546	4430	2909	182	10067
1991	2793	4442	3038	255	10528
1992	3559	4237	2803	248	10847
1993	3193	4458	3343	344	11338
1994	3614	4414	2630	441	11099
1995	3655	4682	3987	460	12784
1996	2872	3995	4057	239	11163
1997	3046	4344	3621	243	11254
1998	2441	3730	4841	157	11169
1999	3257	4052	3752	438	11499
2000	3247	3953	3417	421	11038
2001	3259	3991	3182	420	10852
2002	3440	3305	3384	397	10526
2003	3269	3879	3173	433	10754
2004	3082	3869	2973	403	10327
2005	2949	3848	3395	254	10446
2006	4166	4633	4780	241	13820
2007	3978	5471	6660	420	16529
2008	3799	5356	5923	128	15206
2009	3496	4285	4779	185	12745

Year	FU11	FU12	FU13	Other	Total
2010	2413	3846	5843	569	12671
2011	2697	3702	6432	219	13050
2012	3542	3989	6687	435	14653
2013	3413	3776	5435	234	12858
2014	3257	3179	6207	53	12696
2015	3002	3400	5147	309	11858
2016	3529.4	4402	6447	236	14614.4
2017	2448	3652	5222	250	11572
2018	1961	2536	4141	160	8798

***Includes below minimum size landed discards of 0.4 t.**

Table 14.2.1. *Nephrops*, North Minch (FU11), Nominal Landings of *Nephrops*, 1981–2018.

UK Scotland						**Other United Kingdom and Ireland**	**Total**
year	*Nephrops* trawl	other	creel	Below Minimum Size	Subtotal		
1981	2320	171	370	0	2861	0	2861
1982	2323	105	371	0	2799	0	2799
1983	2784	96	317	0	3197	0	3197
1984	3449	160	534	0	4143	0	4143
1985	3235	117	708	0	4060	0	4060
1986	2641	203	537	0	3381	0	3381
1987	3459	143	482	0	4084	0	4084
1988	3450	148	437	0	4035	0	4035
1989	2603	112	490	0	3205	0	3205
1990	1941	134	471	0	2546	0	2546
1991	2229	126	438	0	2793	0	2793
1992	2978	149	432	0	3559	0	3559
1993	2699	86	408	0	3193	0	3193
1994	2916	245	453	0	3614	0	3614
1995	2940	183	532	0	3655	0	3655
1996	2354	148	370	0	2872	0	2872
1997	2553	102	391	0	3046	0	3046
1998	2023	68	350	0	2441	0	2441
1999	2792	56	409	0	3257	0	3257
2000	2695	28	524	0	3247	0	3247
2001	2649	42	568	0	3259	0	3259
2002	2775	79	586	0	3440	0	3440
2003	2606	45	618	0	3269	0	3269
2004	2391	30	661	0	3082	0	3082
2005	2270	23	656	0	2949	0	2949
2006	3446	23	697	0	4166	0	4166

UK Scotland						Other United Kingdom and Ireland	Total
year	*Nephrops* trawl	other	creel	Below Minimum Size	Subtotal		
2007	3361	26	591	0	3978	0	3978
2008	3229	13	557	0	3799	0	3799
2009	2849	34	613	0	3496	0	3496
2010	1783	9	621	0	2413	0	2413
2011	2109	17	571	0	2697	0	2697
2012	2963	12	565	0	3540	2	3542
2013	2356	480	575	0	3411	2	3413
2014	2752	13	490	0	3255	2	3257
2015	2561	23	418	0	3002	0	3002
2016	3039	15	475	0.4	3529.4	0	3529.4
2017	2041	45	361	0	2447	1	2448
2018	1599	30	329	0	1958	3	1961

***Below minimum size landings not rounded to show it was reported.**

Table 14.2.2. ***Nephrops*** **Scottish sampling levels all FUs in 6.a (including N. Irish for Clyde).**

***Number of trips expressed as number of hauls for discards.**

		2016		2017		2018	
FU		N trips*	N measured	N trips*	N measured	N trips*	N measured
North Minch	Landings	44	32 483	48	33118	44	48
	Discards	23	4402	53	5800	30082	4136
South Minch	Landings	37	20 439	60	40131	36	29
	Discards	8	1274	53	5164	22837	2547
Clyde	Landings	22	19 069	27	21769	19	14517
	N.Irish Landings	28	18218			4	2019
	Discards	21	3337	39	3332	15	1753

Table 14.2.3. *Nephrops* mean weight in the landings (FU11–13).

Year	FU11	FU12	FU13
1990	21.39	19.99	24.27
1991	25.35	21.74	20.65
1992	21.66	24.10	25.16
1993	20.79	21.26	29.44
1994	23.45	24.96	25.28
1995	22.24	21.96	19.24
1996	26.68	23.10	21.68
1997	21.71	23.37	24.21
1998	23.65	22.18	17.98
1999*	22.70	25.14	17.39
2000	24.19	27.30	19.96
2001	25.33	23.79	19.46
2002	25.93	26.83	16.35
2003	26.03	27.86	19.13
2004	25.16	27.37	18.80
2005	27.65	28.11	17.96
2006	24.52	26.24	19.27
2007	23.61	23.95	19.05
2008	23.90	23.91	16.59
2009	25.42	23.87	18.31
2010	29.39	25.86	21.21
2011	27.56	31.10	19.34
2012	23.43	29.17	21.83
2013	27.52	27.48	20.72
2014	27.96	29.91	20.79
2015	28.74	28.15	22.21
2016	25.76	24.76	17.70
2017	25.89	27.76	17.02
2018	27.39	27.27	16.14
Average**	25.90	26.79	16.95

*From 1999 onwards mean weights are shown for trawl and creels combined.

** Average for FU11 and FU12 (1999–2018); FU13 (2015–2018).

Table 14.2.4. ***Nephrops*****, North Minch (FU11): Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest rate.**

YEAR	LANDINGS IN NUMBERS (MILLIONS)	DISCARDS IN NUMBERS (MILLIONS)	REMOVALS IN NUMBERS (MILLIONS)**	ADJUSTED SURVEY VMS (MILLIONS)*	HARVEST RATE VMS	LANDINGS (TONNES)	DISCARDS (TONNES)	DISCARD RATE	DEAD DISCARD RATE	MEAN WEIGHT IN LANDINGS (g)	MEAN WEIGHT IN DISCARDS (g)
1999	144	28	165	794	20.7	3257	273	16.4	12.8	22.7	9.69
2000	134	10	142	1166	12.1	3247	100	6.9	5.2	24.19	10.08
2001	129	17	141	1092	13	3259	160	11.7	9.1	25.33	9.32
2002	133	28	154	1337	11.5	3440	277	17.6	13.8	25.93	9.78
2003	126	30	148	1751	8.5	3269	299	19.2	15.2	26.03	10
2004	122	18	136	1751	7.8	3082	202	13	10.1	25.16	11.02
2005	107	50	144	1540	9.4	2949	507	32	26.1	27.65	10.09
2006	170	74	225	1762	12.8	4166	757	30.3	24.6	24.52	10.27
2007	168	12	177	1206	14.7	3978	214	6.5	5	23.61	18.1
2008	159	19	173	1047	16.5	3799	194	10.5	8.1	23.9	10.36
2009	138	35	164	1195	13.7	3496	327	20.3	16	25.42	9.34
2010	82	12	91	1293	7	2413	128	12.4	9.6	29.39	10.98
2011	96	16	108	1726	6.3	2697	154	14.2	11	27.56	9.66
2012	151	21	167	891	18.7	3542	213	12.6	9.3	23.43	10.33
2013	122	24	140	1403	10	3413	364	16.4	12.8	27.52	15.18
2014	115	8	121	1251	9.6	3257	77	6.3	4.8	27.96	9.99
2015	103	15	114	1445	7.9	3002	143	12.6	9.8	28.74	9.66
2016	136	22	152	1422	10.7	3529***	266	14	10.9	25.76	12.05
2017	93	5	97	1050	9.3	2448	64	5.2	4	25.89	12.51
2018	72	5	76	1188	6.4	1961	59	6.7	5.1	27.39	11.46
Average****									6.67	25.90	10.99

*** harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Includes 0.4 tonnes of below minimum size landings.**

****** Dead discard average: 2016–2018; Mean weight in landings and discards average: 1999–2018.**

Table 14.2.5. ***Nephrops*****, North Minch (FU11): Results of the 1994–2018 TV surveys (values adjusted for bias).**

YEARS	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS/M²)	ABUNDANCE (SEDIMENT; MILLIONS)	95% CONFIDENCE INTERVAL (SEDIMENT; MILLIONS)	ABUNDANCE (VMS; MILLIONS)	95% CONFIDENCE INTERVAL (VMS; MILLIONS)
1994	41	0.29	500	74	820	122
1995				No Survey		
1996	38	0.19	330	47	541	76
1997				No Survey		
1998	38	0.31	547	77	898	127
1999	36	0.27	484	89	794	147
2000	39	0.40	711	82	1166	134
2001	56	0.38	666	81	1092	133
2002	37	0.46	815	91	1337	149
2003	41	0.60	1068	129	1751	211
2004	38	0.60	1068	107	1751	175
2005	41	0.53	939	100	1540	164
2006	30	0.61	1074	101	1762	165
2007	36	0.41	735	92	1206	150
2008	41	0.36	638	95	1047	157
2009	26	0.41	729	138	1195	227
2010	37	0.44	-	-	1293	231
2011	41	0.59	-	-	1726	226
2012	41	0.31	-	-	891	181
2013	41	0.48	-	-	1403	206
2014	44	0.43	-	-	1251	171
2015	41	0.50	-	-	1445	370
2016	39	0.49	-	-	1422	290
2017	42	0.36	-	-	1050	149
2018	44	0.40	-	-	1188	244
2019	47	0.42	-	-	1232	256

Table 14.2.6. ***Nephrops*, North Minch (FU11): Results of the 2019 TV survey.**

STRATUM	AREA (km^2)	NUMBER OF STATIONS	MEAN BURROW DENSITY (no./m^2)	OBSERVED VARIANCE	ABUNDANCE (MILLIONS)	STRATUM VARIANCE	PROPORTION OF TOTAL VARIANCE	SURVEY PRECISION LEVEL (RSE)
2019 TV survey								
VMS	2908	47	0.423	0.092	1231.6	16438	1	
Total	2908	47			1231.6	16438	1	0.105

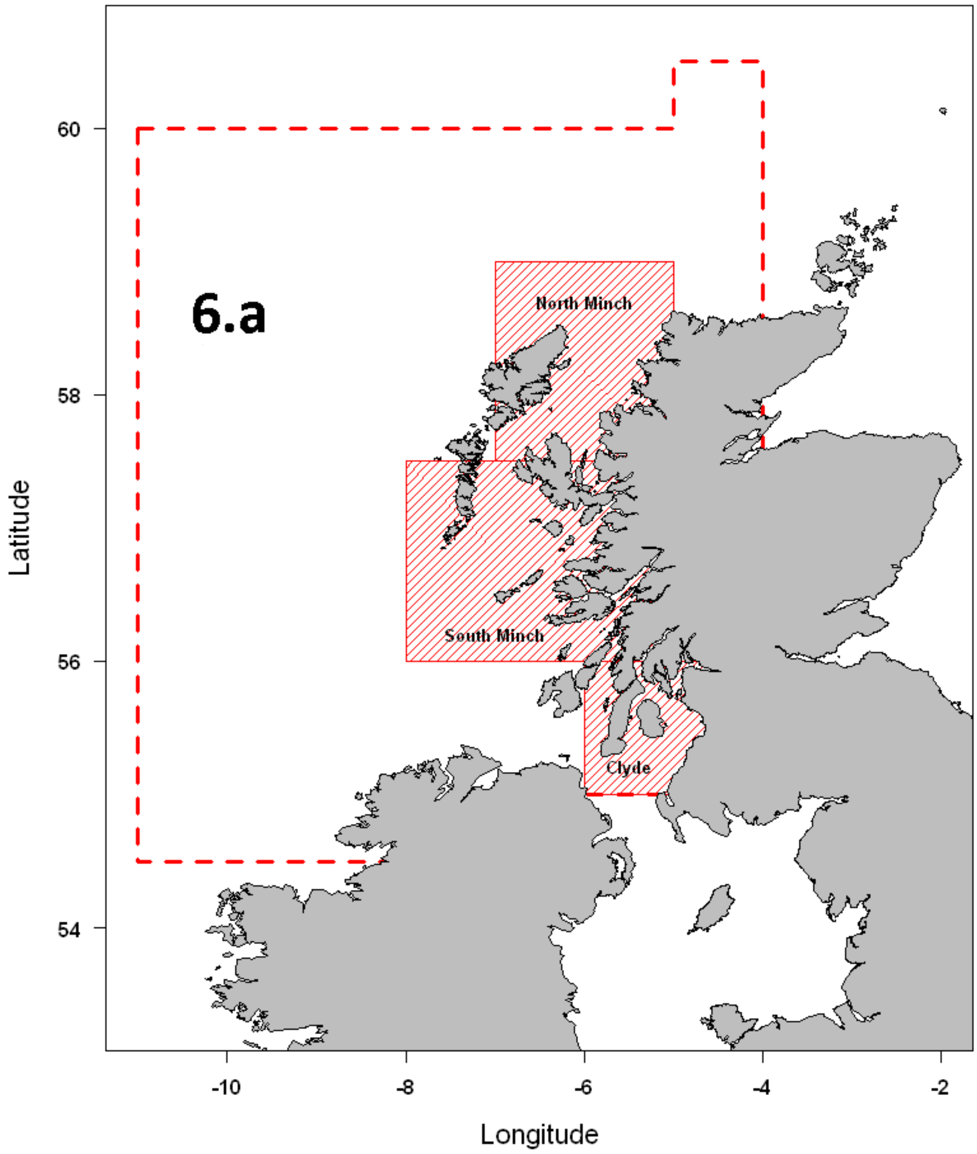


Figure 14.1. ***Nephrops*** **Functional Units in 6.a. North Minch (FU11), South Minch (FU12), Clyde (FU13).**

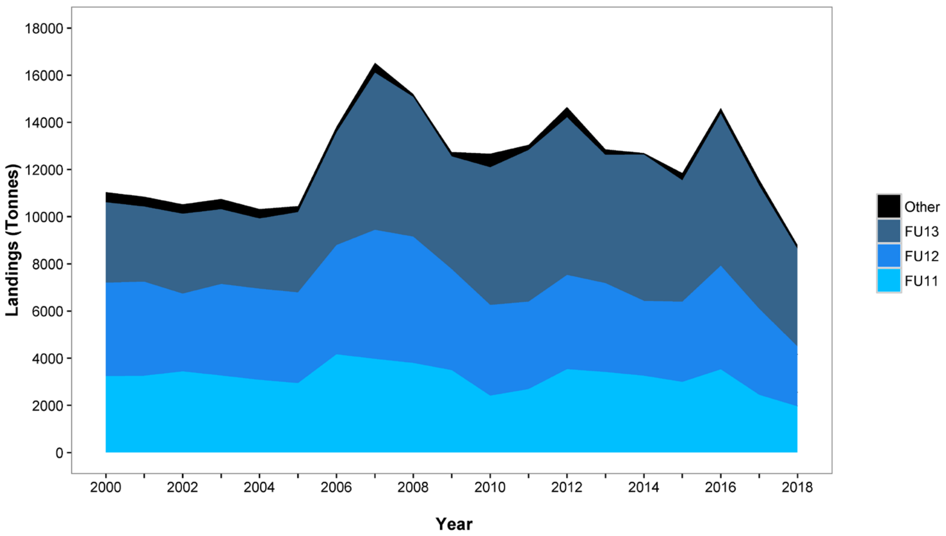
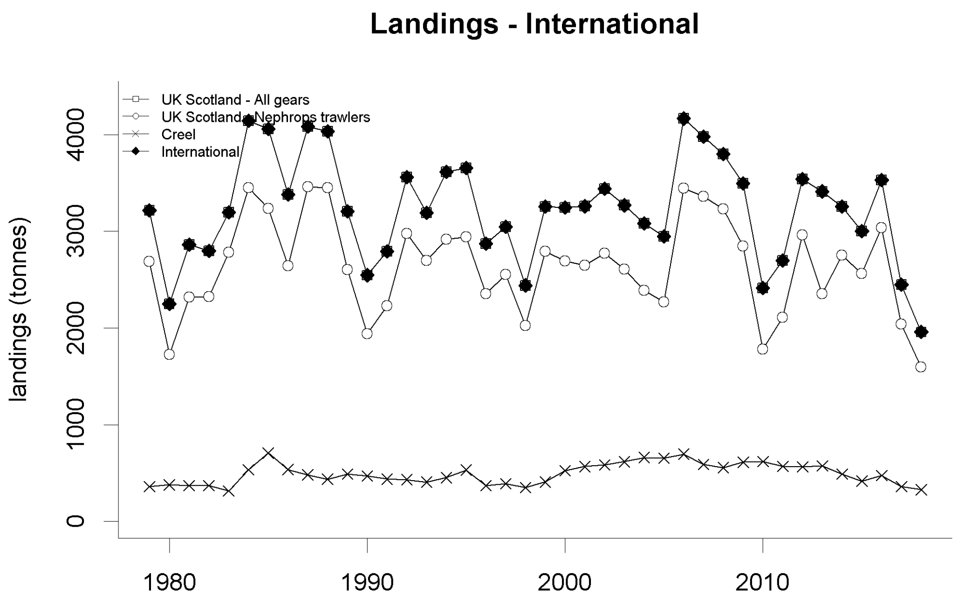


Figure 14.1.1. ***Nephrops*** **in Division 6.a. Landings (tonnes) by functional unit (FU11 to 13) and from rectangles outside the functional units (Other).**



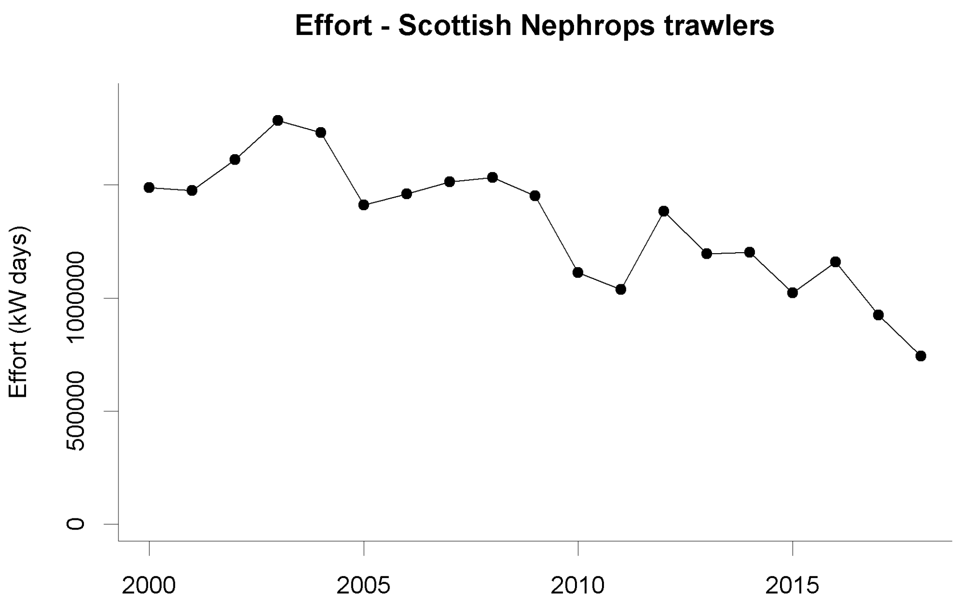


Figure 14.2.1. ***Nephrops*, North Minch (FU11). Long-term landings and effort.**

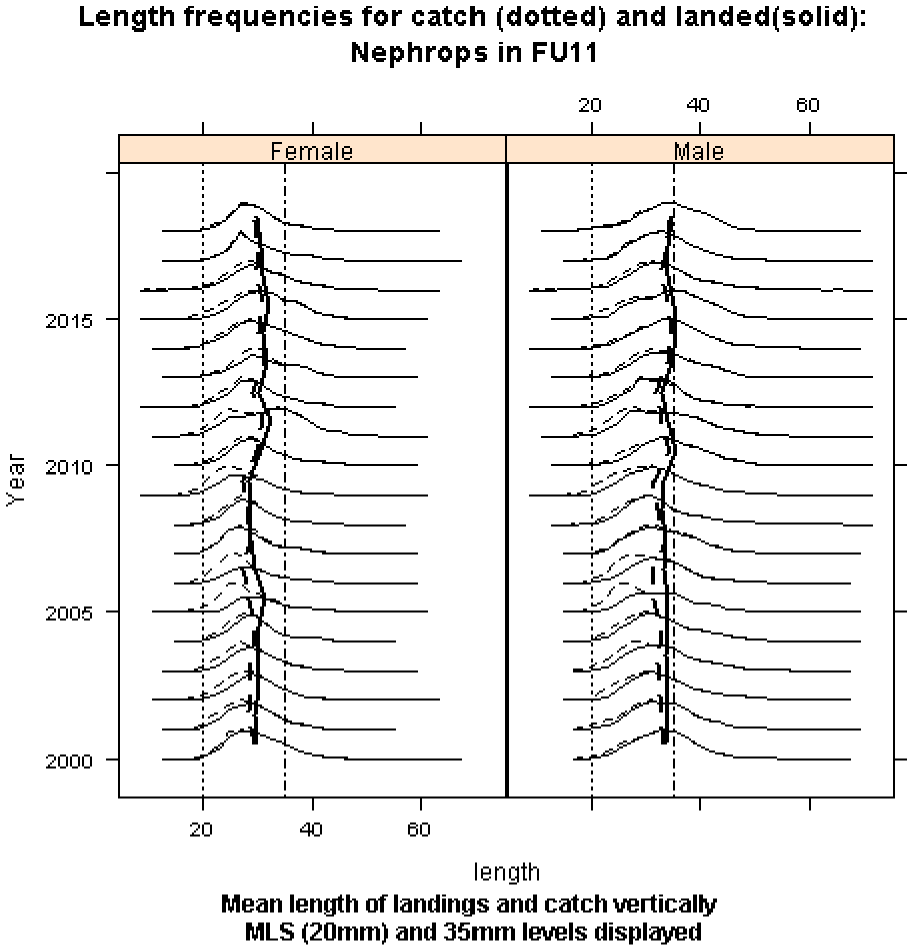
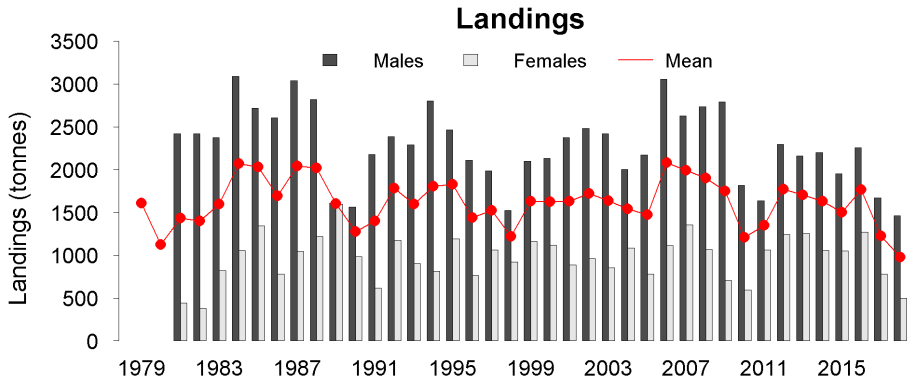


Figure 14.2.2. ***Nephrops*****, North Minch (FU11), Catch length–frequency distribution and mean sizes (red line) for** ***Nephrops*** **in the North Minch, 2000–2018.**



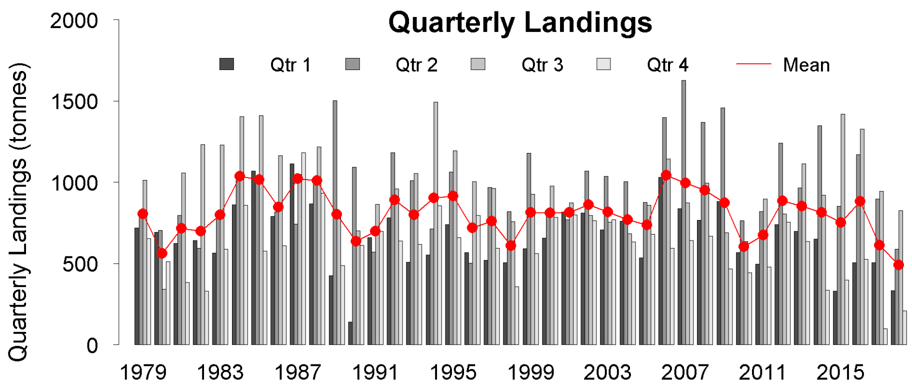


Figure 14.2.3 (a). ***Nephrops,*** **North Minch (FU11), Landings by quarter and sex from Scottish trawlers.**

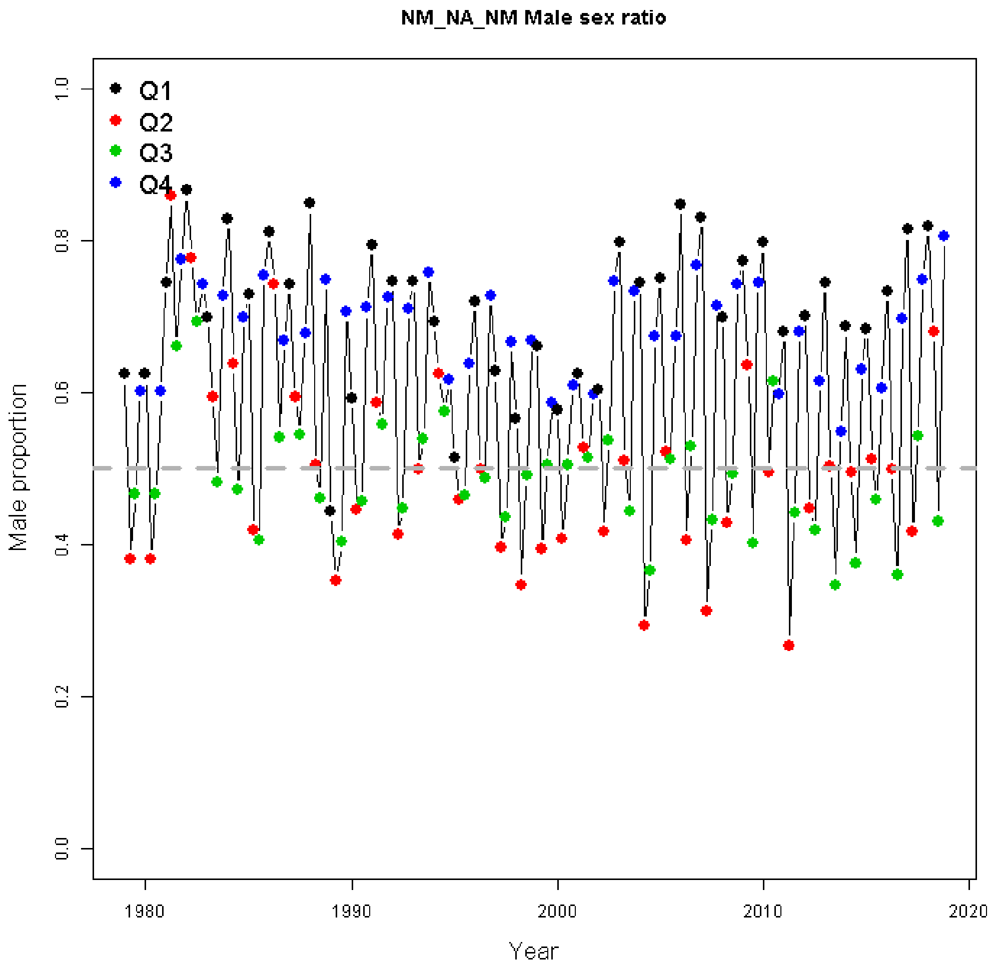


Figure 14.2.3 (b). *Nephrops,* **North Minch (FU11), Proportion of males by quarter (1980–2018).**

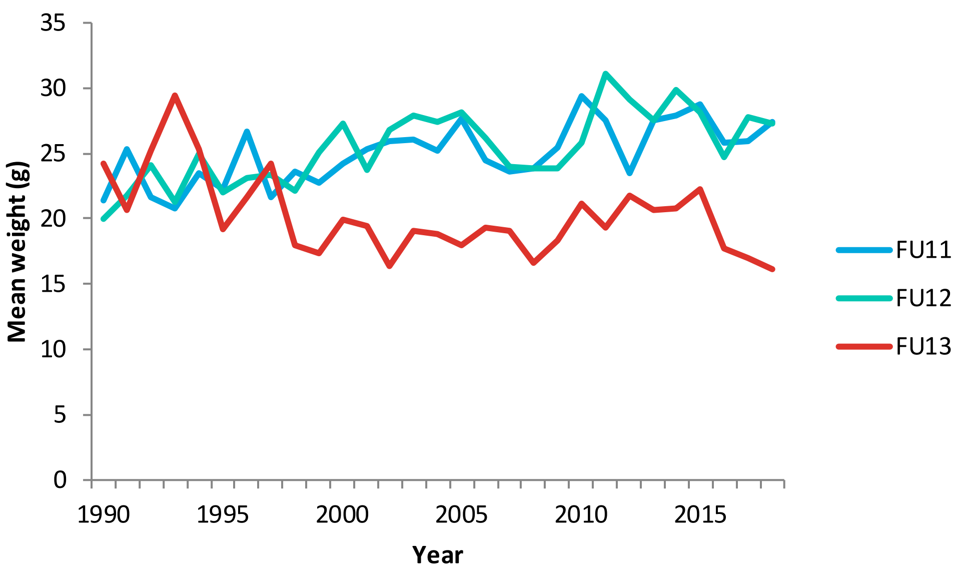


Figure 14.2.4. *Nephrops,* **(FU11 North Minch, FU12 South Minch and FU13 Clyde), mean weight in the landings from 1990–2018 (from Scottish market sampling data).**

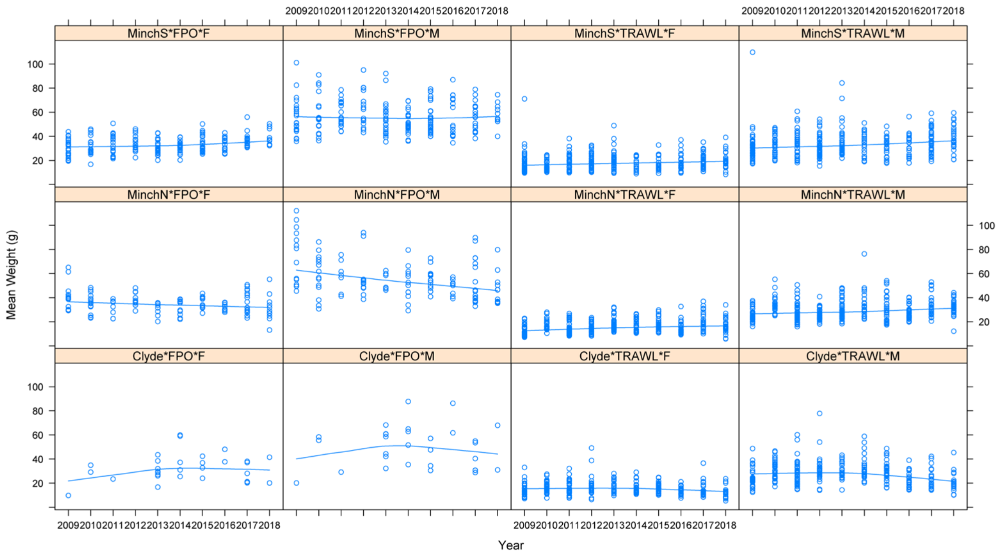


Figure 14.2.5. ***Nephrops*, (FU11 North Minch, FU12 South Minch, FU13 Clyde), mean weight in landings 2009–2018 by sample date, sex, métier and functional unit.**

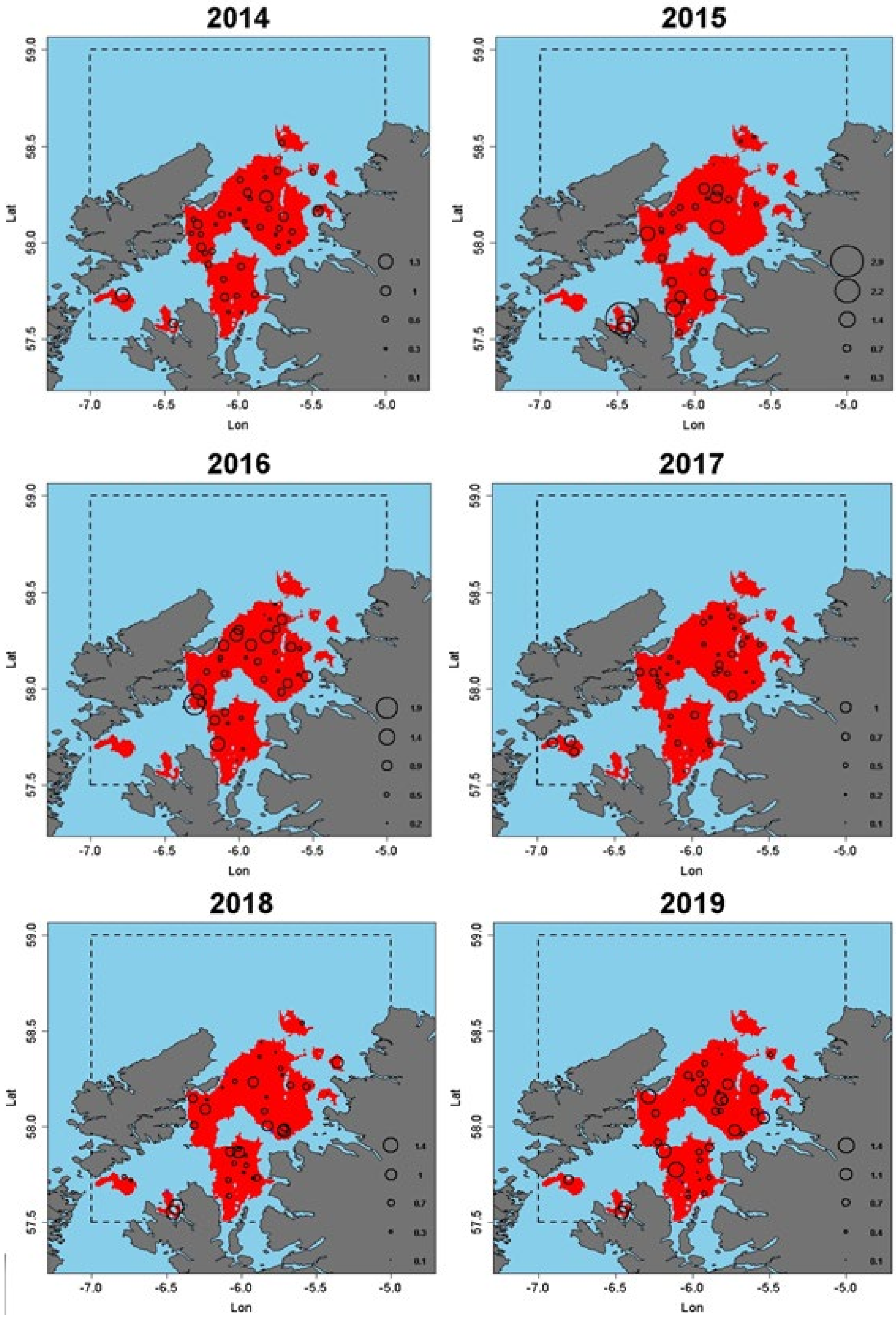


Figure 14.2.6. ***Nephrops*, North Minch (FU11), TV survey station distribution and relative density (burrows/m²), 2014–2019. Bubbles in these figures are all scaled the same. Crosses represent zero observations.**

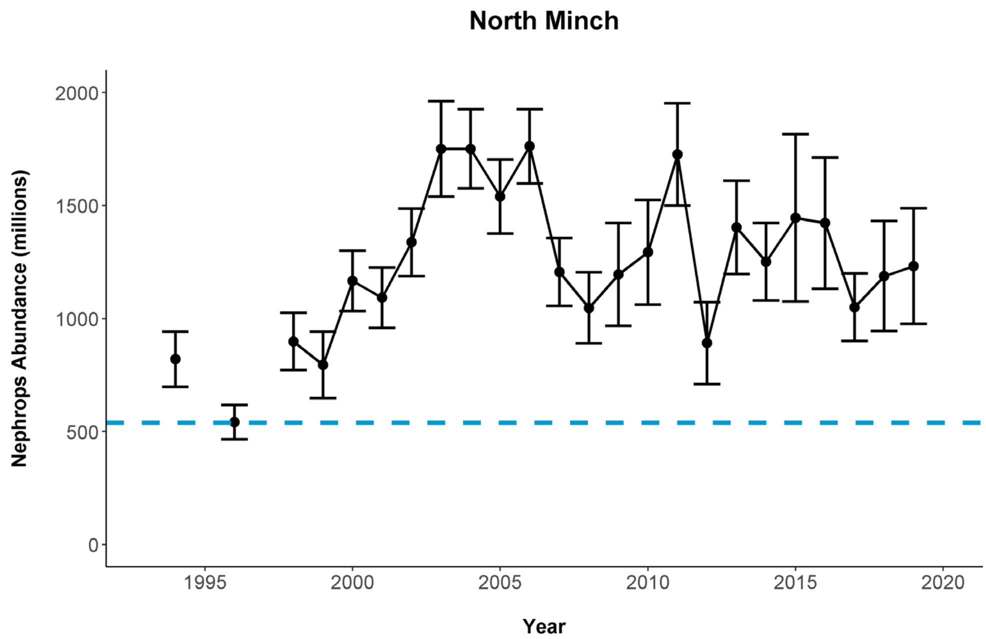


Figure 14.2.7. ***Nephrops*, North Minch (FU11), time-series of revised TV survey abundance estimates (adjusted for bias), with 95% confidence intervals, 1994–2017 (no survey in 1995 and 1997). The dashed blue line is the rounded $B_{trigger}$ value of 540 million individuals.**

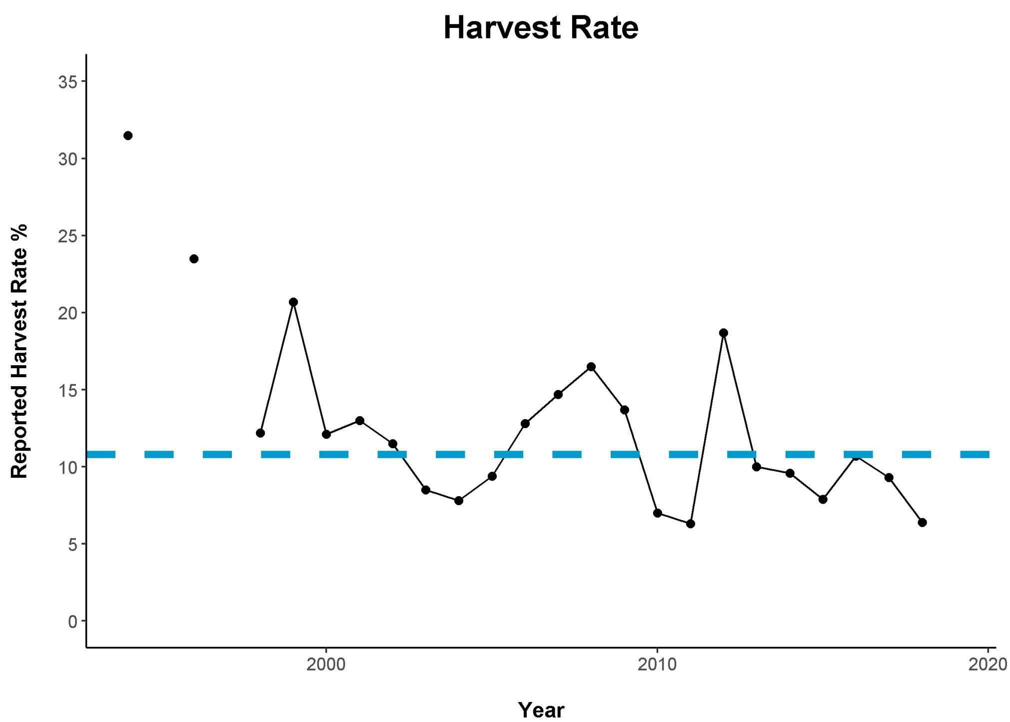


Figure 14.5.1. ***Nephrops*, North Minch (FU11), harvest rate, 1995–2017 (no survey data in 1995 and 1997). The blue dashed and solid lines are the F_{MSY} proxy harvest rate (10.8%) and the harvest rate respectively. Harvest rates prior to 2006 are unreliable.**

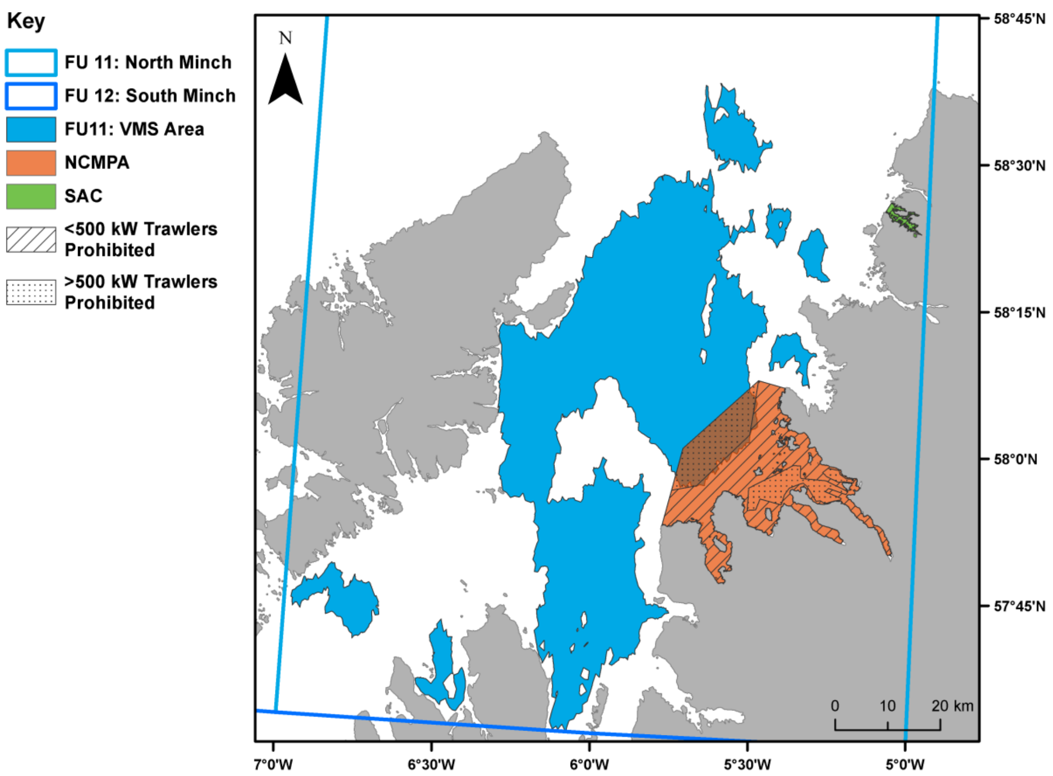


Figure 14.6.1. The area of *Nephrops* habitat (estimated from VMS data) within the North Minch (FU11) relative to the areas of the Nature Conservation MPA (NCMPA) and Special Area of Conservation (SAC) showing areas within these where demersal trawling is banned (hatched) and where it is permitted for vessels below 500 kW (clear; depending on gear type, see SG, 2016). Geographic Coordinate System: OSGB 1936, Datum: OSGB 1936, Projected Coordinate System: British National Grid. Coastline by Wessel and Smith (2016), MPA sites subsetted from NCMPA (SNH, 2015) and SAC (SNH, 2016) layers, management areas by SG (2017b) and functional units generated from merged ICES rectangles (ICES, 2017). Map and modified layers created using ArcGIS (ESRI, 2014).

13 Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 12 (West of Scotland, South Minch)

Type of assessment in 2019

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follow the process defined by the benchmark WG (WKNEPH, 2009; WKNEPH, 2013). Full details are provided in the stock annex.

ICES advice applicable to 2018

'ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should be no more than 4112 tonnes.

To ensure that the stock in functional unit (FU) 12 is exploited sustainably, management should be implemented at the functional unit level.'

ICES advice applicable to 2019

'ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2015–2017, catches in 2019 should be no more than 5844 tonnes.

To ensure that the stock in Functional Unit 12 is exploited sustainably, management should be implemented at the functional unit level.'

13.1 General

Stock description

The South Minch (FU12) is located midway down the west coast of Scotland (North Minch report, Section 15, Figure 15.1). The area is characterised by numerous islands of varying size, and sea lochs occur along the mainland coast. These topographical features create a diverse habitat with complex hydrography and a patchy distribution of soft sediments. Further details are provided in the stock annex.

Management applicable to 2018 and 2019

Management is at the ICES subarea level as described at the beginning of Section 15 (FU11 North Minch report).

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex where available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland compliance officers. In 2018, the fishery was described as very poor, with many vessels moving over to fish on the east coast of Scotland. Vessels unwilling or unable to move fishing areas are struggling financially.

Two distinct fleets operate in the South Minch and the main ports are Oban and Mallaig. In Oban, there are five local prawn trawlers and ten creelers while there are nine *Nephrops* trawlers in Mallaig. There were no major changes to the fleets in 2018, but there was a comment that more creels were on the grounds and that the price for brown crab was very good.

Since 2009, vessels have been required to fit 120 mm square meshed panels, in accordance with the west coast emergency measures (Council Reg. (EU) 43/2009). Large SMPs (200 mm) are also widely used and were made mandatory for all TR2 vessels with power >112 kW fishing as part of the previous Scottish Conservation Credits scheme. Twin rig vessels tend to use a 200 mm square mesh panel with a 100 mm or larger mesh codend. These vessels do not catch bulk quantities and this leads to *Nephrops* of better average size and quality. A comment was noted in 2017 about the use of bungee cords to keep the meshes closed. This was investigated by Compliance officers but was deemed to be legal and was not reported as a problem in 2018.

There is very little fish bycatch landed due to the restrictions on cod, haddock and whiting (detailed in ICES, 2016a, ICES, 2016b and ICES, 2016c). Estimates of discard rates of haddock and whiting remain high (ICES, 2016d and ICES, 2017a). Haddock in areas 6.a are now covered by the landings obligation.

In 2018, there was a large reduction in landings and effort (Figure 16.2.1) in all three functional units on the west coast. This reduction was partly explained by the migration of the west coast fleet to the east coast to take advantage of improved *Nephrops* fishing opportunities in 4a. Anecdotal information from the fishing industry suggests that an additional factor contributing to the migration of the fishing fleet was an issue with foreign crew being unable to work in the inshore grounds of the west coast therefore moved to the offshore grounds of the east coast. Further general information on the fishery can be found in the stock annex.

13.2 Data available

InterCatch

Data for 2018 were successfully uploaded into InterCatch prior to the 2019 WG meeting. Uploaded data were worked up in InterCatch to generate 2018 raised international length–frequency distributions. Allocation schemes for any unsampled fleets are described in the stock annex. Data exploration in InterCatch has previously shown that outputs of raised data were very close to those generated by the previous method applied internally with differences being <0.1%. As such, InterCatch length–frequency outputs have been used in the stock assessment since 2012.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Table 15.1.1 (see FU11 North Minch report, Section 15). These relate to the whole of 6.a of which the South Minch is a part. Landings for FU12 provided through national laboratories are presented in Table 16.2.1, broken down by country and by gear type. Landings from this fishery are predominantly reported from

Scotland, with low levels reported from the rest of the UK and Ireland. Total reported Scottish landings in 2018 were 2457 tonnes (plus 45 tonnes from other UK vessels and 34 tonnes from Ireland), consisting of 1692 tonnes (77%) landed by Scottish *Nephrops* trawlers and 679 tonnes (28%) landed by Scottish creel vessels. The proportion of creel caught landings has remained relatively stable in recent years at ~20% however, there was an increase in the percentage of creel landings in 2018 to 28%.

Effort data

In 2015, WGCSE agreed that effort should be reported in kW days as this is likely to be more informative about changes in the actual fleet effort. Effort shows an overall decreasing trend since 2003 but there are peaks in 2008 and 2012, which can be attributed to visiting North Sea trawlers (Figure 16.2.1). There was a decline in effort in 2017 and 2018, attributed to the poor fishing and the movement of vessels to the East coast of Scotland. Note that the effort time-series range (2000–2018) does not match with the more extensive year range available for landings due to a lack of reliable effort data in the Marine Scotland Science in-house database. The effort is also slightly inconsistent with the landings data in that effort is provided for TR2 vessels while the '*Nephrops* trawl' landings additionally includes landings by large mesh trawlers targeting *Nephrops*.

Sampling levels

Length compositions of landings and discards are obtained during market sampling and on-board observer sampling respectively. These sampling levels are shown in Table 15.2.2 (see FU11 North Minch report, Section 15). Sampling effort decreased in 2018 compared to 2017 because of a change in the sampling design. This change was a trail and has since been reverted to the previous design due to the negative effect on sample numbers. This change had no effect on mean weights in landings and discards, these figures fell well within normal ranges. Length compositions for the creel fishery are available for landings only as the small numbers of discards survive well. Therefore these animals are not considered to be removed from the population and hence a value of 100% survival is used (ICES, 2013).

Length compositions

Figure 16.2.2 shows a series of annual length–frequency distributions from 2000 onwards and appears fairly stable over the time-series. Catch (removals) length compositions are shown for each sex along with the mean size for both. The mean size of males increased slightly in 2018 compared to 2017 in contrast to the females, which showed a decrease. There is little evidence of any recruitment in 2018. The tails of the distributions above 35 mm CL (the size beyond which the effects of recruitment pulses and discards are considered to be negligible) were stable in 2018. It is unclear why there has been an increase in the mean size of the males and a decrease in the mean size of females.

Sex ratio

The sex ratio in the South Minch shows some variation but males consistently make the largest contribution to the annual landings. Males are available throughout the year while females are mainly caught in the summer when they emerge from the burrow after egg hatching. In 2018, landings were lower in quarter one and four (Figure 16.2.3 (a)). Figure 16.2.3 (b) illustrates the sex ratio by season. There are no particularly anomalous values evident in 2018, although there was a higher proportion of males in quarter one and a reduction in the male proportion in quarter two of 2018.

Mean weights

The mean weight in the landings (Figures 15.2.4 and 15.2.5; see FU11 North Minch report, Table 15.2.3) has fluctuated at a high level (in comparison to values for 2006 to 2010) since 2011. Seasonal variability (and occasional outliers) in mean weights is seen in the individual sample estimates. There appears to be a small increase in the mean weight of the males for the trawl caught *Nephrops* and also, for the females caught by creels (Figure 15.2.5). The annual estimate of mean weight in the landings has an effect on the catch forecast. Over the time-series, there is a general increasing trend in mean weights in the landings. This can be explained by the increasing proportion of creel samples (which tend to catch and land larger *Nephrops*).

Discarding

Discarding of undersized and unwanted *Nephrops* occurs in this fishery. Discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates in this FU have varied considerably over the years, ranging from as low as 3% to over 25%. In 2018, the discarding rate was 4.5%, lower than in 2017 (9.1%) and is the second lowest discard rate in the time-series and may be explained because of the poor fishing (Table 16.2.2).

Studies (Charuau *et al*., 1982; Sangster *et al*., 1997; Wileman *et al*., 1999) suggest that some *Nephrops* survive the discarding process, an estimate of 25% survival is assumed for this FU in order to calculate removals (landings + dead discards) from the population. The discard survival rate for creel caught *Nephrops* has been shown to be high (ICES, 2013) and a value of 100% is used. The discard rate (adjusted to account for survival) which will be used in the forecast was estimated by taking a three-year average 2016–2018 and amounts to 7.3%.

Abundance indices from UWTV surveys

Underwater TV surveys using a stratified random approach are available for this stock since 1995. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows. The numbers of valid stations used in the final analysis in each year are shown in Table 16.2.3. On average, 35 stations have been considered valid each year, and raised to a stock area of 5072 km^2 (derived from BGS sediment data). In 2019, 40 valid stations were used in the survey final analysis (Table 16.2.3).

TV survey abundance estimates from 1999–2019 are shown in Table 16.2.3 and Figure 16.2.4. They show that the *Nephrops* population in the South Minch experienced several years of high abundance in the early mid-2000s. Aside from this, it has fluctuated without obvious trend over the period of the survey (Figure 16.2.4). The recently observed 2019 abundance represents a 21.37% increase in relation to 2018.

Table 16.2.4 shows a more detailed summary of the results from the three most recent TV surveys conducted in FU12. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. Mean burrow density increased in 2019, in comparison to the 2018 survey. Densities are generally lower in the western parts of the area towards the Outer Hebrides and higher in the inshore areas to the south west of Skye (Figure 16.2.5). CVs for the three most recent TV surveys (Table 16.2.4) are lower than the precision level agreed by WGNEPS (2019; 12.1%). Figure 16.2.4 show the time-series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates.

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009; ICES, 2013), WGNEPS (ICES, 2018a), WKNEPS (ICES, 2018b) and (Leocádio *et al*., 2018). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative relative to absolute conversion factor estimated for FU12 was 1.32 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 32%.

13.3 Assessment

Comparison with previous assessments

The assessment follows the same procedure as last year and is based on a combination of examining trends in fishery indicators and underwater TV abundance estimates. The process was defined by the benchmark WG and is described in the stock annex.

No major issues were highlighted by the audit conducted last year.

State of the stock

The underwater TV survey is presented as the best available information on the South Minch (FU12) *Nephrops* stock. The details of the 2019 survey are shown in Table 16.2.4, and compared with the 2017 and 2018 outcomes. At present, it is not possible to extract any length or age structure information from the survey and therefore it provides information on abundance over the area of the survey.

TV survey estimated stock abundance in 2019 was 2362 million individuals, above the MSY $B_{trigger}$ value of 1016 million, or the rounded value of 1020 million used for the provision of advice.

The calculated harvest rate in 2019 (dead removals/TV abundance = 4.8%) was below the F_{MSY} proxy for this stock (the value associated with high long-term yield and low risk depletion) of 11.7%.

13.4 Catch scenarios table

Landings predictions and catch options at various harvest rates (based on principles established at WKNEPH (ICES, 2009), will be made on the basis of the 2019 UWTV survey conducted in June. These will be presented in October 2019 for the provision of advice.

Catch scenarios table inputs and historical estimates of mean weight in landings and harvest rates are presented in Table 16.2.2 and summarised below. The calculation of catch scenarios for the South Minch follows the procedure outlined in the stock annex.

Given the variability in mean weights it was considered more appropriate to use a full time-series average, from 1999 (first year with creel and trawl length distributions combined) until 2018.

The table below shows the agreed inputs to the catch scenario table.

Input	Data	2019 assessment
Survey abundance (millions)	UWTV 2019	2362
Mean weight in wanted catch (g)	1999–2018	26.79
Mean weight in unwanted catch (g)	1999–2018	10.08
Dead unwanted catch	2016–2018	7.3%
Discard survival rate	2016–2018	25%

13.5 Reference points

New reference points were derived for this stock at WKMSYRef4 (ICES, 2016e). These are updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years which corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values, a five-year average was chosen. Similarly, the five-year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five-year average of the F above F_{MAX} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy, which occasionally appear. For this stock, the F_{MSY} proxy has been revised from 12.3% to 11.7%.

For *Nephrops* stocks, MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased and is calculated as 1016 million individuals (in 2010). This value was rounded to 1020 million, in the advice from WKMSYRef4 on MSY $B_{trigger}$. Full details are contained in the stock annex.

These should remain under review by WGCSE and may be revised should improved data become available.

Table 16.2.2 and Figure 16.5.1 show the harvest rates for FU12. The harvest rate has fluctuated over the time-series and has been below the F_{MSY} proxy since 2013. The increase in 2016, compared to the 2013–2015 harvest rates, was due to relatively increased landings compared to abundance. The harvest rate has more than halved in 2018 compared to 2017.

It is likely that prior to 2006, the harvest rates are underestimates due to under-reported landings.

13.6 Management strategies

Scotland has established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

On the 8th of February 2016, phase 1 of the fisheries management measures for inshore MPAs in Scottish waters came into force (SG, 2016). These measures relate to both Nature Conservation

MPAs (NCMPAs; Marine (Scotland) Act and the UK Marine and Coastal Access Act) and Special Areas of Conservation (SACs; EC Habitats Directives – Council Directive 92/43/EEC) both of which have the aim of conserving biological diversity in Scottish waters and contribute to Scotland's MPA network (SG, 2017a). Although not specific to the management of the *Nephrops* fishery, they will influence spatial patterns of fishing for *Nephrops* where controls on the two main gear types, demersal trawls and creels, are implemented on *Nephrops* habitat. There are seven protected areas within the South Minch functional unit with fisheries management measures. MPAs on the main areas of *Nephrops* habitat include the Loch Sunart to the Sound of Jura NCMPA where demersal trawling is banned in some areas, i.e. zoned, and seasonal closures implemented in others, Loch Sunart NCMPA/SAC, where demersal trawling is banned and creeling is zoned, the East of Mingulay SAC, demersal trawling banned and creeling zoned, and the Trenish Isles SAC, demersal trawling banned. Another area is the Loch Duich, Long and Alsh NCMPA/SAC, covering some patches of muddy sediment, where demersal trawling is banned or temporally closed in other areas that extend beyond the MPA onto muddy sediment. Other areas include the Loch Creran SAC/NCMPA, demersal trawling banned and creeling zoned, and the Firth of Lorn SAC, which has the same management as the Loch Sunart to the Sound of Jura NCMPA. For the Firth of Lorn and Loch Creran, management was in place prior to 2016 (SG, 2016). An additional NCMPA, at Loch Carron, was designated using emergence powers in 2017 (SG, 2017b). The areas of the SACs and NCMPAs relative to the estimated *Nephrops* habitat within the South Minch functional unit are displayed in Figure 16.6.1.

Also, need to add EU MAP WW 2019 in Section on *Nephrops* 11 as management details and have it referenced also.

13.7 Quality of assessment and forecast

The length and sex composition of the landings data is considered to be adequately sampled, although sampling levels were lower in 2018 compared to 2017 (see Section 16.2). Discard sampling has been conducted for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the trawl fishery adequately. The landings length compositions from 1999 onwards are derived from both creel and trawl samples. The creel fishery, which generally accounts for around 20% of the landings (although increased to 27% in 2018) and increasingly operates over similar areas to trawling, exhibits a length composition composed of larger animals.

There are concerns over the accuracy of historical landings and effort data prior to 2006 when Buyers and Sellers legislation was introduced and the reliability began to improve. Because of this, the final assessment adopted is independent of official statistics. Harvest rates since 2006 are also considered more reliable due to more accurate landings data reported under new legislation. Incorporation of creel length compositions has also improved estimates of harvest rates.

Underwater TV surveys have been conducted for this stock every year since 1995. The number of valid stations in the survey has remained relatively stable throughout the time period. The survey is targeted at known areas of mud, sandy mud and muddy sand within the South Minch. The variance of density estimates in the South Minch is relatively high, particularly in the sandy mud strata, resulting in large confidence intervals and a greater uncertainty on the abundance estimates than in other FUs. This makes it difficult to determine which population changes are significant. Although the CV's have been smaller in recent years.

There is a need to explore options to implement further stratification for the South Minch survey area. In the provision of catch options based on the absolute survey estimates, additional uncertainties related to mean weight in the landings and the discard rates also arise. A three-year average (2016–2018) of discard rates (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options.

The cumulative relative to absolute conversion factor estimates for FU12 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised. The landings derived in the forecast (catch options table) are sensitive to the input dead discard rate and mean weights in landings, and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. Work is underway to improve the area estimation. VMS data linked to landings (from queries of the Scottish FIN database) suggest no major differences between areas fished and the mud sediment maps. Two other factors however, are likely to increase the estimate of ground area available for *Nephrops* and *Nephrops* directed fishing. Firstly, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations and secondly, it is known that most of the sea lochs have areas of mud substrate and are typically fished by creel boats. In recent years, limited TV surveys have taken place in some of the sea lochs and attempts are being made to utilise these data to improve estimates of mud area and *Nephrops* abundance in the South Minch.

13.8 Recommendation for next benchmark

This stock was last benchmarked in 2009. WGCSE will keep the stock under close review and recommend future benchmark as required.

13.9 Management considerations

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the functional unit level could provide controls to ensure effort and catch were in line with resources available.

Creel fishing takes place in this area but overall effort in terms of creel numbers is not known and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the South Minch and estimated discards of whiting and haddock by the TR2 fleet are high in area 6.a generally. It is important that efforts continue to ensure that unwanted bycatch is kept to a minimum in this fishery.

13.10 References

Afonso-Dias, M. S. 1998. Variability of *Nephrops norvegicus* (L.) populations in Scottish waters in relation to the sediment characteristics of the seabed. PhD Thesis University of Aberdeen. 282 pp.

BGS. 2011. Marine SeaBed Sediment Map - UK Waters - 250k (DigSBS250). British Geological Survey, Nottingham. Available at: <http://www.bgs.ac.uk/discoverymetadata/13605549.html> [Accessed: unknown date].

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea, ICES-CM-1982/B:13.

Council Reg. (EU) 43/2009.

EU. 2015. COMMISSION DELEGATED REGULATION (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters. Official Journal of the European Union, L 336/29. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R2438&from=EN> [Accessed: 30/06/2017].

ESRI. 2014. ArcGIS. Version 10.2.1. Environmental Systems Research Institute, Inc.: Redlands, CA.

Howard F.G. and Hall, W.B. 1983. Some observations on the biometrics of *Nephrops norvegicus* (L.) in Scottish waters. ICES, Doc.ShellfishComm.,CM1983/K:36.

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9–11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22. 95 pp.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2013. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2013/45 230 pp.

ICES. 2016a. Stock Annex: Whiting (*Merlangius merlangus*) in Division 6.a (West of Scotland). Working Group for the Celtic Seas Ecoregion (WGSCE). Available at: <http://ices.dk/sites/pub/Publication%20Reports/Stock%20Annexes/2016/whg-scow_SA.pdf.> [Accessed: 30/06/2017].

ICES. 2016b. Stock Annex: West of Scotland cod (Division 6.a). Working Group for the Celtic Seas Ecoregion (WGSCE). Available at: <http://ices.dk/sites/pub/Publication%20Reports/Stock%20Annexes/2016/cod-scow_SA.pdf.> [Accessed: 30/06/2017].

ICES. 2016c. Haddock (*Melanogrammus aeglefinus*) in Subarea 4, Division 6.a and Subdivision 20 (North Sea, West of Scotland, Skagerrak). Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). Available at: <http://www.ices.dk/sites/pub/Publication%20Reports/Stock%20Annexes/2016/had-346a_SA.pdf.> [Accessed: 30/06/2017].

ICES. 2016d. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 4–13 May 2016, Copenhagen, Denmark. ICES CM 2016/ACOM:13. 1343 pp.

ICES. 2016e. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

ICES. 2017a. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 26 April–5 May 2016, Hamburg, Germany. ICES CM 2016/ ACOM:14. 19 pp.

ICES. 2017b. ICES Statistical Rectangles. International Council for the Exploration of the Sea: Copenhagen, Denmark. Available at: <http://geo.ices.dk/index.phpSource> [Accessed: 16/03/2017].

ICES. 2018a. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 6–8 November 2018. Lorient, France. ICES CM 2018/ EOSG:18.227 pp.

ICES. 2018b. Report of the Workshop on *Nephrops* burrow counting, 2–5 October 2018, Aberdeen, UK. ICES CM 2018/ EOSG:25.47 pp.

Leocádio, A., Weetman, A., and Wieland, K. (Eds). 2018. Using UWTV surveys to assess and advise on *Nephrops* stocks. ICES Cooperative Research Report No. 340. 49 pp. http://doi.org/10.17895/ices.pub.4370.

Sangster, G.I., Breen, M., Bova, D.J., Kynoch, R., O'Neill, F.G., Lowry. N., Moth-Poulsen, T. Hansen, U.J., Ulmestrand, M., Valentinsson, D., Hallback, H., Soldal, A.V., and Hoddevik, B. 1997. *Nephrops* survival after escape and discard from commercial fishing gear. Presented at ICES FTFB Working Group, Hamburg, Germany 14–17 April, 1997, ICES CM 1997 CM/B.

SG. 2016. Simple guide to fisheries management measures in Marine Protected Areas. Marine Scotland (The Scottish Government): Edinburgh. Available at: <http://www.gov.scot/Resource/0049/00498320.pdf> [Accessed: 16/05/2017].

SG. 2017a. Marine Protected Areas in Scotland's Seas - Guidelines on the selection of MPAs and development of the MPA network. Marine Scotland (The Scottish Government): Edinburgh. Available at: <http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/mpaguidelines> [Accessed: 16/05/2017].

SG. 2017b. Loch Carron Marine Protected Area Question and Answer Document. Marine Scotland (The Scottish Government): Edinburgh. Available at: <http://www.gov.scot/Resource/0051/00518275.pdf> [Accessed: 01/06/2017].

SG. 2017c. Marine conservation orders (MCOs) and fisheries management measures (MPAs and SACs) - with effect May 2017. Marine Scotland (The Scottish Government): Edinburgh. Available at: <https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?availablelayers=838> [Accessed: 31/05/2017].

SNH. 2015. Nature Conservation Marine Protected Areas. Scottish Natural Heritage (Scottish Government): Inverness. Available at: <https://gateway.snh.gov.uk/natural-spaces/index.jsp> [Accessed: 03/04/2017].

SNH. 2016. Special Areas of Conservation. Scottish Natural Heritage (Scottish Government): Inverness. Available at: <https://gateway.snh.gov.uk/natural-spaces/index.jsp> [Accessed: 03/04/2017].

Wessel, P. and Smith, W.H.F. 2016. GSHHG version 2.3.6 - A Global Self-consistent, Hierarchical, High-resolution Geography Database. National Centres for Environmental Information, National Oceanic and Atmospheric Administration: Boulder, CO. <https://www.ngdc.noaa.gov/mgg/shorelines/gshhs.html> [Accessed: 31/05/2017].

Wileman, D.A., Sangster, G.I., Breen, M., Ulmestrand, M., Soldal, A.V. and Harris, R.R. 1999. Roundfish and *Nephrops* survival after escape from commercial fishing gear. EU Contract Final Report. EC Contract No: FAIR-CT95-0753.

Table 16.2.1. ***Nephrops*****, South Minch (FU12), ICES estimates of landings of** ***Nephrops*****, 1981–2018.**

UK SCOTLAND						OTHER UK	IRELAND	TOTAL
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIUM SIZE	SUB TOTAL			
1981	2966	254	432	0	3652	0	0	3652
1982	2925	206	421	0	3552	0	0	3552
1983	2595	362	456	0	3413	0	0	3413
1984	3229	477	594	0	4300	0	0	4300
1985	3096	424	488	0	4008	0	0	4008
1986	2694	288	502	0	3484	0	0	3484
1987	2928	418	546	0	3892	0	0	3892
1988	3544	364	555	0	4463	10	0	4473
1989	3846	338	561	0	4745	0	0	4745
1990	3732	263	435	0	4430	0	0	4430
1991	3596	342	503	0	4441	1	0	4442
1992	3478	209	549	0	4236	1	0	4237
1993	3609	194	650	0	4453	5	0	4458
1994	3742	264	405	0	4411	3	0	4414
1995	3443	717	508	0	4668	14	0	4682
1996	3108	417	469	0	3994	1	0	3995
1997	3518	329	493	0	4340	3	1	4344
1998	2851	340	538	0	3729	0	1	3730
1999	3165	359	514	0	4038	0	14	4052
2000	2940	311	700	0	3951	0	2	3953
2001	2823	391	768	0	3982	0	9	3991
2002	2234	314	743	0	3291	0	14	3305
2003	2812	203	858	0	3873	0	6	3879
2004	2864	105	879	0	3848	0	21	3869
2005	2812	46	955	0	3813	1	34	3848
2006	3570	97	922	0	4589	9	35	4633
2007	4437	21	959	0	5417	19	35	5471

UK SCOTLAND						OTHER UK	IRELAND	TOTAL
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIUM SIZE	SUB TOTAL			
2008	4433	12	896	0	5341	2	13	5356
2009	3346	24	900	0	4270	4	11	4285
2010	2836	19	969	0	3824	16	6	3846
2011	2876	11	783	0	3670	23	9	3702
2012	3159	32	773	0	3964	19	6	3989
2013	2490	543	729	0	3762	13	1	3776
2014	2490	3	637	0	3130	32	17	3179
2015	2662	18	665	0	3345	22	33	3400
2016	3450	22	838	0	4310	33	59	4402
2017	2741	54	768	0	3563	23	66	3652
2018	1692	86	679	0	2457	45	34	2536

Table 16.2.2. ***Nephrops*****, South Minch (FU12): Adjusted TV survey abundance, landings, discard rate proportion by number) and estimated harvest rate.**

YEAR	LANDINGS NUMBER (MILLIONS)	DISCARDS NUMBER (MILLIONS)	REMOVALS NUMBER (MILLIONS)**	ADJUSTED SURVEY (MILLIONS)	HARVEST RATE*	LANDINGS (TONNES)	DISCARDS (TONNES)	DISCARD RATE (%)	DEAD DISCARD RATE (%)	MEAN WEIGHT IN LANDINGS (g)	MEAN WEIGHT IN DISCARDS (g)
1999	161	29	183	1086	16.9	4052	206	15.4	12	25.14	7
2000	145	33	170	1854	9.2	3953	284	18.7	14.7	27.3	8.5
2001	168	65	216	2037	10.6	3991	591	27.9	22.5	23.79	9.11
2002	123	26	143	1899	7.5	3305	247	17.6	13.8	26.83	9.37
2003	139	38	168	2157	7.8	3879	381	21.3	16.9	27.86	10.1
2004	141	44	175	2558	6.8	3869	454	23.8	19	27.37	10.26
2005	137	49	174	2208	7.9	3848	452	26.5	21.2	28.11	9.17
2006	177	30	199	1845	10.8	4633	324	14.3	11.1	26.24	10.97
2007	228	66	278	1016	27.3	5471	903	22.4	17.8	23.95	13.73
2008	224	74	279	1608	17.4	5356	605	24.7	19.8	23.91	8.23
2009	179	26	199	1542	12.9	4285	216	12.5	9.6	23.87	8.44
2010	149	12	158	2076	7.6	3846	133	7.7	5.9	25.86	10.76
2011	118	11	126	1945	6.5	3702	92	8.2	6.3	31.1	8.78
2012	133	16	145	919	15.8	3989	145	10.8	8.3	29.17	9.05
2013	136	4	140	1718	8.1	3776	50	3.1	2.4	27.48	11.31
2014	105	19	120	2073	5.8	3179	233	15.6	12.1	29.91	12.04
2015	120	10	128	1998	6.4	3400	121	7.7	5.9	28.15	12.04
2016	177	31	201	2118	9.5	4402	365	14.9	11.6	24.76	11.74
2017	127	13	137	1384	9.9	3652	105	9.1	7	27.76	8.29
2018	91	4	94	1946	4.8	2536	54	4.5	3.4	27.27	12.74
Average***									7.3	26.79	10.08

***Harvest rates previous to 2006 are unreliable.**

****Removals numbers take the dead discard rate into account.**

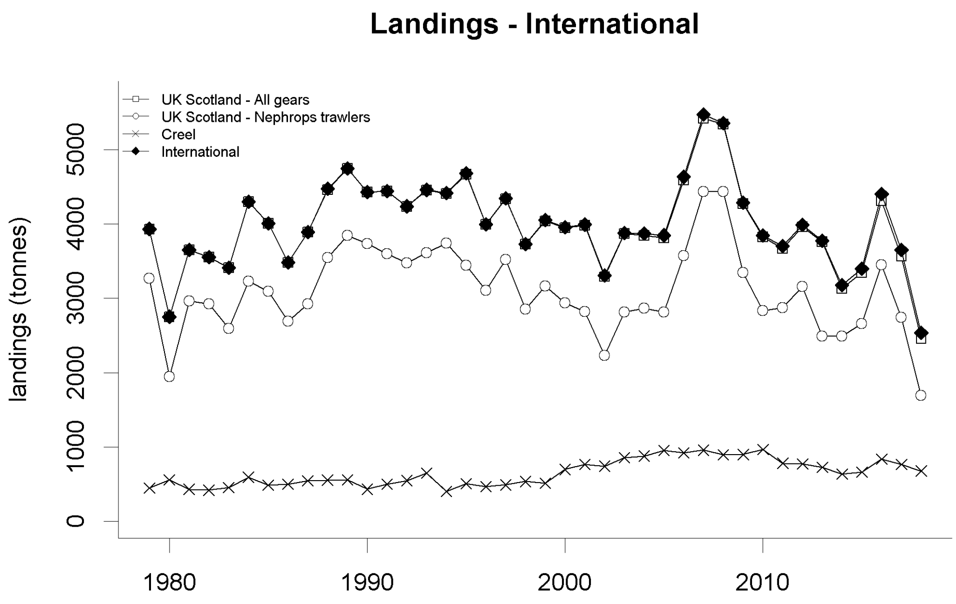
*****Dead discard average: 2016–2018; Mean weight in landings and discards average: 1999–2018.**

Table 16.2.3. ***Nephrops*, South Minch (FU12): Results of the 1995–2019 TV surveys (adjusted for bias).**

YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS/m²)	ABUNDANCE (MILLIONS)	95% CONFIDENCE INTERVAL (MILLIONS)
1995	33	0.227	1152	251
1996	21	0.288	1473	530
1997	36	0.212	1086	185
1998	38	0.288	1452	232
1999	37	0.212	1086	260
2000	41	0.364	1854	348
2001	47	0.402	2037	459
2002	31	0.371	1899	567
2003	25	0.424	2157	756
2004	38	0.508	2558	473
2005	33	0.432	2208	740
2006	36	0.364	1845	598
2007	39	0.197	1016	155
2008	33	0.318	1608	415
2009	25	0.303	1542	634
2010	34	0.409	2076	665
2011	36	0.383	1945	778
2012	38	0.182	919	185
2013	38	0.339	1718	365
2014	36	0.409	2073	530
2015	35	0.394	1998	514
2016	37	0.417	2118	440
2017	41	0.273	1384	282
2018	39	0.383	1946	371
2019	40	0.466	2362	578

Table 16.2.4. ***Nephrops*** **South Minch (FU12). Results by stratum of the 2017–2019 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

STRATUM	AREA (km²)	NUMBER OF STATIONS	MEAN BURROW DENSITY (no./m²)	OBSERVED VARIANCE	ABUNDANCE (MILLIONS)	STRATUM VARIANCE	PROPORTION OF TOTAL VARIANCE	SURVEY PRECISION LEVEL (RSE)
2017 TV Survey								
M	303	0.216	0.001	65.5	65	0.003	0.216	
SM	2741	0.314	0.037	861.1	14725	0.739	0.314	
MS	2028	20	0.226	0.025	457.7	5142	0.258	
Total	5071	41			1384.2	19932	1	0.136
2018 TV Survey								
M	303	2	0.311	0.007	94.2	2	0.311	
SM	2741	19	0.441	0.074	1207.5	19	0.441	
MS	2028	18	0.317	0.021	644.3	18	0.317	
Total	5071	39			1946	34438	1	9.1
2019 TV Suvey								
M	303	2	0.466	0.001	141.2	65	0.001	
SM	2741	20	0.494	0.162	1352.7	61024	0.73	
MS	2028	18	0.428	0.099	867.9	22546	0.27	
Total	5071	40			2361.7	83635		0.121



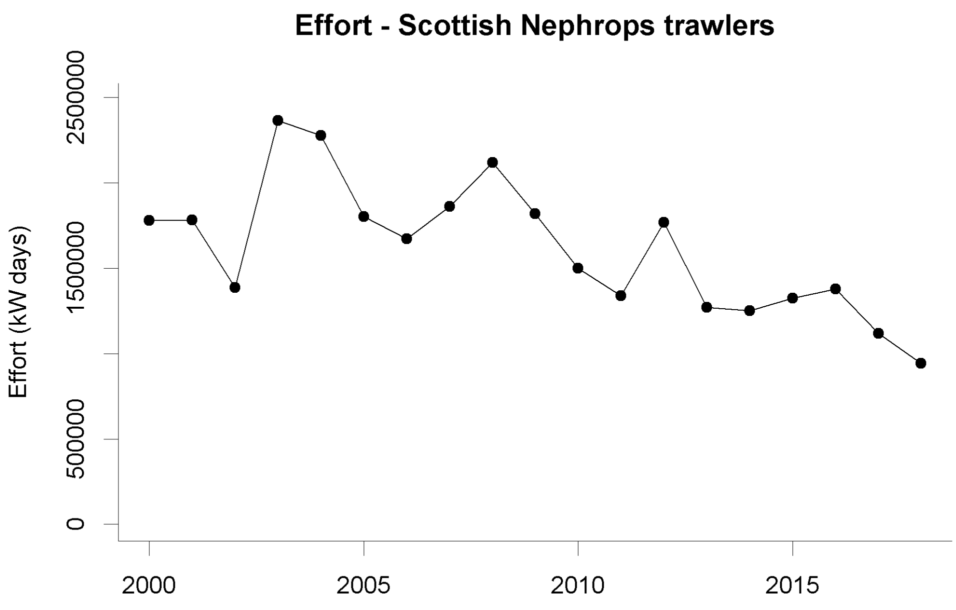


Figure 16.2.1. ***Nephrops,*** **South Minch (FU12). Long-term landings and effort.**

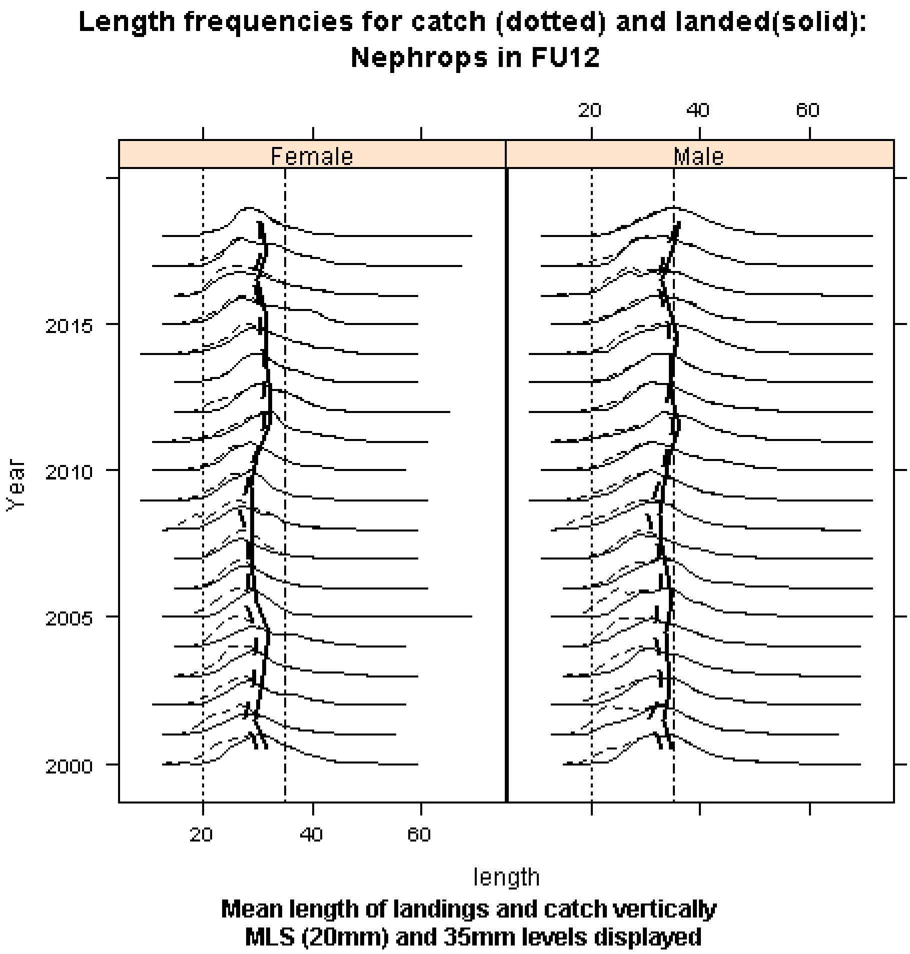


Figure 16.2.2. *Nephrops*. South Minch (FU12). Catch length–frequency distribution and mean size in catches (dotted) and landings (solid) for *Nephrops* in the North Minch, 2000–2018. Vertical lines are minimum conservation reference size (20 mm) and 35 mm.

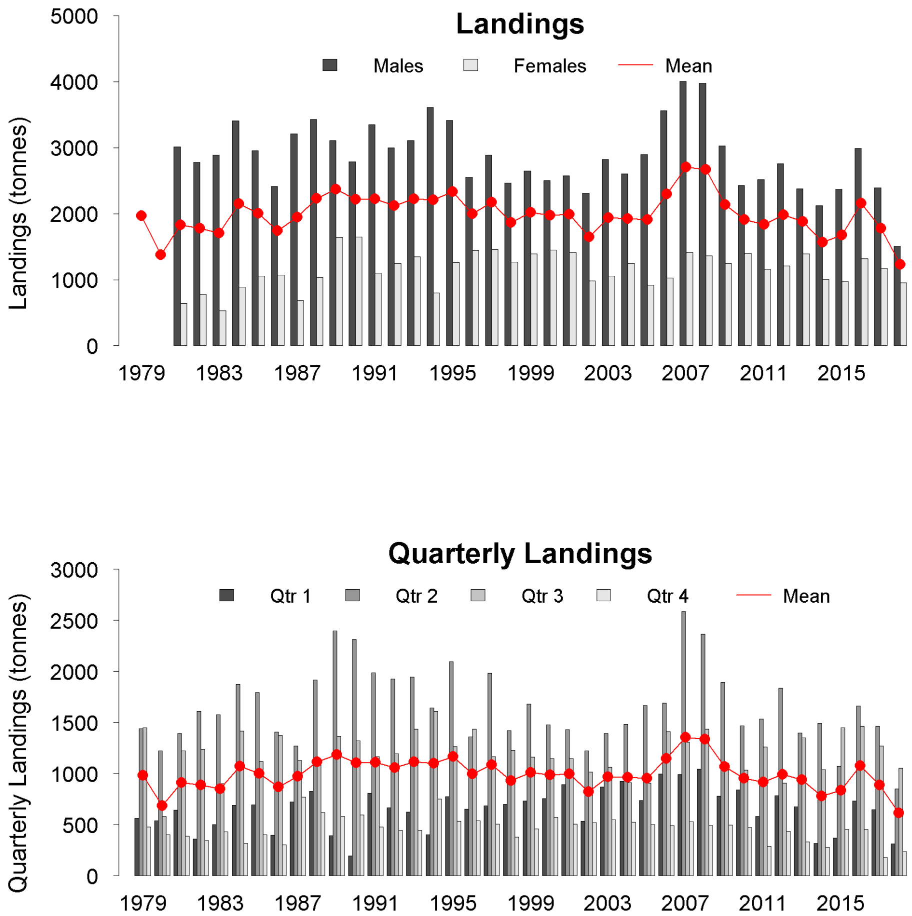


Figure 16.2.3. (a) ***Nephrops*****, South Minch (FU12). Landings by sex and quarter from Scottish trawlers.**

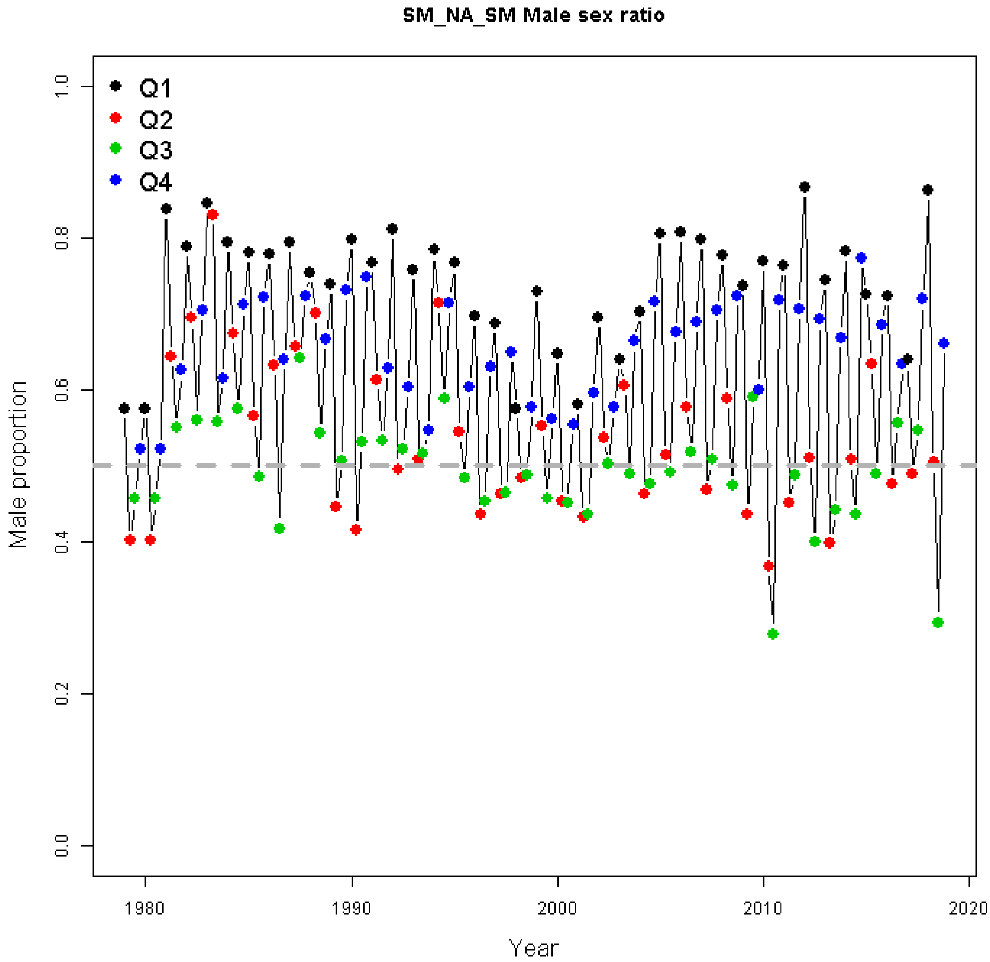


Figure 16.2.3 (b) ***Nephrops,*** **South Minch (FU12), Proportion of males by quarter (1980–2018).**

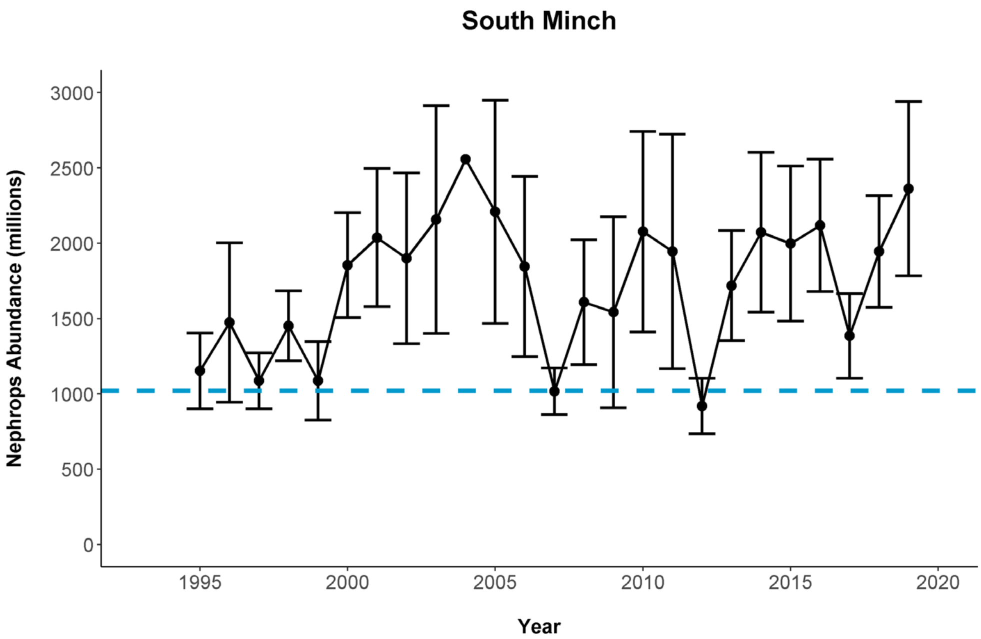


Figure 16.2.4. ***Nephrops*, South Minch (FU12), Time-series of TV survey abundance estimate (adjusted for bias), with 95% confidence intervals, 1995–2019. The dashed blue line is the rounded $B_{trigger}$ value of 1020 million individuals.**

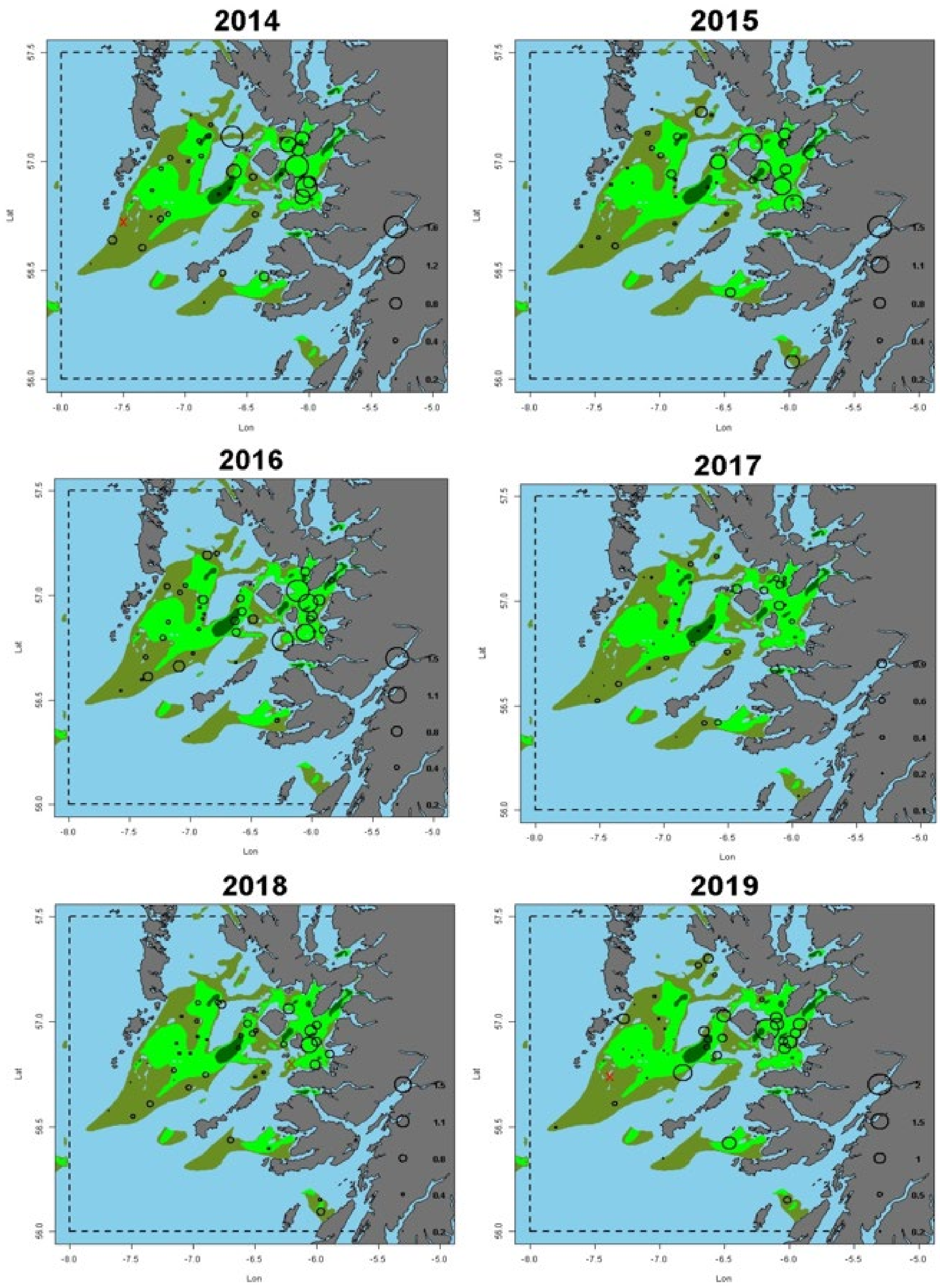


Figure 16.2.5. ***Nephrops*, South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2014–2019. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles in this figure are all scaled the same. Red crosses represent zero observations.**

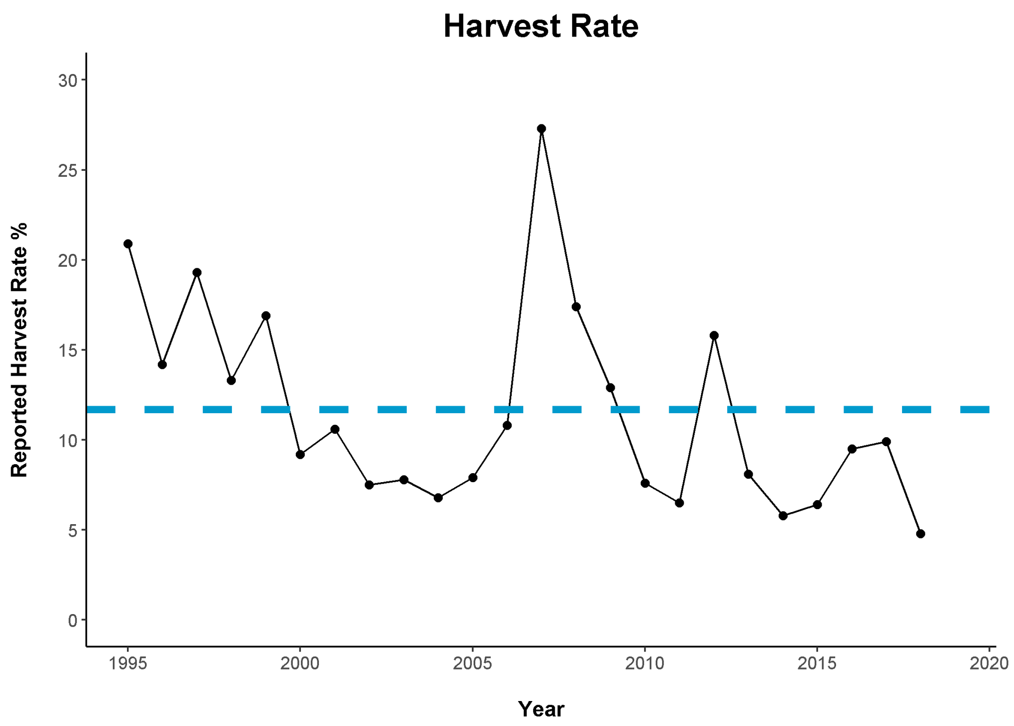


Figure 16.5.1. ***Nephrops*, South Minch (FU12), harvest rate, 1995–2019. The dashed and solid lines are the F_{MSY} proxy harvest rate (11.7%) and the harvest rate respectively. Harvest rates prior to 2006 are unreliable.**

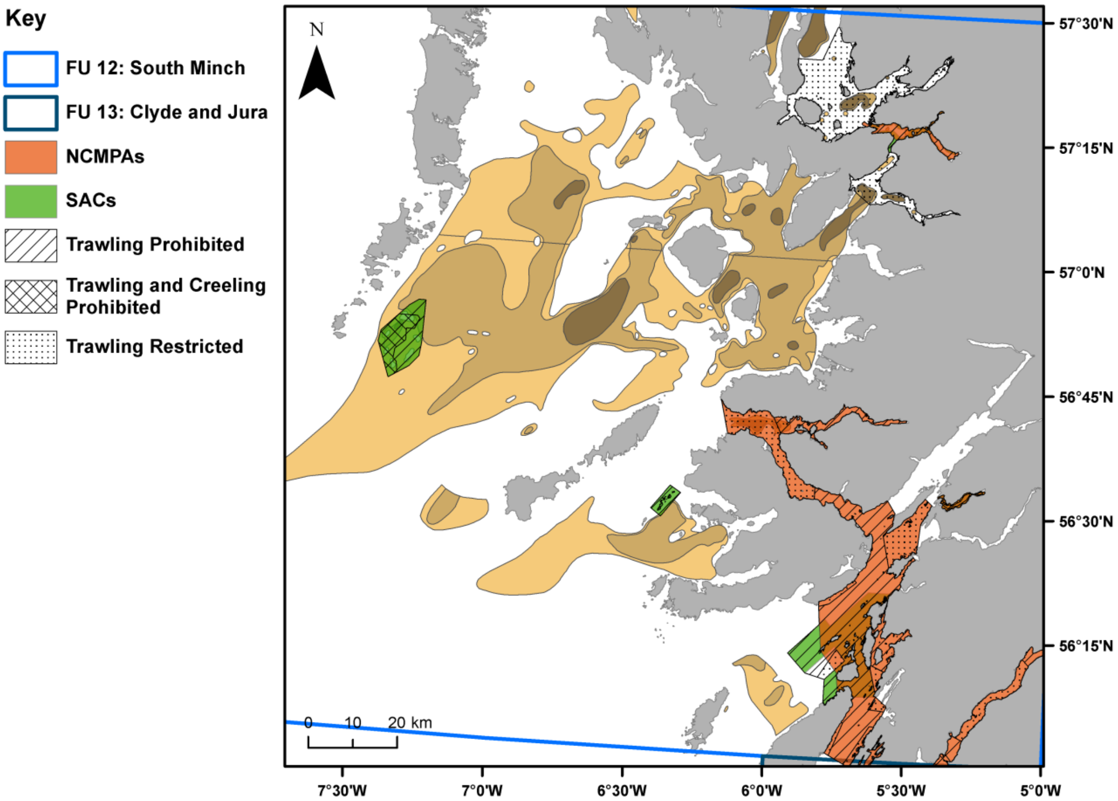


Figure 16.6.1. The area of *Nephrops* habitat (Mud, Muddy Sand and Sandy Mud) within the South Minch (FU12) relative to the areas of the Nature Conservation MPAs (NCMPAs) and Special Area of Conservations (SACs) with fisheries management measures. Areas where demersal trawling is prohibited, restricted (i.e. vessel size restrictions or seasonal closures) and where creeling is prohibited are displayed. For more detailed information see SG (2016). Geographic Coordinate System: OSGB 1936, Datum: OSGB 1936, Projected Coordinate System: British National Grid. Coastline by Wessel and Smith (2016), MPA sites subsetted from NCMPA (SNH, 2015) and SAC (SNH, 2016) layers, management areas from SG (2017c) and functional units generated from merged ICES rectangles (ICES, 2017b). Map and modified layers created using ArcGIS (ESRI, 2014).

14 Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 13 (West of Scotland, the Firth of Clyde and Sound of Jura)

Type of assessment in 2019

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG (WKNEPH, 2009; WKNEPH, 2013). Full details are provided in the stock annex.

ICES advice applicable to 2018

'ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should be no more than 5179 tonnes (4484 tonnes for the Firth of Clyde and 695 tonnes for the Sound of Jura).

To ensure that *Nephrops* stocks are exploited sustainably, management of *Nephrops* in general should be implemented at the functional unit (FU) level. In this particular FU additional measures may be required to ensure that the landings taken in each subarea (Firth of Clyde and Sound of Jura) are in line with the advice.'

ICES advice applicable to 2019

'ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2015–2017, catches in 2019 should be no more than 6588 tonnes (5990 tonnes for the Firth of Clyde and 598 tonnes for the Sound of Jura).

To ensure that *Nephrops* stocks are exploited sustainably, management of *Nephrops* in general should be implemented at the functional unit level. In this particular functional unit additional measures should be implemented to ensure that landings taken in each subarea (Firth of Clyde and Sound of Jura) are in line with the advice.'

14.1 General

Stock description

The Clyde functional unit (FU13) is located in the southern waters off the west coast of Scotland (FU11 report, Section 12, Figure 15.1)). It is comprised of two distinct patches in the Firth of Clyde and the Sound of Jura, to the east and west of the Mull of Kintyre respectively. The hydrography of the two subareas differs, with the Sound of Jura characterised by stronger tidal currents and the Firth of Clyde exhibiting features of a lower energy environment with a shallow entrance sill. Owing to its burrowing behaviour, the distribution of *Nephrops* is restricted to areas of mud, sandy mud and muddy sand. Within the two distinct patches, these substrates are distributed according to prevailing hydrographic and bathymetric conditions. The available area of suitable sediment is smaller in the Sound of Jura, occupying only the deepest parts of the Sound, while in the Firth of Clyde these sediments predominate. Further details are provided in the stock annex.

Management applicable to 2018 and 2019

Management is at the ICES subarea level as described at the beginning of Section 12 (FU11 North Minch report).

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex where available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland fishery compliance officers.

There are 76 resident vessels based in the Campbeltown district, and an even split between trawlers and creel vessels. Vessel power was between 80–585 kW, the most powerful being the over 10 m trawlers. In addition, there are 30 trawlers and 15 creelers of 10–18 m fishing out of Ayr, with vessel power between 75–300 kW. All trawlers use 80 mm single or twin rigs with square mesh panels (SMP) of at least 120 mm, in accordance with west coast emergency measures conditions (Council Reg. (EU) 43/2009). Under the Scottish Conservation Credits scheme, vessels with power >112 kW are required to use a 200 mm SMP.

The activity of Northern Irish vessels was not perceived to be high in 2017 or 2018; vessels did not land locally but went back to their homeport because of better fuel and market prices.

Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night, as are vessels greater than 21 m in length. Most creel boats operating in the Clyde have two crew members and operate around 1000 creels. Creeling activity now takes place quite widely in the northern parts of the Firth operating on some of the same grounds but often taking place during the weekend trawling ban.

In terms of the influence of Marine Protected Area (MPA) management measures on the fishery, it was stated that the South Arran Nature Conservation MPA (NCMPA) removed a large sea area for *Nephrops* trawlers to operate over. This reportedly increased trawling effort outside of prohibited area. However, this allowed creelers to move into the areas were trawling was banned. There have been recent reports of increases in creel numbers in this area and this has resulted in gear conflict within the creel sector. The small area of the Upper Loch Fyne NCMPA closed to trawlers was reported to have had little impact.

In 2018, there was a large reduction in landings and effort (Figure 17.2.1) in all three functional units on the west coast. This reduction was partly explained by the migration of the west coast fleet to the east coast to take advantage of improved *Nephrops* fishing opportunities in 4a. Anecdotal information from the fishing industry suggests that an additional factor contributing to the migration of the fishing fleet was an issue with foreign crew being unable to work in the inshore grounds of the west coast therefore moved to the offshore grounds of the east coast. Further general information on the fishery can be found in the stock annex.

14.2 Data available

InterCatch

Data for 2018 were successfully uploaded into InterCatch prior to the 2019 WG meeting according with the deadline proposed. Uploaded data were worked up in InterCatch to generate 2018 raised international length–frequency distributions. Data exploration in InterCatch has previously shown that outputs of raised data were very close to those generated by the previous method applied internally with differences being <0.1%. As such, InterCatch length–frequency outputs have been used in the stock assessment since 2012.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Table 15.1.1 (see FU11 North Minch report, Section 12). These relate to the whole of area 6.a of which the FU13 is a part. Landings statistics for FU13 provided through national laboratories are presented in Table 17.1.1, broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, although Northern Ireland contributed 303 tonnes in 2018. Total reported Scottish landings in 2018 were 3838 tonnes (plus 303 tonnes from other UK vessels i.e. Northern Ireland), consisting of 3584 tonnes landed by trawlers (93.3%) and 251 tonnes (6.5%) landed by Scottish creel vessels. Creel landings have generally increased in the most recent years, from approximately 3% in 2012 to nearly 7% of total landings in 2018, which is still low compared to the other FUs in the west of Scotland.

Statistical rectangle 40E4 covers parts of both the Firth of Clyde and the Sound of Jura. Table 17.2.1 shows the split in landings between the two subareas comprising FU13. Historically the allocation of landings to the two components of FU13 was carried out by the fishery office and required them to have detailed knowledge of where vessels have been fishing within 40E4. The apparent sudden decline in landings from the Sound of Jura in 2001 is not considered to be associated with a sudden change in fishing practices and is thought more likely to be due to changes in fishery office recording practices. For this reason, the landings split is considered unreliable in recent years and the commercial landings data are now presented for the combined Firth of Clyde and Sound of Jura. Given the relative magnitudes of the fisheries (Clyde likely to be much bigger), the commercial data are likely to be more representative of the Clyde.

Effort data

In 2015, WGCSE agreed that effort should be reported in kW days, as this is likely to be more informative about changes in the actual fleet effort. Effort shows an overall decreasing trend but was stable through 2010 to 2012 (Figure 17.2.1). Effort increased in 2016 in comparison to 2015 but declined in 2017 and 2018. Note that the effort time-series range (2000–2018) does not match with the more extensive year range available for landings due to a lack of reliable effort data in the Marine Scotland Science in-house database. The effort is also slightly inconsistent with the landings data in that effort is provided for TR2 vessels while the '*Nephrops* trawl' landings additionally includes landings by large mesh trawlers targeting *Nephrops*.

Sampling levels

Length compositions of landings and discards are obtained during market and on-board observer sampling respectively. These sampling levels are shown in Table 15.2.2 (see FU11 North

Minch report, Section 12). Sampling effort decreased in 2018 compared to 2017 because of a change in the sampling design. This change was a trail and has since been reverted to the previous design due to the negative effect on sample numbers. This change had no effect on mean weights in landings and discards, these figures fell well within normal ranges.

Sampling of landings length compositions in the Sound of Jura is more infrequent but samples have been included in the FU13 raising procedure when available. Length compositions for the creel fishery are available for landings only. This is because survival in the, probably, low numbers of animals that are discarded (although little quantitative information exists) has been shown to be high (ICES, 2013). Therefore these animals are not considered to be removed from the population and hence a value of 100% survival is used (ICES, 2013).

Length compositions

Although assessments based on detailed catch analysis are not presently carried out, examination of length compositions can provide a preliminary indication of exploitation effects. Figure 17.2.2 shows a series of annual Clyde length–frequency distributions for the period 2000 to 2018. Catch (removals) length compositions are shown for each sex along with the mean size for both. There has been a decline in the mean sizes of both sexes since 2015. Examination of the tails of the distributions above 35 carapace length CL mm (the length beyond which the effects of recruitment pulses and discards are considered to be negligible) shows the maximum sampled size for both sexes has fallen. However, there is no obvious evidence of over- exploitation of the stock.

Sex ratio

Sex ratio in the Clyde shows some variation but males generally make the largest contribution to the annual landings (Figure 17.2.3(a)). This occurs because males are available throughout the year and the fishery takes place in all quarters, although effort is generally reduced during the winter months because of poor weather. Females on the other hand are mainly taken in the summer when they emerge after egg hatching. The seasonal change in proportion of males to females is evident in Figure 17.2.3(b) where males typically dominate in quarters one and four but the ratio is generally more even in quarters two and three. In 2016, males dominated in all quarters, but this was within the normal range of variation which is seen for this stock over the time-series. In 2017, a more expected pattern resumed with males dominating quarters one and four. In 2018, a higher proportion of males were caught in quarters one and four but there was a more even split in quarters in two and three.

Mean weights

The mean weights in the landings have fluctuated in this FU over the time-series. In 2018, the mean weight has declined since 2015, and is more obvious in the trawl caught males. Mean weight for FU13 is generally lower than other areas over the time-series (Table 15.2.3). There is a trend of increasing mean weights in the samples of landings for creel catches, noticeable for both sexes, but particularly for males in the early years of the time-series. However, this has declined in recent years, although sampling levels are low, particularly in the early and most recent years of the time-series. Given the seasonal variation present in other FUs it is not possible to state with any certainty that this trend is real (Figures 15.2.4 and 15.2.5; see FU11 North Minch report, Section 12).

Discarding

Discarding of undersized and unwanted *Nephrops* occurs in the Clyde fishery, and discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discard rates have been high in this FU and have averaged around 27.2% by number in this FU since 1999. Since 2010, discard rates have been estimated to be substantially lower than the long term average and in 2017 discards decreased to a low of 9.2%. In 2018, this decreased to the lowest rate in the time-series at only 2.5% (Table 17.2.2). Studies (Charuau *et al*., 1982; Sangster *et al*., 1997; Wileman *et al*., 1999) suggest that some *Nephrops* survive the discarding process. An estimate of 25% survival is assumed for this FU in order to calculate removals (landings + dead discards) from the population. The discard survival rate for creel caught *Nephrops* has been shown to be high (ICES, 2013) and a value of 100% is used. The discard rate for use in the forecast (adjusted to account for some survival) was estimated to be 7.1% (taking a three-year average from 2016 to 2018).

Abundance indices from UWTV surveys

Underwater TV surveys are available for both subareas since 1995 although the Sound of Jura has been surveyed more infrequently. Underwater television surveys of *Nephrops* burrow distributions avoid the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows. Full details of the UWTV approach can be found in the stock annex and the report of WKNEPH in 2009 (ICES, 2009). On average, 37 stations have been considered valid each year for the Firth of Clyde and 11 for the Sound of Jura. These are then raised to the estimated ground area available for *Nephrops*; in total 2080 km^2 based on contoured superficial sediment information (British Geological Surveys). In 2019, 38 valid stations were used in the survey final analysis for the Firth of Clyde (Table 17.2.3) and 12 stations for the Sound of Jura (Table 17.2.4). Table 17.2.5 shows a detailed breakdown of information from the most recent TV surveys conducted in the Firth of Clyde. This includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. Details for the Sound of Jura are shown in Table 17.2.6. A CV (relative standard error) of <20% is considered an acceptable precision level for UWTV survey estimates of abundance (SGNEPS, ICES, 2012). CVs for the three most recent TV surveys in Firth of Clyde and Sound of Jura are lower than the precision level agreed.

Figure 17.2.4 shows the distribution of stations in recent TV surveys (2014–2019) across FU13 (the two distinct subareas can be clearly seen) with the size of the symbols proportional to the *Nephrops* burrow density. Table 17.2.3 and Figure 17.2.5 show the time-series estimated abundance for the TV surveys in the Firth of Clyde, with 95% confidence intervals on annual estimates. Similar information for the Sound of Jura is shown in Table 17.2.4 and Figure 17.2.6. Most surveys have shown higher density in the southern part of the Clyde. In 2018 and 2019, this appeared to still be the case.

The TV survey estimates of abundance for *Nephrops* in the Firth of Clyde suggest that the population increased until the mid-2000s implying a sustained period of increased recruitment. Following this, abundance has fluctuated around the values previously observed in the early 2000s. In 2019, the abundance decreased but was well within normal ranges (Figure 17.2.5).

There is not a continuous time-series of abundance in the Sound of Jura and in some years (particularly 2002 and 2006) estimates are associated with large confidence intervals. Abundance has fluctuated with no obvious trend. In 2013, the abundance was at the second lowest point in the time-series. The abundance increased in subsequent years to 2016, however decreased in 2017 and 2018 but increased in 2019 (Figure 17.2.6).

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009; ICES, 2013). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative relative to absolute conversion factor estimated for FU13 was 1.19 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 19%.

14.3 Assessment

Comparison with previous assessments

The assessment in 2019 is based on a combination of examining trends in fishery indicators and underwater TV, using an extensive dataseries for the Firth of Clyde component of FU13 and a more limited time-series of UWTV data from the Sound of Jura subarea. The assessment in 2019 follows that of previous years (since 2015) in that the commercial data for Clyde and Sound of Jura have been combined, because of concerns regarding the accuracy of the landings data. There are also no discard samples and limited market samples available for the Sound of Jura. Therefore, the harvest rate and catches for the two areas are presented as a combined total. *Nephrops* abundance will continue to be monitored separately, with a TV survey in both subareas.

State of the stock

The underwater TV surveys are presented as the best available information on the stocks of *Nephrops* in the two subareas of FU13. The surveys provide fishery-independent estimates of *Nephrops* abundance. At present, it is not possible to extract any length or age-structure information from the survey and it therefore only provides information on abundance over the area of the survey.

TV survey estimated stock abundance for the Firth of Clyde in 2019 was 2083 million individuals, a 5% decrease from the 2018 estimate but still well above the $B_{trigger}$ value of 579 million, rounded to 580 million for the provision of advice. TV survey estimated stock abundance for the Sound of Jura in 2019 was 318 million individuals, a 15.6% increase on the 2018 estimate and above the $B_{trigger}$ value of 160 million (this value does not require rounding for the provision of advice).

The calculated harvest rate for the FU13 in 2019 (dead removals for both subareas/Firth of Clyde and Sound of Jura TV abundance = 11.1%) was below the F_{MSY} proxy value (the value associated with high long-term yield and low risk depletion) for both the Clyde (15.1%) and the Sound of Jura (12.0%). Note the F_{MSY} proxy values for this stock was revised in October 2015 at WKMSYRef4 (ICES, 2016b).

14.4 Catch option table

Landings predictions and catch options at various harvest rates (based on principles established at WKNEPH (ICES, 2009)), will be made on the basis of the 2019 UWTV survey conducted in June. These will be presented in October 2019 for the provision of advice.

Catch scenario table inputs and historical estimates of mean weight in landings and harvest rates are presented in Table 17.2.2 and summarised below. The calculation of catch options for the FU13 follows the procedure outlined in the stock annex.

The table below shows the agreed inputs to the catch scenarios table.

Input	Data	2019 assessment
Survey abundance (millions)	UWTV 2019	2083 Clyde 318 SoJ
Mean weight in wanted catch (g)	2016–2018	16.95
Mean weight in unwanted catch (g)	2016–2018	9.18
Unwanted catch	Average 2016–2018 (proportion by number; combined for Firth of Clyde and Sound of Jura)	9.2%
Discards survival	Proportion by number	25%
Average dead unwanted catch rate	2016–2018	7.1%

14.5 Reference points

F_{MSY} proxy for this stock was revised in October 2015 at WKMSYRef4 (ICES, 2016a; ICES, 2016b). These were updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, which corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values a five-year average was chosen. Similarly, the five-year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five year average of the F above F_{MAX} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy, which occasionally appear. For this functional unit the F_{MSY} proxy has been revised to 15.1% for the Clyde and 12.0% for the Sound of Jura respectively.

For *Nephrops* stocks, MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased and is calculated as 579 million individuals for the Firth of Clyde. The advice from WKMSYRef4 (ICES, 2016b) rounded this value to give an MSY $B_{trigger}$ of 580 million.

MSY $B_{trigger}$ was not previously proposed for FU13 (SJ) as there were few points in the survey series (due to missing years). WKMSYRef4 stated that the survey series is now considered to be of sufficient length to allow the B_{loss} (abundance in 1995) to be proposed as the MSY $B_{trigger}$. This results in a value of 160 million (ICES, 2016b). Full details are contained in the stock annex.

These should remain under review by WGCSE and may be revised should improved data become available.

Table 17.2.2 and Figure 17.4.1 show the estimated harvest rates over this period. The harvest rate was calculated from the total dead removals for both subareas divided by the combined abundance for the Firth of Clyde TV survey and the Sound of Jura. This does result in some years were the harvest rate is not calculable as we do not have a full time-series of TV surveys for the Sound of Jura. The combined harvest rate peaked in 2007 at 43.0% before declining to around the F_{MSY} level for the Clyde in 2010–2011. The harvest rate has fluctuated since then and declined in 2018 to 11.1% (below F_{MSY}) from 17.6% in 2017 (above F_{MSY}). It is unlikely that prior to 2006, the estimated harvest rates are representative of actual harvest rates due to under-reporting of landings.

14.6 Management strategies

Scotland has recently established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

A weekend ban on mobile gear was introduced in the Clyde in 1986 under a Scottish Statutory Instrument. Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night, as are vessels greater than 21 m in length.

On the 8th of February 2016, phase 1 of the fisheries management measures for inshore MPAs in Scottish waters came into force (SG, 2016). These measures relate to both NCMPA (Marine (Scotland) Act and the UK Marine and Coastal Access Act) and Special Areas of Conservation (EC Habitats Directives – Council Directive 92/43/EEC) both of which have the aim of conserving biological diversity in Scottish waters and along with other protected sites make up Scotland's MPA network (SG, 2017a). Although not specific to the management of the *Nephrops* fishery they will influence spatial patterns of fishing for *Nephrops* where controls on the two main gear types, demersal trawls and creels, are implemented on *Nephrops* habitat. There are three NCMPAs within the Clyde functional unit. The MPA, which extends onto the main patch of *Nephrops* habitat, is the South Arran NCMPA, within the Firth of Clyde subarea, where a complete ban on demersal vessels greater than 120 gross tonnage has been implemented. Partial closures (i.e. zoned management) for demersal trawlers smaller than this size and creelers are also in place. For Loch Sween, north of the main habitat area in the Sound of Jura subarea, demersal trawling by vessels is banned. However, for trawlers smaller than 75 gross tonnage, temporal closures are in place over some of the area. For the Upper Loch Fyne and Loch Goil NCMPA, just north of the main habitat area in Firth of Clyde subarea, demersal trawling by vessels greater than 75 gross tones is banned and the activity of vessels below this is zoned. Creeling activity is also zoned (SG, 2016). The areas of the NCMPAs relative to the estimated *Nephrops* habitat within the Clyde functional unit are presented in Figure 17.6.1.

14.7 Quality of assessment and forecast

There are concerns over the accuracy of historical landings and effort data and because of this the final assessment adopted is independent of official statistics. Harvest rates since 2006 are also considered more reliable due to more accurate landings data reported under new legislation.

One of the main issues for this FU is the problem of not being able to split the landings between the Sound of Jura and Firth of Clyde. This means that we are unable to provide harvest rates for the two subareas separately. What is currently provided is not actually a harvest rate for either sub area; but is likely more representative of the Firth of Clyde. This has an impact on the quality of the assessment but not on the forecast.

In recent years, the length and sex composition of the landings data is considered to be well sampled. However, in 2018 sampling levels fell below this normal standard. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in the Firth of Clyde subarea fishery since 1990, and is considered to represent the fishery adequately. There are few samples available from the Sound of Jura and these have been included in the FU13 raising procedure.

Underwater TV surveys have been conducted for this stock every year since 1995. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals around the abundance estimates are stable throughout the series and relatively low compared with other FUs in area 6.a. In the provision of catch scenarios based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. A three-year average (2016–2018) of discard rate (adjusted to account for some survival of discarded animals) has been used in the calculation of catch advice.

The cumulative relative to absolute conversion factor estimates for FU13 component is largely based on expert opinion (see stock annex). The precision of these bias corrections cannot yet be characterised. The method to derive landings for the catch options is sensitive to the input dead discard rate and mean weight in landings and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. VMS data, recently made available and linked to landings (from queries of the Scottish FIN database) suggest no major differences between areas fished and the mud sediment maps. The inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations, while in the Clyde the non-estimated sea loch areas are relatively small.

14.8 Recommendation for next benchmark

This stock was last benchmarked in 2009 (ICES, 2009). WGCSE recommends that the issue concerning the split of landings between Sound of Jura and the Firth of Clyde be examined when this stock is next proposed for benchmark process.

14.9 Management considerations

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the Functional Unit level could provide controls to ensure effort and catch were in line with resources available. In this FU, the two subareas imply that additional controls may be required to ensure that the landings taken in each subarea are in line with the landings advice.

Creel fishing takes place in part of this area although the relative scale of the fishery is smaller than in the Minches. Overall effort in terms of creel numbers is not known, and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the Firth of Clyde and estimated discards of whiting and haddock by the TR2 fleet are generally high in area 6.a. It is important that efforts continue to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod include the implementation of large square meshed panels (SMPs) of 120 mm under the west coast emergency measures, and SMPs of 200 mm implemented as part of the previous Scottish Conservation Credits scheme. A seasonal closure (early spring) in the southwest part of the Firth of Clyde is in place to protect spawning cod although *Nephrops* vessels are derogated to fish in those parts where mud sediments are distributed.

14.10 References

Bailey, N. and Chapman, C. J. 1983. A comparison of density, length composition and growth of two populations off the West coast of Scotland. ICES C. M. 1983/K:42.

BGS. 2011. Marine SeaBed Sediment Map - UK Waters - 250k (DigSBS250). British Geological Survey, Nottingham. Available at: <http://www.bgs.ac.uk/discoverymetadata/13605549.html> [Accessed: unknown date].

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea, ICES-CM-1982/B:13.

Council Reg. (EU) 43/2009.

ESRI. 2014. ArcGIS. Version 10.2.1. Environmental Systems Research Institute, Inc.: Redlands, CA.

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L 83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9–11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22. 95 pp.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2013. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2013/ACOM:45. 230 pp.

ICES. 2016a. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

ICES. 2016b. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2017. ICES Statistical Rectangles. International Council for the Exploration of the Sea: Copenhagen, Denmark. Available at: <http://geo.ices.dk/index.phpSource> [Accessed: 16/03/2017].

Sangster, G.I., Breen, M., Bova, D.J., Kynoch, R., O'Neill, F.G., Lowry. N., Moth-Poulsen, T. Hansen, U.J., Ulmestrand, M., Valentinsson, D., Hallback, H., Soldal, A.V., and Hoddevik, B. 1997. *Nephrops* survival after escape and discard from commercial fishing gear. Presented at ICES FTFB Working Group, Hamburg, Germany 14–17 April, 1997, ICES CM 1997 CM/B.

SG. 2016. Simple guide to fisheries management measures in Marine Protected Areas. Marine Scotland (The Scottish Government): Edinburgh. Available at: <http://www.gov.scot/Resource/0049/00498320.pdf> [Accessed: 16/05/2017].

SG. 2017a. Marine Protected Areas in Scotland's Seas - Guidelines on the selection of MPAs and development of the MPA network. Marine Scotland (The Scottish Government): Edinburgh. Available at: <http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/mpaguidelines> [Accessed: 16/05/2017].

SG. 2017b. Marine conservation orders (MCOs) and fisheries management measures (MPAs and SACs) - with effect May 2017. Marine Scotland (The Scottish Government): Edinburgh. Available at: <https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?availablelayers=838> [Accessed: 31/05/2017].

SNH. 2015. Nature Conservation Marine Protected Areas. Scottish Natural Heritage (Scottish Government): Inverness. Available at: <https://gateway.snh.gov.uk/natural-spaces/index.jsp> [Accessed: 03/04/2017].

SNH. 2016. Special Areas of Conservation. Scottish Natural Heritage (Scottish Government): Inverness. Available at: <https://gateway.snh.gov.uk/natural-spaces/index.jsp> [Accessed: 03/04/2017].

Tuck, I.D., Chapman C.J. and Atkinson, R.J.A. 1997. Population biology of the Norway lobster, *Nephrops norvegicus* (L.) in the Firth of Clyde, Scotland. I: Growth and density. ICES J. Mar.Sci 54, 125–135.

Tuck, I.D., Bailey, N., Atkinson, R.J.A. and Marrs, S.J. 1999. Changes in *Nephrops* density in the Clyde Sea area from UWTV survey data. ICES, Doc. Living Resources Comm., CM 1999/G:13 (mimeo).

Wessel, P. and Smith, W.H.F. 2016. GSHHG version 2.3.6 - A Global Self-consistent, Hierarchical, High-resolution Geography Database. National Centers for Environmental Information, National Oceanic and Atmospheric Administration: Boulder, CO. <https://www.ngdc.noaa.gov/mgg/shorelines/gshhs.html> [Accessed: 31/05/2017].

Wileman, D.A., Sangster, G.I., Breen, M., Ulmestrand, M., Soldal, A.V. and Harris, R.R. 1999. Roundfish and *Nephrops* survival after escape from commercial fishing gear. EU Contract Final Report. EC Contract No: FAIR-CT95-0753.

Table 17.1.1. *Nephrops,* **Clyde and Sound of Jura (FU13), ICES estimates of landings of** *Nephrops***, 1981–2018.**

UK SCOTLAND						OTHER UK	IRELAND	TOTAL**
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIMUM SIZE	SUB TOTAL			
1981	2498	404	66	0	2968	0	0	2968
1982	2372	169	79	0	2620	0	0	2620
1983	3889	121	52	0	4062	14	0	4076
1984	3070	153	77	0	3300	10	0	3310
1985	3921	293	65	0	4279	7	0	4286
1986	4073	176	79	0	4328	13	0	4341
1987	2860	82	64	0	3006	3	0	3009
1988	3507	107	43	0	3657	7	0	3664
1989	2577	184	35	0	2796	16	0	2812
1990	2731	121	23	0	2875	34	0	2909
1991	2844	145	26	0	3015	23	0	3038
1992	2530	247	9	0	2786	17	0	2803
1993	3200	110	5	0	3315	28	0	3343
1994	2503	50	28	0	2581	49	0	2630
1995	3766	131	26	0	3923	64	0	3987
1996	3880	108	27	0	4015	42	0	4057
1997	3486	46	26	0	3558	63	0	3621
1998	4540	79	39	0	4658	183	0	4841
1999	3476	29	37	0	3542	210	0	3752
2000	3142	63	75	0	3280	137	0	3417
2001	2890	65	95	0	3050	132	0	3182
2002	3075	53	105	0	3233	151	0	3384
2003	2954	20	119	0	3093	80	0	3173
2004	2619	8	88	0	2715	258	0	2973
2005	3148	5	94	0	3247	148	0	3395
2006	4356	1	179	0	4536	244	0	4780

UK SCOTLAND						OTHER UK	IRELAND	TO-TAL**
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIMUM SIZE	SUB TO-TAL			
2007	6069	4	221	0	6294	366	0	6660
2008	5320	3	184	0	5507	416	0	5923
2009	4304	1	191	0	4496	283	0	4779
2010	5162	5	211	0	5378	465	0	5843
2011	5664	9	219	0	5892	540	0	6432
2012	5617	4	203	0	5824	863	0	6687
2013	4708	4	212	0	4924	511	0	5435
2014	4770	1	258	0	5029	1178	0	6207
2015	4035	8	206	0	4249	898	0	5147
2016	4922	6	267	0	5195	1248	4	6447
2017	4021	3	256	0	4280	941	1	5222
2018	3584	3	251	0	3838	303	0	4141

Table 17.2.1. ***Nephrops,*** **Clyde (FU13), ICES estimated landings of** ***Nephrops*****, in each of the subareas (Firth of Clyde and Sound of Jura 1981–2018).**

YEAR	UK LANDINGS		
	FIRTH OF CLYDE	SOUND OF JURA	ALL SUBAREAS
1981	2277	691	2968
1982	1983	637	2620
1983	3395	681	4076
1984	2600	710	3310
1985	3561	725	4286
1986	3228	1113	4341
1987	2408	601	3009
1988	3509	155	3664
1989	2595	217	2812
1990	2592	317	2909
1991	2654	384	3038
1992	2383	420	2803
1993	2766	577	3343
1994	2095	535	2630
1995	3692	295	3987
1996	3671	386	4057
1997	3135	486	3621
1998	4373	468	4841
1999	3423	329	3752
2000	3229	188	3417
2001	2979	203	3182
2002	3350	34	3384
2003	3154	19	3173
2004	2965	8	2973
2005	3388	7	3395
2006	4768	12	4780
2007	6580	80	6660

YEAR	UK LANDINGS		
	FIRTH OF CLYDE	SOUND OF JURA	ALL SUBAREAS
2008	5845	78	5923
2009	4688	91	4779
2010	5782	61	5843
2011	6363	69	6432
2012	6634	53	6687
2013	NA	NA	5435
2014	NA	NA	6207
2015	NA	NA	5147
2016	NA	NA	6443
2017	NA	NA	5222
2018	NA	NA	4141

Table 17.2.2. *Nephrops*, Clyde (FU13): Firth of Clyde and Sound of Jura combined. Adjusted TV survey abundance (Firth of Clyde subarea), landings, discard rate (proportion by number) and estimated harvest rate. The harvest rate was calculated from the total (dead) removals in number for both subareas divided by the combined abundance from both TV surveys.

YEAR	LANDINGS IN NUMBERS (MILLIONS)	DISCARD IN NUMBERS (MILLIONS)	REMOVALS IN NUMBERS (MILLIONS)**	ADJUSTED SURVEY CLYDE (MILLIONS)	ADJUSTED SURVEY JURA (MILLIONS)	COMBINED HARVEST RATE*	LANDINGS (TONNES)	DISCARDS (TONNES)	DEAD DISCARDS (TONNES)	DISCARD RATE (%)	DEAD DISCARD RATE (%)	MEAN WEIGHT IN LANDINGS (gr)	MEAN WEIGHT IN DISCARDS (gr)
1995	207	82	269	579	160	36.40	3987	619	464	28.4	22.90	19.24	7.54
1996	187	61	233	935	171	21.07	4057	635	476	24.7	19.70	21.68	10.35
1997	150	70	202	1198	NA	NA	3621	598	448	32	26.10	24.21	8.50
1998	269	187	409	1262	NA	NA	4841	1292	969	41	34.20	17.98	6.92
1999	216	93	286	930	NA	NA	3752	566	424	30.2	24.50	17.39	6.05
2000	171	48	207	1411	NA	NA	3417	470	352	22	17.40	19.96	9.75
2001	164	82	225	1486	272	12.80	3182	677	508	33.5	27.40	19.46	8.23
2002	207	50	245	1571	398	12.44	3384	406	305	19.5	15.40	16.35	8.12
2003	166	134	266	1817	260	12.81	3173	1247	935	44.7	37.70	19.13	9.31
2004	158	168	284	1970	NA	NA	2973	1435	1076	51.5	44.30	18.80	8.54
2005	189	69	241	1959	303	10.65	3395	611	458	26.8	21.60	17.96	8.81
2006	248	55	290	1851	430	12.71	4780	515	386	18.2	14.30	19.27	9.31
2007	350	387	640	1233	255	43.01	6660	2566	1924	52.5	45.30	19.05	6.64
2008	357	207	512	1769	NA	NA	5923	1433	1075	36.6	30.30	16.59	6.94
2009	261	169	388	1499	251	22.17	4779	1390	1043	39.3	32.70	18.31	8.23
2010	276	55	317	1750	376	14.91	5843	536	402	16.7	13.10	21.21	9.68
2011	333	74	388	2165	312	15.66	6432	568	426	18.2	14.30	19.34	7.65

YEAR	LANDINGS IN NUMBERS (MILLIONS)	DISCARD IN NUMBERS (MILLIONS)	REMOVALS IN NUMBERS (MILLIONS)**	ADJUSTED SURVEY CLYDE (MILLIONS)	ADJUSTED SURVEY JURA (MILLIONS)	COMBINED HARVEST RATE*	LANDINGS (TONNES)	DISCARDS (TONNES)	DEAD DISCARDS (TONNES)	DISCARD RATE (%)	DEAD DISCARD RATE (%)	MEAN WEIGHT IN LANDINGS (gr)	MEAN WEIGHT IN DISCARDS (gr)
2012	306	93	376	1421	371	20.98	6687	1066	800	23.4	18.60	21.83	11.42
2013	262	62	309	1990	198	14.12	5435	454	341	19	15.00	20.72	7.37
2014	295	78	353	1328	231	22.64	6207	696	522	20.9	16.60	20.79	8.92
2015	232	54	273	1820	376	12.43	5147	401	301	18.9	14.80	22.21	7.43
2016	364	69	416	1946	422	17.57	6447	636	477	15.9	12.40	17.70	9.21
2017	305	31	329	1568	306	17.56	5222	265	199	9.2	7.10	17.02	8.55
2018	268	7	273	2193	275	11.06	4141	68	51	2.5	1.90	16.14	9.79
Average***											7.13	16.95	9.18

*** Harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Dead discard average: 2016–2018; Mean weight in landings and discard average: 2016–2018.**

Table 17.2.3. *Nephrops*, Clyde (FU13): Firth of Clyde subarea. Results of the 1995–2019 TV surveys (values adjusted for bias).

YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS / m^2)	ABUNDANCE (MILLIONS)	95% CONFIDENCE INTERVAL (MILLIONS)
1995	29	0.277	579	176
1996	38	0.454	935	242
1997	31	0.571	1198	262
1998	38	0.605	1262	213
1999	39	0.445	930	289
2000	40	0.681	1411	246
2001	39	0.714	1486	268
2002	36	0.756	1571	288
2003	37	0.874	1817	292
2004	32	0.95	1970	367
2005	44	0.941	1959	287
2006	43	0.882	1851	257
2007	40	0.597	1233	218
2008	38	0.849	1769	291
2009	39	0.723	1499	210
2010	37	0.84	1750	327
2011	40	1.041	2165	305
2012	37	0.681	1421	227
2013	34	0.956	1990	246
2014	35	0.639	1328	237
2015	37	0.875	1820	351
2016	37	0.935	1946	249
2017	38	0.754	1568	239
2018	40	1.055	2193	297
2019	38	1.002	2083	381

Table 17.2.4. ***Nephrops*, Clyde (FU13): Sound of Jura subarea. Results of the 1995–2019 TV surveys (values adjusted for bias).**

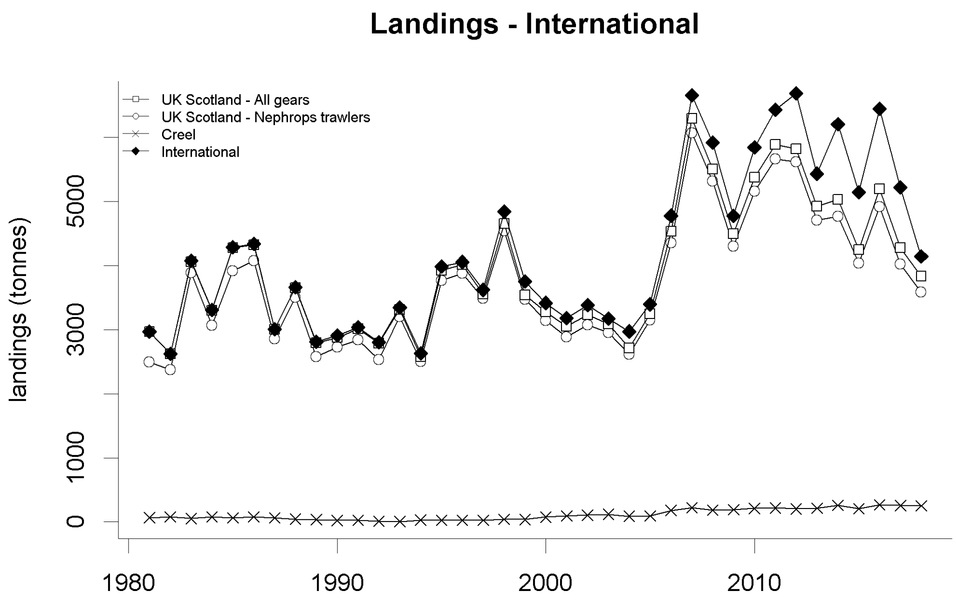
YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS / m²)	ABUNDANCE (millions)	95% CONFIDENCE INTERVAL (millions)
1995	7	0.42	160	58
1996	10	0.45	171	26
1997	no surveys			
1998				
1999				
2000				
2001	13	0.71	272	76
2002	9	1.04	398	167
2003	12	0.68	260	68
2004	no survey			
2005	11	0.79	303	84
2006	10	1.13	430	134
2007	10	0.67	255	58
2008	no survey			
2009	12	0.66	251	68
2010	12	0.98	376	39
2011	12	0.82	312	73
2012	12	0.98	371	61
2013	9	0.52	198	35
2014	9	0.61	231	90
2015	12	0.98	376	127
2016	12	1.11	422	42
2017	12	0.80	306	71
2018	12	0.72	275	53
2019	12	0.832	318	61

Table 17.2.5. ***Nephrops*, Clyde (FU13): Firth of Clyde subarea. Results by stratum of the 2017–2019 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

STRATUM	AREA (km^2)	NUMBER OF STATIONS	MEAN BURROW DENSITY (no./m^2)	OBSERVED VARIANCE	ABUNDANCE (MILLIONS)	STRATUM VARIANCE	PROPORTION OF TOTAL VARIANCE	SURVEY PRECISION LEVEL (RSE)
2017 TV survey								
M	716.8	14	0.634	0.048	454.8	1761	0.123	
SM	698.6	12	0.938	0.201	655	8163	0.57	
MS	664.6	12	0.69	0.119	458.4	4387	0.307	
Total	2080	38			1568.2	14312	1	0.07
2018 TV survey								
M	716.8	13	1.015	0.122	727.5	4821	0.219	
SM	698.6	14	1.284	0.285	897	9909	0.45	
MS	664.6	13	0.855	0.215	568.8	7312	0.332	
Total	2080	40			2193.3	22042	1.001	0.07
2019 TV survey								
M	716.8	14	0.841	0.096	602.8	3517	0.097	
SM	698.6	11	1.329	0.458	928.1	20296	0.559	
MS	664.6	13	0.831	0.367	552.4	12467	0.344	
Total	2080	38			2083.3	36279	1	0.09

Table 17.2.6. ***Nephrops,*** **Clyde (FU13): Sound of Jura subarea. Results by stratum of the 2017–2019 TV surveys. Note that stratification was based on a series of sediment strata.**

STRATUM	AREA (km2)	NUMBER OF STATIONS	MEAN BURROW DENSITY (no./m2)	OBSERVED VARIANCE	ABUNDANCE (MILLIONS)	STRATUM VARIANCE	PROPORTION OF TOTAL VARIANCE	SURVEY PRECISION LEVEL SURVEY (RSE)
2017 TV survey								
M	90	2	0.454	0.014	40.8	57	0.045	
SM	150	5	0.879	0.124	131.8	560	0.44	
MS	142	5	0.939	0.163	133.4	657	0.515	
Total	382	12			306.1	1274	1	0.073
2018 TV survey								
M	90	3	0.739	0.019	66.6	52	0.075	
SM	150	4	0.691	0.008	103.7	43	0.062	
MS	142	5	0.734	0.148	104.3	598	0.863	
Total	382	12			274.5	693	1	0.10
2019 TV survey								
M	90	2	0.689	0.088	62	357	0.389	
SM	150	4	0.878	0.023	131.8	128	0.139	
MS	142	6	0.874	0.129	124.1	434	0.472	
Total	382	12			317.9	919	1	0.101



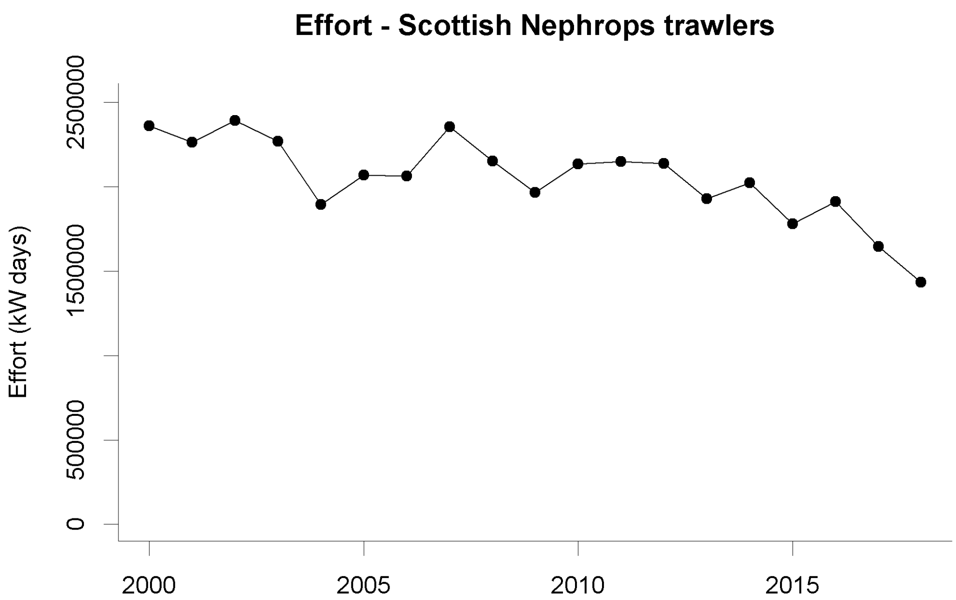


Figure 17.2.1. ***Nephrops*****, Clyde (FU13). Long-term landings and effort.**

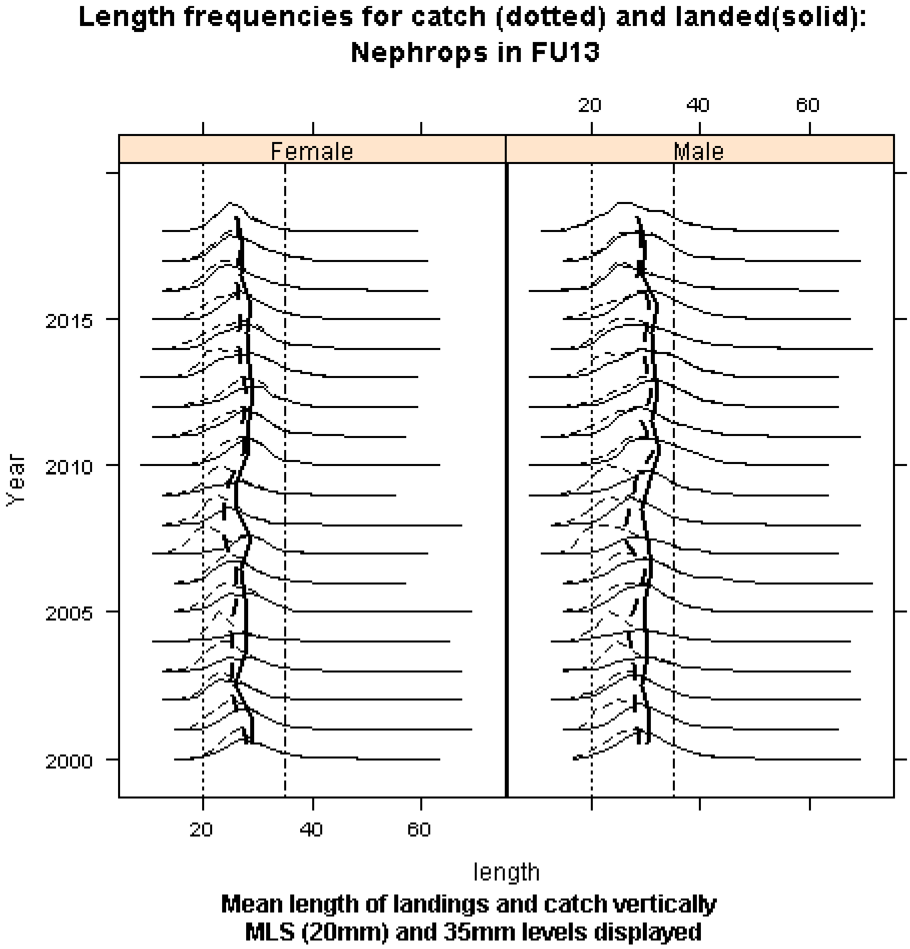
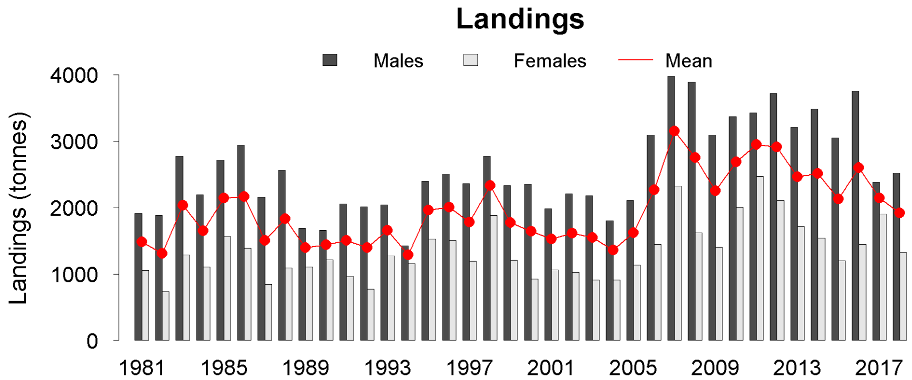


Figure 17.2.2. ***Nephrops,*** **Clyde (FU13). Catch length–frequency distribution and mean size in catches (dotted) and landings (solid) for** ***Nephrops,*** **2000–2018.. Vertical lines are minimum conservation reference size (25 mm) and 35 mm.**



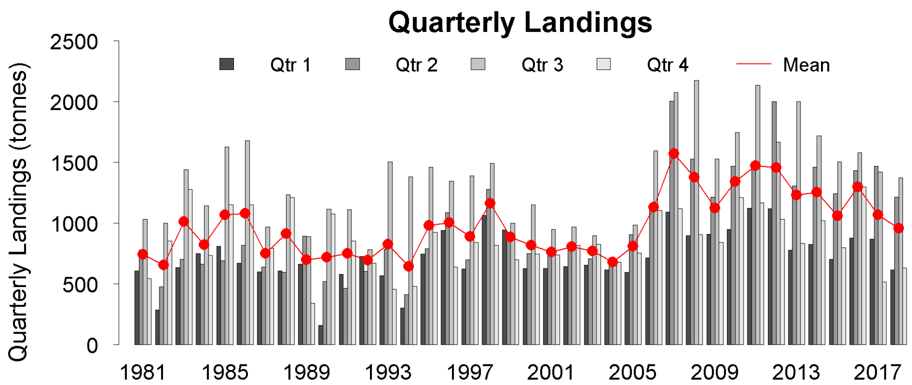


Figure 17.2.3.(a) *Nephrops*, Clyde (FU13). Landings by quarter and sex from Scottish trawlers.

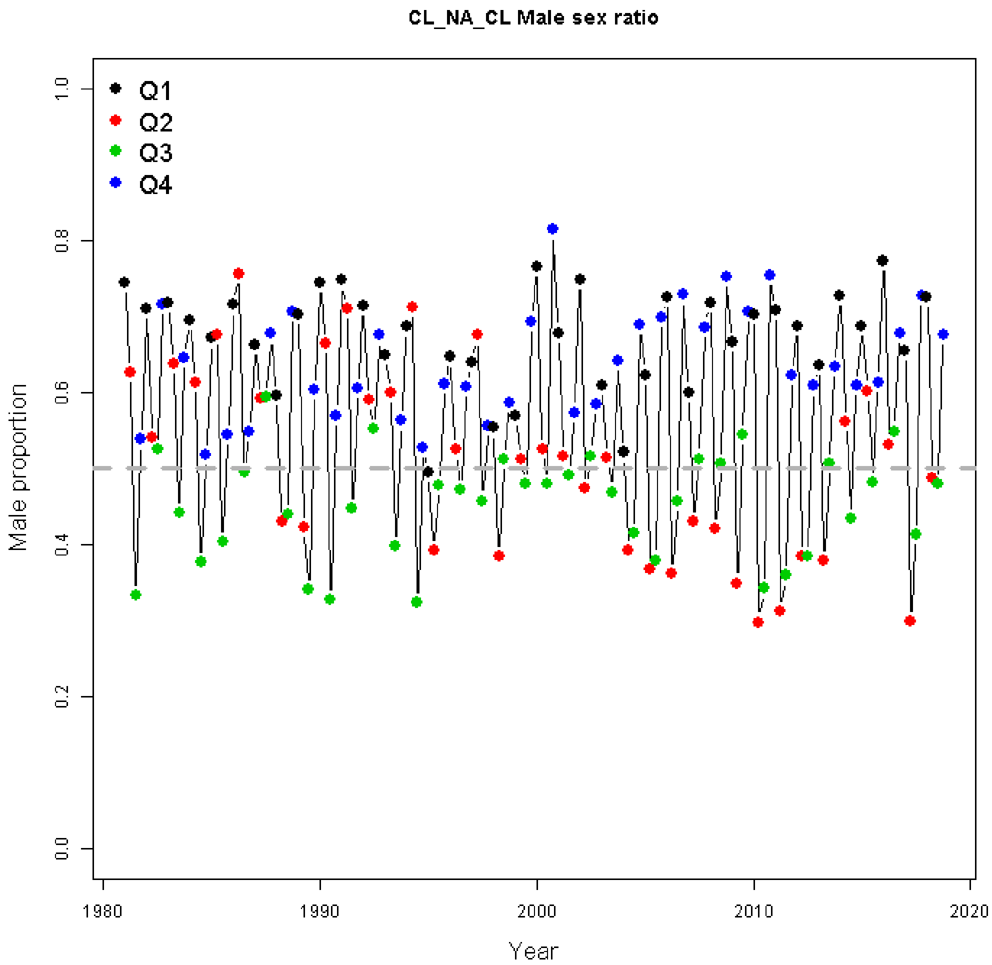


Figure 17.2.3. (b) *Nephrops,* Clyde (FU13), Proportion of males by quarter (1980–2018).

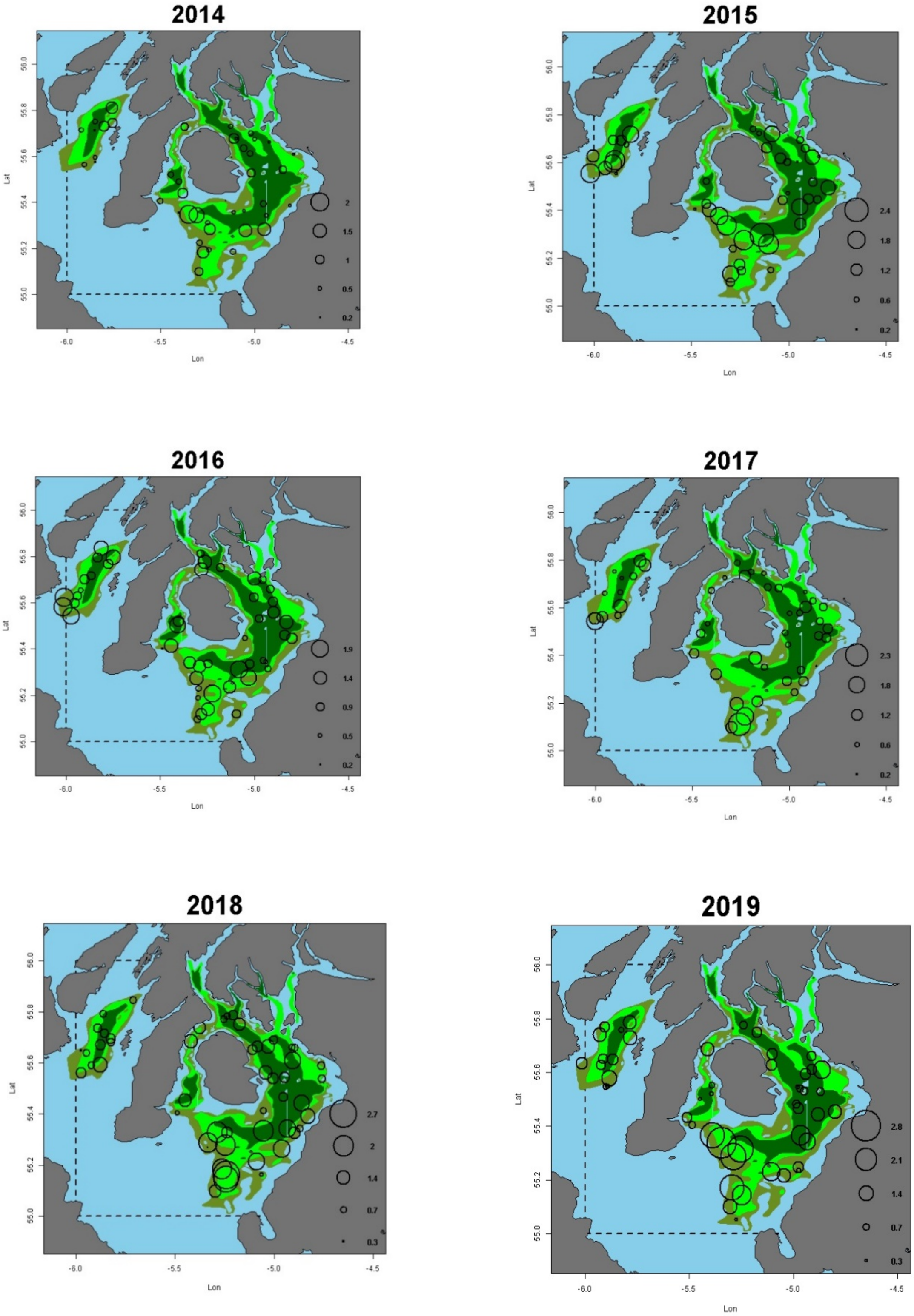


Figure 17.2.4. *Nephrops*, **Clyde (FU13), TV survey station distribution and relative density (burrows/m²) for Firth of Clyde and Sound of Jura subareas, 2014–2019. Sound of Jura located to the east. Shaded green and brown areas represent areas of suitable sediment for** ***Nephrops*****. Bubbles scaled the same. Red crosses represent zero observations.**

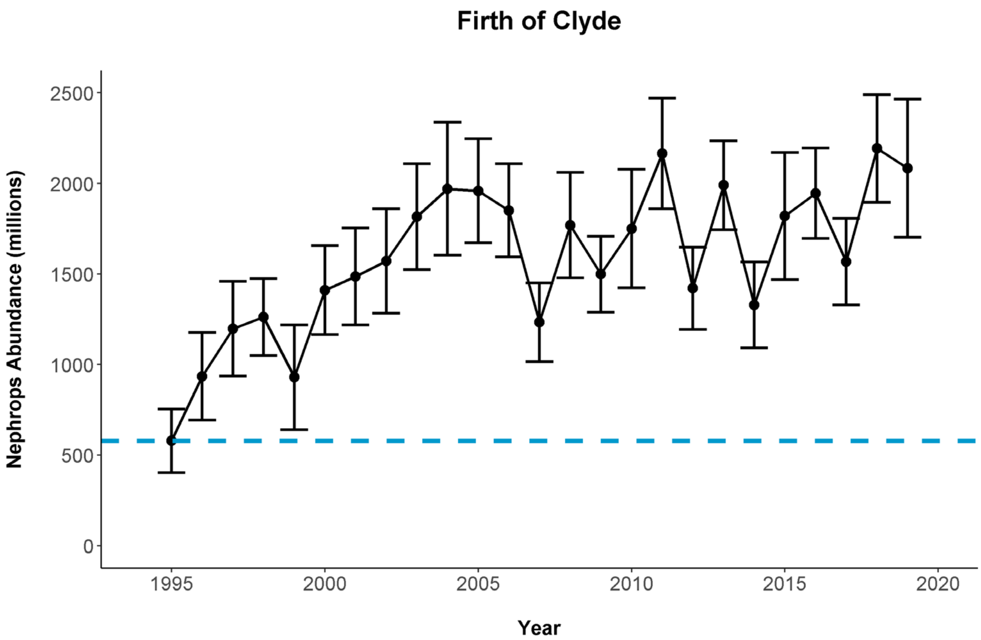


Figure 17.2.5. ***Nephrops*****, Clyde (FU13): Firth of Clyde subarea. Time-series of revised TV survey abundance estimates (adjusted for bias), with 95% confidence intervals, 1995–2019. The dashed blue line is the rounded $B_{trigger}$ value of 580 million individuals.**

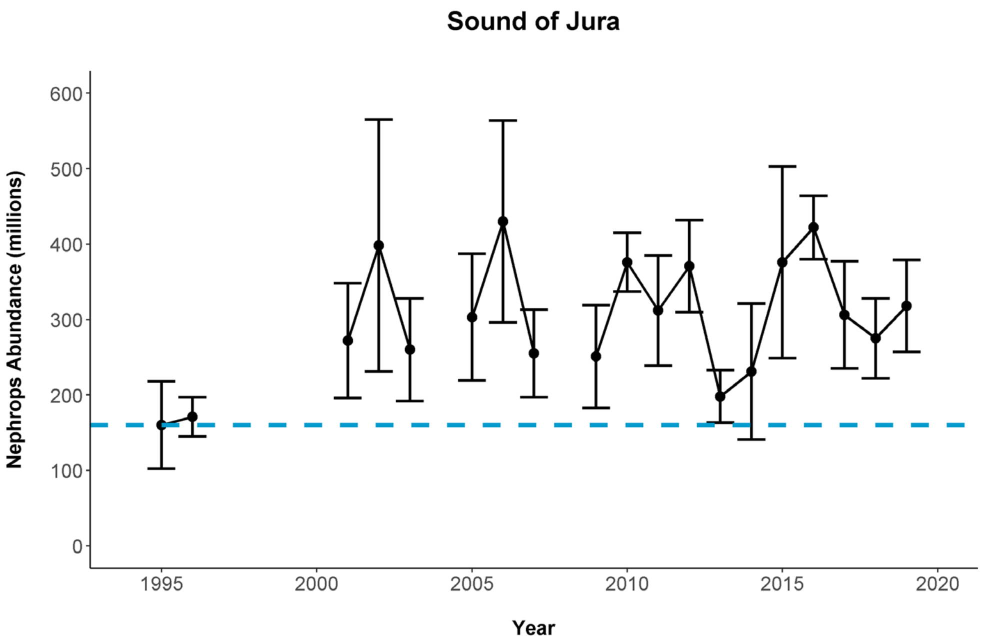


Figure 17.2.6. ***Nephrops*****, Clyde (FU13): Sound of Jura subarea. Time-series of TV survey abundance estimates (adjusted for bias) with 95% confidence intervals, 1995–2019. The dashed blue line is the rounded $B_{trigger}$ value of 160 million individuals.**

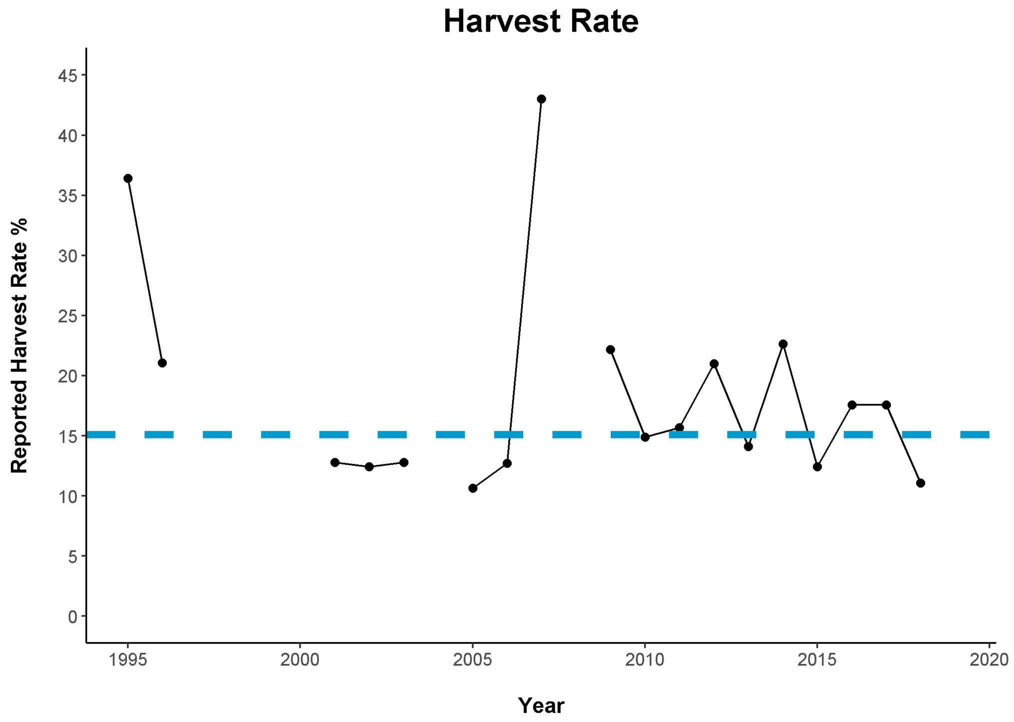


Figure 17.4.1. Clyde (FU13) *Nephrops* harvest rate, 1995–2019. The harvest rate is calculated by dead removals (both subareas combined)/TV abundances (both sub-areas combined). The dashed and solid lines are the F_{MSY} proxy harvest rate (for the Firth of Clyde 15.1%) and the harvest rate respectively. Harvest rates prior to 2006 are unreliable.

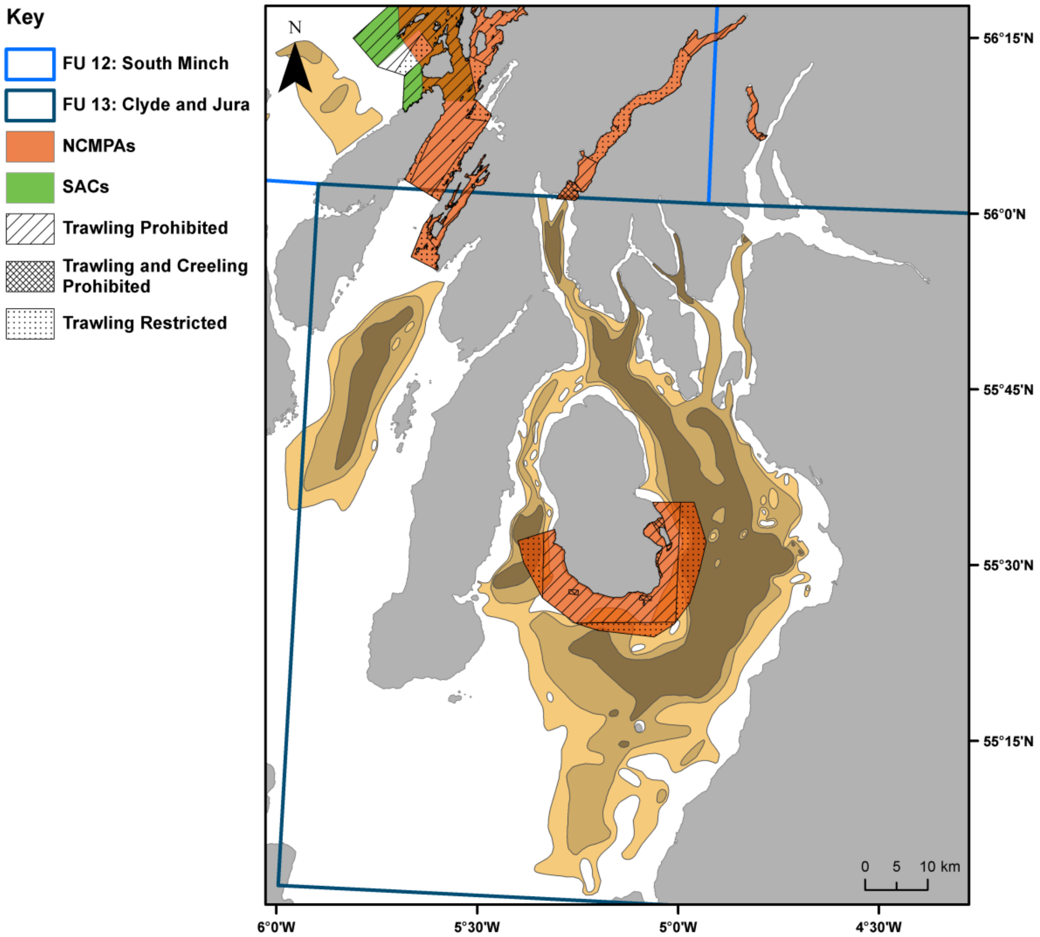


Figure 17.6.1. The area of *Nephrops* habitat (Mud, Muddy Sand and Sandy Mud) within the Clyde functional unit (FU13) relative to the areas of the Nature Conservation MPAs (NCMPAs) which fisheries management measures. Areas where demersal trawling is prohibited, restricted (i.e. vessel size restrictions or seasonal closures) and where creeling is prohibited are displayed. For more detailed information see SG (2016). Geographic Coordinate System: OSGB 1936, Datum: OSGB 1936, Projected Coordinate System: British National Grid. Coastline by Wessel and Smith (2016), MPA sites subsetted from NCMPA (SNH, 2015) and SAC (SNH, 2016) layers, management areas by SG (2017b) and functional units generated from merged ICES rectangles (ICES, 2017). Map and modified layers created using ArcGIS (ESRI, 2014).

15 Norway lobster (*Nephrops norvegicus*) in Division 7.a, Functional Unit 14 (Irish Sea East)

15.1 *Nephrops* Subarea 7 general section

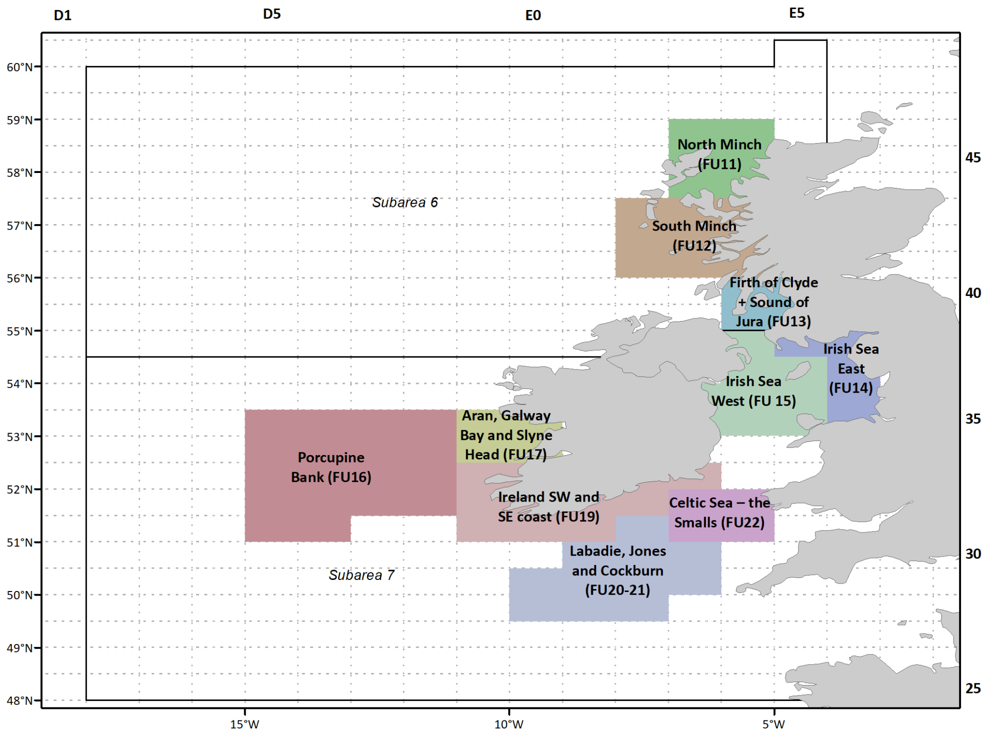
Stock description and management units

A TAC is in place for ICES Area 7, which does not correspond to the assessment units. As *Nephrops* are limited to muddy habitats, the distribution of suitable sediment defines the species distribution and the stocks are therefore assessed as eight separate Functional Units. There are also some smaller catches from areas outside these Functional Units. The ICES statistical rectangles covered by the Functional Units in ICES Area 7 are listed in the table below.

FU no.	Name	ICES Divisions	ICES Statistical rectangles
14	Irish Sea East	7a	35–38E6; 38E5
15	Irish Sea West	7a	35E3, 36E3; 35–37 E4–E5; 38E4
16	Porcupine Bank	7b,c,j,k	31–35 D5–D6; 32–35 D7–D8
17	Aran Grounds	7b	34–35 D9–E0
18*	Northwest Irish Coast	7b	36–37 D9; 37E0–E1
19	Southeast and southwest Irish Coast	7a,g,j	31–33 D9–E0; 31E1; 32E1–E2; 33E2–E3
20–21	Labadie, Jones and Cockburn Bank	7g,h	28 EO–E2; 29 E0–E3; 30E1–E3; 31E2
22	Smalls Ground	7g	31–32 E3–E4

*** Landings from FU18 are reported to other statistical rectangles outside FUs as these are minimal. WGCSE will monitor FU18 landings in case of any fishery developments.**

Nephrops Functional Units in Subarea 7 (FU 14–22). The TAC covers all of Subarea 7. (Note: Functional Units in Subarea 6 (FU 11–13) also shown):



Landings Obligation

On the West Coast and around Ireland **(FU 11–22), in** 2017, vessels where 30% or more of their landings in 2014 and 2015 were *Nephrops* had to land all *Nephrops*. **In 2018**, vessels where 20% or more of their landings in 2015 and 2016 were *Nephrops* had to land all *Nephrops*. High survival exemptions existed for creel caught *Nephrops*. *De minimis* exemptions apply to *Nephrops* vessels, for Subarea 7 allowing them to discard *Nephrops*, as long as they made up no more than 7% of the catch in 2016 and 2017; this decreased to 6% in 2018 and will do again to 5% for 2019.

Minimum Conservation Reference Size (Minimum landing size)

Under the Landing Obligation, minimum landings sizes have been abolished. Instead a Minimum Conservation Reference Size (MCRS) for each species has been introduced. Unless exempt, *Nephrops* below the MCRS must be landed and may be sold but cannot go for human consumption. In most cases, the MCRS is the same as old MLS, being 25 mm carapace length (or over 85 mm total length) around Ireland (FUs 16–22); the MCRS is 20 mm CL (>70 mm TL) on the West coast (6.a, FUs 11–13) and the Irish Sea (7a, FUs 14–15).

The MCRS implemented for the Irish Sea at 20 mm CL is less than the rest of the ICES Area 7 (set at 25 mm CL) and applies to the Irish and UK fleets. A more restrictive regulation is adopted by the French Producers' Organisations (35 mm CL or 115 mm TL) to all French trawlers.

Management applicable in 2017 and 2018

The TAC is currently set for the whole Area 7. The TAC for 2018 was 29 091 t, this represented an increase of 15% in relation to 2017 with 25 356 t. The TAC area includes a number of *Nephrops* stocks showing different levels of exploitation. A single TAC covering a number of distinct stocks allows the possibility of unrestricted catches being taken from a heavily exploited stock when advice suggests they should be limited.

Details of all regulations including effort controls in place are provided in the stock annex for all functional units under this subarea.

Council Regulation (EU) 2018/120 of 23 January 2018 fixing for 2018 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2017/127.

TAC in 2018

Species:	**Norway lobster** *Nephrops norvegicus*	**Zone:**	**7 (NEP/07.)**
Spain	1745		
France	7074		
Ireland	10729		
United Kingdom	9543		
Union	29091		Analytical TAC
TAC	29091		Article 12(1) of this Regulation applies

Special condition:
Within the limits of the abovementioned quotas, no more than the quantities given below may be taken in the following zone:

	Functional Unit 16 of ICES Subarea 7 (NEP/*07U16):
Spain	825
France	516
Ireland	992
United Kingdom	401
Union	2 734

COUNCIL REGULATION (EU) 2017/127 of 20 January 2017 fixing for 2017 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters.

TAC in 2017

Species:	**Norway lobster** *Nephrops norvegicus*	**Zone:**	**VII (NEP/07.)**
Spain	1 521		
France	6 166		
Ireland	9 352		
United Kingdom	8 317		
Union	25 356		Analytical TAC
TAC	25 356		Article 11(1) of this Regulation applies

Special condition:
within the limits of the abovementioned quotas, no more than the quantities given below may be taken in the following zone:

	Functional Unit 16 of ICES Subarea VII (NEP/*07U16):
Spain	935
France	586
Ireland	1 124
United Kingdom	455
Union	3 100

Landings area 7

Table below gives the summary of reported landings by Functional Unit for ICES Area 7.

Year	FU 14 - Irish Sea East	FU 15 - Irish Sea West	FU 16 - Porcupine Bank	FU 17 - Aran Grounds	*FU 18 - Ireland Northwest Coast	FU 19 - Ireland Southwest and Southeast coast	FU 20–21 - Labadie, Jones, Cockburn	FU 22 - Smalls Grounds	FUs 20+21+22 - All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea 7	TAC for 7
1978	961	7,296	1,744	481						249	10731	
1979	900	8,948	2,269	452						237	12806	
1980	730	4,578	2,925	442						205	8880	
1981	829	7,249	3,381	414						382	12255	
1982	869	9,315	4,289	210						234	14917	
1983	763	9,448	3,426	131					3,667	174	17609	
1984	602	7,760	3,571	324					3,653	187	16097	
1985	498	6,901	3,919	207					3,599	194	15318	
1986	671	9,978	2,591	147					2,638	113	16138	
1987	449	9,753	2,499	62					3,409	107	16279	24,700
1988	462	8,586	2,375	828					3,165	140	15556	24,700

Year	FU 14 - Irish Sea East	FU 15 - Irish Sea West	FU 16 - Porcupine Bank	FU 17 - Aran Grounds	*FU 18 - Ireland Northwest Coast	FU 19 - Ireland Southwest and Southeast coast	FU 20–21 - Labadie, Jones, Cockburn	FU 22 - Smalls Grounds	FUs 20+21+22 - All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea 7	TAC for 7
1989	401	8,128	2,115	344		899			4,005	134	16026	26,000
1990	563	8,300	1,895	519		754			4,290	102	16423	26,000
1991	747	9,554	1,640	410		1077			3,295	169	16892	26,000
1992	427	7,541	2,015	372		888			4,165	409	15817	20,000
1993	515	8,102	1,857	372	10	905	3,466	1182		455	16864	20,000
1994	447	7,606	2,512	729	126	390	4202	941		570	17523	20,000
1995	584	7,796	2,936	866	26	695	3536	1081		397	17917	23,000
1996	475	7,247	2,230	525	46	888	2822	937		623	15793	23,000
1997	566	9,971	2,409	841	15	756	2038	944		340	17880	23,000
1998	388	9,128	2,155	1,410	78	827	1713	835		514	17048	23,000
1999	624	10,786	2,289	1,140	16	579	1,152	1775		322	18683	23,000
2000	567	8,370	910	880	9	696	1,778	2890		243	16344	21,000
2001	532	7,441	1,222	913	2	815	1,833	2938		368	16064	18,900

Year	FU 14 - Irish Sea East	FU 15 - Irish Sea West	FU 16 - Porcupine Bank	FU 17 - Aran Grounds	*FU 18 - Ireland Northwest Coast	FU 19 - Ireland Southwest and Southeast coast	FU 20–21 - Labadie, Jones, Cockburn	FU 22 - Smalls Grounds	FUs 20+21+22 - All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea 7	TAC for 7
2002	577	6,793	1,327	1,154	14	1318	2,674	1993		243	16093	17,790
2003	376	7,052	1,064	933	16	1239	2,953	2065		186	15884	17,790
2004	472	7,266	1,406	525	22	1074	2,443	1828		161	15197	17,450
2005	570	6,529	2,197	778	15	711	2,469	2533		180	15982	19,544
2006	628	7,535	2,185	637	14	741	2,523	1761		270	16294	21,498
2007	959	8,424	2,074	913	3	957	2,419	2950		206	18905	25,153
2008	726	10,482	1,000	1,057	1	841	2,980	3090		111	20288	25,153
2009	693	9,166	879	626	10	833	3,145	2185		322	17860	24,650
2010	583	8,929	922	939	7	722	1,793	2714		316	16925	22,432
2011	561	10,159	1,278	659	13	608	1,237	1636		359	16510	21,759
2012	531	10,527	1,258	1,246	28	770	1,189	2618		110	18276	21,759
2013	495	8,672	1,141	1,295	0	781	1,387	2257		325	16354	23,605
2014	679	8,613	1,189	766	0	468	1,836	2526		194	16271	20,989

Year	FU 14 - Irish Sea East	FU 15 - Irish Sea West	FU 16 - Porcupine Bank	FU 17 - Aran Grounds	*FU 18 - Ireland Northwest Coast	FU 19 - Ireland Southwest and Southeast coast	FU 20–21 - Labadie, Jones, Cockburn	FU 22 - Smalls Grounds	FUs 20+21+22 - All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea 7	TAC for 7
2015	378	8,632	1,394	370	0	507	2,116	2350		174	15921	21,619
2016	237	7327	2154	641	0	591	2,453	3329		80	16812	23348
2017	265	6149	2632	295	0	420	1,849	3560		137	15307	25356
2018	268											29091
Average	530	8301	2081	648	19	784	2,504	2,117	4,621	231	16210	22,540

*Landings from FU18 are reported to other statistical rectangles outside FUs as these are minimal since 2013. WGCSE will monitor FU18 landings in case of any fishery developments.

Nephrops FU14 section

Type of assessment in 2019

This stock was inter-benchmarked in September 2015 (ICES, 2015) and the assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the inter-benchmark process and described in the stock annex (updated at WGCSE 2018). The UWTV survey undertaken in the summer 2019 forms the basis of advice for this stock.

ICES advice applicable to 2018

"ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should be no more than 1281 tonnes.

To ensure that the stock in Functional Unit 14 is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2019

"ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2016–2017, catches in 2019 should be no more than 922 tonnes.

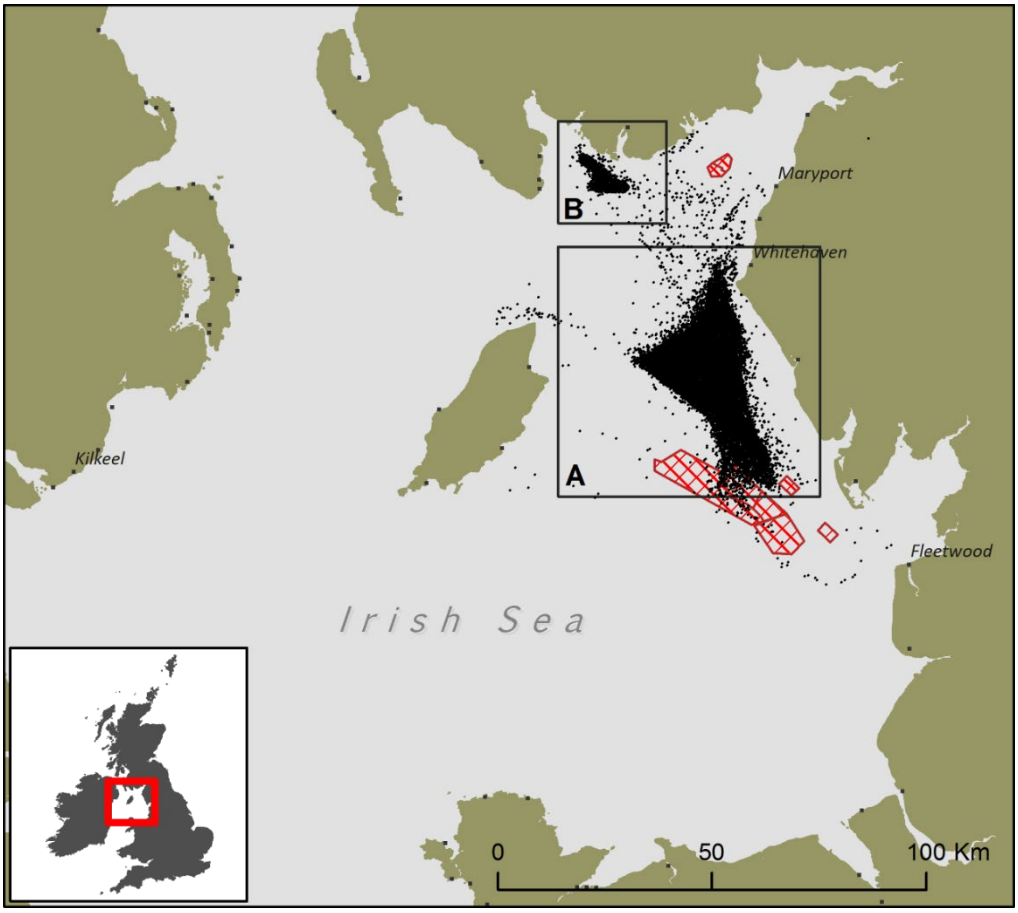
To ensure that the stock in Functional Unit 14 is exploited sustainably, management should be implemented at the functional unit level."

15.2 General

Stock description and management units

The Irish Sea East *Nephrops* stock (FU14) is in ICES Subarea 7and comprises ICES rectangles: 38E5, 38E6, 37E6, 36E6, 35E6.

In FU14 *Nephrops* are caught on two spatially discrete grounds. Most of the fishery takes place on the main ground located between the West coast of England and Isle of Man, additionally there is also fishing activity in a small inshore ground known as Wigtown Bay.



East Irish Sea fishing grounds: A= Main fishing ground; B= Wigtown bay area. Windfarms represented by red polygons. (Source: ICES, 2015).

Main landing ports: Whitehaven, Fleetwood, Maryport and Kilkeel.

Fishery in 2018

The Eastern Irish Sea *Nephrops* fishery is dominated by UK activity, representing on average 93% of the reported annual international landings (2008–2018). This is a relative small fishery compared to other FUs in the TAC area. Landings have been generally declining over the past eleven years (Table 3.8.2), from a high of 959 tonnes in 2007 to a low of 237 tonnes in 2016, with landings of 268 tonnes in 2018. The main fleets targeting *Nephrops* include directed single-rig and twin-rig otter trawlers operating out of ports in UK (E&W), UK (NI), Republic of Ireland and UK (S).

As in previous years, in 2018, the UK fleet accounted for the highest proportion of landings in tonnes.

A more detailed historical fishery description is provided in the stock annex.

Information from stakeholders

No additional information was provided.

15.3 Data

InterCatch

Data for 2018 were successfully uploaded into InterCatch prior the 2019 WG meeting. Uploaded data were worked up in InterCatch to generate 2018 raised international length–frequency distributions, and to derive catch and discard length frequencies for 2018. The same allocation procedure was followed as in 2017: English landings were raised with English samples, Northern Irish landings raised with Northern Irish samples and all other remaining landings with pooled English and Northern Irish samples.

Landings

Official landings as reported to ICES from FU14 are presented in Table 3.8.1.

There are reported landings for this functional unit since 1973 with a minimum and maximum of 178.7 t (in 1974) and 960.5 t (in 1978) respectively. Between 1987 and 2006, landings from FU14 appeared relatively stable fluctuating around a long-term average of about 550 t. The introduction of the Buyers and Sellers legislation in 2006 by the UK precludes direct comparison with previous years, as reported levels are considered to have significantly improved. Over the period 2007–2018, landings have declined considerably from the peak year of 2007; landings in 2018 (268 t) were very similar to 2017 (265 t).

Effort

Following discussions at WGCSE, it was concluded that effort should be reported in the WGCSE report in kWdays, and LPUE should be reported in KG/kWdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. The time-series of effort and LPUE is updated in Table 3.8.3 and Figure 3.8.2. There has been a general decline in targeted effort across the available time series and is now around the lowest recorded levels (although 2018 did see a small rise in effort compared to 2017).

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by IBPNeph 2015, documented in the stock annex, and examined further at WGCSE 2018. Recent sampling levels have fluctuated; prior to 2016 sample data have only been available from landings into England; however, since 2016 samples have also been available from landings into Northern Ireland. In 2018, nine English samples (four from at-sea observations and five from port-side catch sampling) and two Northern Irish samples were used to raise the data.

Commercial length–frequency distributions

The raised catch length distributions are shown in Figure 3.8.3. The mean sizes for both sexes from 2008 fluctuate considerably. For 2018, the mean size of the landings was higher than the record low of 2016.

Length composition

Between 2010 and 2012, sampling levels are considered insufficient to reliably characterise the length composition of extractions. Increased sampling levels from 2013 onwards have allowed for length compositions to be constructed. For 2013 and 2014, a full revision was done through an inter-benchmark process (ICES, 2015; described in the stock annex). Data aggregating and raising procedures from 2015 to 2017 were conducted according to benchmark procedures (ICES, 2005) and referred in the stock annex. These were revised during WGCSE 2018 to account for Northern Irish sampling data since 2016 and are described further in the stock annex.

Updated historical trends in length distributions and proportion discarded are shown in Figure 3.8.3 and Table 3.8.4. Discard selection curve estimates for the East Irish Sea shows a L50= 23.54 and a L25=24.77 mm CL (Figure 3.8.4), which shows a selectivity at higher sizes compared with FU15.

Mature females are mainly caught in the non-berried state between the moulting, which reaches its peak in May. Females mature at about 23 mm carapace length. (Thomas and José Figueiredo, 1965).

Sex ratio

The catch sex ratio by year is shown in Figure 3.8.5. The ratio is quite variable but average sex ratio is 54% male (1999–2018), the sex ratio for 2018 being just above this (58%).

Mean weight explorations

The annual mean weight estimate for landings and discards is provided in Table 3.8.4 and in Figure 3.8.6. There is a substantial difference between the mean weights prior to 2011 and after 2013 (the gap being where sampling was too low to be reliable). Since 2016, NI sampling has been included, and the mean weight of NI samples is considerably lower than for English sampling (e.g. in 2018, mean weight of landings from English sampling was 30.7 g compared to 21.5 in Northern Irish sampling). As a result, comparison with years prior to 2016 is not practical. Mean weights over the last three years (2016–2018) are variable without trend.

Discarding

Discard selection was revised at the IBP process in 2015 (ICES, 2015) and described in the stock annex. Figure 3.8.4 shows a single discard ogive fitted by pooling all years (2003–2014) and mesh sizes. Final discard selection for the East Irish Sea shows a L50= 23.54 and a L25=24.77 mm CL (Figure 4.3.4), which shows a selectivity at higher sizes compared with FU15. Due to high inter-annual variation in mean sizes of both landings and discards, the discard ogive was not updated using 2015 to 2018 data.

Table 3.8.5 gives raised international landings and discard weight and numbers by year.

At IBPNeph (ICES, 2015), it was agreed that the discard survival rate should be up-dated from 0% to 10%. Although there are no direct survivability studies available for this area, it is expected that the survivability of discarded animals should be similar to the fishery in FU15 where fishing practices are similar, and both are largely spring/summer fisheries and animals discarded are exposed to warmer temperatures before being returned to the sea.

Abundance indices from UWTV surveys

In August of 2007–2019 the UK and the Republic of Ireland carried out an underwater TV survey of the *Nephrops* grounds in the eastern Irish Sea. The survey is of a fixed grid design and is carried out using the same protocols used in UWTV surveys in the western Irish Sea (ICES, 2007; ICES, 2014). The survey stations used in 2019 are presented in Figure 3.8.7.

Due to the construction of the windfarm in the southern part of the ground, the survey area was reviewed at IBP 2015 but the protocols and standardised process to run the survey were not modified (see stock annex and IBP 2015 report ICES, 2015). The new survey area (based on a co-kriging model) is shown in Figure 3.8.8. The boundary used to define the ground limits for absolute abundance runs close to the outer survey stations.

Ground	Area Km^2	Source
Main ground 2008–2010	1032.75	WGCSE 2008
Main ground 2011–2019	1019.79	IBP 2015 – ICES, 2015
Wigtown Bay	67.21	IBP 2015 – ICES, 2015

Wigtown Bay in relation to Main ground = 6.6% * (increase from 1.9% prior to the windfarm construction).

Abundance indexes were revised back to 2011, the year where the effect of effort displacement is clearly visible due to the windfarm construction. Final updated abundance burrow density estimates are presented in Table 3.8.6 and visualised in Figure 3.8.9 where the geo-spatial model was updated using the new area based on the co-kriging approach (1019.79 Km^2) and the extrapolation to Wigtown Bay using 6.6%.

The abundance estimate for 2019 (399 million) is a decrease of 22% compared to the 2018 figure of 514 million (Figure 3.8.10). This is the second lowest value in the series, but is only 18% below the 2008–2018 average. The surveys show a clear spatial distribution pattern, with highest densities in the central north of the patch and more variable in the area further south. The grounds are fairly well delineated by consistently low-density ground to the northeast and west (Figure 3.8.9). CVs over the entire time-series (Table 3.8.6) are within the accepted precision level of 20% (ICES, 2012).

The use of the UWTV surveys for the provision of *Nephrops* management advice was extensively reviewed by WKNEPH (2009). A number of potential factors were highlighted, including those due to edge effects; species burrow misidentification and burrow occupancy. Using the same process adopted at WKNEPH, a cumulative absolute conversion factor for this FU was predicted to be 1.2 for FU14 (see stock annex) which means the TV survey is likely to overestimate *Nephrops* abundance by 20%. The burrow abundances shown in Table 3.8.5 and Figure 3.8.9 have been adjusted using this conversion factor since 2008.

15.4 Assessment

Comparison with previous assessments

The WGCSE 2019 carried out an UWTV based assessment for this stock. The methods used were very much in line with WKNEPH (ICES, 2009) and the approach taken for other *Nephrops* stocks in 6 and 7 by WGCSE. This approach was inter-benchmarked at IBPNeph (ICES, 2015). The 2019 assessment uses a three-year average for weights and discarding rates (2016–2018). This is in contrast to the 2018 assessment, which only had reliable weights for both fleet components (England and Northern Ireland) for 2016–2017.

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated between abundance values of 350 and 694 million *Nephrops*. The 2019 estimate (399 million) decreased by 22% in relation to 2018 and although below average is above the MSY $B_{trigger}$ (350 million).

Table 3.8.5 and Figure 3.8.11 summarise the abundance estimated including the confidence intervals and the harvest ratios (% dead removed / UWTV abundance) which have been above the F_{MSY} proxy.

15.5 Catch scenarios table

Catch scenarios table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 3.8.5 and summarised below. The calculation of catch options for the FU14 follows the procedure outlined in the stock annex. The basis for the catch options:

Variable	Value	Notes
Stock abundance	399 million	UWTV 2019
Mean weight in wanted catch	18.72 g	Average 2016–2018
Mean weight in unwanted catch	9.22 g	Average 2016–2018
Unwanted catch proportion	12.71%	Average 2016–2018 (proportion by number)
Unwanted catch survival rate	10%	Only applies in scenarios where discarding is allowed.
Dead unwanted catch rate	11.59%	Average 2016–2018 (proportion by number), only applies in scenarios where discarding is allowed.

15.6 Reference points

Reference points were defined for this stock at the IBPNeph (ICES, 2015) and no new proposals were made by WKMSYRef4 (ICES, 2016a; 2016b).

Based on the fact that some biological parameters are poorly known; inconsistent biological sampling; uncertainties about the stability of the stock over the reference period and uncertainties about the variability of recruitment it is expected that a combined sex $F_{0.1}$ is a suitable F_{MSY} proxy for this stock. This corresponds to a harvest rate of 11% and this value is expected to deliver high long-term yield with a low probability of recruitment over-fishing. These calculations assume that the UWTV survey has knife-edge selectivity at 17 mm and that the supplied length frequencies represented the population in equilibrium. Currently this fishery is being harvested at 3.14% (Fsq_2016–2018 = 3.14%; F2018 = 2.55%), and historically the available data show a maximum harvest rate of 8.2% in 2008 which is below the F_{MSY} proxy.

At the IBP, a MSY $B_{trigger}$ was defined for this stock. Accordingly, with this definition $B_{trigger}$ it was set for FU14 as 350 million, corresponded to the abundance observed in 2009.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	350 million individuals	The lowest observed abundance estimate from the UWTV survey time-series.	ICES (2015)
	F_{MSY}	11% harvest rate	F_{MSY} proxy equivalent to $F_{0.1}$ for combined sexes.	ICES (2015)

15.7 Management strategies

There are no explicit management strategies for this stock.

15.8 Quality of assessment and forecast

The quality of landings data has improved in the last four years, but concerns over the accuracy of earlier years limits the period we can be confident about regarding trends in LPUE and landings.

Underwater TV surveys have been conducted annually for this stock since 2007. The quality of the data from the first survey and the limited number of valid stations in the survey limits the number of useable surveys to 2008–2019.

The revised algorithm used to derive distance covered by the sledge is considered as significantly more robust than the previous algorithm.

The IBP 2015 managed to address key points:

- Revisions to the area of the *Nephrops* grounds based on new available data: VMS, UWTV data and sediment information;
- A review of fishery data and raising procedures;
- Review of Reference points: F_{MSY} proxies and MSY $B_{trigger}$.

After this revision, the quality of the assessment improved. Although there are still specific uncertainties and assumptions that need to be examined further for the East Irish Sea before less conservative F_{MSY} proxies could be considered.

There are several key uncertainties and bias sources in the method proposed (these are discussed further in ICES, 2009a). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (ICES, 2007; ICES, 2008; ICES, 2009b). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate but no more precise (ICES, 2009a).

The cumulative absolute conversion factor estimates for FU14 are largely based on expert opinion. However, these were based on experience on other grounds and relatively limited experience on these grounds which would make this less reliable. The precision of these cannot yet be characterised. Ultimately, there still remains a degree of subjectivity in the production of UWTV abundance estimates.

The effect of this assumption on realised harvest rates has not been investigated, but remains a key uncertainty.

15.9 Recommendation for next benchmark

This stock was last benchmarked by IBPNeph (ICES, 2015). WGCSE will keep the stock under close review and recommend future benchmark as required.

At IBP 2015, it was mentioned that there are specific uncertainties and assumptions that need to be examined further for the East Irish Sea before less conservative F_{MSY} proxies could be considered.

- More accurate mapping of the spatial extent of the grounds and fisheries, this includes having positional data for <12 metre vessels and more survey data in Wigtown Bay area to better define this ground. Station grid was extended to Wigtown Bay in 2016.
- For now, the total abundance estimate for FU14 is based on the abundance estimates of the geospatial model for the main ground plus adding the area of Wigtown Bay. As this area is becoming a more significant fishing patch, it is worth to consider the use of a separate geospatial model in this ground. This should be explored in a future benchmark work.
- Improvement of spatial coverage and sampling of landings and discards, this includes increasing the sampling levels to cover Northern Irish vessels, as the current sampling is mainly focused on local vessels form Whitehaven port.
- Area specific length–weight and maturity data to validate the parameters used for this FU.
- Better knowledge of the difference in growth and population structure across the area.
- If following the current advice, the recommended catches are taken, then the stock may decrease to well below MSY $B_{trigger}$ in the short term. The basis for setting MSY $B_{trigger}$ is currently from recent history may be too high, it could also be due to recent low recruitment (transitory issue) or that the F_{MSY} is too high. As such, the $MSY_{trigger}$ reference point needs to be looked into. It was noted that the basis for MSY $B_{trigger}$ was the recent history and that the value may be too high.
- Advice is compiled for ADGNEPH in October. Lagged (one year) TV survey gives good correlation with LPUE, could this be used to calculate harvest rate rather than the in-year ratio?

15.10 Management considerations

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the Functional Unit level could allow effort and catch to be controlled in line with the scale of the resource.

There are no explicit recruitment indices.

The UWTV survey data allow for the provision of catch options and also to adopt the MSY approach. The UWTV surveys are conducted annually and a benchmark process has been adopted in 2015. In the past, this stock has only been assessed biannually. These data provide the opportunity to reassess this stock more reliably on an annual basis.

15.11 References

EU. 2017. Council Regulation (EU) 2017/127 of 20 January 2017 fixing for 2017 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters. Available at <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02017R0127-20170101> [Accessed: 25/09/2018].

EU. 2018. Council Regulation (EU) 2018/120 of 23 January 2018 fixing for 2018 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2017/127. Available at <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R0120> [Accessed: 25/09/2018].

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM:14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES 2009a. Report of Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM:2009/ACOM:33.

ICES. 2009b. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2014. Report of the Working Group on *Nephrops* Surveys (WGNEPS). ICES CM 2014/SSGESST:20. 57 pp.

ICES. 2015. Report of the Inter-Benchmark Protocol of *Nephrops* in FU 17 and 14 (IBPNeph), from June to September 2015, by correspondence. ICES CM 2015/ACOM:38. 86 pp.

ICES. 2016a. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES Subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

ICES. 2016b. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

Table 3.8.1. Irish Sea: Landings (tonnes) by FU, 2000–2012. 2017* refers to preliminary landings data. In 2012 and 2013 landings outside FU for Area 7a were not provided, so have been calculated from ICES official landings for 7a minus the FU areas.

YEAR	FU14	FU15	OTHER	TOTAL
2000	567	8370	1	8938
2001	532	7441	3	7976
2002	577	6793	1	7371
2003	376	7052	3	7431
2004	472	7267	25	7764
2005	570	6554	103	7227
2006	628	7561	52	8241
2007	959	8491	83	9533
2008	676	1050	122	11306
2009	708	9198	57	9963
2010	582	8963	23	9568
2011	561	10162	61	10784
2012	531	10527	208	11266
2013	495	8672	89	9256
2014	679	8613	NA	9292
2015	378	8632	NA	9010
2016	237	7327	9	7564
2017*	265	6149	NA	6414

Table 3.8.2. Irish Sea East (FU14): Landings (tonnes) by country and total discards, 2000–2018.

Year	Rep. Of Ireland	UK	Other Countries	Total Landings	Discards
2000	114	451	2	567	80
2001	26	506	0	532	42
2002	203	373	1	577	42
2003	69	306	1	376	11
2004	62	409	1	472	28
2005	34	536	0	570	33
2006	34	594	0	628	22
2007	86	873	0	959	47
2008	29	652	0	681	37
2009	16	692	0	708	6
2010	45	538	0	583	9
2011	31	530	0	561	0
2012	53	478	0	531	0
2013	35	460	0	495	38
2014	31	648	0	679	35
2015	88	290	0	378	18
2016	21	216	0	237	20
2017	7	258	0	265	28
2018	5	263	0	268	9

Table 3.8.3. Irish Sea East (FU14): Effort data for the UK and Irish trawl *Nephrops* directed fleet.

	UK direct fleet			Irish direct fleet		
YEAR	EFFORT (KW DAYS)	LANDINGS (TONNES)	LPUE	EFFORT (KW DAYS)	LANDINGS (TONNES)	LPUE
2000	145,794	392,925	2.7	47,958	109,046	2.3
2001	141,686	417,382	2.9	8,691	21,242	2.4
2002	97,368	285,106	2.9	72,588	201,108	2.8
2003	114,096	225,573	2.0	23,269	41,097	1.8
2004	107,570	322,982	3.0	26,345	54,810	2.1
2005	124,349	395,041	3.2	17,504	33,975	1.9
2006	249,846	407,773	1.6	6,509	18,331	2.8
2007	345,818	668,017	1.9	25,309	79,193	3.1
2008	308,427	507,761	1.6	7,785	14,888	1.9
2009	262,030	499,174	1.9	5,282	13,069	2.5
2010	217,937	356,188	1.6	13,496	44,615	3.3
2011	188,876	355,672	1.9	8,181	29,734	3.6
2012	163,110	301,146	1.8	20,288	52,755	2.6
2013	170,799	339,429	2.0	11,304	35,459	3.1
2014	179,356	403,720	2.3	10,259	28,507	2.8
2015	79,960	155,122	1.9	27,128	83,714	3.1
2016	59,970	100,733	1.7	9,496	21,225	2.2
2017	42,461	98,292	2.3	2,620	6,710	2.6
2018	58,264	112,751	1.9	3,042	5,176	1.7

Table 3.8.4. Irish Sea East (FU14): Mean size (CL) and weight combined by sex for total annual landings and discards and proportion discarded.

Year	Mean CL (mm) Landings	Mean CL (mm) Discards	Mean Weight (g) Landings	Mean Weight (g) Discards	Proportion dis-carded
2000	29.83	22.32	19.05	7.52	0.26
2001	30.59	22.74	20.87	7.97	0.17
2002	30.64	23.75	22.41	8.98	0.15
2003	33.69	22.43	29.12	7.62	0.10
2004	31.01	22.24	21.93	7.57	0.15
2005	30.74	23.16	21.48	8.44	0.13
2006	32.36	22.75	25.07	7.98	0.10
2007	31.81	21.92	23.94	7.33	0.14
2008	31.07	23.14	22.88	8.49	0.13
2009	35.57	23.21	36.49	8.58	0.04
2010*					
2011*					
2012*					
2013	30.14	22.43	19.94	7.87	0.16
2014	31.01	24.34	22.37	9.60	0.11
2015	32.05	22.57	25.19	7.82	0.13
2016**	27.39	23.11	15.82	8.38	0.14
2017	29.05	24.07	18.97	9.50	0.18
2018	30.58	24.46	21.39	9.78	0.07

*** Values for 2010, 2011 and 2012 are not reliable due to poor sampling.**

**** Values for 2016 revised at WGCSE 2018 due to inclusion of Northern Irish sampling in 2016 and 2017.**

Table 3.8.5. Irish Sea East (FU14): Sumary table for forecast inputs (current used shaded in blue) and historical estimates of raised landings and discards, mean weight in landings and harvest rate.

Year	Landings in number	Total discards in number	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	millions		%	tonnes	tonnes	gramme	gramme
2000	30	11	40	24.4	26.4				567	80	19.05	7.52
2001	26	5	31	15.5	17.0				532	42	20.87	7.97
2002	26	5	30	14.1	15.4				577	42	22.41	8.98
2003	13	1	14	9.0	9.9				376	11	29.39	7.64
2004	22	4	25	13.5	14.8				472	28	21.93	7.57
2005	275	4	30	11.8	13.0				570	33	21.48	8.44
2006	25	3	28	9.2	10.1				628	22	25.07	7.98
2007	40	6	46	12.5	13.8				959	47	23.94	7.33
2008	30	4	34	11.6	12.7	408	63	8.2	676	37	22.88	8.49
2009	19	1	20	3.3	3.7	350	76	5.7	707	6	36.49	8.58
2010						422	103		582			
2011						449	99		561			
2012						694	99		531			
2013	25	5	30	15.0	16.4	487	82	6.0	495	39	19.94	7.87
2014	30	4	34	9.8	10.8	449	92	7.5	679	32	22.37	9.60
2015	15	2	17	11.9	13.0	591	86	2.9	378	18	25.19	7.82
2016*	15	2	17	12.4	13.6	430	106	4.0	237	20	15.82	8.38
2017	14	3	17	16.2	17.6	580	89	2.9	265	29	18.97	9.50
2018	12	1	13	6.3	6.9	399	66	2.6	268	9	21.39	9.78

Note: Abundance is adjusted by using a cumulative absolute conversion factor of 1.2. Abundance (millions) including Wigtown Bay (1.9% 2008–2010; 6.6% 2011–2018). Due to poor sampling no estimates for 2010–2012.

*** Values for 2016 revised at WGCSE 2018 due to inclusion of Northern Irish sampling in 2016 and 2017.**

Table 3.8.6. ***Nephrops*****, Irish Sea East (FU14): Results of the 2008–2018 TV surveys (values adjusted for bias).**

Year	No valid stations	Mean Kriged density (no./m²)	Abundance (millions) including Wigtown Bay (1.9% 2008–2010)	Abundance (millions) including Wigtown Bay (6.6% 2011–2018)	95% CI	CV
2007			Unreliable data			
2008	32	0.38	408		63	
2009	32	0.33	350		76	
2010	26	0.4	422		103	
2011	26	0.41		449	99	11.2%
2012	26	0.64		694	99	7.3%
2013	31	0.45		487	82	8.5%
2014	34	0.41		449	92	10.4%
2015	42	0.54		591	86	7.4%
2016	48	0.40		430	106	12.6%
2017	45	0.53		580	89	7.8%
2018	46	0.47		514	118	11.7%
2019	41	0.30		399	69	8.8%

Note: Abundance is adjusted by using a cumulative absolute conversion factor of 1.2. Abundance (millions) including Wigtown Bay (1.9% 2008–2010; 6.6% 2011–2018).

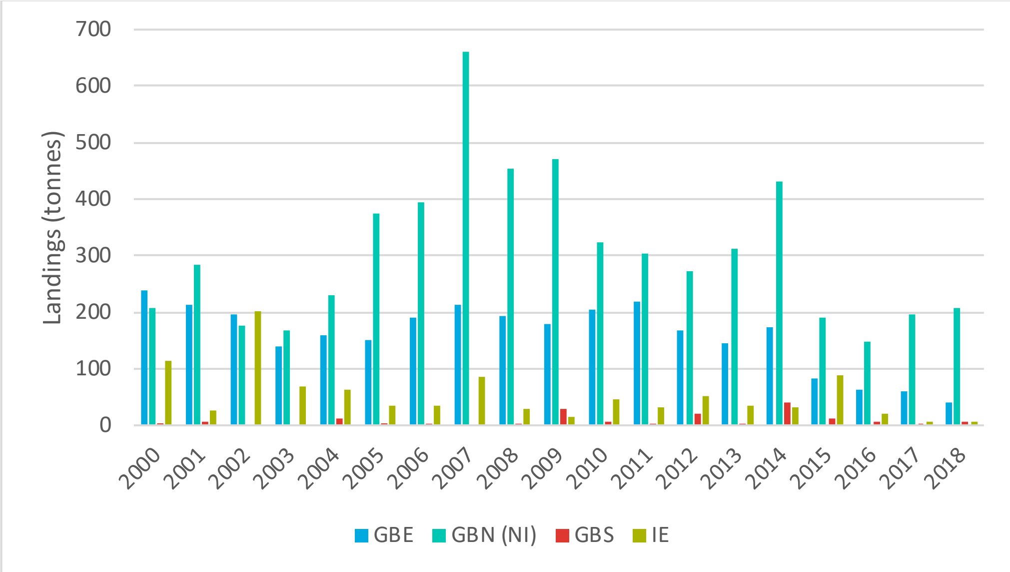


Figure 3.8.1. Irish Sea East (FU14): Landings in tonnes by country. GBE=England; GBN=Northern Ireland; GBS=Scotland; Rep. of Ireland=Republic of Ireland.

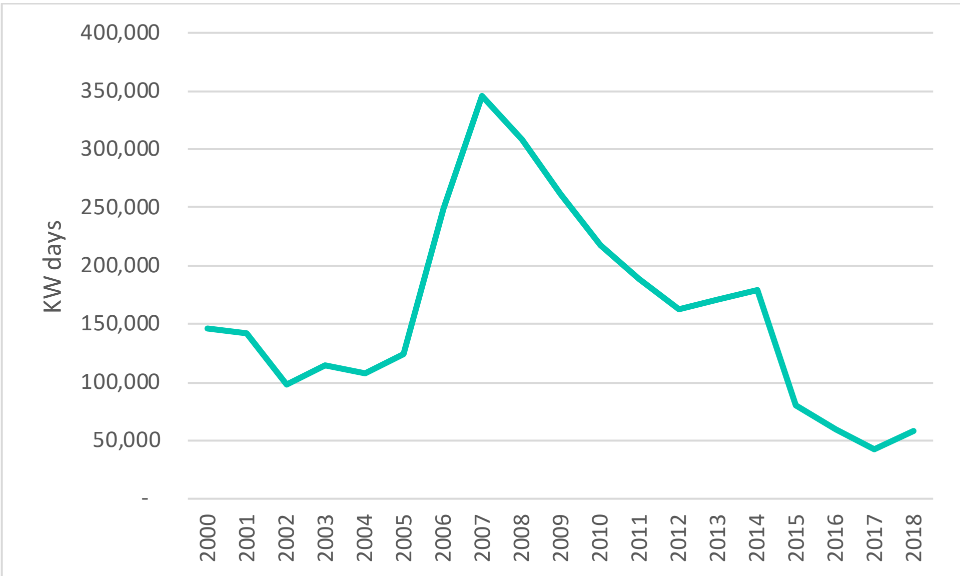


Figure 3.8.2. Irish Sea East (FU14): Effort data (KW days) for UK directed *Nephrops* fleet.

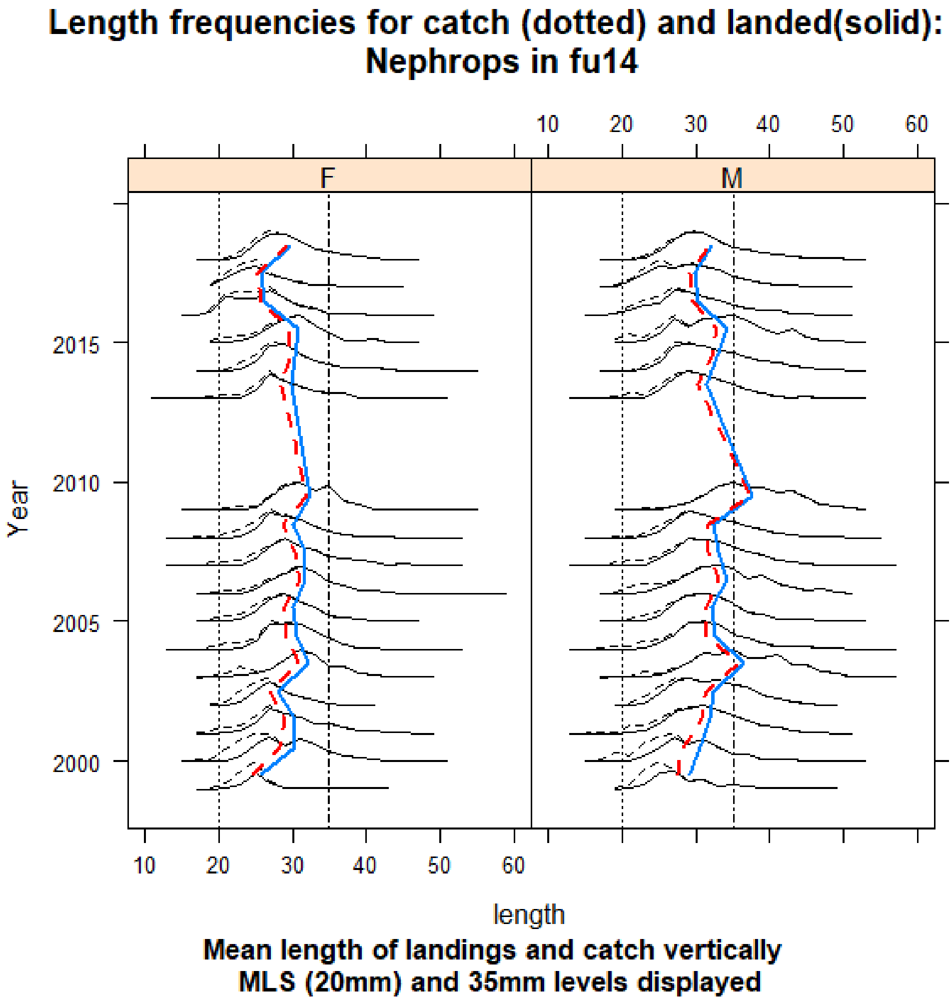


Figure 3.8.3. Irish Sea East (FU14): Length distribution of landings (solid lines) and catch (dotted lines), 2000–2017. Length frequencies for 2010–2012 are based in very poor sampling so not reliable. Figure shows a vertical display of MLS (20 mm CL) and 35 mm CL levels.

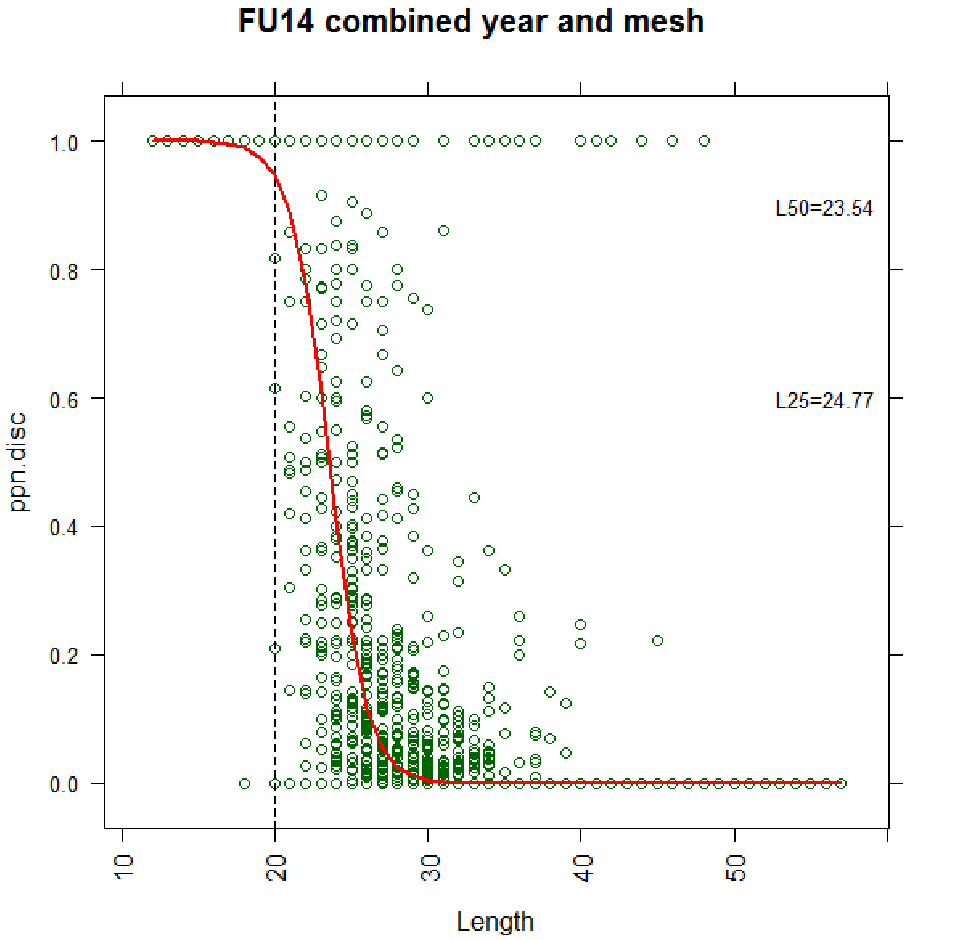


Figure 3.8.4. Irish Sea East (FU14): Final discard ogive pooled for all years (2003–2014) and mesh sizes. L50=23.54 and L25=24.77, (IBPNeph 2015).

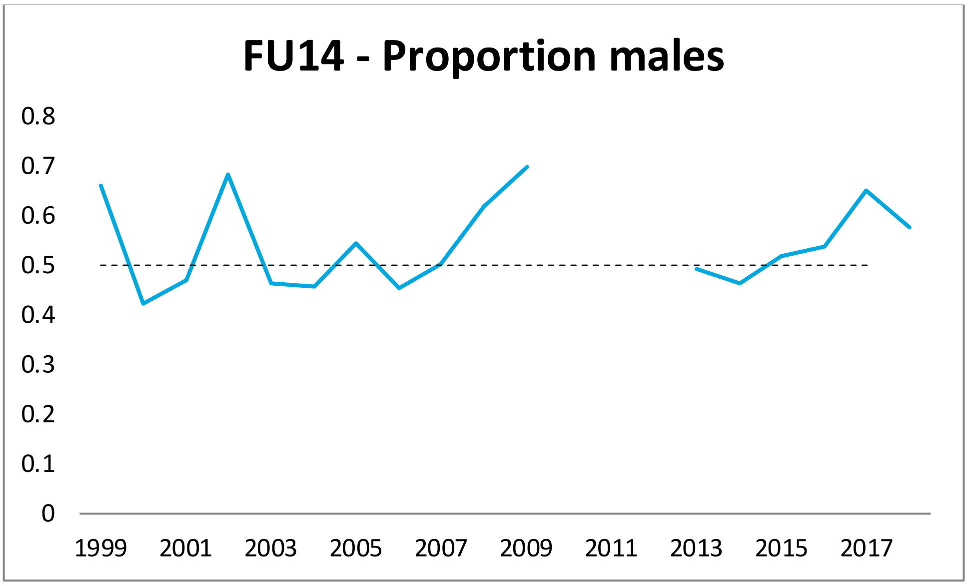


Figure 3.8.5. Irish Sea East (FU14): Proportion of males in catch since 1999. Between 2010 and 2012 due to poor sampling levels, estimates of sex ratio are not reliable.

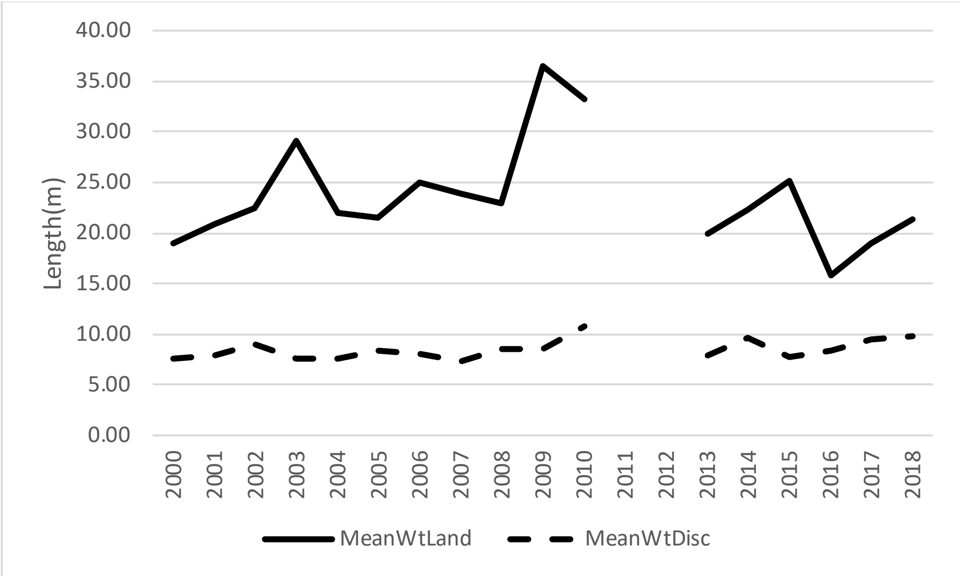


Figure 3.8.6. Irish Sea East (FU14): Mean weight (g) combined by sex for total annual landings and discards. Values for 2010, 2011 and 2012 are not reliable due to poor sampling.

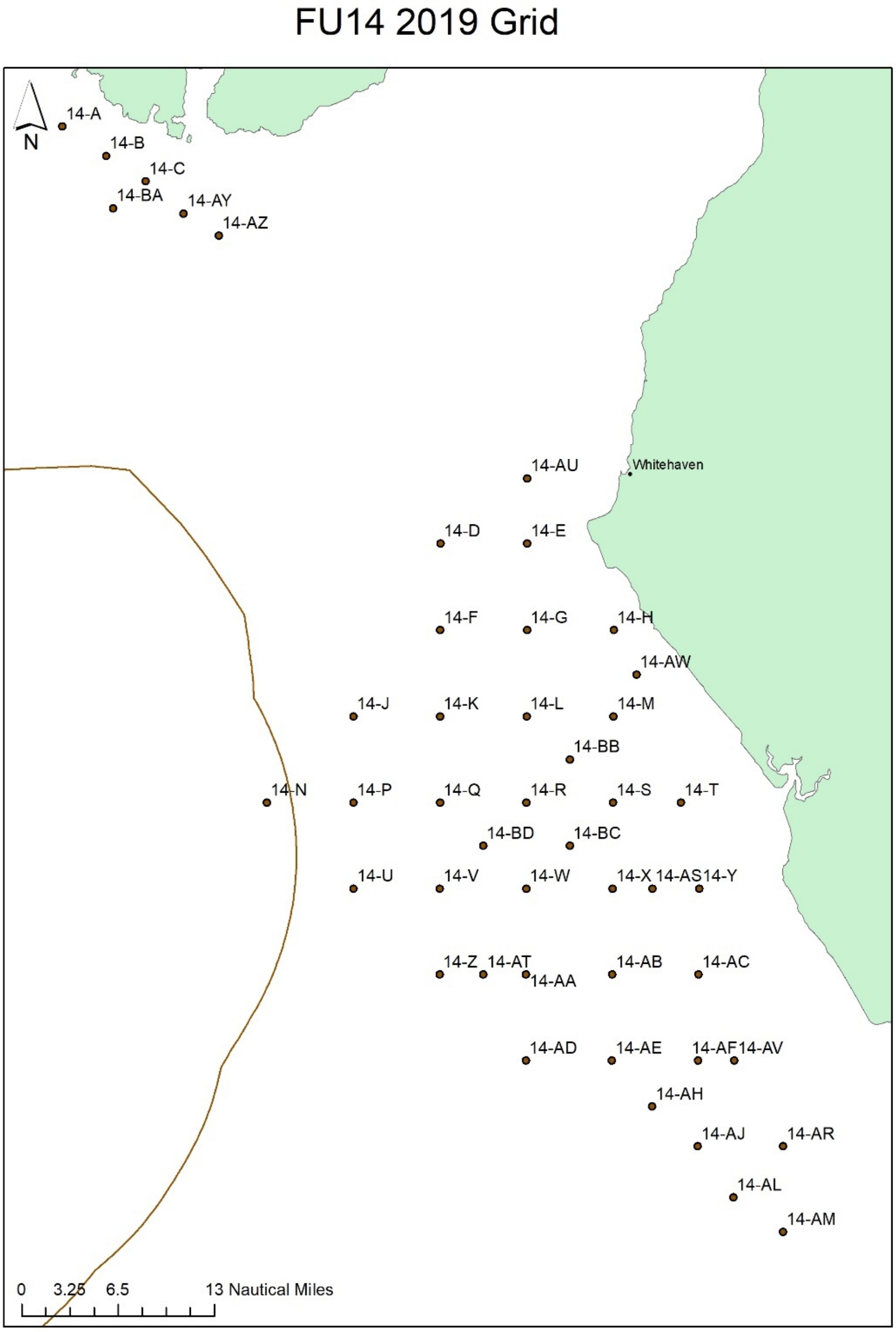


Figure 3.8.7. Irish Sea East (FU14): UWTV Survey stations for 2019.

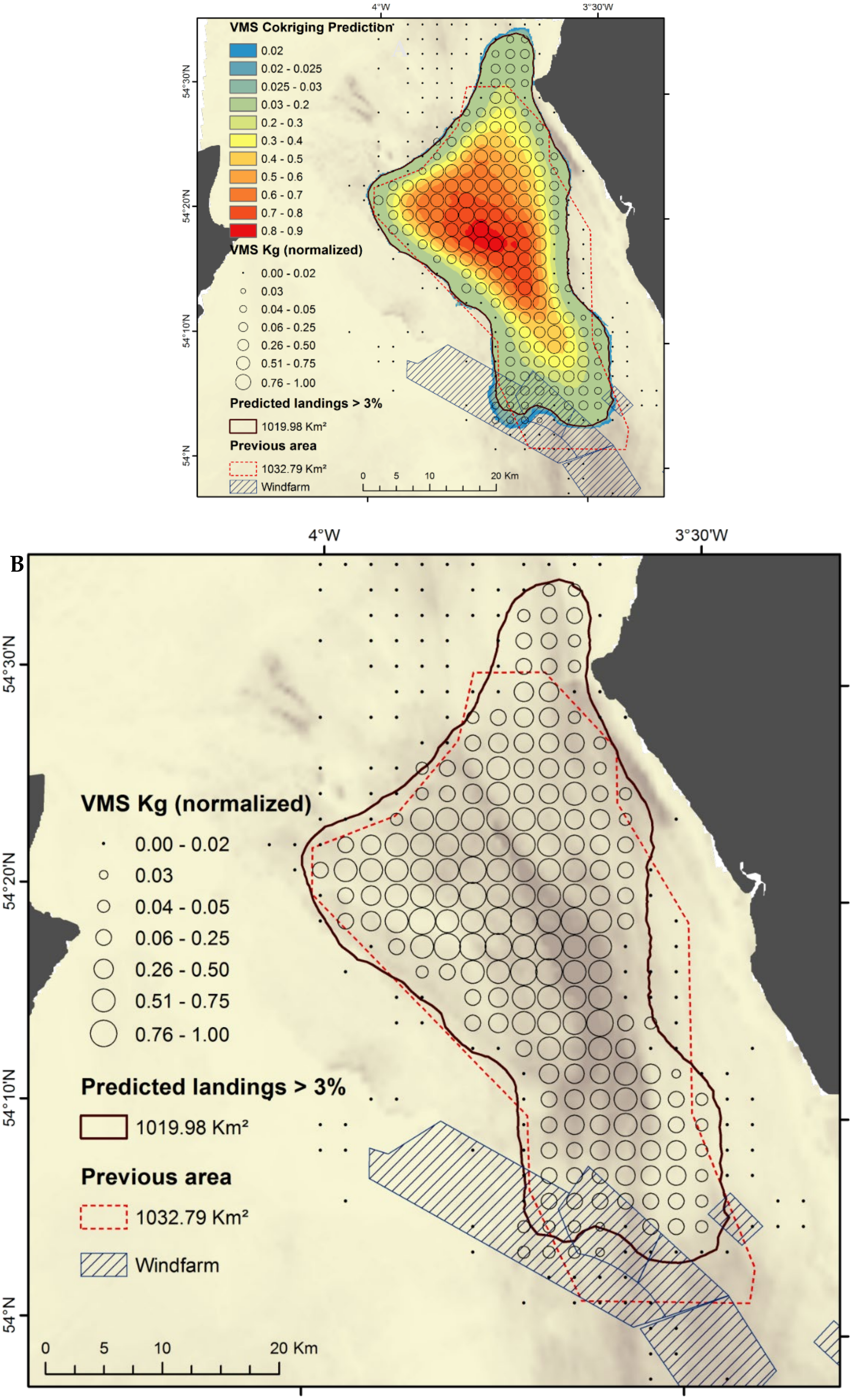
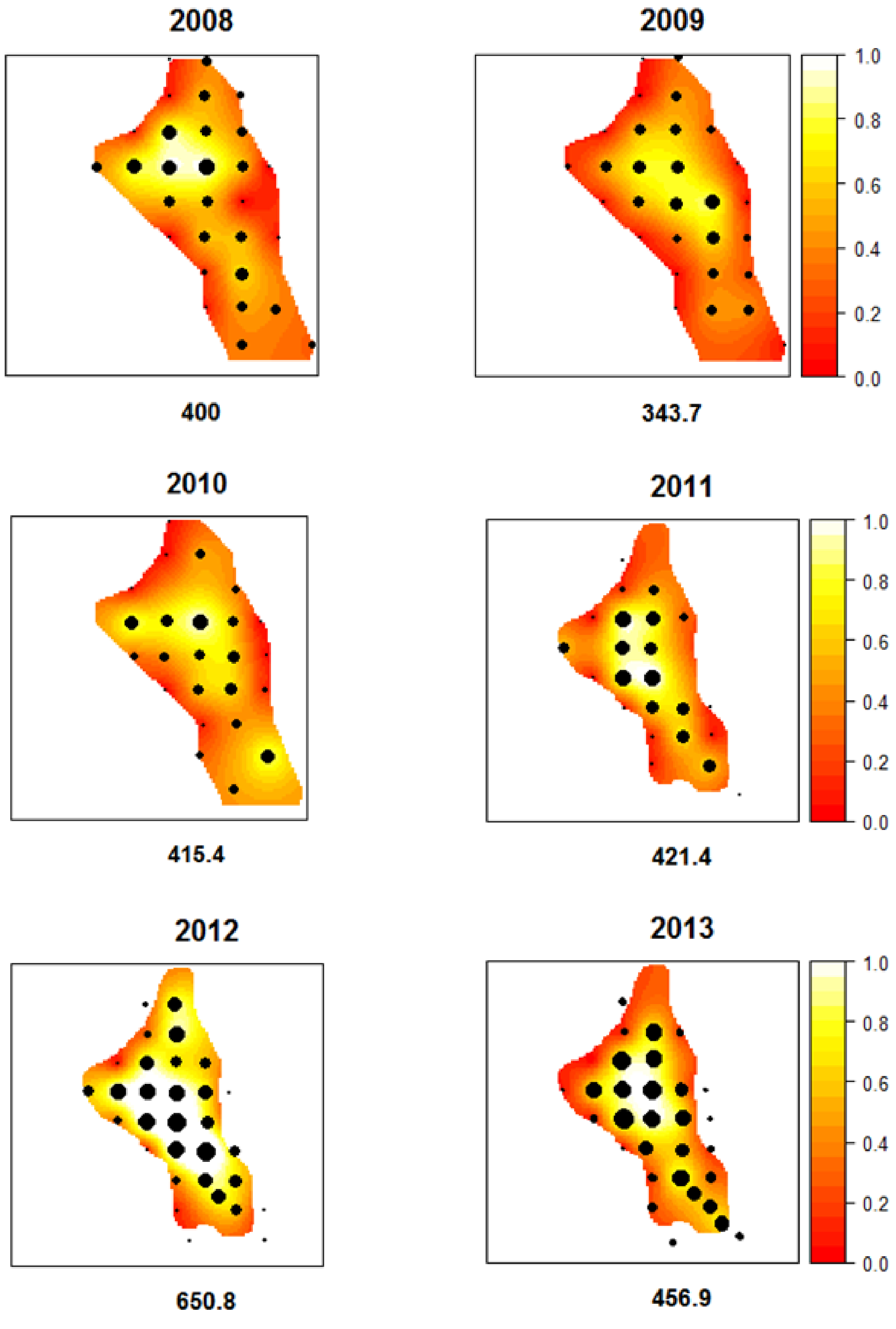


Figure 3.8.8. Irish Sea East (FU14): Co-kriging approach. Interpolation result of VMS (cut off 3%), survey density (2013–2015) data and mud distribution. A - model output; B - final polygon.


2008
400
2009
343.7
1.0
0.8
0.6
0.4
0.2
0.0
2010
415.4
2011
421.4
1.0
0.8
0.6
0.4
0.2
0.0
2012
650.8
2013
456.9
1.0
0.8
0.6
0.4
0.2
0.0

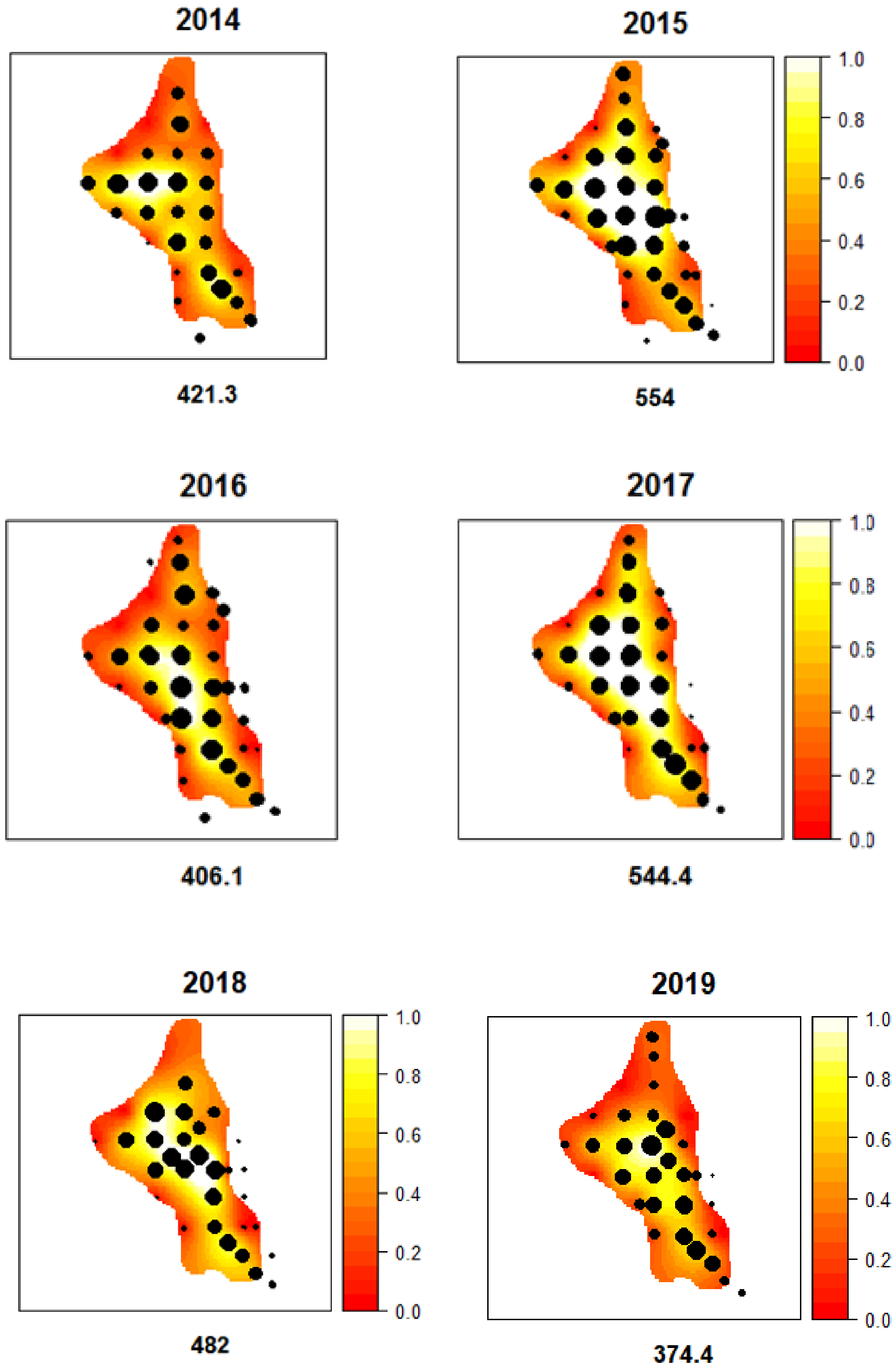


Figure 3.8.9. Irish Sea East (FU14): Burrow density estimates from the UWTV Survey 2008–2018 (individuals / m².) Abundance estimates (millions) given at the bottom of each plot are adjusted with the cumulative absolute conversion factor (but does not contain the additional area for Wigtown Bay). Area of ground = 1032.75 Km² for 2008–2010 and 1019.79 Km² for 2011–2019.

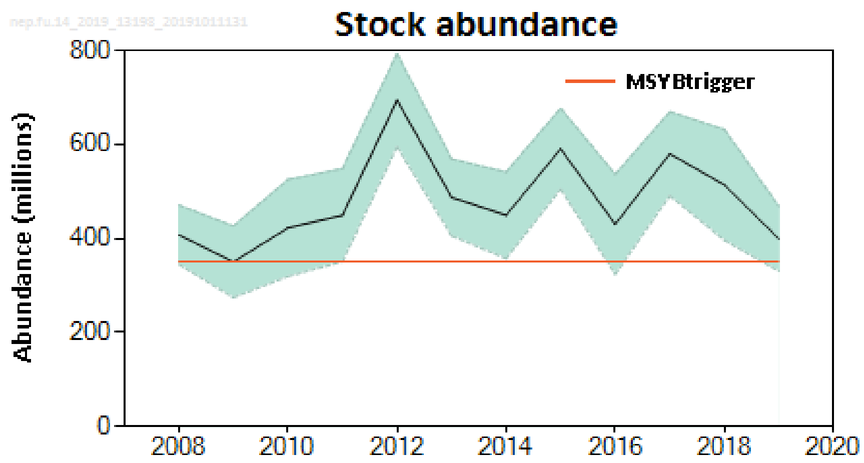


Figure 3.8.10. Irish Sea East (FU14): Burrow density estimates from the UWTV Survey 2008–2019. $B_{trigger}$ set as 350 million (orange dashed line).

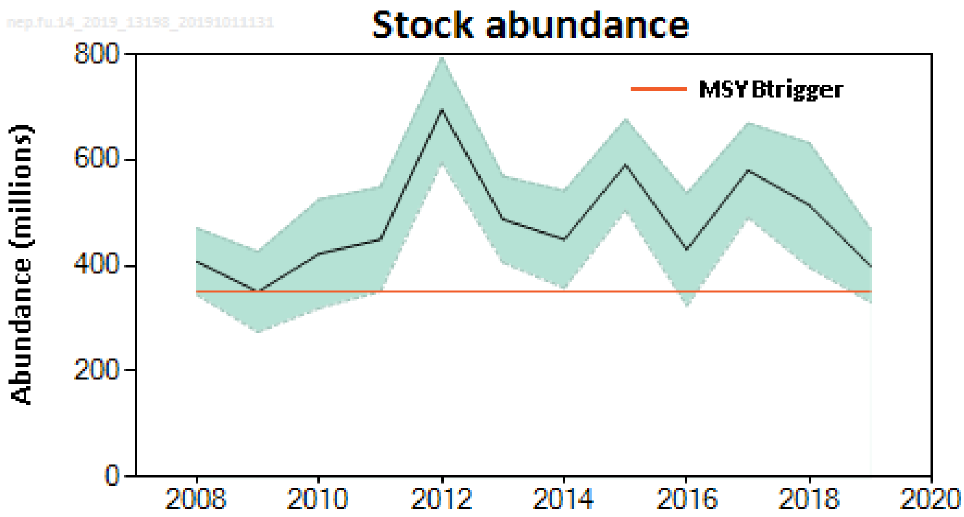


Figure 3.8.11. Irish Sea East (FU14): Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy (11%) and the harvest rate respectively. Between 2010 and 2012 due to poor sampling levels, harvest rate estimates are not reliable.

16 Norway lobster (*Nephrops norvegicus*)in Division 7.a, Functional Unit 15 (Irish Sea, west)

Type of assessment

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the general process defined by WK*NEPH* (2009) described in the stock annex. The TV survey is due to be repeated in the summer of 2019 and the new survey will form the basis of advice for this stock in the autumn.

ICES advice applicable to 2018

ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should be no more than 11 807 tonnes.

To ensure that the stock in Functional Unit 15 is exploited sustainably, management should be implemented at the functional unit level.

ICES advice applicable to 2019

ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2015–2017, catches in 2019 should be no more than 11 107 tonnes.

To ensure that the stock in Functional Unit 15 is exploited sustainably, management should be implemented at the functional unit level.

16.1 General

Stock description and management units

The Irish Sea West (FU15) is comprised of ICES rectangles 35E3–E5, 36E3–E5, 37E3–E5 and 38E4 within 7a. It is included in ICES Area 7 together with the Irish Sea East (FU14), Porcupine Bank (FU16), Aran Grounds (FU17) northwest Irish Coast (FU18), southeast and southwest Irish Coast (FU19), NW Labadie, Baltimore and Galley, and Jones and Cockburn (FU20-21) and the Smalls (FU22).

A TAC is in place for ICES Area 7, which does not correspond to the assessment units. As *Nephrops* are limited to muddy habitats the distribution of suitable sediment defines the species distribution and the stocks are therefore assessed as seven separate Functional Units. The TAC for Area 7 is shown in the tables section.

Fishery description

The FU15 *Nephrops* fishery first developed in the late 1950s. The environment in the Western Irish Sea is very suitable for *Nephrops*, with a large mud patch and a gyre that retains the larvae over the mud patch, thus ensuring good recruitment. The ground can be characterized as an area of very high densities of small *Nephrops*. Northern Ireland and Ireland are the main countries involved in the FU15 *Nephrops* fishery.

The fishery in 2017

The *Nephrops* fishery in the Irish Sea west is economically the most important in ICES Division 7.a and is mainly prosecuted by vessels from UK (Northern Ireland) and Ireland. Working Group landings from FU15 are presented in Table 17.1 and Figure 17.1. Total declared international *Nephrops* landings reported from FU15 in 2018 was 5756 t, which are the lowest observed landings since 1980 (Table 17.1). There has been a trend for Irish, since 2012, and more recently Northern Irish vessels to switch to multi (quad) rig trawls. Provisional data suggest a ~30% increase in *Nephrops* catch rates and a reduction in fish bycatch of ~30% due to the lower headline height. Since March 2012, it is mandatory for all Irish vessels to use specified species selective gears. Similar conditions have been introduced in October 2012 for the UK (Northern Ireland) vessels. In 2018, there was marked decrease in LPUE in 2018 (Table 17.2). Recent decline in landings is considered to reflect overall decline in fishing effort with reports of a number of vessels leaving the fishery.

Further general information on the fishery can be found in the stock annex.

Information from stakeholders

No information from stakeholders.

16.2 Data

Commercial size composition data for landings and discards were provided by Northern Ireland and Ireland. Other biological data used in the assessment were as listed in the stock annex compiled by the Benchmark meeting WK*NEPH* (2009).

InterCatch

Data were available in InterCatch and used to derive assessment input data.

Landings

Working Group landings from FU15 are presented in Table 17.1 and Figure 19.1. Total declared international *Nephrops* landings reported from FU15 in 2018 was 5756 t, which are the lowest observed landings since 1980. Ireland's landings were 1387 t, a small increase from 2017. UK vessels landed 4369 t in 2018, a decrease of 11% compared to landings in 2017, landings by Northern Irish vessel contributed to over 98% of these landings.

Effort

Effort by the UK fleet remained relatively stable since 2002 following a steady decline from the early 1990s. There was a further marginal reduction in effort and LPUE time-series for Ireland (Table 17.3) compared to 2016, with effort at the lowest reported value in the series. In previous years, these interannual fluctuations have been attributed to the high mobility and flexibility, in terms of fishing in other areas within the TAC area, whereas the Northern Irish effort is mostly concentrated on FU15. Fishing activity from the Irish fleet in FU15 increasingly concentrates on good fishing periods during the year, resulting in a larger and increasing LPUE. The LPUE and effort LPUE series for Northern Ireland are updated to provide kW days (kWd) and LPUE as kg/kWd. A change to e-logbooks and recording of fishing hours after 2013 means that the recent data are not comparable with the historic series. Recent LPUE and effort after 2013 has remained stable. The LPUE for the Northern Irish and Irish fleets in 2018 were similar 2.10 kg/kWd and 2.30 kg/kWd but both declines since 2017 from 3.05 kg/kWd and 2.43 kg/kWd.

Sampling levels

Sampling catches by means of the fisher self-sampling scheme for Northern Irish vessels has continued at sustained high levels with 107 samples collected from the reference fleet, with 34, 25, 29 and 19 samples in quarters 1–4 respectively. The number of discard and catch samples collected from the Irish fleet was seven, six, nine and four samples collected in quarters 1–4 respectively. These rates correspond to one sample per 40.1 t landed by the Northern Irish fleet and one sample for every 53.3 t landed by the Irish fleet. Sampling levels compared to previous years are lower as a number of vessel in the fisher self-sampling scheme left the fleet.

Commercial length–frequency distributions

Length and sex compositions of *Nephrops* landed from the Irish Sea West are estimated from port sampling by Ireland and Northern Ireland. Sampling of Northern Ireland catches was not possible during 2003–2007, with the Irish length frequencies raised to the international catch for these years. Northern Ireland sampling resumed in 2008 and these data are combined with those from Ireland for that year.

This Northern Irish fisher self-sampling scheme uses a reference fleet of vessels selected vessels from the main Northern Irish ports. The reference vessels selection is designed to be representative of the entire fleet with systematic rota sampling. The mean sizes of *Nephrops* in the catches of both the Northern Ireland and Ireland fisheries have fluctuated for the last decade (Tables 19.4–19.5; Figure 17.1). There is little evidence to suggest a long-term trend in the mean size of males and females in the landings and catches, which continues to fluctuate around the series mean (Figure 17.2).

Sex ratio

The sex ratio by year is shown in Figure 17.3. This shows some fluctuations over time. In general, the sex ratio in landings and catches are biased toward males, with a geomean of 56.2% males in landings (1986–2018) and 52.4% in catches (1986–2018). A bias toward males in catches was observed in 2017 comprising 61% in landings and 55.6% in the catch compared to 64.3% in the catch and 59.2% in landings in 2018. The stronger bias of males in landings relates to the average larger size of male *Nephrops*.

Mean weights

Explorations of the mean weight in the catch samples by sex shows a strong seasonal pattern in the females (Figure 17.4). This corresponds with the emergence of mature females from the burrows to mate in summer. There is no evidence of a recent trend toward decreasing mean weights (Figure 17.5), however compared to the early part of the time-series mean weights have decreased. The mean weights in landings (2016–2018) and mean weights in discards (2016–2018) are used in the basis for calculating catch options (Section 19.4).

Discards

Annual discard rates are estimated using unsorted catch and discards sampling. Unsorted catches and samples of retained catch are provided by vessels. The catch sample is partitioned into landings and discards using a discard selection ogive. This selection ogive can be derived per sample or as aggregation of samples within a quarter or year when sampling rates are low. Sampling effort is stratified weekly, but quarterly aggregations are used for quarterly length frequencies and discard estimates. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate raising factors. Discarding practice is highly variable, mainly driven by market demand, and was 29% of the catch by number in 2018 (Table 17.6). A discard survival rate of 10% is assumed for *Nephrops* from this FU (WKNEPH 2009).

Surveys

Abundance indices from UWTV surveys

Since 2003, Ireland and Northern Ireland have jointly carried out underwater television surveys of the main *Nephrops* grounds in the western Irish Sea. These surveys were based on a randomised fixed-grid design. The methods used during the surveys were similar to those employed for UWTV surveys of other *Nephrops* stocks and were as agreed by WKNEPHTV (ICES, 2007), WKNEPBID (ICES, 2008), SGNEPS (ICES, 2009; 2010; 2012) , WKNEPH (ICES, 2009) and WGNEPS (ICES, 2013; 2014; 2015; 2016). From 2003 to 2011 year an average of 146 valid stations was covered by the two surveys combined and the data were raised to a stock area of around 5290 x 10-6 km^2 as detailed in Table 17.7. Details of the survey methodology are available in WGNEPS (ICES, 2016). Figure 17.6 shows the distribution of stations sampled in 2019. The number of stations were significantly reduced in 2012 following a recommendation from SGNEPS 2012 that a CV (or relative standard error) of <20% is an acceptable precision level for UWTV survey estimates of abundance. This allowed sampling intensity to be reduced, and survey effort allocated to other areas and FUs in area 7. Figures 17.7–17.9 are contour plot of the krigged-density estimates for FU15 over the period 2003–2019. The resulting krigged burrow abundance estimate was 4.4 billion burrows. This was a similar result of that obtained in 2015, but a 10% lower than the abundance in 2018. In contrast to 2017, the spatial distribution of burrows shows a high density band on the central western area of the survey ground. (Table 17.7). A violin plot of the burrow densities observed in the survey (2003–2019) is shown in Figure 17.10. The character of the burrow densities encountered has remained consistent over time; characterised by a relatively high occurrence of low density stations and a normal distribution densities around one burrow/m^2. Confidence in the survey estimates and design are assured through the maintained low coefficient of variation on the burrow estimates.

The use of the UWTV surveys for the provision of *Nephrops* management advice was extensively reviewed by WKNEPH (ICES, 2009) and potential biases were highlighted including those due to edge effects; species burrow misidentification and burrow occupancy. A cumulative bias correction factor estimated for FU15 was 1.14, which means the TV survey is likely to overestimate *Nephrops* abundance by 14%.

Nephrops trawl surveys

In addition to UWTV surveys, Northern Ireland have completed spring (April) and summer (August) *Nephrops* trawl surveys since 1994 and provide data on catch rates, size composition and biological data from fixed stations in the western Irish Sea as detailed in the Stock Annex (Stock Annex Figure 1). Survey CPUE has remained stable over time. Mean carapace length-by-sex (from the trawl survey) shows inter-annual variation fluctuating around mean with no apparent trend over time (Figure 17.11).

Due to reduced resources, the spring survey series was terminated in 2010 as part of a national rationalisation of the survey programme after considering benefits to management and stock assessment. Due to a major ship breakdown, no data are available for the 2013 summer survey. The summer trawl survey catch rates correlate somewhat with UWTV survey abundance estimates (Figure 17.12), but showed a deviating trend, especially in 2010. The longer time-series of the trawl survey shows that catch rates in the last few years (2005–2009, 2011) are close to the mean of the series when UWTV burrow abundances were in the range of 5–6 billion burrows. The reduction in the 2010 trawl estimate, that showed a conflicting trend to the UWTV abundance, is most likely associated with the survey taking place in suboptimal tidal conditions. Usually the trawl survey coincides with slack tides, but this was not optimal in 2010 due to availability of the ship and synchronisation with the UWTV survey.

16.3 Assessment

Comparison with previous assessments

The assessment approach used by WGCSE 2018 is consistent with that set out in the stock annex and WK*NEPH* (WK*NEPH*, 2009). Since the most recent three years of sampling data were available, three-year averages of mean weights in the landings and proportions retained in the fishery have been used. This is in line with the procedure used for other stocks in areas 6 and 7 by WGCSE.

State of the stock

The stock size is estimated to show a decrease, but within the limits previously observed for the stock. The harvest ratio has decreased further in 2018 and is below F_{MSY} (Figure 17.13). This stock has previously sustained landings at around 9000 t for many years. The stock increased until 2003, with a general decrease until 2014 and has increased since then. The most recent UWTV abundance estimate of 4.4 billion in 2018 follows a period (2016–2017) of above average size. The geometric mean of current series is 4.92 billion. Figure 17.13 is the stock summary plot for FU15. Recent harvest rates have fluctuated around F_{MSY}, but is estimated as 10.0 in 2018, having decreased from 19.9 in 2015 (Table 17.6). The stock is estimated to be well above $B_{trigger}$ (3000 million).

16.4 Catch option table

Catch option table inputs are presented in Table 17.6 and summarised below. A three-year average (2016–2018) of mean weight in the landings and proportion of removals retained was used.

A landings prediction for 2020 was made for FU15 using the approach agreed at the Benchmark Workshop (WK*NEPH*, 2009) and outlined in the stock annex made on the basis of the 2019 UWTV survey.

The basis for the catch options.

Variable	Value	Notes
Stock abundance	4.4 billion individuals	UWTV survey 2019.
Mean weight in landings	14.5 g	Average 2016–2018.
Mean weight in discards	7.8 g	Average 2016–2018.
Discard rate	28.5%	Average 2016–2018 (by number).Calculated as discards divided by landings + discards.
Discard survival rate	10%	Only applies in scenarios where discarding is allowed.
Dead discard rate	26.4%	Average 2016–2018 (by number). Calculated as dead discards divided by dead removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

16.5 Reference points

A decision-making framework for the choice of F_{MSY} proxy reference points is available in the introduction to the *Nephrops* ICES advice sheets. The current F_{MSY} proxy reference points for FU15 *Nephrops* was evaluated at WKMSYRef4. The MSY reference point for FU15 *Nephrops* is the F_{MAX} for combined sexes. No precautionary reference points have been defined for *Nephrops* stocks. Whereas the F_{MSY} proxy reference points were chosen with the intent that they should lead to a low probability of stock overfishing.

Previously the CPUE data from the trawl surveys were scaled to the UWTV index to provide a $B_{trigger}$ approximation based on the mean of the five lowest survey catch rates in the time-series (Figure 17.8), this is still accepted as an appropriate $B_{trigger}$ for FU15.

Stock code	MSY Flower	F_{MSY}	MSY Fupper with AR	MSY $B_{trigger}$	MSY Fupper with no AR
nep-15	12.4	18.2	18.2	3000*	18.2

***Abundance in millions.**

16.6 Management strategy

As yet there are no explicit management strategies for this stock.

16.7 Quality of assessment and forecast

Uncertainties in the survey, mean weight in the landings and discard rates are not taken into account in the deterministic catch option. There is some variability in these over time.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009). These have led to a revision in the historical time-series of survey abundance estimates for FU15, which was presented to last year's Working Group. Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al*., 1996).

Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that was more accurate but no more precise (WK*NEPH* 2009). The survey estimates themselves are very precisely estimated (CVs 2–5%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU15 are largely based on expert opinion (see Stock Annex). The precision of these bias corrections cannot yet be characterised but is likely to be higher than that observed in the survey.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. These parameters are quite variable, in future years the uncertainty in these key parameters should be estimated.

The quality of landings data has improved since 2007 with the implementation of sales notes and buyers and sellers legislation. Prior to that, there were concerns that landings were underreported. The harvest ratio may be under estimated prior to 2007.

16.8 Recommendations for next benchmark

WGCSE will keep the stock under close review and recommend future benchmark as required.

16.9 Management considerations

The FU15 *Nephrops* fishery first developed in the late 1950s. Since then it has sustained landings of around 8500 t for more than 30 years. Fishing effort in the past has been very high but has declined somewhat in recent years. The environment in the western Irish Sea is very suitable for *Nephrops* with a large mud patch and gyre, which retains the larvae over the mud patch thus ensuring good recruitment. The ground can be characterised as an area of very high densities of small *Nephrops*. All available information indicates that size structure of catches appears to have changed little since the fishery first began.

The *Nephrops* trawl fisheries take bycatches of other species, especially juvenile whiting, but also cod. Catches of these species should be reduced to as low as possible because of the poor status of these stocks. A conditional national licence has been introduced by Ireland since March 2012, making the use of grids or separator panels mandatory for all TR2 boats fishing in the Irish Sea. Around 55% of the Irish vessels use separator trawls and while 45% have opted to use Swedish grids to reduce bycatch. Additionally, there has been a trend for Irish vessels to switch to multi (quad) rig trawls. Provisional data suggests a ~30% increase in *Nephrops* catch rates and a reduction in fish bycatch of ~30% due to the lower headline height.

Since October 2012, all TR2 vessels in the UK (Northern Ireland) fleet are required to use a highly selective fishing gear. In the Irish Sea, these currently include Seltra 300 mm box trawl, 270 mm diamond mesh panel Seltra box trawl and 300 mm square mesh panel. All these gears are being developed with the aim of achieving exemption from the cod recovery plan under Article 11 (less than 1.5% cod catch). Enforcement is through the issue cod recovery zone fishing authorisations, where no authorisation is given to a vessel that is not using a highly selective gear.

ICES has repeatedly advised that management should be at a smaller scale than the ICES Subarea 7. Management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort are at the same scale as the resource.

A number of cod recovery measures have been introduced since 2000 to promote recovery of Irish Sea cod stocks. These include a closure of the western Irish Sea cod spawning grounds from mid-February to end of April since 2000, with a later extension to the eastern Irish Sea closure. Despite a partial derogation for *Nephrops* vessels during the closed period, the distribution of effort on *Nephrops* has been affected by this management plan. There have also been decommissioning schemes to reduce fishing effort.

16.10 References

Briggs, R.P., Armstrong, M.J., Dickey-Collas, M., Allen, McQuaid, N. and Whitmore, J. 2002. Estimation of *Nephrops* Biomass in the Western Irish Sea from Annual Larval Production. ICES Journal of Marine Research, 59: 109–119.

Hill, A. E., Durazo, R. and Smeed, D. A. 1994. Observations of a cyclonic gyre in the western Irish Sea. Continental Shelf Research, 14: 479–490.

Hill, A.E., Brown, J. and Fernand, L. 1996. The western Irish Sea gyre: a retention mechanism for the Norway Lobster (*Nephrops norvegicus*)? Oceanologica Acta 19: 357–369.

McQuaid, N., Briggs R. P. and Roberts D. 2009. Fecundity of *Nephrops norvegicus* from the Irish Sea. Journal of the Marine Biological Association of the UK, 89: 1181–1188.

Marrs, S.J., Atkinson, R.J.A., Smith, C.J. and Hills, J.M. 1996. Calibration of the towed underwater TV technique for use in stock assessment of *Nephrops norvegicus*. Reference no. 94/069 (Study Project in support of the Common Fisheries Policy XIV/1810/C1/94, call for proposals 94/C 144/04).

ICES. 2016XX. EU request to ICES to provide FMSY ranges for selected stocks in ICES subareas 5 to 10. In Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

ICES. 2016YY. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

SGNEPS. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC.

WKNEPH. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2009/ACOM:33.

WKNEPHBID. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

WKNEPHTV. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14.

Table 17.1. Irish Sea West (FU15): Landings (tonnes) by country, 2000–2018.

Year	Ireland	Isle of Man	UK	Other countries	Total
2000	3433	0	4937	0	8370
2001	2689	3	4749	0	7441
2002	2291	1	4501	0	6793
2003	2709	4	4352	0	7065
2004	2786	13	4470	1	7270
2005	2133	0	4420	0	6554
2006	2051	1	5508	1	7561
2007	2767	0	5724	0	8491
2008	3132	50	7323	2	10508
2009	2343	1	6855	0	9198
2010	2578	0	6384	0	8963
2011	3575	2	6584	0	10162
2012	3794	3	6732	0.2	10529
2013	2465	31	6175	0.2	8672
2014	2938	0**	5676	0.0	8613
2015	2199	0**	6433	0.3	8632
2016	1609	0**	5715	3	7327
2017	1253	0**	4896	0	6150
2018	1387		4369	0	5756

*** provisional. **included in UK landings.**

Table 17.2. Irish Sea West (FU15): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) Republic of Ireland *Nephrops* Directed Trawlers 2000–2013. Time-series updated in 2018.

Year	Landings (Kg)	Effort (Hours)	Effort (days)	Effort (kwdays)	LPUE
1995	1706969	44459	3516	835977	2.041885
1996	1406140	31409	2326	607785	2.313549
1997	2801501	60502	4518	1124379	2.491599
1998	2696979	52277	4051	1053491	2.560039
1999	4031508	73786	5260	1367903	2.947217
2000	3227565	61936	4396	1199896	2.68987
2001	2428587	51111	3435	939387	2.585289
2002	2015965	46072	2900	873563	2.307749
2003	1620391	47704	3120	878568	1.844355
2004	2586760	52673	3500	1033073	2.503946
2005	2111185	50825	3414	1003901	2.102981
2006	2031881	53461	3535	1084251	1.873995
2007	2728841	52550	3575	1056291	2.583419
2008	3165781	49218	3401	1027919	3.079796
2009	2333433	34651	2368	706178	3.304312
2010	2505061	36504	2546	739345	3.388218
2011	3554343	47640	3229	921298	3.857972
2012	3725318	49313	3560	966006	3.856413
2013	2269336	33818	2571	682793	3.323608
2014	2449612	40371	3007	852740	2.872635
2015	2119880	35898	2733	756719	2.80141
2016	1529418	28249	2301	556452	2.748516
2017	1120690	22516	1749	410628	2.729208
2018	1363910	27084	1919	535002	2.549353

Table 17.3. Irish Sea West (FU15): Landings (tonnes), effort (‘000 hours trawling), LPUE (kg/hour trawling), effort (‘000 kW days) and LPUE (kg/kWd) of Northern Ireland *Nephrops* trawlers, 2000–2018.

Year	Landings	Effort ('000 hours)	LPUE ('000 hrs)	kW days ('000)	LPUE kWd
2000	4758	168.7	28.2		
2001	4587	163.7	28.0		
2002	4495	130.8	34.4		
2003	4146	136.1	29.0		
2004	4273	144.3	29.6		
2005	4235	138.4	30.6		
2006	5356	144.1	37.2		
2007	5512	126.9	43.4		
2008	7056	141.4	49.9		
2009	6487	134.7	48.2		
2010	5888	141.1	41.7		
2011	5952	132.7	44.9		
2012	5865	137.8	42.6		
2013	5605	135.7	41.3	2151.9	2.60
2014	5190	114.6	45.3	2111.2	2.46
2015	6396			1962.6	3.26
2016	5638			2107.3	2.68
2017	4789			1904.3	2.51
2018*	4293			2079.3	2.06

* provisional.

Table 17.4. Irish Sea West (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Northern Ireland catches, landings and discards, 2000–2018.

Year	Catches		Landings		Discards	
	Males	Females	Males	Females	Males	Females
2000	27.7	24.5	29.4	26.3	22.5	22.6
2001	25.7	23.6	26.1	24.4	21.7	21.2
2002	26.7	24.1	26.7	24.9	21.8	21.7
2003	na	na	na	na	na	na
2004	na	na	na	na	na	na
2005	na	na	na	na	na	na
2006	na	na	na	na	na	na
2007	na	na	na	na	na	na
2008	25.9	24.6	26.9	25.5	21.4	21.5
2009	27.7	25.1	29.3	26.5	23.6	23.2
2010	28.3	25.6	29.5	26.3	23.2	22.8
2011	27.6	26.0	29.3	27.7	22.6	22.8
2012	26.8	24.3	27.7	25.4	21.7	21.1
2013	26.2	24.2	27.2	25.4	21.5	21.3
2014	26.3	23.9	27.1	24.9	21.1	20.6
2015	25.3	23.4	26.8	24.7	21.6	21.3
2016	25.9	24.3	26.9	25.5	22.3	21.8
2017	27.0	24.8	28.0	26.1	22.9	22.5
2018	27.6	25.1	28.8	26.6	23.3	22.5

na = not available.

Table 17.5. Irish Sea West (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Republic of Ireland catches, landings and discards, 2000–2018.

Year	Catches		Landings		Discards	
	Males	Females	Males	Females	Males	Females
2000	29.1	27.1	32.2	29.7	24.3	24.0
2001	26.7	24.8	28.6	27.0	23.0	22.2
2002	28.9	25.4	30.2	27.8	24.6	23.6
2003	27.7	24.9	29.7	26.9	24.0	23.1
2004	28.1	26.1	29.7	27.8	23.9	23.7
2005	28.5	26.8	30.1	29.1	23.9	23.2
2006	27.7	25.5	29.5	27.1	23.8	23.1
2007	27.7	25.4	29.8	27.9	24.0	23.3
2008	27.4	24.6	28.9	26.6	22.0	21.4
2009	28.5	26.3	30.5	29.2	24.3	23.4
2010	28.0	25.9	29.6	27.6	23.8	23.3
2011	27.0	25.7	28.8	27.3	23.7	23.5
2012	26.8	25.6	28.3	27.0	23.2	23.0
2013	26.3	25.1	27.4	26.5	23.1	22.6
2014	27.7	24.9	29.2	26.3	23.6	23.3
2015	27.7	25.7	29.5	27.4	24.4	24.0
2016	26.0	25.0	27.3	26.4	23.5	23.3
2017	27.2	25.0	28.1	26.2	23.4	22.6
2018	27.4	24.9	29.8	22.8	24.6	22.8

Table 17.6. Irish Sea West (FU15): Proportion discarded by weight and number from FU15. (Note a 10% survivorship of discards is assumed in HR and forecast calculations).

Year	Landings in number (millions)	Total discards in number (millions)	Removals in number (millions)	UWTV abundance estimates (billions)	95% conf. intervals	Harvest rate	Mean weight in landings (g)	Mean weight in discards (g)	Discard rate by number	Dead discard rate
2003	404	291	666	5.5	0.27	12.1	17.5	9.1	42%	39%
2004	416	218	612	5.5	0.3	11	17.5	9.1	34%	32%
2005	346	157	488	5.7	0.44	8.6	18.9	9	31%	29%
2006	467	261	701	5.4	0.41	13	16.1	8.8	36%	33%
2007	511	375	848	5.1	0.34	16.5	16.5	8.7	42%	40%
2008	755	191	927	4.3	0.25	21.6	13.9	7.4	20%	19%
2009	567	335	868	4.6	0.26	18.8	16.2	8.8	37%	35%
2010	572	180	733	5	0.31	14.7	15.7	8.6	24%	22%
2011	644	332	943	4.9	0.23	19.4	15.8	8.1	34%	32%
2012	771	258	1003	5.1	0.29	19.8	13.7	7.2	25%	23%
2013	662	229	867	4.3	0.27	20.1	13.1	7	26%	24%
2014	641	198	819	4.6	0.25	17.8	13.4	7.2	24%	22%
2015	620	280	872	4.4	0.29	19.9	13.9	8.0	31%	29%
2016	562	245	783	5.1	0.3	15.4	13.0	7.9	30%	28%
2017	426	152	563	5.3	0.3	10.6	14.4	8.0	26%	24%
2018	360	145	491	4.9	0.3	10.0	16.1	7.4	29%	27%
Average 2016–2018				4.4 (2019 UWTV)			14.5	7.7	28.5%	26.4%

Table 17.7. Irish Sea West (FU15): Results from NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003–2019.

Ground	Year	Number of stations	Mean Density (No./M^2)	Domain Area (km^2)	Estimate (billions)	CV on Burrow estimate
Western Irish Sea	2003	160	0.99	5295	5.5	3%
	2004	147	1.00	5310	5.5	3%
	2005	141	1.02	5281	5.7	4%
	2006	138	0.97	5194	5.4	4%
	2007	148	0.93	5285	5.1	3%
	2008	141	0.77	5287	4.3	3%
	2009	142	0.83	5267	4.6	3%
	2010	149	0.90	5307	5.0	3%
	2011	156	0.88	5289	4.9	2%
	2012	99	0.91	5291	5.1	3%
	2013	80	0.78	5278	4.3	3%
	2014	99	0.83	5272	4.6	3%
	2015	100	0.79	5279	4.4	3%
	2016	100	0.84	5260	5.1	3%
	2017	101	0.90	5304	5.3	3%
	2018	100	0.85	5791	4.9	3%
	2019	100	0.76	5370	4.4	3%

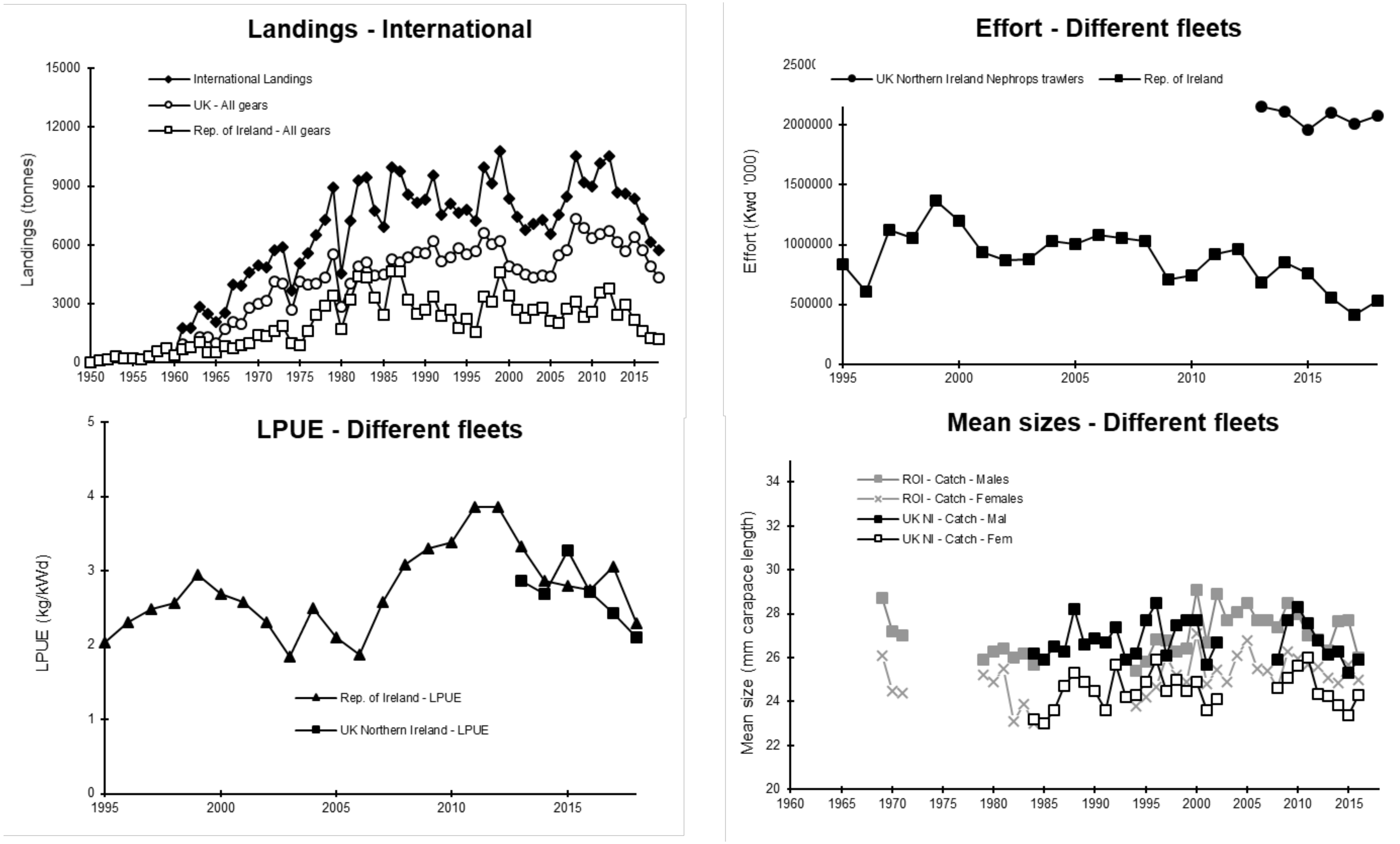


Figure 17.1. Irish Sea West (FU15): Long-term trends in landings, effort, LPUE, and mean sizes of *Nephrops*. [The quality of landings data has improved since 2007 with the implementation of sales notes and buyers and sellers legislation, which result in misleading LPUE trend plots pre and post 2007].

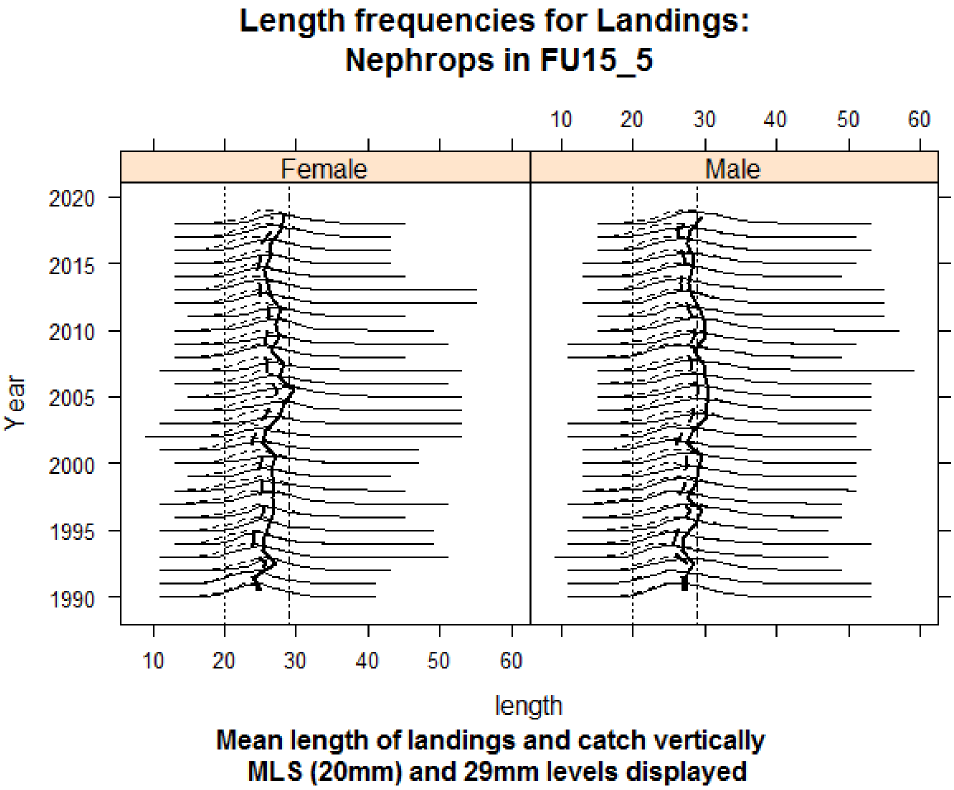


Figure 17.2. Irish Sea West (FU15): Length distributions in the landings (solid) and catches (dotted) 1986–2018.

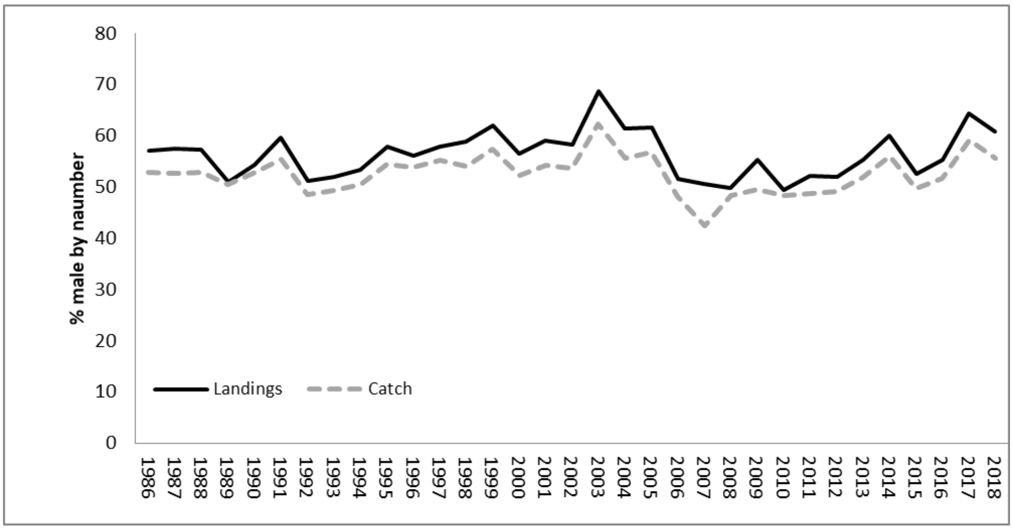


Figure 17.3 *Nephrops* in FU15 (Irish Sea West). Sex ratio of landings (1986–2018) and catch (1986–2018).

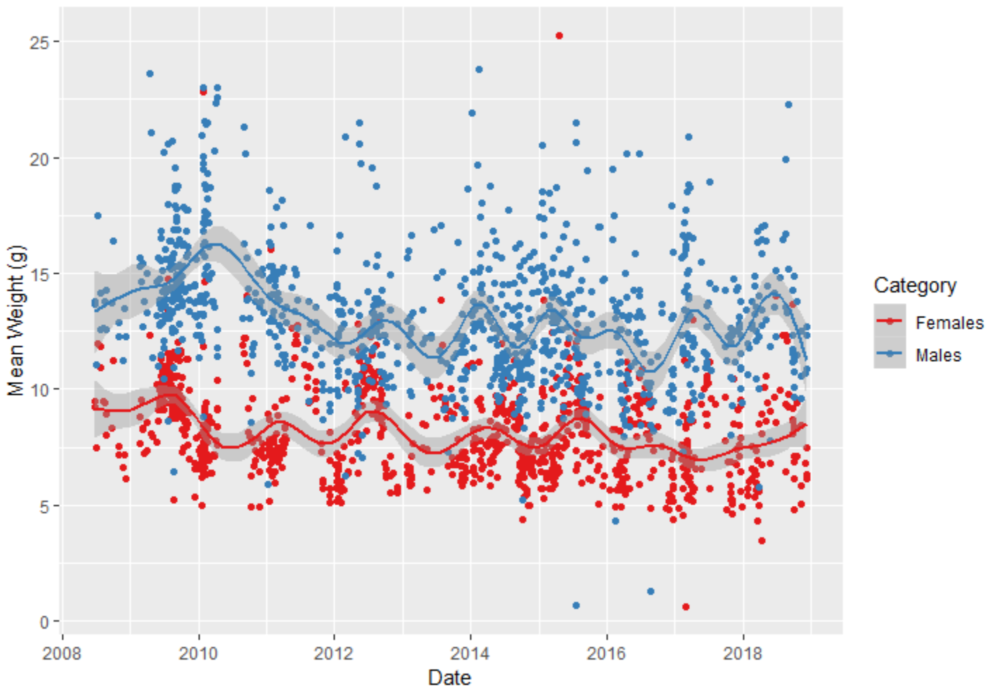


Figure 17.4 ***Nephrops*** **in FU15 (Irish Sea West).Mean weight in catch samples by sex with GAM loess smoother (k=20).**

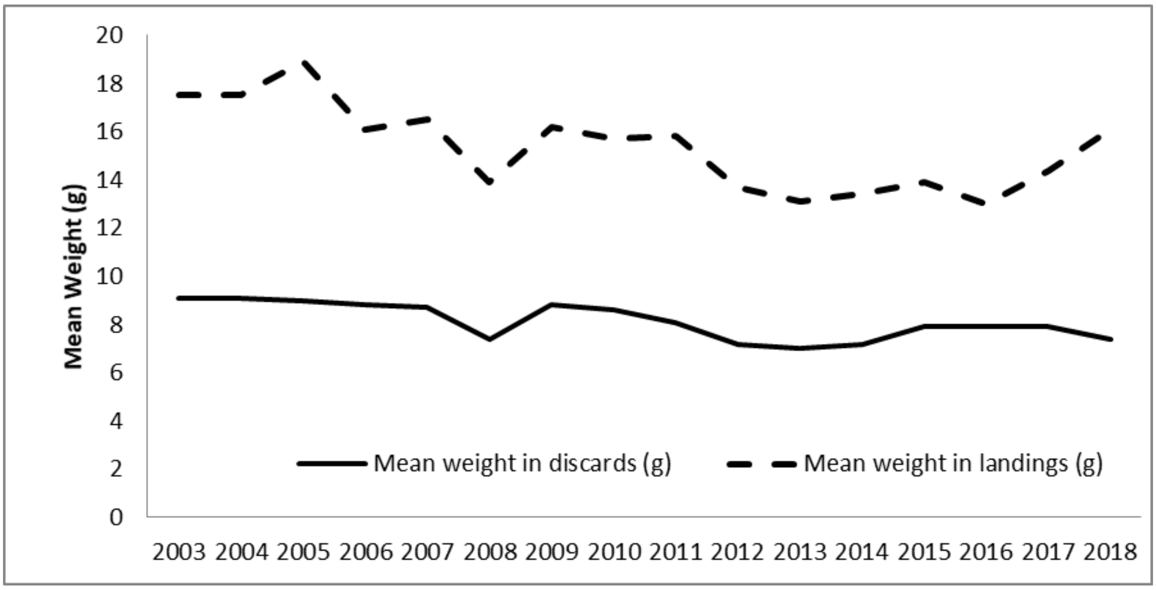


Figure 17.5 ***Nephrops*** **in FU15 (Irish Sea West). Mean weight in landings and discards.**

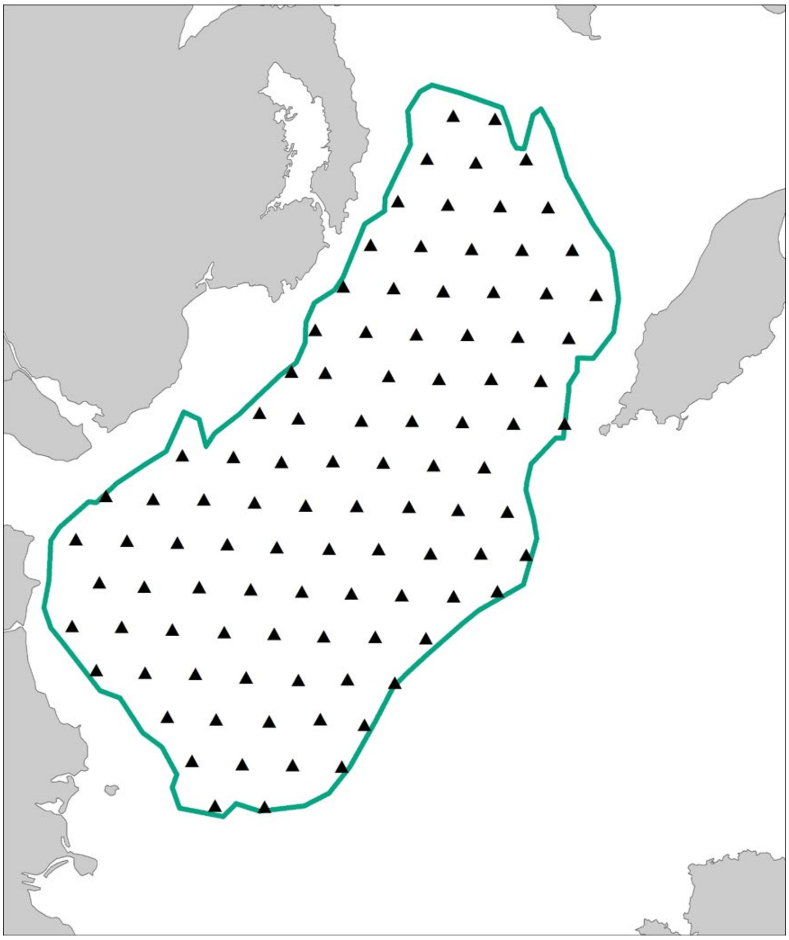


Figure 17.6. Irish Sea West (FU15): 2019 UWTV survey stations.

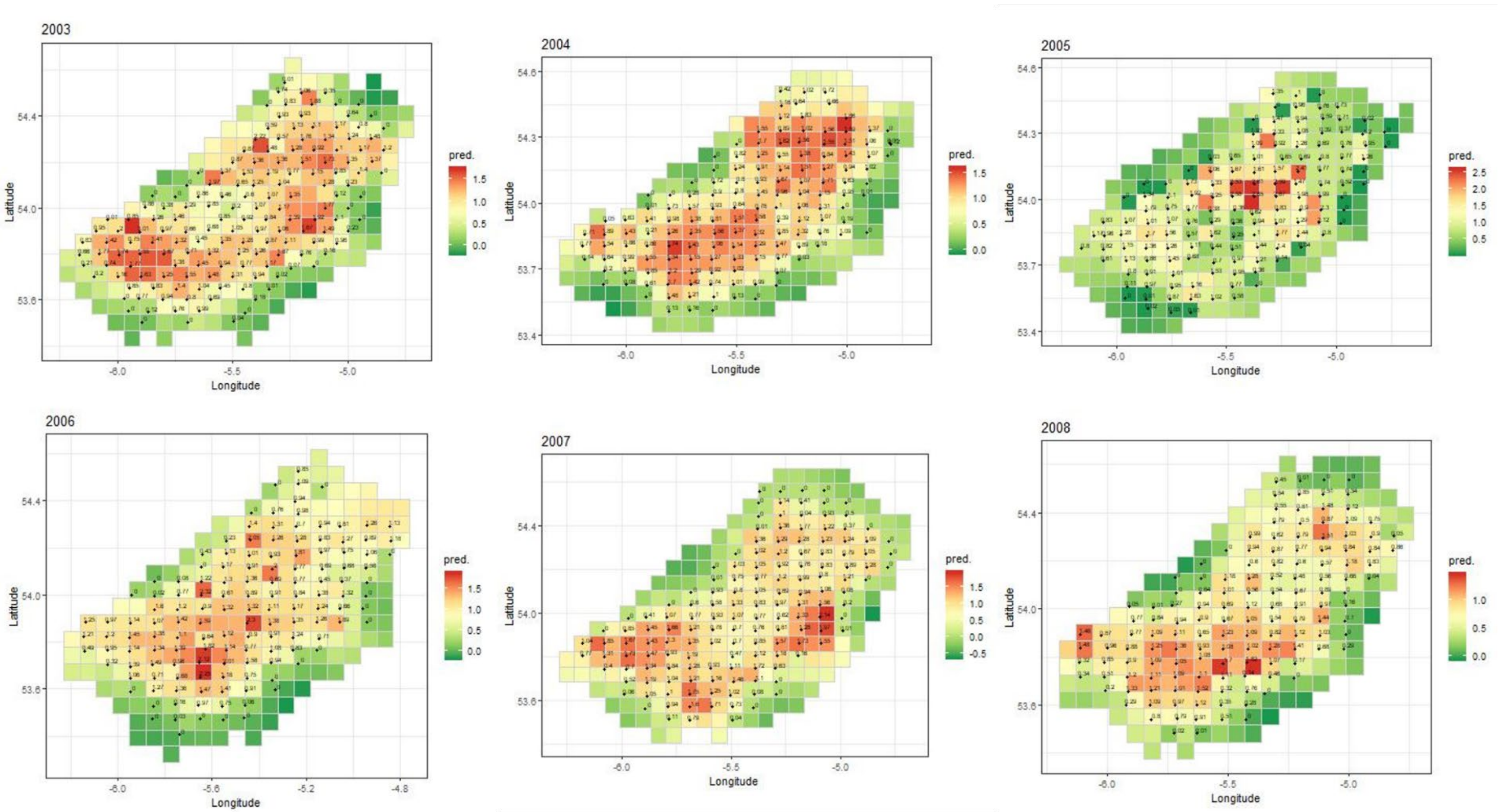


Figure 17.7. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2003–2008.

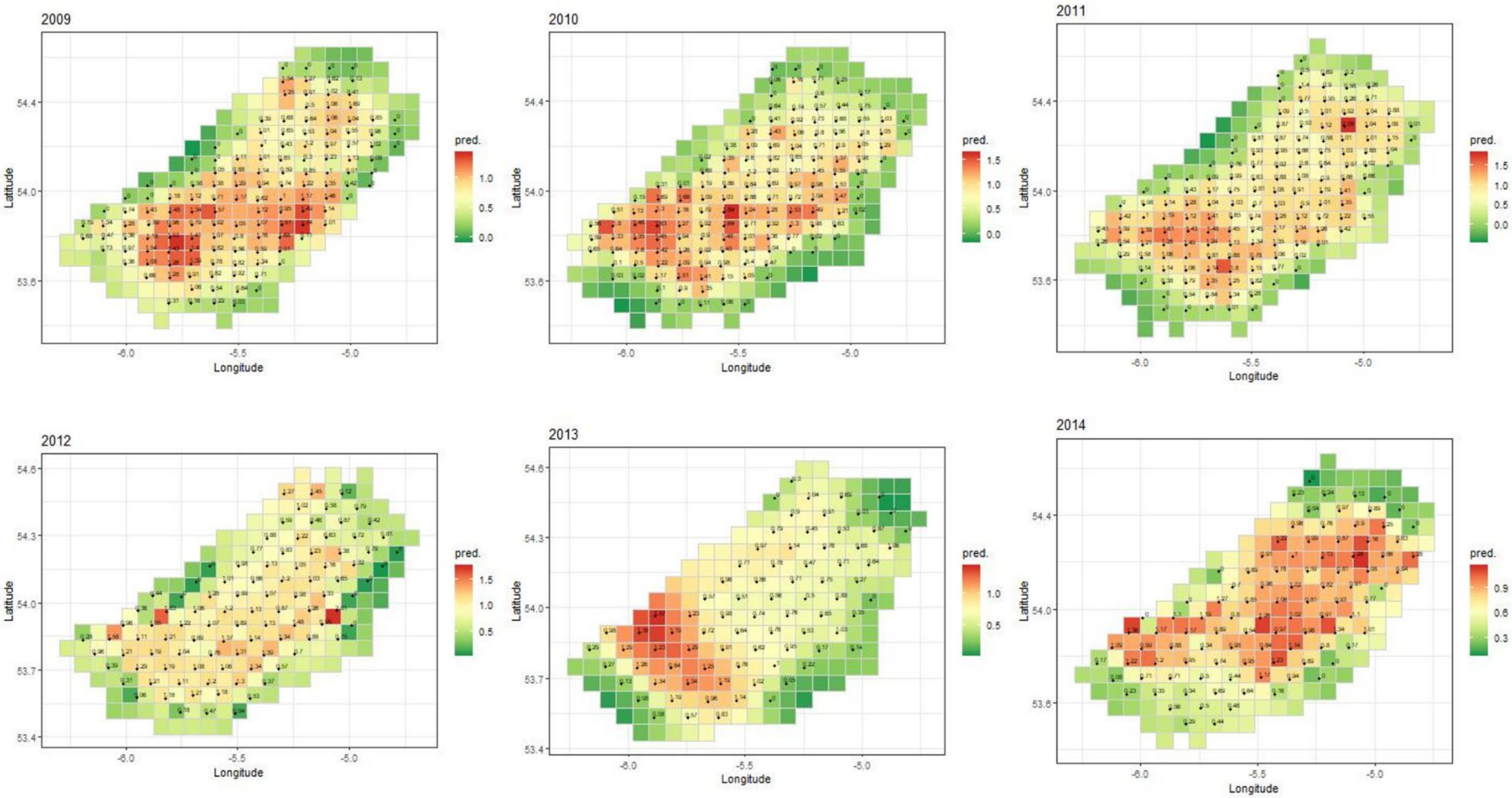


Figure 17.8. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2009–2014.

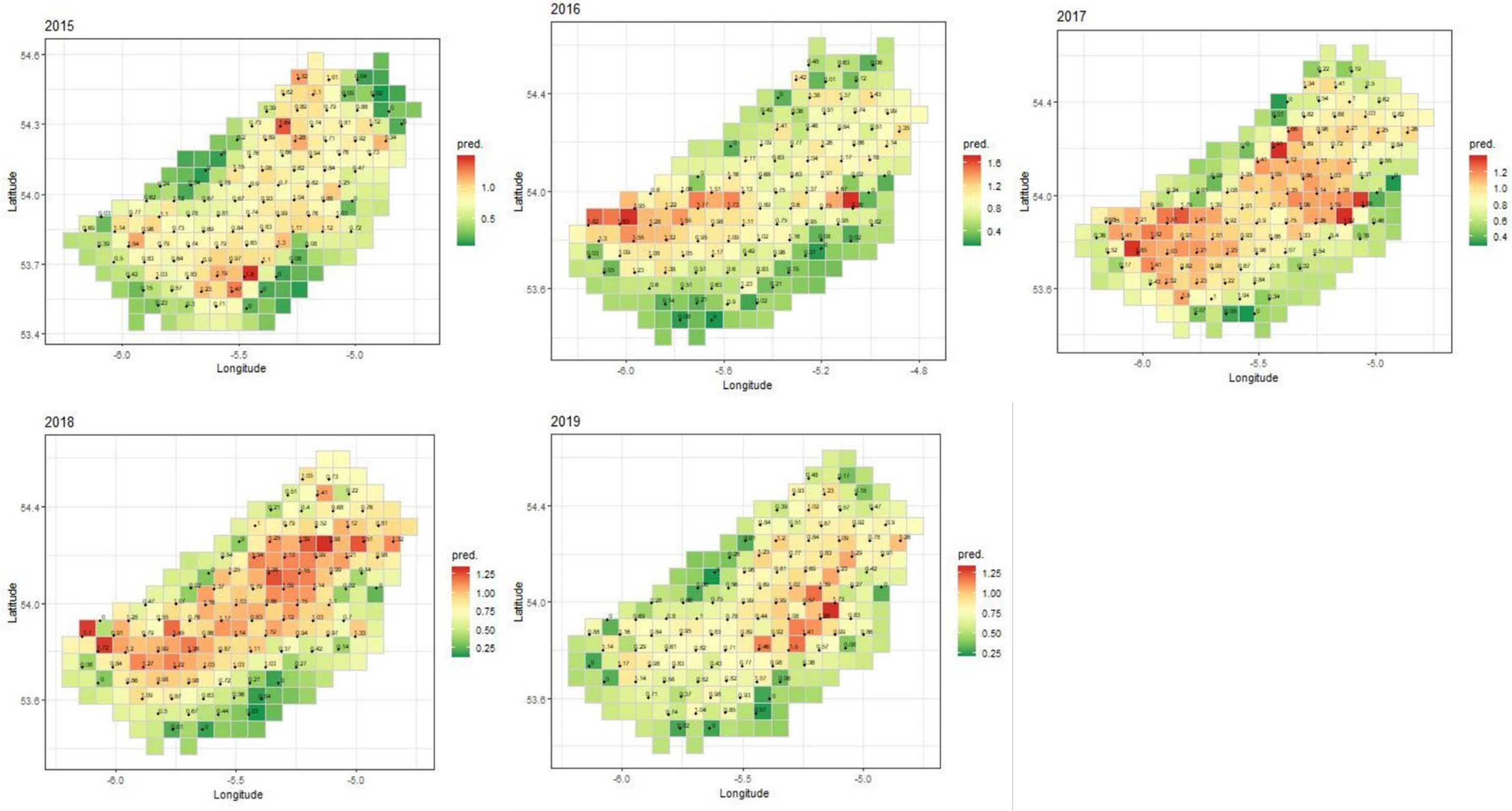


Figure 17.9. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2009–2019.

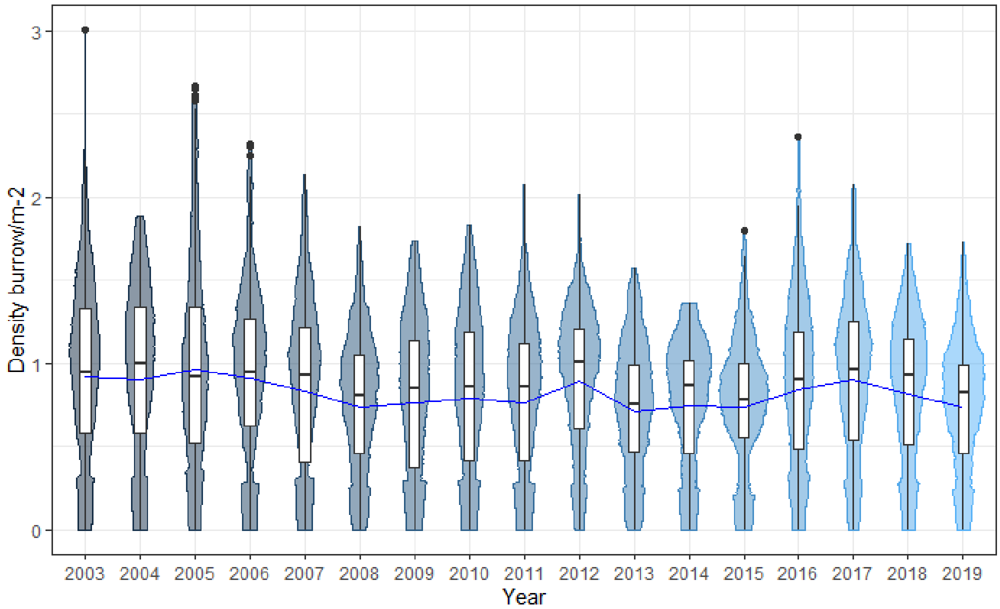


Figure 17.10. Irish Sea West (FU15): Box and kite plot of burrow density observed during UWTV survey 2003–2019.

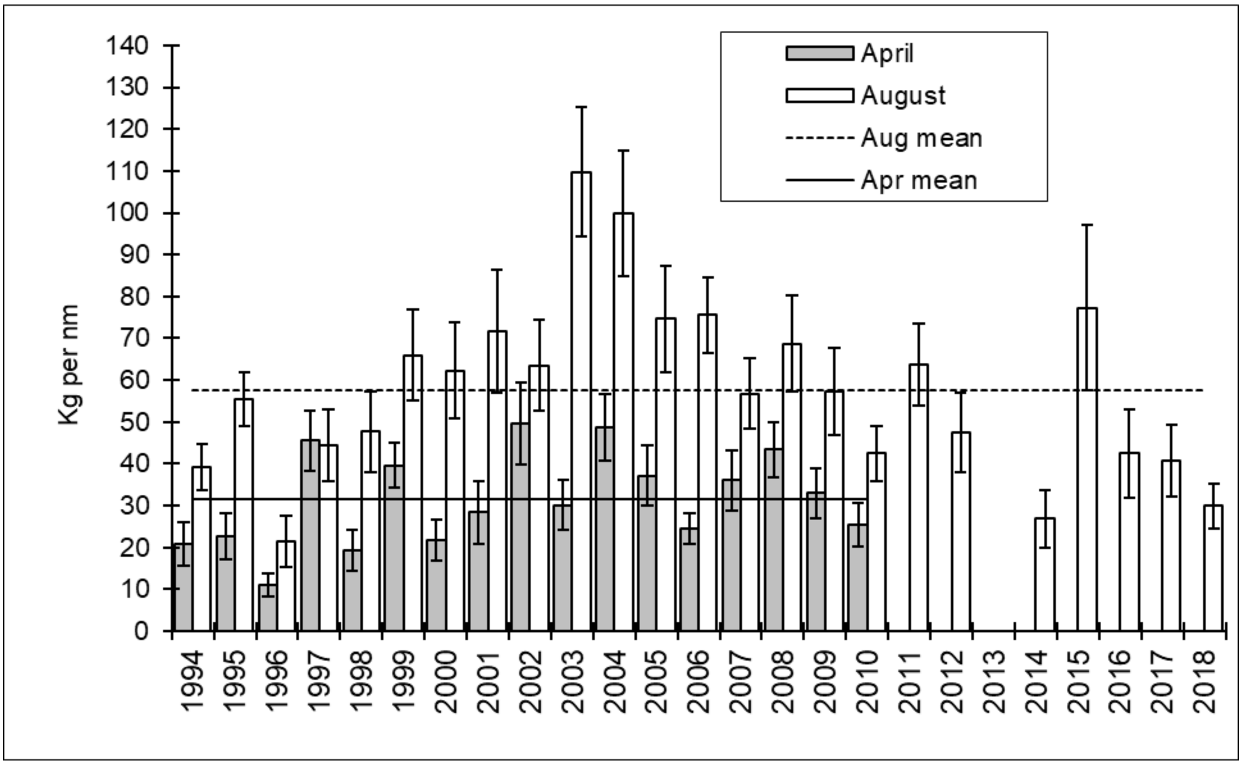


Figure 17.11 Irish Sea West (FU15): *Nephrops* catches (kg per nm) from NI trawl surveys. No data available in 2013 due to ship breakdown.

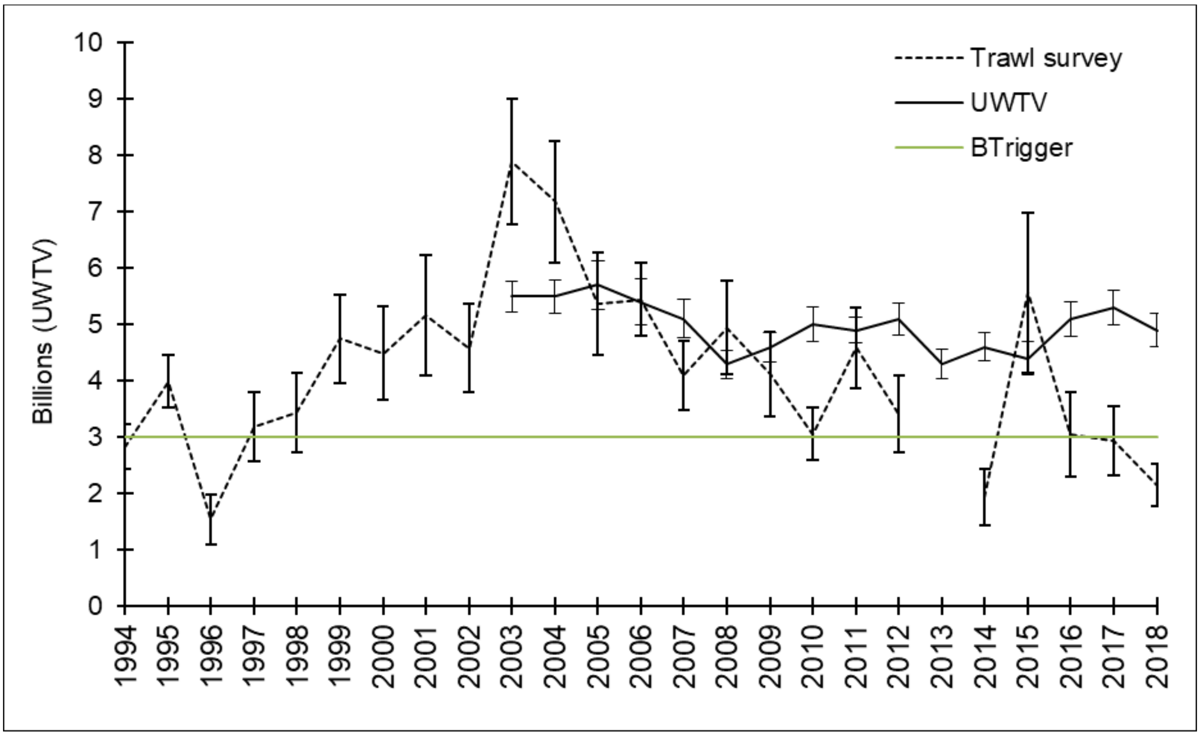


Figure 17.12. Irish Sea West (FU15): Revised UWTV index and scaled trawl survey. CPUE along with $B_{trigger}$ based upon mean of five lowest trawl survey values. Abundance figures have not been bias corrected.

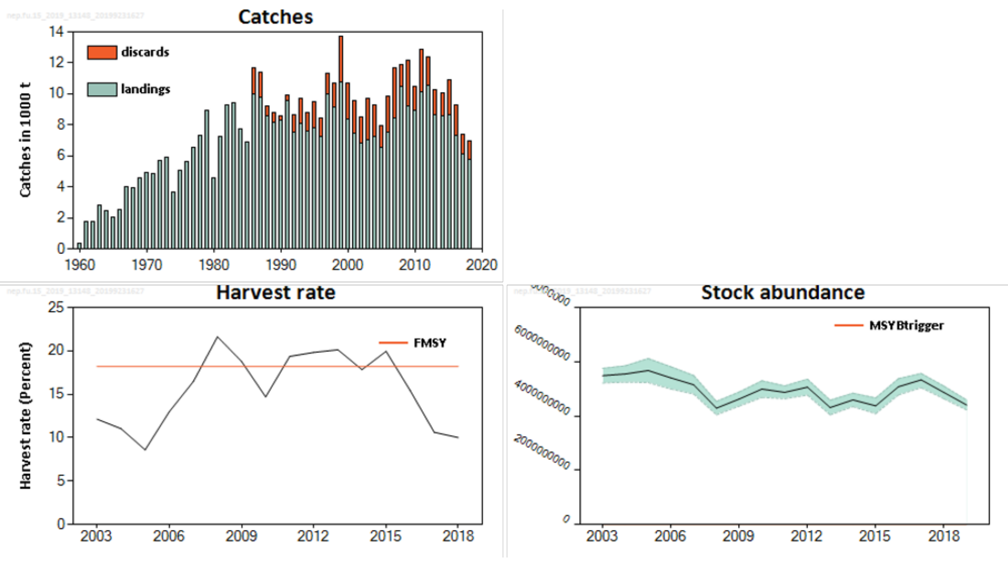


Figure 17.13. Norway lobster in Division 7.a, Functional Unit 15. Summary of the stock assessment. Catches (discard data are only available from 1986), harvest rate (sum of landings and dead discards in numbers, divided by total abundance), survey abundance (Underwater TV, billions; SSB proxy; 95% confidence intervals). Harvest rates between 2003 and 2006 may be unreliable because of underreporting of landings. Orange lines represent MSY $B_{trigger}$ and the F_{MSY} harvest rate.

17 Norway lobster (*Nephrops norvegicus*) in divisions 7.b–c and 7.j–k, Functional Unit 16 (west and southwest of Ireland, Porcupine Bank)

Type of assessment in 2019

Available data on the fishery for 2018 and 2019 and other stock indicators have been updated here according to the stock annex (*Nephrops* FU16). The assessment and catch options follow the agreed procedures set out in the stock annex.

ICES advice applicable to 2018

"ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 2734 tonnes."

ICES advice applicable to 2019

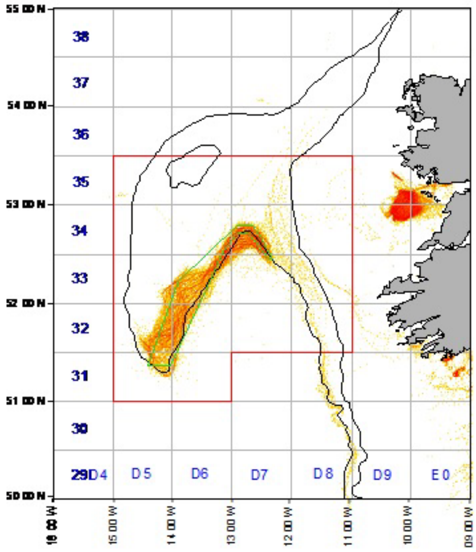
"ICES advises that when the MSY approach is applied, and assuming zero discards, catches in 2019 should be no more than 2645 tonnes.

To ensure that the stock in Functional Unit 16 is exploited sustainably, management should be implemented at the functional unit level."

17.1 General

Stock description and management units

The TAC area is Subarea 7, since 2011 an 'of which' clause was introduced specifically for the Porcupine Bank (FU16) see Table 20.1. The Functional Unit for assessment includes some parts of the following ICES divisions 7.b, c, j, and k. The exact stock area is shown on the map below and includes the following ICES Statistical rectangles: 31–35 D5–D6; 32–35 D7–D8.



The FU16 outlined by the red line. The closed area from 1 May–31 July since 2010 (reduced to only May since 2013) is shown with a green line. Irish *Nephrops* directed fishing effort between 2006–2009 derived from integrated VMS and logbook information is shown as a heat map.

Management applicable to 2018 and 2019

TAC in 2018

COUNCIL REGULATION (EU) 2018/120 of 23 January 2017 fixing for 2018 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters.

Species:	Norway lobster *Nephrops norvegicus*	**Zone:**	7 (NEP/07.)
Spain	1 745 (1)		
France	7 074 (1)		
Ireland	10 729 (1)		
United Kingdom	9 543 (1)		
Union	29 091 (1)		
TAC	29 091 (1)		Analytical TAC Article 12(1) of this Regulation applies

(1) Special condition: within the limits of the abovementioned quotas, no more than the quantities given below may be taken in the following zone:

	Functional Unit 16 of ICES Subarea 7 (NEP/*07U16):
Spain	825
France	516
Ireland	992
United Kingdom	401
Union	2 734

TAC in 2019

COUNCIL REGULATION (EU) 2019/124 of 30 January 2019 fixing for 2019 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters.

Species:	Norway lobster *Nephrops norvegicus*	**Zone:**	7 (NEP/07.)
Spain	1 187 (1)		
France	4 811 (1)		
Ireland	7 296 (1)		
United Kingdom	6 490 (1)		
Union	19 784 (1)		
TAC	19 784 (1)		Analytical TAC Article 13(1) of this Regulation applies

(1) Special condition: within the limits of the abovementioned quotas, no more than the quantities given below may be taken in the following zone:

	Functional Unit 16 of ICES Subarea 7 (NEP/*07U16):
Spain	798
France	500
Ireland	959
United Kingdom	388
Union	2 645

17.2 Closed area restrictions

A seasonal closed area has been in place for three months May 1–31 July between 2010–2012 (shown in the map above and co-ordinates below). The period of the closure was been reduce to only one month after 2013. Article 11 of COUNCIL REGULATION (EU) 2017/127 is given below:

Article 11

Closed fishing seasons

1. It shall be prohibited to fish or retain on board any of the following species in the Porcupine Bank during the period from 1 May to 31 May 2017: cod, megrims, anglerfish, haddock, whiting, hake, Norway lobster, plaice, pollack, saithe, skates and rays, common sole, tusk, blue ling, ling and picked dogfish.

For the purposes of this paragraph, the Porcupine Bank shall comprise the geographical area bounded by rhumb lines sequentially joining the following positions:

Point	Latitude	Longitude
1	52° 27′ N	12° 19′ W
2	52° 40′ N	12° 30′ W
3	52° 47′ N	12° 39,600′ W
4	52° 47′ N	12° 56′ W
5	52° 13.5′ N	13° 53,830′ W
6	51° 22′ N	14° 24′ W
7	51° 22′ N	14° 03′ W
8	52° 10′ N	13° 25′ W
9	52° 32′ N	13° 07,500′ W
10	52° 43′ N	12° 55′ W
11	52° 43′ N	12° 43′ W
12	52° 38,800′ N	12° 37′ W
13	52° 27′ N	12° 23′ W
14	52° 27′ N	12° 19′ W

By way of derogation from the first subparagraph, transit through the Porcupine Bank while carrying on board the species referred to in that paragraph, shall be permitted in accordance with Article 50(3), (4) and (5) of Regulation (EC) No 1224/2009.

The following TCMs are in place for *Nephrops* in 7 (excluding 7.a) after EC 850/98 in operation since 2000:

Minimum Landing Sizes (MLS); total length >85 mm, carapace length >25 mm, tail length >46 mm. Although it is legal to land smaller prawns from this fishery, marketing restrictions imposed by producer organizations in France mean smaller *Nephrops* (<35 mm CL or 115 mm whole length) are not retained in this fishery.

The mesh size restrictions apply to towed gears in 7.b–k targeting *Nephrops and* are given in Section 7.1. Vessels mainly used 80–99 mm mesh to target *Nephrops* on the Porcupine Bank.

The landing obligation applied since 2016 for certain vessels that matched the criteria set out in the discard plans: https://ec.europa.eu/fisheries/cfp/fishing_rules/discards_en

17.3 Fishery in 2018 and 2019

WGCSE reviewed effort trends for Irish vessels that accounted for over 80% of the total landings in recent years. The fishery in 2018 took place up to July, after which the fishery was closed, but was reopened in November. The industry reported very good catches of *Nephrops* but commented that the mean size had declined significantly in 2017 before increased again in 2018.

Effect of regulations

Prior to 2011 TACs and quotas were applied to the whole of 7 so the FU16 fishery was not been restricted by quotas. Since 2011, the "of which clause" was implemented in the TAC regulation specifically for the Porcupine Bank. Quotas have been very restrictive for Irish vessels and this has led to various changes in fishing patterns. Vessels have tried to optimise the economic value of the catch by targeting areas and periods with relatively smaller[1] volumes of larger higher value *Nephrops*. The FU16 specific quota has also increased the risk of area misreporting, discarding and of highgrading landings. Area misreporting diminished in 2018 with the introduction of a national legislation preventing Irish vessels' fishing in FU16 and other areas during the same fishing trip.

Information from stakeholders

The provision of grade information by individual fishers and coops remains a highly important assessment input. In 2017 and 2018, the percentage of landings where grade data were provided decreased, but in 2019, it has increased to the highest value in recent years.

Year	% of Irish landings where grade data were provided
2011	60%
2012	45%
2013	57%
2014	33%
2015	44%
2016	49%
2017	31%
2018	31%
2019	65%

[1] There is a large price differential between the large and small grades. So less volume of the larger grade generates an economically viable return for fishing.

The industry has also collaborated with the development of the IFSRP survey since 2010 (Stokes and Lordan, 2011).

The Irish industry considers that the stock has increased significantly and no longer requires the Functional Unit "*of which*" clause.

17.4 Data

InterCatch

Data were available in InterCatch and used on a trial basis.

Landings

Total international landings increased by ~5% in 2018 to 2751 t (Figure 20.1 and Table 20.2). Since 2011, total landings for FU16 had included "unallocated landings" from other FU due to misreporting. In 2018, no reallocation was applied as there was no information concerning misreporting.

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by WKNEPH 2013, and are documented in the stock annex. Recent sampling rate is provided in Table 20.3.

Since 2010, landings length distributions have been reconstructed using the methods outlined in the stock annex. This involves using samples of the grade length structure from Irish sampling and estimates of the volume of each commercial size grade provided by the fishing industry. This was used to reconstruct Irish LFDs, landings by other fleets which accounted for 20% of the landings were unsampled.

Commercial length–frequency distributions

The time-series of raised international length–frequency distributions of the sampled landings by sex, are given in Figure 20.2. This also shows significant shift towards larger individuals in the landings between 2002–2009 when few individuals at smaller sizes were observed. The length distribution in 2018 is relatively broad and to the right of 2017. The mean lengths by sex and year are presented in Table 20.4.

Sex ratio

Previous *Nephrops* working groups have highlighted stability in sex ratio as an important indicator for *Nephrops* stocks. The landings and fishery-independent survey catches show a dramatic switch in the sex ratio for this stock with larger proportions of females in the catches of 2008 and 2009 (Figure 20.3). Both the commercial and survey data indicate that sex ratio switched back to a more usual situation since 2010 with males accounting for larger proportions of the catch/landings.

Nephrops moult once a year shortly after hatching of eggs in April or May. There is a 24 hour period after moulting when the male *Nephrops* can mate with the female (Farmer, 1974). If there are insufficient males in the population to mate with the recently moulted females, this can result in a change in female behaviour, whereby unmated females concentrate on feeding and growth instead of reproduction. This so called "sperm limitation" hypothesis could explain the sex ratio changes observed in the Porcupine *Nephrops*. WKNEPH 2013 examined the available scientific data on proportions of females mated observed on the Spanish survey. These results showed high proportions of unmated females and a high L_{50} for mated females in catches in 2009. Simulations were also carried out to investigate the densities at which sperm limitation may become an issue given plausible ranges of stock density, sex ratios, search radii. The conclusion was that at the densities recently observed on the Porcupine Bank that sperm limitation was a real possibility.

Mean weight explorations

The mean weights in in the landings are shown for the full time-series in Figure 20.4 and Table 20.5. In 2019, the mean weight on the catch samples has been consistent with the grade information in the landings provided by the fishery.

Discards

There are few historical estimates of discards for this stock. Irish sampling up to 2016, observed very minimal discarding (mainly limited to small and damaged individuals <5% by number). Four Irish trips were sampled in 2016. Discards were not recorded on one of these trips. However, on the other three trips, discards were estimated to be around 8%, 9% and 15% by number (3%, 3% and 6% by weight). In 2017, there were two trips where discards were recorded, 17% and 43% by number. In 2018, discards were observed on one of the two trips (74% by number), no discards were observed on the other trip. The discarding observed on these trips is likely not reflective of the overall discard pattern as the skippers advised the scientist on board that they had increased their discards to remain within quota during the observed trip. This means that the 2018 discard pattern is unknown, but can be no longer considered negligible. In 2019, discards were observed on one of the three trips (14% by number), and no discards were observed on the other two trips.

A detailed examination of discard estimates was provided in Spain in 2014. No estimate of was provided in InterCatch by Spain since 2015.

Abundance indices from UWTV surveys

Operational details of the 2019 UWTV survey are available (Aristegui *et al.*, 2019). These surveys use the standard UWTV methodology and conforms to WGNEPS best practice and guidelines. WKNEPH 2013 recommended that these surveys could be used for assessment and provision of catch options. The results are given in Table 20.6. Further detail of the survey is provided in the annex and annual survey reports are available at http://oar.marine.ie/handle/10793/59.

The spatial distributions of burrow densities are shown as a heat maps and bubble plots in Figure 20.5. The 2019 burrow surface shows an area of higher density in the north of the ground. The abundance estimate derived from the krigged burrow surfaces (and adjusted for edge effect) decreased by 9.5% (from 1117 million in 2018 to 1010 million in 2019), with an estimated area of the ground of 7131 km^2 and a CV on the abundance of 5.1% (Figure 20.6 and Table 20.7).

Trawl surveys

The longest time-series of fishery-independent source of data is from the Spanish Porcupine trawl survey 2001–2018 (SpPGFS-WIBTS-Q4). This survey is carried out in September when *Nephrops* catchability is quite low, particularly of adults. Further information on this survey is provided in the IBTS report (ICES, 2015) and in previous IBTS reports.

Distribution of *Nephrops* catches and biomass in Porcupine surveys between 2001 and 2018 is shown in Figure 20.7. There was a year effect in 2008 when unusual gear parameters were observed. Catch rates in 2011 may also have been reduced due to exceptionally poor weather and gear performance issues. The stratified abundance estimate and biomass increased significantly since 2015 (Figure 20.8).

The size structure of the catches in the survey shows two things: a lower mean size than in the commercial fleets and an increasing trend in mean size for both sexes up to 2008. In 2009, there is large reduction of mean size in both sexes due to a recruiting year class with a modal length at around 27 mm (possibly the 2006 year class). Tracking of cohorts was carried out at WKNEPH 2013 but the results are inconclusive (ICES, 2013). The survey shows increased recruitment since 2013 with significantly increased catch rates of individuals <21 mm (Figure 20.9). This has also led to increase catch rates of juveniles and adult *Nephrops* since 2016.

An Irish Fisheries Science Research Partnership (IFSRP) survey was developed in collaboration with the Irish fishing industry to obtain data from the closed area in 2010–2012. Details of the design and methodology are presented in Stokes and Lordan (2011). The survey uses both commercial gear (Comm) and a baca trawl similar to the SpPGFS-WIBTS-Q4. WKNEPH concluded that the IFSRP trawl survey is too short (with changes in coverage, gears and vessels) to draw an inference about CPUE changes reflecting changing stock abundance (ICES, 2013). The surveys carried out between 2010–2012 provided very useful data on population structure across the ground as well as data on grade structure and maturity-at-length.

Commercial CPUE

In the past, the *Nephrops* fishery on the Porcupine Bank was both seasonal and opportunistic with increased targeting during periods of high *Nephrops* emergence and good weather. Freezing of catches at sea has become increasingly prevalent since 2006 and the fishery now operates throughout the year, mainly targeting larger more valuable *Nephrops* in lower volumes. Fishing effort has fluctuated considerably in the recent past in response to availability of *Nephrops*.

Effort and LPUE/CPUE data are generally not standardized, and hence do not take into account vessel capacity, efficiency, seasonality or other factors that may bias perception of LPUE/CPUE and abundance trends over the longer term. WKNEPH concluded that effort and LPUE series should be maintain in the WGCSE report for information purposes (ICES, 2013). WGCSE 2016 recommended presenting the effort in KWDays and LPUE in tonnes/KWDays. Any inferences about changes in stock abundance from these data, should take account of the quality and bias concerns raised above.

These data are presented by country in Table 20.8.

17.5 Stock assessment

Comparison with previous assessments

This assessment is based on UWTV approach outlined in WKNEPH 2013 and using parameter in the stock annex (ICES, 2013). This year's assessment has been updated based on the results of the June 2019 UWTV survey.

State of the stock

The UWTV results are shown in Table 20.6. In 2017, the harvest rate was above F_{MSY} for the first time, but in 2018, the harvest rate decreased below F_{MSY} again due to an increase in the abundance estimate of the 2018 UWTV survey. Total abundance decreased in 2019, but it is still the second highest value in the time-series.

Catch options table

The inputs to the catch options are given below. At this point, it is not possible to estimate the numbers and mean weights of discards in the fishery, although there are indications that discards have increased since 2016.

Variable	Value	Notes
Stock abundance (2020)	1010 million	UWTV survey 2019 (number of individuals).
Mean weight in wanted catch	42.1 g	Average 2017–2019.
Mean weight in unwanted catch	-	Unknown.
Unwanted catch	-	Discarding is assumed to be negligible.
Discards survival	-	Not applicable.
Dead unwanted catch	-	Assumed to be zero.

17.6 Reference points

New reference points were evaluated by WKMSYREF4 (ICES, 2016a) and advised by ICES (2016b). The F_{MSY} for this stock was increased from 5.0% to 6.2%. The F_{MSY} for this stock is based on $F_{0.1}$ for both sexes combined given the low density of *Nephrops* on the Porcupine Bank.

Stock code	MSY Flower*	F_{MSY}*	MSY F_{upper}* with AR	MSY $B_{trigger}$	MSY F_{upper}* with no AR
nep-16	5.0%	6.2%	6.2%	Not defined	6.2%

*** Harvest rate (HR).**

17.7 Management strategies

There is no management plan for this stock.

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES Subarea 7 and also demersal stocks.

17.8 Quality of assessment and forecast

The main quality considerations for this stock are related to mean weight and discarding. The mean weight for this stock has been fluctuating, the most recent estimates maybe overestimate due to the non-inclusion of discards. The mean weight has declined in the last few years as strong year classes recruit to the fishery. Since 2017, a recent mean weight in the landing was considered the most appropriate basis in the calculation of catch scenarios. In previous years, a long-term mean weight was used.

The provision of grade information (commercial size categories) by individual fishers and fishery coops remains highly important for calculating mean weight in the landings. The proportion of landings for which grade data were provided has declined from 49% in 2016 to 20% in 2018, increasing the uncertainty around the mean weight assumption.

There is good evidence from surveys and length structure of landings that recruitment has improved and this has resulted in a reduction in mean weight in the stock in recent years. The mean weight in 2019 may well increase again as the stronger cohorts grows. Currently there is no methodology to take this into account in the calculation of catch options.

Up to 2015, discarding was considered negligible for this functional unit. Since 2016, the amount of discards observed on catch sampling trips has increased. This may be temporary linked to the incoming recruitment. It will result is an underestimate of recent harvest rates of similar magnitude to the numbers. The main concern is that the mean weight derived from the landings grades maybe bias due to unknown discarding levels.

The UWTV survey provides abundance since 2012 (except 2015) with high precision, but the time-series is short and an abundance $MSYB_{trigger}$ has yet to be defined.

The landings are considered fairly well estimated up to 2018 (an unallocated component related to area misreporting was included from 2011 to 2017).

17.9 Recommendation for next benchmark

This stock was benchmark in 2013 at WK*NEPH*. WGCSE will keep the stock under close review and recommend future benchmark as required.

17.10 Management considerations

There is a separate catch limit for Functional Unit (FU) 16 within the wider TAC for Subarea 7. This has resulted in very restrictive quotas for some vessels, which increased area misreporting and the risk of discarding from 2011 to 2017. Area misreporting diminished in 2018 with the introduction of a national legislation restricting Irish vessels' fishing areas, where since March 2018, Irish vessels targeting *Nephrops* in subareas 6 and 7 may only fish in either of (1) Subarea 6 or Subarea 7, excluding FU16, or (2) FU16 of Subarea 7 (Fisheries Management Notice No. 20 of 2018). Although there was an increase on landings in 2018, the harvest rate decreased due to an increase in the abundance estimate of the 2018 UWTV survey. Given the vulnerability of this stock to overexploitation, the separate catch limit for Functional Unit (FU) 16 should remain in place.

A seasonal closed area (May 1–July 31) has been in place since 2010. The period of the closure was reduced to one month, May, since 2013. There hasn't been an ICES evaluation of the impact of this closure and whether it provides a conservation benefit over and above catch limits. Some sectors of the fishing industry want to extend the period of closure because they believe that this is a more effective conservation measure than catch limits.

Productivity of deep-water *Nephrops* stocks is generally lower than that in shelf waters, though individual *Nephrops* grow to relatively large sizes and attain high market prices. Other deep-water *Nephrops* stocks off the Spanish and Portuguese coast have collapsed and have been subject to recovery measures for several years e.g. FU25, 26, 27 and 31. Recruitment in *Nephrops* populations in deep water may be more sporadic than for shelf stocks with strong larval retention mechanisms. This makes these stocks more vulnerable to over exploitation and potential recruitment failure as has been observed on the Porcupine Bank in the early 2000s.

From 2019, vessels using highly selective gears in Subarea 7 can be exempted from the landings obligation on the basis of the high survival exemption (see discard plans). It is unknown if *Nephrops* discarded on the Porcupine Bank could actually survive the discarding process.

Discarding by the *Nephrops* trawl fishery is around 50% of the total catch by weight. The main species that are discarded by weight are blue mouth-red fish, blue whiting and argentines (Marine Institute and Bord Iascaigh Mhara, 2011).

17.11 References

Aristegui, M., O'Brien, S., Tully, D., Galligan, S., McCorriston, P., Bentley, K. and Lordan, C. 2019. Porcupine Bank *Nephrops* Grounds (FU16) 2019 UWTV Survey Report and catch scenarios for 2020. Marine Institute UWTV Survey report.

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L 83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj.

ICES. 2013. Report of the Benchmark Workshop on *Nephrops* Stocks (WKNEPH), 25 February–1 March 2013, Lysekil, Sweden. ICES CM 2013/ACOM:45. 230 pp.

ICES. 2015. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 23–27 March 2015, Bergen, Norway. ICES CM 2015/SSGIEOM:24. 278 pp.

ICES. 2016a. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2016b. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. In Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

Marine Institute and Bord Iascaigh Mhara. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp. http://hdl.handle.net/10793/666.

Stokes, D. and Lordan, C. 2011. "Irish fisheries-science research partnership trawl survey of the Porcupine Bank *Nephrops* Grounds July 2010", Irish Fisheries Bulletin No. 39, Marine Institute 2011. http://hdl.handle.net/10793/712.

Table 20.1. *Nephrops* Porcupine Bank (FU 16): Of which catch limit.

Year	France	Ireland	Spain	UK	Total
2011	241	454	377	188	1260
2012	238	457	380	185	1260
2013	340	653	543	264	1800
2014	349	671	557	271	1848
2015	349	671	558	272	1850
2016	349	671	558	272	1850
2017	586	1124	935	455	3100
2018	516	992	825	401	2734
2019	500	959	798	388	2645

Table 20.2. ***Nephrops*** **Porcupine Bank (FU 16): Landings (tonnes) by country.**

Year	France	Ireland	Spain	UK E& W	UK Scotland	Unallocated	Total
1965	514						514
1966	0						0
1967	441						441
1968	441						441
1969	609						609
1970	256						256
1971	500		1444				1944
1972	0		1738				1738
1973	811		2135				2946
1974	900		1894				2794
1975	0		2150				2150
1976	6		1321				1327
1977	0		1545				1545
1978	2		1742				1744
1979	14		2255				2269
1980	21		2904				2925
1981	66		3315				3381
1982	358		3931				4289
1983	615		2811				3426
1984	1067		2504				3571
1985	1181		2738				3919
1986	1060		1462	69			2591
1987	609		1677	213			2499
1988	600		1555	220			2375
1989	324	350	1417	24			2115
1990	336	169	1349	41			1895
1991	348	170	1021	101			1640
1992	665	311	822	217			2015

Year	France	Ireland	Spain	UK E& W	UK Scotland	Unallocated	Total
1993	799	206	752	100			1857
1994	1088	512	809	103			2512
1995	1234	971	579	152			2936
1996	1069	508	471	182			2230
1997	1028	653	473	255			2409
1998	879	598	405	273			2155
1999	1047	609	448	185			2290
2000	351	227	213	120			910
2001	425	369	270	158			1222
2002	369	543	276	139			1327
2003	131	307	489	108	29		1064
2004	289	494	468	126	28		1406
2005	397	754	681	208	156		2197
2006	462	731	636	201	155		2185
2007	302	1060	384	146	183		2074
2008	26	562	234	41	138		1000
2009	4	356	348	13	159		879
2010	4	579	240	10	90		922
2011	8	643	182	23	122	301	1278
2012	0.46	605	198	0	134	320	1258
2013	5.8	651	132	1	118	234	1141
2014	3	813	129	0	96	148	1189
2015	3	744	84	0	109	454	1394
2016	35	1052	58	1	160	849	2154
2017	63	743	73	249	131	1373	2632
2018	81	2079	158	288	144	0	2751

Table 20.3. *Nephrops* Porcupine Bank (FU 16): Recent sampling used in the assessment.

Year	Spain		France		Ireland	
	Number of Trips	Type	Number of Trips	Type	Number of Trips	Type
2018					2	Graded Landings
2017					2	Graded Landings
2016					4	Graded Landings
2015					3	Graded Landings
2014					3	Graded Landings
2013					3	Graded Landings
2012	0		0		3	Graded Landings
2011	0		0		2	Graded Landings
2010	0		0		3	Graded Landings

Table 20.4. *Nephrops* Porcupine Bank (FU 16): Mean sizes (mm CL) of male and female *Nephrops* in Spanish, French and Irish landings and the Spanish Porcupine Groundfish survey 1981–2018.

Year	Spain		Ireland		France		Porcupine Survey	
	Landings		Landings		Landings		Catch	
	Males	Females	Males	Females	Males	Females	Males	Females
1981	39.9	34.5	-	-	-	-	-	-
1982	40.9	34.8	-	-	-	-	-	-
1983	40.8	34.0	-	-	-	-	-	-
1984	39.7	33.1	-	-	-	-	-	-
1985	38.7	33.5	-	-	-	-	-	-
1986	40.7	36.4	-	-	-	-	-	-
1987	39.3	35.0	-	-	-	-	-	-
1988	40.7	38.3	-	-	-	-	-	-
1989	40.5	36.8	-	-	-	-	-	-
1990	41.0	36.1	-	-	-	-	-	-
1991	39.4	34.5	-	-	-	-	-	-
1992	39.2	34.1	-	-	-	-	-	-
1993	41.6	36.1	-	-	-	-	-	-
1994	40.8	36.5	-	-	-	-	-	-
1995	41.3	36.6	40.7	36.5	43.2	38.3	-	-
1996	41.6	35.1	34.6	35.3	41.7	38.9	-	-
1997	39.7	34.8	35.9	34.5	41.9	38.4	-	-
1998	41.1	34.6	37.2	35.6	41.9	38.4	-	-
1999	41.5	35.7	36.6	33.7	43.1	39.1	-	-
2000	41.1	34.8	na	na	45.3	40.5	-	-
2001	41.1	36.3	37.8	35.4	45.4	39.4	36.0	28.9
2002	39.7	35.3	36.1	38.5	45.3	40.3	37.5	31.7
2003	41.4	37.8	44.5	36.2	46.2	38.9	39.7	30.9
2004	43.5	38.5	43.5	35.7	46.4	41.5	39.9	30.5
2005	43.4	38.1	46.9	40.6	45.9	41.0	45.1	33.8
2006	43.9	38.0	na	na	48.9	41.4	44.3	35.0

Year	Spain Landings		Ireland Landings		France Landings		Porcupine Survey Catch	
	Males	Females	Males	Females	Males	Females	Males	Females
2007	43.7	41.0	na	na	48.3	43.8	45.9	37.8
2008	51.0	40.6	43.3	37.5	na	na	48.8	38.7
2009	43.0	42.7	44.1	40.1	na	na	32.6	28.9
2010	na	na	43.2	40.4	na	na	36.3	31.8
2011	na	na	39.5	38.4	na	na	39.0	33.6
2012	na	na	41.1	38.1	na	na	41.1	30.8
2013	na	na	42.9	38.9	na	na	37.6	25.1
2014	na	na	45.1	40.9	na	na	36.4	31.0
2015	na	na	40.3	39.7	na	na	35.5	32.7
2016	na	na	37.8	37.3	na	na	32.2	27.8
2017	na	na	35.7	32.9	na	na	34.1	26.8
2018	na	na	39.7	36.2	na	na	35.0	28.1

Table 20.5. ***Nephrops*** **Porcupine Bank (FU16): Time-series of numbers landed and mean weight in the landings.**

Year	Numbers (millions)	Weight Landed (Tonnes)	Mean Weight in landings (gr)
1986	55.7	2591	46.53
1987	60.3	2499	41.42
1988	48.1	2375	49.34
1989	45.6	2115	46.4
1990	38.9	1895	48.67
1991	37.3	1640	43.98
1992	47	2015	42.84
1993	38.5	1857	48.29
1994	54.4	2512	46.15
1995	65.5	2936	44.79
1996	52.9	2230	42.15
1997	59.1	2409	40.73
1998	49.9	2155	43.16
1999	52.3	2290	43.76
2000	15.1	910	60.13
2001	24.6	1222	49.65
2002	32	1327	41.49
2003	18.4	1064	57.76
2004	21.5	1406	65.28
2005	31.5	2197	69.84
2006	28.7	2185	76.24
2007	29.2	2074	71.05
2008	17.9	1000	55.89
2009	16.5	879	53.19
2010	14.1	922	65.32
2011	27.9	1278	45.81
2012	25	1258	50.36
2013	19.8	1141	57.54
2014	17.3	1189	68.54
2015	27.4	1394	50.86
2016	53.5	2154	40.29
2017	84.9	2632	31.01
2018	66.2	2751	41.55
2019			53.73
Average 2017–2019			42.10

Table 20.6. *Nephrops* Porcupine Bank (FU16): Assessment summary.

Year	UWTV abundance estimate	95% Confidence Interval	Landings in number	Total discards in number*	Removals in number	Harvest rate (by number)***	Landings	Total discards*	Discard proportion (by number)	Dead discard proportion (by number)	Mean weight in landings	Mean weight in discards
	Millions					%	tonnes		%		grammes	
2012	787	79	25	0	25	3.2	1258	0	0	0	50.4	NA
2013	768	61	20	0	20	2.6	1141	0	0	0	57.5	NA
2014	722	35	17	0	17	2.4	1189	0	0	0	68.5	NA
2015	NA	NA	27	0	27	3.3**	1394	0	0	0	50.9	NA
2016	958	68	53	NA	53	5.6	2154	NA	NA	NA	40.3	NA
2017	850	90	85	NA	85	10.0	2632	NA	NA	NA	31.0	NA
2018	1117	92	66	NA	66	5.9	2751	NA	NA	NA	41.6	NA
2019	1010	101									53.7	

*Discarding up to 2015 was considered to be negligible. Discard estimates are not available since 2016 and are therefore not included in the assessment.

** The harvest rate is estimated based on a linear interpolation of abundance for 2015 as no survey was carried out in this year.

*** Values since 2016 onwards may be underestimates due to insufficient discard data.

NA = not available.

Table 20.7. *Nephrops* Porcupine Bank (FU16): Results summary table for geostatistical analysis of UWTV survey series.

Year	Number of stations	Mean Density adjusted (burrow/m²)	Domain Area (km²)	Geostatistical Abundance Estimate adjusted (millions)	CV on Burrow estimate (%)
2012	47	0.151	7108	787	4.9
2013	68	0.106	7108	768	4.4
2014	67	0.099	7108	722	2.5
2015	0				
2016	65	0.132	7108	958	3.6
2017	63	0.118	7134	850	5.4
2018	69	0.156	7130	1117	4.2
2019	65	0.139	7131	1010	5.1

Table 20.8. ***Nephrops*** **Porcupine Bank (FU16): Effort and LPUE for the various different fleets exploiting the stock 1971–2017.**

Year	Spain[1]		France[2]		Ireland[3]	
	Effort ('000's Hrs)	LPUE (kg/hr)	Effort[2] ('000's Hrs)	LPUE (>10%) (kg/hr)	Effort[3] ('000's KwDays)	LPUE (t/KWdays)
1980	318	9				
1981	272	12				
1982	237	17				
1983	196	14	18	35		
1984	194	13	30	35		
1985	200	14	33	36		
1986	162	9	28	38		
1987	174	10	24	26		
1988	180	9	22	27		
1989	173	8	14	23		
1990	159	9	15	23		
1991	138	7	19	18		
1992	96	9	32	21		
1993	80	9	36	22		
1994	80	10	38	28		
1995	67	9	42	30	584.9	1.4
1996	58	8	41	26	192.5	1.59
1997	57	8	41	25	327.3	1.26
1998	56	7	40	22	284.6	1.59
1999	53	8	43	21	278	1.29
2000	47	5	23	14	92.8	1.25
2001	44	6	24	15	230.2	1.12
2002	54	5	18	18	339.8	1.3
2003	66	5	7	19	294.7	0.8
2004	59	10	9	25	569.2	0.68
2005	60	13	15	26	756.2	0.83

Year	Spain[1]		France[2]		Ireland[3]	
	Effort ('000's Hrs)	LPUE (kg/hr)	Effort[2] ('000's Hrs)	LPUE (>10%) (kg/hr)	Effort[3] ('000's KwDays)	LPUE (t/KWdays)
2006	65	9	22	21	952.8	0.72
2007	58	8	17	18	1199.4	0.81
2008	42	6	4	7	830.7	0.67
2009	44	7			411.3	0.83
2010	42	6			704.1	0.81
2011	na	na			986.9	0.63
2012	15	na			817.1	0.63
2013	na	na			885.7	0.92
2014	na	na			1019.8	0.92
2015	na	na			1219.2	0.99
2016	na	na			1359.3	1.43
2017	na	na			1328.9	1.59
2018	na	na			1721.2	1.21

1 = Effort and LPUE between 1980 and 2010 was estimated based on fishing days in 7. Effort in 2012 was based on logbooks for FU16.

2 = Effort and LPUE for vessels where <10% of landed value was *Nephrops*.

3 = Effort and LPUE for vessels where 30% of the landed weight was *Nephrops*.

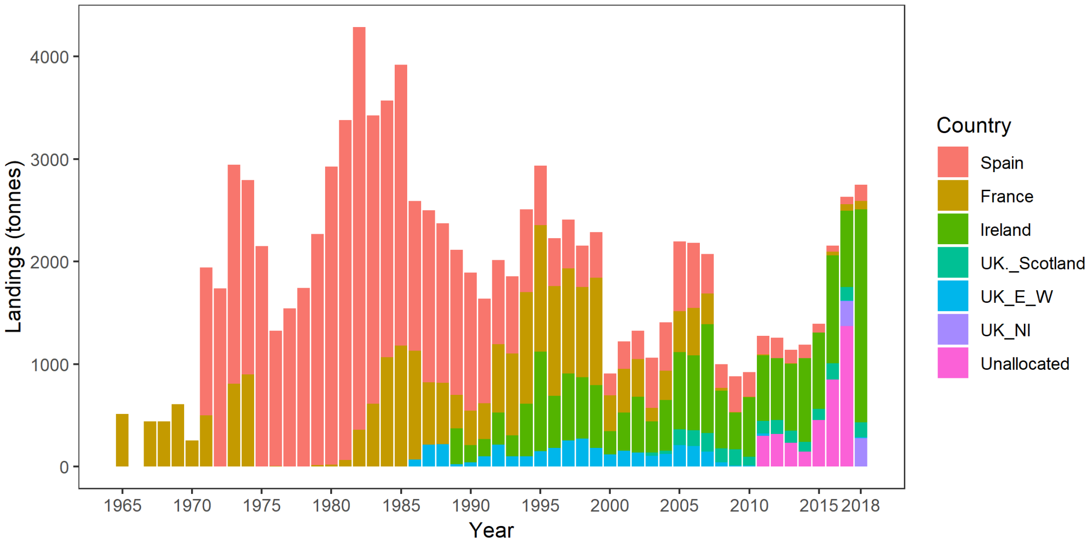


Figure 20.1. ***Nephrops*** **in FU16 (Porcupine Bank). WG's best estimates of landings in tonnes by country.**

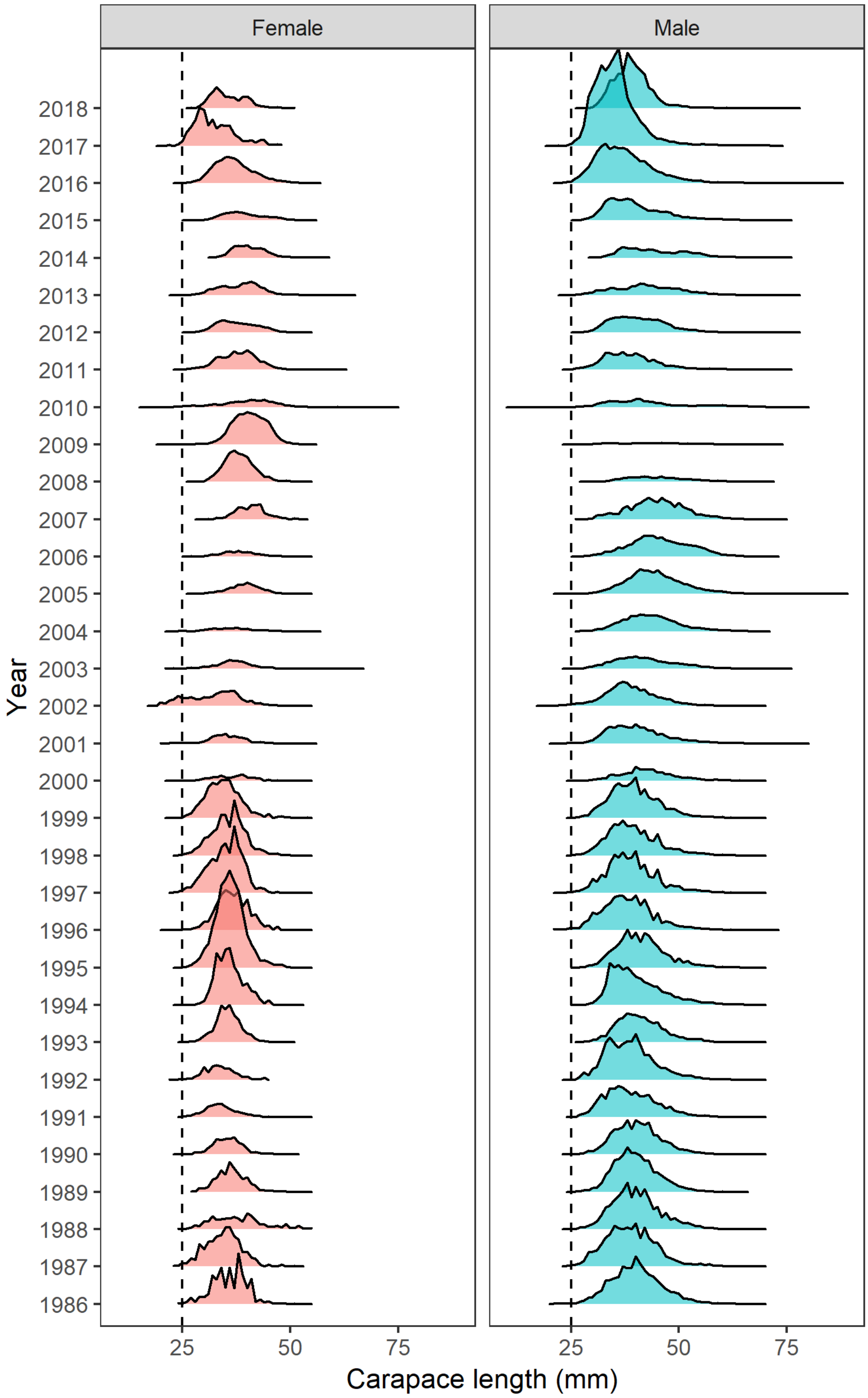


Figure 20.2. ***Nephrops*** **in FU16 (Porcupine Bank). Female and male length distributions of raised international landings. Vertical dashed lines refer to Minimum Landing Size (25 mm).**

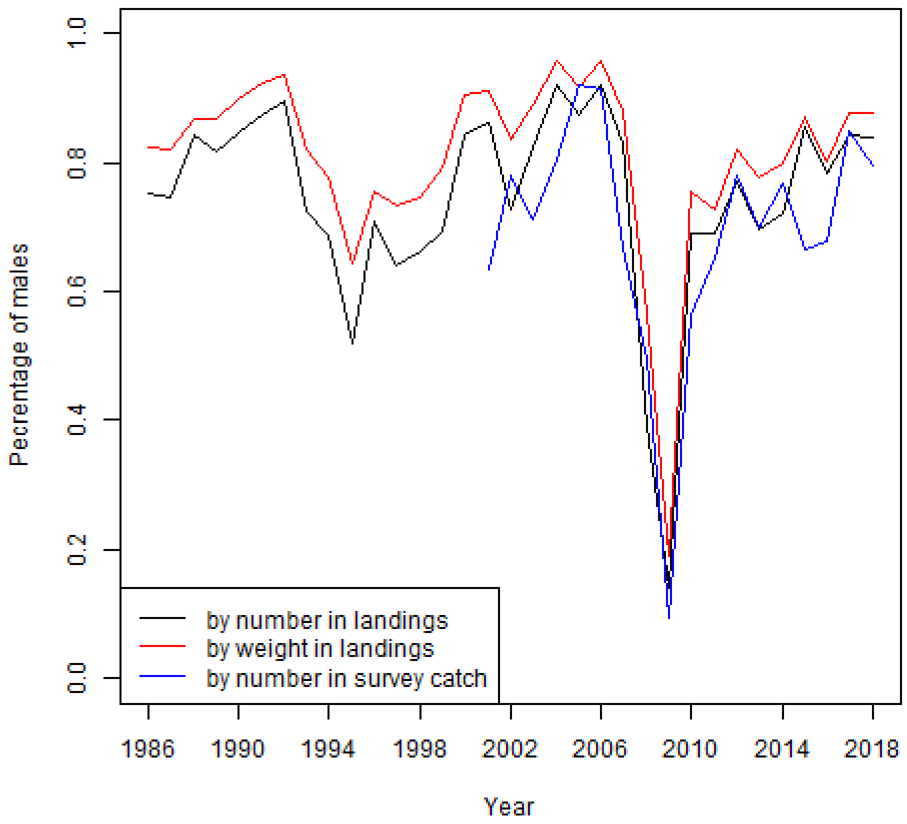


Figure 20.3. ***Nephrops*** **in FU16 (Porcupine Bank). The percentage males in the landings and survey over time.**

Figure 20.4. ***Nephrops*** **in FU16 (Porcupine Bank). Mean weight in the commercial landings.**

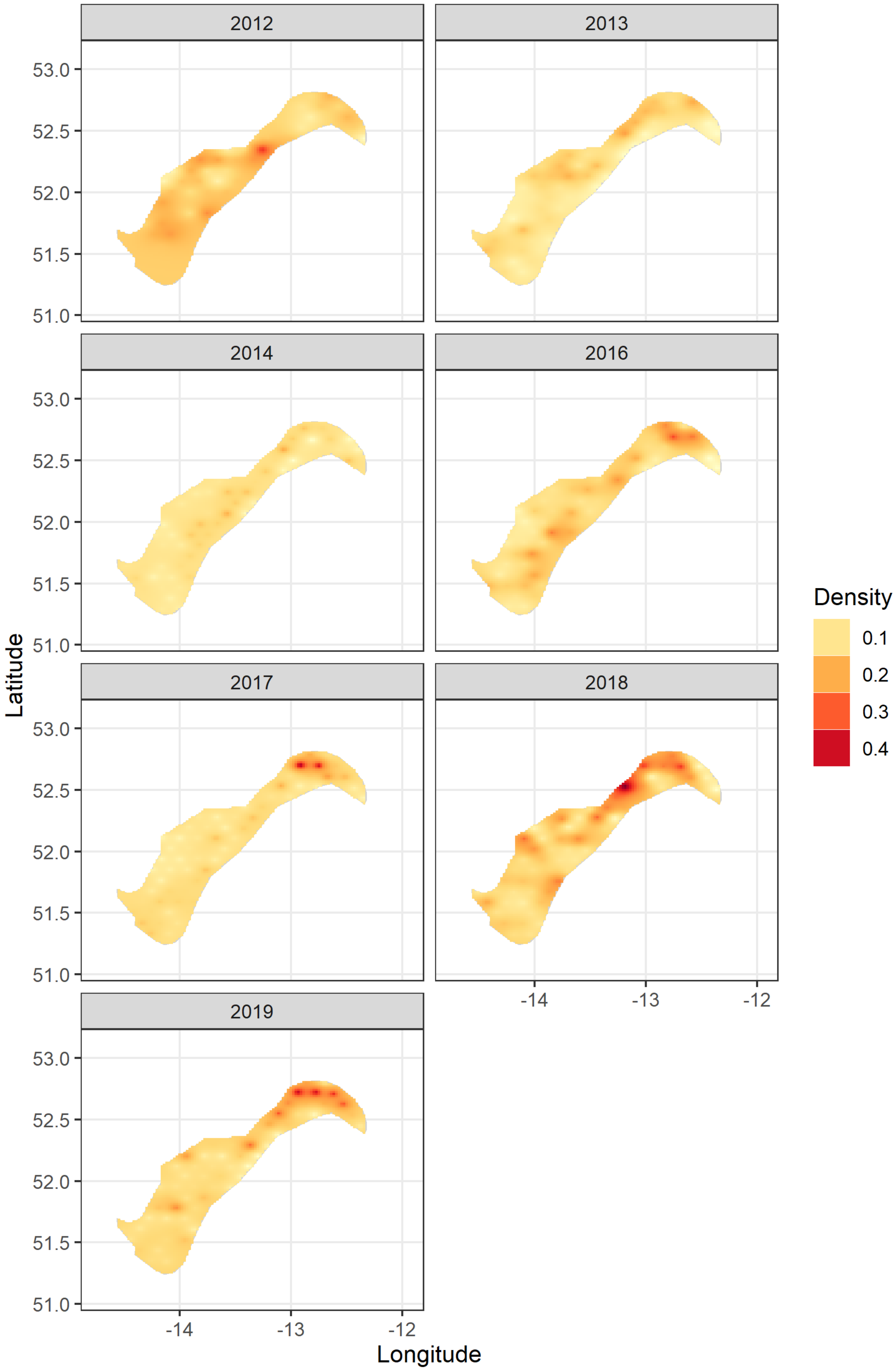


Figure 20.5. ***Nephrops*** **in FU16 (Porcupine Bank). Contour plots of the krigged density estimates for the Porcupine UWTV surveys from 2012 (top left) to 2019 (bottom left) (except 2015).**

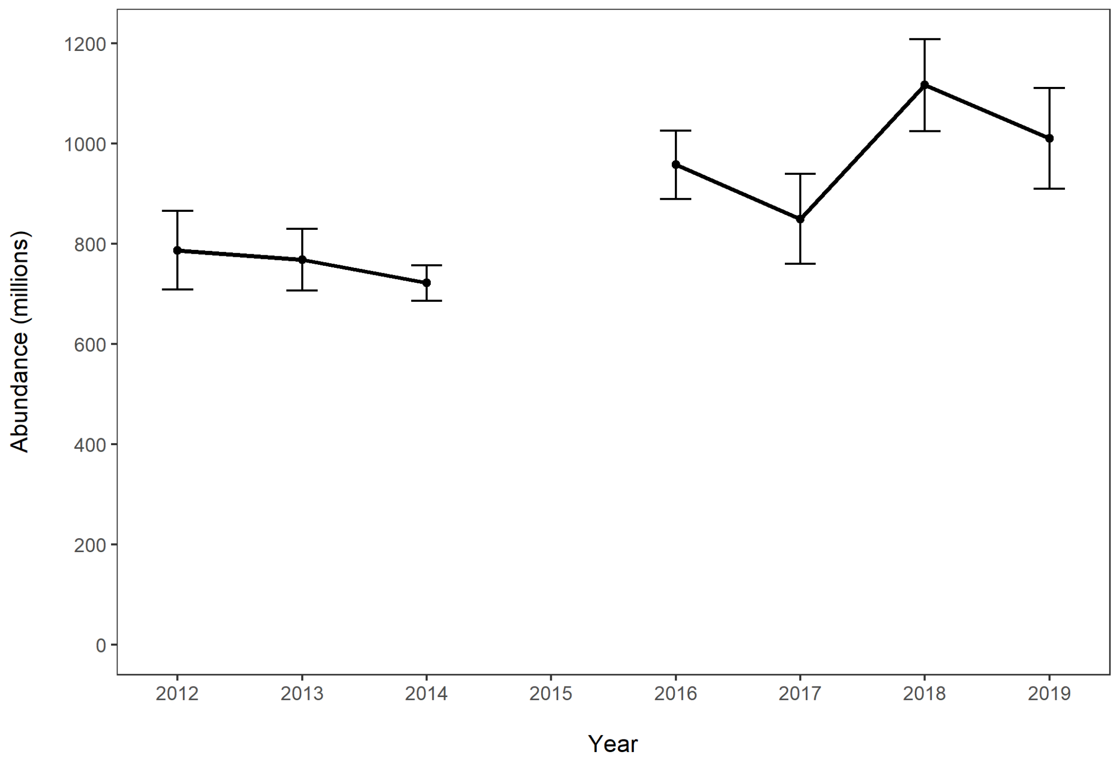


Figure 20.6. ***Nephrops*** **in FU16 (Porcupine Bank).** ***Nephrops*** **abundance estimates for 2012–2019 (except 2015).**

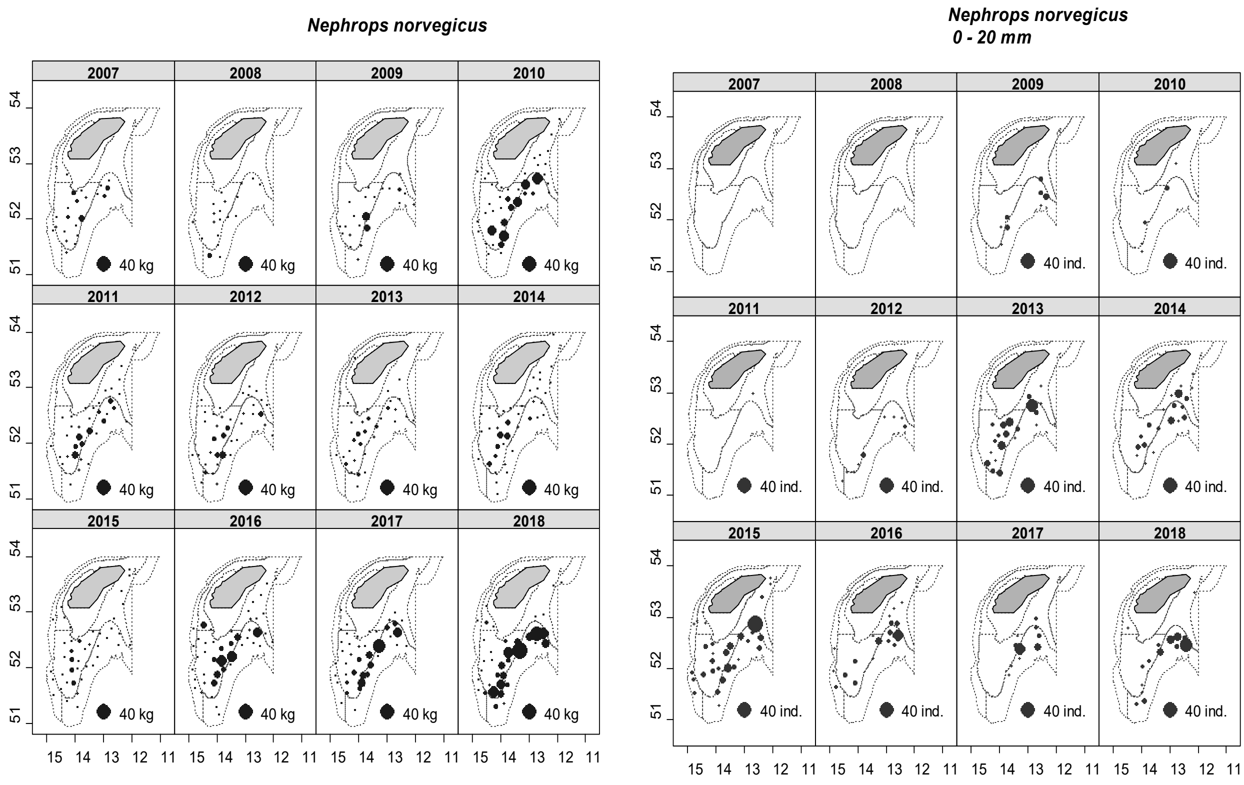


Figure 20.7. ***Nephrops*** **in FU16 (Porcupine Bank). Distribution of** ***Nephrops norvegicus*** **in Porcupine surveys top biomass, bottom No. juveniles (<20 mm carapace length).**

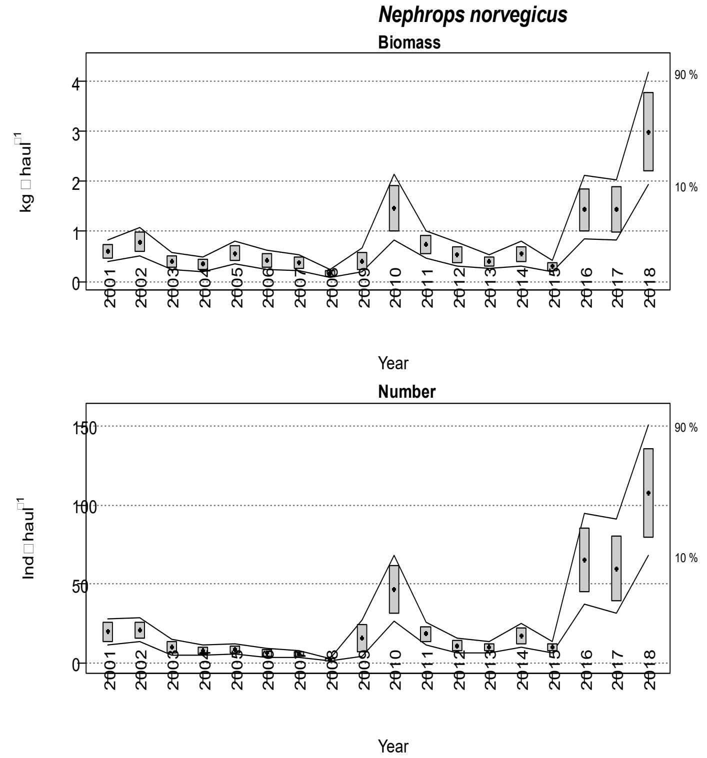


Figure 20.8. ***Nephrops*** **in FU16 (Porcupine Bank). Changes in** ***Nephrops norvegicus*** **biomass and number stratified indices during Porcupine Survey time-series. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α=0.80, bootstrap iterations=1000).**

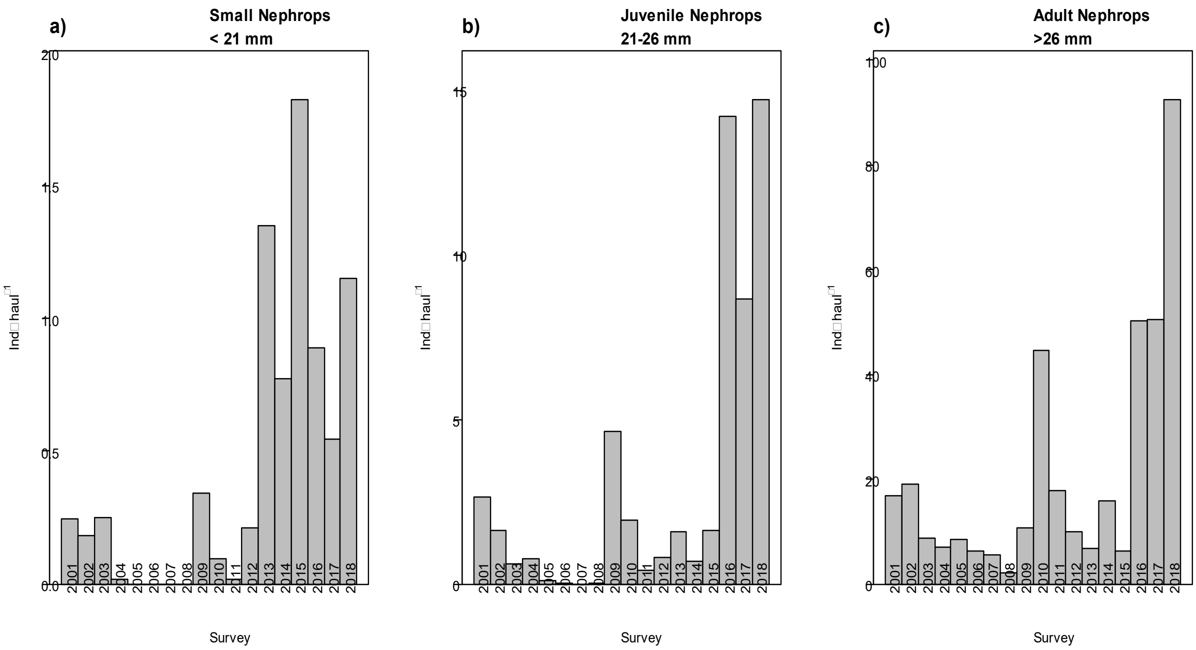


Figure 20.9. ***Nephrops*** **in FU16 (Porcupine Bank). Abundance of a) small** ***Nephrops*** **(<21 mm), b) juveniles between 21–26 mm and c) adults (>26 mm) in Porcupine survey.**

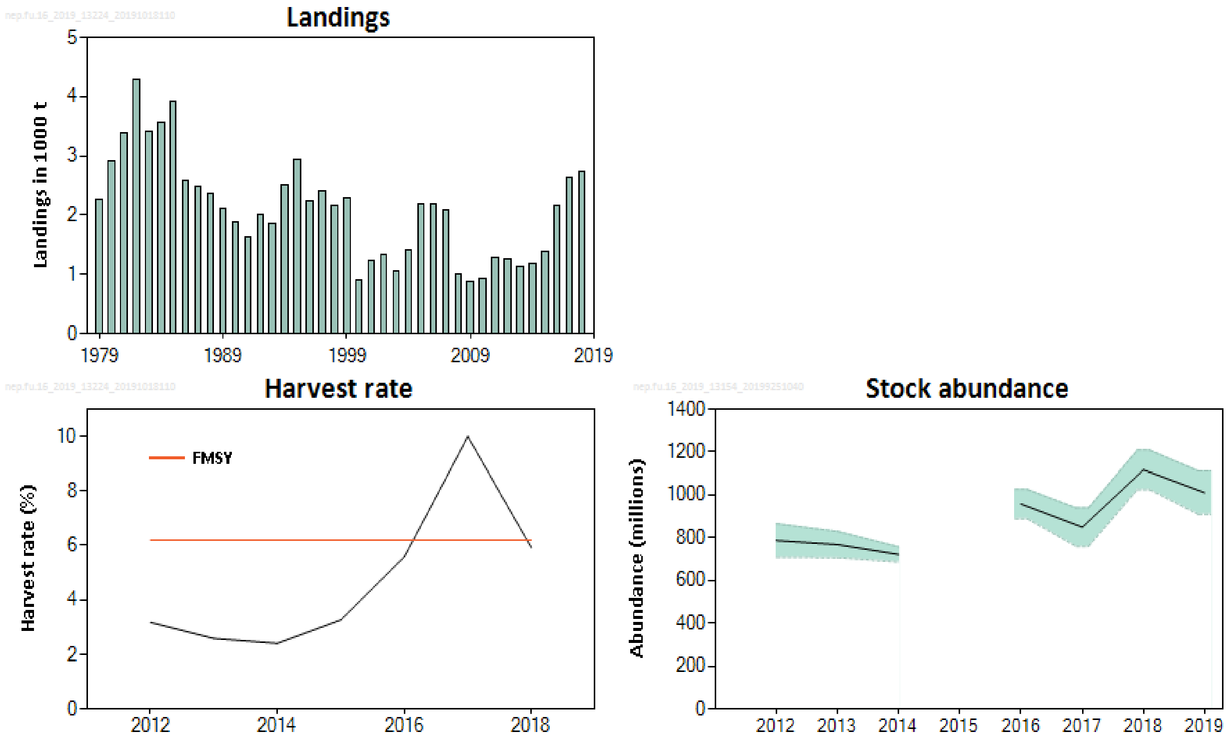


Figure 20.10. ***Nephrops*** **in FU16 (Porcupine Bank). Summary of stock status for Porcupine *Nephrops*.**

18 Norway lobster (*Nephrops norvegicus*) in Division 7.b, Functional Unit 17 (west of Ireland, Aran Grounds)

Type of assessment in 2019

This stock was inter-benchmarked in September 2015 by correspondence (ICES, 2015). The assessment and catch options follow the agreed procedures set out in the stock annex.

ICES advice applicable to 2018

"ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should be no more than 551 tonnes.

To ensure that the stock in functional unit (FU) 17 is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2019

"ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2015–2017, catches in 2019 should be no more than 1002 tonnes.

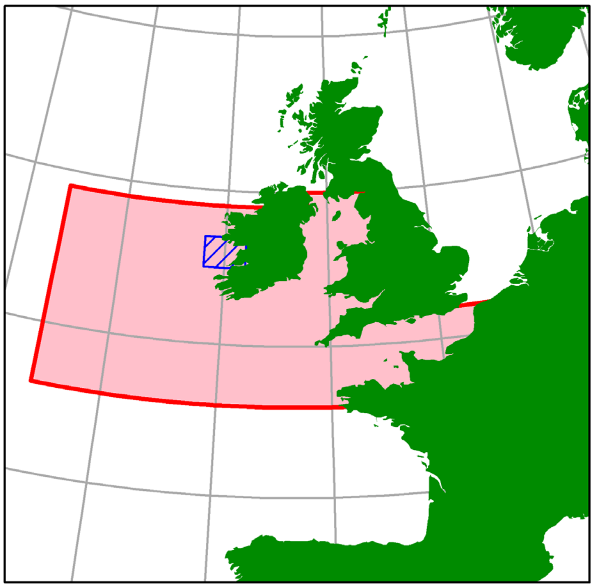
To ensure that the stock in Functional Unit 17 is exploited sustainably, management should be implemented at the functional unit level."

18.1 General

Stock description and management units

The Aran Grounds *Nephrops* stock (FU17) covers ICES rectangles 34–35 D9–E0 within 7.b. This stock is included as part of the TAC Area 7 *Nephrops*, which includes the following stocks: Irish Sea East and West (FU14, FU15), Porcupine Bank (FU16), northwestern Irish Coast (FU18), southeastern and southwestern Irish Coast (FU19) and the Celtic Sea (FU20–22).

Map below shows FU17 assessment area (blue) and TAC area (red). See Section 18 for details on *Nephrops* Subarea 7 general section.



Ecosystem aspects

Details of the ecosystem on the Aran grounds are provided in the stock annex updated by IBPNeph (ICES, 2015a).

Fishery description

A description of the fleet is given in the stock annex. The time-series of numbers of vessels is updated in Figure 21.1.1. The numbers of vessels has been relatively stable since 1995. The time-series of vessel power is shown as a box and kite plot in Figure 21.1.2.

The majority of the landings are made with 80 mm mesh.

The majority of the landings come from the grounds to the west and southwest of the Aran Islands known as the 'back of the Aran ground' (See stock annex). The fishery on the Aran Grounds operates throughout the year, weather permitting with a seasonal trend (See stock annex).

Fishery in 2018

In recent years, several newer vessels specializing in *Nephrops* fishing have participated periodically in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. There has been a trend for Irish vessels to switch to multi (quad) rig trawls since 2012. These vessels are more efficient at catching *Nephrops* (BIM, 2014).

Information from stakeholders

Voluntary effort restriction were put in place by the Irish fishing industry in April and May 2015. These measures reduced catches and effort significantly on the stock in advance of the 2015 UWTV survey.

18.2 Data

InterCatch

Data were available in InterCatch and used for catch data only.

Landings

The reported landings time-series is shown in Figure 21.2.1 and Table 21.2.1. The 2018 landings increased by about 82% from those made in 2017 and amounted to 536 t.

Effort

The IBPNeph 2015 reviewed Irish commercial landings and effort data in detail. They concluded that effort should be reported in the WGCSE report in KWdays and LPUE should be reported in KG/kwdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. The time-series of effort and LPUE is updated in Figure 21.2.2 and Table 21.2.2. There was a significant decline in LPUE and effort in 2015 due to the local management efforts put in place in April and May. In 2016 effort level increased to values similar to those observed previously prior to 2011. However, in 2017 and 2018 effort levels declined again to values similar to 2015.

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by IBPNeph 2015 and are documented in the stock annex. The time-series of samples is shown in Figure 21.2.3 and Table 21.2.3. Sampling levels in 2018 were similar to 2016 and 2017 levels.

Commercial length–frequency distributions

The raised catch length distributions are shown in Figure 21.2.4. The mean length of females decreased in 2018, increasing the discard rate for females.

Sex ratio

In 2018, due to the strong dominance of small females in the catches (Figure 21.2.4), the difference on the proportion of males between the catches and the landings is higher than in previous years (Figure 21.2.5). Sex ratio has a distinct seasonal pattern with lowest male proportions in the samples in May and June. Males dominate the catches in the autumn and winter.

Mean weight explorations

Explorations of the mean weight in the catch samples by sex shows a strong cyclical pattern in females, which corresponds with the emergence of mature females from the burrows to mate in summer (Figure 21.2.6). The annual mean weight estimate for landings and discards is shown in Figure 21.2.7. The mean weight estimates have been relatively stable from 2011, where main change occurred in 2008–2011. There has been an increase on the landings mean weight since 2015.

Discarding

Table 21.2.4 gives weights, numbers and proportions of the landings and discard raised internationally according to the stock annex. A 25% discard survival rate is assumed in line with other *Nephrops* stocks in the Celtic sea (see stock annex) as the basis for the catch scenarios. Gear selectivity trials by Bord Iascaigh Mhara (BIM, 2017) reported a 64% survivor rate for *Nephrops* caught in a trawl with a SELTRA selectivity device in the outer Galway Bay area.

Abundance indices from UWTV surveys

The spatial extent of the *Nephrops* grounds in FU17 was re-defined by IBPNeph 2015 and the total abundance estimates were revised using a new procedure (ICES, 2015a). The redefinition of the polygons in FU17 resulted in ~30% increase in overall area from 1007 km² to 1320 km² (stock annex). Operational details of the 2019 UWTV survey are available (Aristegui *et al*., 2019).

The spatial distributions of burrow densities are shown in Figure 21.2.8. The densities have fluctuated considerably over the time-series and throughout the Aran grounds. In general, the densities are higher towards the middle-western side of the ground and there is a notable trend towards lower densities towards the east. On the southwestern boundary, there are often high densities close to the boundary. In this area, there is a sharp transition from mud to rocky substrate. The decrease in densities in 2019 was mainly towards the north of the ground.

In 2018, the Aran Grounds account for ~93% of the total estimated burrow abundance from FU17 (Table 21.2.5). Galway Bay accounts for ~5% and Slyne Head for ~2% (Table 21.2.6). The Galway Bay estimates fluctuate widely but appear to be highly correlated with the Aran ground except in 2004 (Figure 21.2.9). Estimates for the Slyne Head ground also fluctuate considerably but show no significant correlation with the other areas except for the peaks of 2010, 2015 and 2018 (Figure 21.2.9). In 2019, abundance estimates decreased for the three grounds.

Aran ground abundance estimate's CV (4%) (Table 21.2.5) is well below the recommendation of 20% by SGNEPS (ICES, 2012). The CVs on the abundance estimates for Galway Bay and Slyne Head are relatively higher (11% and 8%) (Table 21.2.6), but still within the recommendation, showing the surveys are precise. Figure 21.2.10 and Table 21.2.7 show the total abundance estimate for FU17 with the IBPNeph proposed MSY $B_{trigger}$. The 2019 combined abundance estimate (493 million) was 11% lower than in 2018 and is below the MSY $B_{trigger}$ (540 million).

18.3 Assessment

Comparison with previous assessments

The WGCSE 2019 carried out an UWTV based assessment for this stock. The methods used were very much in line with WKNEPH (ICES, 2009) and the approach taken for other *Nephrops* stocks in 6 and 7 by WGCSE. This approach was inter-benchmarked at IBPNeph (ICES, 2015a).

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated widely with an overall declining trend and is below MSY $B_{trigger}$ since 2012 (except 2015 and 2018). The 2019 estimate is the sixth lowest observed in the time-series and is below the MSY $B_{trigger}$. The 2019 abundance remains below the average of the series (geomean [2002–2019]: 655 million). Harvest rate (calculated as *(landings + dead discards)/abundance estimate*) has been below the $F_{MSYproxy}$ for the last two years (Table 21.3.1.and Figure 21.3.1).

18.4 Catch scenario table

Catch scenario table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 21.3.1, and summarised below. The calculation of catch options for the Aran Grounds follows the procedure outlined in the stock annex.

The basis for the catch scenarios.

Variable	Value	Notes
Stock abundance	493 million individuals	UWTV Survey 2019
Mean weight in landings	22.4 g	Average 2008–2018
Mean weight in discards	11.04 g	Average 2008–2018
Discard rate	23.6%	Average (proportion by number) 2016–2018. Calculated as discards/(landings + discards)
Discard survival rate	25%	Only applies in scenarios where discarding is allowed.
Dead discard rate	18.9%	Average 2016–2018 (proportion by number). Calculated as dead discards divided by dead removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

Given the fluctuations observed in mean weights for landings and discards (Figure 21.2.7) an average from 2008 to the most recent year is used in the calculation of catch options as set out in the stock annex. The discard rates and proportions for the last three years are used to account for recent on-board retention practices (this is also according to the stock annex).

18.5 Reference points

New reference points were defined for this stock at the IBPNeph (ICES, 2015a) and no new proposals were made by WKMSYRef4 (ICES, 2016a). For *Nephrops* stocks MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased. This corresponds to the abundance observed in 2008 rounded to the nearest 10 = 540 million individuals (Figure 21.2.10 and Table 21.2.7).

The F_{MSY} proxy was revised during the benchmark in 2015. The observed burrow density has declined, from high (>0.8 individuals m^{-2}) at the start of the series to medium density (~0.3 individuals m^{-2}) towards the end of the time-series. The nature of the fishery has also changed, from a continuous fishery throughout the year to a fishery, which is more concentrated on sporadic periods of high catch rates. For these reasons a harvest rate consistent with a combined sex $F_{0.1}$ = 8.5% is considered an appropriate proxy for F_{MSY}.

These should remain under review by WGCSE and may be revised while data become available.

18.6 Management strategies

As yet there are no explicit management strategies for this stock, but there have been some discussions among the fishing industry and scientists about developing a long-term plan for the management of the Aran fishery. Sustainable utilization of the *Nephrops* stock will form the cornerstone of any management strategy for this fishery.

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES Subarea 7 and also demersal stocks.

18.7 Quality of assessment and forecast

Biological sampling for this stock is adequate. Since 2002, a dedicated annual UWTV survey has provided abundance estimates for the Aran Grounds with high precision. The area of the Aran Grounds was revised in 2015, resulting in a recalculation of the abundance time-series, which now also includes Galway Bay and Slyne Head. A number of other biological parameters such as mean weights and length distributions have also been revised. The revisions were made as part of an inter-benchmark process and have improved the quality of the assessment.

In the provision of catch options based on the absolute survey estimates, additional uncertainties related to mean weight in the landings and the discard rates also arise. From 2016, fisheries catching *Nephrops* in Subarea 7 are covered by the EU landings obligation (EU, 2015). Creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 5% discard rate by weight for the trawl fishery in 2019 (reduced from 6% in 2018 and 7% in both 2016 and 2017). The average discard rate by weight for FU17 over the last three years is 12.4%. Catch advice and scenarios are provided this year on the assumption that discarding is assumed to continue at recent average.

Irish discard survival experiments indicate that the trawl discard survival may be around 64% (BIM, 2017). As a result, an exemption from the landings obligation based on high survivability has been granted by the European Commission. ICES continues to use the survival rate of 25% (ICES, 2016) as the survival rates estimated by BIM (2017) have not been evaluated by ICES.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009; WGNEPS 2014; WKNEPS 2016). Ultimately, there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al*., 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise WK*NEPH* (ICES, 2009).

Landings data were adjusted to take into account landings that had been misreported from FU16 from 2011 to 2017. This adjustment is thought to be reasonably accurate (See Section 18).

18.8 Recommendation for next benchmark

This stock was last benchmarked by IBPNeph (ICES, 2015a). WGCSE will keep the stock under close review and recommend future benchmark as required.

18.9 Management considerations

A meeting was held with stakeholders in March 2015 to discuss the state of the Aran *Nephrops* stock. In response to this meeting, voluntary effort limits were put in place for April, May and June 2015. These voluntary measures have significantly reduced effort and catches on the Aran grounds in 2015 before the UWTV survey.

Small whole *Nephrops* are the main species comprising the discards. The main fish species discarded are haddock, hake, whiting, megrim and dogfish (Anon, 2011).

The ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level. Management at the Functional Unit level could provide controls to ensure effort and catch were in line with resources available.

18.10 References

Anon. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp.

Aristegui, M., Doyle, J., O'Brien, S., Fitzgerald, R., Vacherot, J.P., Sugrue, S. and Quinn, M. 2019. Aran, Galway Bay and Slyne Head *Nephrops* Grounds (FU17) 2019 UWTV Survey Report and catch scenarios for 2020. Marine Institute UWTV Survey report. In draft.

BIM. 2014. Catch comparison of Quad and Twin-rig trawls in the Celtic Sea *Nephrops* fishery. Bord Iascaigh Mhara, June 2014. http://www.bim.ie/media/bim/content/publications/Catch,comparison,of,Quad,and,Twin-rig,trawls,in,the,Celtic,Sea,Nephrops,fishery,Trial,Report,2014.pdf

BIM. 2017. Report on *Nephrops* survivability in the Irish demersal trawl fishery. Bord Iascaigh Mhara, 29 September 2017. http://www.bim.ie/media/bim/content/publications/fisheries/6882-BIM-nephrops-survival-report-final.pdf

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L 83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj.

Marrs S.J., Atkinson R.J.A., Smith C.J., Hills J.M. 1996. Calibration of the towed underwater TV technique for use in stock assessment of *Nephrops norvegicus*. EC DGXIV Final Report, Study Project 94/069.

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM:14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2009/ACOM:33.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2012/SSGESST:19.

ICES. 2014. Report of the Working Group on *Nephrops* Surveys (WGNEPS). ICES CM 2014/SSGESST:20. 57 pp.

ICES. 2015a. Report of the Inter-Benchmark Protocol of *Nephrops* in FU 17 and 14 (IBPNeph). ICES CM 2015/ACOM:38.

ICES. 2015. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 10–13 November 2015, Cadiz, Spain. ICES CM 2015/ SSGIEOM:30.52 pp.

ICES. 2015. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 23–27 March 2015, Bergen, Norway. ICES CM 2015/ SSGIEOM:20. 124 pp.

ICES. 2016. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 7–8 November 2016, Reykjavík, Iceland. ICES CM 2016/ SSGIEOM:33.67 pp.

ICES. 2016. Report of the Workshop on *Nephrops* Burrow counting (WKNEPS), 9–11 November 2016, Reykjavík, Iceland. ICES CM 2016/ SSGIEOM:34.65 pp.

ICES. 2016. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

ICES. 2016a. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 183 pp.

Table 21.2.1. ***Nephrops*** **in FU17 (Aran Grounds). Landings in tonnes by country.**

Year	France	Rep. of Ireland	UK	Total
1974	477			477
1975	822			822
1976	131			131
1977	272			272
1978	481			481
1979	452			452
1980	442			442
1981	414			414
1982	210			210
1983	131			131
1984	324			324
1985	207			207
1986	147		1	148
1987	62		0	62
1988	14	814		828
1989	27	317	3	347
1990	30	489		519
1991	11	399		410
1992	11	361	2	374
1993	11	361	0	372
1994	18	707	4	729
1995	91	774	2	867
1996	2	519	7	528
1997	2	839	0	841
1998	9	1401	0	1410
1999	0	1140	0	1140
2000	1	879	0	880
2001	1	912	0	913

Year	France	Rep. of Ireland	UK	Total
2002	2	1152	0	1154
2003	0	933	0	933
2004	0	525	0	525
2005	0	778	0	778
2006	0	637	0	637
2007	0	913	0	913
2008	0	1050	7	1057
2009	0	625	0	625
2010	0	930	9	939
2011	0	659	0	659
2012	0	1246	0	1246
2013	0	1295	0	1295
2014	0	766	0	766
2015	0	370	0	370
2016	0	641	0	641
2017	0	295	0.4	295
2018	0	494	42	536

Table 21.2.2. ***Nephrops*** **in FU17 (Aran Grounds). Effort data for the Irish otter trawl** ***Nephrops*** **directed fleet.**

Year	Effort (Kw Days)	Landings (Kgs)
1995	286,939	522,007
1996	174,030	312,421
1997	260,676	442,218
1998	445,308	940,902
1999	366,839	782,407
2000	293,684	561,244
2001	362,754	586,462
2002	350,346	798,744
2003	492,284	801,813
2004	355,673	420,652
2005	396,202	708,540
2006	337,503	618,515
2007	460,396	905,282
2008	512,245	1,052,077
2009	319,873	613,220
2010	441,080	910,346
2011	332,300	667,564
2012	488,721	1,139,413
2013	571,916	1,239,469
2014	460,818	774,097
2015	232,190	461,409
2016	396,502	578,420
2017	277,117	258,052
2018	233,793	483,723

Table 21.2.3. *Nephrops* in FU17 (Aran Grounds). Sampling levels.

Year	Quarter	Number of samples		Numbers Measured	
		Catch	Discards	Catch	Discards
2008	1	2	3	565	1376
2008	2	9	8	2224	3758
2008	3	5	4	1266	1834
2008	4	3	3	889	1733
2009	1	3	3	800	1184
2009	2	6	6	1685	1978
2009	3	6	6	2260	2726
2009	4	2	2	1491	1149
2010	1	4	4	3322	2322
2010	2	8	7	3577	2957
2010	3	2	2	951	742
2010	4	6	4	3209	1802
2011	1	7	7	3755	3537
2011	2	7	7	7399	6617
2011	3	4	2	3531	2386
2011	4	5	5	2440	2271
2012	1	3	3	1538	1250
2012	2	17	15	6481	5113
2012	3	0	0	-	-
2012	4	5	5	2333	1945
2013	1	10	9	3108	2983
2013	2	11	11	3733	3733
2013	2	3	3	1163	1263
2013	4	7	7	2956	1779
2014	1	3	3	1208	1223
2014	2	12	12	5365	3563
2014	3	2	2	786	499
2014	4	8	8	3542	2760

Year	Quarter	Number of samples		Numbers Measured	
		Catch	Discards	Catch	Discards
2015	1	2	2	827	611
2015	2	2	2	961	664
2015	3	0	0	-	-
2015	4	2	2	1047	1388
2016	1	5	4	2292	876
2016	2	11	11	4756	3383
2016	3	6	5	3020	2048
2016	4	6	6	1389	1311
2017	1	3	3	1214	845
2017	2	6	4	2911	1569
2017	3	2	1	1018	223
2017	4	3	3	1176	839
2018	1	3	3	1224	1241
2018	2	8	8	3179	2971
2018	3	1	1	467	388
2018	4	6	6	1894	2487

Table 21.2.4. ***Nephrops*** **in FU17 (Aran Grounds). Raised landings and discard weight and numbers by year.**

Year	Landings (t)	Discards (t)	Landings in number ('000s)	Discards in number ('000s)	Discards by weight (%)	Discards by number (%)
2008	1057	248	48,162	22,074	19.0	31.4
2009	626	129	24,935	9,487	17.1	27.6
2010	939	224	37,341	15,246	19.3	29.0
2011	659	92	31,950	8,542	12.2	21.1
2012	1246	86	61,076	8,292	6.5	12.0
2013	1295	129	60,016	12,034	9.1	16.7
2014	766	48	33,882	5,038	5.9	12.9
2015	370	15	17,693	1,622	3.8	8.4
2016	641	69	30,231	6,375	9.7	17.4
2017	295	38	13,269	3,605	11.3	21.4
2018	536	106	22,049	10,490	16.5	32.2

Table 21.2.5. *Nephrops* in FU17 (Aran Grounds). Results summary table for geostatistical analysis of UWTV survey.

Ground	Year	Number of stations	Mean Density adjusted (burrow/m²)	Domain Area (km²)	Geostatistical Abundance Estimate adjusted (millions burrows)	CV on Burrow estimate %
Aran Grounds	2002	49	0.79	1196	947	3
	2003	41	0.94	1196	1118	6
	2004	64	1.08	1196	1297	3
	2005	70	0.81	1196	972	2
	2006	67	0.46	1196	556	3
	2007	71	0.69	1196	828	2
	2008	63	0.41	1196	494	3
	2009	82	0.52	1196	627	2
	2010	87	0.63	1196	752	2
	2011	76	0.51	1196	609	2
	2012	31*	0.33	1196	397	3
	2013	31*	0.33	1196	390	4
	2014	33*	0.28	1196	332	4
	2015	34*	0.40	1197	480	4
	2016	34*	0.29	1197	343	3
	2017	31*	0.31	1196	377	3
	2018	33*	0.40	1196	488	3
	2019	31*	0.38	1196	458	4

***reduced isometric grid.**

Table 21.2.6. ***Nephrops*** **in FU17 (Galway Bay and Slyne Head). Results summary table for analysis of UWTV survey. Random stratified estimates given for these grounds only.**

Ground	Year	Number of stations	Mean Density adjusted (burrow/m²)	Domain Area (km²)	Raised Abundance Estimate adjusted (millions burrows)*	CV on Burrow estimate %
Galway Bay	2002	7	1.18	79.0	93.1	7
	2003	3	1.30	79.0	102.6	16
	2004	8	1.17	79.0	92.2	14
	2005	4	1.30	79.0	103.0	11
	2006	3	0.74	79.0	58.8	9
	2007	5	0.91	79.0	71.8	8
	2008	5	0.40	79.0	31.6	4
	2009	8	0.71	79.0	56.3	4
	2010	10	1.24	79.0	97.6	11
	2011	6	0.55	79.0	43.2	12
	2012	4	0.64	79.0	50.9	10
	2013	5	0.37	79.0	29.6	10
	2014	3	0.50	79.0	39.8	6
	2015	5	0.71	79.0	55.8	15
	2016	7	0.32	79.0	25.1	7
	2017	5	0.20	79.0	15.8	4
	2018	5	0.41	79.0	32.5	17
	2019	5	0.29	79.0	22.8	11
Slyne Head	2002	5	0.76	39.1	29.8	8
	2003*	0	0.65	39.1	25.3	0
	2004	3	0.53	39.1	20.8	10
	2005	3	0.44	39.1	17.4	1
	2006	3	0.30	39.1	11.8	9
	2007	4	0.51	39.1	19.8	12
	2008*	0	0.41	39.1	16.0	0
	2009	6	0.31	39.1	12.2	7
	2010	7	0.73	39.1	28.7	4

Ground	Year	Number of stations	Mean Density adjusted (burrow/m²)	Domain Area (km²)	Raised Abundance Estimate adjusted (millions burrows)*	CV on Burrow estimate %
	2011	7	0.51	39.1	20.0	5
	2012	3	0.52	39.1	20.5	2
	2013	4	0.54	39.1	21.1	10
	2014	4	0.28	39.1	11.0	6
	2015	5	0.50	39.1	19.6	4
	2016	4	0.27	39.1	10.8	3
	2017	4	0.27	39.1	10.7	4
	2018	5	0.84	39.1	33.0	12
	2019	5	0.29	39.1	11.5	8

*estimated as no survey data available for these years.

Table 21.2.7. *Nephrops* in FU17. Results summary table for analysis of UWTV survey for the combined grounds.

Year	Abundance (Millions)	Upper bound	Lower bound
2002	1070	1154	985
2003	1246	1434	1059
2004	1410	1517	1302
2005	1092	1154	1030
2006	627	703	551
2007	920	982	858
2008	541	588	494
2009	696	739	653
2010	879	926	831
2011	672	720	624
2012	468	520	417
2013	441	506	376
2014	383	440	327
2015	556	627	484
2016	379	420	339
2017	404	445	362
2018	554	637	471
2019	493	558	427

Table 21.3.1. *Nephrops* in FU17 (Aran Grounds). Forecast inputs (bold) and historical estimates of mean weight in landings and harvest rate. Removals estimated in years with no sampling (*) using ratio of removals to landings in adjacent years. na= not available due to non-cooperation with sampling programmes.

Year	Landings in number millions	Total discards in number* millions	Removals in number millions	Dead Discard Rate number %	Discard Rate number %	UWTV abundance estimate millions	95% Confidence Interval	Harvest rate %	Landings tonnes	Total discards* tonnes	Mean weight in landings gramme	Mean weight in discards gramme
2001	48.7	25.4	67.8	28.2	34.3				912			
2002	54.5	17.7	67.8	19.6	24.5	1070	84	6.30	1152	192	21.2	10.8
2003	44.1	18.3	57.8	23.7	29.3	1246	188	4.60	933	183	21.2	10
2004	29	11.4	37.6	22.9	28.2	1410	107	2.70	525	112	18.1	9.9
2005	42.4	19.7	57.2	25.9	31.7	1092	62	5.20	778	182	18.4	9.2
2006	na	na	49.5*	na	na	627	76	7.90	636	na	na	na
2007	na	na	57.3*	na	na	920	62	6.20	913	na	na	na
2008	48.2	22.1	64.7	25.6	31.4	541	47	12.00	1057	248	21.9	11.2
2009	24.9	9.5	32	22.2	27.6	696	43	4.60	626	129	25.1	13.6
2010	37.3	15.2	48.8	23.4	29.0	879	47	5.60	939	224	25.2	14.7
2011	31.9	8.5	38.4	16.7	21.1	672	48	5.70	659	92	20.6	10.8
2012	61.1	8.3	67.3	9.2	12.0	468	52	14.40	1246	86	20.4	10.4

Year	Landings in number	Total discards in number*	Removals in number		Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*		Mean weight in landings	Mean weight in discards
	millions	millions	millions		%	%	millions		%	tonnes	tonnes		gramme	gramme
2013	60	12	69		13.1	16.7	441	65	15.70	1295	129		21.6	10.7
2014	33.9	5	37.7		10.0	12.9	383	57	9.80	766	48		22.6	9.6
2015	17.7	1.6	18.9		6.4	8.4	556	71	3.40	370	15		20.9	9.1
2016	30.2	6.4	35.0		13.7	17.4	379	41	9.20	641	69		21.2	10.9
2017	13.3	3.6	16.0		16.9	21.4	404	41	4.0	295	38		22.2	10.5
2018	22.0	10.5	29.9		26.3	32.2	554	83	5.4	536	106		24.3	10.1
2019							493	66						
			Average 2016-2018		**18.9**	**23.7**					Average 2008–2018		**22.4**	**11.0**

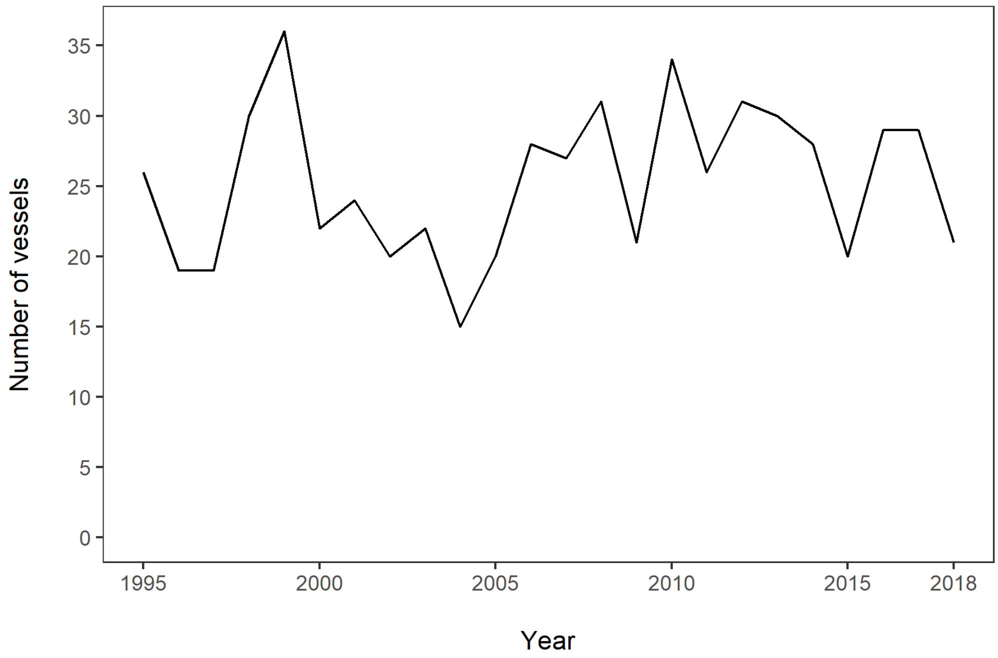


Figure 21.1.1. ***Nephrops*** **in FU17 (Aran Grounds). Time-series of the number of Irish vessels reporting landings of** ***Nephrops*** **from FU17 with a >10 t threshold.**

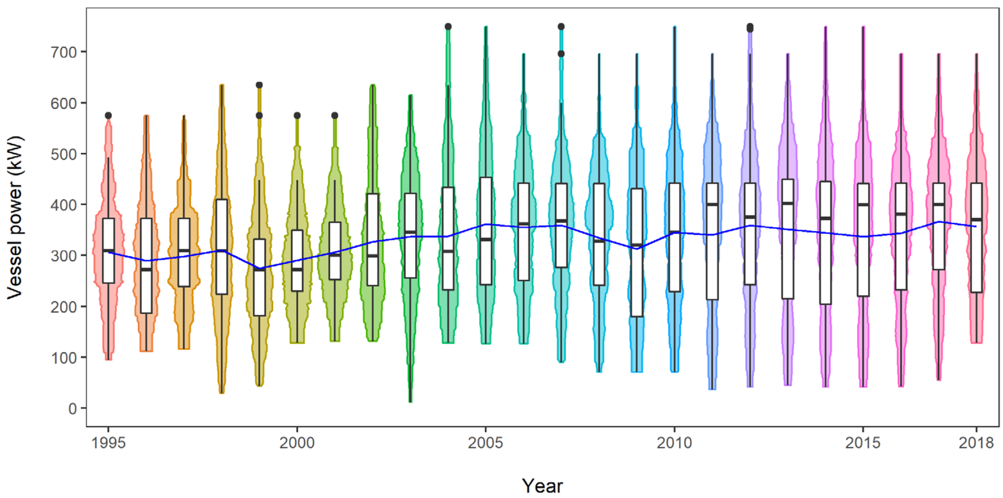


Figure 21.1.2. ***Nephrops*** **in FU17 (Aran Grounds). Combined box and kite plot of Irish vessel's power on the Aran Grounds by year. The blue line indicates the mean.**

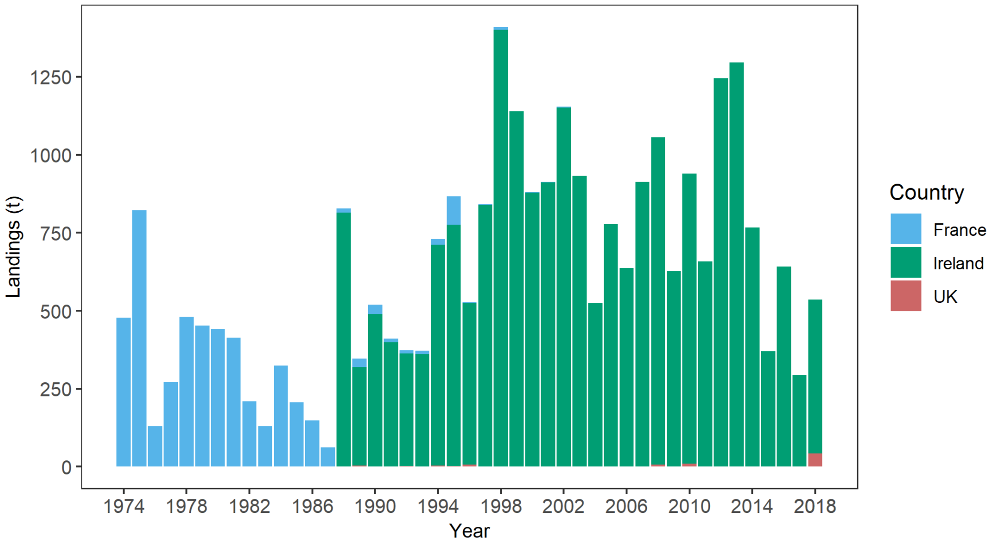


Figure 21.2.1. ***Nephrops*** **in FU17 (Aran Grounds). Landings in tonnes by country.**

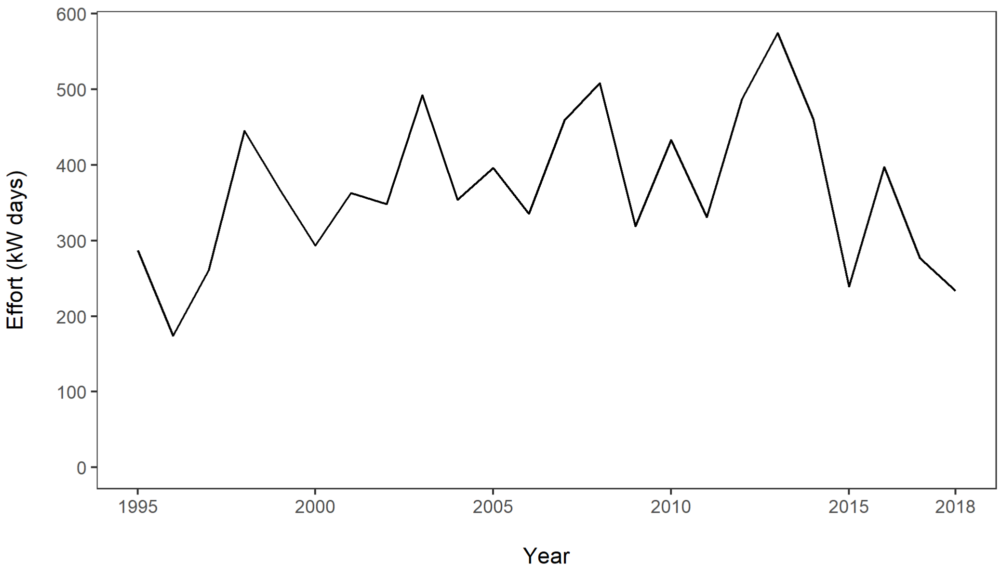


Figure 21.2.2. ***Nephrops*** **in FU17 (Aran Grounds). Effort data (kW days) for Irish directed** ***Nephrops*** **fleet.**

Figure 21.2.3. ***Nephrops*** **FU17 (Aran Grounds). Sampling levels for the Aran grounds.**

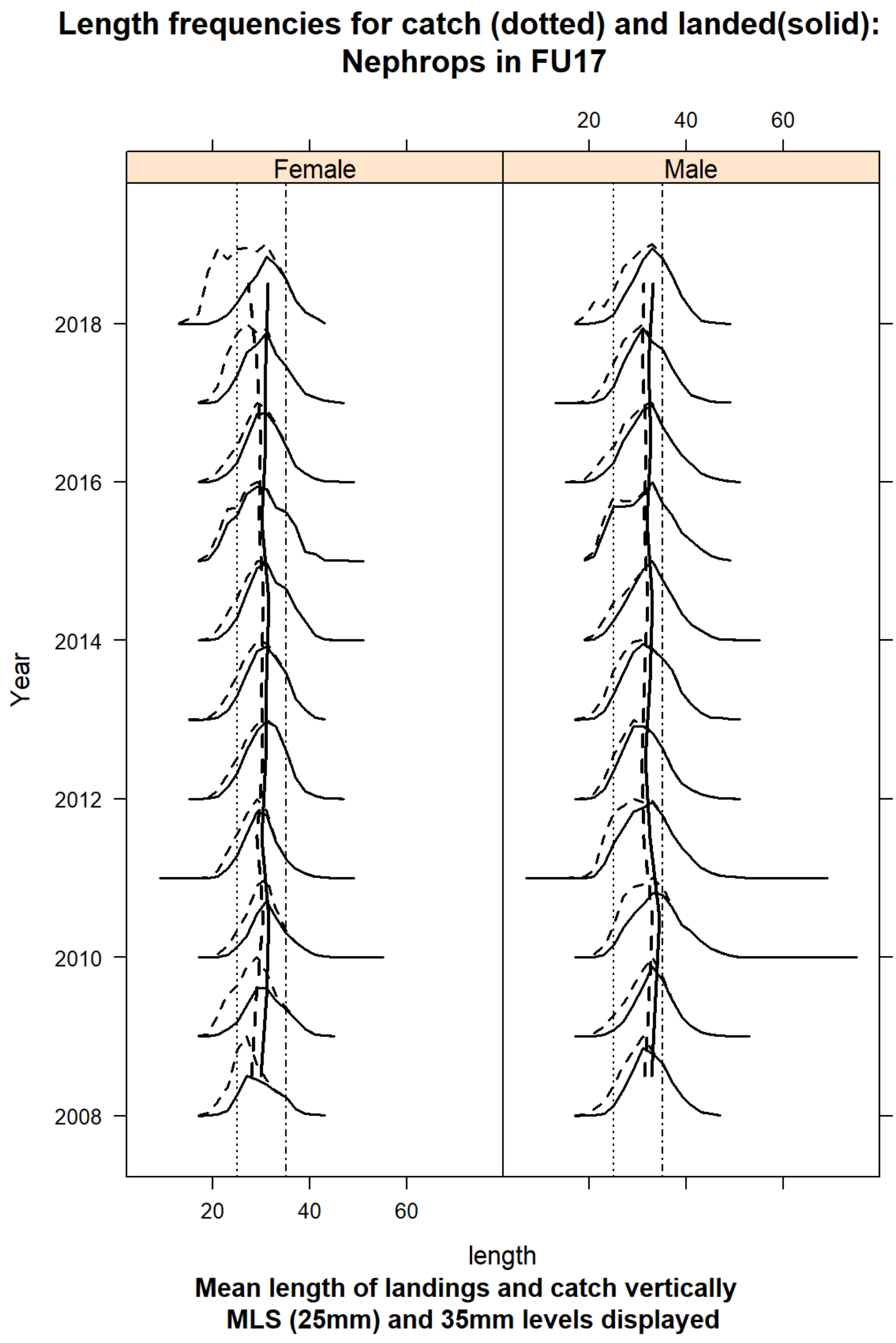


Figure 21.2.4. *Nephrops* **FU17 Aran Grounds. Annual length composition of catches (dotted line) and landings (solid line) for females (left) and males (right) from 2008 (bottom) to 2018 (top). Annual mean length of catches (dotted vertical line) and landings (solid vertical line) are also shown. Minimum Landing Size (25 mm) and 35 mm levels are also displayed with vertical lines.**

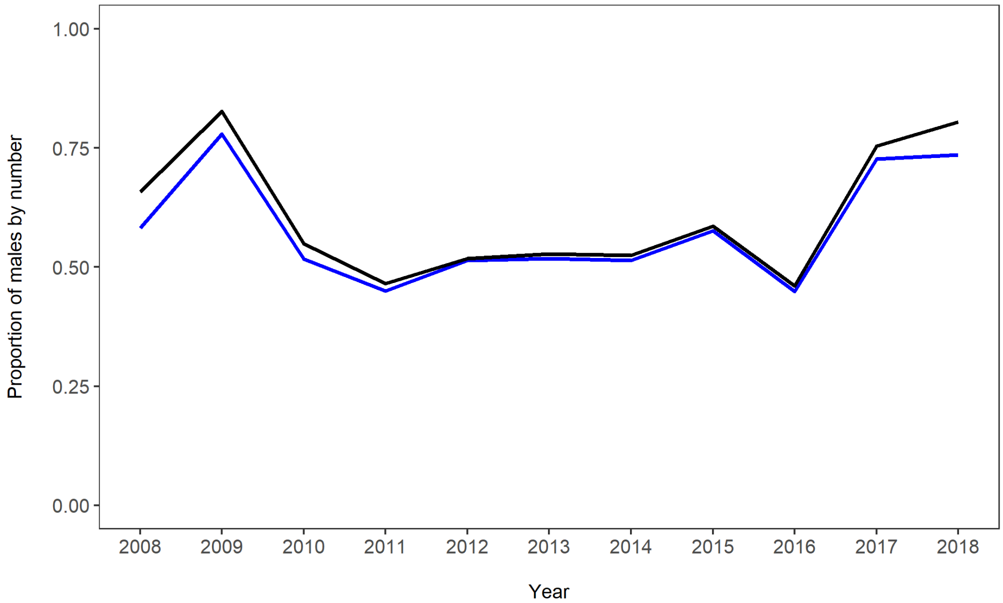


Figure 21.2.5. ***Nephrops*** **FU17 (Aran Grounds). Proportion of males by number in the catch (blue) and landings (black).**

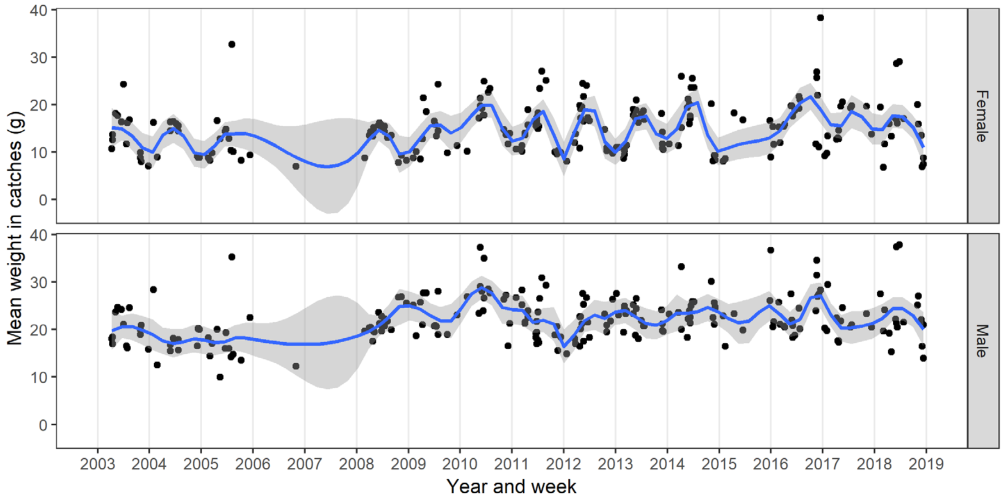


Figure 21.2.6. ***Nephrops*** **FU17 (Aran Grounds). Mean weight in catch samples by sex showing cyclical trends.**

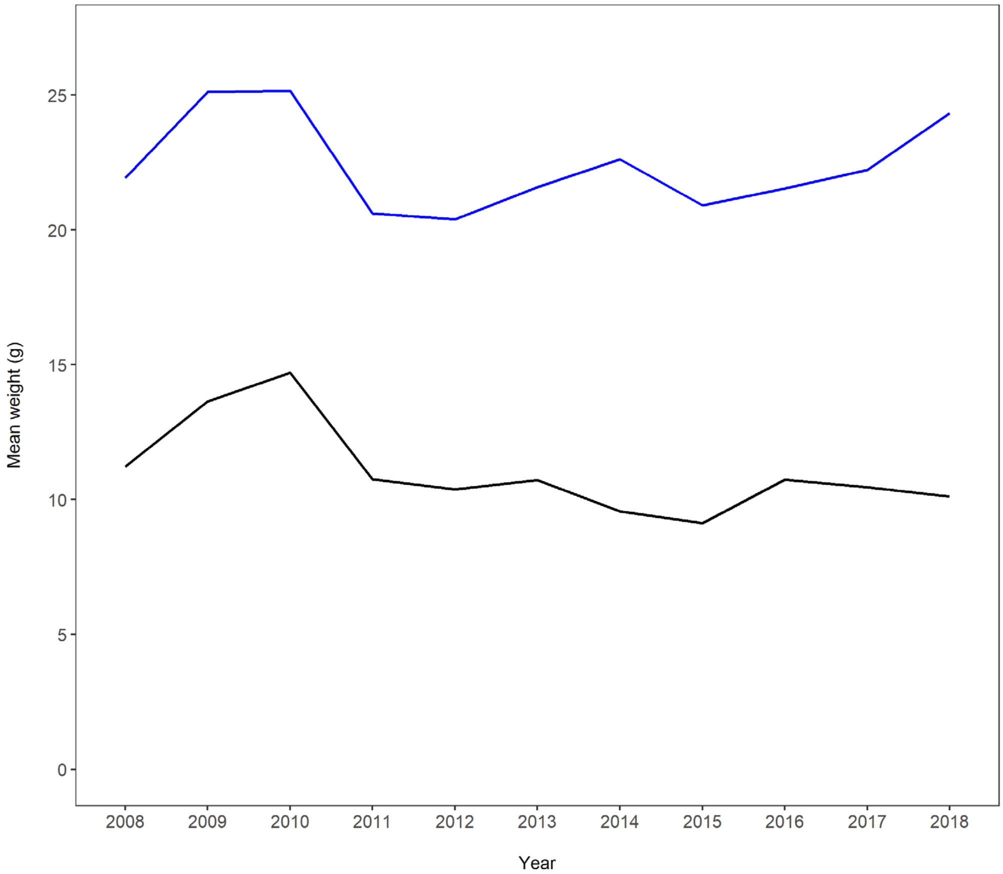


Figure 21.2.7. *Nephrops* FU17 (Aran Grounds). Annual mean weight (g) estimates of landings (blue) and discards (black).

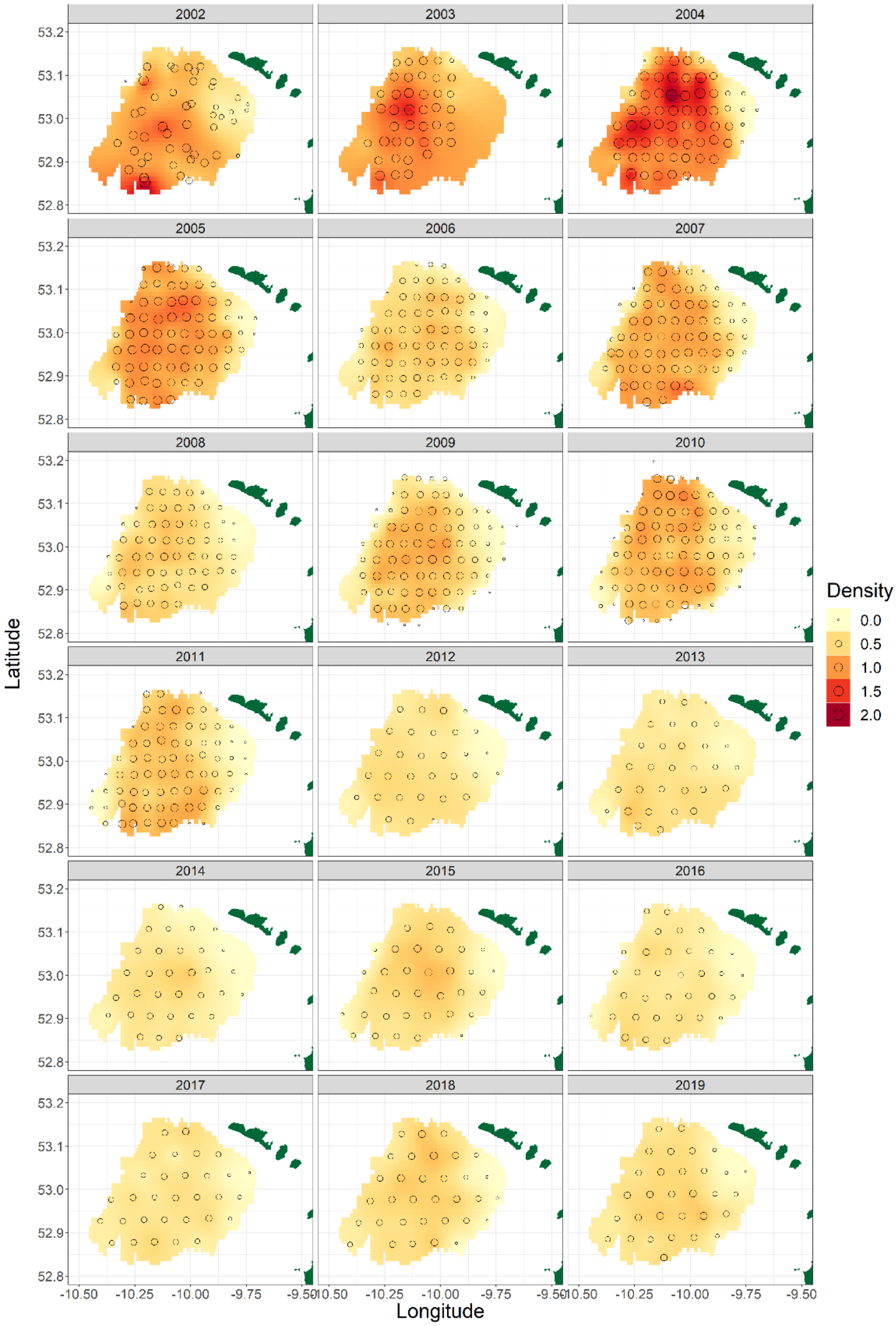


Figure 21.2.8. ***Nephrops*** **in FU17 (Aran Grounds). Contour plots of the krigged density estimates for the Aran Ground UWTV surveys from 2002 (top left) to 2018 (bottom centre).**

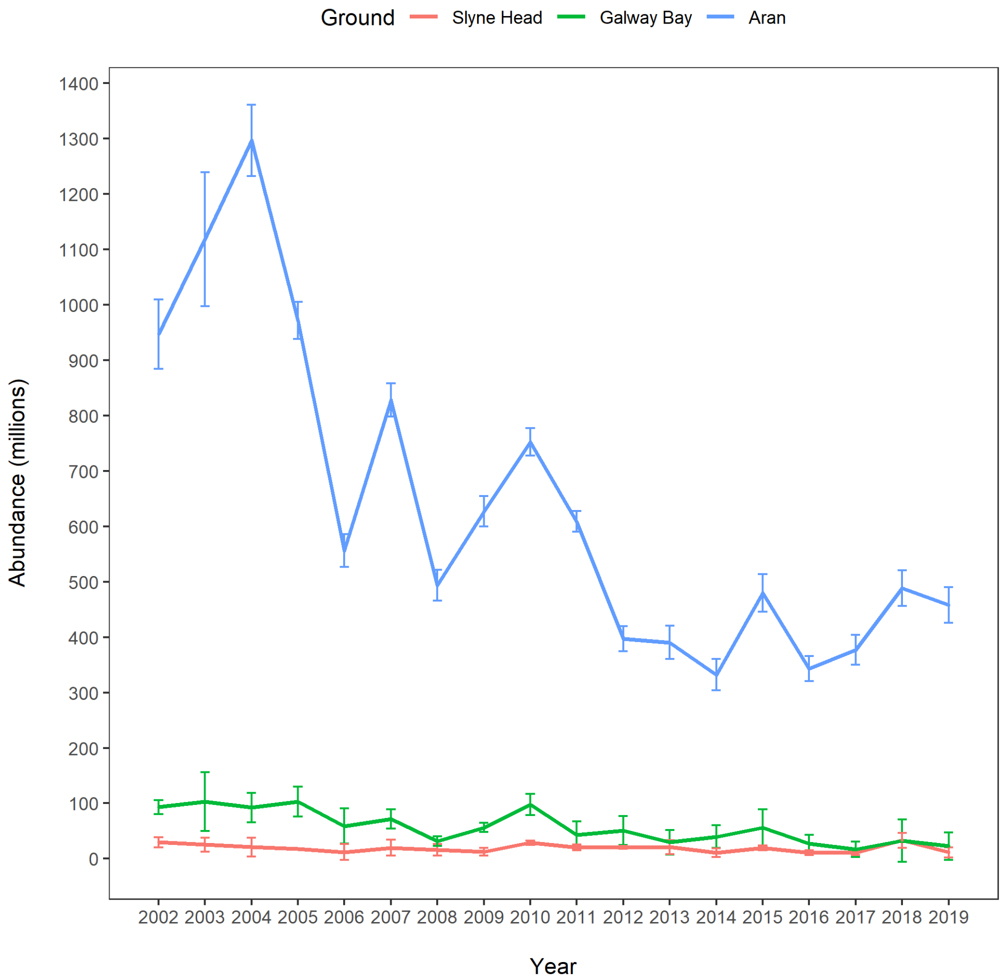


Figure 21.2.9. *Nephrops* FU17 Aran Grounds. *Nephrops* burrow estimates in FU17 Aran (blue), Galway Bay (green) and Slyne Head (red) grounds 2002–2018.

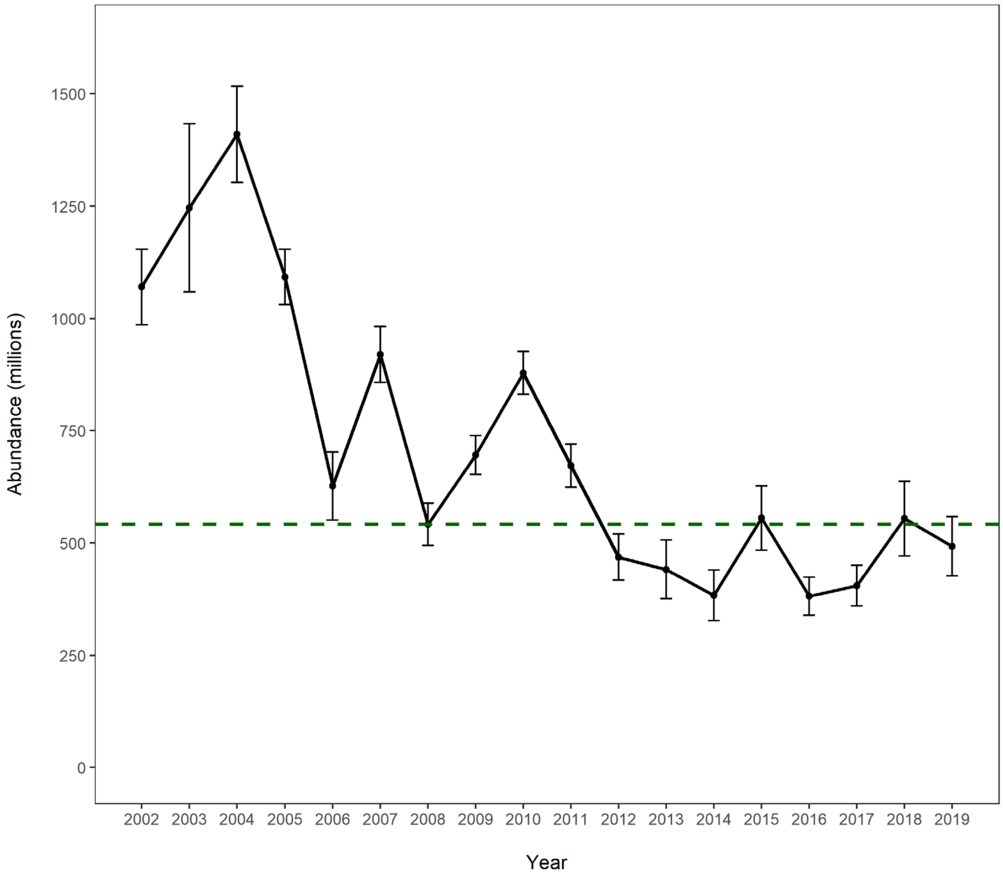


Figure 21.2.10. Time-series of total abundance estimates for FU17 (error bars indicate 95% confidence intervals) and $B_{trigger}$ is dashed green line.

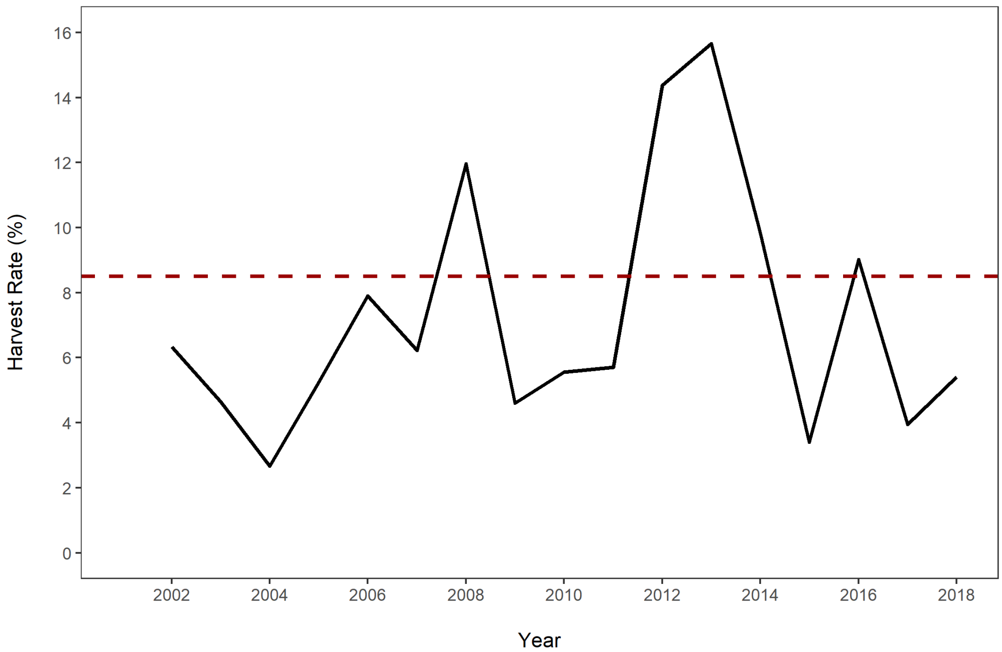


Figure 21.3.1. *Nephrops* FU17 Aran Grounds. Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.

19 Norway lobster (*Nephrops norvegicus*) in divisions 7.a, 7.g and 7.j, Functional Unit 19 (Irish Sea, Celtic Sea, eastern part of southwest of Ireland)

Type of assessment in 2019

This stock was benchmarked in February 2014 and the assessment and provision of catch advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG (ICES, 2014) and set out in the stock annex.

ICES advice applicable to 2018

"ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should be no more than 1192 tonnes.

To ensure that the stock in functional unit (FU) 19 is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2019

"ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2015–2017, catches in 2019 should be no more than 173 tonnes.

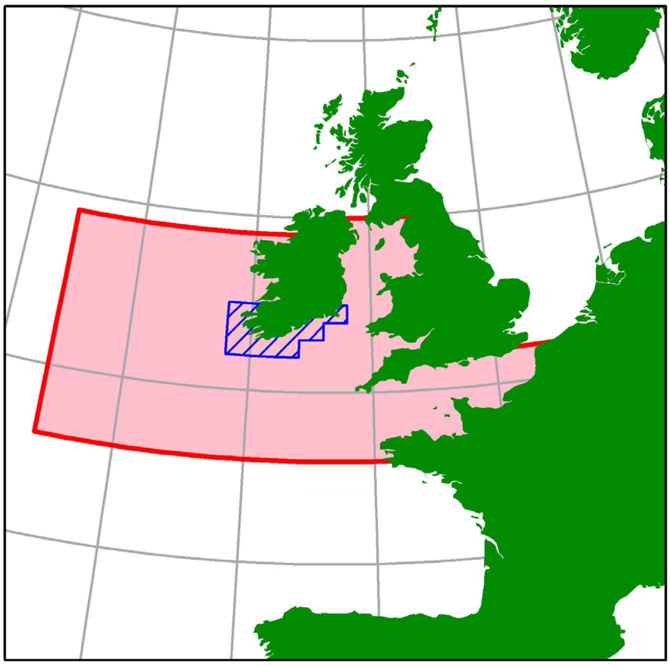
To ensure that the stock in Functional Unit 19 is exploited sustainably, management should be implemented at the functional unit level."

19.1 General

Stock description and management units

In FU19 *Nephrops* are caught on a large number of spatially discrete small inshore grounds and on some larger grounds further offshore and of these the 'Galley ground 4' and around Cork channels appear to be the most important (see Figure 22.1.1). The *Nephrops* stock (FU19) covers ICES rectangles ; 31–33 D9–E0; 31E1; 32E1–E2; 33E2–E3 within 7.a, 7.g, and 7.j. This stock is included as part of the TAC Area 7 *Nephrops*, which includes the following stocks: Irish Sea East and West (FU14, FU15), Porcupine Bank (FU16), northwestern Irish Coast (FU18) and the Celtic Sea (FU20–22).

The map below shows FU19 assessment area (blue) and TAC area (red). There is no evidence that the individual functional units belong to the same stock. See Section 18 for details on *Nephrops* in Subarea 7 general section.



Ecosystem aspects

This section is detailed in stock annex. There are no updates.

Fishery description

A description of the fleet is given in the stock annex.

The time-series of numbers of vessels reporting landings greater than 10 t is updated in Figure 22.1.2. The numbers of vessels has been relatively stable since 1995 except in 2018 where there was a sharp decrease. The time-series of vessel power is shown as a box and kite plot in Figure 22.1.3.

Fishery in 2018

There has been a trend for Irish vessels (>18 m) to switch to multi (quad) rig trawls. Provisional data suggest a ~30% increase in *Nephrops* catch rates and a reduction in fish bycatch of ~30% due to the lower headline height. The number of French vessels reporting landings in FU19 has decreased from 35 vessels in 2005 to seven vessels in 2018.

Information from stakeholders

None available.

19.2 Data

InterCatch

All data were available in InterCatch and used for catch data only. French catch data provided directly by the national expert and not extracted from InterCatch.

Landings

Landings data for FU19 are summarized in Table 22.2.1. The Republic of Ireland, France and the UK report landings for FU19. Landings data for Ireland were revised back to 2008, which resulted in minor revisions in the order of 1 to 5 % (stock annex). These revised data have been used in the assessment this year. The Republic of Ireland landings have fluctuated considerably throughout the time-series, with a marked dip in 1994 (Table 22.2.1; Figure 22.2.1). The highest landings in the time-series were observed in 2002–2004 (>1000 t). Landings in 2005 and 2006 have been below average for the series. In 2017, landings decreased by approximately 30% for the Irish fleet and were below the series average. This can be explained due to the poor weather conditions in quarter 1, which hampered fishing activities of smaller vessels and the larger vessels maximising effort in other FUs. In 2018, landings further decreased by 50% compared to 2017. Landings by the French fleet have fluctuated with a declining trend throughout the time-series from the highest value in 1989 of 245 t to 4 t in 2018. Landings from the UK are minor at 4 t.

Effort

In line with WGCSE 2015 recommendation effort is reported in KWdays and lpue reported in KG/kwdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. The effort series is based on the same criteria for FU15, 16, 17, 22 and 20–21 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks.

Disaggregated effort and landings data are available for the Irish *Nephrops* directed fleet in FU19 from 1995–2018 for all vessels and vessels >18 metres total length. (Table 22.2.2; Figure 22.2.2). For vessels >18 effort (since early 2000s) has fluctuated with an overall decreasing trend in recent three years. This can be explained by fleet mobility where vessels target *Nephrops* in this area in periods of good emergence. For vessels <18 effort has decreased in 2017 to 2018 due to weather conditions.

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by WKCELT 2014, and are documented in the stock annex. The time-series of samples is shown in Figure 22.2.3 and Table 22.2.3. Sampling levels in 2018 were good and are comparable to 2017 levels.

Commercial length–frequency distributions

Spatial and temporal coverage is problematic with landings from FU19 coming from several discrete grounds (see stock annex.) The sampling intensity and coverage has varied over the time-series (see stock annex). Since 2008, sampling has been good although the majority of the samples come from Bantry Bay recently. Also, sampling of the discards is quite sparse over the time-series and are difficult to obtain due to the spatial coverage of the grounds. The catch samples from 2008 to 2018 were split using the discard selection ogive agreed at the benchmark. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate quarterly raising factors. The length distributions are shown in Figure 22.2.4. The mean size has remained relatively stable and the trend in mean size is stable in recent years.

Sex ratio

The sex ratio in the landings is male biased in most years but there is a trend towards increased percentage of females in the landings (Figure 22.2.5). The proportion of females was higher in 2013 and this was confirmed by the industry.

Mean weight explorations

Explorations of the mean weight in the catch samples by sex shows a strong cyclical pattern in the females for Bantry Bay (Figure 22.2.6) and also, all grounds combined (Figure 22.2.7). This corresponds with the emergence of mature females from the burrows to mate in summer. These data also show an increase in mean weights for males in 2016. The annual mean weight estimate for landings and discards is shown in Figure 22.2.8. The landings mean weight estimates show a slight decrease in 2018.

Discarding

Sampling of the discards has quite sparse over the time-series and are difficult to obtain due to the spatial coverage of the grounds (see stock annex). Since 2002, discard rates have been estimated using unsorted catch and discards sampling (as described in the stock annex). WKCELT 2014 examined the available discard data observations for FU19. An average discard selection ogive using data from Bantry Bay in years 2008 and 2013 was generated and deemed appropriate given the variable sampling intensity and coverage. The catch data from 2008 to 2013 were then revised and split into landings and discards. Catch data sampling for years previous to 2008 were not revised as was considered to be not of good enough quality. The 2018 catch data were split using this selection ogive since 2008.

Discard rates range between 25–86% of total catch by weight and 40–80% of total catch by number (Table 22.2.4). These high discard rates are very high compared with other FUs. This is because the fleet is mainly smaller inshore vessels with limited space for extra crew. On-board “tailing” of the smaller *Nephrops* is not usually practised and the bigger *Nephrops* are picked from catches. There is no information on discard survival rate in this fishery but a 25% discard survival rate is assumed in line with other *Nephrops* stocks in the Celtic Sea.

Gear selectivity trials by Bord Iascaigh Mhara (BIM, 2017) reported a 64% survivor rate for *Nephrops* caught in a trawl with a SELTRA selectivity device in the outer Galway Bay area.

Table 22.3.1 gives weights, numbers and mean weights of the landings and discard raised internationally according to the stock annex.

Abundance indices from UWTV surveys

The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Ireland and elsewhere are documented by WKNEPHTV (ICES, 2007), WKNEPHBID (ICES, 2008), SGNEPS (ICES, 2009; 2010; 2012), WGNEPS (ICES, 2013; 2014; 2015; 2016a; 2017; 2018a), WKNEPS (ICES, 2016b; 2018b) and Leocádio, A. *et al*., 2018. Given the scale of the area and the number of distinct patches, it is unrealistic to expect sufficient stations (~10) in each individual patch to estimate densities separately. The random stratified approach may cause problems in years where the planned survey coverage is not achieved. WKCELT 2014 concluded that WGCSE or WGNEPS should make recommendations on the most appropriate fill in procedure to be adopted in these cases.

The spatial extent of the *Nephrops* grounds in FU19 has been re-defined by WKCELT 2014 and the abundance estimates are calculated using these areas. The redefinition of the polygons in FU19 resulted in ~16% increase in overall area from 1653 km² to 1973 km² (see stock annex). The discrete grounds have been named as: Bantry Bay, Galley Ground 1–4, Cork Channels and Helvick 1–2 and are shown in Figure 22.1.1. In terms of area the Galley Grounds (1–4) account for 61% of the total grounds in FU19 and Galley Ground 4 is the largest of these representing 47% of the total area (Table 22.2.5). Helvick patches 2 and 3 were also amalgamated and renamed Helvick 2 based on the information from the VMS data.

From 2011 to 2019, an average of 40 stations have been completed annually. The survey design is based on randomly picked stations from the ground polygons and the sampling effort on each ground was determined by relative area.

All grounds except Galley Ground 4 in 2011 and Galley Ground 1 in 2012 were covered by the TV survey. Since 2015, a new patch Kenmare Bay was surveyed. Operational details of the 2019 UWTV survey are available (Doyle, 2019).

Detailed summary statistics for the various *Nephrops* patches in FU19 over the time-series are presented in Table 22.2.6. The mean density varies across the different patches, but there is some consistency to the estimates over time. The UWTV coverage has improved. In 2019, all discrete grounds were covered by the TV survey and also two stations on a new patch Dunmanus Bay (Doyle *et al.*, 2019).

The 2019 mean density estimates vary between patches from the lowest value 0.0 (no./m²) observed at Helvick 2 to the highest observed at 0.66 (no./m²) at Galley ground 2 (Table 22.2.6, Figure 22.2.9). The overall mean density for FU19 in 2019 is 0.20 (no./m²) which is the second lowest observed in the time-series (Table 22.2.7).

Figure 22.2.10 and Table 22.2.7 shows the total abundance estimate for FU19 with the WKMSYRef4 proposed MSY $B_{trigger}$ (ICES, 2016XX, ICESYY). The 2019 abundance estimate was 220% higher than in 2018 and at 386 million is below the MSY $B_{trigger}$ (430 million) with a RSE of 15%, which is below the 20% limit recommended by SGNEPs (2012).

Information from Irish Groundfish survey

Length–frequency data of the *Nephrops* catches on the Irish groundfish survey (IGFS-WIBTS-Q4) from 2003–2017 are available (Stokes *et al.*, 2014; ICES, 2015). These data were investigated for trends in indicators such as possible recruitment signals (Figure 22.2.11). The mean size of males and females in from the survey was fairly stable over time at 33 mm for males and 25 mm for females.

19.3 Assessment

Comparison with previous assessments

The WGCSE 2019 carried out an UWTV based assessment for this stock. The methods used were very much in line with WK*NEPH* (ICES, 2009) and the approach taken for other *Nephrops* stocks in 6 and 7 by WGCSE. This approach was benchmarked at WKCELT 2014 (ICES, 2014).

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated although the series is quite short. The 2019 estimate is the second lowest observed and is below the MSY $B_{trigger}$. The 2019 abundance remains below the average of the series (geomean: [2011–2019]: 471 million).

Table 22.3.1 summarizes recent abundance estimates, harvest rates for the stock along with other stock parameters. Harvest rate is calculated as (landings + dead discards)/(abundance estimate).

Table 22.3.1.and Figure 22.3.1 summarize recent harvest ratios, which have been below the $F_{MSYproxy}$ for the last three years.

19.4 Catch scenario table

Catch scenario table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 22.3.1 and summarised below.

The basis for the catch options.

Variable	Value	Notes
Stock abundance	386 million individuals	UWTV survey 2019
Mean weight in wanted catch	29.0 g	Average 2016–2018
Mean weight in unwanted catch	14.8 g	Average 2016–2018
Unwanted catch rate	38.5%	Average 2016–2018 (by number). Calculated as discards divided by landings + discards.
Discard survival rate	25.0%	Only applies in scenarios where discarding is allowed.
Dead unwanted catch rate	31.9%	Average 2016–2018 (by number). Calculated as dead discards divided by removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

The average in the recent three years is used to calculate the mean weight for landings and discards. The discard rates and proportions for the last three years are used to account for recent on-board retention practices (this is also according to the stock annex).

A prediction of landings for the FU19 using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the stock annex will be made on the basis of the 2018 UWTV survey. This will be presented in October 2019 for the provision of advice.

19.5 Reference points

WKMSYRef4 updated the F_{MSY} reference points for FU19 (ICES, 2016XX; 2016YY) on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. The updated harvest rate calculated at 9.3% is expected to deliver high long-term yield with a low probability of recruitment overfishing. This is close to the harvest rate of 8.1% calculated by WKCELT (ICES, 2014)

This stock previously did not have MSY $B_{trigger}$ specified, the time-series and range of indicator biomass is also limited such that direct use of B_{loss} is considered too close to equilibrium biomass. The workshop proposed to use the 5% interval on the probability distribution of indicator biomass assuming a normal distribution, which is analogous to the 5% on B_{MSY} proposed for finfish stocks assuming these *Nephrops* FU have been exploited at a rate close to near HR_{MSY}. The MSY $B_{trigger}$ for FU 19 is 434 million individuals rounded to 430 million.

These reference points shown in text table below should remain under review by WGCSE should improved data become available.

Stock code	MSY Flower*	FMSY*	MSY Fupper* with AR	MSY Btrigger	MSY Fupper* with no AR
nep-19	8.3%	9.3%	9.3%	430***	9.3%

*** Harvest rate (HR).**

***** Abundance in millions.**

19.6 Management strategies

No specific management plan exists for this stock.

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES Subarea 7 and also demersal stocks.

19.7 Quality of assessment and forecast

Biological sampling for this stock is improving given the spatial distribution of the *Nephrops* mud patches. A number of other biological parameters such as mean weights and length distributions have also been revised. The revisions were made as part of the benchmark process and have improved the quality of the assessment.

In the provision of catch options based on the absolute survey estimates, additional uncertainties related to mean weight in the landings and the discard rates also arise. For FU19 deterministic estimates of the mean weight in the landings and discard rates for 2016–2018 are used, although there is some variability of these over time.

From 2016, fisheries catching *Nephrops* in Subarea 7 are covered by the EU landings obligation (EU, 2015). Creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 5% discard rate by weight for the trawl fishery in 2019 (reduced from 6% in 2018 and 7% in both 2016 and 2017).

Irish discard survival experiments indicate that the trawl discard survival may be around 64% (BIM, 2017). As a result, an exemption from the landings obligation based on high survivability has been granted by the European Commission. The average discard rate by weight for FU19 over the last three years is 24%. Catch advice and scenarios are provided this year on the assumption that discarding is assumed to continue at the recent average.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009; WGNEPS 2014). Ultimately, there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al*., 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise WK*NEPH* (ICES, 2009).

Different densities are apparent on the various different grounds within this FU. For the 2019 survey, the number of observations on each individual patch is relatively low making the relative standard error (RSE) estimates not that relevant. Aggregating all areas together gives a mean burrow density of 0.20 with a RSE of around 17%, which is below the 20% threshold recommended by SGNEPS (ICES, 2012). The cumulative bias estimates for FU19 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterized, but is likely to be lower than that observed in the survey.

Landings data are adjusted to take into account landings that have been misreported from FU16 since 2011. This adjustment is thought to be reasonably accurate (See Section 19).

19.8 Recommendations for next benchmark

This stock was benchmarked by ICES in February 2014 (ICES, 2014). WGCSE will keep the stock under close review and recommend future benchmark as required.

19.9 Management considerations

The trends from the fishery (landings, effort, mean size, etc.) appear to be relatively stable. The UWTV abundance and mean density estimates vary between the discrete patches and population dynamics between these are not fully understood. The 2019 survey result is the second lowest observed in the time-series.

In recent years, several newer vessels specializing in *Nephrops* fishing have participated in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. Since the introduction of effort management associated with the cod long-term plan (EC 1342/2008) there have been concerns that effort will be displaced towards FU19 and other *Nephrops* grounds where effort control has not been put in place.

Nephrops fisheries in this area are fairly mixed, also catching megrim, anglerfish and other demersal species. There are also some catches of hake, and in the offshore parts of the area. The *Nephrops* grounds in FU19 coincide with an important nursery area for juvenile hake and anglerfish among other species (ICES, 2009).

19.10 References

Anon. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp.

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea. ICES CM 1982/B:13.

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L 83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj.

Doyle, J., Aristegui, M., O'Brien, S., Lynch, D., Vacherot, JP. and Fitzgerald, R. 2019. FU19 *Nephrops* Grounds (FU19) 2019 UWTV Survey Report and catch scenarios for 2020. Marine Institute UWTV Survey report. in draft.

Gerritsen, H.D. and Lordan, C. 2011. Integrating Vessel Monitoring Systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES Journal of Marine Science, 68(1): 245–453.

BIM. 2017. Report on *Nephrops* survivability in the Irish demersal trawl fishery. Bord Iascaigh Mhara, 29 September 2017 .http://www.bim.ie/media/bim/content/publications/fisheries/6882-BIM-nephrops-survival-report-final.pdf .

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM:14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2009/ACOM:33.

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9–11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 012/SSGESST:19.

ICES. 2013. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 5–8 November 2013, Barcelona, Spain. ICES CM 2013/SSGESST:21. 27 pp.

ICES. 2014. Report of the Benchmark Workshop on Celtic Sea stocks (WKCELT), 3–7 February 2014, ICES Headquarters, Copenhagen, Denmark. ICES CM 2014\ACOM:42. 194 pp.

ICES. 2014. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 4–6 November 2014, Lisbon, Portugal. ICES CM 2014/SSGESST:20. 57 pp.

ICES. 2015. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 10–13 November 2015, Cadiz, Spain. ICES CM 2015/ SSGIEOM:30.52 pp.

ICES. 2015. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 23–27 March 2015, Bergen, Norway. ICES CM 2015/ SSGIEOM:20. 124 pp.

ICES. 2016a. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 7–8 November 2016, Reykjavík, Iceland. ICES CM 2016/ SSGIEOM:33.67 pp.

ICES. 2016b. Report of the Workshop on *Nephrops* Burrow Counting (WKNEP), 9–11 November 2016, Reykjavík, Iceland. ICES CM 2016/ SSGIEOM:33.65 pp.

ICES. 2016XX. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

ICES. 2016YY. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2016YY. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2017. Report of the Working Group on *Nephrops* Surveys (WGNEPS). 28 November–1 December 2017, Heraklion, Greece. ICES CM 2017/SSGIEOM: 30. Ref: ACOM/ SCICOM.

ICES. 2018a. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 6–8 November 2018. Lorient, France. ICES CM 2018/ EOSG:18.227 pp.

ICES. 2018b. Report of the Workshop on *Nephrops* burrow counting, 2–5 October 2018, Aberdeen, UK. ICES CM 2018/ EOSG:25.47 pp.

ICES. In prep. Manual for the *Nephrops* Underwater TV Surveys. Series of ICES Survey Protocols (SISP).

Leocádio, A., Weetman, A., and Wieland, K. (Eds). 2018. Using UWTV surveys to assess and advise on *Nephrops* stocks. ICES Cooperative Research Report No. 340. 49 pp. http://doi.org/10.17895/ices.pub.4370.

Marrs S.J., Atkinson R.J.A., Smith C.J., Hills J.M. 1996. Calibration of the towed underwater TV technique for use in stock assessment of *Nephrops norvegicus*. Reference no. 94/069 (Study Project in support of the Common Fisheries Policy XIV/1810/C1/94, call for proposals 94/C 144/04).

Stokes, D., Gerritsen. H., O'Hea, B., Moore, S.J. and Dransfeld, L. 2014. "Irish Groundfish Survey Cruise Report, 24 September–17 December 2014", FEAS Survey Series; 2014/01. http://hdl.handle.net/10793/1064.

Table 22.2.1. *Nephrops* in FU19 (SW and SE Ireland). Landings in tonnes by country.

Year	FU 19			
	France	Rep. of Ireland	UK	Total
1989	245	652	2	899
1990	181	569	4	754
1991	212	860	5	1077
1992	233	640	15	888
1993	229	672	4	905
1994	216	153	21	390
1995	175	507	12	695
1996	145	736	7	888
1997	93	656	7	756
1998	92	733	2	827
1999	77	499	3	579
2000	144	541	11	696
2001	111	702	2	815
2002	188	1130	0	1318
2003	165	1075	0	1239
2004	76	997	1	1074
2005	62	648	2	711
2006	65	675	1	741
2007	63	894	0	957
2008	46	790	15	851
2009	55	798	15	868
2010	14	660	13	687
2011	23	619	1	643
2012	11	837	1	849
2013	4	783	6	794
2014	6	459	3	468
2015	5	502	0	507
2016	4	583	3	590
2017	4	412	4	420
2018	4	210	4	219

Table 22.2.2. ***Nephrops*** **in FU19 (SW and SE Ireland). Irish** ***Nephrops*** **directed effort (Kw Days) and landings.**

Year	Irish Fleet - *Nephrops* trawlers (>30% landings weight)			
	All Vessels		Vessels >18 m	
	kW days ('000)	Landings Tonnes	kW days ('000)	Landings Tonnes
1995	222.0	380	80.7	121
1996	178.6	355	55.6	86
1997	161.0	306	53.9	101
1998	329.6	498	144.6	189
1999	182.9	236	42.3	47
2000	142.0	217	56.2	86
2001	193.3	397	89.1	139
2002	506.7	883	323.7	446
2003	555.9	693	318.8	364
2004	488.1	558	303.0	311
2005	405.0	471	220.6	219
2006	424.2	478	208.8	186
2007	558.8	713	287.4	262
2008	534.1	643	288.1	319
2009	472.0	613	224.5	243
2010	382.2	494	103.7	114
2011	337.3	449	142.9	167
2012	355.5	541	91.9	126
2013	336.1	571	88.6	133
2014	213.6	332	52.1	74
2015	244.6	393	85.5	118
2016	287.3	558	111.2	233
2017	118.2	425	111.4	179
2018	71.6	107.1	24.1	29.9

Table 22.2.3. ***Nephrops*** **in FU19 (SW and SE Ireland). Irish Sampling levels.**

Year	Quarter	Number of samples			Numbers Measured		
		Catch	Discards	Landings	Catch	Discards	Landings
2008	1	3	0	0	1502	0	0
2008	2	6	0	0	3521	0	0
2008	3	6	0	0	6412	0	0
2008	4	3	0	0	876	0	0
2009	1	3	0	0	1347	0	0
2009	2	6	0	0	3369	0	0
2009	3	2	0	0	1003	0	0
2009	4	5	0	0	1882	0	0
2010	1	2	0	0	840	0	0
2010	2	7	0	0	2989	0	0
2010	3	4	0	0	1457	0	0
2010	4	6	0	0	2376	0	0
2011	1	3	0	0	1493	0	0
2011	2	5	0	0	2747	0	0
2011	3	2	0	0	938	0	0
2011	4	5	0	0	2686	0	0
2012	1	6	0	0	2053	0	0
2012	2	7	0	0	3956	0	0
2012	3	4	0	0	1980	0	0
2012	4	4	0	0	1969	0	0
2013	1	3	0	0	1857	0	0
2013	2	8	5	0	4117	2059	0
2013	2	3	3	0	1177	1250	0
2013	4	3	3	0	1472	1276	0
2014	1	3	2	0	1137	941	0
2014	2	7	7	0	3331	2319	0
2014	3	3	2	0	1344	682	0
2014	4	10	8	0	3455	2200	0
2015	1	1	1	0	417	310	0
2015	2	3	3	0	1417	1267	0
2015	3	2	2	1	856	648	321
2015	4	3	2	0	1250	774	0
2016	1	3	3	0	1500	1631	0
2016	2	6	5	0	2310	1760	0
2016	3	9	7	0	3328	2448	0
2016	4	5	5	0	1,923	1521	0

Table 22.2.3. Continued.

Year	Quarter	Number of samples			Numbers Measured		
		Catch	Discards	Landings	Catch	Discards	Landings
2017	1	4	4	0	1860	1283	0
2017	2	3	3	0	1572	1281	0
2017	3	2	2	0	998	943	0
2017	4	4	2	0	1200	785	0
2018	1	1	1	0	304	380	0
2018	2	7	7	0	3579	3230	0
2018	3	1	1	0	255	275	0
2018	4	1	1	0	370	404	0

Table 22.2.4. ***Nephrops*** **in FU19 (SW and SE Ireland). Landings and estimated discards by weight and numbers.**

	Female '000s		Male '000s		Both sexes
Year	Landings (t)	Discards (t)	Landings (t)	Discards (t)	% Discard
2008	99	29	691	69	11
2009	117	106	681	141	24
2010	138	98	522	148	27
2011	169	155	450	250	39
2012	190	202	647	265	36
2013	259	210	525	220	35
2014	106	71	353	87	26
2015	79	64	423	101	25
2016	154	91	429	100	25
2017	133	58	280	79	25
2018	64	25	146	38	23
2008	3,893	1,781	19,516	3,255	18
2009	5,819	8,250	20,324	8,793	39
2010	6,276	8,147	16,001	10,117	45
2011	7,295	12,895	16,900	18,192	56
2012	9,266	17,635	22,540	19,108	54
2013	11,680	18,945	17,399	17,034	55
2014	4,862	5,647	11,183	5,572	41
2015	3,706	5,255	13,111	6,462	41
2016	6,877	6,761	12,610	6,668	41
2017	5,295	4,400	9,022	5,044	40
2018	2,617	1,692	4,818	2,279	35

Table 22.2.5. ***Nephrops*** **in FU19 (SW and SE Ireland). Area (Km²) of discrete patches and percentage contribution to overall area.**

Ground	Area (Km²)	% Contribution
Bantry	121.5	6%
Cork Channels	562.0	28%
Galley Grounds 1	60.9	3%
Galley Grounds 2	76.7	4%
Galley Grounds 3	133.9	7%
Galley Grounds 4	925.1	47%
Helvick 1	33.1	2%
Helvick 2	59.5	3%
Total	1972.8	

Table 22.2.6. ***Nephrops*** **in FU19 (SW and SE Ireland). Detailed summary statistics for the various** ***Nephrops*** **patches in FU19 over the time-series. (N = number of stations, Mean Density (no/m²) is adjusted for the bias correction factor in Table 3, sd, se and ci are the standard deviation, standard error and 95% confidence intervals on the mean density).**

Year	Ground	N	Mean Density (no/m²)	sd	se	ci
2006	Galley Grounds 4	6	0.21	0.18	0.08	0.19
2011	Bantry	5	0.33	0.23	0.1	0.28
2011	Cork Channels	12	0.35	0.32	0.09	0.2
2011	Galley Grounds 1	3	0.52	0.41	0.24	1.02
2011	Galley Grounds 2	3	0.59	0.43	0.25	1.07
2011	Galley Grounds 3	4	0.58	0.22	0.11	0.35
2011	Helvick 1	3	0.6	0.01	0.01	0.04
2011	Helvick 2	5	0.12	0.21	0.09	0.26
2012	Bantry	1	0.2	NA	NA	NA
2012	Cork Channels	9	0.27	0.17	0.06	0.13
2012	Galley Grounds 2	4	0.59	0.12	0.06	0.19
2012	Galley Grounds 3	1	0.51	NA	NA	NA
2012	Galley Grounds 4	16	0.39	0.16	0.04	0.09
2012	Helvick 1	3	0.33	0.13	0.08	0.33
2012	Helvick 2	6	0.33	0.41	0.17	0.43
2013	Bantry	4	0.38	0.2	0.1	0.31
2013	Cork Channels	11	0.12	0.1	0.03	0.07
2013	Galley Grounds 1	2	0.23	0.18	0.13	1.59
2013	Galley Grounds 2	3	0.48	0.44	0.25	1.09
2013	Galley Grounds 3	4	0.59	0.24	0.12	0.38
2013	Galley Grounds 4	13	0.19	0.27	0.07	0.16
2013	Helvick 1	1	0.09	NA	NA	NA
2013	Helvick 2	2	0.06	0.05	0.04	0.48
2014	Bantry	4	0.25	0.05	0.03	0.09
2014	Cork Channels	10	0.1	0.06	0.02	0.04
2014	Galley Grounds 1	2	0.61	0.41	0.29	3.69
2014	Galley Grounds 2	2	0.82	0.14	0.1	1.23
2014	Galley Grounds 3	4	0.66	0.23	0.12	0.37
2014	Galley Grounds 4	14	0.29	0.29	0.08	0.17
2014	Helvick 1	2	0.67	0.28	0.2	2.53
2014	Helvick 2	2	0.03	0.04	0.03	0.39
2015	Bantry	2	0.32	0.11	0.08	1.02
2015	Cork Channels	10	0.08	0.11	0.03	0.08
2015	Galley Grounds 1	2	0.32	0.46	0.32	4.12
2015	Galley Grounds 2	2	0.53	0.08	0.06	0.74
2015	Galley Grounds 3	4	0.40	0.14	0.07	0.23
2015	Galley Grounds 4	14	0.27	0.19	0.05	0.11
2015	Helvick 1	2	0.30	0.23	0.16	2.08
2015	Helvick 2	2	0.09	0.09	0.06	0.79
2015	Kenmare Bay	1	0.30	NA	NA	NA

Table 22.2.6. Continued

Year	Ground	N	Mean Density (no/m²)	sd	se	ci
2016	Bantry	4	0.20	0.07	0.04	0.12
2016	Cork Channels	10	0.21	0.11	0.03	0.08
2016	Galley Grounds 1	2	0.03	0.01	0.01	0.08
2016	Galley Grounds 2	2	0.53	0.12	0.09	1.11
2016	Galley Grounds 3	4	0.16	0.12	0.06	0.19
2016	Galley Grounds 4	14	0.17	0.20	0.05	0.12
2016	Helvick 1	2	0.38	0.08	0.06	0.70
2016	Helvick 2	2	0.07	0.09	0.06	0.81
2016	Kenmare Bay	2	0.24	0.15	0.11	1.33
2017	Bantry	3	0.29	0.15	0.09	0.37
2017	Cork Channels	10	0.25	0.20	0.06	0.14
2017	Galley Grounds 1	2	0.24	0.11	0.08	1.00
2017	Galley Grounds 2	2	0.63	0.06	0.04	0.55
2017	Galley Grounds 3	3	0.45	0.12	0.07	0.30
2017	Galley Grounds 4	15	0.16	0.16	0.04	0.09
2017	Helvick 1	2	0.46	0.07	0.05	0.66
2017	Helvick 2	2	0.16	0.23	0.16	2.03
2017	Kenmare Bay	2	0.16	0.22	0.16	1.97
2018	Bantry	4	0.06	0.02	0.01	0.04
2018	Cork Channels	10	0.11	0.11	0.04	0.08
2018	Galley Grounds 1	2	0.06	0.01	0.01	0.10
2018	Galley Grounds 2	2	0.19	0.19	0.14	1.75
2018	Galley Grounds 3	4	0.11	0.09	0.05	0.14
2018	Galley Grounds 4	14	0.07	0.08	0.02	0.05
2018	Helvick 1	2	0.11	0.10	0.07	0.92
2018	Helvick 2	2	0.06	0.03	0.02	0.28
2018	Kenmare Bay	2	0.07	0.03	0.02	0.25
2019	Bantry	4	0.13	0.04	0.02	0.06
2019	Cork Channels	10	0.16	0.17	0.06	0.13
2019	Galley Grounds 1	2	0.12	0.17	0.12	1.57
2019	Galley Grounds 2	2	0.66	0.38	0.27	3.40
2019	Galley Grounds 3	4	0.21	0.14	0.07	0.23
2019	Galley Grounds 4	14	0.18	0.23	0.06	0.13
2019	Helvick 1	2	0.34	0.27	0.19	2.46
2019	Helvick 2	2	0.00	0.00	0.00	0.00
2019	Kenmare Bay	2	0.27	0.10	0.07	0.88
2019	Dunmanus Bay	2	0	0	0	0

Table 22.2.7. ***Nephrops*** **in FU19 (SW and SE Ireland). Summary statistics for FU19 combined over the time-series. No TV survey from 2007–2010.**

Year	Number of stations	Mean Density adjusted (burrow /m²)	Standard Deviation	Raised abundance estimate adjusted (million burrows)	Upper 95%CI on Abundance	Lower 95%CI on Abundance	CVs
2006	6	0.21	0.18	408	789	26	36%
2007	na	na	na	na	na	na	na
2008	na	na	na	na	na	na	na
2009	na	na	na	na	na	na	na
2010	na	na	na	na	na	na	na
2011	35	0.34	0.26	665	842	488	13%
2012	40	0.3	0.18	594	708	480	9%
2013	40	0.25	0.26	487	653	320	17%
2014	40	0.32	0.31	636	829	442	15%
2015	39	0.24	0.2	482	612	352	13%
2016	42	0.2	0.17	399	501	296	13%
2017	41	0.25	0.20	499	622	376	12%
2018	42	0.09	0.09	176	230	122	15%
2019	42	0.20	0.21	386	517	255	17%

Table 22.3.1. *Nephrops* in FU19 (SW and SE Ireland). Forecast inputs (bold) and historical estimates of mean weight in landings and harvest rate (landings + dead discards)/(abundance estimate), discard rate (discards divided by landings + discards) and dead discard rate as dead discards divided by removals (landings + dead discards).

Year	Landings in number	Total discards* in number	Removals in number	Discard Rate number	Dead discard rate number	UWTV abundance estimate	95% Conf. intervals	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	**millions**	**millions**	**%**	**%**	**millions**	**millions**	**%**	**tonnes**	**tonnes**	**grammes**	**grammes**
2006	26.2	2.6	28.1	8.9	6.8	na	na	na	741	37	28.3	14.4
2007	30.8	1.5	31.9	4.8	3.6	na	na	na	957	26	31.1	17
2008	25.2	5.4	29.3	17.7	13.9	na	na	na	866	107	33.7	19.3
2009	28.4	18.5	42.3	39.5	32.8	na	na	na	833	258	30.5	14.5
2010	23.2	19.0	37.4	45.1	38.1	na	na	na	722	269	29.6	13.5
2011	25.8	32.4	50.1	55.7	48.5	665	171	7.10	608	387	25	12.6
2012	32.3	37.3	60.2	53.6	46.4	594	111	9.10	770	420	26.4	12.7
2013	29.5	36.5	56.8	55.3	48.1	487	161	11.00	781	404	27.4	12.1
2014	16.3	11.4	24.9	41.1	34.4	636	188	3.90	468	161	28.6	14.1
2015	17.0	11.8	25.9	41.1	34.3	482	126	5.50	507	177	29.8	13.8
2016	19.7	13.6	29.9	40.8	34.1	399	100	7.50	591	194	29.9	14.2
2017	14.6	9.6	21.8	39.7	33.1	499	120	4.4	420	138	28.8	14.45
2018	7.8	4.2	10.9	34.8	28.6	176	53	6.2	219	65	28.2	15.7
2019						**386**	**127**					
			Average 16–18	**38.5**	**31.9**					**Average 16–18**	**29.0**	**14.8**

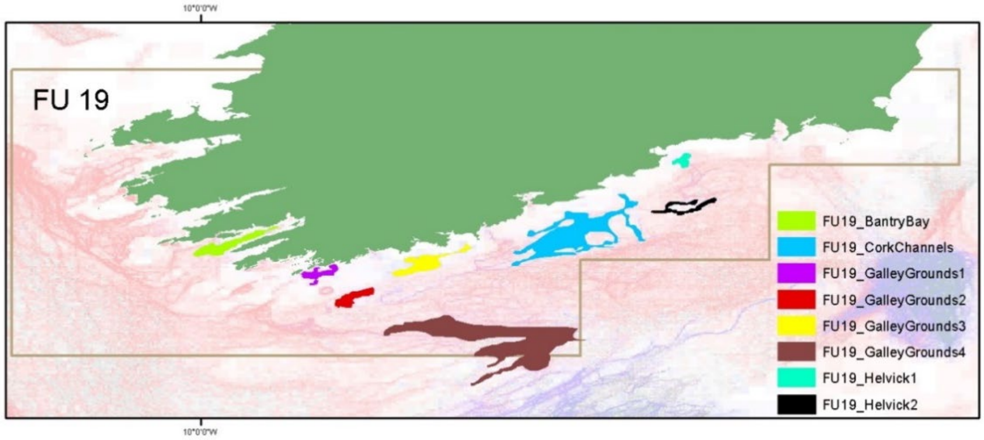


Figure 22.1.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Revised discrete patches overlaid on overlaid on proportion of *Nephrops* in the Irish landings overlaid on international OTB effort (red=0% *Nephrops*; blue=50–60% *Nephrops*; grey=unknown (no Irish landings).**

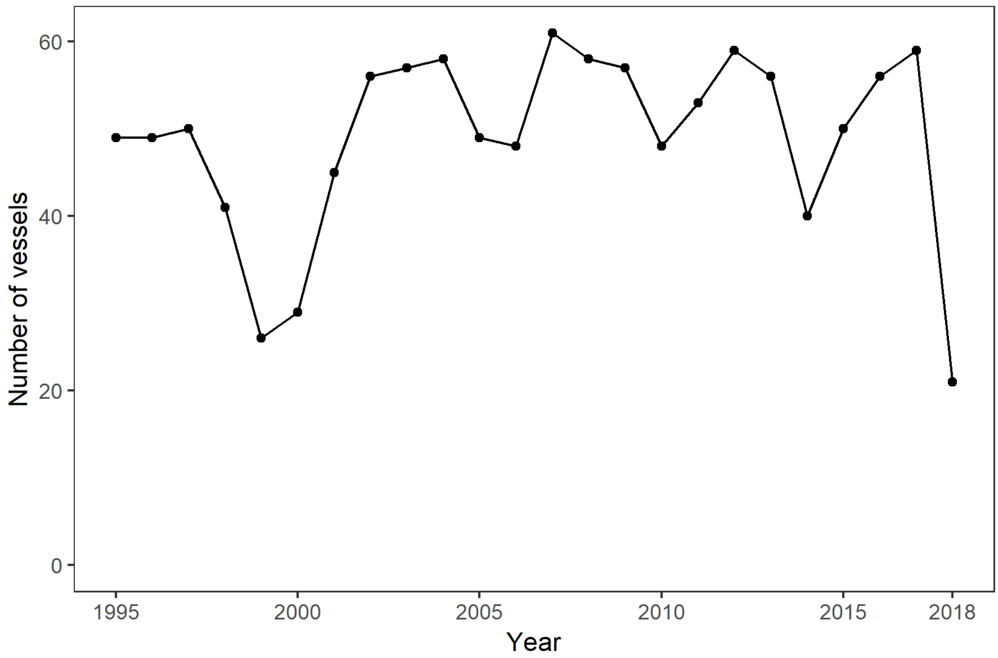


Figure 22.1.2. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Time-series of the number of Irish vessels reporting landings of *Nephrops* from FU19 with a >10 t threshold.**

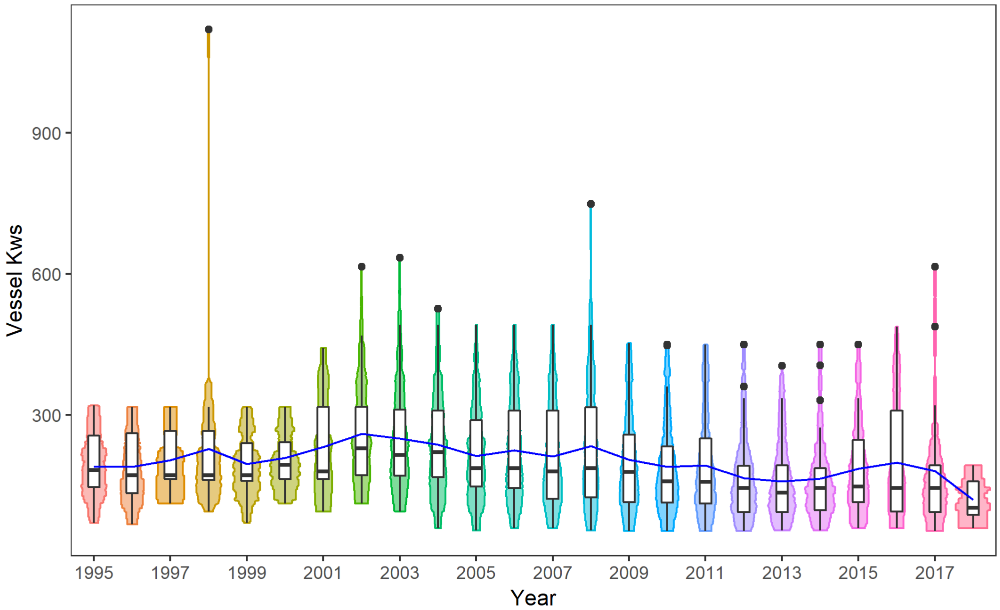


Figure 22.1.3. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Combined box and kite plot of vessel power by year. The blue line indicates the mean.**

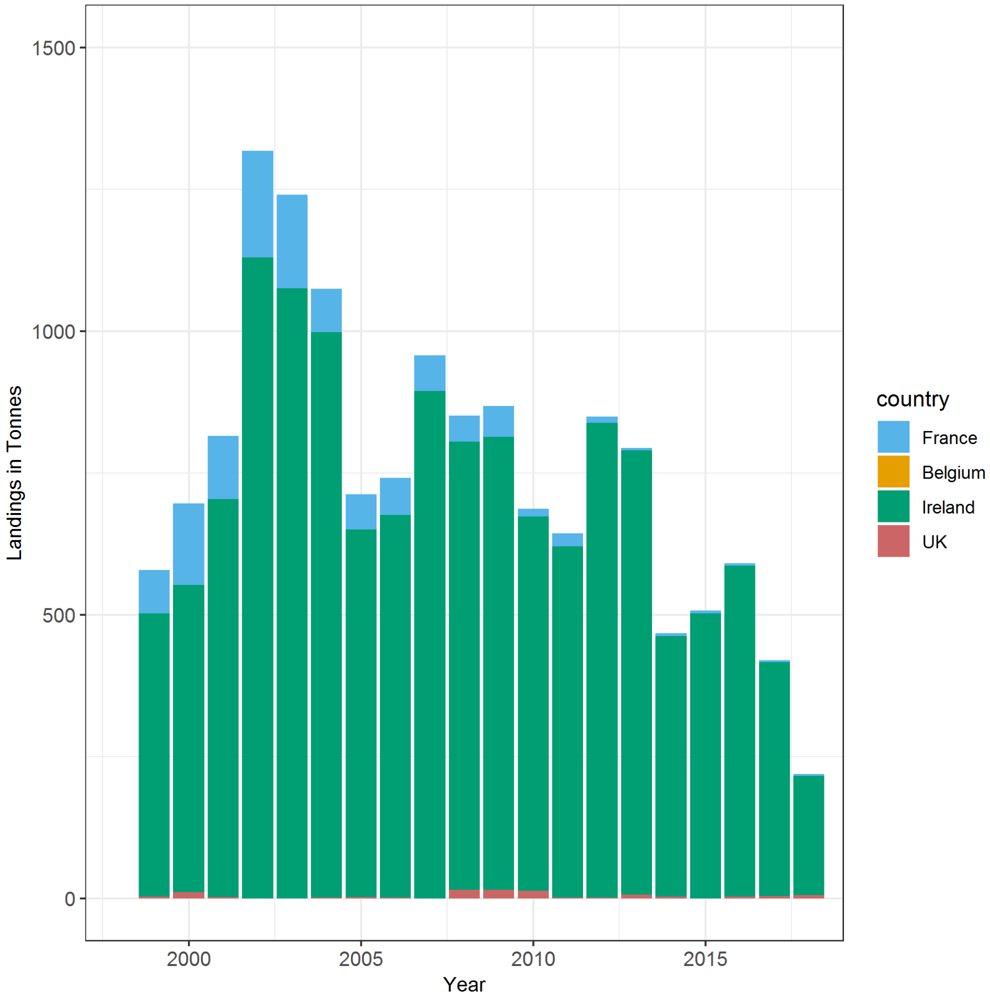


Figure 22.2.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Landings in tonnes by country.**

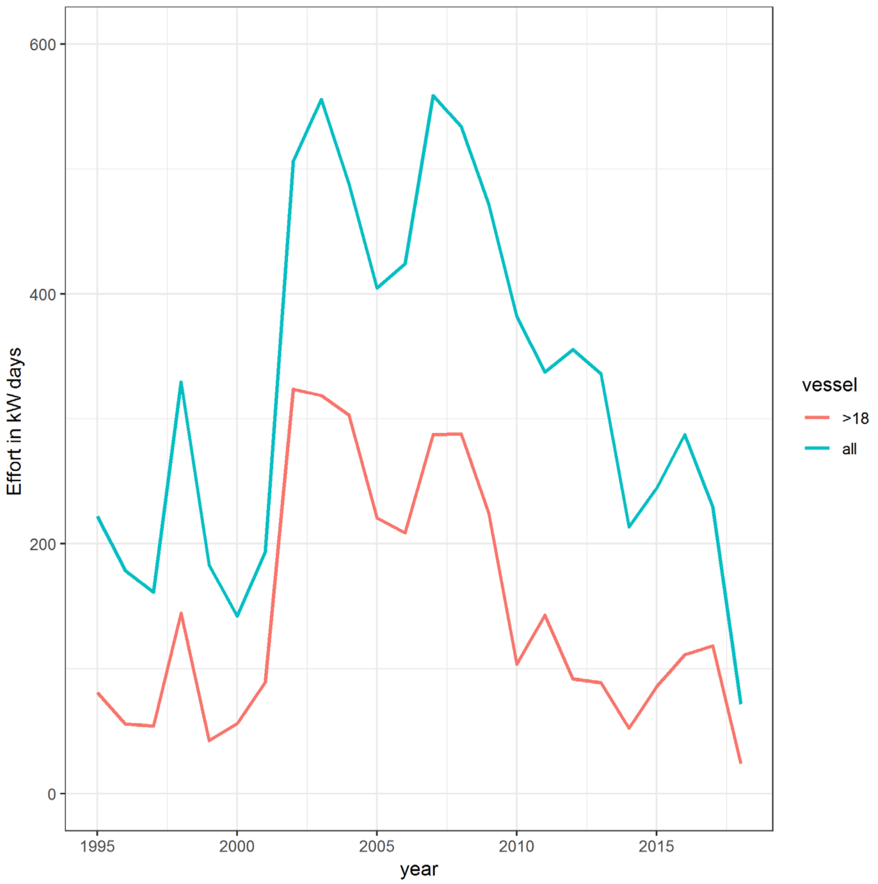


Figure 22.2.2. *Nephrops* in FU19 (Ireland SW and SE Coast). Trawl effort for Irish OTB vessels where >30% of landed weight was *Nephrops*.

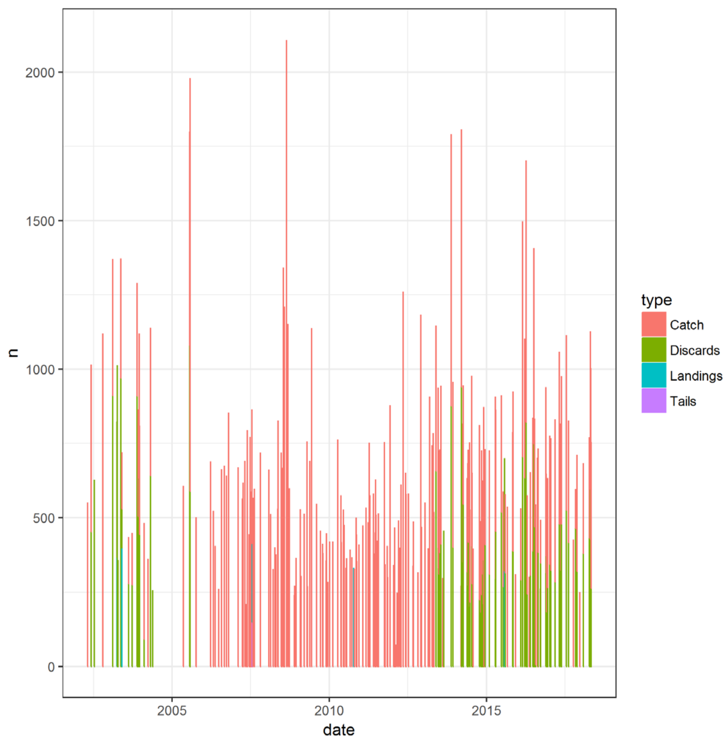


Figure 22.2.3. *Nephrops* in FU19 (Ireland SW and SE Coast). Sampling levels for FU19.

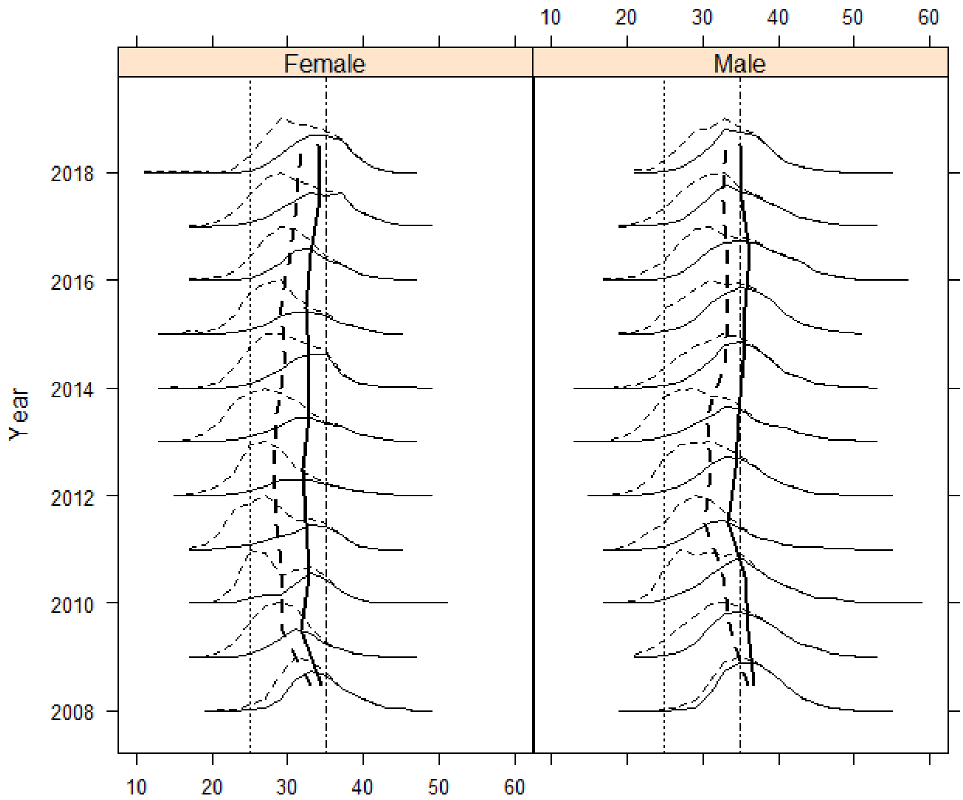


Figure 22.2.4. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches (dotted) and whole landings (solid) by sex 2002–2018. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and 35 mm CL.**

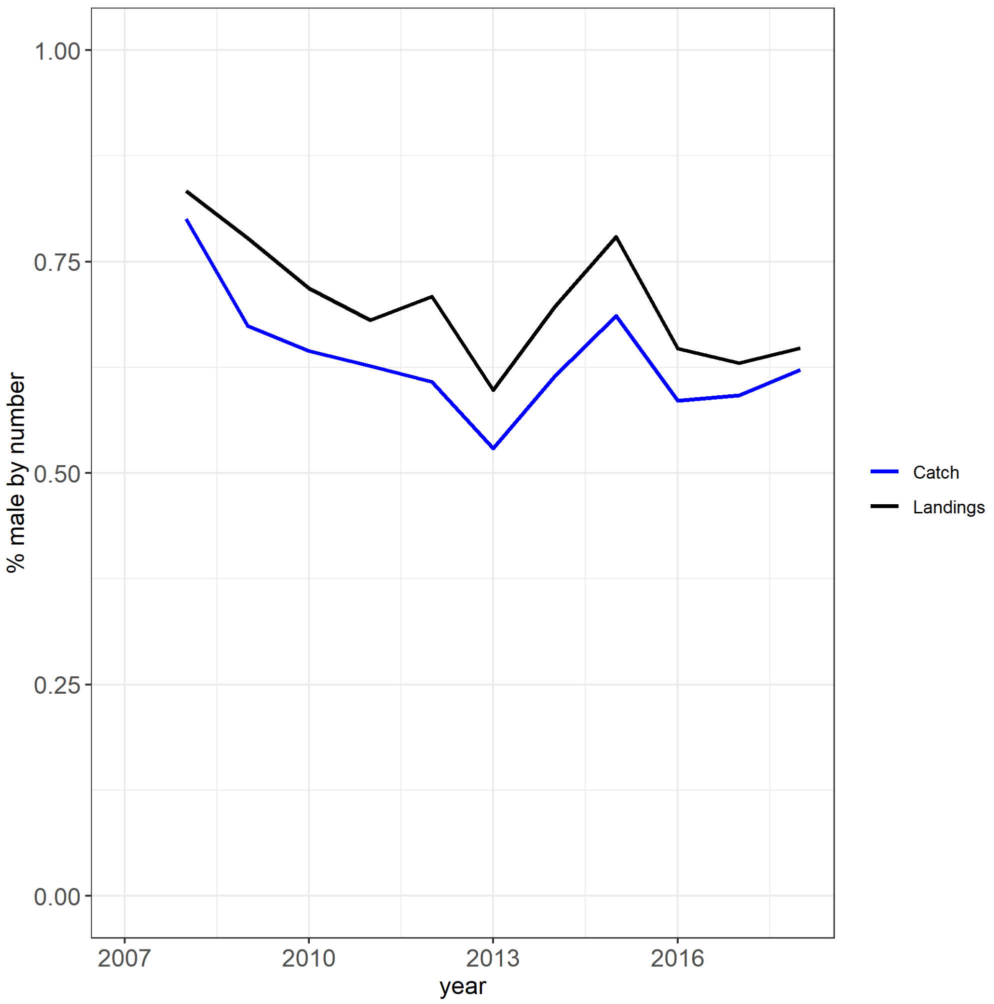


Figure 22.2.5. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Annual sex ratio of landings (2008–2018) and catch (2008–2018).**

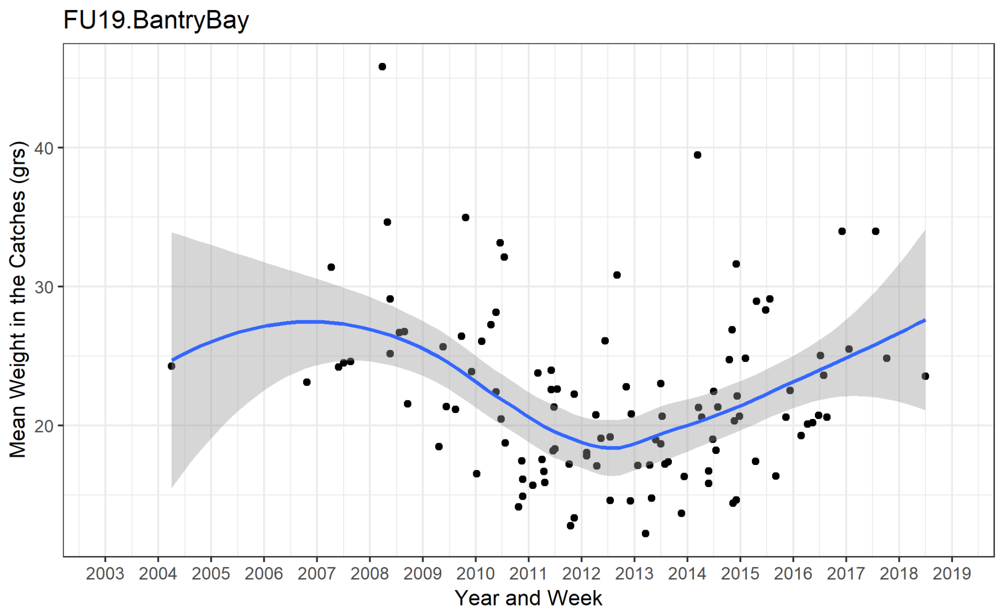


Figure 22.2.6. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean weight in Bantry Bay catch samples by sex with loess smoother and showing cyclical trends.**

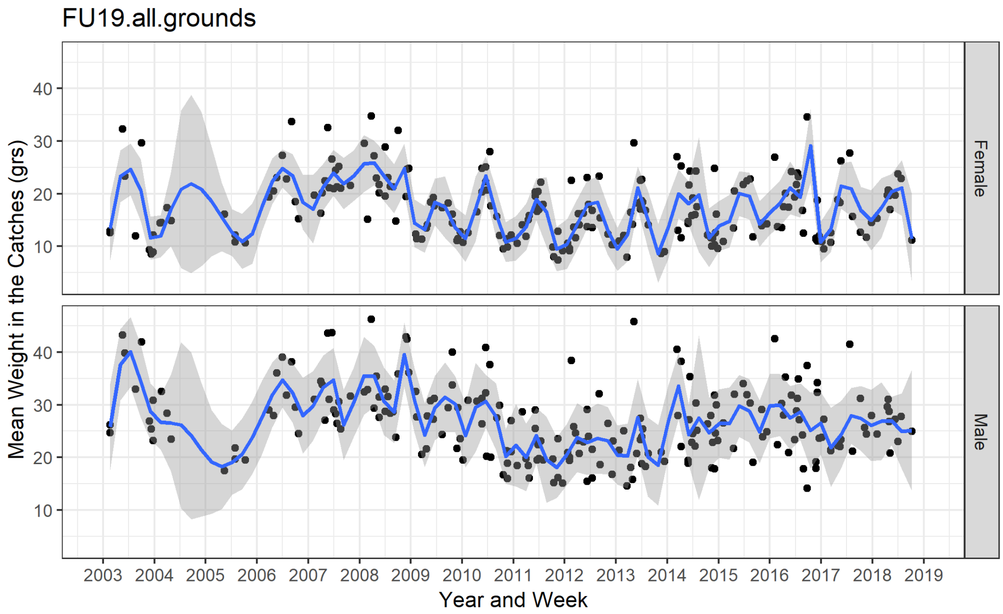


Figure 22.2.7. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean weight in catch data for all grounds in FU19 by sex with loess smoother and showing cyclical trends.**

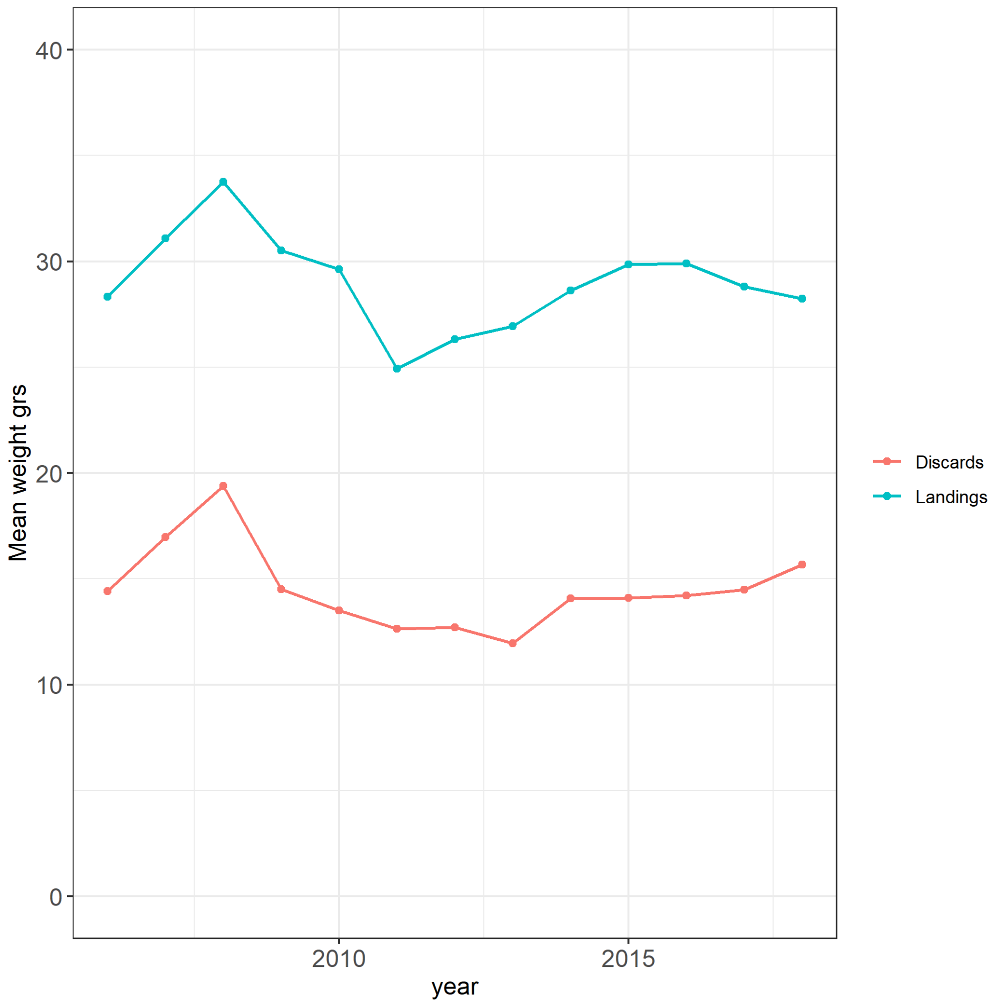


Figure 22.2.8. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Annual estimated mean weights (gr) in the landings and discards.**

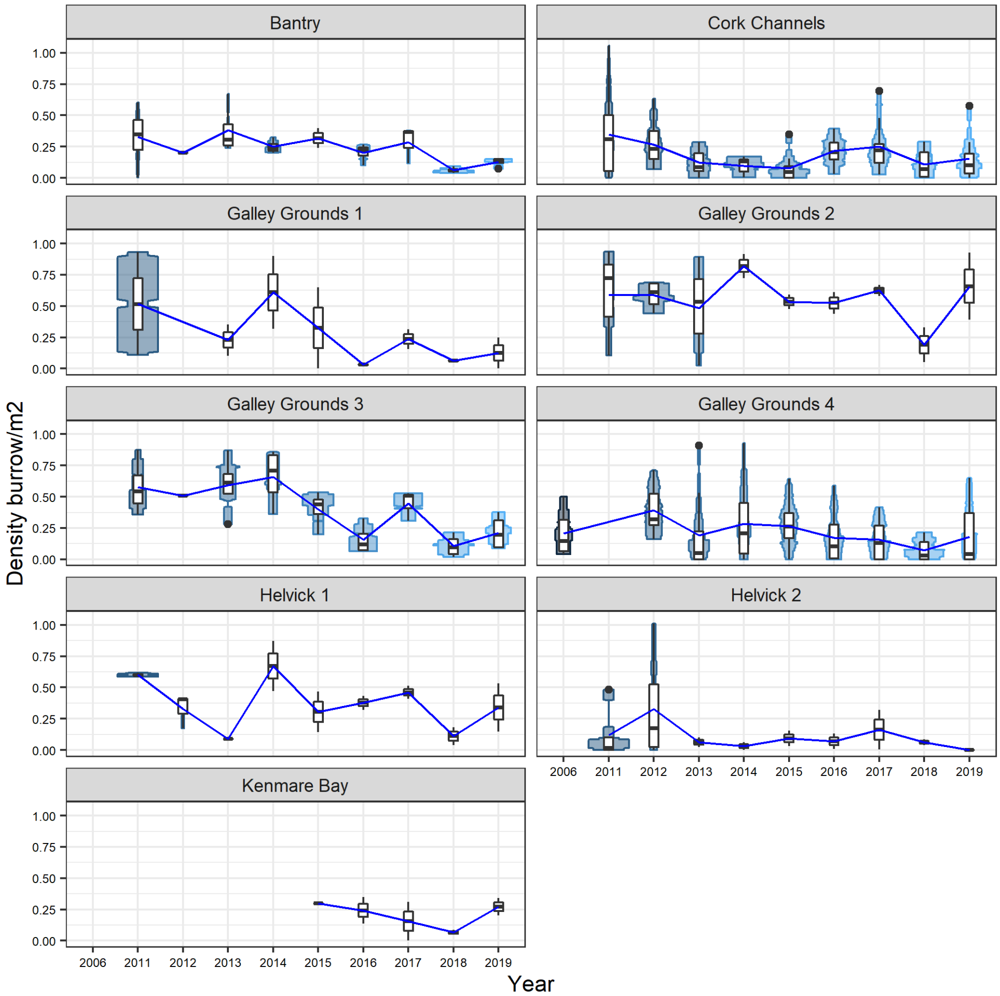


Figure 22.2.9. *Nephrops* in FU19 (Ireland SW and SE Coast). Violin and box plot a of adjusted burrow density (burrow/m²) distributions by year from 2006–2019. The blue line indicates the mean density over time. The horizontal black line represents the median, white box is the interquartile range, the black vertical line is the range and the black dots are outliers. No estimate available for Galley Ground 4 in 2011, Galley Ground 1 in 2012. No TV survey from 2007 to 2010.

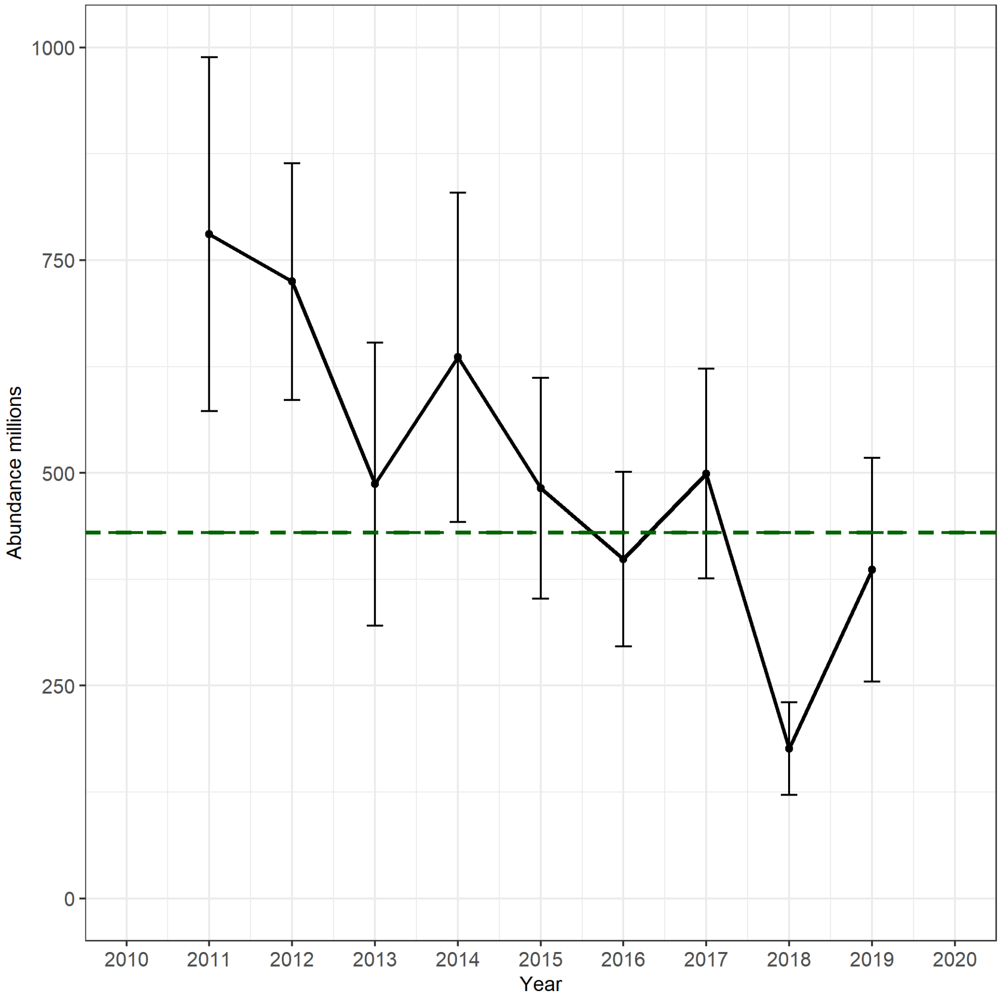


Figure 22.2.10. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Time-series of total abundance estimates for FU19 (error bars indicate 95% confidence intervals) and $B_{trigger}$ is dashed green line.**

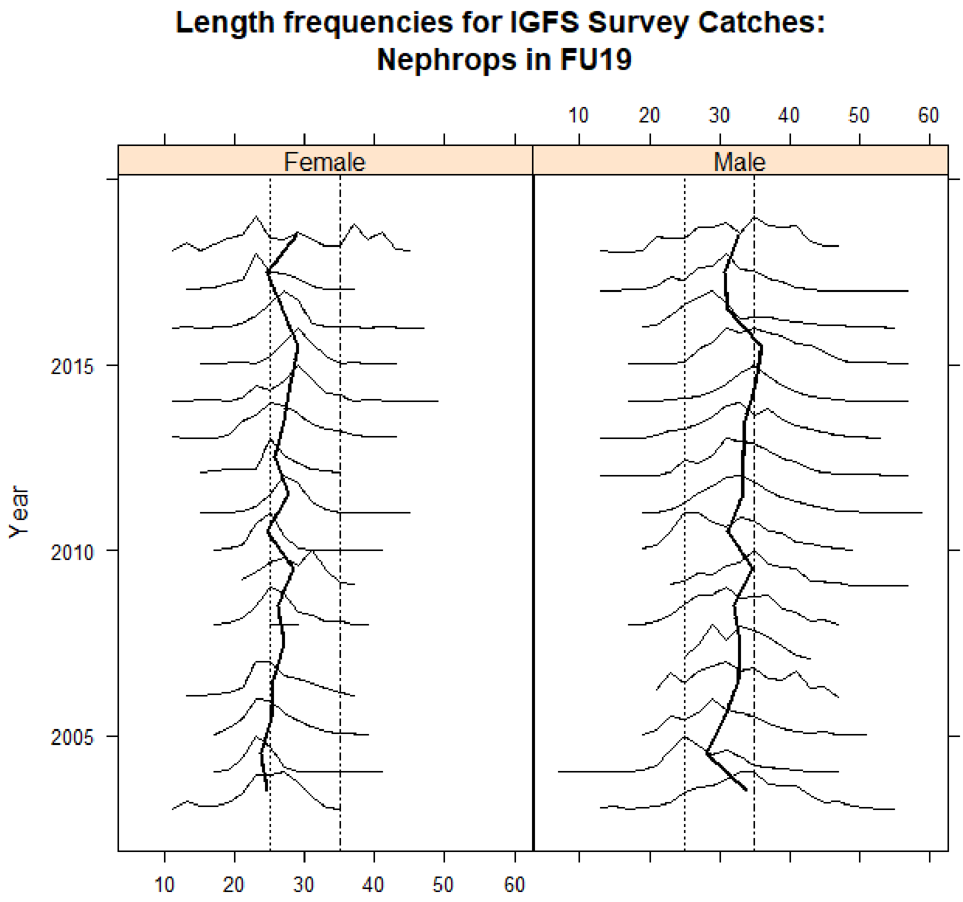


Figure 22.2.11. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches by sex from Irish Groundfish Survey 2003–2018. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and 35 mm CL.**

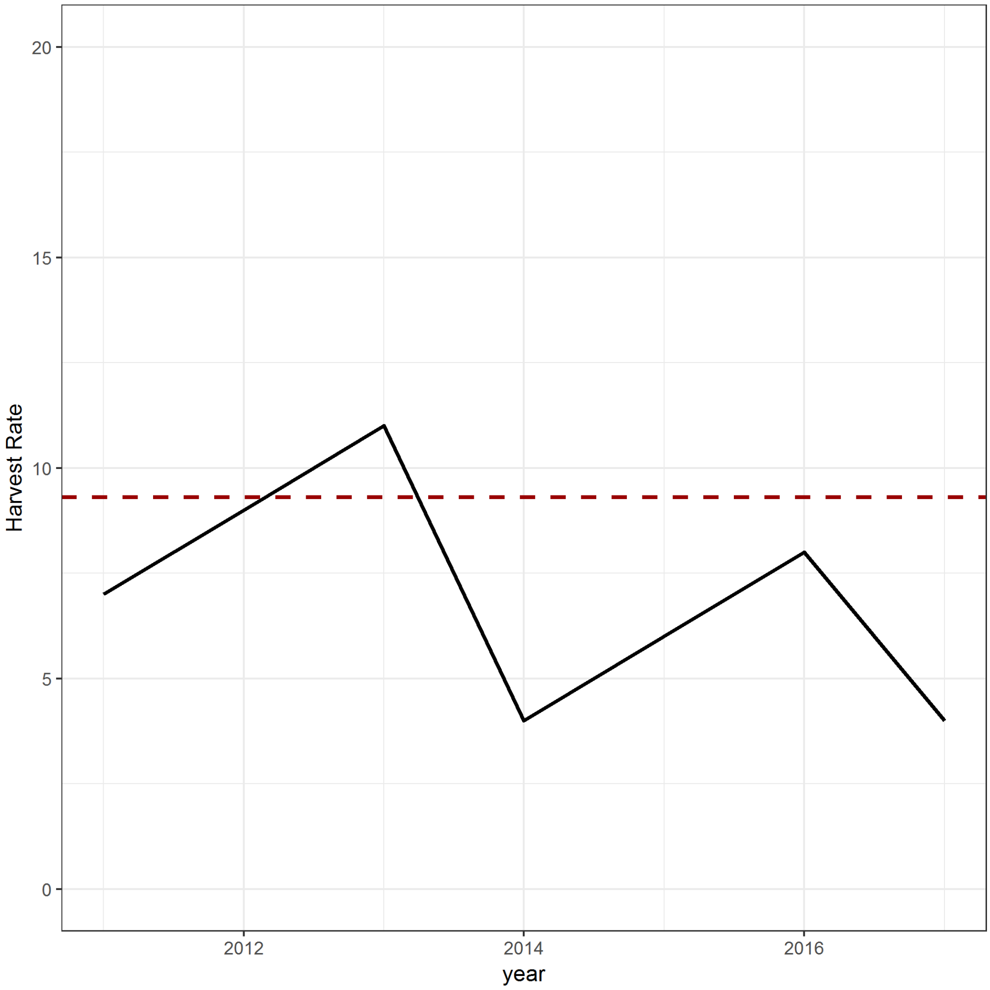


Figure 22.3.1. *Nephrops* in FU19 (Ireland SW and SE Coast). Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.

20 Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h, Functional Units 20 and 21 (Celtic Sea)

Type of assessment in 2019

A full UWTV based assessment was carried out and catch options based on the new stock-specific reference points estimated by WGCSE 2016 using the methods applied to other *Nephrops* stocks at WKFMSYREF4 (ICES, 2016).

ICES advice applicable to 2018

"ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should be no more than 8673 tonnes.

To ensure that the stock in functional unit (FU) 20 and 21 is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2019

"ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2015–2017, catches in 2019 should be no more than 5320 tonnes.

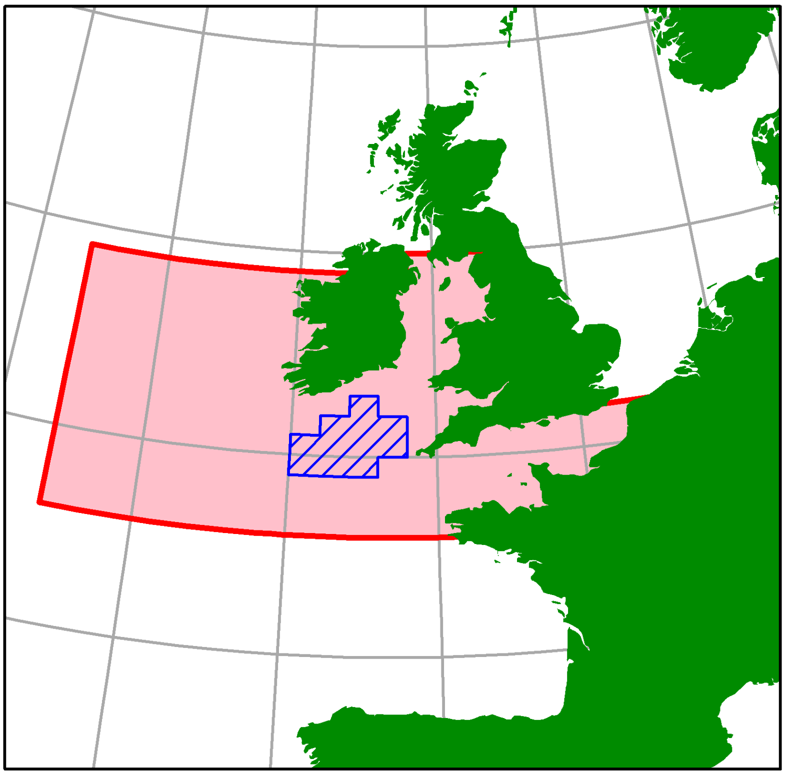
To ensure that the stock in functional units 20 and 21 is exploited sustainably, management should be implemented at the level of the combined functional units 20 and 21."

20.1 General

Stock description and management units

The FU20–21 *Nephrops* stock is included in the whole ICES Area 7 together with Irish Sea East and West [FU14, FU15], Porcupine Bank [FU16], Aran Islands [FU17], northwest Irish Coast [FU18], southeast and southwest Irish Coast [FU19], Smalls [FU22]. The TAC is set for Subarea 7, which does not correspond to the stock area.

Historically FU20–22 fishery and sampling data covered an amalgamation of several spatially distinct mud patches; FU20 NW Labadie, Baltimore and Galley, FU21 Jones and Cockburn and FU22 the Smalls. WGCSE 2013 recommended that FU20–22 should be split into FU20–21 combined and FU22 for the purposes of assessment and advice provision. There is evidence that the Celtic Sea *Nephrops* patches are linked in meta-population sense (O'Sullivan *et al*., 2015). However, fishing mortality and biological parameters (density, growth, M, etc.) may vary across the different patches. The map below shows FU20-21 assessment area (blue) and TAC area (red). There is no evidence that the individual functional units belong to the same stock. See Section 18 for details on *Nephrops* in Subarea 7 general section.



Ecosystem aspects

Details of the ecosystem on FU20–21 are provided in the stock annex updated by WKCELT.

Fishery description

Ireland, France and the UK are the main countries involved in the FU20–21 *Nephrops* fishery. In the early 2000s, the Republic of Ireland fleet had on average 10% of the landings and this has increased to approximately 60% from this FU in recent times. A description of this fleet is given in the stock annex. The fishery on FU20–21 grounds operates throughout the year, weather permitting with a seasonal trend and has expanded in the mid-2000s. In 2011, Irish landings were higher than French landings for the first time. The time-series of numbers of vessels with landings greater than 10 tonnes is updated in Figure 23.1.1. The time-series of vessel power is shown as a box and kite plot in Figure 23.1.2. In recent years, the Irish fleet have increased landings from the southern part of the grounds (see stock annex).

French trawlers targeting *Nephrops* in the Celtic Sea operate mainly in the FU20–21 component of the stock. France dominated in the landings in the early 2000s on average 90% of landings and this has decreased to about 20% in recent times. A description of this fleet is given in the stock annex.

There is an increase in participation by the UK in this fishery in the most recent years The UK fleet had on average 20% of the landings from this FU in recent times (2016–2018) with highest landings recorded in 2016 (445 t).

Fishery in 2018

Ireland

In recent years, several newer vessels specializing in *Nephrops* fishing have participated periodically in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. There has been a trend for Irish vessels to switch to multi (quad) rig trawls since 2012. These vessels are more efficient at catching *Nephrops* (BIM, 2015).

In 2018, 53 vessels reported landings in excess of 10 t accounting for 92% of total Irish landings.

France

In 2018, 36 French vessels reported landings from FU20–21 where many of these switch between FU20–21 and FU22 within a trip.

UK

18 UK(E&W) vessels reported landings for FU20–21, seven vessels from Scotland and four vessels from Northern Ireland.

Information from stakeholders

None presented.

20.2 Data

InterCatch

Data were available in InterCatch and used, and used for catch data only. French data provided directly by the national expert and not extracted from InterCatch.

Landings

The reported landings time-series is shown in Figure 23.2.1 and Table 23.2.1.

The reported Irish landings from FU20-21 have increased since the mid-2000s to the second highest in the Irish time-series in 2016 (1531 t) although have decreased in 2018 to 1197 t. French landings have gradually decreased since the early 2000s to the present lowest value of 195 t. Reported landings from the UK have fluctuated with an increasing trend since 2015. UK England & Wales had the highest landings at 348 t followed by Scotland (34 t), Northern Ireland reporting 28 t, and minor landings from Belgium less than 0.2 t.

The overall fishing profile remains typically seasonal with the majority of the Irish and UK landings coming from the second quarter (see stock annex).

Effort

Effort data are available for the Irish *Nephrops* directed fleet in FU2021 from 1995–2018. The effort series is based on the same criteria for FU15, 16, 17, 19and 22 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks. Effort data are not standardized, and hence do not take into account vessel capabilities, efficiency, seasonality or other factors that may bias perception of LPUE as an abundance trend over the longer term. These data are not used in the assessment.

WGCSE 2015 recommended that effort data in Kw days should be presented as these data are more informative that uncorrected effort data. Effort data are available from 1995 for the Irish otter trawl *Nephrops* directed fleet. In 2018, this fleet accounted for ~90% of the landings compared with an average of 70% over the time period. Effort shows an increasing trend since the mid-2000s to a sharp decrease since 2015 (Figure 23.2.2 and Table 23.2.2).

Effort data in KW days are not available for France. Previously effort data were reported from 1983 to 2008 for the French *Nephrops* fleet for the combined Celtic Sea FU20–22 (see stock annex). Since 2009, a new registration system of official French statistics has changed the way fishing effort is computed, and a new threshold method of 500 kg landed by trip is used to report effort. French fishing effort reported in hours and LPUE (kg/hr) since 2009 shows an overall declining trend (Table 23.2.3).

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by WKCELT 2014 and are documented in the stock annex. The time-series of samples is shown in Table 23.2.4, and remains sparse due to the offshore nature of the fishery although progress is being made by Ireland.

Commercial length–frequency distributions

Prior to 2012 there was insufficient Irish sampling to generate length–frequency distributions although since then efforts are being progressed. For France limited data were available for 1997 and 2010–2013 (see stock annex for details).

Length–frequency distributions of landings and discards for both countries from 2012 to 2018 are presented in Figure 23.2.3 along with the European minimum conservation reference size (25 CL mm) and French (35 CL mm) minimum landings size also shown.

The short series on LFDs for both countries shows that the LFDs differ between the two countries. The French fishery caught higher proportions of larger individuals (>35 mm) on average 70% compared to 41% for the Irish fishery for the available time-series.

Sex ratio

The sex ratio is male biased from the available French and Irish sampling data (Table 23.2.5).

Mean weight explorations

The numbers in the French landings and discards raised to FU20–21 only for 2012–2016 were provided to WGCSE 2017. These data (years 2012–2015) are similar to that reported by WGCSE 2015, which could not be reproduced at WGCSE 2016. At WGCSE 2016, a scaling factor was applied to the French dataset as these were provided raised to the whole of area FU20–22. The French dataset provided to WGCSE 2017 (years 2012–2015) results in an increase in mean weights and decrease in removals from that previously reported at WGCSE 2016 (Table 23.2.6). The working group accepted the French dataset, and this is used to calculate the estimated annual mean weights in the landings and discards.

WGCSE 2019 used the length–weight relationship as described in stock annex to raise both countries sampling data, which are based on Scottish data (Pope and Thomas, 1955).

The mean weight in the landings for France is higher than that in the Irish landings (Table 23.2.7). The estimated annual mean weights in the landings and discards by country and also combined scaled to the international landings is shown in Table 23.2.8 and Figure 23.2.4).

Discards

For the Irish data, discard rates have been estimated using unsorted catch and discards sampling. This involves unsorted catch and discard samples being provided by vessels or collected by observers at-sea on discard trips. The catch sample is partitioned into landings and discards using an on-board discard selection ogive derived for the discard samples. Due to sparse sampling effort annual aggregations are used to derive length distributions and selection ogives. Figure 23.2.5 shows the annual discard ogive from the Irish sampling used to partition the catch. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate annual raising factors. The sampling intensity and coverage has varied over the short time-series, and is relatively poor compared to other *Nephrops* stocks but at present it is the best available.

Estimated discard rates range between 18–41% of total catch by number and 10–27% of total catch by weight in the Irish fishery shown in Table 23.2.7. In the French fishery, estimated discard rates range between 25–78% of total catch by number and 16–56% of total catch by weight shown in Table 23.2.6.

Estimated discard rates for both countries combined in shown in Table 23.2.8 and these range between 24–52% of total catch by number and 14–31% of total catch by weight. Discard rate of females tends to be higher due to the smaller average size and market reasons as is observed in other *Nephrops* fisheries.

There is no information on discard survival rate in this fishery. 25% is assumed in line with other *Nephrops* stocks in the Celtic Sea (Charuau *et al*., 1982).

Gear selectivity trials by Bord Iascaigh Mhara (BIM, 2017) reported a 64% survivor rate for *Nephrops* caught in a trawl with a SELTRA selectivity device in the outer Galway Bay area.

Table 23.3.1 gives weights, numbers and mean weights of the landings and discard raised internationally according to the stock annex.

Abundance indices from UWTV surveys

The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Ireland and elsewhere and are documented by WKNEPHTV (ICES, 2007), SGNEPS (ICES, 2009; 2010; 2012), WGNEPS (ICES, 2013; 2014; 2015; 2016a; 2017; 2018a), WKNEPS (ICES, 2016b; 2018b) and Leocádio *et al*., 2018. SGNEPS (ICES, 2012) recommended that a CV (or relative standard error) of <20% is an acceptable precision level for UWTV survey estimates of abundance. UWTV surveys conducted in 2006 and 2012 are deemed exploratory as stations were chosen based on areas heavily fished by vessels (Doyle *et al*., 2013). These are likely to be biased estimate of density and cannot be extrapolated to estimate density for the whole area. A randomised isometric grid design was employed with UWTV stations at 6.0 nmi intervals for 2013–2018 surveys. The 2013 survey achieved partial coverage ~60% of the total area. The 2013 abundance has been scaled up to the entire area since densities in the un-surveyed part of the ground were not significantly different in 2014. From 2014 to 2018, full survey coverage was achieved. The geo-statistical analysis for years 2013 to 2019 follows the steps documented in White *et al*., 2019.

The 2019 mean burrow density was 0.06 burrows/m² compared with 0.27 burrows/m² in 2018. The 2019 geostatistical abundance estimate was 617 million a 77% decrease on the abundance for 2018 with a CV of 5%, which is well below the upper limit of 20% recommended by SGNEPS 2012. There was a general decrease in densities observed in 2019. Figure 23.2.6 shows the krigged contour and density plots for the time-series. The summary statistics from this geostatistical analysis are given in Table 23.2.9 and plotted in Figure 23.2.7. The estimation variance of the survey is very low (CVs in the order 5%).

The *Nephrops* Underwater TV Surveys SISP guidelines (ICES, in prep) were followed in 2019 given the substantial decrease observed. A random selection of 20% of UWTV stations were reviewed in the laboratory following the same procedures that are carried out on board. Full details are available in R-markdown (ICES, 2019 Annex 3, WD 10). The results showed an overall increase (15.5%) in the review counts for these selected stations comparing them with the on-board counts. The review process also confirmed the observed low density estimates in 2019. The on-board count data are used to calculate the abundance estimate for determining catch scenarios for 2020.

Groundfish survey data

There are two IBTS-GFS catching *Nephrops* in FU20–21: French groundfish survey EVHOE-WIBTS-Q4 since 1997 and Irish groundfish survey-Q4: IGFS-WIBTS-Q4 commenced in 2003 (Stokes *et al.*, 2014). These provide information on length–frequency compositions, mean size in the catches, CPUE of *Nephrops* in FU20–21 (ICES, 2015). The mean size of the catches is stable over the time-series except in 2006 and 2008, which signals recruitment into the fishery in 2006 and 2007 as shown by the Irish IBTS survey in Figure 23.2.8 and the French IBTS survey (Figure 23.2.9). There is no 2017 length dataset for EVHOE due to research vessel breakdown.

20.3 Assessment

Comparison with previous assessments

The WGCSE 2019 carried out a full UWTV based assessment for this stock using the stock stock-specific reference points were estimated by the 2016 working group based on methods for other *Nephrops* stocks used by WKMSYREF4 (ICES, 2016). This is in accordance with recommendations by WKCELT 2014 where data improvements have been made for this stock such as:

- complete survey coverage of the stock area giving quality assured density estimates and abundance estimates conforming to WGNEPS recommendations; and also
- improved sampling data achieving better coverage and robust estimates of the various parameters need to calculate catch options (e.g. mean weight in the landings and discards, discard percentage in numbers).

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated over the short time-series. The 2019 estimate is a decrease from 2018 estimate by 77%.

No MSY $B_{trigger}$ has been proposed as the time-series is too short (six years of full TV survey coverage).

Table 23.3.1 and Figure 23.3.1 summarize recent harvest ratios, which have been below the F_{MSY} proxy for the last three years.

20.4 Catch scenario table

Catch scenario table inputs and estimates of mean weight in landings and harvest ratios are presented in Table 23.3.1 and summarised below.

In line with previous practice, an average (2016–2018) of mean weights is used to account for this variability. Three-year average (2016–2018) of proportion of removals retained was used as is standard for other *Nephrops* stocks.

The basis for the catch scenario.

Variable	Value	Notes
Stock abundance	617 million individuals	UWTV survey 2019
Mean weight in wanted catch	33.1 g	Average 2016–2018
Mean weight in unwanted catch	18.3 g	Average 2016–2018
Unwanted catch rate	29.2%	Average 2016–2018 (by number). Calculated as discards divided by landings + discards.
Discard survival rate	25%	Only applies in scenarios where discarding is allowed.
Dead unwanted catch rate	23.7%	Average 2016–2018 (by number). Calculated as dead discards divided by removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

A prediction of landings for the FU20–21 using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the stock annex will be made on the basis of the 2019 UWTV survey. This will be presented in October 2019 for the provision of advice.

20.5 Reference points

New reference points were estimated by WGCSE 2016 using the same method and approach used at WKMSYREF4 (ICES, 2016). The detailed analysis is available in working document 11. In the case of FU20–21 there is a limited number of years for which length–frequency data were available, so the three-year moving window could only be applied to give two estimates. The resulting potential F_{MSY} harvest rates and ranges are given in the following table.

YEAR	FMAX	FMAX.LOW	FMAX.UP	F35	F35.LOW	F35.UP	F0.1	F0.1.LOW	F0.1.UP
2012	9.12	6.51	12.60	11.03	6.11	13.21	5.91	5.08	15.11
2013	9.45	6.71	13.26	11.17	6.30	13.78	6.10	5.23	15.93

Given the low density in the area and combined sex $F_{0.1}$ was considered and appropriate F_{MSY} proxy.

STOCK CODE	MSY FLOWER*	FMSY*	MSY FUPPER*WITH AR	MSY BTRIGGER	MSY FUPPER*WITH NO AR
nep-2021	5.9%	6.0%	6.0%	Not defined	6.0%

*** Harvest rate (HR).**

No proposal has been made for MSY $B_{trigger}$ as the time-series is too short.

20.6 Management plans

There is no specific management plan for the FU20–21 *Nephrops*.

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES subarea 7 and also demersal stocks.

20.7 Quality of assessment and forecast

Since the benchmark in 2014, UWTV and sampling coverage has been improving in this area. There are now six years of full UWTV survey coverage (2014–2019).

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009; WGNEPS 2014 and ICES, in prep). Ultimately, there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al*., 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise (WK*NEPH*, 2009). The survey estimates themselves are very precisely estimated (CVs ~5%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU20–21 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised, but is likely to be lower than that observed in the survey.

At WGCSE 2018, the group recommended that a review of historical survey data should be undertaken given the large fluctuations observed in the short time-series to date for this survey, that is, to randomly check 20% of UWTV stations in years 2016 and 2017. This process was conducted in July 2018 during the FU20–21 UWTV survey. The analysis was presented to WGNEPS (ICES, 2018a) and subsequently to the 2019 WGCSE meeting where full details are available in R-markdown (ICES, 2018a; Annex 7). Following this analysis, WGNEPS 2018 recommended that the Manual for the *Nephrops* Underwater TV Surveys (SISP) (ICES, in prep) to include guidelines on quality control where there are large unexplained fluctuations between abundance estimates from previous years. In that, it is recommended to review 20% of the survey stations, and when the partial review differs more than 20% from the survey counts, then a full review of the survey should be considered. This guidelines ensure further quality control of the count data from UWTV surveys.

Sampling of landing and discards for FU20–21 remains low but there is a limited number of years for which length–frequency data were available so the three year moving window could only be applied to give two estimates to calculate F_{MSY} reference points.

French and Irish trawlers cover different areas and have presented contrasting features over the last decade. The French fleet moved gradually from the "Smalls" Ground (mainly 31E3) to the

"Labadie" (30E2, increase of 28E2 in the early 2010s, although no trend is revealed within FU20–21 throughout the overall time-series): in the late 1990s, more than 40% of French landings were reported from the "Smalls" area whereas by the end of 2000s the contribution of this rectangle became minor (less than 10%). Irish vessels have increased their production on FU20–21 since the mid-2000s and a gradual expansion towards the southern rectangles is obvious during the recent years (stock annex).

20.8 Recommendations for next benchmark

This stock was last benchmarked by WKCELT (ICES, 2014). WGCSE will keep the stock under close review and recommend future benchmark as required.

20.9 Management considerations

The indications are the *Nephrops* in FU20–21 are lightly exploited now relative to the past and recent average landings are broadly sustainable. Overall effort in the fishery has declined to less than 25% of the peak effort observed in the early 1990s. Harvest rates based on recent landings and UWTV surveys suggest that the HR is low relative to most other *Nephrops* fisheries.

In recent years, the Irish fishery in the area expanded whereas the French fishery continued to decline. The fishing patterns of the French and Irish fleet are very different with the Irish fleet specialising on *Nephrops* whereas the French fishery remains more mixed. French *Nephrops* fisheries in this area are fairly mixed, also catching whiting, cod, megrim, anglerfish and other demersal species (Davie and Lordan, 2011). *Nephrops* tend to dominate the landings of Irish fisheries in the area but catches are more mixed in the North (~50% *Nephrops*) and cleaner *Nephrops* towards the south (~75% *Nephrops*) (Gerritsen *et al.*, 2012). The French trawlers showed an overall decline in effort and landings during the last decade, mainly explained by decommissioning schemes associated to constraints linked to fuel prices.

In recent years, several newer vessels specializing in *Nephrops* fishing have participated in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates.

From 2016, fisheries catching *Nephrops* in Subarea 7 are covered by the EU landings obligation (EU, 2015). Creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 5% discard rate by weight for the trawl fishery in 2019 (reduced from 6% in 2018 and 7% in both 2016 and 2017). Irish discard survival experiments indicate that the trawl discard survival may be around 64% (BIM, 2017). As a result, an exemption from the landings obligation based on high survivability has been granted by the European Commission. The average discard rate by weight for FU20–21 over the last three years is 19%. Catch advice and scenarios are provided this year on the assumption that discarding is assumed to continue at the recent average.

UWTV survey coverage has improved. A new survey point available by autumn 2019 provides a more up to date estimate of density and abundance. The use of the most up to date survey information is considered for this stock.

Landings data are adjusted to take into account landings that have been misreported from FU16 since 2011. This adjustment is thought to be reasonably accurate (See Section 19).

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the functional unit level could provide controls to ensure effort and catch were in line with resources available.

20.10 References

Anon. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp.

BIM. 2017. Report on *Nephrops* survivability in the Irish demersal trawl fishery. Bord Iascaigh Mhara, 29 September 2017 .http://www.bim.ie/media/bim/content/publications/fisheries/6882-BIM-nephrops-survival-report-final.pdf .

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea. ICES CM 1982/B:13.

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L 83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj

Davie S., Lordan C. 2011. Definition, dynamics and stability of métiers in the Irish otter trawl fleet. Fish. Res. 111, 145–158. http://dx.doi.org/10.1016/j.fishres.2011.07.005 or http://hdl.handle.net/10793/673.

Gerritsen H.D., Lordan C. 2011. Integrating Vessel Monitoring Systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES Journal of Marine Science, 68(1): 245–453.

Gerritsen H.D., Lordan C., Minto C., Kraak S.B.M. 2012. Spatial patterns in the retained catch composition of Irish demersal otter trawlers: High-resolution fisheries data as a management tool. Fisheries Research, Vol. 129–130, pp 127–136. Available from http://www.sciencedirect.com/science/article/pii/S0165783612002032.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WK*NEPH*). ICES CM 2009/ACOM:33.

ICES. 2014a. Report of the Benchmark Workshop on Celtic Sea Stocks (WKCELT), 3–7 February 2014, ICES Headquarters, Copenhagen, Denmark. ICES CM 2014\ACOM:42. 194 pp.

ICES. 2014b. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:12.

ICES. 2015. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 10–13 November 2015, Cadiz, Spain. ICES CM 2015/ SSGIEOM:30.52 pp.

ICES. 2015. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 23–27 March 2015, Bergen, Norway. ICES CM 2015/ SSGIEOM:20. 124 pp.

ICES. 2016a. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 7–8 November 2016. Reykjavík, Iceland. ICES CM 2016/ SSGIEOM:33.67 pp.

ICES. 2016b. Report of the Workshop on *Nephrops* Burrow counting (WKNEPS), 9–11 November 2016. Reykjavík, Iceland. ICES CM 2016/ SSGIEOM:34.65 pp.

ICES. 2016XX. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

ICES. 2016YY. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES 2017. Report of the Working Group on *Nephrops* Surveys (WGNEPS). 28 November–1 December 2017, Heraklion, Greece. ICES CM 2017/SSGIEOM: 30. Ref: ACOM/ SCICOM.

ICES. 2018a. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 6–8 November 2018. Lorient, France. ICES CM 2018/ EOSG:18.227 pp.

ICES. 2018b. Report of the Workshop on *Nephrops* burrow counting, 2–5 October 2018, Aberdeen, UK. ICES CM 2018/ EOSG:25.47 pp.

ICES. In prep. Manual for the *Nephrops* Underwater TV Surveys. Series of ICES Survey Protocols (SISP).

Leocádio, A., Weetman, A., and Wieland, K. (Eds). 2018. Using UWTV surveys to assess and advise on *Nephrops* stocks. ICES Cooperative Research Report No. 340. 49 pp. http://doi.org/10.17895/ices.pub.4370.

O'Sullivan D., Lordan C., Doyle J., Berry A., Lyons K. 2013. Study of local hydrodynamics and larval dispersal on *Nephrops* fishing grounds. Irish Fisheries Investigation. No 26: Marine Institute.2014.http://hdl.handle.net/10793/985.

Stokes D., Gerritsen H., O'Hea B., Moore S.J., Dransfeld L. 2014. "Irish Groundfish Survey Cruise Report, 24 September–17 December 2014", FEAS Survey Series; 2014/01. http://hdl.handle.net/10793/1064.

White, J., Aristegui, M., Blaszkowski, M., Fee, D., O'Connor, S., Power, J., Notaro, D., O' Brien and Doyle, J. 2019. The Labadie, Jones and Cockburn Banks *Nephrops* Grounds (FU20–21) 2019 UWTV Survey Report and catch scenarios for 2020. Marine Institute UWTV Survey report.

Table 23.2.1. ***Nephrops*** **FU 20–21. Landings in tonnes by country.**

	FU 20–21 Landings (t)				
Year	France	Rep. of Ireland	UK	Belgium	Total
1995	3419	117	na		3536
1996	2721	101	na		2822
1997	1957	81	na		2038
1998	1583	130	na		1713
1999	1051	83	18		1152
2000	1661	107	10		1778
2001	1750	69	14		1833
2002	2559	104	11		2674
2003	2796	148	9		2953
2004	2140	299	4		2443
2005	2008	455	6		2469
2006	2066	450	7		2523
2007	1816	600	3		2419
2008	2036	937	7		2980
2009	1930	1202	13		3145
2010	975	756	62		1793
2011	566	637	34		1237
2012	453	708	28		1189
2013	486	844	57		1387
2014	465	1342	29		1837
2015	355	1620	141		2116
2016	477	1531	445		2453
2017	341	1113	395	0.2	1849
2018	195	1197	411	0.2	1803

Table 23.2.2. ***Nephrops*** **FU 20–21. Effort data for the Irish otter trawl** ***Nephrops*** **directed fleet.**

Year	Effort (Kw Days)	Landings (tonnes)
1995	57	104
1996	49	74
1997	40	59
1998	56	102
1999	37	48
2000	39	62
2001	29	45
2002	78	165
2003	82	86
2004	159	164
2005	255	360
2006	301	348
2007	402	512
2008	562	920
2009	801	1,249
2010	498	633
2011	424	535
2012	357	534
2013	445	672
2014	885	1,170
2015	1,180	1,542
2016	920	1,404
2017	704	1,004
2018	695	1,084

Table 23.2.3. ***Nephrops*** **FU 20–21. Effort data for the French fleet.**

Year	Effort France ('000 hrs)	LPUE France (kg/hr)
1983	231	14
1984	205	16
1985	203	16
1986	163	15
1987	190	15
1988	171	16
1989	179	17
1990	230	16
1991	225	11
1992	277	12
1993	268	13
1994	259	14
1995	239	15
1996	220	14
1997	187	13
1998	155	13
1999	151	11
2000	194	14
2001	170	15
2002	166	19
2003	192	18
2004	153	16
2005	147	16
2006	137	16
2007	102	19
2008	100	23
2009	93	23
2010	67	17
2011	52	12
2012	42	13
2013	48	12
2014	36	15
2015	35	11
2016	35	15
2017	34	11
2018	21	10

Table 23.2.4.a. *Nephrops* FU 20–21. Sampling levels by Ireland.

IRELAND		Number of Samples			Numbers Measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
2009	2	1			489		
2010	2	1			461		
2011	2	1			270		
2012	1	8	5	1	2654	2024	1747
2013	1	1	1		319	423	
2013	2	9	7	1	2514	2038	2187
2014	2	2	2		718	782	
2015	1			1			1724
2015	2	6	6	2	2714	3997	3204
2015	3			4			4750
2015	4	2	2		650	419	
2016	2	8	5	1	2859	1485	384
2016	4	3	2	4	767	1678	1743
2017	1	2	1	1	722	297	1616
2017	2	7	4	1	2813	1035	365
2017	3	3	1		1154	296	
2017	4	12	7		3631	1983	
2018	1	3	3		987	1036	
2018	2	17	17		6691	5742	
2018	3	2			389		
2018	4	2	1		544	369	

Table 23.2.4.b. *Nephrops* FU 20–21. Sampling levels by France.

FRANCE		Number of Samples			Numbers Measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
2012	1		31	9		391	1431
2012	2		13	8		198	1202
2012	3		47	8		667	1155
2012	4		6	6		16	860
2013	1		0	12		0	1362
2013	2		68	72		1,120	3151
2013	3		16	68		131	1917
2013	4		2	14		12	1303
2014	1		0	10		0	1221
2014	2		40	47		1,127	3536
2014	3		20	33		458	1934
2014	4		0	9		0	1360
2015	1		2	14		60	1508
2015	2		24	44		520	3249
2015	3		1	9		1	1366
2015	4		0	9		0	1357
2016	1		3	44		464	3164
2016	2		4	42		519	1263
2016	3		1	25		217	1971
2016	4		2	20		5	1935
2017	1		3	46		429	1659
2017	2		3	80		852	2390
2017	3		2	9		84	344
2017	4		1	23		307	952
2018	1		8	8		460	36
2018	2		9	9		1190	254
2018	3		30	30		1140	105
2018	4		10	10		149	19

Table 23.2.5. *Nephrops* FU 20–21. Sex ratio in the landings by country based on available sampling.

Ireland			
Year	**Females (‘000s)**	**Males (‘000s)**	**% Males in Landings**
2012	1,171	25,306	96
2013	8,452	15,752	65
2014	13,630	25,467	65
2015	8,916	39,018	81
2016	15,807	23,835	60
2017	11,836	29,183	71
2018	15,967	28,486	64
France			
2012	1,545	9,323	86
2013	1,678	7,641	82
2014	3,292	7,316	69
2015	1,144	6,244	85
2016	819	8,815	91
2017	1,119	5,110	82
2018	1,863	3,605	66

Table 23.2.6. ***Nephrops*** **FU 20–21. Landings and discards by number and weight (t), dead discard rate and discard rate by number, discard rate by weight and estimated mean weights (grs) in the landings and discards for France. 25% discards survival.**

France										
Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	Discard Rate weight	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	%	tonnes	tonnes	gramme	gramme
2012	10.9	17.8	24.2	55.1	62.1	41.5	453	322	41.7	18.1
2013	9.3	10.0	16.9	44.7	51.9	26.6	486	176	52.2	17.6
2014	10.6	37.0	38.4	72.4	77.7	55.8	465	588	43.8	15.9
2015	7.4	7.7	13.2	43.9	51.1	31.7	355	165	48.1	21.4
2016	9.6	3.2	12.0	19.7	24.7	16.2	477	92	49.5	29.1
2017	6.2	5.9	10.7	41.6	48.7	26.2	341	121	54.8	20.5
2018	5.5	4.7	9.0	39.0	46.1	32.3	195	93	35.6	19.9

Table 23.2.7. ***Nephrops*** **FU 20–21. Landings and discards by number and weight (t), dead discard rate and discard rate by number, discard rate by weight and estimated mean weights (grs) in the landings and discards for Ireland. 25% discards survival.**

Ireland										
Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	Discard Rate weight	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	%	tonnes	tonnes	gramme	gramme
2012	26.5	17.5	39.6	33.1	39.7	22.6	708	207	26.7	11.9
2013	24.2	8.3	30.5	20.5	25.6	14.0	844	137	34.9	16.4
2014	39.1	17.6	52.3	25.3	31.1	14.8	1342	233	34.3	13.3
2015	47.9	18.6	61.9	22.5	27.9	13.3	1620	248	33.8	13.4
2016	39.6	27.5	60.3	34.2	41.0	26.9	1531	564	38.6	20.5
2017	41.0	9.2	47.9	14.4	18.4	9.7	1113	120	27.1	13.0
2018	44.5	11.9	53.4	16.8	21.2	14.4	1197	201	26.9	2018

Table 23.2.8. ***Nephrops*** **FU 20–21. Landings and discards by number and weight (t), dead discard rate and discard rate by number, discard rate by weight and estimated mean weights (grs) in the landings combined by both countries based on available sampling and scaled to international landings. 25% discards survival.**

Combined and scaled to the international landings										
Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	Discard Rate weight	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	%	tonnes	tonnes	gramme	gramme
2012	38.2	36.1	65.3	41.4	48.5	31.3	1,189	542	31.1	15.0
2013	34.8	19.2	49.2	29.3	35.6	19.1	1,387	327	39.9	17.0
2014	50.6	55.5	92.2	45.2	52.3	31.2	1,836	834	36.3	15.0
2015	59.4	28.1	80.5	26.2	32.2	17.3	2,116	442	35.7	15.7
2016	60.2	37.5	88.3	31.8	38.4	24.6	2,453	801	40.7	21.4
2017	60.1	19.2	74.5	19.4	24.3	14.2	1,849	306	30.8	15.9
2018	64.7	21.5	80.8	20.0	25.0	17.5	1803	381	27.9	17.7

Table 23.2.9. ***Nephrops*** **FU 20–21. Results summary table for geo-statistical analysis of UWTV survey.**

Ground	Year	Number of stations	Mean Density adjusted (burrows/m²)	Domain Area (km²)	Geostatistical Abundance Estimate adjusted (millions burrows)	CV on Burrow estimate
FU20–21	2006	9	0.44		nr	nr
	2012	54	0.57		nr	nr
	2013	55	0.16	5,701	942	3%
	2013*	55		10,014	1624	
	2014	98	0.19	10,014	2051	3%
	2015	96	0.2	10,014	2003	3%
	2016	93	0.18	10,014	1879	5%
	2017	86	0.44	10,014	4428	4%
	2018	96	0.27	10,014	2721	4%
	2019	95	0.06	10,014	617	5%

*** The 2013 survey achieved partial coverage ~60% of the total area. The abundance has been scaled up to the entire area since densities in the unsurveyed part of the ground were not significantly different in 2014. nr= no reliable abundance estimate could be calculated because survey coverage was partial.**

Table 23.3.1. *Nephrops* FU 20–21. Short-term catch options prediction inputs and recent estimates of mean weight in landings and harvest rates. Cells in bold indicates inputs to catch option calculations.

Year	Landings in number millions	Total discards in number* millions	Removals in number millions	Dead Discard Proportion number %	Discard Proportion number %	UWTV abundance estimate millions	95% Confidence Interval	Harvest rate %	Landings tonnes	Total discards* tonnes	Mean weight in landings gramme	Mean weight in discards gramme
2012	38.2	36.1	65.3	48.5	41.4				1189	542	31.1	15.0
2013	34.8	19.2	49.2	35.6	29.3	1624	103	3.0	1387	327	39.9	17.0
2014	50.6	55.5	92.2	52.3	45.2	2051	131	4.5	1836	834	36.3	15.0
2015	59.4	28.1	80.5	32.2	26.2	2003	129	4.0	2116	442	35.7	15.7
2016	60.2	37.5	88.3	38.4	31.8	1879	157	4.7	2453	801	40.7	21.4
2017	60.1	19.2	74.5	24.3	19.4	4428	332	1.7	1849	306	30.8	15.9
2018	64.7	21.5	80.8	20.0	25.0	2721	212	3.0	1803	381	27.9	17.7
2019						617	58					
			Average 16–18	**23.7**	**29.2**					**Average 16–18**	**33.1**	**18.3**

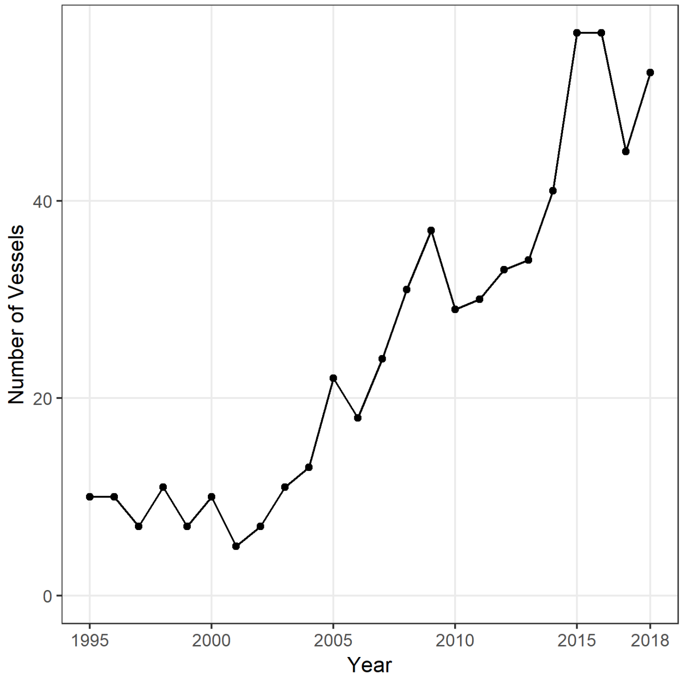


Figure 23.1.1. ***Nephrops*** **FU 20–21. Number of Irish vessels reporting landings >10 t by year.**

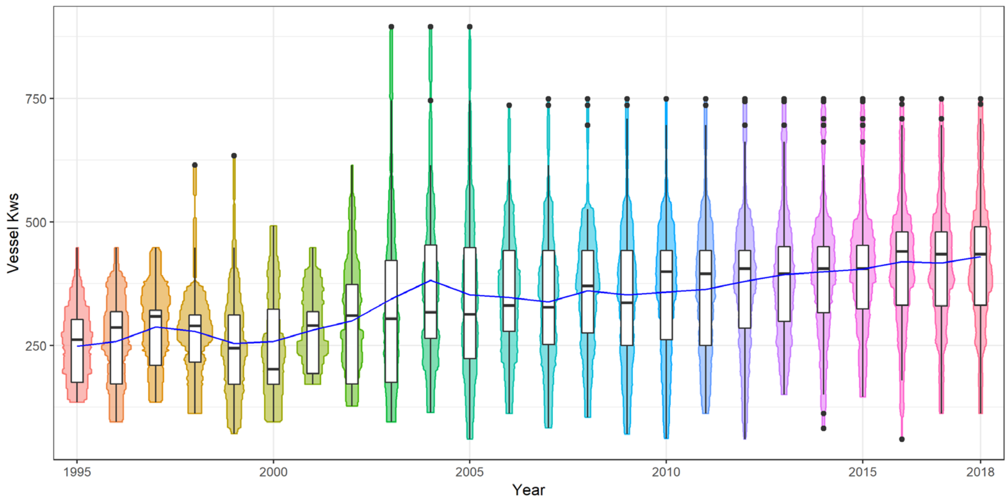


Figure 23.1.2. ***Nephrops*** **FU 20–21. Combined box and kite plot of vessel power on the FU20–21 grounds by year. The blue line indicates the mean.**

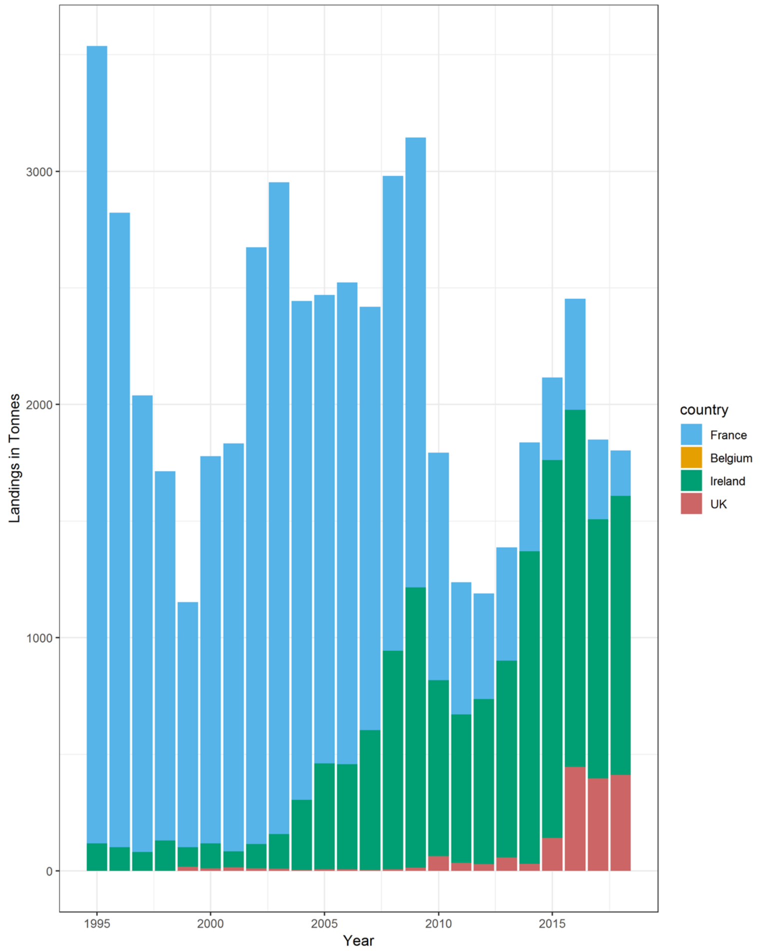


Figure 23.2.1. ***Nephrops*** **FU 20–21. Landings in tonnes by country.**

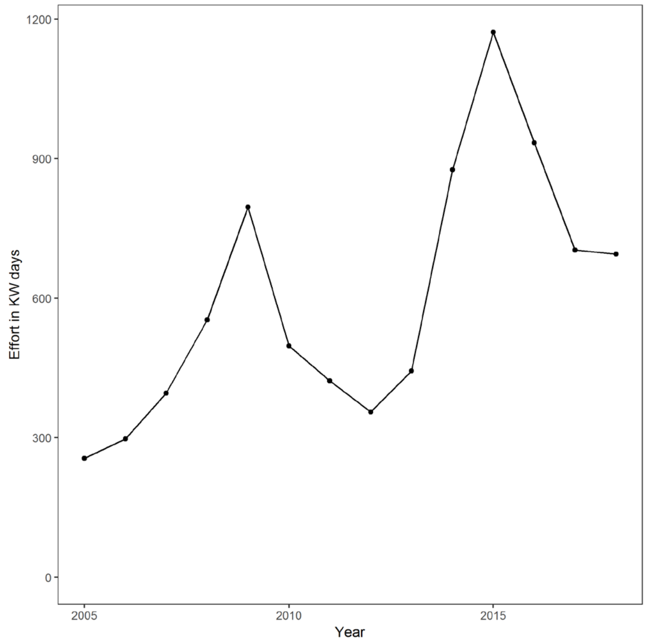


Figure 23.2.2. ***Nephrops*** **FU 20–21. Effort data (Kw days) for the Irish otter trawl** ***Nephrops*** **directed fleet.**

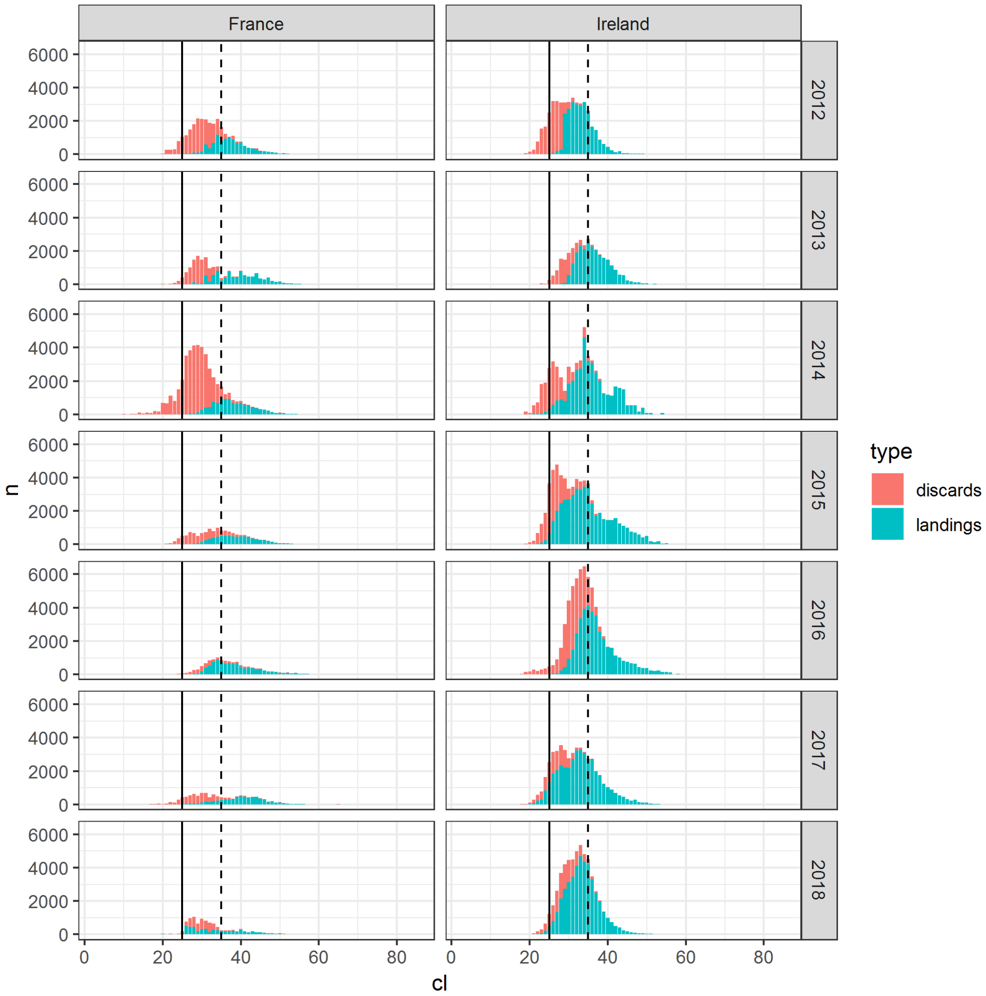


Figure 23.2.3. ***Nephrops*** **FU 20–21. Commercial length–frequency distribution by country. Minimum conservation reference size of 25 CL mm (European MCR) and 35 CL mm (French MLS) displayed.**

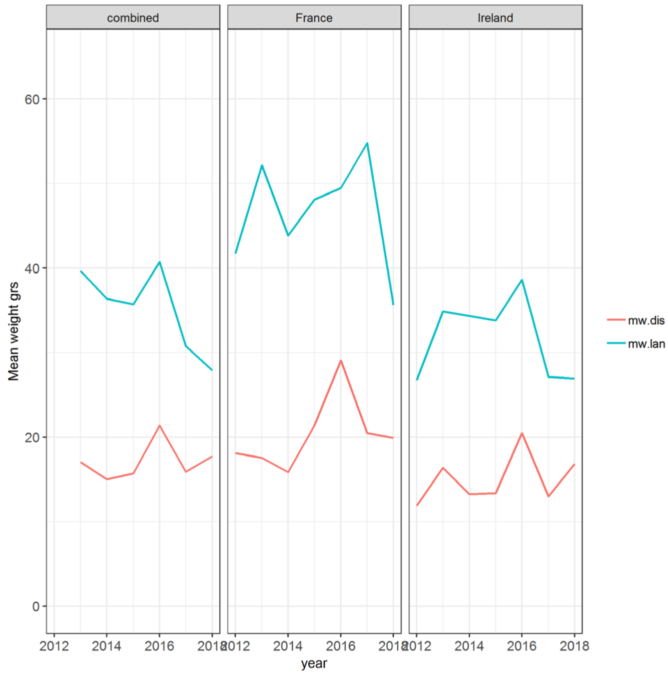


Figure 23.2.4. ***Nephrops*** **FU 20–21. Annual mean weights (gr) in the landings (blue line) and discards (red line) by country and combined scaled to international landings.**

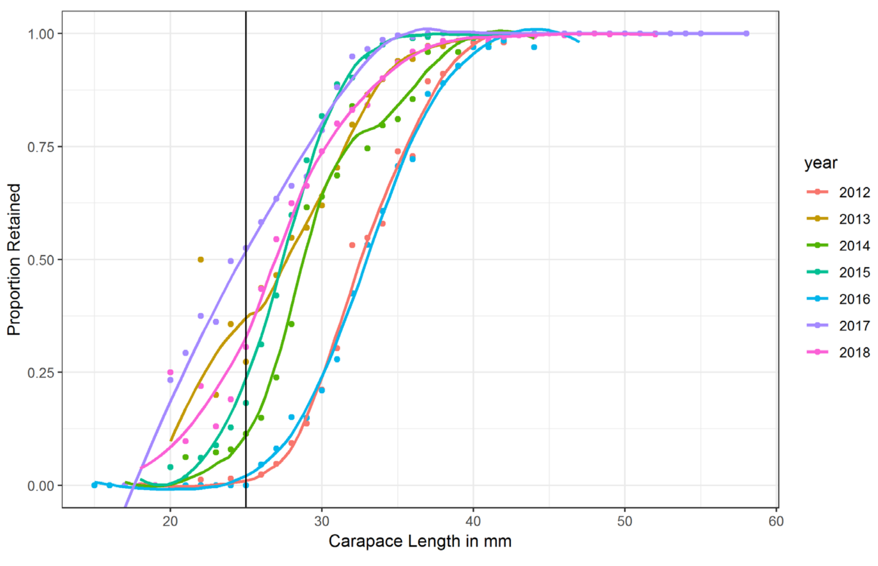


Figure 23.2.5. ***Nephrops*** **FU 20–21. Annual discard ogive derived from Irish sampling. Minimum landing size of 25 CL mm (European MCR) as black line.**

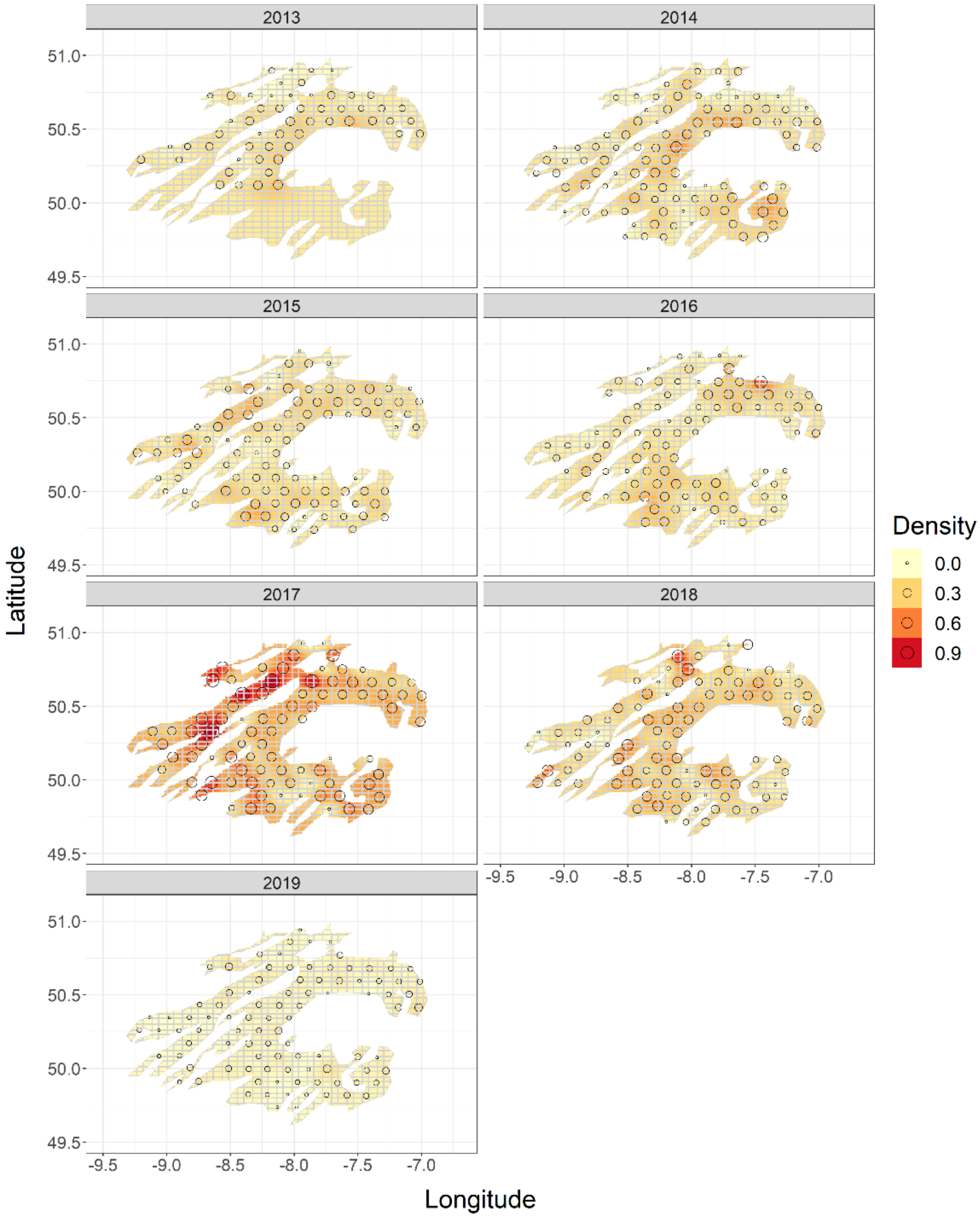


Figure 23.2.6. ***Nephrops*** **FU 20–21. Contour plots of krigged density estimates for the UWTV surveys from 2013 to 2019.**

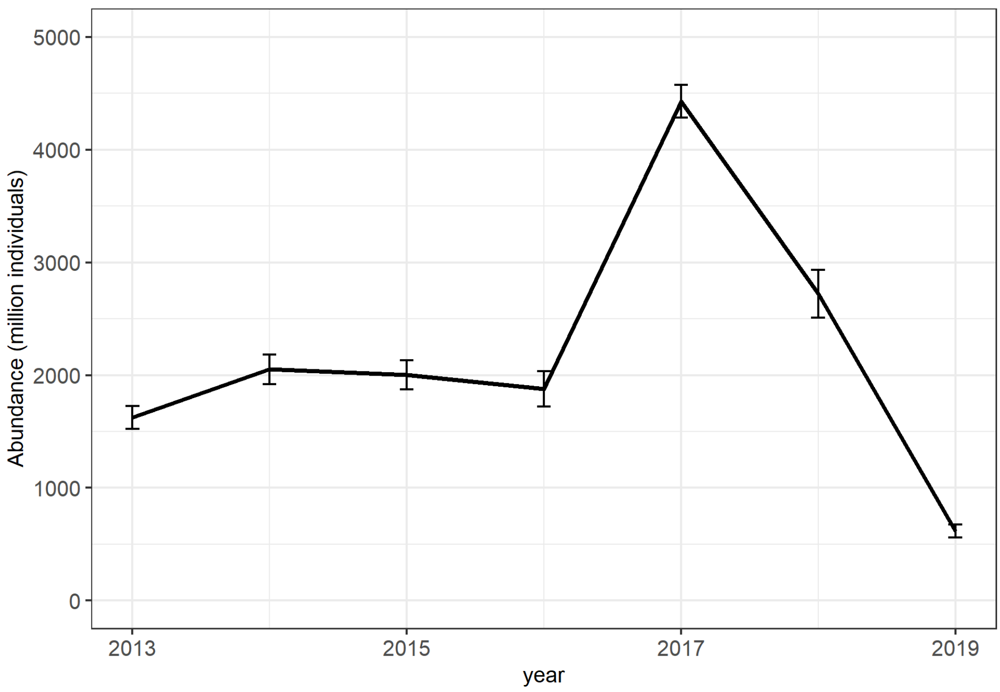


Figure 23.2.7. ***Nephrops*** **FU 20–21. Time-series of abundance estimates for FU20–21 (error bars indicate 95% confidence intervals).**

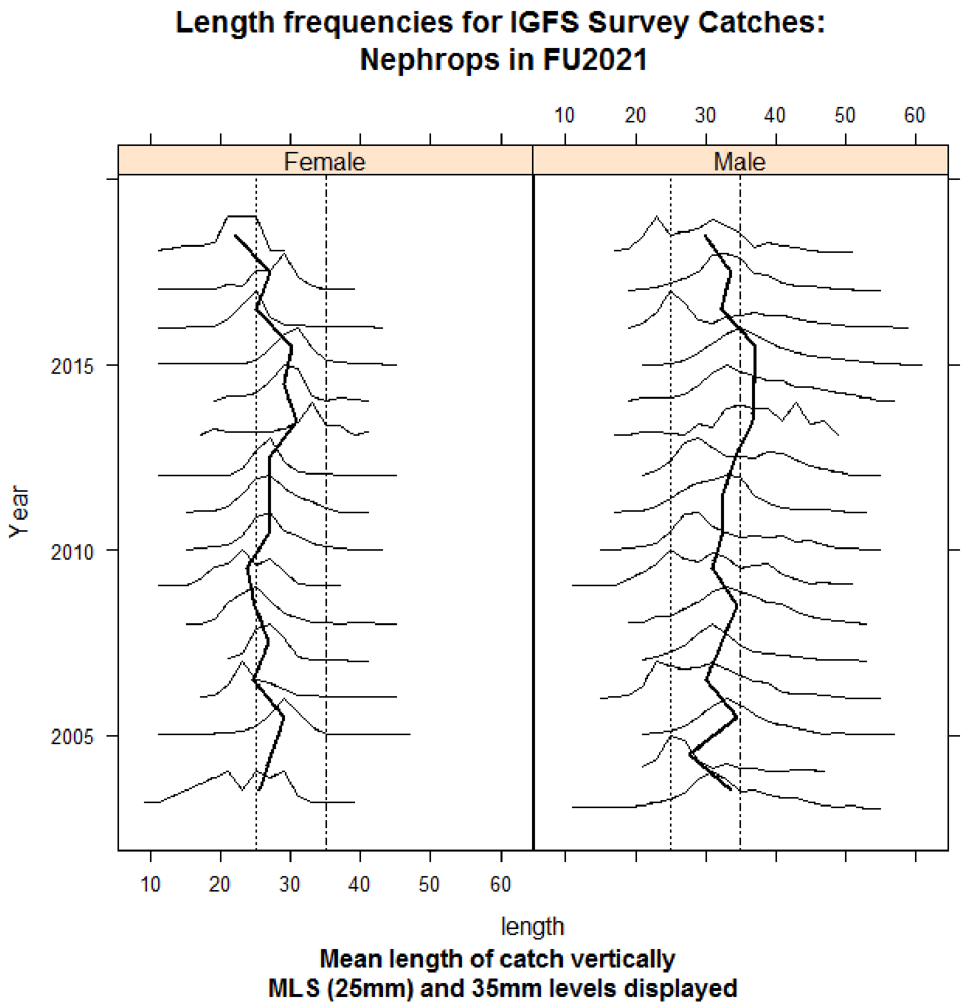


Figure 23.2.8. ***Nephrops*** **FU 20–21. Mean size trends for catches by sex from the IBTS-IGFS Irish survey in the Celtic Sea.**

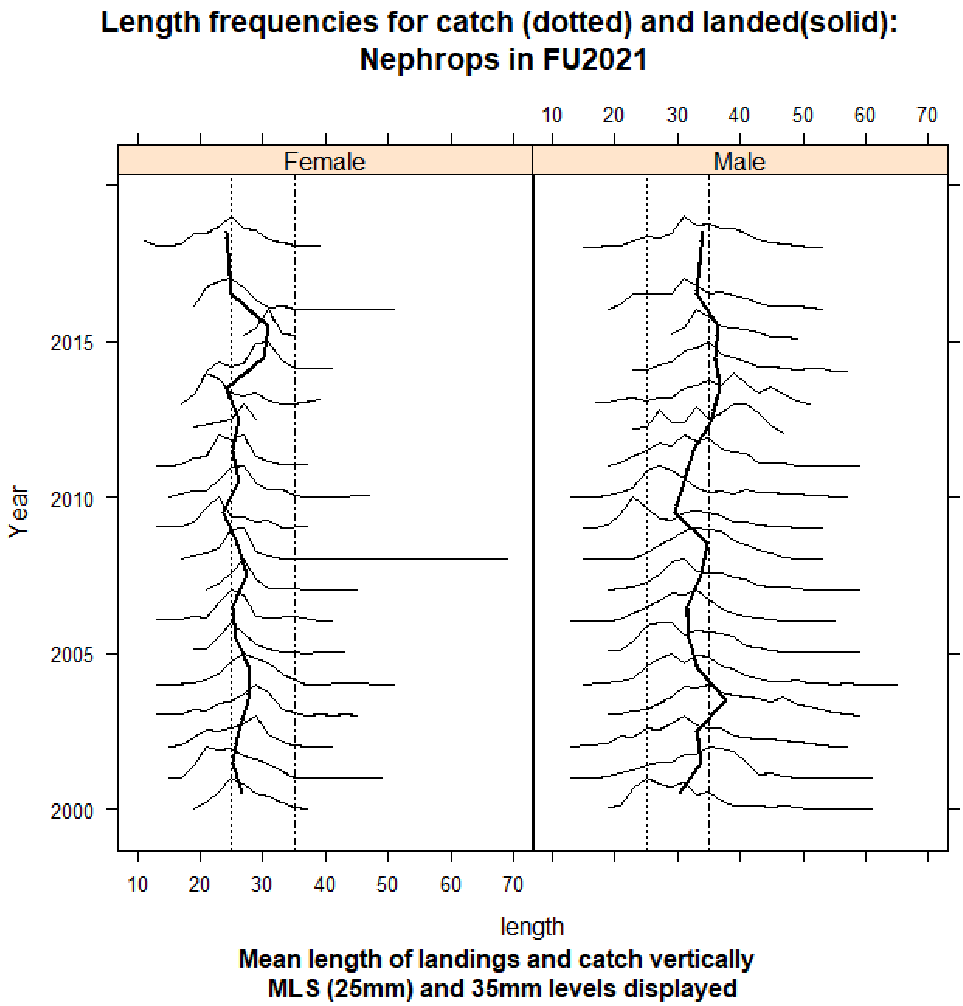


Figure 23.2.9. ***Nephrops*** **FU 20–21. Mean size trends for catches by sex from the IBTS-EVHOE French survey in the Celtic Sea. No survey data available for 2017.**

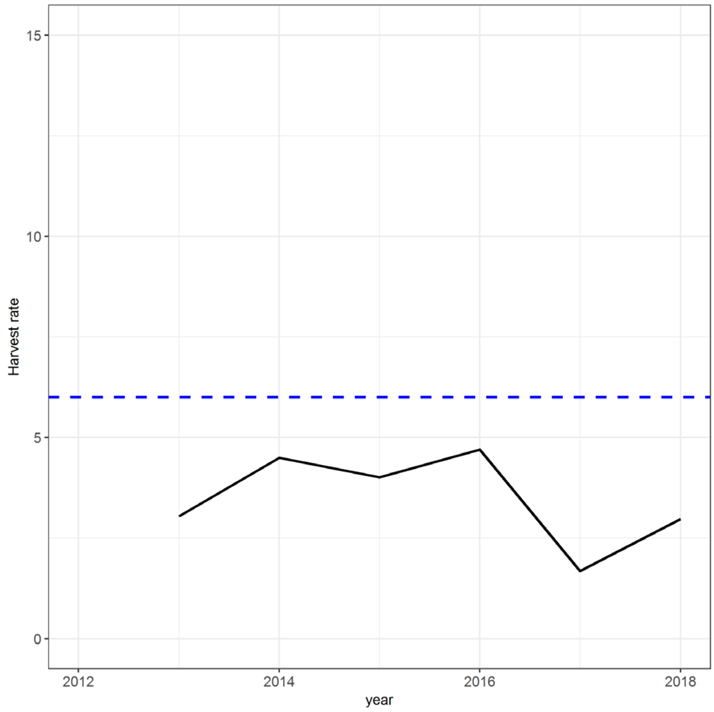


Figure 23.3.1. ***Nephrops*** **FU 20–21. Harvest ratio (% dead removed / UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

21 Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.f, Functional Unit 22 (Celtic Sea, Bristol Channel)

Type of assessment in 2019

UWTV based assessment using WK*NEPH* 2009 protocol as described in the stock annex. The TV survey is due to be repeated in the summer 2019, and the new survey will form the basis of advice for this stock in the autumn.

ICES advice applicable to 2018

"*ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should be no more than 4322 tonnes.*

To ensure that the stock in functional unit (FU) 22 is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2019

"*ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2015–2017, catches in 2019 should be no more than 2084 tonnes.*

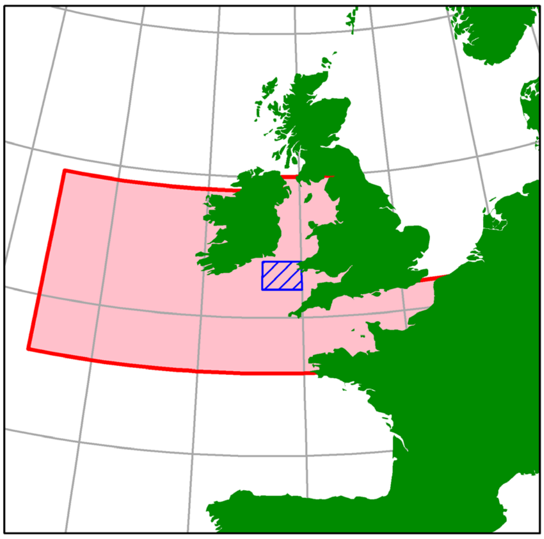
To ensure that the stock in Functional Unit 22 is exploited sustainably, management should be implemented at the functional unit level."

24.1 General

Stock description and management units

The Smalls *Nephrops* stock (FU22) covers ICES rectangles 31–32E3, 31–32E4 within 7.f.g. It is included in the whole ICES Area 7 together with Irish Sea East and West [FU14, FU15], Porcupine Bank [FU16], Aran Grounds [FU17], northwest Irish Coast [FU18], southeast and southwest Irish Coast [FU19], NW Labadie, Baltimore and Galley [FU20–21], Jones and Cockburn [FU21].

Historically FU20–22 has covered an amalgamation of several spatially distinct mud patches; FU 20 NW Labadie, Baltimore and Galley, FU 21 Jones and Cockburn and FU22 the Smalls. There is no evidence that the whole exploited area belongs to the same stock, or that there are several patches linked in meta-population sense. WGCSE 2013 recommended that FU20–22 should be split into FU20–21 and FU22 for the purposes of assessment and advice provision. The map below shows FU22 assessment area (blue) and TAC area (red). There is no evidence that the individual functional units belong to the same stock. See Section 18 for details on *Nephrops* in Subarea 7 general section.



Ecosystem aspects

This section is detailed in stock annex.

Fishery description

Ireland, France and the UK are the main countries involved in the FU22 *Nephrops* fishery. In the early 2000s, the Republic of Ireland fleet had on average over 70% of the landings and this has increased to over 90% from this FU in recent times. A description of this fleet is given in the stock annex. The time-series of numbers of vessels is updated in Figure 24.1.1. The numbers of vessels has been decreasing in recent years where the highest number was recorded in 2016. The time-series of vessel power is shown as a box and kite plot in Figure 24.1.2.

Irish landings from this FU come mainly from ICES statistical rectangle 31E3. The fishery on the Smalls grounds operates throughout the year, weather permitting with a seasonal trend.

French trawlers targeting *Nephrops* in the Celtic Sea operate mainly in FU20–21. In the early 2000s, French fleet had on average 30% of the landings from FU22 where this has decreased to ~2% in recent times. 80–90% of the FU22 French landings come from ICES statistical rectangle 31E3.

UK fleet had on average ~10% of the landings in recent year and is mainly UK-Northern Irish vessels in this fishery.

Fishery in 2018

In 2018, 74 Irish vessels reported landings from FU22. Of these, 57 vessels reported landings in excess of 10 t. Vessels >18 m account for 90% of the landings in 2018. In recent years, several newer vessels specializing in *Nephrops* fishing have participated periodically in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. In 2018, 15 French trawlers reported landings for FU22. French vessels switch between FU20–21 and FU22. In 2018, 34 UK vessels reported landings for this FU.

The French minimum mesh size of codend was set at 100 mm since January 2000, the majority of Irish landings are from vessels with 80–99 mm codend mesh.

Information from stakeholders

None presented.

24.2 Data

InterCatch

Data were available in InterCatch and used for catch data only. French catch data provided directly by the national expert.

Landings

The reported landings time-series by country is shown in Figure 24.2.1 and Table 24.2.1. The reported Irish landings from FU22 have increased since 2000. In 2018, the landings decreased from 2017 by 42% to approximately 1640 t. French landings have gradually decreased since the early 2000s to the present to the lowest level (3 t). Reported landings from the UK have fluctuated with a recent (three year) increasing trend coming mainly from the Northern Irish fleet. In 2018, Northern Ireland had the highest landings at 258 t followed by England and Wales reporting 48 t and 25 t from Scotland. Belgium reported minimal landings in 2018.

Effort

In line with WGCSE 2015 recommendation effort is reported in Kwdays and LPUE reported in t/Kwdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. The effort series is based on the same criteria for FU15, 16, 17, 22 and 20–21 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks. Effort data are available for the Irish *Nephrops* directed fleet in FU22 from 1995–2018. The time-series of effort and LPUE is updated in Figure 24.2.2 and Table 24.2.2.

Effort shows an increasing trend since the early 2000s (Table 24.2.2. and Figure 24.2.2) with a decrease in 2018.

Sampling levels

A dedicated sampling of landings and discards began in 2003 by Ireland. Sampling levels in 2018 were good and comparable to levels in 2017 (Figure 24.2.3).

Sampling and Raising Procedure Review

The national sample raising procedures for FU22 were reviewed and fully documented through an r markdown document (Annex 3, ICES, 2018 and stock annex). Annual discard ogives are calculated and are applied to quarterly length distributions and then raised to total quarterly landings before aggregation. A further raising procedure is applied to raise the annual sampled Irish data where these address quarters with missing length samples. Next, the international raising factor is applied. This raising procedure is used to assess this stock and to calculate mean weights, sex ratio and discard rates as inputs for catch scenarios and advice.

Commercial length–frequency distributions

The Irish sampling programme started in 2003 and since then coverage and intensity have been very good covering the seasonal trend of the fishery. The mean size of *Nephrops* in Irish landings has remained stable for both sexes. The mean size of *Nephrops* in the catch has remained relatively stable since 2005 (Figure 24.2.5). There is decrease in mean size in the catches in 2007 to 2009 for both sexes, which is linked to the recruitment signal picked up by both the 2006 UWTV and Irish groundfish survey.

Sex ratio

The sex ratio by year is shown in Figure 24.2.6. This shows some fluctuations over time. The sex ratio has a distinct seasonal pattern (Figure 24.2.7) with lowest males proportions in the samples in May and June. Males dominate the catches in the autumn and winter.

Mean weight explorations

Explorations of the mean weight in the catch samples by sex shows a strong cyclical pattern in the females (Figure 24.2.7). This corresponds with the emergence of mature females from the burrows to mate in summer. There is a decrease in mean weight in 2007 to 2009 for both sexes which is linked to the recruitment signal picked up by both the beam trawl during the UWTV in 2006 and 2007 Doyle et al, and Irish groundfish survey (Figure 24.2.11). The annual mean weight estimate for landings and discards is shown in Figure 24.2.8. The mean weight estimates in the landings show a slight decrease but are stable in recent four years.

Discarding

Since 2003 discard rates have been estimated using unsorted catch and discards sampling. This involves unsorted catch and discard samples being provided by vessels or collected by observers at sea on discard trips. The catch sample is partitioned into landings and discards using an on-board discard selection ogive derived for the discard samples. Sampling effort is stratified monthly, but annual aggregations are used to derive length distributions and selection ogives. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate quarterly raising factors. The sampling intensity and coverage has varied over the time-series, but overall has been good.

Discard rates range between 9–39% of total catch by weight and 15–52% of total catch by number (Table 24.2.4). Discard rate of females tends to be higher due to the smaller average size and market reasons. There is no information on discard survival rate in this fishery. 25% is assumed in line with other *Nephrops* stocks in the Celtic Sea (Charuau *et al*., 1982). Highest discard rates were observed in 2007 as a result of the recruitment into the fishery in 2006.

Gear selectivity trials by Bord Iascaigh Mhara (BIM, 2017) reported a 64% survivor rate for *Nephrops* caught in a trawl with a SELTRA selectivity device in the outer Galway Bay area.

Table 24.3.1 gives weights, numbers and mean weights of the landings and discard raised internationally according to the stock annex.

Surveys

Abundance indices from UWTV surveys

The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Ireland and elsewhere and are documented by WKNEPHTV (ICES, 2007), SGNEPS (ICES, 2009; 2010; 2012), WGNEPS (ICES, 2013; 2014; 2015; 2016a, 2017a, 2018a), WKNEPS (2016b, 2018b) and Leocádio *et al*. (2018). SGNEPS 2012 (ICES, 2012) recommended that a CV (or relative standard error) of <20% is an acceptable precision level for UWTV survey estimates of abundance. This allowed sampling intensity to be reduced from around 90 stations in the past to around 41 on the Smalls grounds in 2019, which allowed survey coverage of other FUs. A randomised isometric grid design was employed with UWTV stations at 4.5 nmi intervals, whereas previously a 3.0 nmi square grid was used. Operational details of the 2019 UWTV survey are available (Doyle *et al*., 2019).

Seven stations in FU22 were not surveyed successfully in 2015 due to very poor visibility conditions encountered as a result of strong tides. WKCELT 2014 concluded that WGCSE or WGNEPS should make recommendations on the most appropriate fill in procedure to be adopted in cases when stations could not be surveyed. WGCSE 2015 agreed the following procedure for this case: Two buffer zones of 1 nmi and 2 nmi distance were generated around the missing stations. The counts and mean of historic density estimates within the 1 and 2 nmi buffers were calculated. The standard kriging procedure was carried out and summary results were computed for the 1 and 2 nmi "fill-ins". Finally the mean of historic densities within 2 nmi buffer of the planned stations were used in the calculation of the 2015 abundance.

The blanked krigged contour plot and posted point density data are shown in Figure 24.2.9. The krigged contours correspond very well to the observed data. In general, the densities are higher in the central area of the ground with a localised hotspot centrally and also in the southwestern leg. Densities and abundance have remained stable in the time-series with the exception of the first year and 2017, which were the highest in the series. The 2019 mean density 0.40 burrows/m^2 is approximately 30% increase compared with 0.31 burrows/m^2 in 2018. The summary statistics from this geostatistical analysis are given in Table 24.2.5 and plotted in Figure 24.2.10.

The 2019 estimate of 1121 million burrows is above the MSY $B_{trigger}$ (990 million). The estimation variance of the survey as calculated by EVA is very low (CVs in the order <9%).

Groundfish survey data

The Irish groundfish survey (IGFS-WIBTS-Q4) has been carried out since 2003 (Stokes *et al*., 2014; ICES, 2017b). This provides information on length–frequency compositions, mean size in the catches, CPUE of *Nephrops* in FU22. The mean size of the catches is stable over the time-series except in 2006 and 2008, which signals recruitment into the fishery in 2006 and 2007 (Figure 24.2.11). This signal of recruitment was also picked up from the length frequency distributions from beam trawls during the 2006 UWTV survey (Doyle *et al*., 2019). The groundfish survey provides a useful indicator of recruitment in this FU.

24.3 Assessment

Comparison with previous assessments

The WGCSE 2019 carried out an UWTV based assessment for this stock. The methods used were in line with WK*NEPH* (ICES, 2009) and the approach taken for other *Nephrops* stocks in areas 6 and 7 by WGCSE.

State of the stock

UWTV abundance estimates suggest that the stock size shows a recent declining trend with an increase in 2019. The 2019 estimate is above the MSY $B_{trigger}$ (990 million). The 2019 estimate (1121 million) is below the average of the series (geomean [2006–2019]: 1223 million).

Harvest rate is calculated as (landings + dead discards)/(abundance estimate). Table 24.3.1 and Figure 24.3.1 summarize recent harvest rates. The recent fluctuations in harvest rates are a combination of large changes in recent UWTV abundance and variable landings. The current harvest rate is 13.8%, which is just above F_{MSY}.

24.4 Catch scenarios table

Catch scenario table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 24.3.1 and summarised below.

Since 2003, mean weight in the landings has varied between 18–27 gr (Figure 24.2.8). In previous assessments the long-term average (rather than a three-year average) was used as input for the mean weight in landings and discards in the calculation of catch scenarios, to account for interannual variation. In 2019, the last three year average was considered to be more appropriate given that average weights have been stable at a lower level since 2015.
Three year average (2016–2018) of proportion of removals retained was used as is standard for other *Nephrops* stocks. The estimate harvest rate has also varied a lot, 6–27% with 2007 being the highest observed (Figure 24.3.1). This is a result of recruitment into the fishery in 2006 and 2007.

The basis for the catch scenarios.

Variable	Value	Notes
Stock abundance	1121 million individuals	UWTV survey 2019
Mean weight in wanted catch	20.9 g	Average 2016–2018
Mean weight in unwanted catch	10.6 g	Average 2016–2018
Unwanted catch rate	22.8%	Average 2016–2018 (by number). Calculated as discards divided by landings + discards.
Discard survival rate	25.0%	Only applies in scenarios where discarding is allowed.
Dead Unwanted rate	18.2%	Average 2016–2018 (by number). Calculated as dead discards divided by removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

A prediction of landings for the FU22 using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the stock annex will be made on the basis of the 2019 UWTV survey. This will be presented in October 2020 for the provision of advice.

24.5 Reference points

New reference points were derived by WKMSYRef4 (ICES, 2016XX, 2016YY) for FU22. These were updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values, a five-year average was chosen. Similarly, the five-year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five-year average of the F above F_{max} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy, which occasionally appear.

This stock previously did not have MSY $B_{trigger}$ specified; the time-series and range of indicator biomass is also limited such that direct use of B_{loss} is considered too close to equilibrium biomass. The workshop proposed to use the 5% interval on the probability distribution of indicator biomass assuming a normal distribution, which is analogous to the 5% on B_{MSY} proposed for finfish stocks assuming these *Nephrops* FU have been exploited at a rate close to near HR_{MSY}. The MSY $B_{trigger}$ for FU22 is 987 million individuals rounded to 990 million.

Stock code	MSY F_{lower}*	F_{MSY}*	MSY Fupper* with AR	MSY $B_{trigger}$	MSY Fupper* with no AR
nep-22	10.2%	12.8%	12.8%	990***	12.8%

*** Harvest rate (HR).**

***** Abundance in millions.**

24.6 Management strategies

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES Subarea 7, and also to demersal stocks.

24.7 Quality of assessment and forecast

Since 2006, a dedicated annual UWTV survey has provided abundance estimates for FU22 with high precision. There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009; WGNEPS 2016, WGNEPS 2018b). Ultimately, there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al.*, 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise (WK*NEPH* 2009). The survey estimates themselves are very precisely estimated (CVs 2–9%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU22 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised, but is likely to be lower than that observed in the survey.

In 2015, there is added uncertainty, not accounted for in the model or CV estimate, because 17% of the planned TV stations could not be successfully surveyed due to poor visibility on the seabed. However, the spatial distributions of densities have been fairly consistent over time and the overall density has also been relatively stable. The fill in procedure used to generate density estimates for the seven missing stations should be a good approximation.

A review of sampling and raising procedures was presented to WGCSE 2018, and is accepted as the current method to calculate the fishery dependant inputs FU22 (Annex 3, ICES, 2018 and stock annex).

In the provision of catch scenarios based on the absolute survey estimates, additional uncertainties related to mean weight in the landings and the discard rates also arise. For FU22 deterministic estimates of the mean weight in the landings and discard rates for 2003–2018 have been used previously by the WG to account for the variability in these over time. This variability has occurred when large recruitments are observed in the stock as was the case in 2006 and 2007. The mean weights have been stable since 2015, and hence the recent 3 year average is used in the catch scenarios for 2020.

From 2016, fisheries catching *Nephrops* in Subarea 7 are covered by the EU landings obligation with several exemptions (EU, 2015). The average discard rate by weight for FU22 over the last three years is 13%. Irish discard survival experiments indicate that the trawl discard survival may be around 64% (BIM, 2017). As a result, an exemption from the landings obligation based on high survivability has been granted by the European Commission. Catch advice and scenarios are provided this year on the assumption that discarding is assumed to continue at the recent average.

Landings data are adjusted to take into account landings that have been misreported from FU16 since 2011. This adjustment is thought to be reasonably accurate (See Section 20).

Sampling and discard estimates have improved over the time-series.

24.8 Recommendation for next benchmark

This stock has not been formally benchmarked by ICES although the approach used has. WGCSE recommends that the issue list below can be addressed through an inter-bench process:

- The biological parameters used as inputs to the SCA should be reconsidered; growth parameters, length-at-maturity and natural mortality.
- The historical time-series of landings and effort by rectangle should be disaggregated and options for standardisation of LPUE investigated.
- Historical sampling and groundfish survey data in this FU should also be disaggregated as far as possible back in time and investigated for useful trends and signals.

24.9 Management considerations

The trends from the fishery (landings, effort, mean size, etc.) appear to be relatively stable. The UWTV abundance and mean density estimates show some fluctuations in burrow abundance in the recent five years although it is stable over the time-series. There are fluctuations in the harvest rates, which are related to the recent large changes in stock abundance. Recent harvest rates for the FU22 Smalls fluctuate and suggest the stock is exploited above F_{MSY}.

This up to date survey information will be used to generate catch options and the provision of advice in October 2020.

In recent years, several newer vessels specializing in *Nephrops* fishing have participated in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. There have been concerns that effort could be displaced towards the Smalls and other *Nephrops* grounds due to effort controls in 7.a and 6.a. This has not happened to date and the 2014 effort was just below the recent average in the time-series.

There has been a trend for Irish vessels (>18 m) to switch to multi (quad) rig trawls. Provisional data suggest a ~30% increase in *Nephrops* catch rates and a reduction in fish bycatch of ~30% due to the lower headline height.

Nephrops fisheries in the Smalls have non-*Nephrops* bycatch composition. Cod, whiting and to a lesser extent haddock are the main bycatch species (Davie and Lordan, 2011). A target whiting fishery also overlaps with the *Nephrops* fishery in this area but this has negligible bycatch of *Nephrops*.

24.10 References

Anon. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp.

BIM. 2017. Report on *Nephrops* survivability in the Irish demersal trawl fishery. Bord Iascaigh Mhara, 29 September 2017 .http://www.bim.ie/media/bim/content/publications/fisheries/6882-BIM-nephrops-survival-report-final.pdf .

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea. ICES CM 1982/B:13.

Davie S., Lordan C. 2011. Definition, dynamics and stability of métiers in the Irish otter trawl fleet. Fish. Res. 111, 145–158. http://dx.doi.org/10.1016/j.fishres.2011.07.005 or http://hdl.handle.net/10793/673.

Doyle, J., O'Brien, S., Fitzgerald, R., Vacherot, JP., Sugrue, S., and Quinn M. 2019. The "Smalls" *Nephrops* Grounds (FU22) 2019 UWTV Survey Report and catch scenarios for 2020. Marine Institute UWTV Survey report.

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L 83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WK*NEPH*). ICES CM 2009/ACOM:33.

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9–11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 012/SSGESST:19.

ICES. 2014. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 4–6 November 2014, Lisbon, Portugal. ICES CM 2014/SSGESST:20. 57 pp.

ICES. 2015. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 10–13 November 2015, Cadiz, Spain. ICES CM 2015/ SSGIEOM:30.52 pp.

ICES. 2016b. Report of the Workshop on *Nephrops* Burrow counting (WKNEPS), 9–11 November 2016. Reykjavík, Iceland. ICES CM 2016/ SSGIEOM:34.65 pp.

ICES. 2016XX. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

ICES. 2016YY. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2017a. Interim Report of the Working Group on *Nephrops* Surveys (WGNEPS), 28 November–1 December 2017, Heraklion, Greece. ICES CM 2017/ SSGIEOM:19 pp.

ICES. 2017b. Interim Report of the International Bottom Trawl Survey Working Group (IBTSWG), 27–31 March 2017, Copenhagen, Denmark. ICES CM 2017/ SSGIEOM:01. 343 pp.

ICES. 2018a. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 6–8 November 2018. Lorient, France. ICES CM 2018/ EOSG:18. 227 pp.

ICES. 2018b. Report of the Workshop on *Nephrops* burrow counting (WKNEPS), 2–5 October 2018, Aberdeen, UK. ICES CM 2018/ EOSG:25. 47 pp.

ICES .In prep. Manual for the *Nephrops* Underwater TV Surveys. Series of ICES Survey Protocols (SISP).

Leocádio, A., Weetman, A., and Wieland, K. (Eds). 2018. Using UWTV surveys to assess and advise on *Nephrops* stocks. ICES Cooperative Research Report No. 340. 49 pp. http://doi.org/10.17895/ices.pub.4370.

O'Brien, S., Blaszkowski, M., Butler, R., Fee, D., Hernon, P., Santana, C., Lordan, C. and Doyle, J. 2017. The "Smalls" *Nephrops* Grounds (FU22) 2017 UWTV Survey Report and catch options for 2018. Marine Institute UWTV Survey report.

Marrs S.J., Atkinson R.J.A., Smith C.J., Hills J.M. 1996. Calibration of the towed underwater TV technique for use in stock assessment of *Nephrops norvegicus*. Reference no. 94/069 (Study Project in support of the Common Fisheries Policy XIV/1810/C1/94, call for proposals 94/C 144/04).

Stokes, D., Gerritsen. H., O'Hea, B., Moore, S.J. and Dransfeld, L. 2014. "Irish Groundfish Survey Cruise Report, 24 September–17 December 2014", FEAS Survey Series; 2014/01. http://hdl.handle.net/10793/1064.

Table 24.2.1. ***Nephrops*** **in FU22 (Smalls Grounds). Landings in tonnes by country.**

FU 22 Landings (t)					
Year	France	Rep. of Ireland	UK	Belgium	Total
1999	1034	741	0		1775
2000	1192	1687	11		2890
2001	882	2054	2		2938
2002	598	1392	3		1993
2003	799	1257	10		2065
2004	454	1349	26		1828
2005	478	1987	68		2533
2006	293	1442	19	7	1761
2007	216	2716	13	5	2950
2008	301	2539	241	9	3090
2009	258	1609	306	12	2185
2010	129	2219	351	15	2714
2011	64	1521	44	7	1636
2012	65	2506	41	6	2618
2013	83	2054	107	12	2257
2014	29	2428	61	8	2526
2015	9	2215	121	5	2350
2016	5	2967	354	3	3329
2017	7	2815	737	1	3560
2018	3	1639	331	1	1974

Table 24.2.2. *Nephrops* in FU22 (Smalls Grounds). Effort data for the Irish otter trawl *Nephrops* directed fleet.

Year	Effort ('000s Kw Days)	Landings (tonnes)	LPUE (t/KwDays)
1995	552	1226	2.2
1996	412	1010	2.5
1997	474	1096	2.3
1998	524	1353	2.6
1999	292	620	2.1
2000	586	1335	2.3
2001	789	1964	2.5
2002	615	1298	2.1
2003	639	1000	1.6
2004	620	981	1.6
2005	986	1882	1.9
2006	855	1374	1.6
2007	1131	2677	2.4
2008	1047	2501	2.4
2009	702	1605	2.3
2010	962	2198	2.3
2011	724	1497	2.1
2012	970	2260	2.3
2013	902	1849	2.0
2014	915	2182	2.4
2015	971	2076	2.1
2016	1270	2761	2.2
2017	1229	2712	2.2
2018	748	1509	2.0

Table 24.2.4. ***Nephrops*** **in FU22 (Smalls Grounds). Landings and discards weight and numbers by year.**

Year	Landings (t)	Discards (t)	Landings ('000s numbers)	Discards ('000s numbers)	% Discard by weight	% Discard by number
2003	1257	438	57.9	41.1	25.8	41.5
2004	1349	149	52.1	9.7	9.9	15.6
2005	1987	1292	93.6	100.9	39.4	51.9
2006	1442	372	82.0	37.0	20.5	31.1
2007	2716	1755	152.1	166.5	39.3	52.3
2008	2539	237	118.0	21.4	8.5	15.3
2009	1609	274	67.7	24.3	14.5	26.4
2010	2219	520	99.6	36.4	19.0	26.8
2011	1521	183	55.7	12.2	10.7	18.0
2012	2506	332	115.2	30.0	11.7	20.7
2013	2054	452	85.1	36.5	18.1	30.0
2014	2428	442	96.3	32.1	15.4	25.0
2015	2215	424	107.6	41.8	16.1	28.0
2016	2967	463	142.7	47.7	13.5	25.1
2017	2815	336	130.0	31.0	10.7	19.2
2018	1639	291	81.1	25.9	15.1	24.2

Table 24.2.5. ***Nephrops*** **in FU22 (Smalls Grounds). Results summary table for geostatistical analysis of UWTV survey.**

Ground	Year	Number of stations	Mean Density adjusted (burrows/m²)	Area Surveyed (km²)	Domain Area (km²)	Burrow Count	Geostatistical Abundance Estimate adjusted (millions burrows)	CV on Burrow estimate %
Smalls	2006	100	0.49	15	2962	10,498	1503	2
	2007	107	0.37	16	2955	8,571	1136	6
	2008	76	0.36	15	2698	9,411	1114	6
	2009	67	0.36	10	2824	6,362	1093	5
	2010	90	0.37	15	2861	8,195	1141	4
	2011	107	0.41	15	2881	8,191	1256	3
	2012*	47	0.49	6	2934	4,327	1498	8
	2013*	41	0.41	7	2975	3,719	1254	7
	2014*	52	0.53	9	2970	5,715	1622	8
	2015*	40	0.49	5	3064	2,897	1363	7
	2016*	41	0.31	6	3063	2,457	866	7
	2017*	40	0.55	6	3063	4,224	1600	5
	2018*	42	0.31	7	3063	2,534	876	9
	2019*	41	0.40	7	3063	3,573	1121	6

*** reduced isometric grid 4.5 nmi.**

Table 24.3.1. *Nephrops* in FU22 (Smalls Grounds). Short-term catch option prediction inputs and recent estimates of mean weight in landings and harvest rate (cells in bold indicates inputs to catch scenrio calculations).

Year	Landings in number millions	Total discards in number* millions	Removals in number millions	Dead Discard Rate number %	Discard Rate number %	UWTV abundance estimate millions	95% Confidence Interval	Harvest rate %	Landings tonnes	Total discards* tonnes	Mean weight in landings gramme	Mean weight in discards gramme
2003	95.2	67.6	145.8	34.7	41.5	NA	NA	NA	2,065	720	21.7	10.7
2004	70.7	13.1	80.5	12.2	15.6	NA	NA	NA	1,828	202	25.9	15.4
2005	119.3	128.6	215.7	44.7	51.9	NA	NA	NA	2,533	1648	21.2	12.8
2006	100.2	45.2	134.1	25.3	31.1	1503	70	8.9	1,761	454	17.6	10.1
2007	165.2	180.9	300.8	45.1	52.3	1136	126	26.5	2,950	1906	17.9	10.5
2008	143.6	26.0	163.1	12.0	15.3	1114	123	14.6	3,090	289	21.5	11.1
2009	92.0	33.0	116.8	21.2	26.4	1093	108	10.7	2,185	371	23.7	11.3
2010	121.8	44.5	155.2	21.5	26.8	1141	88	13.6	2,714	636	22.3	14.3
2011	60.0	13.2	69.8	14.1	18.0	1256	72	5.6	1,636	196	27.3	14.9
2012	120.3	31.4	143.9	16.3	20.7	1498	239	9.6	2,618	347	21.8	11.1
2013	93.5	40.1	123.6	24.3	30.0	1254	177	9.9	2,257	497	24.1	12.4
2014	100.2	33.4	125.2	20.0	25.0	1622	268	7.7	2,526	460	25.2	13.8

Year | Landings in number millions | Total discards in number* millions | Removals in number millions | Dead Discard Rate number % | Discard Rate number % | UWTV abundance estimate millions | 95% Confidence Interval | Harvest rate % | Landings tonnes | Total discards* tonnes | Mean weight in landings gramme | Mean weight in discards gramme

Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	millions		%	tonnes	tonnes	gramme	gramme
2015	114.1	44.4	147.4	22.6	28.0	1363	180	10.8	2,350	450	20.6	10.1
2016	160.2	53.5	200.3	20.0	25.1	866	112	23.1	3,329	519	20.8	9.7
2017	164.4	39.2	193.7	15.2	19.2	1600	153	12.1	3,560	424	21.7	10.8
2018	97.8	31.3	121.2	19.3	24.2	876	154	13.8	1,974	350	20.2	11.2
2019						**1121**	141					
			Average 16–18	**18.2**	**22.8**					Average 16–18	**20.9**	**10.6**

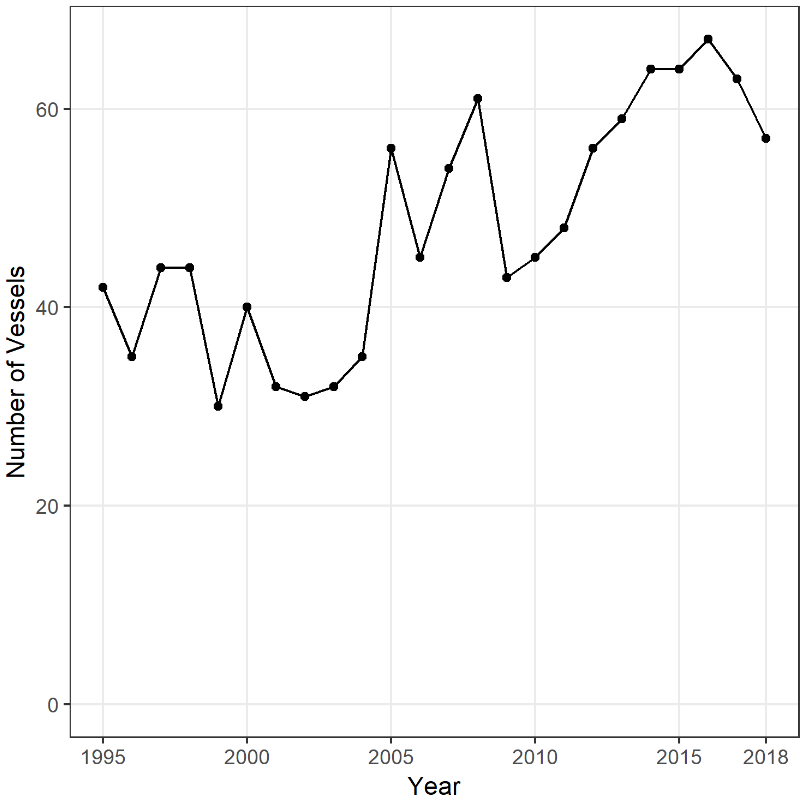


Figure 24.1.1. *Nephrops* in FU22 (Smalls Grounds). Time-series of the number of Irish vessels reporting landings of *Nephrops* from FU22 with a >10 t threshold.

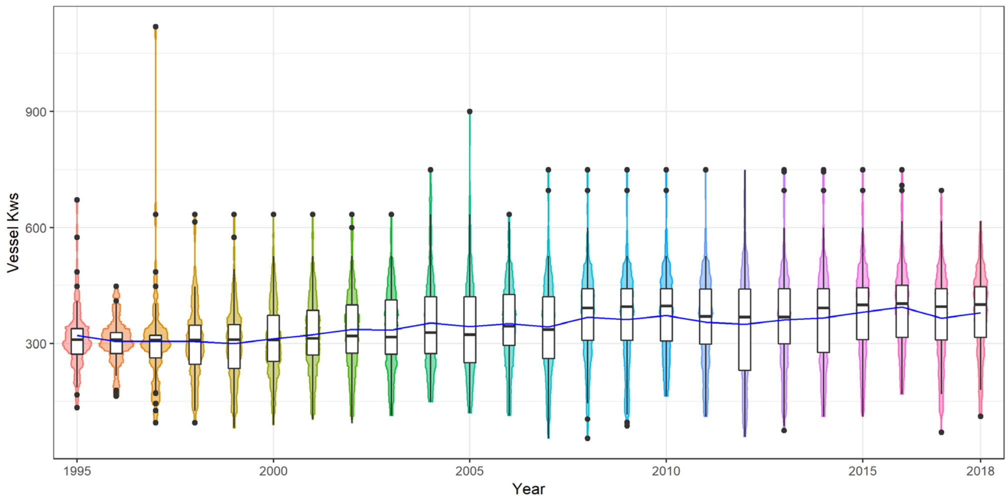


Figure 24.1.2. *Nephrops* in FU22 (Smalls Grounds). Combined box and kite plot of vessel power on the Smalls Grounds by year. The blue line indicates the mean.

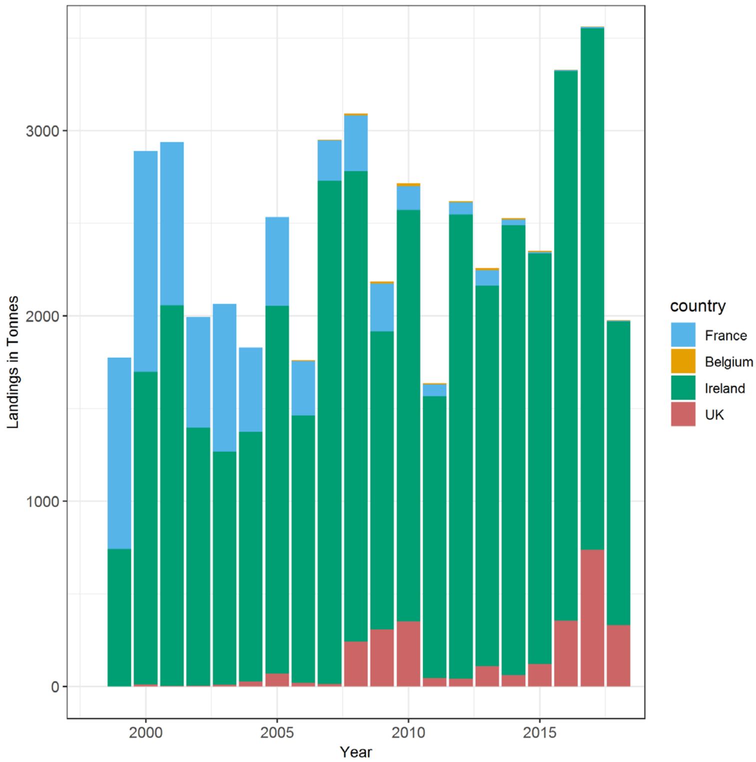


Figure 24.2.1. ***Nephrops*** **in FU22 (Smalls Grounds). Landings in tonnes by country.**

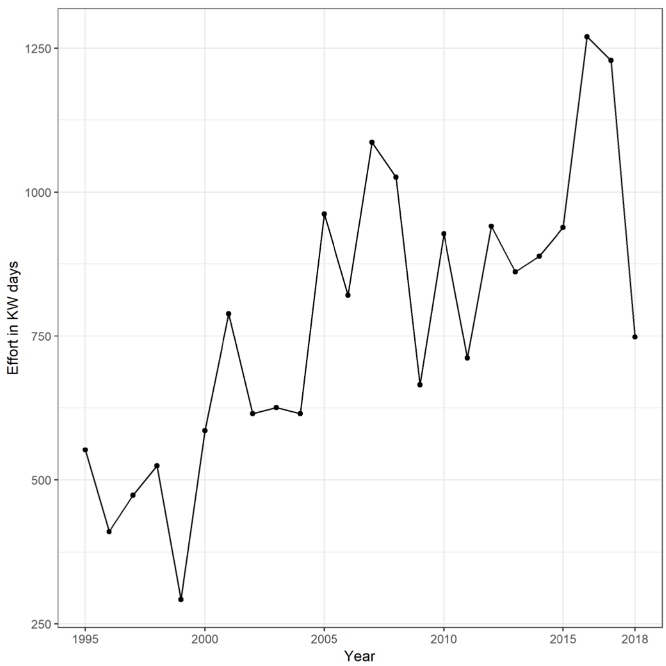


Figure 24.2.2. ***Nephrops*** **in FU22 (Smalls Grounds). Fishing effort Kw days for the Irish otter trawl** ***Nephrops*** **directed fleet (30% of** ***Nephrops*** **weight in total landings).**

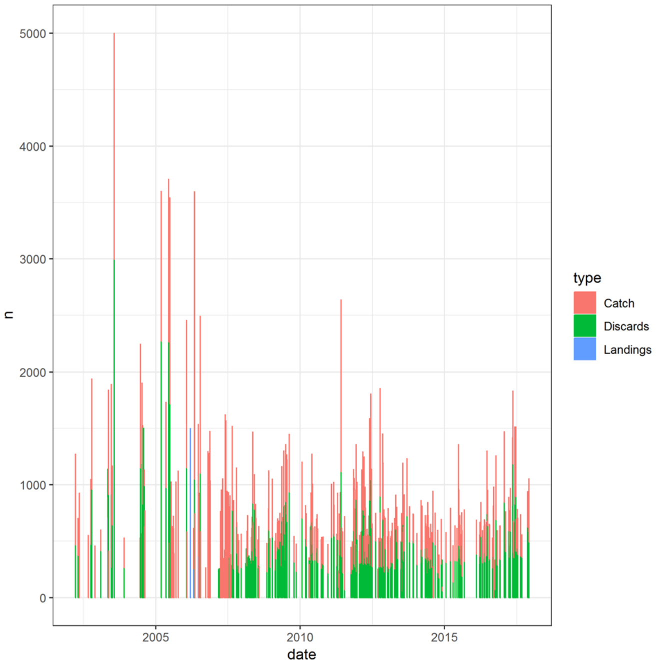


Figure 24.2.3. ***Nephrops*** **in FU22 (Smalls Grounds). Sampling levels.**

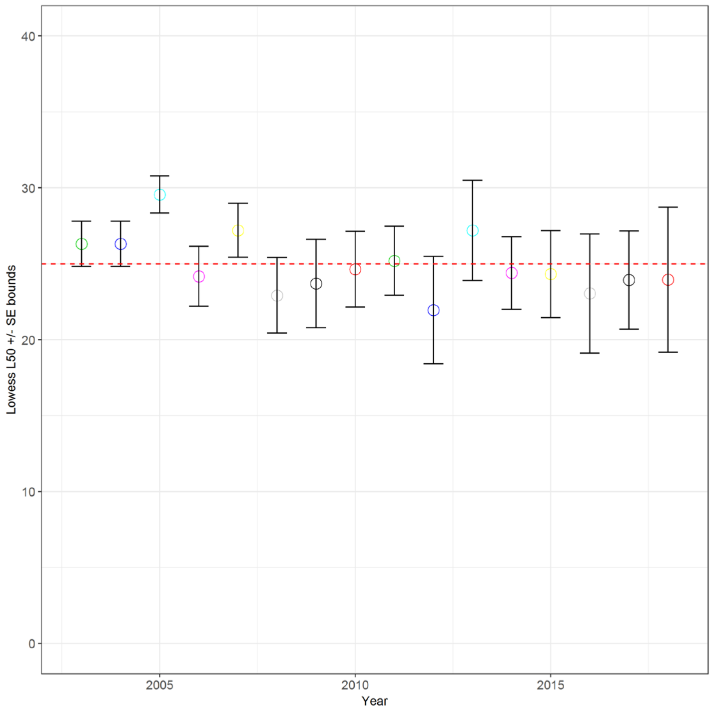


Figure 24.2.4. ***Nephrops*** **in FU22 (Smalls Grounds). The annual estimated L_{50} with standard error bounds for the on-board retention ogives for samples from the Smalls grounds. Minimum conservation size (MCR) 25 Carapace Length (mm) shown as dashed line.**

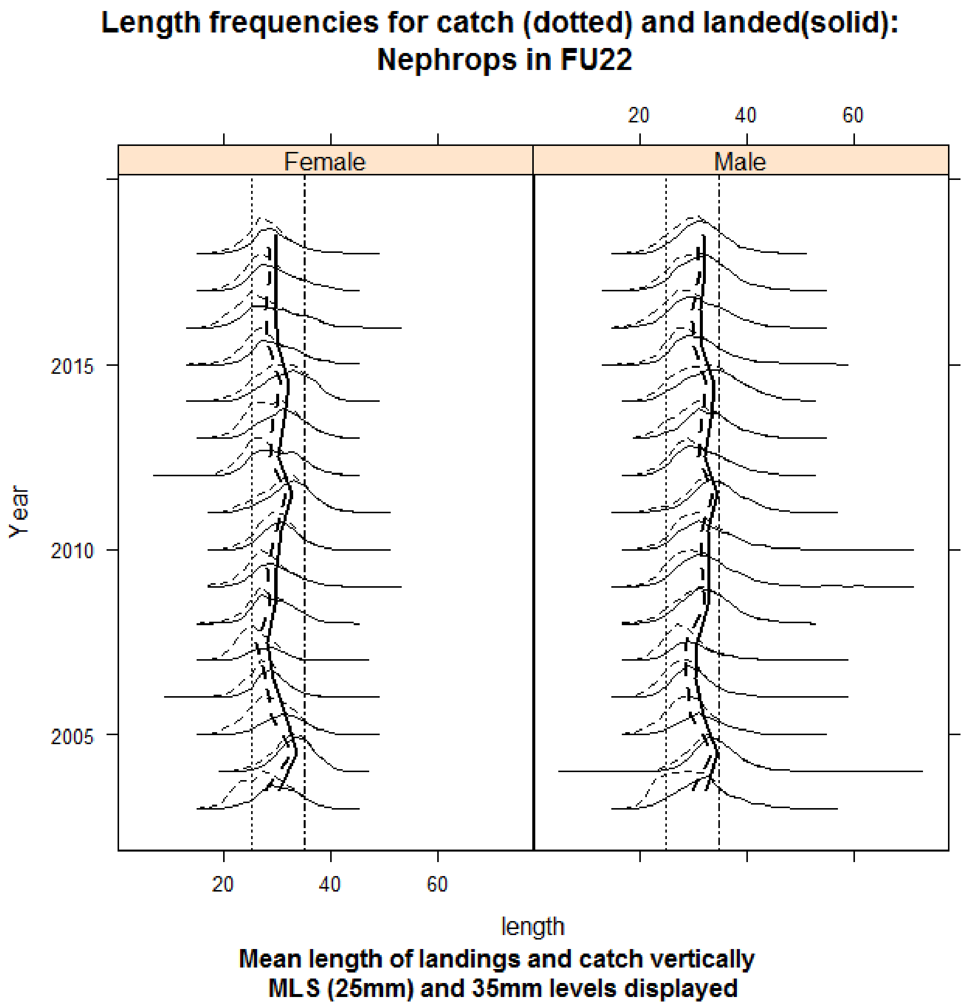


Figure 24.2.5. ***Nephrops*** **in FU22 (Smalls Grounds). Mean size trends for catches and whole landings by sex over the time-series.**

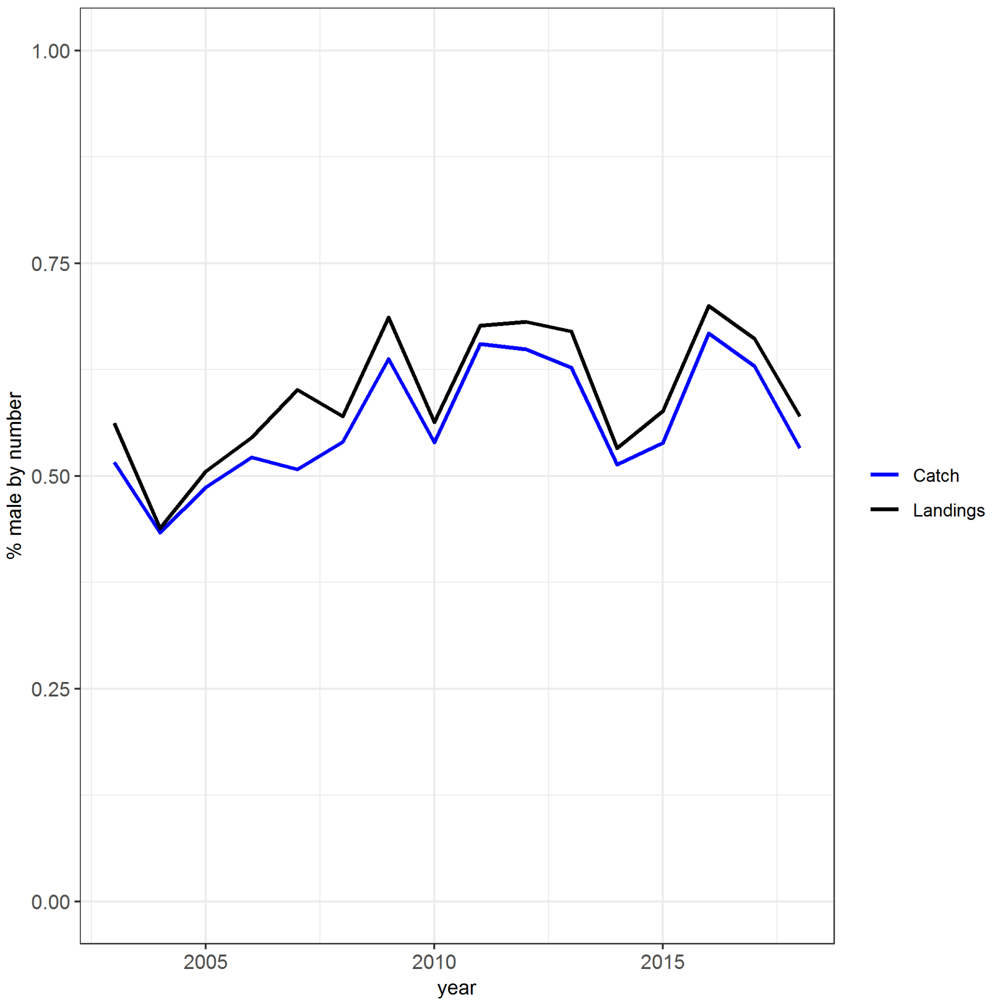


Figure 24.2.6. *Nephrops* in FU22 (Smalls Grounds). The percentage males in the over the time-series.

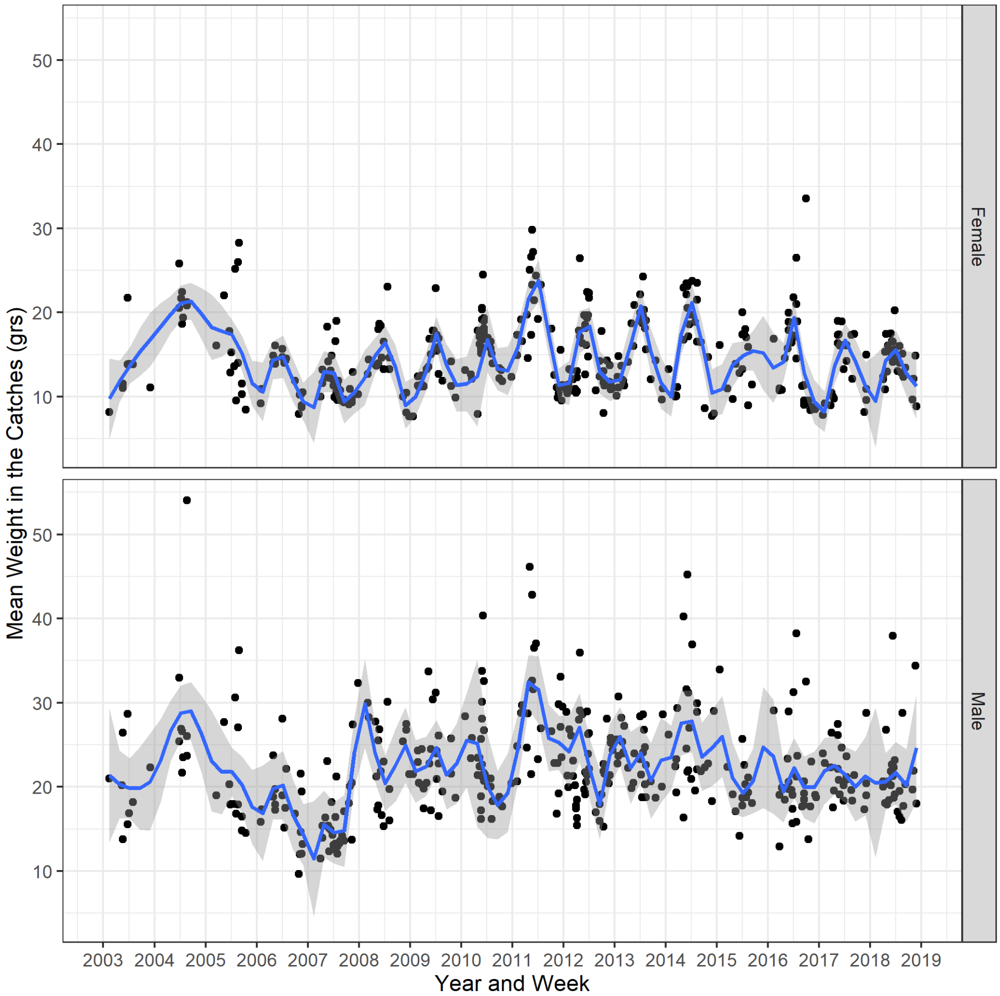


Figure 24.2.7. ***Nephrops*** **in FU22 (Smalls Grounds). Mean weight in catch samples by sex with loess smoother and showing cyclical trends.**

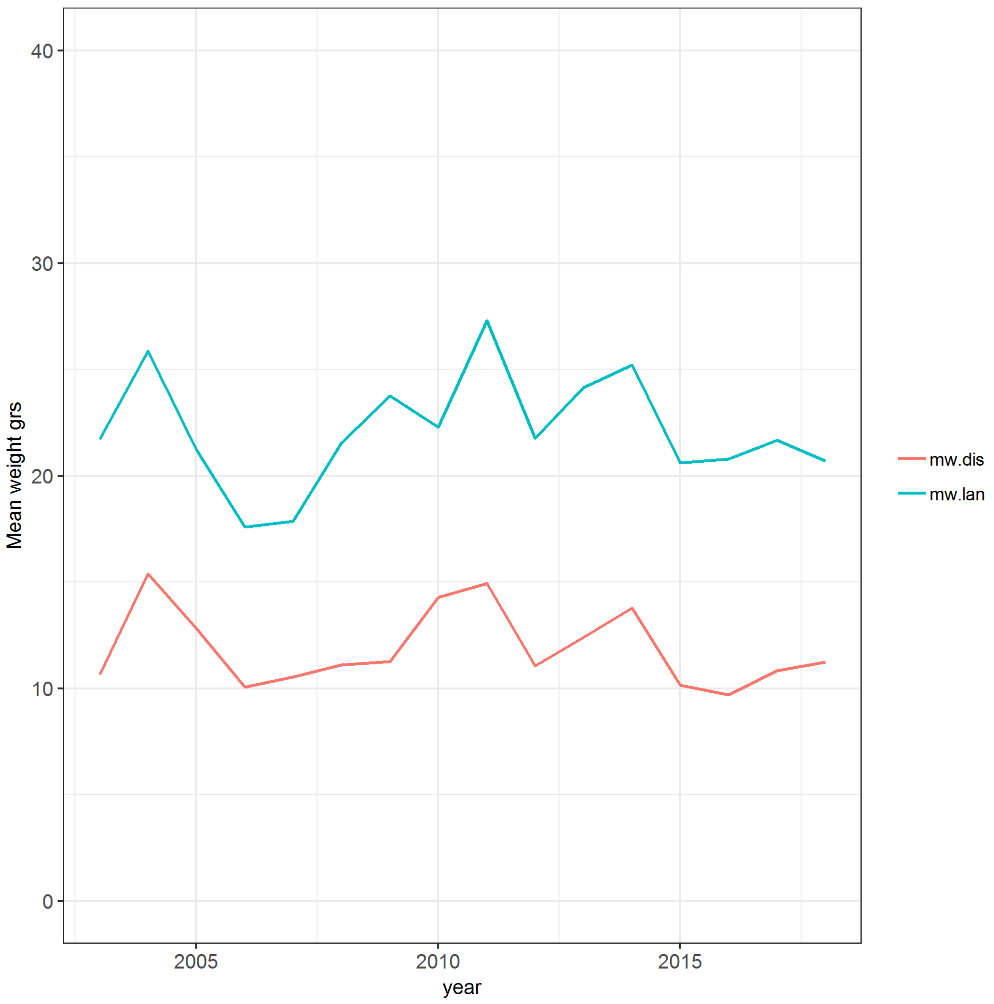


Figure 24.2.8. ***Nephrops*** **in FU22 (Smalls Grounds). Annual mean weights (gr) in the landings and discards.**

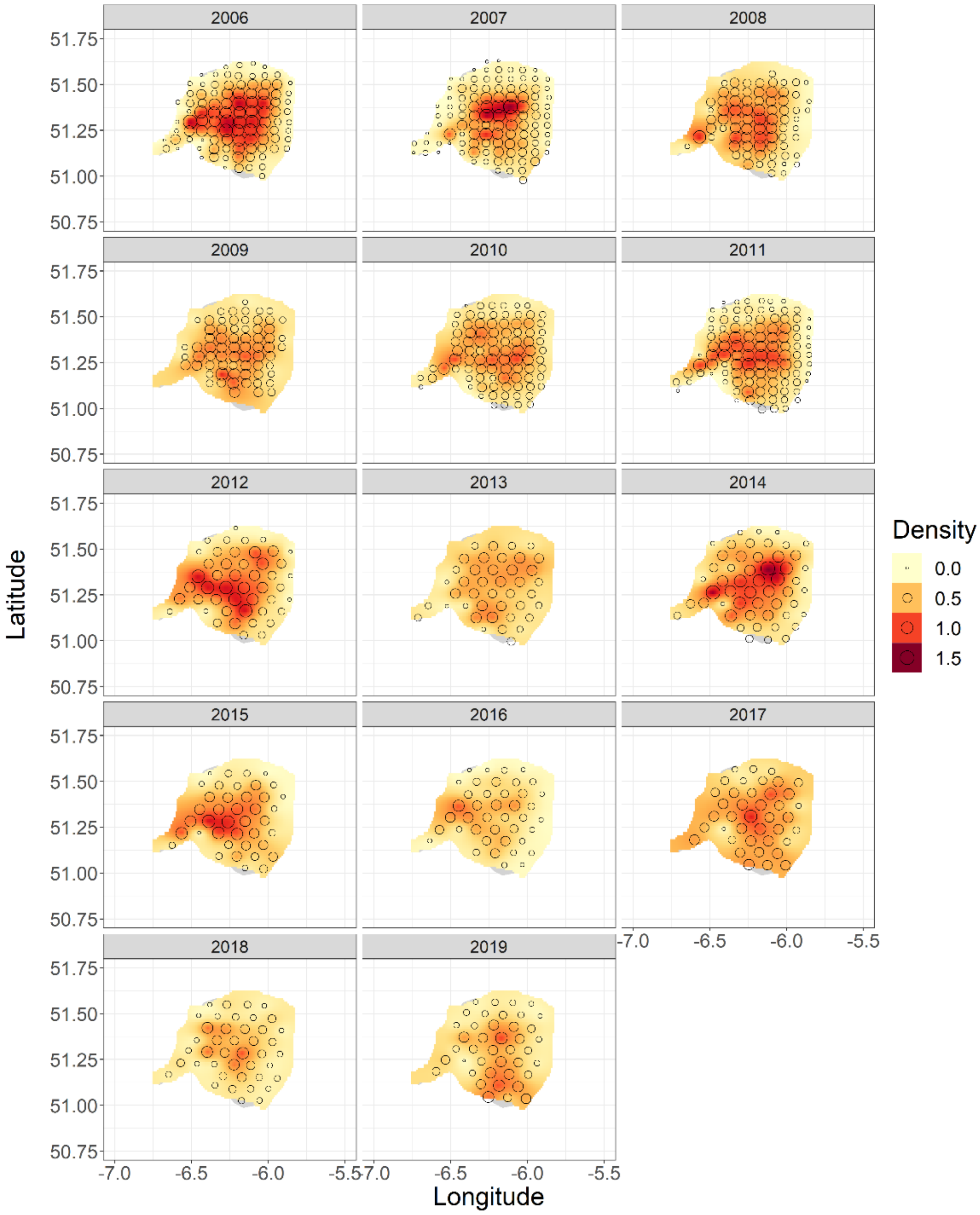


Figure 24.2.9. ***Nephrops*** **in FU22 (Smalls Grounds). Contour plots of the krigged density estimates for the UWTV surveys over the time-series.**

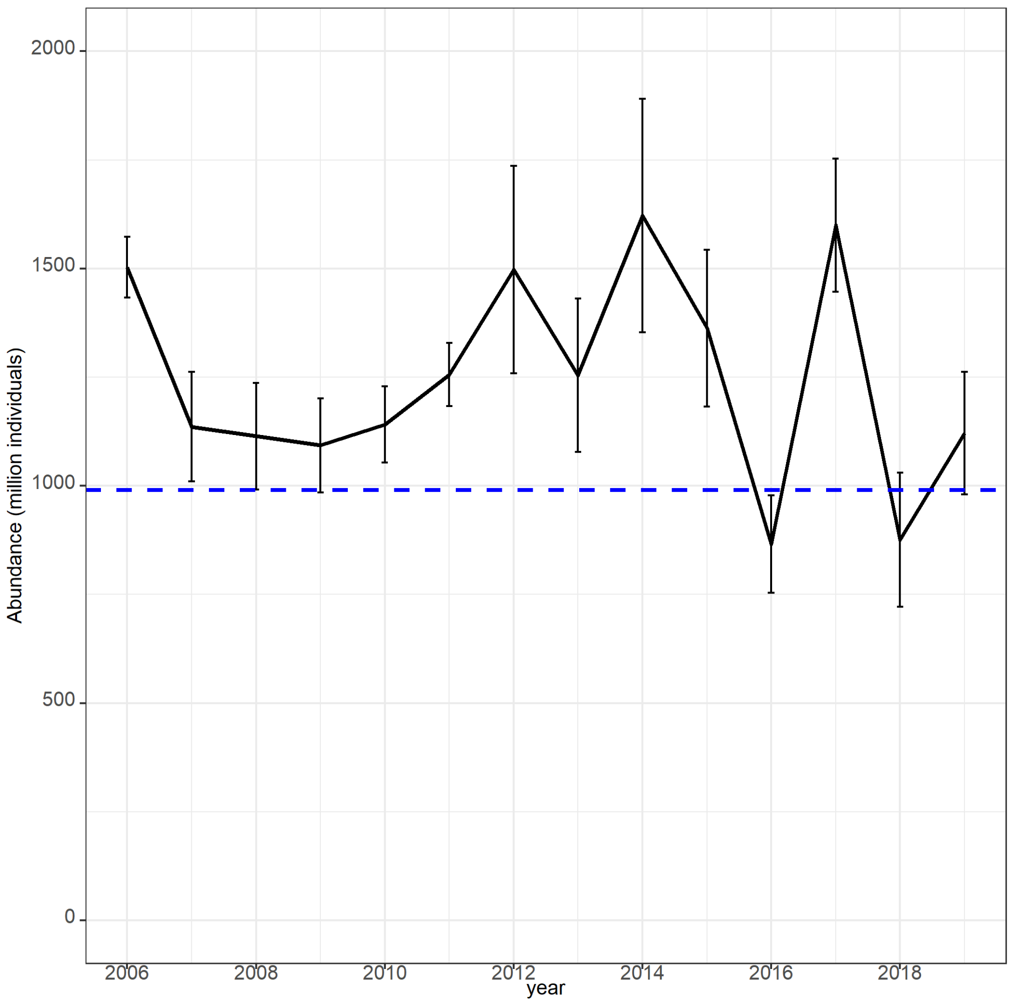


Figure 24.2.10. ***Nephrops*** **in FU22 (Smalls Grounds). Time-series of abundance estimates for FU22 (error bars indicate 95% confidence intervals) and MSY $B_{trigger}$ is dashed blue line.**

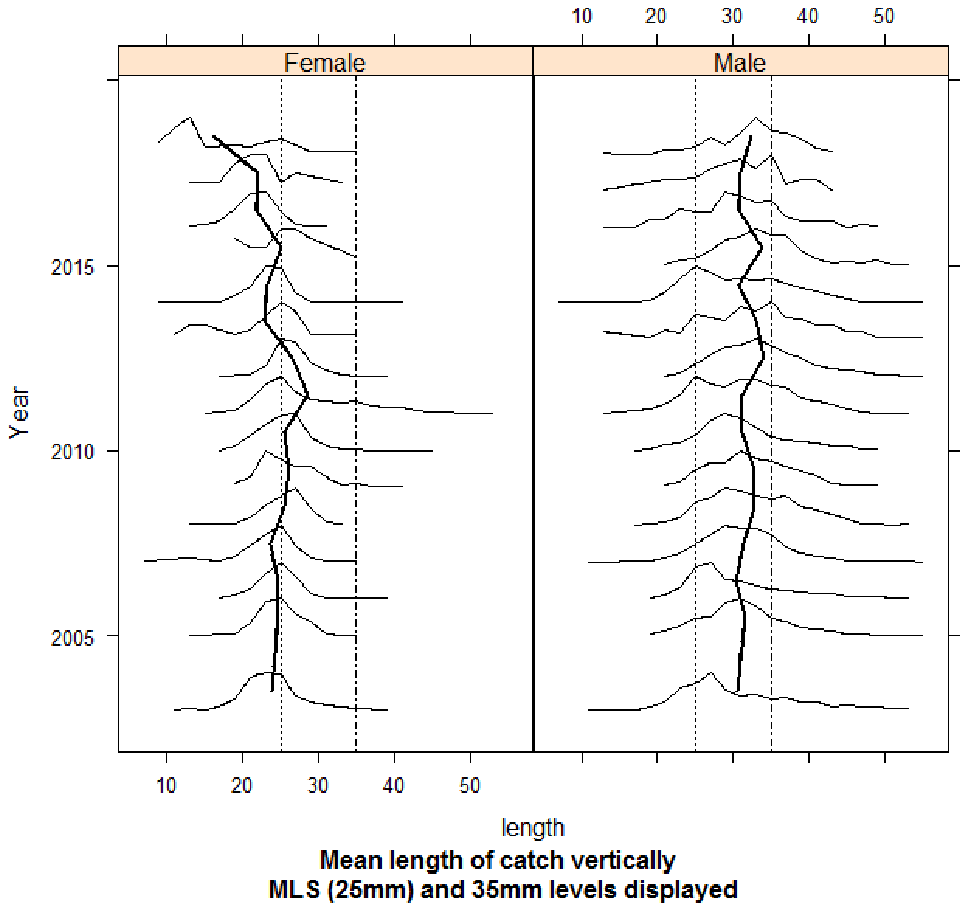


Figure 24.2.11. ***Nephrops*** **in FU22 (Smalls Grounds). Mean size trends (Carapace length CLmm) for catches by sex from Irish Groundfish Survey 2003–2018.**

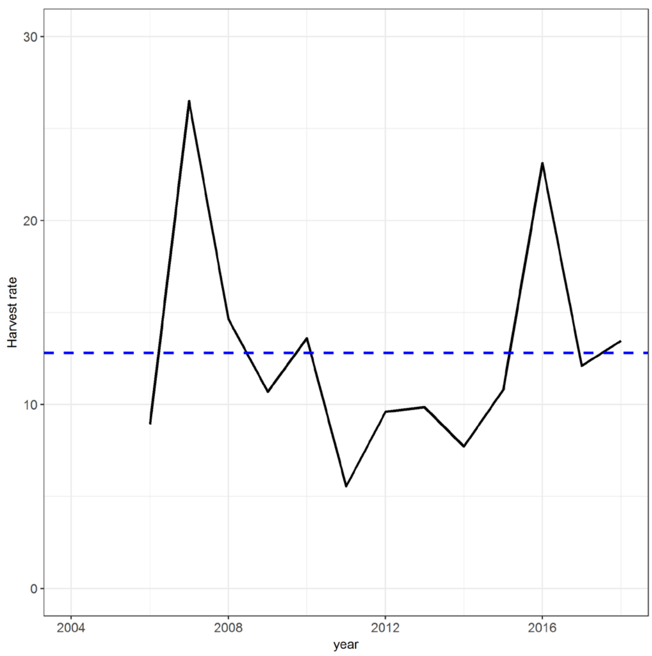


Figure 24.3.1. ***Nephrops*** **in FU22 (Smalls Grounds). Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

22 Plaice in Division 27.7.a (Irish Sea)

Type of assessment in 2019

WKIrish3 (ICES, 2017) benchmarked this assessment and choose the SAM model, including estimates of discards-at-age into the catch matrix. A baseline run of the model was performed using discards since 1981 reconstructed according to the medium dis-card scenario (ICES, 2017).

ICES advice applicable to 2018

ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 3336 tonnes. If this stock is not under the EU landing obligation in 2018 and discard rates do not change from the average of the last three years (2014–2016), this implies landings of no more than 1793 tonnes.

ICES advice applicable to 2019

ICES advises that when the MSY approach is applied, catches in 2019 should be no more than 3503 tonnes.

Last year's advice is available at:

http://ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/ple.27.7a.pdf

22.1 General

Stock description and management units

The stock assessment area and the management unit are both Division 27.7.a (Irish Sea).

Management applicable in 2018 and 2019

Management of plaice in Division 27.7.a is by TAC and there is a Minimum Conservation Reference Size (MCRS) of 27 cm in force. The agreed TACs and associated implications for plaice in Division 27.7.a are detailed in the tables below.

2018

Species: Plaice *Pleuronectes platessa*		**Zone:** 7a (PLE/07A.)
Belgium	46	
France	20	
Ireland	1 255	
The Netherlands	14	
United Kingdom	458	
Union	1 793	
TAC	1 793	Analytical TAC Article 7(2) of this Regulation applies

(Source: Council Regulation (EU) 2018/120, ANNEX IA)

2019

Species:	Plaice *Pleuronectes platessa*	**Zone:**	7a (PLE/07A.)
Belgium	134		
France	58		
Ireland	1 499		
The Netherlands	41		
United Kingdom	1 343		
Union	3 075		
TAC	3 075		Analytical TAC Article 7(2) of this Regulation applies

(Source: Council Regulation (EU) 2019/124, ANNEX IA)

The fishery in 2018

National landings data reported to ICES and Working Group estimates of total landings are given in Table 21.1. A summary by gear is given below.

Catch (2018)		Landings			Discards		
81% dead	19.04% surviving	Beam trawl	Otter trawl	Other gear types	Beam trawl	Otter trawl	Other gear types
		33%	64%	2.5%	54%	41%	5.0%
830 t		435 t			395 t		
					60% dead		40% surviving

The TAC for 2018 was 1793 tonnes and the working group estimate of landings in 2018 was 435 tonnes, which is a 26% decrease in landings comparable to 2017 and represents 24% of the 2018 TAC. This shortfall in estimated landings relative to the TAC has occurred in previous years, increasing steadily from 7% of the TAC in 2003 to around 70% in 2008, 2009 and 2012 and around 80% in 2013 and 2014, before falling to 60% in 2015 and 2016. The poor uptake of the quota is not a consequence of an inability to catch sufficient quantities of plaice greater than the MCRS but rather is most likely due to the limited market demand and poor value of the catch.

Landings (based on working group estimates) by the Irish, NI, UK and Belgian fleets comprised approximately 58%, 17%, 14% and 10% respectively of total landings in 2018. The landings of plaice are mainly split between beam trawlers (44%; primarily Irish vessels then Belgian vessels) targeting sole, and otter trawlers (52 %; UK and Irish vessels). Historically, otter trawling was dominated by UK vessels fishing for whitefish, but in recent years, many vessels have switched to target *Nephrops* (Figure 21.1). Otter trawlers from Ireland and N. Ireland typically target *Nephrops* in the western Irish Sea.

High levels of discarding are known to occur in all fisheries that catch plaice in the Irish Sea (see Figures 21.4 and 21.5).

A general description of the fishery can be found in the stock annex and also in 'Other Relevant Data' section below. For general mixed fisheries advice applicable to this stock and other species taken in the same fisheries, see Section 6.1.

22.2 Data

Landings

National landings data reported to ICES and Working Group estimates of total landings are given in Table 21.1. The working group procedures used to determine the total international landings numbers- and weights-at-age are documented in the stock annex. As a result of increased rates of discarding, landed numbers-at-age for the younger ages (ages 2 to 4) have declined more rapidly over the last two decades than landings of older fish (Figure 21.2a).

Discards

Discard sampling has been conducted by the UK(E&W) since 2002 and by Ireland since 1993; Northern Ireland has collected data from 1996 (but not between 2003 and 2005), and Belgium since 2003. Length distributions (LD) of landed and discarded fish estimates for year 2018 are available from InterCatch are presented for UK(E&W) and Irish otter trawlers targeting demersal fish and to *Nephrops* (Figure 21.4 and Figure 21.5). For all the fleets except the Irish otter trawlers the pattern is dominated by discarding of small fish, below the MCRS of 27 cm.

WKFLAT (ICES, 2011) first estimated total international discards-at-age and introduced them to the assessment of the stock for the first time. Due to limitations in the data available by gear type, discards for Ireland, France and Northern Ireland, for the years 2004–2011 were raised using UK estimates on the basis of equivalent gear types. A raising factor based on tonnages landed for these countries was calculated and applied to the UK(E&W) estimates of discard numbers. Finally, these estimates were added to those calculated for Belgium to give estimates of total international discard numbers-at-age.

Since 2012, catch data (landings and discards) are available from InterCatch disaggregated by country and fleet. Total international discards are raised from available discards data.

The total discard estimates (Table 21.1, Figure 21.2b) confirm the significant proportion of discarding that occurs in the fishery, which has increased in time. Since 2004, the majority of the catch has been discarded (61% and 82% average discard in weight and in numbers respectively, since 2004).

There is a considerable historic time period (1981–2003) for which no international raised discard estimates are available. The method for reconstructing discards prior to 2004 is based on size-varying discard rates and is documented in Annex 4 of the WKIrish3 report (ICES, 2017).

Biological

Landings numbers-at-age are given in Table 21.5 and plotted in Figure 21.2a. Weights-at-age in the landings are given in Table 21.6. Discard weights-at-age are given in Table 21.7 and weights-at-age in the stock in Table 21.8. The history of the derivation of the landings weights and stock weights used in this assessment is described in the stock annex.

Mean weight-at-age in the landings and survey data indicate declines in both sexes throughout the Irish Sea since 1993 so that plaice at ages ≤4 are typically below MRCS.

Surveys

All available tuning data are shown in Tables 21.2, 21.3 (a and b) and 21.4. Due to inconsistencies in the available commercial tuning fleets, Irish Sea plaice assessments since 2004 have only included the UK (E&W) beam trawl survey (UK (E&W)-BTS-Q3) and the two NIGFS-WIBTS spawning biomass indices based on ground fish surveys (NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4). For more information see WGNSDS (ICES, 2004). The UK (E&W)-BTS-Q3 index was revised by WKFLAT 2011 to include stations in the western Irish Sea and in St George's Channel. A second revision was conducted last year to correct for some inconsistency in the index calculation This revision did not substantially change the trend of the biomass index (see WD Cambiè and Earl, 2017 in WGCSE 2017 report).

Reviews of the UK (E&W)-BTS-Q3 mean standardised cpue trends have indicated that the survey has good internal consistency in monitoring trends across the stock area. For the entire Irish Sea, the biomass index of ages 1–4 fish calculated from the UK (E&W)-BTS-Q3 (Figure 21.3, right) indicates two periods of upwards trend, 1993–2003 and from 2007–2015. It is however, detected to have dropped from 2016. An increase of biomass in older ages is observed (Figure 21.3, left). The NIGFS-WIBTS surveys show similar increases in biomass between 1993 and 2003 and then a further increase subsequently until most recent years.

The NIGFS-WIBTS survey strata can be disaggregated into western (Strata 1–3) and eastern (Strata 4–7) subareas, where the subareas are divided by the deep trench that runs roughly north–south to the west of the Isle of Man (Figure 21.6, Tables 21.3a and b). The opposite trend between spring and autumn estimates of mean biomass in 2018 is mainly driven from eastern (Strata 4–7) subarea.

The SSB of plaice in the Irish Sea is also independently estimated using the Annual Egg Production Method (AEPM), according to Armstrong *et al.*, 2001 methodology.

Year	SSB (tonnes)	Catch/SSB harvest rate
1995	9081	
2000	13 303	
2006	14 417	15.16
2008	14 352	12.77
2010	15 071	19.5

Catch (discards available from 2004) to egg survey biomass ratios indicate historically that the plaice in the Irish Sea has been lightly exploited. Splitting the SSB estimates from the AEPM into eastern and western Irish Sea areas (Figure 21.7) also indicates that the perceived increase in plaice biomass is due to increased production in the eastern Irish Sea only (for more details see stock annex).

In summary, the UK (E&W)-BTS-Q3 in September, the NIGFS-WIBTS-Q4 index in October (but not NIGFS-WIBTS-Q1 March), and the AEPM indicate a sustained increase in biomass in the eastern Irish Sea, but this rise does not appear to extend across the deep channel to plaice in the western Irish Sea (Figure 21.7).

Commercial cpue

Age-based tuning data available for this assessment, comprise three commercial fleets: the UK(E&W) otter trawl fleet (UK(E&W) OTB, from 2008), the UK(E&W) beam trawl fleet (UK(E&W) BT, from 1989) and the Irish otter trawl fleet (IR-OTB, from 1995). Due to inconsistencies in the available tuning fleets, Irish Sea plaice assessments since 2004 have omitted these indices. For more information, see WGNSDS 2004. The effort and catch by these commercial fleets has been very low in recent years and the cpue data are no longer considered informative.

Other relevant data

Table 21.2 and Figure 21.1 show that effort levels have decreased since 2002 for the majority of fleets. Both the UK otter and beam trawl fleets are close to their lowest recorded effort levels in time-series extending back to 1972 and 1983 respectively. Effort by UK *Nephrops* trawlers has greatly increased in the years 2006–2014 but has decreased in the last years. However, this fleet is now the dominant UK fleet in terms of hours fished in 27.7.a. Belgian vessels operating in Division 7 typically move in and out of the Irish Sea, depending on the season, from specifically the Bristol Channel and Celtic Sea, the Bay of Biscay and the southern North Sea.

Since 2013, a problem with the gear effort information (000s hours fished) reported for the UK (E+W) commercial beam trawl fleet has been registered. Effort information from this fleet is largely missing as a result of a larger component of the fleet using the EU electronic logbook system to report its activities. Gear effort information reporting has not been mandatory with this system to date. As a result, few trips reported their gear effort information rendering the overall effort reported and resulting lpue unusable. However, an initial inspection of an alternate effort indicator for this gear (days fished) suggests that UK beam trawl effort in 2013, 2014, 2015, 2016, and 2017 is at the level observed in 2012. The otter trawl fleet effort reporting was unaffected by this as these vessels were not reporting their landings via this method in these years.

22.3 Historical stock development

Model: Age-based analytical assessment (State-space Assessment Model, SAM) that uses landings and discards (Nielsen and Berg, 2014).

Software: R version 3.5.1 with additional packages (version in parenthesis):

stockassessment (0.8.1); FLCore (2.6.13); reshape (0.8.8); ggplot2 (2.3.1.1); Cairo (1.5–10); doParallel (1.0.14); TMB (1.7.15); devtools (2.0.2).

Model options chosen

The AP model (Aarts and Poos, 2009) was replaced by SAM. WGCSE (ICES, 2016) agreed that the AP model was not the definitive assessment tool for Irish Sea plaice but a temporary solution to the fitting of datasets which included recent discards estimates but for which historic discard information was not available. Reconstructed values of historic discards (prior 2004) were provided in the WKIrish3 (ICES, 2017). The SAM model incorporates the estimated historic discards and is used to run the assessment since 2017.

The model runs were performed using the R package 'stockassessment'. Settings for this update stock assessment are given in the table below. The update assessment follows the same procedure as in the WKIrish3 benchmark assessment. A baseline run of the model was performed using discards since 1981 reconstructed according to the medium discard scenario (ICES, 2017). Discard survival was set at 40%, and natural mortality followed a Lorenzen curve, scaled to 0.12.

Input data types and characteristics

Commercial catch-at-age data. Discards values available from 2004. Estimates of discards reconstructed for 1981–2003 (WKIrish3). Only the dead fraction of discards (0.6) is accounted for in the model. Three survey indices (UK (E&W)-BTS-Q3, NIGFS-WIBTS-Q1, and NIGFS-WIBTS-Q4); fixed maturity ogive; natural mortality constant over years and different across ages.

Final update assessment

WKIrish3 benchmarked this assessment and included estimates of discards-at-age into the catch matrix.

The assessment settings are shown in the following table, with changes to the previous year's settings highlighted in bold. Historic settings are given in the stock annex.

Assessment year		2015	2016	2017	2018	2019
Assessment model		AP	AP	SAM	SAM	SAM
Tuning fleets	UK (E&W)-BTS-Q3	Survey omitted	Survey omitted	Survey omitted	Survey omitted	Survey omitted
	Extended UK (E&W)-BTS-Q3	1993–**2014**, ages 1–6	1993–**2015**, ages 1–6	1993–**2016**, ages 1–7	1993–**2017**, ages 1–7	1993–**2018**, ages 1–7
	UK(E&W) BTS Mar	Survey omitted	Survey omitted	Survey omitted	Survey omitted	Survey omitted
	UK(E&W) OTB	Series omitted	Series omitted	Series omitted	Series omitted	Series omitted
	UK(E&W) BT	Series omitted	Series omitted	Series omitted	Series omitted	Series omitted
	IR-OTB	Series omitted	Series omitted	Series omitted	Series omitted	Series omitted
	NIGFS-WI-BTS-Q1	1992–**2014**	1992–**2015**	1992–**2016**	1992–**2017**	1992–**2018**
	NIGFS-WI-BTS-Q4	1992–**2014**	1992–**2015**	1992–**2016**	1992–**2017**	1992–**2018**
Selectivity model		Linear Time Varying Spline at age (TVS)	Linear Time Varying Spline at age (TVS)	Correlated random walk	Correlated random walk	Correlated random walk
Discard fraction		Polynomial Time Varying Spline at age (PTVS)	Polynomial Time Varying Spline at age (PTVS)	Estimated by WKIRISH3	Estimated by WKIrish3	Estimated by WKIRISH3
Landings N at age		1–9+	1–9+	1–8+	1981–**2017**, ages 1–8+	1981–**2018**, ages 1–8+
Discards N at age		2004–**2013**, ages 1–5	2004–**2014**, ages 1–5	1981–**2016**, ages 1–8+	1981–**2017**, ages 1–8+	1981–**2018**, ages 1–8+

The estimated selectivity patterns split into the landed and discarded components are shown in Figure 21.8. Until early 1990s, the landings selectivity had the highest values for fish aged 4 (indicating that four years age fish were selected). This selectivity shifted to age 5 in late the 1990s and early 2000s, due to the increase of the MCRS in 1998 (from 250 mm to 270 mm). Since late 2000s landings gradually fell over time to very low values relative to the discard pattern, which became dominant and expanded to the older aged fish during the most recent years.

The catchability of the UK(E&W)-BTS-Q3 survey is elevated for ages 1 and 2 and reflects the nature of the survey, which was designed as a recruit index (Figure 21.9).

Diagnostic output from the SAM model is shown in Figure 21.10. In the catch residuals, negative values are apparent in ages 8+ from 1998. A year effect in 2004 is present in the UK(E&W)–BTS-Q3 residuals (which is the first year for which discard data are available). A pattern of negative residuals between 2004 and 2009 is present in the residuals of the NIGFS-WIBTS due to large fluctuations in the SSB indices, which are due potentially to variable catchability of the survey.

Recruitment is fluctuating without an overall trend, and it is estimated at its lowest values in 2017 and 2018. The standardised values of the recruitment estimated by the SAM model and the standardised value of age 1 from the UK-BTS survey are characterised by similar pattern, demonstrating consistency in the model estimates (Figure 21.11).

The estimated SSB from the SAM model shows an increasing trend from 1995 until 2004–2005, followed by a drop in 2006 and 2007. This change in SSB trend from 2004 is probably due to the inclusion of more reliable discards values since 2004, when international raised discard estimates became available. Since 2012, SSB has increased reaching the highest value of the whole time-series in 2016. A slight decrease is observed in estimated SSB in 2017 followed by an increase in 2018. The SSB trend is largely in agreement with independent SSB estimates from the Annual Egg Production Method (AEPM), up to the most recent estimate in 2010, as well as with the survey data used in the assessment (NIGFS-WIBTS-Q1 and -Q4; UK(E&W)-BTS-Q3, Figure 21.12).

Estimates of numbers-at-age in the landings, discards and population, and fishing mortality numbers-at-age are given in Tables 21.9–21.12. A summary plot for the SAM assessment is shown in Figure 21.13 and the time-series estimates for F_{bar}, SSB and recruitment are given in Table 21.13.

Comparison with previous assessments

In 2017, the Aarts and Poos model was replaced by the state–space assessment model (SAM). The assessment used the Lorenzen M scaled to 0.12, and the most recent maturity ogive for the survey.

The methodology provided is as robust as possible and does not currently appear to suffer from a serious retrospective pattern (Figure 21.14). The ten assessment model configurations compared in WKIrish3 perform similarly in terms of temporal trends in SSB, recruitment, catch and F_{bar}. Small retrospective bias in SSB in 2004 likely resulted from the introduction of discards estimates based on samples collected from that year (prior to 2004, discards estimates are reconstructed values based on size-varying discard rates). A Mohn's rho analysis for a five-years peel resulted in values of 0.23% for recruitment, 4.64% for SSB and -5.47% for F_{bar}.

State of the stock

Trends in F_{bar} SSB, recruitment and catch, for the full time-series, are shown in Table 21.13 and Figure 21.13. The assessment consistently estimates that fishing mortality declined from high levels in the 1980s and early 1990s to very low levels, having been <0.1 since 2013. Since 2012, SSB has increased reaching the highest value of the whole time-series in 2016, whereas it has slightly decreased in 2017. Estimated recruitments are highly variable. An increasing trend was present until 2015 although it seems to have dropped to the lowest values in 2017 and 2018. Catch has decreased to low levels and, since 2006, the majority of the catch has been discarded (61% in weight and 82% and number respectively, averaged since 2004).

22.4 Short-term projections

Forecasting takes the form of short-term stochastic projections. A total of 1000 samples are generated from the estimated distribution of survivors. These replicates are then simulated forward according to model and forecast assumptions (see table below), using the usual exponential decay equations, but also incorporating the stochastic survival process (using the estimated survival standard deviation) and subject to different catch-options scenarios. Recruitment in the intermediate year (2019) was taken as the median from a distribution about the assessment estimate. Estimates of recruitment for intermediate year and subsequent years were resampled from the 2015–2018 year classes, reflecting recent low levels of recruitment. These re-sampled recruitments are only used for SAM forecasts in order to evaluate future stock dynamics.

Initial stock size	Starting populations are simulated from the estimated distribution at the start of the intermediate year (including covariances)
Maturity	Average of final three years of assessment data
Natural mortality	Average of final three years of assessment data
F and M before spawning	Both taken as zero
Weight at age in the catch	Average of final three years of assessment data
Weight at age in the stock	Assumed to be the same as weight-at-age in the catch
Exploitation pattern	Fishing mortalities taken as a three-year average
Stock recruitment model used	Recruitment for the intermediate year onwards is sampled, from 2015 to the final year of catch data.
Procedures used for splitting projected catches	An average of final three years of landing fractions are used in the forecast period. Discard values are raised to include the live portion. Discard numbers multiplied by 5/3 to account for discard survival. Total catch is sum of three components: landings, discards assumed to die, and discards assumed to survive.

F estimates 2016–2018 has fluctuated around similar values, from 0.050 (2016) to 0.066 (2017) and 0.064 (2018). F *status quo*, Fsq, is set to the same level as F in 2018 and mean F_{bar} has been estimated by averaging the F over 2016–2018.

A full management options table is provided in Table 21.14. Note that the values that appear in the catch scenarios are medians from the distributions that result from the stochastic forecast. Implementing the management plan for this stock with F_{MSY}=0.196 leads to a total catch of 3299 t (1931 t of landings and 1368 t of discards including dead and survivors) in 2020 and SSB of 18 354 t in 2021.

22.5 Medium-term projections

There are no medium-term projections for this stock.

22.6 MSY explorations

The reference points for this stock were estimated in 2018 (ICES, 2018) as ICES request for EU western waters stocks and are presented in the table below.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	8757 tonnes	Lower 5th percentile of B F_{MSY}	ICES (2018)
	F_{MSY}	0.196	Stochastic simulations with segmented regression from the entire time-series (1981–2017)	ICES (2018)
Precautionary approach	B_{lim}	3958 tonnes	B_{loss} = minimum SSB observed	ICES (2018))
	B_{pa}	5294 tonnes	$B_{lim} \times \exp(1.645 \times \sigma)$; σ = 0.177	ICES (2018)
	F_{lim}	0. 50	F with 50% probability of SSB < B_{lim}	ICES (2018)
	F_{pa}	0.36	$F_{lim} \times \exp(-1.645 \times \sigma)$; σ = 0. 201	ICES (2018)
Management plan	SSB_{mgt}	Not applica-ble		
	F_{mgt}	Not applica-ble		

Yield per Recruit analysis

There are no yield per recruit analyses for this stock.

22.7 Management plans

There are no management plans for this stock.

22.8 Uncertainties and bias in assessment and forecast

The assessment was benchmarked in 2017 (WKIrish3), which resulted in the SAM model being fitted using catches based on reconstructed estimates of discards prior to 2004. This discard reconstruction introduces additional uncertainty in the model. The model estimates of stock development since 2004 are more reliable as based on direct discard estimates. The SAM model considered only the dead portion of the discards (60%), but in the forecast the estimates are raised to include the surviving discards.

22.9 Recommendations for next benchmark

There is evidence of substantial substock structure and incorporating information about the differences in growth and maturity between the east and west sides of the Irish Sea, as well as by sex should be explored.

Incorporating data on changes in maturity and natural mortality over time, linked to the decreasing in weights-at-age observed in survey data, should also be considered. There is evidence of a decline in weight-at-age from the commercial landings data and survey data. The UK(E&W)-BTS-Q3 survey data also indicate declines in length-at-age and maturity-at-age.

Creating age-based indices for the NI groundfish surveys would improve the assessment.

Ecosystem information ought to be explored.

Year	Candidate Stock	Supporting Justification	Suggested time	Indicate expertise necessary at benchmark meeting
2019	27.7.a Plaice	- Incorporating data on changes in maturity and natural mortality over time, linked to the decreasing in weights-at-age observed in survey data. - Incorporate information about the differences in growth and maturity be-tween the east and west sides of the Irish Sea, and by sex. - Creating age based indices for the NI groundfish surveys	when sufficient progress has been made	Expert group members

22.10 Management considerations

The high level of discarding in this fishery indicates a mismatch between the minimum landing size and the mesh size of the gear being used. Any measures that effect a reduction in discards will result in increased future yield. However, the market demand for plaice is poor and small plaice are particularly undesirable. Strong year effects are seen in the discard data and these are likely due to spatial structure in the stock. Spatial management of fleets in the Irish Sea may reduce the discarding of plaice.

The overall state of the stock is consistently estimated to have low fishing mortality and high spawning biomass. Therefore, the stock is considered to be within safe biological limits.

Discarding has increased throughout the period in which data are available, while landings of plaice have decreased, even though the TAC is not restrictive. Effort has decreased in fisheries targeting plaice (including UK(E&W) and Belgian beam-trawl fisheries, and UK(E&W) and Irish otter trawl fisheries targeting demersal fish). In contrast, effort by the UK(E&W) *Nephrops* fleet has increased, however, this is still small in comparison to effort by the Irish *Nephrops* fleet. The main *Nephrops* grounds are located in the western Irish Sea, where relatively small plaice are found. Technical measures to mitigate discarding by all *Nephrops* fleets could include the use of sorting grids: gear selectivity trials and monitoring from four Irish *Nephrops* trawlers using grids since 2009 indicate a potential reduction in fish discarding by 75% (BIM, 2009).

22.11 References

Aarts, G., and Poos, J.J. 2009. Comprehensive discard reconstruction and abundance estimation using flexible selectivity functions. ICES Journal of Marine Science, 66: 763–771.

Armstrong M. J., Connolly P., Nash R. D. M., Pawson M. G., Alesworth E., Coulahan P. J., Dickey-Collas M., Milligan S. P., O'Neill M., Witthames P. R. and Woolner L. 2001. An application of the annual egg production method to estimate spawning biomass of cod (*Gadus morhua* L.), plaice (*Pleuronectes platessa* L.) and sole (*Solea solea* L.) in the Irish Sea. ICES Journal of Marine Science, 58, 183–203.

BIM. 2009. Summary report of Gear Trials to Support Ireland's Submission under Articles 11 & 13 of Reg. 1342/2008. *Nephrops* Fisheries VIIa & VIIb–k. Project 09.SM. T1.01. Bord Iascaigh Mhara (BIM) May 2009.

Cambiè and Earl, 2017. Review of the UK (E&W)-BTS-Q3 abundance index for Irish Sea plaice (ple-iris, plaice 7a) Working Document for Working Group on Celtic Seas Ecoregion (WGCSE), 9–18 May, Copenhagen, Denmark. ICES CM 2017/ACOM:13.

ICES. 2004. Report of the Working Group on the assessment of Northern Shelf Demersal Stocks (WGNSDS). ICES Document CM 2005/ACFM: 01. 722 pp.

ICES. 2011. Report of the Benchmark Workshop on Flatfish (WKFLAT), 1–8 February 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:39.

ICES, 2016. Report of the Working Group on Celtic Seas Ecoregion (WGCSE). 4–13 May, Copenhagen, Denmark ICES CM 2016/ACOM:13.

ICES. 2017. Report of the Benchmark Workshop on the Irish Sea Ecosystem (WKIrish3), 30 January–3 February, Galway, Ireland. ICES CM 2017/BSG:01.

ICES. 2018. ICES Special Request Advice Celtic Seas Ecoregion. EU request to ICES to provide plausible and updated FMSY ranges for the stocks of species inhabiting western EU waters. https://doi.org/10.17895/ices.pub.4149

Nielsen, A., and Berg, C.W. 2014. Estimation of time-varying selectivity in stock assessments using state–space models. Fisheries Research, 158: 96–101.

Table 21.1. Plaice in Division 7.a. History of official landings and ICES estimates of discards. Weights are in tonnes.

Year	Belgium	France	Ireland	Netherlands	UK (NI, Eng.&Wales)	UK (Isle of Man)	UK (Scotland)	Total official landings	Discards
1994	332	13	547	-	1082	14	63	2051	
1995	327	10	557	-	1050	20	60	2024	
1996	344	11	538	69	878	16	18	1874	
1997	459	8	543	110	798	11	25	1954	
1998	327	8	730	27	679	14	18	1803	
1999	275	5	541	30	687	5	23	1566	
2000	325	14	420	47	610	6	21	1443	
2001	482	9	378	-	607	1	11	1488	
2002	636	8	370	-	569	1	7	1591	
2003	628	7	490	-	409	1	9	1544	
2004	431	2	328	-	369	0	4	1134	1031
2005	566	9	272	-	422	0	1	1270	1210
2006	343	2	179	0	413	0	0	937	1254
2007	194	2	194	0	412	0	-	802	1744
2008	157	2	102	0	301	1	1	564	1268
2009	197	0	73	0	187	1	2	460	1132
2010	138	0	89	0	150	0	3	380	2561
2011	332	0	118	0	146	0	0	596	603
2012	236	0	108	0	164	0	0	508	1010
2013	144	0	103	0	92	0	0	339	725
2014	100	0	123	0	59	0	0	282	943
2015	115	0	244	0	80	0	0	439	572
2016	82	0	605	-	56	-	-	742	437
2017	77	0	446	-	62	-	-	585*	852
2018	52	0	315	-	64	-	-	432*	395

*** Preliminary.**

Table 21.2. Irish Sea plaice: English standardised lpue and effort, Belgian beam trawl lpue and effort and Irish otter trawl lpue and effort series.

Year	CPUE			LPUE							Effort							
	UK(E&W) Beam trawl survey[1]			UK (E&W)[2]				Belgian[5]	Irish[7]		UK (E&W)					Belgian	Irish[9]	
	March	September Prime only	September Extended	Otter[3] Trawl	Otter[4] Trawl	Beam[3] Trawl	Beam[4] Trawl	Beam Trawl	Otter Trawl	Beam Trawl	Otter[3] Trawl	Otter[4] Trawl	Beam Trawl	Beam[4] Trawl	Nephrops[3] Trawl	Beam Trawl	Otter Trawl	Beam Trawl
1972				6.96				9.8			128.4					6.8		
1973				6.33				9.0			147.6					16.5		
1974				7.45				10.4			115.2					14.2		
1975				7.71				10.7			130.7					16.2		
1976				5.03				5.8			122.3					15.1		
1977				4.82				5.3			101.9					13.4		
1978				6.77		4.88		6.9			89.1		0.9			12.0		
1979				7.18		15.23		8.0			89.9		1.7			13.7		
1980				8.24		8.98		8.6			107.0		4.3			20.8		
1981				6.87		4.91		7.1			107.1		6.4			26.7		
1982				4.92		1.77		4.4			127.2		5.5			21.3		
1983				5.32	1021	3.08	0	7.8			88.1	1716.5	2.8	0		18.5		
1984				7.77	1472	6.98	810	6.8			103.1	7932.1	4.1	263		13.6		
1985				9.97	1946	25.70	5487	8.8			102.9	6930.8	7.4	428.1		21.9		
1986				9.27	1597	4.21	753	8.7			90.3	6693.2	17.0	1122.9		38.3		
1987				7.20	1479	3.57	963	8.2			130.6	9008.9	22.0	1178.5		43.2		
1988		392		5.02	1060	3.05	743	6.3			132.0	8292.4	18.6	1019.2		32.7		
1989		253		5.51	1109	13.59	2559	6.2			139.5	16161.4	25.3	1344.5		36.7		
1990		239		5.93	1074	12.02	3011	7.2			117.1	7724.5	31.0	1473.1		38.3		
1991		157		4.79	916	10.56	2807	7.5			107.3	7081.1	25.8	1211.3		15.4		
1992		188		4.20	719	9.99	2303	11.9			96.8	6671.8	23.4	908.1		23.0		
1993	91	235	149	3.97	667	9.50	2220	5.0			78.9	6013.1	21.5	826.9		24.4		
1994	128	225	132	4.90	770	7.79	1020	9.2			43.0	3060	20.1	1451.6	0	31.6		
1995	134	169	109	5.08	806	7.69	1001	9.5	3.2	17.3	43.1	3357	20.9	1429.4	0	27.1	80.1	8.5
1996	-[6]	210	111	5.37	732	12.96	2587	11.8	4.1	19.0	42.2	3085.1	13.3	894.3	0	22.2	64.7	6.2
1997	147	262	148	5.25	662	7.66	944	13.9	3.1	13.7	39.9	2903.3	10.8	784.4	0	29.3	92.0	9.9
1998	113	249	146	5.00	657	5.66	766	12.3	3.7	22.3	36.9	2620.6	10.4	696	0	23.8	93.5	11.5
1999	-[6]	264	151	5.38	632	7.76	895	7.1	2.3	23.2	22.9	1803.5	11.0	778.9	0	37.2	109.7	14.7
2000	-[6]	357	169	5.02	828	13.04	1773	7.8	2.0	13.8	27.0	2034.9	6.3	410.7	0	27.0	82.6	11.4
2001		281	147	3.35	539	8.33	1017	9.2	2.9	14.0	33.0	2352.9	12.5	767.4	0	41.9	77.4	13.1
2002		340	200	5.66	840	5.46	445	7.4	2.8	7.9	24.8	1774	8.0	535.1	0	52.5	77.4	17.7
2003		503	247	2.60	414	3.76	400	7.5	4.1	9.5	23.9	1728.3	14.0	863.7	0	48.7	73.8	18.6
2004		540	249	3.17	472	4.20	255	11.2	2.1	8.6	23.5	1727	7.4	419.9	0	36.1	72.5	14.2
2005		367	177	4.85	540	4.67	381	12.8	2.0	8.0	16.7	1313.6	11.6	627.8	1	42.1	69	14.7
2006		356	166	6.50	610	2.19	202	10.8	1.4	6.2	5.2	478.5	4.6	280.1	10.9	28.9	66.8	12.2
2007		432	190	17.94	756	4.22	550	6.9	1.3	6.1	4.4	397.2	3.2	193.5	12.6	23.8	75.9	14.2
2008		416	189	9.03	469	4.47	267	9.5	0.9	5.1	2.7	320.4	1.3	98	11.5	12.4	59.9	9.5
2009		467	199	6.46	338	1.21	169	10.1	1.1	3.8	1.5	157.7	0.46	24.9	10.0	14.7	42.8	7.6
2010		400	164	11.55	371	14.39	151	7.9	1.0	4.8	1.0	151	0.19	10.2	9.2	15.2	45.8	9.4
2011		417	140	4.35	183	11.95	701	17.3	1.2	6.8	0.69	72.7	1.56	91.2	8.6	16.4	54.5	8.1
2012		460	188	0.74	276	7.25	164	14.9	1.0	5.0	0.4	85	0.9	60.7	12.1	14.5	58.3	7.2
2013		550	207	7.41	236	-[8]	0	14.0	1.6	5.4	0.3	31.9	-[8]	1.3	10.6	8.9	42.6	5.0
2014		592	255	-	87	-[8]	0	13.9	1.5	8.3	-	16.1	-[8]	0.4	8.3	5.1	47.8	6.0
2015		564	230	-	0	-[8]	48	20.4	3.3	8.6	-	0	-[8]	0.9	4.5	4.6	39.8	8.3
2016		582	220	-	0	-[8]	0	26.4	4.6	32.8	-	0	-[8]	3.9	2.5	2.5	33.4	7.9
2017		525	170	-	244	-[8]	0	17.1	11.3	35.4	-	160.7	-[8]	0	0.3	4.2	12.1	7.5
2018		554	139	-	237	-[8]	0	-	8.4	19.5	-	238	-[8]	0	-	-	13.6	9.6

1 Kg/100km. Sept Prime: ISS/ISN Traditional Prime Stations Only. Sept Extended: ISS/ISN/ISW/SGC All Stations.
2 Whole weight (kg) per corrected hour fished, weighted by area
3 '000 hours fished (corrected for fishing power GRT)
4 days fished
5 Corrected for fishing power (HP) [data for 1999-2010, replaced at 2011WG following recalculation at WKFLAT 2011]
6 Carhelmar survey, Kg/100km not available
7 All years updated in 2007 due to slight historical differences
8 Effort not reported in hours for this fleet, see Section 6.7.2 for more detail
9 '000s hours
Fishing power corrections are detailed in Appendix 2 of the 2000 working group report

Table 21.3a. Irish Sea plaice: NIGFS-WIBTS-Q1 indices of relative biomass trends by region in spring.

NIGFS-WIBTS-Q1	ESTIMATED MEAN ABUNDANCE (kg/3 miles)			ESTIMATED STANDARD ERROR		
Mar (Spring)	Combined	West	East	Combined	West	East
Year	Str 1–7	Str 1–3	Str 4–7	Str 1–7	Str 1–3	Str 4–7
1992	8.35	5.47	9.20	3.45	1.96	4.44
1993	12.36	18.43	10.54	2.14	4.78	2.39
1994	9.65	4.47	11.09	2.43	1.46	3.12
1995	7.27	4.79	7.64	1.24	0.83	1.59
1996	7.29	12.60	5.70	1.64	5.71	1.28
1997	13.87	14.72	13.54	3.19	5.68	3.77
1998	10.40	13.32	9.00	2.73	7.10	2.84
1999	10.71	13.53	9.59	1.81	4.92	1.84
2000	12.92	26.29	8.88	4.11	17.00	1.66
2001	12.06	18.03	9.92	1.41	4.25	1.31
2002	15.27	27.95	11.17	2.53	8.39	2.14
2003	20.97	40.71	15.09	6.11	23.98	3.44
2004	8.55	5.69	9.40	1.74	1.21	2.24
2005	11.10	19.43	8.62	1.93	5.99	1.76
2006	7.85	12.14	6.39	1.39	4.62	1.16
2007	6.25	14.47	3.80	1.27	4.80	0.83
2008	4.46	5.11	4.57	0.76	1.23	0.91
2009	7.90	7.85	7.86	1.27	2.04	1.53
2010	19.40	8.77	17.30	1.86	2.70	2.28
2011	16.34	26.20	13.03	3.51	10.11	3.41
2012	14.22	21.47	11.05	2.37	7.48	2.13
2013	21.89	28.98	16.57	3.74	8.04	4.21
2014	11.43	10.96	9.65	2.04	4.82	2.22
2015	22.81	22.57	18.66	2.84	7.18	3.01
2016	34.52	30.29	35.77	7.17	9.95	8.82
2017	16.10	14.85	16.47	3.16	3.90	3.70
2018	19.26	22.86	18.18	4.11	10.19	4.39
2019	5.47	6.61	5.14	1.14	2.06	1.34

Table 21.3b. Irish Sea plaice: NIGFS-WIBTS-Q4 indices of relative biomass trends by region in autumn.

NIGFS-WIBTS-Q4	ESTIMATED MEAN ABUNDANCE (kg/3 miles)			ESTIMATED STANDARD ERROR		
Oct (Autumn)	Combined	West	East	Combined	West	East
Year	Str 1–7	Str 1–3	Str 4–7	Str 1–7	Str 1–3	Str 4–7
1992	4.81	2.31	5.55	0.92	1.10	1.15
1993	4.48	2.08	5.20	1.00	0.87	1.27
1994	8.73	5.49	9.69	2.30	2.83	2.86
1995	4.17	5.50	3.77	1.13	2.23	1.31
1996	8.68	8.85	8.63	2.25	5.94	2.33
1997	7.93	5.76	8.58	2.24	2.59	2.80
1998	5.33	3.68	5.82	1.46	2.48	1.74
1999	5.81	4.30	6.26	1.67	3.08	1.97
2000	9.75	2.20	12.00	5.76	1.13	7.47
2001	13.85	2.30	17.30	6.57	1.67	8.51
2002	9.80	5.90	10.97	3.91	3.61	4.97
2003	18.01	7.52	21.14	5.84	4.16	7.48
2004	7.79	1.64	9.63	1.80	0.81	2.33
2005	11.35	3.41	13.72	4.51	2.18	5.82
2006	6.61	2.56	7.82	1.53	1.42	1.94
2007	7.15	4.07	8.07	1.41	2.00	1.73
2008	8.68	3.28	10.27	2.20	2.09	2.78
2009	12.44	4.06	15.01	2.59	3.12	3.23
2010	15.58	5.83	18.53	5.26	5.21	6.65
2011	14.48	5.39	15.94	3.55	2.66	4.55
2012	16.05	17.89	15.65	4.43	11.16	4.68
2013	17.90	13.55	19.09	4.33	11.27	4.51
2014	22.18	27.67	20.35	7.61	24.88	6.52
2015	18.21	11.15	20.31	4.39	8.76	5.06
2016	17.57	0.95	22.53	4.52	0.43	5.86
2017	18.55	2.96	23.20	4.25	1.59	5.50
2018	7.21	6.89	7.30	1.86	6.08	1.59

Table 21.4. Irish Sea plaice: UK (E&W)-BTS-Q3 biomass index (extended area). Ages in bold are those used in the assessment (ages 1–7).

Year	Distance towed (kms)	0	1	2	3	4	5	6	7	8	9+
1993	292.77	0.13	4.64	4.03	0.82	0.43	0.03	0.04	0.08	0.01	0.02
1994	218.65	0.33	4.13	2.48	1.42	0.28	0.10	0.03	0.02	0.03	0.04
1995	218.65	0.78	5.56	1.96	0.84	0.41	0.07	0.05	0.02	0.00	0.03
1996	222.36	0.26	5.79	2.17	0.53	0.19	0.20	0.05	0.02	0.00	0.02
1997	218.65	0.96	5.47	2.91	1.26	0.30	0.16	0.17	0.05	0.02	0.03
1998	218.65	0.56	4.50	4.26	1.09	0.38	0.21	0.08	0.06	0.01	0.04
1999	214.95	1.86	3.96	3.91	1.99	0.68	0.29	0.09	0.07	0.03	0.05
2000	218.65	1.22	8.74	2.80	1.47	1.11	0.47	0.12	0.09	0.03	0.04
2001	214.95	0.83	5.99	3.62	1.11	0.60	0.54	0.11	0.06	0.02	0.01
2002	214.95	0.23	6.46	4.94	2.27	0.88	0.53	0.48	0.10	0.04	0.04
2003	211.24	2.07	6.12	5.85	2.61	1.58	0.58	0.38	0.25	0.07	0.07
2004	214.95	1.09	8.07	5.36	3.94	1.88	1.15	0.21	0.19	0.13	0.10
2005	211.24	1.75	3.76	4.75	1.98	1.42	0.80	0.48	0.11	0.09	0.06
2006	214.95	3.56	5.01	3.45	2.46	1.10	0.79	0.36	0.20	0.02	0.07
2007	214.95	1.15	7.97	4.47	1.66	1.20	0.65	0.33	0.25	0.14	0.06
2008	200.12	1.22	4.68	5.71	2.03	1.15	0.82	0.31	0.12	0.08	0.05
2009	214.95	1.23	4.74	3.40	3.30	0.99	0.66	0.63	0.16	0.11	0.20
2010	211.24	2.01	6.22	4.31	2.05	1.44	0.66	0.54	0.36	0.20	0.19
2011	211.24	1.02	6.73	4.28	1.75	1.00	1.08	0.47	0.27	0.24	0.37
2012	214.95	1.40	6.52	6.37	1.71	1.03	0.47	0.53	0.30	0.14	0.42
2013	214.95	2.04	4.33	5.05	3.08	1.60	1.07	0.47	0.44	0.20	0.42
2014	214.95	1.56	7.82	6.85	3.13	2.16	0.99	0.77	0.44	0.20	0.28
2015	214.95	1.02	6.16	6.88	2.60	1.80	1.04	0.66	0.37	0.19	0.50
2016	211.24	0.18	2.91	5.97	3.95	2.45	1.61	0.96	0.74	0.45	0.58
2017	214.95	0.03	1.35	4.77	2.81	2.23	1.84	0.75	0.59	0.38	0.26
2018	214.95	0.36	1.97	2.75	2.28	1.51	1.37	1.24	0.75	0.56	0.27

Table 21.5. Irish Sea plaice: Landings number-at-age 1 to 8+ (thousands), where rows are years 1981–2018 and columns are ages 1 to 8+.

IRISH SEA PLAICE
1 2
1981 2018
1 8
1

22	1742	5939	2984	837	222	105	236
27	715	3288	3082	1358	330	137	213
51	2924	2494	3211	1521	648	211	252
41	3159	5179	1182	1054	459	299	252
4	2357	6152	3301	614	429	262	340
31	1652	5280	2942	1287	344	371	308
62	3717	5317	5252	1341	1072	123	338
46	2923	5040	2552	1400	750	316	405
24	1735	5945	2671	854	436	214	364
15	1019	2715	2935	1132	465	259	223
180	2008	1506	1929	1205	465	182	226
151	1958	3209	1435	1358	903	388	294
28	910	1649	1357	474	556	377	302
97	1146	2173	1309	644	318	245	263
21	961	1703	1936	764	318	138	157
37	856	1345	1196	943	370	128	135
28	830	1590	1513	1003	482	285	257
6	691	1739	1025	612	476	403	385
68	803	1505	1294	696	280	196	242
0	450	1174	1284	686	212	219	203
14	374	1138	1083	767	409	179	166
1	206	940	1482	842	539	318	170
0	286	1031	1314	707	415	253	222
8	198	967	1104	705	247	114	186
6	228	708	1177	890	461	204	213
5	180	620	550	684	346	220	218
0	64	351	860	507	401	151	164
1	99	386	389	409	215	141	119
0	13	204	374	351	272	117	120
0	7	75	271	306	193	160	115
2	53	199	357	483	305	194	191
0	8	150	292	301	367	218	226
1	16	87	203	166	149	144	165
3	6	65	165	160	143	70	158
0	1	43	93	185	210	149	349
14	14	58	162	224	346	180	482
5	4	24	145	206	241	209	520
0	6	84	110	201	178	151	358

Table 21.6. Irish Sea plaice: Landings weight-at-age 1 to 8+ (kg), where rows are years 1981–2018 and columns are ages 1 to 8+

IRISH SEA PLAICE

1 3

1981 2018

1 8

1

0.069	0.176	0.267	0.376	0.512	0.592	0.678	1.085
0.201	0.274	0.284	0.348	0.421	0.545	0.650	0.889
0.232	0.261	0.290	0.319	0.368	0.426	0.484	0.699
0.260	0.290	0.330	0.380	0.470	0.560	0.660	0.964
0.290	0.310	0.340	0.390	0.470	0.540	0.630	0.851
0.270	0.280	0.340	0.420	0.500	0.540	0.630	0.980
0.260	0.290	0.315	0.370	0.440	0.520	0.610	0.916
0.230	0.260	0.300	0.370	0.460	0.550	0.680	1.243
0.227	0.272	0.321	0.374	0.430	0.491	0.555	0.761
0.200	0.257	0.316	0.376	0.439	0.504	0.570	0.747
0.247	0.267	0.295	0.332	0.377	0.431	0.494	0.652
0.169	0.218	0.274	0.337	0.407	0.484	0.568	0.799
0.260	0.270	0.292	0.328	0.375	0.436	0.508	0.690
0.156	0.207	0.268	0.338	0.416	0.504	0.600	0.816
0.189	0.224	0.262	0.329	0.353	0.406	0.461	0.699
0.204	0.223	0.270	0.333	0.398	0.493	0.584	0.837
0.205	0.233	0.241	0.286	0.354	0.410	0.510	0.620
0.185	0.226	0.249	0.316	0.353	0.410	0.468	0.655
0.205	0.236	0.250	0.300	0.375	0.457	0.483	0.615
0.000	0.259	0.270	0.307	0.337	0.429	0.437	0.623
0.232	0.233	0.271	0.334	0.396	0.439	0.571	0.764
0.228	0.271	0.267	0.308	0.386	0.476	0.518	0.673
0.000	0.235	0.289	0.335	0.383	0.458	0.567	0.678
0.214	0.239	0.258	0.297	0.347	0.416	0.543	0.571
0.235	0.245	0.265	0.292	0.322	0.394	0.441	0.632
0.200	0.256	0.265	0.282	0.321	0.378	0.425	0.568
0.000	0.280	0.266	0.281	0.320	0.371	0.416	0.481
0.246	0.228	0.257	0.281	0.311	0.364	0.431	0.553
0.000	0.257	0.256	0.265	0.305	0.330	0.395	0.482
0.000	0.260	0.265	0.282	0.301	0.356	0.392	0.492
0.236	0.251	0.257	0.283	0.298	0.354	0.404	0.513
0.117	0.259	0.254	0.281	0.299	0.318	0.345	0.430
0.249	0.245	0.249	0.267	0.297	0.330	0.386	0.417
0.181	0.250	0.282	0.300	0.336	0.373	0.457	0.492
NA	0.183	0.264	0.287	0.299	0.340	0.403	0.617
0.113	0.149	0.229	0.318	0.422	0.362	0.433	0.660
0.166	0.222	0.273	0.345	0.370	0.405	0.442	0. 505
0.000	0.292	0.327	0.353	0.345	0.398	0.399	0.465

Table 21.7. Irish Sea plaice: Discards weight-at-age 1 to 8+ (kg), where rows are years 1981–2018 and columns are ages 1 to 8+.

IRISH SEA PLAICE

1 23

1981 2018

1 8

1

0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.057	0.115	0.145	0.164	0.211	0.290	0.238	0.210
0.099	0.117	0.134	0.179	0.178	0.277	0.644	0.356
0.141	0.113	0.141	0.145	0.162	0.210	0.274	0.077
0.044	0.081	0.113	0.140	0.150	0.205	0.219	0.243
0.096	0.097	0.116	0.135	0.151	0.173	0.217	0.170
0.033	0.080	0.119	0.147	0.165	0.196	0.232	0.276
0.083	0.101	0.138	0.183	0.201	0.140	0.194	0.225
0.077	0.098	0.116	0.141	0.157	0.168	0.164	0.176
0.026	0.038	0.081	0.119	0.162	0.200	0.157	0.182
0.064	0.069	0.094	0.116	0.144	0.157	0.181	0.181
0.056	0.067	0.084	0.120	0.128	0.150	0.152	0.153
0.088	0.059	0.079	0.101	0.095	0.126	0.152	0.136
0.136	0.103	0.109	0.120	0.146	0.161	0.155	0.170
0.093	0. 080	0. 118	0. 124	0. 128	0. 153	0. 137	0. 157
0.022	0.053	0.075	0.109	0.142	0.143	0.146	0.202

Table 21.8. Irish Sea plaice: New stock weights-at-age modified to include discard element (kg), where rows are years 1981–2018 and columns are ages 1 to 8+.

IRISH SEA PLAICE

1 4

1981 2018

1 8

1

0.087	0.124	0.190	0.351	0.509	0.592	0.678	1.085
0.091	0.141	0.210	0.327	0.418	0.545	0.650	0.889
0.097	0.173	0.231	0.303	0.366	0.426	0.484	0.699
0.100	0.196	0.275	0.362	0.467	0.560	0.660	0.964
0.089	0.203	0.293	0.374	0.468	0.540	0.630	0.851
0.098	0.171	0.292	0.401	0.497	0.540	0.630	0.980
0.102	0.208	0.266	0.353	0.437	0.519	0.610	0.916
0.104	0.171	0.250	0.351	0.456	0.549	0.680	1.243
0.100	0.183	0.261	0.352	0.425	0.490	0.555	0.761
0.090	0.172	0.253	0.349	0.431	0.502	0.570	0.747
0.140	0.165	0.230	0.305	0.369	0.429	0.494	0.652
0.106	0.159	0.209	0.302	0.395	0.481	0.568	0.799
0.097	0.141	0.209	0.291	0.363	0.434	0.508	0.690
0.101	0.134	0.193	0.299	0.400	0.501	0.600	0.816
0.091	0.138	0.184	0.289	0.340	0.404	0.461	0.699
0.091	0.130	0.181	0.286	0.377	0.488	0.583	0.837
0.091	0.118	0.168	0.247	0.335	0.406	0.509	0.620
0.088	0.116	0.148	0.223	0.305	0.399	0.466	0.655
0.100	0.125	0.150	0.216	0.321	0.444	0.480	0.615
NA	0.121	0.157	0.222	0.300	0.420	0.436	0.623
0.091	0.119	0.161	0.239	0.352	0.431	0.569	0.764
0.088	0.114	0.161	0.228	0.347	0.467	0.517	0.673
NA	0.115	0.165	0.234	0.335	0.448	0.566	0.678
0.070	0.131	0.169	0.217	0.304	0.407	0.540	0.570
0.103	0.127	0.161	0.238	0.234	0.377	0.454	0.602
0.141	0.122	0.162	0.175	0.256	0.323	0.417	0.564
0.044	0.084	0.123	0.167	0.209	0.290	0.335	0.377
0.096	0.100	0.131	0.168	0.204	0.279	0.397	0.285
0.033	0.081	0.125	0.173	0.213	0.266	0.333	0.413
0.083	0.101	0.140	0.191	0.211	0.190	0.226	0.290
0.078	0.104	0.137	0.182	0.221	0.271	0.334	0.364
0.026	0.038	0.088	0.142	0.199	0.246	0.232	0.294
0.065	0.071	0.098	0.133	0.185	0.240	0.292	0.363
0.056	0.068	0.089	0.135	0.153	0.194	0.214	0.296
0.088	0.060	0.083	0.115	0.130	0.163	0.269	0.515
0.133	0.105	0.117	0.152	0.240	0.259	0.307	0.522
0. 093	0. 081	0. 121	0. 145	0. 163	0.198	0.223	0. 303
0.022	0.054	0.098	0.138	0.199	0.253	0.269	0.39

Table 21.9. Irish Sea plaice: Estimated landed numbers-at-age (thousands).

year\age	1	2	3	4	5	6	7	8	total
1981	23	1720	4565	3179	829	247	108	250	10919
1982	23	871	3798	3316	1331	360	130	216	10044
1983	49	2676	2749	2939	1438	641	205	229	10927
1984	45	2709	4943	1436	1088	534	294	231	11280
1985	5	2459	5190	3082	613	508	272	310	12438
1986	35	1851	5328	3091	1438	298	290	348	12680
1987	59	3199	4886	3719	1475	784	160	406	14686
1988	56	2664	4984	2594	1385	611	347	316	12958
1989	33	1704	4896	2601	917	503	234	307	11194
1990	12	1156	2978	3142	1134	411	237	270	9340
1991	150	1604	1758	1912	1500	525	195	266	7911
1992	143	2072	3167	1196	1041	907	318	301	9145
1993	32	1239	2113	1721	402	376	411	285	6577
1994	96	1187	2926	1446	710	205	168	330	7068
1995	26	1005	1763	2087	619	289	95	225	6108
1996	24	982	1384	1222	999	304	125	165	5206
1997	25	664	1844	1305	722	566	199	193	5518
1998	6	716	1173	1097	664	382	308	250	4597
1999	58	754	1347	1226	624	317	186	255	4766
2000	376	401	1006	1563	780	292	175	227	4820
2001	14	462	888	1101	1100	369	145	222	4301
2002	1	228	1133	1028	834	636	195	210	4264
2003	208	280	1008	1246	645	428	286	225	4328
2004	19	259	795	926	747	251	160	236	3393
2005	9	223	733	1353	640	526	152	290	3926
2006	2	177	789	567	783	433	241	297	3290
2007	0	56	293	680	485	328	189	251	2283
2008	0	91	402	473	485	250	142	139	1983
2009	0	10	179	388	326	319	99	201	1522
2010	0	5	72	300	183	212	96	154	1022
2011	2	83	318	409	567	308	166	274	2127
2012	0	5	120	256	264	322	133	278	1378
2013	1	17	74	174	226	190	144	301	1128
2014	1	6	58	172	151	137	63	266	853
2015	0	1	39	97	165	118	114	382	915
2016	9	29	87	189	269	285	169	398	1436
2017	7	5	27	140	182	150	131	393	1036
2018	0	3	101	122	264	310	178	539	1518

Table 21.10. Irish Sea plaice: Estimated discarded numbers-at-age (thousands). All discards are included (dead and alive portions).

year\age	1	2	3	4	5	6	7	8	total
1981	480	4531	5851	402	7	0	0	0	6762
1982	653	3129	3537	403	14	0	0	0	4642
1983	699	3451	1606	317	17	1	0	0	3654
1984	581	2759	1880	124	12	1	0	0	3214
1985	577	2684	1502	217	5	1	0	0	2991
1986	566	3034	1587	239	13	0	0	0	3264
1987	631	2549	1762	316	16	1	0	0	3165
1988	435	3557	2058	253	20	1	0	0	3796
1989	326	1951	2232	283	18	2	0	0	2887
1990	493	1450	1533	432	34	2	0	0	2366
1991	303	2687	1144	345	62	4	0	0	2728
1992	500	2248	2626	285	58	9	1	0	3435
1993	526	4339	2211	454	25	4	1	0	4536
1994	404	2950	3509	391	50	2	0	0	4384
1995	618	2618	2508	605	48	4	0	0	3841
1996	787	3541	2397	426	99	6	0	0	4353
1997	842	5925	3571	534	83	13	1	0	6581
1998	746	6879	6517	1461	234	25	4	0	9520
1999	495	4189	6669	1644	222	20	3	0	7945
2000	0	3350	4217	1897	220	14	2	0	5820
2001	517	3621	3182	1221	267	15	1	0	5295
2002	471	3763	3819	1081	186	24	1	0	5607
2003	0	3216	3605	1539	186	20	1	0	5140
2004	216	1805	2935	1408	344	19	1	0	4037
2005	283	2774	2892	1260	1001	89	10	35	5007
2006	464	2729	3772	2029	548	212	13	3	5862
2007	644	4134	4092	2821	907	312	131	194	7941
2008	419	4072	3323	1647	993	200	27	325	6604
2009	243	2208	3792	1369	628	294	60	101	5217
2010	506	3053	3956	3611	1708	701	502	479	8709
2011	387	2089	1813	1016	692	247	68	217	3917
2012	345	3135	2790	1540	701	498	201	337	5728
2013	239	1731	2619	1396	614	208	121	90	4211
2014	298	1900	2390	1925	1085	564	244	366	5263
2015	103	1247	1495	1153	800	558	130	102	3353
2016	66	647	1291	971	517	300	139	156	2452
2017	65	783	1210	1326	1061	694	332	547	3611
2018	108	707	994	909	689	410	187	216	2533

Table 21.11. Irish Sea plaice: Estimated population numbers-at-age (thousands).

year\age	1	2	3	4	5	6	7	8	total
1981	16495	19801	17653	7241	2019	695	329	763	64996
1982	22526	12567	13234	7622	3261	1010	396	655	61272
1983	24055	20521	7903	6336	3292	1657	571	637	64972
1984	23097	21236	14271	3343	2713	1488	880	690	67718
1985	21331	20418	14644	7198	1534	1406	808	919	68259
1986	22025	17914	14778	7012	3450	778	816	976	67749
1987	21540	19783	12400	7519	3117	1791	396	1006	67552
1988	15728	20382	13224	5347	2930	1377	842	765	60596
1989	12442	13496	14656	5974	2155	1257	624	818	51420
1990	15931	9327	9220	7453	2730	1052	647	737	47098
1991	16174	14284	5694	4610	3634	1359	540	734	47029
1992	17719	12847	9593	2561	2148	1986	742	700	48297
1993	15629	16188	7682	4088	895	876	1024	708	47089
1994	14814	12325	11355	3529	1637	495	429	843	45427
1995	17498	10975	7643	5472	1556	773	271	638	44825
1996	22024	13608	6904	3542	2813	920	403	532	50744
1997	22871	18092	9637	3892	2071	1743	650	630	59586
1998	19684	20909	12279	4756	2187	1228	1041	837	62921
1999	18741	16989	15333	6370	2507	1276	811	1100	63127
2000	23790	14840	11792	9048	3556	1398	940	1212	66575
2001	24108	18898	10634	6885	5526	2003	919	1400	70372
2002	24726	20771	14985	7082	4649	3963	1473	1587	79235
2003	21854	22082	16466	10801	4378	3241	2762	2170	83754
2004	20535	17585	17288	11435	7160	2571	2169	3173	81915
2005	17721	18432	13042	10771	7357	4576	1783	3509	77190
2006	22571	15203	14689	8556	6307	4315	2867	3427	77935
2007	26478	18661	12021	10531	5435	3708	2970	4065	83869
2008	21204	23182	13210	8270	7259	3363	2228	4685	83400
2009	17106	16699	18260	9095	6138	5762	2422	4700	80183
2010	23108	15703	12816	13001	7263	4964	4814	5340	87010
2011	27130	17758	11415	8210	8910	5232	3655	7121	89432
2012	23650	24832	14382	9315	6010	6697	4215	7970	97071
2013	23617	20486	19635	11926	7804	4976	5285	8633	102362
2014	28211	21940	17647	15223	9915	6776	4561	10580	114853
2015	16576	24085	17998	13904	11485	8642	5409	12446	110546
2016	14079	15087	19168	15679	11699	9782	7636	14830	107959
2017	9902	13200	13306	15297	13460	9709	8111	17737	100721
2018	11443	10154	11389	10770	11650	10471	8031	18447	92355

Table 21.12. Irish Sea plaice: Estimated fishing mortality-at-age.

year\age	1	2	3	4	5	6	7	8	Fbar (3–6)
1981	0.020	0.272	0.660	0.689	0.571	0.469	0.421	0.421	0.597
1982	0.020	0.264	0.640	0.678	0.567	0.471	0.425	0.425	0.589
1983	0.021	0.282	0.685	0.736	0.623	0.524	0.473	0.473	0.642
1984	0.018	0.246	0.597	0.647	0.555	0.476	0.433	0.433	0.569
1985	0.018	0.238	0.579	0.637	0.550	0.480	0.437	0.437	0.562
1986	0.018	0.246	0.596	0.667	0.583	0.518	0.468	0.468	0.591
1987	0.022	0.293	0.705	0.793	0.696	0.619	0.550	0.550	0.703
1988	0.022	0.288	0.686	0.779	0.698	0.631	0.568	0.568	0.699
1989	0.020	0.257	0.597	0.672	0.605	0.549	0.501	0.501	0.606
1990	0.021	0.262	0.592	0.657	0.590	0.532	0.486	0.486	0.593
1991	0.022	0.273	0.604	0.664	0.591	0.526	0.479	0.479	0.596
1992	0.027	0.332	0.738	0.826	0.749	0.661	0.598	0.598	0.743
1993	0.024	0.290	0.641	0.722	0.675	0.605	0.549	0.549	0.660
1994	0.025	0.294	0.631	0.698	0.647	0.579	0.530	0.530	0.639
1995	0.025	0.287	0.601	0.639	0.578	0.507	0.461	0.461	0.581
1996	0.024	0.278	0.566	0.581	0.506	0.435	0.396	0.396	0.522
1997	0.025	0.285	0.575	0.581	0.500	0.426	0.389	0.389	0.521
1998	0.025	0.282	0.576	0.577	0.491	0.417	0.377	0.377	0.515
1999	0.021	0.229	0.461	0.458	0.384	0.317	0.279	0.279	0.405
2000	0.017	0.190	0.382	0.380	0.316	0.257	0.220	0.220	0.334
2001	0.015	0.161	0.327	0.331	0.276	0.222	0.183	0.183	0.289
2002	0.012	0.136	0.278	0.289	0.242	0.191	0.150	0.150	0.250
2003	0.010	0.113	0.229	0.239	0.202	0.155	0.116	0.116	0.206
2004	0.008	0.085	0.171	0.179	0.152	0.114	0.082	0.082	0.154
2005	0.011	0.115	0.224	0.233	0.197	0.144	0.098	0.098	0.199
2006	0.013	0.136	0.249	0.250	0.206	0.148	0.096	0.096	0.213
2007	0.016	0.156	0.278	0.273	0.224	0.159	0.100	0.100	0.233
2008	0.013	0.124	0.214	0.207	0.172	0.124	0.078	0.078	0.179
2009	0.009	0.089	0.154	0.152	0.129	0.095	0.061	0.061	0.133
2010	0.014	0.133	0.226	0.224	0.194	0.145	0.091	0.091	0.197
2011	0.009	0.083	0.140	0.141	0.124	0.097	0.062	0.062	0.126
2012	0.009	0.084	0.142	0.144	0.128	0.103	0.066	0.066	0.129
2013	0.007	0.056	0.093	0.094	0.084	0.069	0.044	0.044	0.085
2014	0.007	0.057	0.094	0.097	0.090	0.077	0.050	0.050	0.089
2015	0.004	0.034	0.057	0.062	0.061	0.057	0.038	0.038	0.059
2016	0.004	0.030	0.049	0.054	0.054	0.052	0.036	0.036	0.052
2017	0.005	0.039	0.062	0.067	0.067	0.064	0.044	0.044	0.065
2018	0.006	0.046	0.067	0.068	0.064	0.058	0.039	0.039	0.064

Table 21.13. Irish Sea plaice: SAM stock assessment summary (± 2 standard deviation uncertainty). Recruitment (000s), spawning–stock biomass (SSB, tonnes), mean fishing mortality (Fbar) for ages 3–6, total spawning biomass (TSBS, tonnes), landings and discards tonnage.

Year	Recruitment (thousands)			SSB (t)			Fbar (3–6)			TSB (t)			Discards (t)			Landings (t)		
	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High
1981	11220	16495	24249	5751	7066	8681	0.462	0.597	0.773	10595	12799	15462	595	803	1084	2691	3632	4904
1982	16118	22526	31483	5572	6753	8184	0.465	0.589	0.747	10463	12436	14780	422	544	702	2721	3509	4525
1983	17331	24055	33387	5079	6066	7246	0.507	0.642	0.812	10888	12978	15469	324	409	517	2773	3506	4434
1984	16717	23097	31913	6406	7673	9191	0.449	0.569	0.72	13291	15897	19015	285	363	462	3298	4201	5352
1985	15469	21331	29415	7040	8443	10127	0.445	0.562	0.709	13906	16621	19865	263	336	430	3698	4727	6043
1986	15956	22025	30403	7533	9032	10829	0.47	0.591	0.743	14153	16788	19913	288	367	467	3959	5041	6420
1987	15499	21540	29936	7095	8450	10064	0.562	0.703	0.88	13997	16591	19667	285	361	457	4251	5383	6817
1988	11420	15728	21662	6614	7884	9398	0.557	0.699	0.876	12442	14715	17403	343	432	544	3781	4763	6000
1989	8815	12442	17561	5865	7033	8433	0.482	0.606	0.762	10793	12847	15292	267	341	436	3144	4020	5139
1990	11607	15931	21866	5327	6390	7666	0.472	0.593	0.745	9369	11069	13078	220	280	355	2726	3463	4401
1991	11864	16174	22048	4285	5103	6076	0.476	0.596	0.747	9124	10778	12730	249	312	391	2141	2681	3357
1992	13130	17718	23910	4285	5103	6077	0.599	0.743	0.923	8500	10012	11793	324	405	507	2422	3030	3791
1993	11913	15629	20505	3544	4233	5056	0.526	0.66	0.83	7530	8894	10505	413	517	646	1794	2244	2806
1994	11258	14814	19494	3653	4418	5343	0.51	0.639	0.8	7356	8726	10351	417	521	651	1842	2302	2877
1995	13336	17498	22958	3199	3884	4715	0.46	0.581	0.734	6673	7919	9399	362	453	566	1532	1915	2394
1996	16750	22024	28957	3414	4175	5104	0.411	0.522	0.663	7251	8637	10287	404	500	619	1425	1764	2182
1997	17425	22871	30018	3583	4377	5347	0.412	0.521	0.657	7783	9282	11071	608	753	934	1360	1686	2091
1998	15008	19684	25817	3864	4755	5851	0.402	0.515	0.66	8040	9629	11532	916	1140	1420	1206	1501	1869
1999	14189	18741	24754	4400	5484	6836	0.309	0.405	0.531	8880	10727	12957	791	985	1227	1220	1519	1892
2000	17720	23790	31940	4769	6015	7588	0.247	0.334	0.451	9074	11071	13507	587	737	926	1163	1461	1835

Year	Recruitment (thousands)			SSB (t)			Fbar (3–6)			TSB (t)			Discards (t)			Landings (t)		
	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High
2001	18170	24108	31986	5712	7317	9373	0.212	0.289	0.395	10396	12809	15783	518	644	800	1262	1569	1951
2002	18514	24726	33023	6655	8646	11234	0.182	0.25	0.343	11528	14415	18023	549	680	843	1249	1548	1919
2003	16168	21854	29540	7827	10324	13617	0.146	0.206	0.291	12870	16374	20833	515	646	809	1224	1533	1920
2004	15321	20535	27523	7926	10492	13889	0.108	0.154	0.221	12595	16124	20642	452	573	725	894	1131	1432
2005	13279	17721	23650	7816	10306	13590	0.141	0.199	0.281	12502	15839	20065	568	713	893	1044	1309	1642
2006	16999	22571	29970	7035	9323	12354	0.153	0.213	0.297	12399	15617	19671	644	802	1000	884	1101	1372
2007	19740	26478	35514	5803	7704	10227	0.168	0.233	0.324	8897	11330	14429	719	898	1121	609	761	951
2008	15946	21204	28196	5826	7708	10196	0.13	0.179	0.248	10183	12837	16184	623	773	960	514	637	791
2009	12669	17106	23098	6553	8745	11670	0.095	0.133	0.186	9223	11890	15328	494	624	788	390	492	621
2010	17330	23108	30811	6622	8672	11355	0.141	0.197	0.277	10595	13351	16823	1038	1322	1684	274	349	444
2011	20218	27130	36404	7675	10320	13878	0.09	0.126	0.176	11813	15187	19523	379	472	589	565	704	878
2012	17705	23650	31591	6416	8672	11720	0.093	0.129	0.18	8442	11052	14469	407	506	630	362	450	560
2013	17673	23617	31561	7734	10471	14176	0.061	0.085	0.119	11193	14547	18906	338	421	525	305	380	473
2014	20429	28211	38959	7852	10576	14245	0.064	0.089	0.125	11314	14681	19051	430	535	666	265	331	412
2015	12140	16576	22635	10143	14118	19649	0.042	0.059	0.083	13365	17907	23993	237	298	375	325	409	514
2016	10452	14079	18964	14898	20433	28023	0.037	0.052	0.074	19112	25409	33781	242	303	379	509	638	799
2017	7099	9902	13812	11448	15622	21319	0.046	0.065	0.091	14294	18972	25181	359	449	562	354	443	554
2018	7696	11443	17014	12572	17522	24422	0.045	0.064	0.092	14128	19350	26502	206	265	340	477	613	789

Table 21.14 Short term forecast. Annual catch options. All weights are in tonnes.

	Total catch (2020)	Wanted catch (2020)	Total unwanted catch* (2020)	F total (2020)	F wanted (2020)	F unwanted** (2020)	SSB (2021)	dSSB ***	dTAC^	dAdvice^^
Fmsy	3299	1931	1368	0.196	0.054	0.142	18354	-4	7	-6
F = FMSY lower	2288	1341	947	0.133	0.036	0.097	16576	-13	-26	-35
F = FMSY upper	4772	2779	1993	0.293	0.08	0.213	17057	-11	55	36
F = 0	0	0	0	0	0	0	21332	11	-100	-100
F = Fpa	5640	3300	2340	0.355	0.097	0.258	16371	-15	83	61
F = Flim	7467	4375	3092	0.495	0.136	0.359	14812	-23	143	113
SSB (2021)=Blim	20103	12253	7850	2.515	0.689	1.826	3958	-79	554	474
SSB (2021)=Bpa	18728	11285	7443	2.063	0.565	1.498	5294	-72	509	435
SSB(2021)= MSY B	14839	8839	6000	1.287	0.353	0.934	8757	-54	383	324
F = F2019	1070	625	445	0.06	0.017	0.043	20323	6	-65	-69

*** Dead + surviving unwanted catch.**

****F unwanted concerns dead unwanted catch only.**

***** SSB 2021 relative to SSB 2020.**

^ Total catch in 2020 relative to TAC in 2019 (3075 t).

^^ Catch advice value 2020 relative to catch advice value 2019 (3503 t).

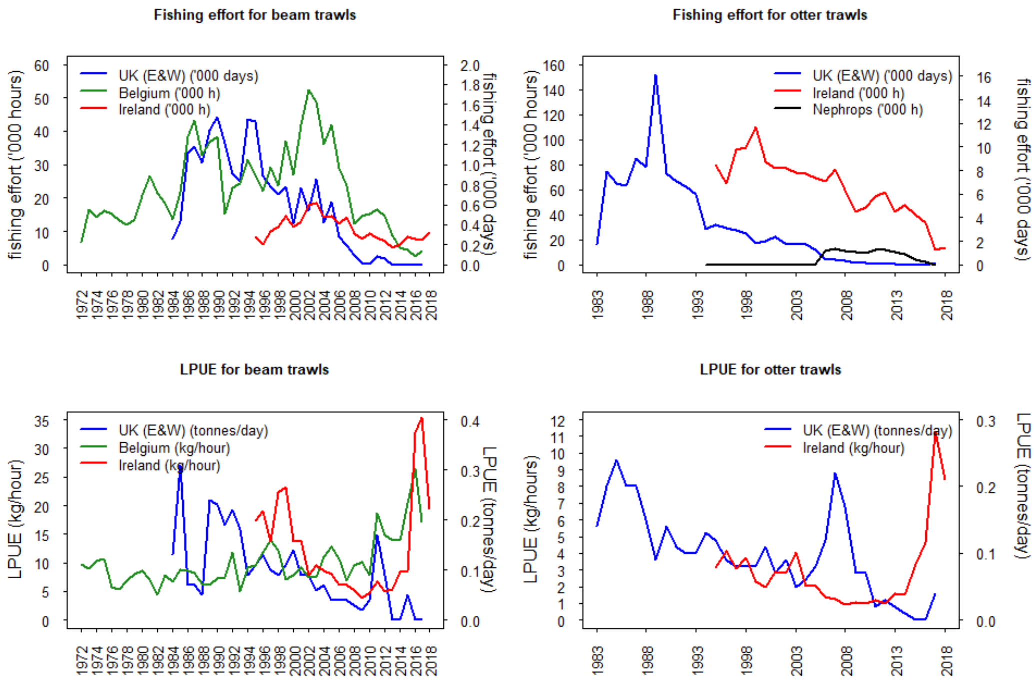


Figure 21.1. Irish Sea plaice: Effort and lpue for commercial fleets from UK (E&W), Ireland and Belgium.

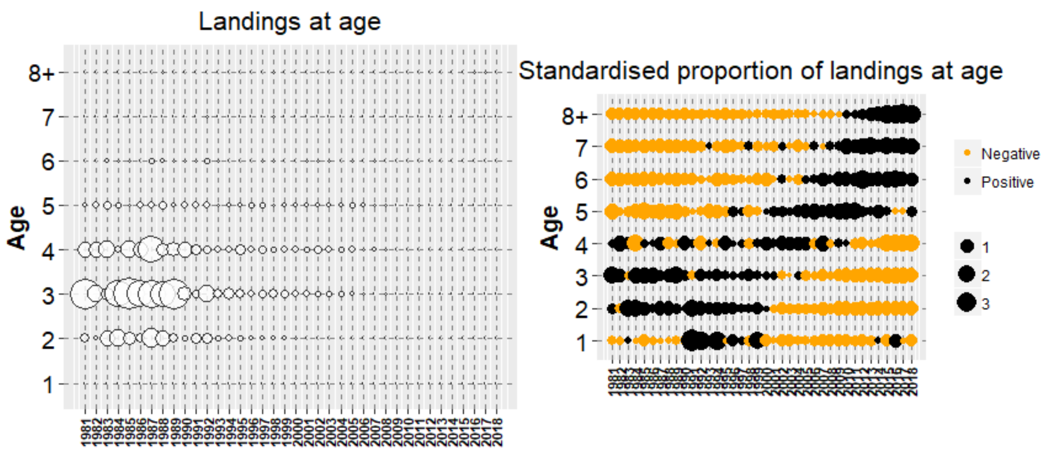


Figure 21.2a. Landings-at-age data (left) and mean standardised proportion-at-age (right, black bubbles are positive values and orange bubbles are negative). Mean standardised proportion-at-age = [(proportion-at-age in year) – mean (proportion-at-age over all years)] / STDEV(proportion-at-age over all years).

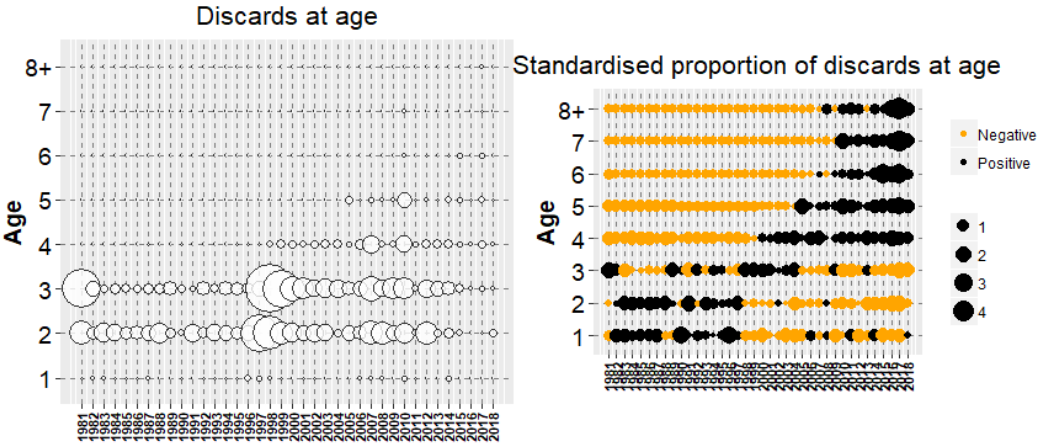


Figure 21.2b. Discards-at-age data (left) and mean standardised proportion-at-age (right, black bubbles are positive values and orange bubbles are negative). Mean standardised proportion-at-age = [(proportion-at-age in year) – mean (proportion-at-age over all years)] / STDEV(proportion-at-age over all years).

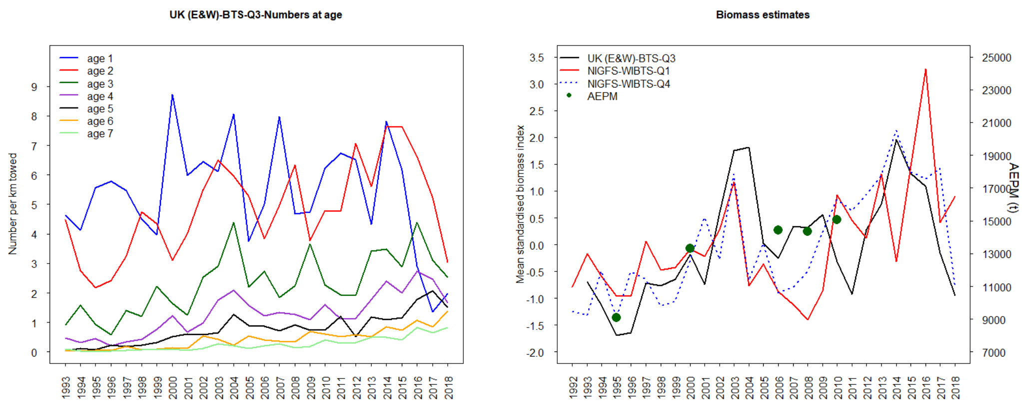


Figure 21.3. Left: UK(E&W)-BTS-Q3 (extended area) cpue by age. Right: standardised indices of SBB derived from NIGFS-WIBTS, biomass of ages 1–4 from UK(E&W)-BTS-Q3 (extended area) and the SSB estimates from the Annual Egg Production Methods (circles, right).

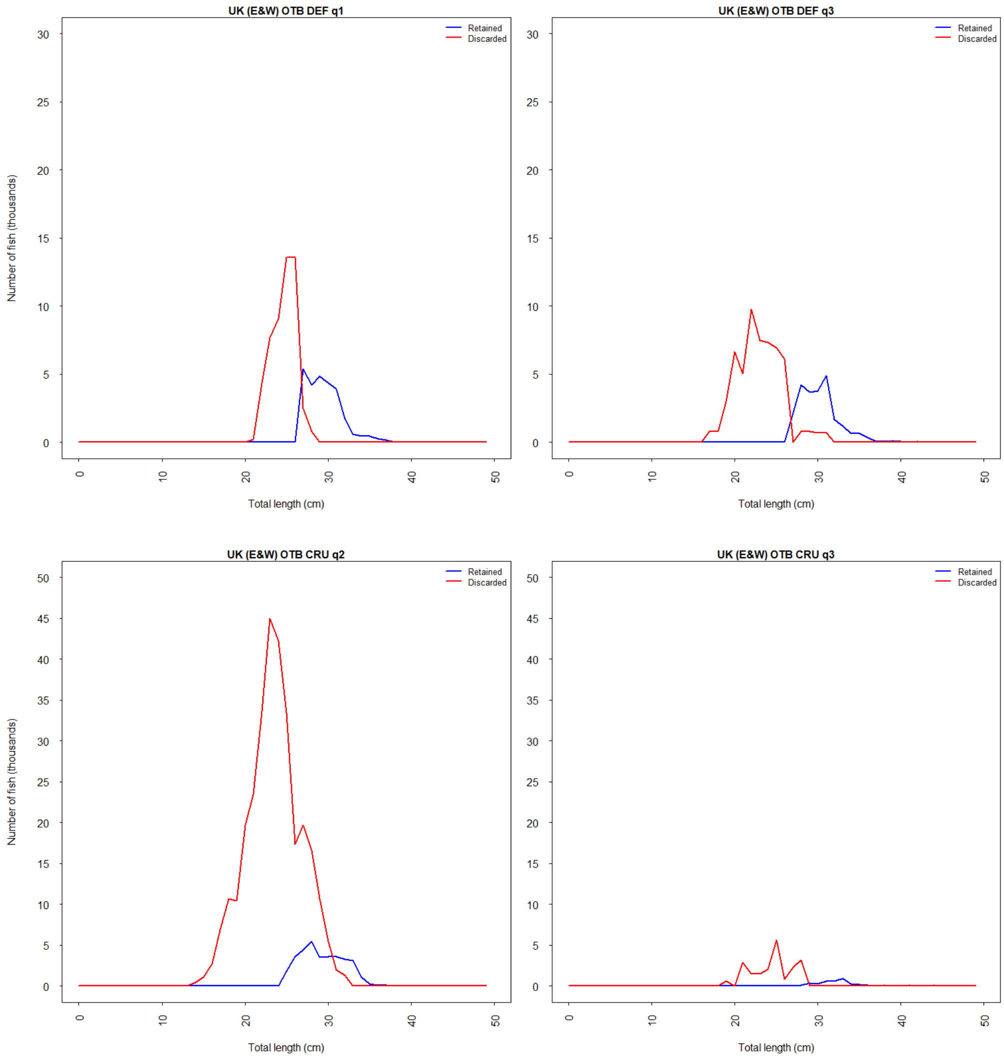


Figure 21.4. Length distributions of discarded and retained catches of year 2018 from UK(E&W) as available at InterCatch.

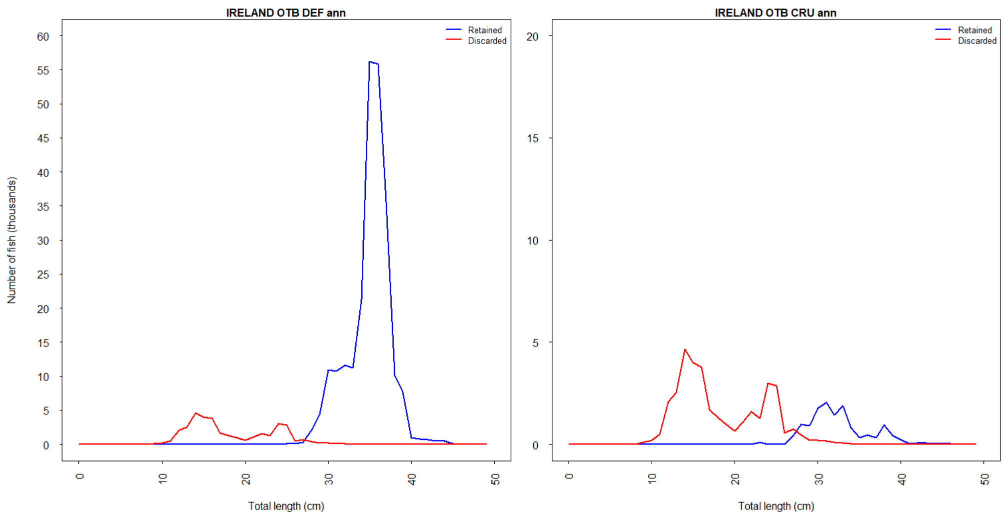


Figure 21.5. Length distributions of discarded and retained catches year 2018 from Ireland as available at InterCatch.

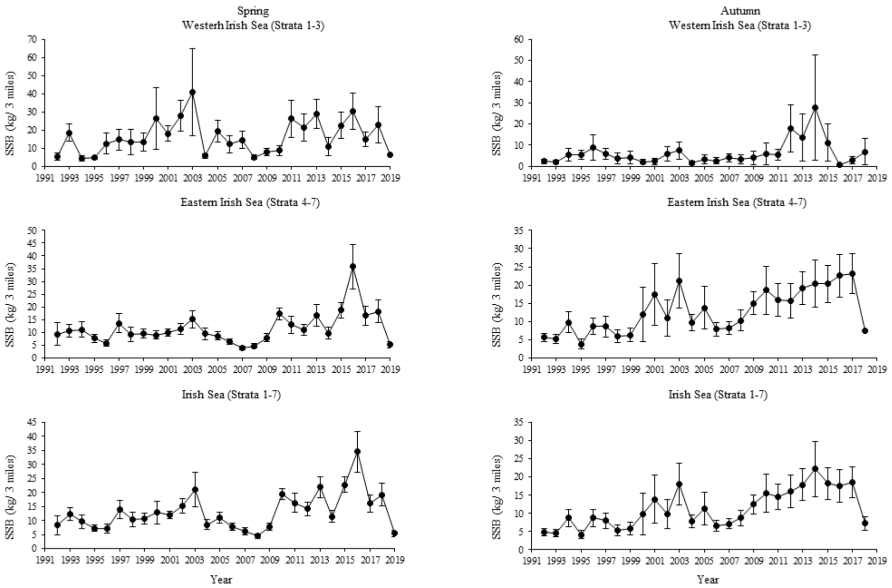


Figure 21.6. Northern Irish Groundfish Survey SSB indices split into spring (left hand panels) and autumn (right hand panels) sampling by western strata (1–3), eastern strata (4–7) and total survey area (strata 1–7) with confidence intervals (± 1 standard error, vertical lines).

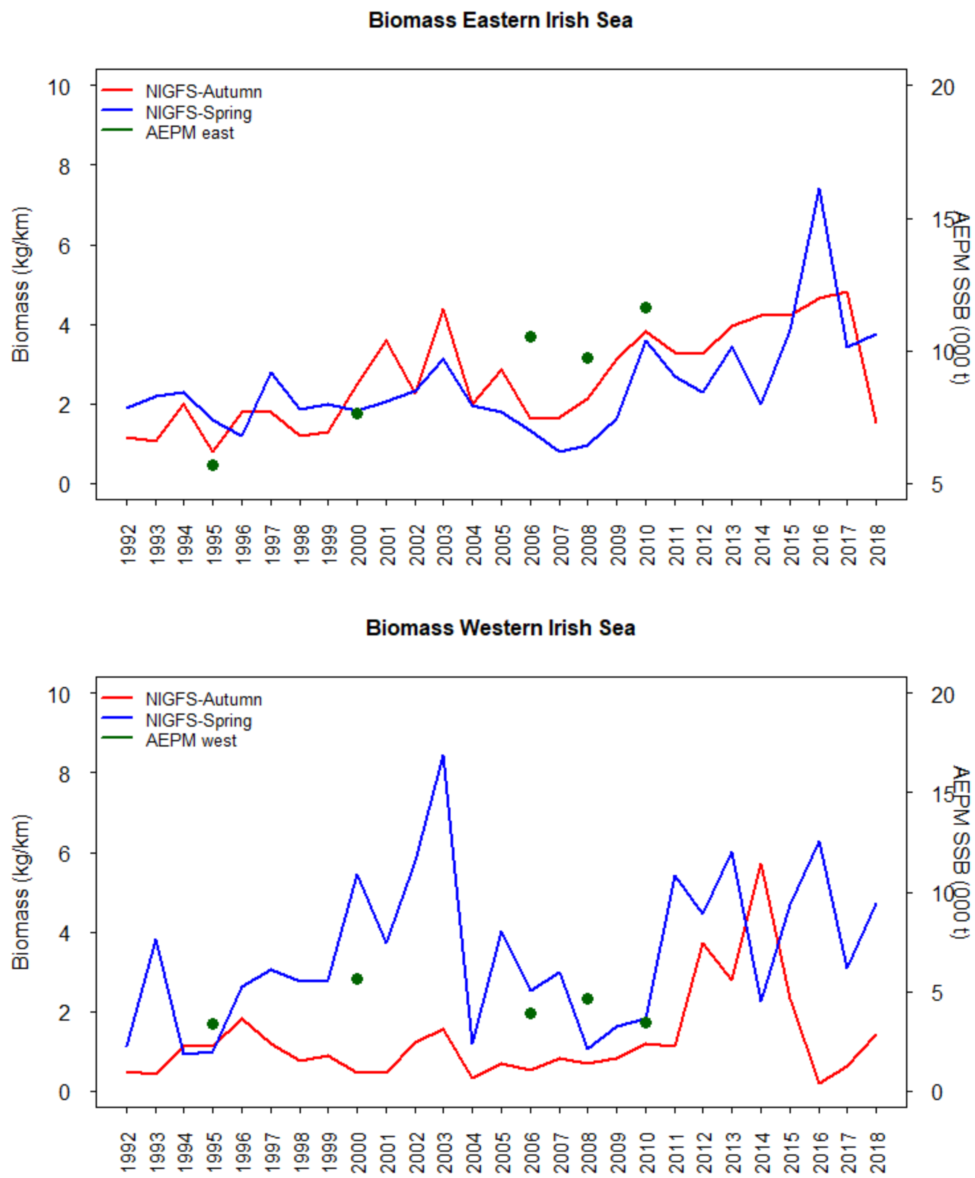


Figure 21.7. Trends in biomass indices (kg per km towed) the NIGFS-WIBTS-Q1 and -Q4 (blue and red lines respectively) in the eastern Irish Sea (top) and the western and southern Irish Sea (bottom). Also shown (green dots, right axis) are the estimates of SSB from the Annual Egg Production Method (AEPM) from Armstrong *et al.* (2011).

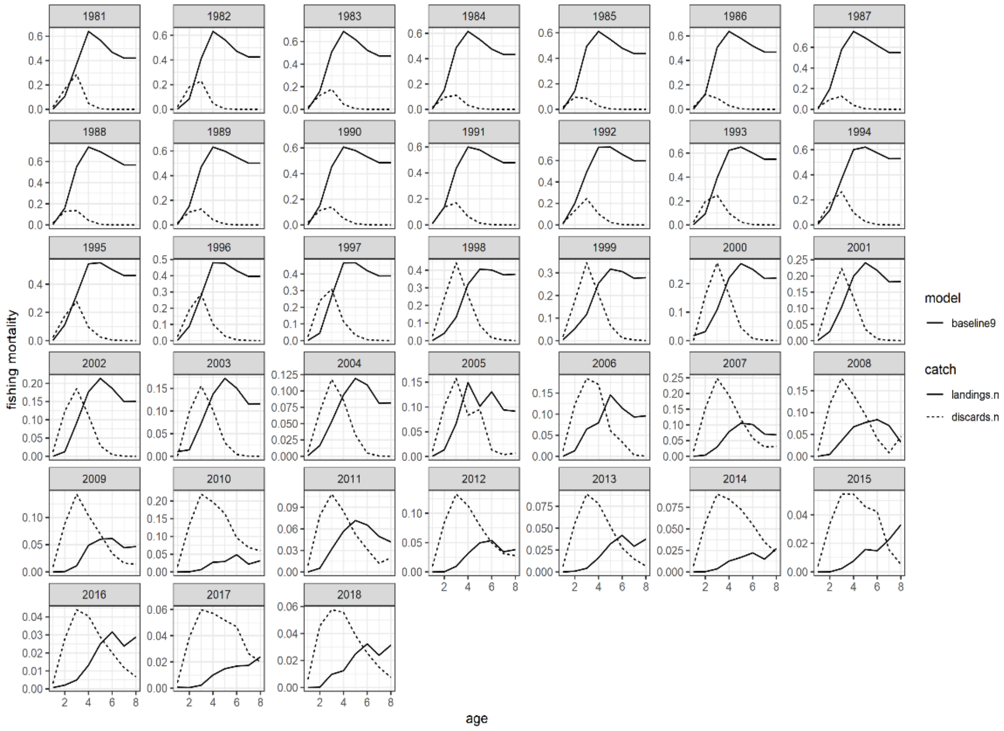


Figure 21.8. Selectivity of the fishery split into the landed (solid) and discarded (dashed) components as estimated by the SAM model, where the x-axis shows age and the y-axis gives the fishing mortality-at-age scaled so that the maximum value is 1 and split by the proportion of fish (by number) discarded and landed at-age.

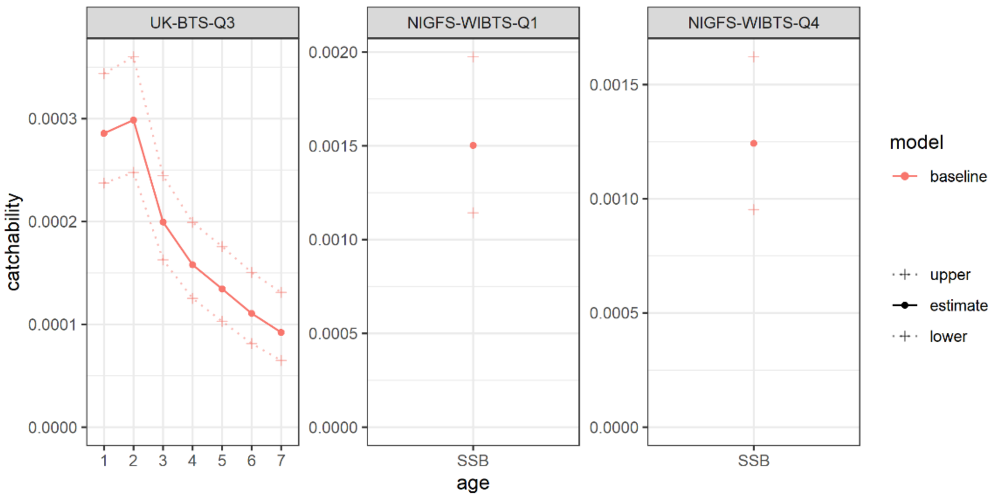


Figure 21.9. Catchability for the UK (E&W)-BTS-Q3 extended index by age, NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 as estimated by the SAM model.

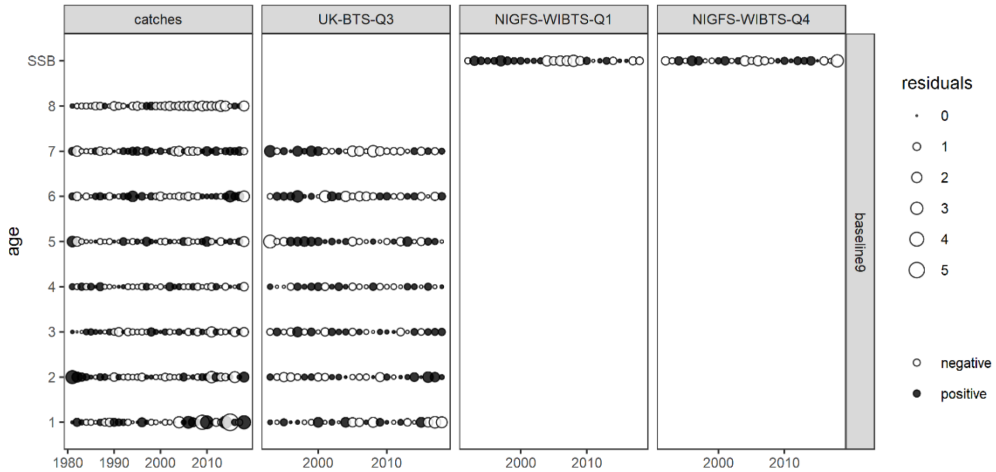


Figure 21.10. Residuals in fits to catch and survey data from the baseline model. Expected values were estimated by the SAM model.

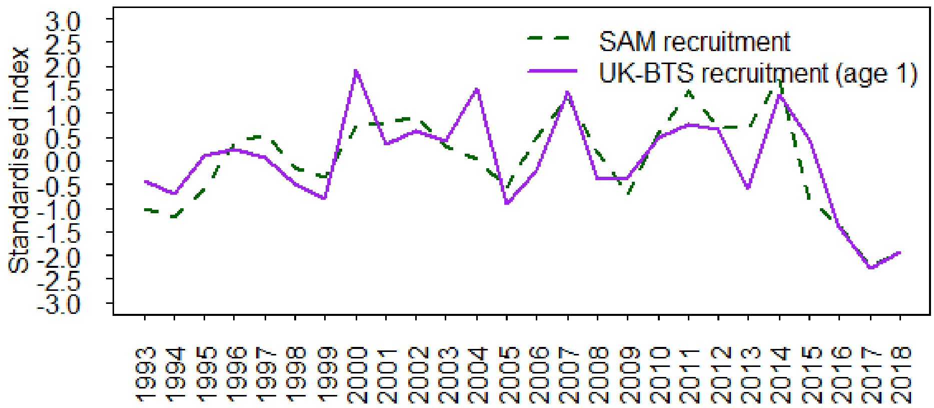


Figure 21.11. Comparison of the standardised age 1 index from the UK (E&W)-BTS-Q3 extended area (red) and the standardised recruitment (blue dashed line) estimated by the SAM model.

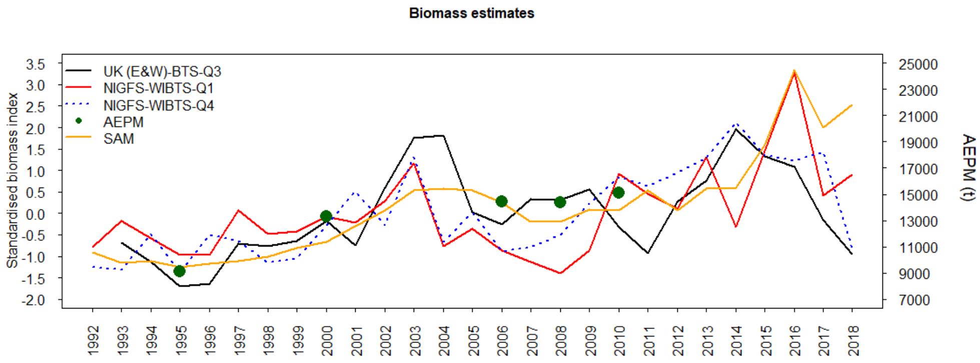


Figure 21.12. SAM model estimates of mean standardised SSB (orange line) overlain with standardised NIGFS in spring (red) and autumn (blue dashed) relative SSB indices, standardised biomass (ages 1–4) from the UK(E&W)-BTS (black solid line) and AEPM SSB index (circles, right axis). Standardized: minus mean and divided by standard deviation.

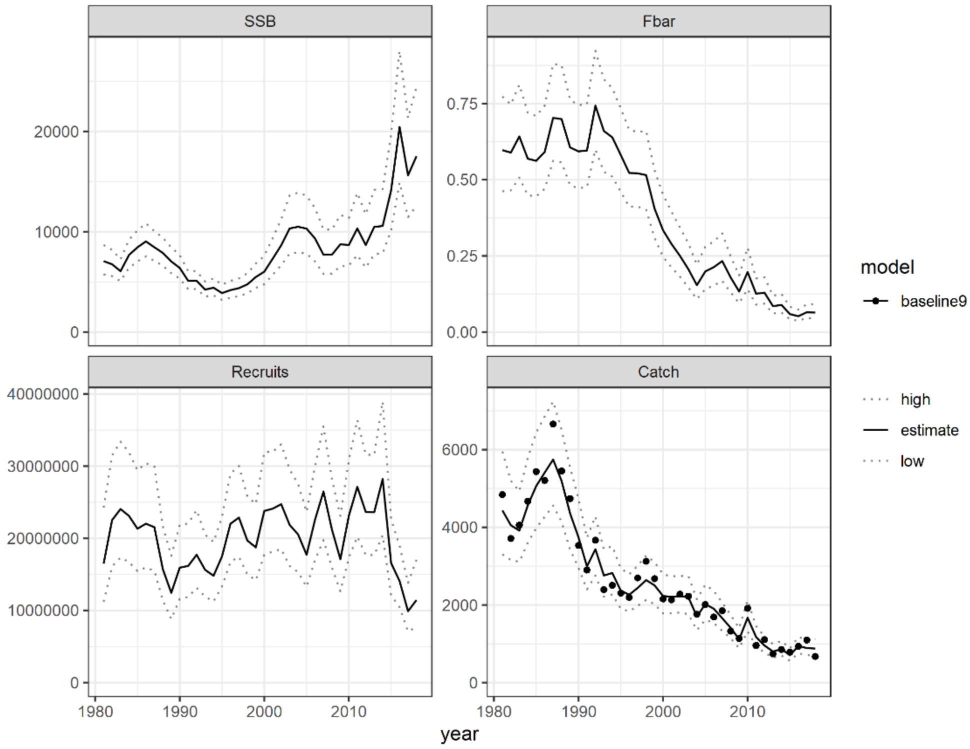


Figure 21.13. Modelled SSB (tonnes, top left), recruitment (thousands, bottom left), F_{bar} (ages 3–6, bottom right) catch tonnage (bottom right) using the SAM model. Error dashed lines indicate 2 × standard deviation.

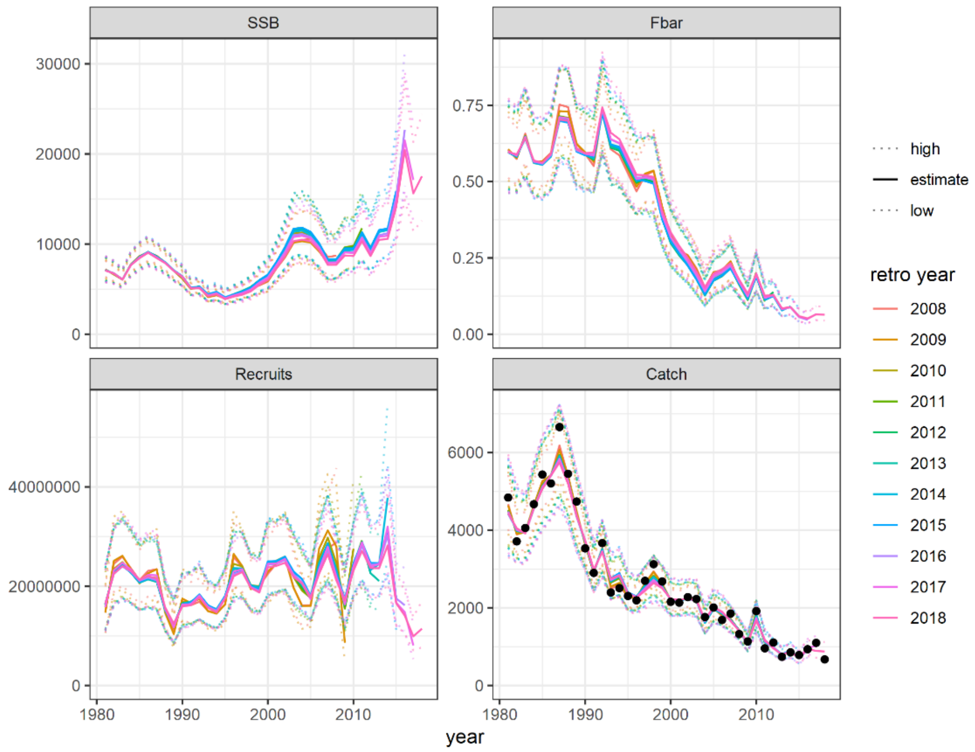


Figure 21.14. Retrospective assessments for years 2008–2018 from the baseline model. SSB (tonnes, top left), recruitment (thousands, bottom left), FBAR (ages 3–6, bottom right) catch tonnage (bottom right). Error dashed lines indicate 2 × standard deviation.

23 Plaice (*Pleuronectes platessa*) in divisions 7.b–c (West of Ireland)

Type of assessment in 2019

No assessment was performed.

23.1 General

Stock Identity

Plaice in 7.b are mainly caught by Irish vessels on sandy grounds in coastal areas. Plaice catches in 7.c are negligible. There are two distinct areas in which plaice are caught by Irish vessels in 7.b: an area around Galway Bay and an area in the north of 7.b, which extends into 6.a (the Stags and Broadhaven Ground). During 1995–2000 a large proportion of the 7.bc plaice landings were taken from the Stags Grounds (Rectangles 37D8, 37D9, 37E0 and 37E1). The landings and LPUE in this area have dropped sharply since 2000, in line with a general decrease of LPUE in Division 6.a. Plaice in this area appear to be more linked with 6.a than populations further south. The landings and LPUE on the Aran grounds appear to have been more or less stable since the start of the logbooks' time-series in 1995 (WD 1, WGCSE 2009). It is not known, how much exchange there is between plaice on the Aran grounds and those on the Stags ground. The commercial LPUE time-series may not be reflective of overall stock abundance due to changing fishing practices.

Data

The time-series of official landings is presented in Table 22.1 and Figure 22.1.

Sampling is carried out in Ireland but numbers of samples varies over time due to the low landings levels and varying encounter probability and is not sufficient to generate a time-series of annual length or age distributions. Sampling in 2018 was relatively good with 13 length sample units (1289 fish measured) and seven discard trips. Figure 22.2 describes the length–frequency distribution of the discard trips, and the contribution of these length classes to hauls and trips, no landings were recorded on these trips in 2018.

Table 22.1. Landings of plaice in 7.bc as officially reported to ICES.

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1908	0	0	0	135	0	135	1963	0	471	2	67	0	540		
1909	0	0	0	49	0	49	1964	0	427	2	66	0	495		
1910	0	0	0	36	0	36	1965	0	417	2	99	0	518		
1911	0	0	2	54	0	56	1966	0	0	1	127	0	128		
1912	0	0	1	40	0	41	1967	0	182	2	112	0	296		
1913	0	0	0	54	0	54	1968	0	403	0	89	0	492		
1914	0	0	0	85	0	85	1969	0	281	2	99	0	382		
1915	0	0	1	23	0	24	1970	0	124	0	110	0	234		
1916	0	0	0	22	0	22	1971	0	0	1	89	0	90		
1917	0	0	0	36	0	36	1972	0	110	0	124	0	234		
1918	0	0	0	29	0	29	1973	0	60	1	124	0	185		
1919	0	0	1	32	0	33	1974	0	45	1	106	0	152		
1920	0	0	25	15	0	40	1975	0	10	0	153	0	163		
1921	0	0	9	34	0	43	1976	0	9	0	133	0	142		
1922	0	0	1	37	0	38	1977	0	4	0	135	0	139		
1923	0	0	1	30	0	31	1978	0	16	0	122	0	138		
1924	0	0	4	166	0	170	1979	0	6	0	117	2	125		
1925	0	0	5	28	0	33	1980	0	12	0	142	65	219		
1926	0	13	10	42	0	65	1981	0	9	4	135	58	206		
1927	0	126	14	45	0	185	1982	0	8	4	122	22	156		
1928	0	40	7	35	0	82	1983	0	37	0	108	7	152		
1929	0	262	25	31	0	318	1984	0	2	6	110	0	118		
1930	0	96	6	44	0	146	1985	0	10	7	150	0	167		
1931	0	238	8	58	0	304	1986	0	11	5	114	0	130		
1932	0	411	19	76	0	506	1987	0	13	1	153	0	167		
1933	0	595	29	29	0	653	1988	0	9	2	157	0	168		
1934	0	406	31	33	0	470	1989	0	1	14	159	0	174		
1935	0	249	18	33	0	300	1990	0	11	92	130	0	233		

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1936	0	265	47	37	0	349	1991	0	9	3	179	0	191		
1937	0	242	59	25	0	326	1992	0	3	9	180	0	192		
1938	0	359	25	20	0	404	1993	0	2	3	191	0	196		
1939	0	0	0	24	0	24	1994	0	1	5	200	0	206		
1940	0	0	0	47	0	47	1995	0	5	2	239	0	246		
1941	0	0	0	43	0	43	1996	0	1	2	248	0	251	-11	240
1942	0	0	0	41	0	41	1997	0	3	0	206	0	209	4	213
1943	0	0	0	29	0	29	1998	0	0	1	160	0	161	22	183
1944	0	0	0	42	0	42	1999	0	0	2	157	0	159	13	172
1945	0	0	0	30	0	30	2000	0	31	0	99	0	130	-22	108
1946	0	0	5	32	0	37	2001	0	8	0	70	0	78	9	87
1947	5	0	9	36	0	50	2002	0	17	2	51	0	70	1	71
1948	0	0	8	47	0	55	2003	0	7	0	56	2	65	7	72
1949	0	0	20	63	0	83	2004	0	14	0	39	1	54	1	55
1950	0	289	16	42	0	347	2005	0	12	0	25	0	37	1	38
1951	0	100	12	31	0	143	2006	0	11	0	20	1	32	-2	30
1952	0	120	18	46	0	184	2007	0	12	0	23	0	35	-1	34
1953	0	340	8	48	0	396	2008	0	9	0	21	1	31	4	35
1954	0	273	5	72	0	350	2009	0	7	0	45	0	52	1	53
1955	0	111	3	96	0	210	2010	0	6	0	27	0	33	0	33
1956	0	174	1	64	0	239	2011	0	2	0	16	0	18	-2	16
1957	0	80	1	60	0	141	2012	0	9	0	20	0	29	-3	26
1958	0	204	0	71	0	275	2013	0	3	0	15	0	18	0	18
1959	0	392	5	54	0	451	2014	0	6	0	17	0	23	0	23
1960	0	197	3	46	0	246	2015	0	7	0	15	0	22	0	22
1961	0	182	0	30	0	212	2016	0	11	0	17	0	29	0	29
1962	0	239	0	42	0	281	2017	0	1	0	11	0	12	0	12
							2018	0	5	<1	22	0	0	0	9

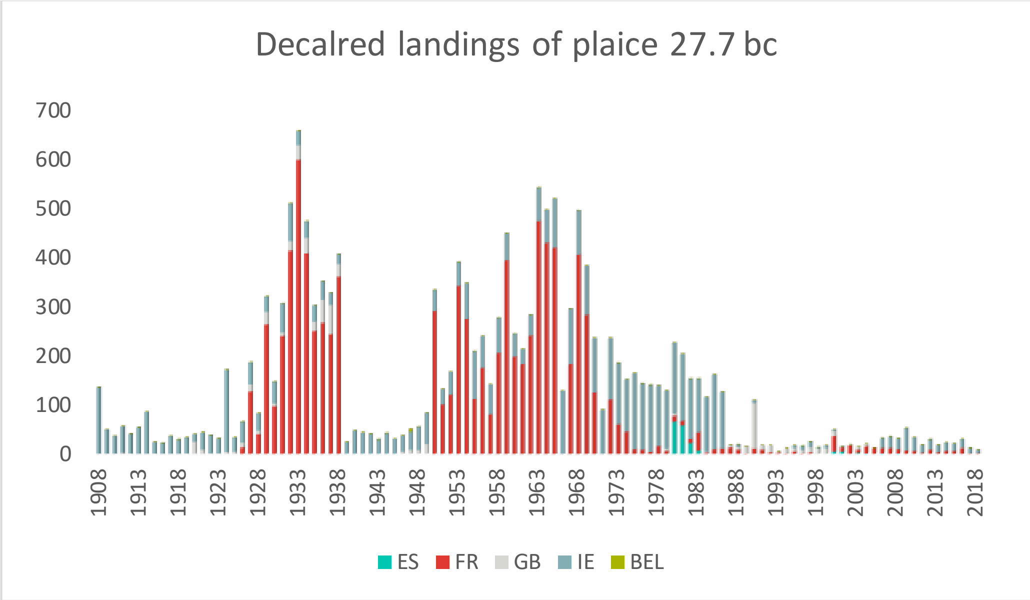


Figure 22.1. Landings of plaice in 7.bc as officially reported to ICES (1908–2018).

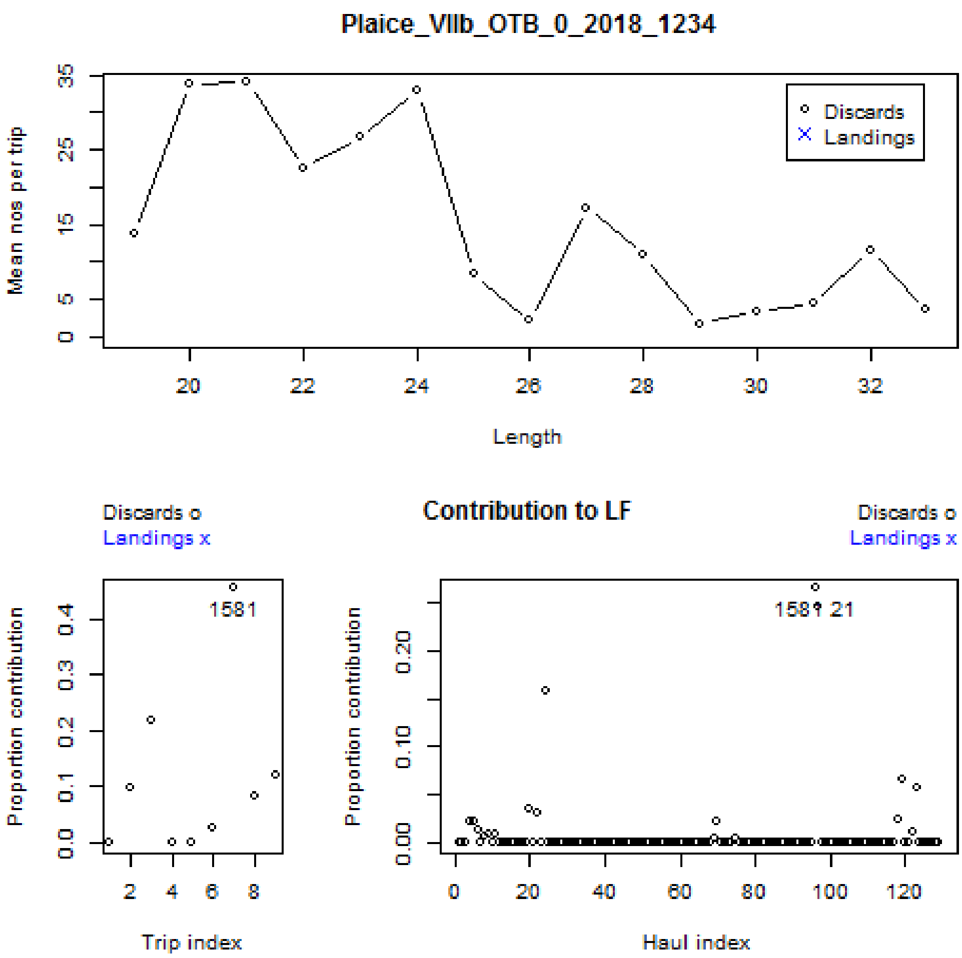


Figure 22.2. Estimated age distribution of plaice 7.bc in 2018 based on Irish sampling (landings in blue, discards in black).

24 Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel

Type of assessment in 2018

Last year's assessment report is available at: http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2018/WGCSE/27_Plaice_7e_2018.pdf

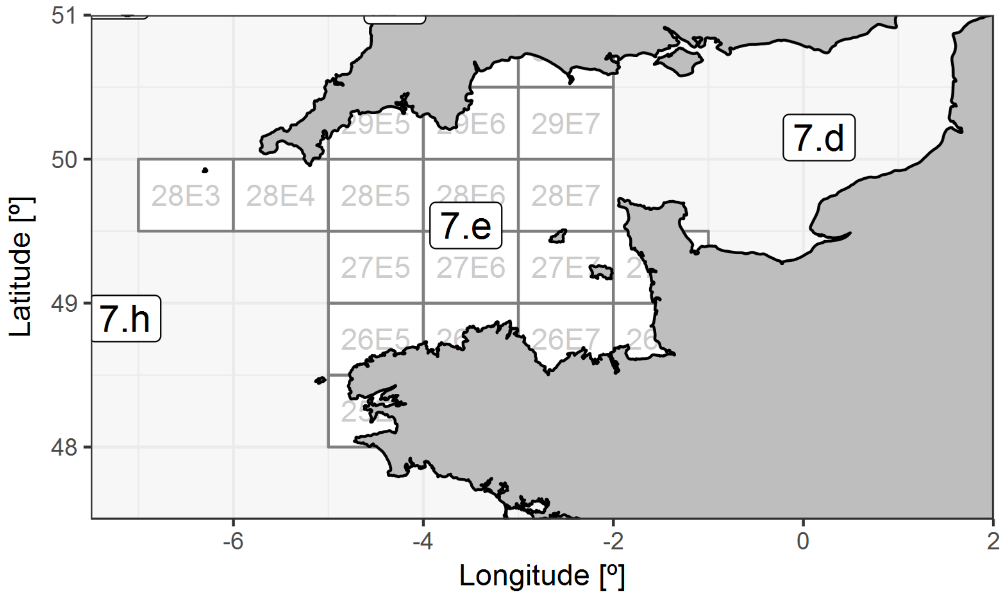
ICES advice applicable to 2019

Last year's advice is available at: http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/ple.27.7e.pdf

24.1 General

Stock description and management units

The management area for this stock is strictly that for ICES Division 7.e, called the Western English Channel. The TAC area does not correspond to the stock area given that it includes the larger component of 7.d (Eastern English Channel). However, WKFLAT 2010 found that a significant proportion of the catches of the 7.e stock are taken in the adjacent division during the spawning period. Plaice is not the main target species in 7.e, and it is generally taken as bycatch in fisheries targeting sole.



TAC area = 7.d–e; Assessment area = 7.e.

Management applicable to 2017 and 2018

There are technical measures in operation including a minimum 80 mm mesh size and a minimum landings size (27 cm) for this species.

The TAC and the national quotas by country for 2018

Species:	Plaice *Pleuronectes platessa*	Zone:	7d and 7e (PLE/7DE.)
Belgium	1695		
France	5651		
United Kingdom	3014		
Union	10 360		
TAC	10 360		Analytical TAC

(Source: Council Regulation (EU) 2018/120, EU, 2018b).

The TAC and the national quotas by country for 2019

Species:	Plaice *Pleuronectes platessa*	Zone:	7d and 7e (PLE/7DE.)
Belgium	1 694		
France	5 648		
United Kingdom	3 012		
Union	10 354		
TAC	10 354		Analytical TAC Article 7(2) of this Regulation applies

(Source: Council Regulation (EU) 2019/124, EU, 2019).

Landing obligation

The landing obligation is being phased in between 2019 and 2021 for plaice in 7.e with a discard plan defined in the Commission Delegated Regulation (EU) 2018/2034 (EU, 2018a) and referring to Regulation (EU) No 1380/2013 (EU, 2013). According to this discard plan, the landing obligation applies to plaice in 7.e. since 1 January 2019. There are, however, survivability exemptions for plaice when caught with specific gears. This includes all (a) trammelnets and (b) otter trawls. Furthermore, there is a provisional exemption for only 2019 including BT2 beam trawls (i.e. 80 mm to 120 mm mesh size) for (c) vessels with a maximum engine power greater than 221 kW and fitted with a flip-up rope or benthic release panel, and (d) for vessels with a maximum engine power of 221 kW or a maximum length of 24 m, when fishing within 12 nautical miles of the coast and with average tow durations of no more than 1:30 hours. (Commission Delegated Regulation (EU) 2018/2034, Article 6, EU, 2018a).

Prior to the introduction of the landing obligation, a substantial part of the plaice 7.e catches has been discarded and not accounted for in the stock assessment. In the first year of the phasing in of the landing obligation, the exemptions are likely to cover the majority of plaice catches and the impact on fishing or stock assessment is likely to be negligible. In the following two years of the discard plan, the situation should be closely monitored because of potential changes in the landings data and composition which might affect the stock assessment.

24.2 Data

The fishery in 2018

International catch data are collated on the ICES InterCatch platform. In the Western English Channel, plaice are taken mainly as bycatch in bottom trawls targeting sole and anglerfish. In 2018, 70% of the landings were taken by beam trawls, 23% by otter trawls, 4.9% by gillnets and 1.62% by other gears. Of the total international landings 84% were taken by the UK, 7.1% by France, 8.7% by Belgium, 0.198% by Ireland and 0.20% by the Netherlands (Table 23.1, Figures 23.1 and 23.2).

This stock is the smaller of the two plaice stocks that make up the larger TAC Area 7d–e. The official landings from this stock amounted to 19% of the TAC in 2017 and 16% of the TAC in 2018.

Landings

National landings data reported to ICES and estimates of total landings used by the Working Group are given in Table 23.1. Total international landings in for 7.e were 1915 t in 2017 and 1644 t in 2018.

In addition to the estimated 2018 landings for 7.e, an extra of 236 tonnes was added from the 7.d plaice stock representing an adjustment for migration of 15% of the mature component of quarter 1 landings between the two divisions. This process was agreed at WKFLAT 2010, and the migration correction was revised at WKPLE 2015. The process has been described in the Stock Annex. A reciprocal correction was made to the 7.d plaice stock at WGNSSK 2019. Figure 23.19 shows the total annual landings split by divisions 7.e and 7.d.

Discards

Although discards have not been used in the assessment of 7.e plaice in the past, some discard data are available. Discard tonnages are available within InterCatch and were provided by the UK(E&W) for the years 2012–2018, by France for 2014–2018, by Belgium for 2012–2013 and 2015–2018 and by Ireland for 2017–2018 (zero discards reported). Discard coverage and sampling is at a high level. In 2018, 469 t of discards were reported in InterCatch for 7.e and these discard estimates accounted for 92% of reported landings. For the remaining 7.7% of landings for which no discard estimates were provided, an additional discard estimate of 21 t was raised. Age samples for discards have only been provided by the UK(E&W) but cover the years 2012–2018. In 2018, the sampled discards covered 94% of the submitted discards.

In analogy to the landings, the discards are also uplifted by a migration correction from 7.d. For 2018, 236 t (15% of the mature Q1 plaice discards in 7.d) were added resulting in total discards of 624 t for the 7.e plaice stock.

For historical reasons, Figure 23.3 shows various discard rates for plaice in 7.e. Since WGCSE 2017, the discard rate is calculated as the contribution of total discards (raised, including migration correction) to the total plaice landings (including migration component) and this discard rate was 25% in 2018 (Figure 23.4).

Sampling

This year, all nations (apart from Scotland and the Belgian beam trawl fleet) provided data disaggregated by fleet and by quarter and these were all uploaded into the ICES InterCatch database. Quarterly age compositions for landings in 2018 were available only from the UK (England) only and were provided for six fleets (GNS_DEF_all_0_0_all Q1, Q2, Q3, Q4, MIS_MIS_0_0_0_HC Q1, OTB_DEF_>=120_0_0_all Q2, Q3, OTB_DEF_70-99_0_0_all Q1, Q2, Q3, Q4, TBB_DEF_>=120_0_0_all Q4, TBB_DEF_70-99_0_0_all Q1, Q2, Q3, Q4, Figure 23.9). These data accounted for 80% of the total reported international landings. Additional landings data were available by quarter/fleet from Belgium, France, Ireland (Q3, Q4), the Netherlands, UK (E+W, Guernsey, Jersey) and UK Scotland (annual). These datasets were aggregated to an international age-structured catch using the ICES InterCatch platform.

Length compositions were provided by the UK(E&W) and France (Figure 23.6).

An additional age composition representing the migration adjustment (15% of the mature component of quarter 1 landings for 7.d) was supplied on request by the WGNSSK stock coordinator for the 7.d plaice stock.

The method for the derivation of the international catch numbers and the calculation of the catch and stock weights-at-age has been fully described in the Stock Annex, Section B1 (Figure 23.17). Landings numbers-at-age (including the migration element) are given in Table 23.2 and in Figure 23.10. Landings and stock weights-at-age are given in Table 23.3 and Table 23.4 and plotted in Figure 23.18.

Catch weights are assumed to be mid-year values and stock weights are interpolated back (in year) to January 1st, as standard for this stock.

Revisions

No revisions to data for previous years were submitted.

Biological

The natural mortality and the maturity ogives used were identical to previous assessments and as described in the stock annex.

Surveys

Two surveys currently provide abundance estimates to the Working Group (Figure 23.14, Figure 23.15, Table 23.5 and Figure 23.16 for internal consistency).

In the 2018 FSP survey, landings numbers were dominated by plaice (34%) and sole (27%). In terms of total catch numbers (including discards), catches were dominated by bycatch species red gurnard and common dragonet (both 11%), lesser spotted dogfish (9%) and anglerfish (8%). The actual targeted species sole and plaice accounted for 5% and 9% respectively of total catch numbers. Plaice continues to be widespread and were encountered at 82 of 89 stations with greater numbers caught in Bigbury Bay and Great West Bay and fewer in the western part of the survey area. The catch of commercially important species (sole, plaice, megrim, lemon sole, anglerfish, monkfish) has been dominated by plaice in recent years but has dropped in 2018 due to high catches of monkfish. Aggregated plaice cpue estimates for the UK FSP-7e survey increased continuously since 2009 and reached a time-series maximum in 2014 and have been declining again since then. Currently, ages 3, 4 and 5 are most abundant in the index. There are some year effects visible (high catches in 2014) but cohort effects are not evident from looking at the catch curves. The internal consistency is good for ages larger than three.

The Q1SWBeam survey is based on a stratified random survey approach that covers the entire region of the management area and some adjacent waters. Cpue estimates for the Q1SWBeam survey gradually increased from 2006 to 2012 and increased rapidly thereafter to reach the highest levels on record in 2014. Since then, the index is very variable, mainly caused by changes in the abundance of plaice aged three and four. The internal consistency is reasonable for ages three to six. There is no correlation between the catches-at-age two and three and between seven and eight.

Commercial fleet effort and lpue

UK(E&W) beam trawl and otter trawl time-series are shown in Figure 23.5.

UK(E&W) beam trawl effort is relatively stable at high levels since the early 2000s but the landings increased substantially in after 2015.

UK(E&W) otter trawl effort (days fished-GRT corrected) has declined since 1989 to very low levels in recent years. In 2016, this fleet reported 0 effort and no landings, i.e. there is no lpue value for 2016. The reason for is that the lpue otter trawl index is calculated only with vessels of at least 12 m length and in 2016 only smaller vessels deploying otter trawls reported any activity. Due to a change in the database system, there are no consistent values available for the otter trawl fleet after 2016.

24.3 Data-limited methods

In 2017, ICES requested to trial data-limited methods for category 3 stocks in order to try to estimate the stock status relative to (proxy) MSY reference points and this is being provided since then.

During WGCSE 2019, the length-based indicator (LBI) method as developed during WKLIFE workshops (ICES, 2014; 2015e) and the Surplus Production in Continuous Time (SPiCT, Pedersen and Berg, 2017) were again applied.

Length-based indicators

Internationally raised length frequencies from InterCatch were only available for 2014–2018. Figure 23.7 shows these length distributions (landings and discards), including the length of first capture (L_c, calculated as first length class where the abundance is equal or larger to half of the maximum observed abundance in any length class) and the mean length in the catch above L_c.

As no country submitted life-history parameters for plaice, these had to be estimated with the available data. The data used were the age–length key from commercial UK data. For 2017, data were available for discards and landings, for 2018 only for landings. Von Bertalanffy growth functions were fitted to this dataset (Figure 23.8). This led to estimates of:

data	L_{inf} [cm]	k [year^{-1}]	t_0 [years]
2017 (landings and discards)	67.570754	0.08029	−3.86813
2018	81.31199	0.05747263	−4.715559
all	69.05451	0.07841	−3.86361

The estimates of L_{inf} appear reasonable but the estimated growth rates (k) seem too low for plaice. These estimates should be treated very carefully as they were based on commercial data and were from one country only. Furthermore, as the data are commercial, the data are most likely biased as fishery selectivity is not considered. The fish in the age–length key are mostly within the age range 4–7 and data for very young or older fish are scarce, impeding a robust model fit.

Several possible length-based indicators are suggested by ICES, but for plaice only the MSY proxy indicator $L_{mean}/L_{F=M}$ was calculated, as this is the only one that would be used to inform on the stock status regarding MSY proxies.

The reference length is defined as $L_{F=M} = \frac{L_{inf}+\frac{2M}{l}L_c}{1+\frac{2M}{k}}$.

Due to the uncertainty in the life-history parameters, the approximation of $M/k = 1.5$ was adopted and L_{inf} used derived from all data combined. For the calculation of the proxy reference length, the life-history parameters or proxies were set constant for all years, whereas L_c was calculated for every year. The following table shows the used parameters and the ratio $L_{mean}/L_{F=M}$:

year	2014	2015	2016	2017	2018
L_c [cm]	24	26	26	27	26
L_{mean} [cm]	30.2	32.3	33.3	33.0	32.7
$L_{F=M}$ [cm]	35.3	36.8	36.8	37.5	36.8
$L_{mean}/L_{F=M}$	0.857	0.878	0.906	0.879	0.889

According to this table, the stock would be slightly below the reference points for the last five years. At WGCSE 2019, these values were rejected (as in the previous years) due to uncertainty in in the life-history parameters, uncertainty about the assumption that $F = M$ is proxy for MSY and because a variety of data for this stock are available and falling back onto length data when a longer age-disaggregated catch history and survey data exist, is implausible.

SPiCT

During WKProxy (ICES, 2016b) a SPiCT assessment with a set of predefined parameter settings was used to assess plaice in 7.e. The workshop came up with reference values for biomass (exploitable biomass) and fishing mortality and found that the stock is in a desirable state, both in term of biomass and fishing mortality. The results from this assessment are also available on www.stockassessment.org. This assessment was reviewed at WGCSE 2017 and rejected, as it could not be reproduced.

As in the last two years, a trial assessment with SPiCT was conducted for plaice in 7.e. The input data comprised the same two tuning surveys as used in the traditional XSA assessment (FSP-UK and Q1SWBeam). For both surveys, an annual biomass value was created by summing up the biomass catch-at-age for the same ages as used in XSA. The catch input for SPiCT consisted of the total landings time-series. Several attempts were made to fit SPiCT. The result from the baseline run are shown in Figure 23.11 and Table 23. 11, the diagnostic plots in Figure 23.12.

Even though the model converged, the results are not appropriate. The uncertainty in the estimates were very high. This was true for the absolute and relative estimates as well as the estimated reference points. Furthermore, the datapoints on the production curve are all on the left, indicating a lack of contrast required for good model fit. According to the assessment estimates the stock is currently below 50% of B_{MSY} and the fishing mortality well above F_{MSY}, indicating an undesirable stock status.

The model was highly sensitive to the input data range. Figure 23.13 shows results of a retrospective and "inverted retrospective" (removing years from the beginning of the time-series) analysis. Removing years from the end or the beginning of the time-series led to a massive rescaling. This indicates a lack of consistency and the results of the model should be treated very cautiously.

Consequently, due to the high uncertainty, missing consistency and the inability of tracking stock dynamic properly the SPiCT model fit was rejected and should not be used to inform on the stock status.

As last year, instead of using proxy reference points, the stock status evaluation for plaice in 7.e is based on analytical reference points from an XSA assessment, as described later in this report.

24.4 Stock assessment

Catch-at-age analysis

During this year's WGCSE an XSA assessment was performed with the settings defined in the stock annex.

Data compilation and screening

The age range for the analysis was 2–10+ in accordance with the updated procedures outlined at IBPWCFlat2 2015 and detailed in the Stock Annex. The landings data were processed according to the stock annex, and formed the reference dataset for this year's assessment.

As this was an update assessment, full data screening, tuning data and extensive exploratory XSA trials were not carried out.

Available tuning information consisted of five fleets: three UK commercial series, UK otter historic, UK otter trawl, UK beam trawl; and two UK survey series: FSP-7e (UK(E&W)) and Q1SWBeam but in accordance with the decision of WGCSE in 2015, only the UK surveys were analysed and used in the assessment.

Update assessment

The settings used for the final run are shown in the table below. The full assessment history is given in the stock annex.

		2017 XSA	2018 XSA	2018 XSA
Catch-at-age data	Landings	1980–2016, 2–10+, 15% mature Q1 catch from 7.d added	1980–2017, 2–10+, 15% mature Q1 catch from 7.d added	1980–2018, 2–10+, 15% mature Q1 catch from 7.d added
	Discards	–	–	–
Fleets	UK-WEC-BTS – Survey	–	–	–
	UK WECOT – Commercial	–	–	–
	UK WECOT–Commercial historic	–	–	–
	UK WECBT – Commercial	–	–	–
	FSP-7e – Survey	2003–2016, 2–8 (exc. 2008)	2003–2017, 2–8 (exc. 2008)	2003–2018, 2–8 (exc. 2008)
	Q1SWBeam – Survey	2006–2016, 2–9	2006–2017, 2–9	2006–2018, 2–9
Taper		No	No	No
Taper range		–	–	–
Ages catch dep. Stock size		None	None	None
q plateau		6	6	6
F shrinkage se		1.0	1.0	1.0
Year range		3	3	3
Age range		3	3	3
Fleet SE threshold		0.3	0.3	0.3
Prior weighting		–	–	–
Plus group		10	10	10
F Bar Range		F(3–6)	F(3–6)	F(3–6)

The log-catchability residuals for the XSA run (landings only) are shown in Figure 23.20. For 2016, most residuals for the UK-FSP survey are negative, whereas they are positive for the Q1SWBeam survey. This is because of contradictory signals from the two surveys. This behaviour did not repeat afterwards.

Fishing mortalities and stock numbers estimated from the final run are given in Table 23.6 and Table 23. 7, and the assessment summary is shown in Table 23.8.

Retrospective patterns in stock status and fishing mortality estimates exhibited an unacceptably high degree of temporal variability since the late 1990s, thereby indicating an excessive level of uncertainty and a lack of robustness in the assessment outputs. Consequently, since 2015 the Working Group assessed the status of the plaice 7.e stock using a qualitative evaluation of survey trends only in accordance with the ICES Data-Limited Stock (DLS) category 3 approach.

A five-year retrospective analysis (Figure 23.21) was conducted. Compared to previous years, the retrospective has almost disappeared entirely and does not seem to be a problem anymore. The stock is still treated as a category 3 stock, mainly because of a missing discard time-series.

A Mohn's rho analysis was conducted based on the XSA stock assessment results, i.e. the last data year (2018) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 3-6)	recruitment
Mohn's rho value	0.00417205310419406	-0.0149021219845442	-0.127110812447642

The Mohn's rho values for this assessment are very low and well below the threshold of 20% imposed by ICES for 2019 assessments, i.e. the current assessment indicates a very high consistency.

Comparison with previous assessments

The assessment shows a high consistency compared to last year's assessment (Figure 23.23).

Intermediate year

As recommended by the advice drafting group (ADG) in 2017, the SSB is now presented until the intermediate year. All age groups used in the assessment contribute to the SSB (plaice at-age 2, the recruitment age, are thought to be 26% mature). Therefore, to obtain an SSB estimate for 2018, an assumption about the recruitment in 2019 is required. Due to a lack of data to predict recruitment in 2019, the long-term (entire time-series) geometric mean was used.

State of the stock

As in the last years, the XSA assessment based on landings data only was used as final assessment run. A summary of this assessment is given in Table 23. 8 and Figure 23.22.

As this is a category 3 stock, the results of the stock assessment are indicative of trends only for giving advice. In Figure 23.22, absolute and relative (to mean of time-series) results of the stock assessment are presented. Table 23.8 shows the absolute assessment results and Table 23.9 relative assessment summary results.

Spawning–stock biomass was relatively stable from 1982 to 1985 and then increased until 1989 above the long-term average following strong recruitment events during the mid-1980s. Subsequently, spawning–stock biomass decreased until 1996. A strong year class in 1996 generated an increase in spawning–stock biomass between 1996 and 2000. However, successive poor year classes resulted in spawning–stock biomass declining to the lowest levels in 2007. A combination of above average recruitment and a reduction in fishing mortality has increased spawning–stock biomass since 2008 to reach the highest level on record in 2016. However, since then, the SSB has decreased but is still a high level.

Fishing mortality gradually increased from the 1980s up until the 2000s, peaking briefly in 2007. Following a large reduction in fishing mortality in 2009, this assessment shows a general decline that has reached the lowest levels on record in 2015. Since then, F has increased again.

This assessment estimates that recruitment has been above the long-term geometric mean (1980–2018) between 2010 and 2015 and below afterwards.

However, the optimistic stock development in recent years is uncertain due to assessment uncertainty and omitting discard information. The decision to omit discard data is mainly due to uncertainty in the actual discard rate and unknown proportion of surviving plaice in the discards.

State of the stock in comparison to analytical reference points

Analytical reference points for the landings only XSA assessment were estimated during WKMSYREF4 (ICES, 2016a) but never used due to the downgrading of the stock to category 3. The main reason for this was an unacceptable retrospective pattern. This problem has now disappeared and consequently the analytical reference points have been restored in 2017.

In comparison with reference points, F surpassed F_{MSY} in 2016 and is above since then. The SSB is well above $MSYB_{trigger}$, B_{pa} and B_{lim}.

24.5 Short-term projections

As in the last years, plaice in 7.e continues to be treated as a category 3.2.0 stock and the assessment is indicative of trends only. Therefore, catch advice was provided by applying the ICES DLS framework for category 3 stocks where temporal trends in spawning–stock biomass are used as an index of stock development. The advice is based on a comparison of the two latest index values (index A) with the three preceding values (index B), multiplied by the recent advised catch. The SSB estimates from the landings only assessment are used as index values for this stock.

As basis for calculating the landings corresponding to the catch advice, the total catches as raised in InterCatch, including the migration correction from 7.d is used.

The basis for the catch options is presented in Table 23.10. For stocks in ICES data categories 3–6, one catch option is provided.

The index ratio (2019–2018 / 2017–2015) is 0.93 and therefore the uncertainty cap does not need to be applied.

The fishing mortality derived from XSA is above F_{MSY} and the precautionary buffer has never been applied since this stock is treated as category 3, therefore the precautionary buffer should be applied and reduce the advised catch by 20%.

The advised catch in 2018 for 2019 was 3648 tonnes and is used as the basis for calculating the new advice.

This leads to the following advice for the 7.e plaice stock:

ICES advises that when the precautionary approach is applied, catches of the Division 7.e plaice stock should be no more than 2721 tonnes in 2019. If discard rates do not change from the average of the last six years (2012–2018), this implies landings of no more than 1909 tonnes.

The average proportion of the landings of the 7.e plaice stock taken in Division 7.e between 2003–2018 is 10%. The year range (2003 until most recent year) was agreed between the two stocks (7.e and 7.d) and is also used in the advice for the 7.d stock. The calculation of this proportion only includes landings and disregards discards, as discard estimates for the plaice 7.e stock only exist from 2012 onwards. The advised catch for the stock is reduced by the average proportion to give advice for the 7.e area.

This leads to the following advice for plaice in Division 7e:

Assuming the same proportion of the Division 7.e plaice stock is taken in Division 7.d as during 2003–2018, this will correspond to catches of plaice in Division 7.e of no more than 2456 tonnes. If discard rates do not change from the average of the last seven years (2012–2018), this implies landings of plaice in Division 7.e of no more than 1722 tonnes.

24.6 Biological reference points

The currently used reference points are the ones calculated at WKMSYREF4 (ICES, 2016a) and shown in the following table:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$*	2443 t	B_{pa}	ICES (2016a)
	F_{MSY}	0.238	Eqsim run with segmented regression with breakpoint at B_{loss}. F_{MSY} was taken as the peak of the median landings yield curve.	ICES (2016a)
Precautionary approach	B_{lim}	1745 t	B_{loss}	ICES (2016a)
	B_{pa}	2443 t	1.4*B_{lim}	ICES (2016a)
	F_{lim}	0.88	Based on segmented regression simulation of recruitment without error	ICES (2016a)
	F_{pa}	0.63	Flim*exp(-1.645*σ); σ=0.2	ICES (2016a)

*** The value for MSY $B_{trigger}$ is not the value published in WKMSYREF4. The advice drafting group in 2017 and 2018 decided to base MSY $B_{trigger}$ on B_{pa}.**

Reference points for 7.e plaice were calculated at WKMSYREF4 (ICES, 2016a) using the results from an XSA with parameters implemented at WGCSE 2015. In contrast to the WGCSE assessment 2015, absolute values from the XSA assessment were used instead of the relative values for the calculation of the values. ICES did not adopt these reference points initially due to the classification of the plaice 7.e as category 3.

Instead MSY proxies were calculated at WKMSYPROXY 2015 (ICES, 2016b) which are presented in the following table.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$ proxy	1910 t	F_{MSY} (estimated by SPiCT from model parameters using data from 1980–2014)	WKPROXY 2015 (ICES, 2016b)
	F_{MSY} proxy	0.56	0.5 x B_{MSY} (estimated by SPiCT from model parameters using data from 1980–2014)	WKPROXY 2015 (ICES, 2016b)

These values have been used to assess the relative stock status at WGCSE 2016. At WGCSE 2017, these values have been rejected. Instead, the values from the WKMSYREF4 were restored and used in 2017, 2018 and 2019.

24.7 Exploratory assessment including discards

At the 2019 working group, an exploratory assessment including a full catch time-series, including discards, was trialled for the first time. Reliable discard data are available from 2012 onwards from InterCatch but not routinely used in the stock assessment.

For the years for which discard data are available, the raising was done inside InterCatch and for the strata for which no discard estimates were available, discards were estimated based on available discard information. Age allocations for discards were performed in InterCatch the same as for landings.

For the years prior to 2012, discards were estimated based on available discard information. Discard ratios at-age (for numbers) were calculated for 2012–2018 and a linear regression fitted, independently for each age used in the assessment. This was then extrapolated back in time to the beginning of the landings time-series in 1980. For the ages for which the linear regression did not indicate a decrease in the discards rate when going back in time, the average discard rate for 2012–2018 was used for all historical years prior to 2012. Discard weights-at-age where calculated as the mean of 2012–2018. Based on these discard numbers and weights-at-age, total discards were calculated, and the total catch corrected for discards. Total catch split into landings and discards, including the historical estimated discards are shown in Figure 23.24.

Based on the total catch estimates, an exploratory XSA assessment was conducted using identical XSA assessment settings as for the accepted landings only assessment. The results of this total catch assessment in comparison to the landings only assessment are shown in Figure 23.25. New reference points were calculated with EqSim with the same settings and assumptions as during WKMSYRef4 but using the results from the total catch assessment.

According to the total catch assessment and the revised reference points, the stock is lower than estimated by the landings only assessment and the recent decline is more pronounced. The fishing mortality is higher and above F_{MSY} and F_{PA} and below F_{lim}.

It should be noted that this assessment is only exploratory and should not yet be used for providing advice. Further work and model validations are required.

The conclusion from this exploratory assessment run is that the stock is likely to be in less favourable condition as estimated by the accepted routine landings only assessment.

24.8 Management plans

There is no management plan in place for this stock.

24.9 Uncertainties and bias in assessment and forecast

A degree of uncertainty exists over the landings statistics for this stock given that mature plaice migrate between 7.d and 7.e during the spawning period. The current assessment applies a spawning migration correction that reallocates 15% of quarter 1 landings for the mature proportion of the catch from 7.d to 7.e. Consequently, the assessment results depend on the mixing rate assumption estimated from existing tagging data. Further work is required to examine stock structure and the mixing rate during the spawning period. Additional data are also needed to determine if the current mixing rate remains valid given the increased abundance of plaice stocks in the English Channel in recent years.

There is a heavy reliance on the age composition data derived from UK(E&W) sampling. Around 25% of the landings for this stock are taken by countries that do not provide age-based data, and this situation is improved only slightly once the migration correction data from 7.d are added.

Discard data are only available for 2012–2018 and these data are mainly from the UK(E&W). Historical discarding rates are highly uncertain but available discard data reported imply a significant increase between 2012 and 2015. Discards are not included in the assessment. The assessment contains a certain degree of uncertainty due to excluding discards and is likely to be overly optimistic. Fishing mortality is likely to be higher, and SSB lower than estimated by the current assessment. The decision to exclude discards in the assessment is based on the uncertainty in the available discards data and unknown discard survival rate of plaice.

24.10 Recommendations for next Benchmark

The perception of issues has not changed since last year's report. Therefore, the recommendations presented here, are identical to last year as they have not been addressed so far.

A benchmark assessment was developed for this stock at WKFLAT 2010 and an inter-benchmark meeting (IBPWCFlat2) subsequently convened in 2015 to revise the input data and update the XSA assessment settings. Nevertheless, any future benchmark meeting will need to consider the following issues.

Since 2017, ICES asked for the additional application of data-limited methods for category 3 stocks. This massively increased the workload for the stock coordinator and assessor but with little benefit for this stock. Upgrading this stock to category 1 is desirable and feasible within a reasonable timeframe.

The decisive reason for downgrading the stock to category 3 were unacceptable retrospective patterns in the XSA assessment. This has disappeared and a fully analytical assessment is possible. For doing so, the following issues need to be considered:

- A discard time-series should be developed and included into the assessment as discarding was substantial in recent years. The current assessment is based on landings only and therefore possibly fails to accurately model actual stock dynamics, particularly as the discard rate in recent years is variable.
- Discards including age compositions are now routinely estimated within InterCatch and exist for 2012–2017. Some UK discard data prior to 2012 exist, but have never been used. The discard time-series should be extended back in time, as it has been done for other plaice and similar stocks.
- Including discards in the assessment might require a re-parameterization of XSA settings and the exploration of alternative age-structured assessment models.
- Biological data such as natural mortality and maturity ogives are time invariant in the current assessment and borrowed from other plaice stocks (divisions 7.fg and 7.a). There

have been benchmarks for other plaice stocks and a similar approach could be pursuit for plaice in 7.e. The natural mortality used for plaice in 7.e was originally borrowed from plaice in Division 7.a. The values for plaice in 7.a have been changed during the last benchmark but the original values are still used for plaice in 7.e.

Furthermore, the following points should be considered:

- Smoothing of stock and catch weights. The raw catch weights are corrected for migration from 7.d and then smoothed using a polynomial function of 2nd degree. Even though the fit seems to be quite reasonable different more appropriate methods should be evaluated.
- Abundance estimates derived from the UK FSP-7e and Q1SWBeam surveys included in the assessment are spatially restricted to the same areas as the commercial tuning fleets, and therefore little population abundance information exists along the French coast. Cpue estimates from additional research surveys in French coastal waters would improve the robustness of future assessment outputs.
- Investigate the addition of age composition information from the French and Belgian fleets. These fleets collectively account for about 16% of the total landings of this stock. In particular, inclusion of French data would add information on the stock dynamics on the French coast.

24.11 Management considerations

The stock unit (Division 7.e) does not correspond with the management unit (Divisions 7.d and 7.e), and this divisional mismatch hampers the effective management of plaice in the Western English Channel. However, some provision must be made to consider the effective management of adjacent plaice stocks given that components of the 7.e stock are also taken during spawning period in 7.d. WKPLE 2015 revised the established migration correction, so that 15% of quarter 1 landings for the mature proportion of the catch are reallocated from 7.d to 7.e and the associated age composition is applied to plaice 7.e.

The total allowable catch (TAC) for the management area for 2016 has been doubled compared to 2015 but was reduced for 2017 and increased again slightly for 2018 and 2019.

Due to migration patterns, catches of this stock also occur in Division 7.d during the spawning period; therefore, to be consistent with the advised catch for the Division 7.e plaice stock, the actual catches of plaice in Division 7.e should be lower than the advised catch for the stock. ICES has calculated the corresponding actual catches in Division 7.e, assuming that the proportion of Division 7.e stock catches taken in Division 7.d remains as in previous years (i.e. 10%, the average of 2003–2018, taking the age structure of the population into account). As the mixing rate of the two plaice stocks is uncertain, this calculation provides only an approximation.

In accordance with the guidelines for category 3 stocks, a fully analytical assessment of the plaice 7.e stock including short-term forecast was not conducted at WGCSE 2018. Consequently, this year's category 3 assessment is indicative of trends only. Relative values presented for recruitment, spawning–stock biomass and fishing mortality estimates had similar temporal trends to absolute values presented at previous Working Groups.

The recent stock trends for plaice in 7.d are similar to plaice in 7.e.

24.12 References

EU. 2013. Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC. OJ L 354, 28.12.2013, p. 22–61. http://data.europa.eu/eli/reg/2013/1380/oj

EU. 2017. Council Regulation. (EU) 2017/127 of 20 January 2017 fixing for 2017 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters. OJ L 24, 28.1.2017, p. 1–172. http://data.europa.eu/eli/reg/2017/127/oj

EU. 2018a. Commission Delegated Regulation (EU) 2018/2034 of 18 October 2018 establishing a discard plan for certain demersal fisheries in North-Western waters for the period 2019–2021. C/2018/6789. OJ L 327, 21.12.2018, p. 8–16. http://data.europa.eu/eli/reg_del/2018/2034/oj

EU. 2018b. Council Regulation. (EU) 2018/120 of 23 January 2018 fixing for 2018 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2017/127. OJ L 27, 31.1.2018, p. 1–168. http://data.europa.eu/eli/reg/2018/120/oj

EU. 2019. Council Regulation (EU) 2019/124 of 30 January 2019 fixing for 2019 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters. ST/15733/2018/INIT. OJ L 29, 31.1.2019, p. 1–166. http://data.europa.eu/eli/reg/2019/124/oj

ICES. 2014. Report of the Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE IV), 27–31 October 2014, Lisbon, Portugal. ICES CM 2014/ACOM:54. 223 pp.

ICES. 2015e. Report of the Fifth Workshop on the Development of Quantitative Assessment Methodologies based on Life-history Traits, Exploitation Characteristics and other Relevant Parameters for Data-limited Stocks (WKLIFE V), 5–9 October 2015, Lisbon, Portugal. ICES CM 2015/ACOM:56. 157 pp.

ICES. 2016a. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2016b. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

Pedersen, M. W., and Berg, C. W. 2017. A stochastic surplus production model in continuous time. Fish and Fisheries, 18(2), 226–243.

24.13 Tables

Table 23.1. Plaice in 7.e. Nominal landings (t) in Division 7e, as used by the Working Group.

Year	Landings Belgium	Netherlands	France	UK (E &W) incl. CI's	Others	Total reported	Unallocated*	Total*	7.e stock caught in 7.d**	ICES estimated landings	Discards***
1976	5	-	323	312	-	640	-	640	-	640	
1977	3	-	336	363	-	702	-	702	-	702	
1978	3	-	314	467	-	784	-	784	-	784	
1979	2	-	458	515	-	975	2	977	-	977	
1980	23	-	325	609	9	966	113	1079	99	1178	
1981	27	-	537	953	-	1517	−16	1501	175	1676	
1982	81	-	363	1109	-	1553	135	1688	190	1878	
1983	20	-	371	1195	-	1586	−91	1495	219	1714	
1984	24	-	278	1144	-	1446	101	1547	211	1758	
1985	39	-	197	1122	-	1358	83	1441	236	1677	
1986	26	-	276	1389	-	1691	119	1810	268	2078	
1987	68	-	435	1419	-	1922	36	1958	314	2272	
1988	90	-	584	1654	-	2328	130	2458	377	2835	
1989	89	-	448	1712	-	2249	109	2358	384	2742	
1990	82	-	N/A	1891	2	1977	616	2593	392	2985	
1991	57	-	251	1326	-	1634	214	1848	335	2183	
1992	25	-	419	1110	14	1568	56	1624	258	1882	
1993	56	-	284	1080	24	1444	−27	1417	197	1614	
1994	10	-	277	998	-	1285	−129	1156	248	1404	
1995	13	-	288	857	-	1158	−127	1031	216	1247	
1996	4	-	279	855	-	1138	−94	1044	222	1266	
1997	6	-	329	1038	1	1374	−51	1323	260	1583	
1998	22	-	327	892	1	1242	−111	1131	215	1346	
1999	12	-	194	947	-	1153	146	1299	244	1543	

Year	Landings Belgium	Netherlands	France	UK (E &W) incl. CI's	Others	Total reported	Unallocated*	Total*	7.e stock caught in 7.d**	ICES estimated landings	Discards***
2000	4	-	360	926	+	1290	−9	1281	345	1625	
2001	12	-	303	797	-	1112	−6	1106	204	1310	
2002	27	-	242	978	+	1247	10	1257	215	1472	
2003	39	-	216	985	-	1240	37	1277	110	1387	
2004	46	-	184	912	-	1142	70	1212	126	1337	
2005	48	-	198	887	-	1133	70	1203	117	1319	
2006	52	-	223	964	-	1239	74	1313	97	1411	
2007	84	-	202	680	-	966	37	1003	143	1146	
2008	66	-	148	676	-	890	86	976	135	1112	
2009	53	2	191	729	-	975	−52	923	101	1024	
2010	51	2	227	843	-	1123	−31	1092	116	1208	
2011	141	3	274	936	-	1354	−20	1334	83	1417	
2012	134	2	224	1003	-	1363	3	1366	126	1492	448
2013	97	1	221	1041	-	1360	−9	1351	121	1472	351
2014	41	0	323	976	-	1340	1	1341	149	1490	1133
2015	111	1	224	912	1	1249	3	1246	178	1424	1276
2016	145	< 1	204	1430	-	1780	−1	1777	235	2013	618
2017	151	< 1	153	1602	1	1911	4	1915	213	2128	821
2018^	142	3	118	1373	-	1640	4	1644	236	1880	624

***Estimated by the working group.**

****Migration correction (15% of the mature population caught in Quarter 1 in Division 7.d) added to stock.**

*****Discard estimated by the working group, including discards from the migration correction.**

^Preliminary.

Table 23.2. Plaice in 7.e. Landings numbers-at-age.

	Numbers-at-age [thousands]									
year/age	2	3	4	5	6	7	8	9	10+	TOTAL NUM
1980	754	758	244	226	62	63	22	13	137	2279
1981	667	2068	555	118	101	20	46	18	94	3688
1982	279	1928	1371	257	87	82	16	28	121	4168
1983	720	799	1613	586	101	40	47	2	99	4009
1984	928	1650	659	518	191	90	28	33	50	4146
1985	596	1424	1326	154	248	140	27	15	51	3980
1986	914	2326	908	478	110	127	66	28	61	5018
1987	1063	2083	1355	648	228	86	49	44	51	5608
1988	1817	4627	1087	456	149	112	38	24	52	8362
1989	269	2748	2873	825	268	118	94	31	100	7326
1990	331	3151	2668	1198	263	133	76	56	71	7946
1991	557	1192	1876	956	510	103	43	33	51	5320
1992	699	1299	734	646	441	258	69	32	49	4227
1993	670	1377	631	262	267	216	165	39	85	3712
1994	326	1503	831	250	106	116	78	84	63	3357
1995	322	732	943	263	118	56	79	68	88	2667
1996	1050	668	379	382	122	59	38	47	105	2848
1997	861	2228	435	177	147	75	31	17	99	4070
1998	536	1482	1107	155	64	60	22	21	61	3507
1999	650	2135	1124	407	92	37	39	17	45	4546
2000	351	1157	2037	496	181	38	14	22	52	4348
2001	469	785	788	950	145	79	19	11	37	3283
2002	1017	1190	460	394	456	106	42	12	40	3718
2003	886	964	532	182	166	236	58	45	38	3107
2004	471	1364	566	338	107	74	109	51	38	3119
2005	796	880	775	277	146	50	49	58	48	3080
2006	995	1358	517	379	115	61	27	18	53	3523

	Numbers-at-age [thousands]									
year/age	2	3	4	5	6	7	8	9	10+	TOTAL NUM
2007	393	1077	699	287	199	72	31	10	50	2819
2008	919	703	570	259	112	87	32	15	29	2727
2009	647	1255	297	151	79	32	21	7	17	2505
2010	759	974	758	215	114	47	16	18	23	2924
2011	1132	1441	725	255	75	50	27	12	18	3735
2012	204	1561	1066	373	253	101	51	21	35	3664
2013	137	1075	1377	510	200	149	45	49	36	3579
2014	135	636	1407	845	356	135	70	54	35	3673
2015	90	392	642	924	553	234	61	50	35	2982
2016	61	888	1116	828	897	426	155	64	55	4490
2017	88	460	1619	1148	646	468	220	133	134	4917
2018	72	392	913	1307	713	339	226	122	114	4199

Table 23.3. Plaice in 7.e. Landings weights-at-age.

	Weights-at-age [kg]								
year/age	2	3	4	5	6	7	8	9	10+
1980	0.329	0.435	0.538	0.640	0.741	0.840	0.939	1.035	1.392
1981	0.273	0.400	0.526	0.647	0.767	0.883	0.997	1.108	1.448
1982	0.302	0.391	0.474	0.548	0.617	0.678	0.732	0.780	0.890
1983	0.224	0.338	0.446	0.547	0.642	0.730	0.812	0.888	1.085
1984	0.254	0.356	0.461	0.570	0.682	0.797	0.914	1.034	1.510
1985	0.222	0.337	0.450	0.561	0.669	0.775	0.878	0.979	1.341
1986	0.260	0.353	0.450	0.551	0.655	0.764	0.877	0.994	1.490
1987	0.287	0.347	0.418	0.503	0.599	0.710	0.833	0.968	1.387
1988	0.225	0.310	0.407	0.515	0.634	0.765	0.906	1.059	1.398
1989	0.224	0.293	0.370	0.454	0.547	0.647	0.756	0.872	1.167
1990	0.270	0.315	0.371	0.437	0.514	0.602	0.700	0.809	1.081
1991	0.252	0.316	0.389	0.473	0.566	0.670	0.784	0.908	1.246
1992	0.286	0.345	0.417	0.503	0.601	0.713	0.838	0.976	1.330
1993	0.263	0.338	0.418	0.503	0.596	0.694	0.798	0.907	1.194
1994	0.266	0.336	0.412	0.494	0.582	0.676	0.775	0.879	1.136
1995	0.282	0.362	0.445	0.531	0.619	0.709	0.803	0.899	1.083
1996	0.268	0.371	0.474	0.577	0.681	0.786	0.891	0.997	1.216
1997	0.272	0.345	0.427	0.514	0.608	0.709	0.816	0.931	1.196
1998	0.190	0.313	0.435	0.556	0.674	0.793	0.911	1.028	1.339
1999	0.206	0.295	0.382	0.466	0.548	0.628	0.706	0.781	1.006
2000	0.206	0.293	0.380	0.468	0.555	0.642	0.729	0.817	1.066
2001	0.218	0.301	0.388	0.480	0.576	0.677	0.782	0.891	1.268
2002	0.256	0.331	0.410	0.496	0.588	0.686	0.788	0.895	1.208
2003	0.266	0.371	0.475	0.577	0.675	0.772	0.866	0.959	1.273
2004	0.300	0.361	0.429	0.505	0.588	0.679	0.778	0.883	1.203
2005	0.293	0.366	0.445	0.528	0.616	0.709	0.806	0.908	1.134
2006	0.296	0.361	0.433	0.512	0.600	0.694	0.795	0.904	1.121

	Weights-at-age [kg]								
year/age	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**
2007	0.255	0.333	0.415	0.499	0.586	0.677	0.770	0.868	1.105
2008	0.281	0.357	0.441	0.531	0.627	0.729	0.838	0.954	1.308
2009	0.242	0.379	0.513	0.644	0.771	0.894	1.013	1.128	1.383
2010	0.274	0.364	0.460	0.562	0.668	0.779	0.895	1.016	1.285
2011	0.241	0.351	0.463	0.577	0.693	0.811	0.931	1.052	1.376
2012	0.207	0.310	0.413	0.515	0.618	0.721	0.824	0.927	1.239
2013	0.268	0.318	0.382	0.458	0.548	0.650	0.766	0.894	1.355
2014	0.207	0.280	0.358	0.441	0.528	0.619	0.714	0.814	1.164
2015	0.244	0.306	0.380	0.466	0.563	0.672	0.792	0.923	1.251
2016	0.279	0.325	0.379	0.441	0.512	0.591	0.677	0.773	1.001
2017	0.270	0.310	0.357	0.411	0.472	0.540	0.616	0.697	0.926
2018	0.219	0.262	0.322	0.397	0.487	0.594	0.716	0.855	1.177

Table 23.4. Plaice in 7.e. Stock weights-at-age.

	Stock weights-at-age [kg]								
year/age	2	3	4	5	6	7	8	9	10+
1980	0.275	0.381	0.485	0.587	0.688	0.788	0.886	0.983	1.342
1981	0.207	0.336	0.462	0.585	0.705	0.823	0.937	1.049	1.393
1982	0.253	0.345	0.430	0.508	0.579	0.643	0.701	0.751	0.874
1983	0.164	0.282	0.393	0.497	0.595	0.687	0.772	0.851	1.059
1984	0.202	0.302	0.405	0.512	0.621	0.733	0.849	0.967	1.433
1985	0.163	0.280	0.394	0.506	0.615	0.722	0.827	0.929	1.295
1986	0.215	0.306	0.401	0.500	0.603	0.709	0.820	0.935	1.422
1987	0.261	0.313	0.378	0.455	0.545	0.648	0.764	0.892	1.292
1988	0.186	0.266	0.357	0.460	0.573	0.698	0.833	0.980	1.309
1989	0.193	0.258	0.330	0.411	0.500	0.596	0.701	0.813	1.098
1990	0.250	0.290	0.340	0.401	0.472	0.554	0.647	0.750	1.009
1991	0.224	0.282	0.350	0.428	0.516	0.615	0.723	0.842	1.167
1992	0.259	0.310	0.375	0.453	0.544	0.648	0.765	0.895	1.231
1993	0.227	0.298	0.375	0.458	0.547	0.641	0.742	0.848	1.126
1994	0.230	0.297	0.369	0.447	0.531	0.620	0.715	0.816	1.063
1995	0.243	0.322	0.403	0.487	0.573	0.663	0.755	0.850	1.031
1996	0.217	0.319	0.421	0.524	0.628	0.732	0.837	0.943	1.160
1997	0.237	0.308	0.385	0.469	0.559	0.657	0.761	0.872	1.129
1998	0.128	0.251	0.374	0.495	0.616	0.735	0.853	0.971	1.283
1999	0.160	0.250	0.339	0.424	0.508	0.589	0.667	0.743	0.972
2000	0.162	0.248	0.335	0.422	0.509	0.596	0.683	0.771	1.019
2001	0.178	0.259	0.344	0.434	0.528	0.626	0.729	0.836	1.205
2002	0.215	0.285	0.361	0.443	0.529	0.621	0.719	0.822	1.119
2003	0.211	0.318	0.422	0.524	0.624	0.722	0.817	0.911	1.227
2004	0.272	0.329	0.393	0.464	0.544	0.630	0.725	0.827	1.136
2005	0.257	0.328	0.404	0.484	0.569	0.659	0.754	0.853	1.074
2006	0.265	0.326	0.395	0.471	0.554	0.644	0.741	0.846	1.057

	Stock weights-at-age [kg]								
year/age	2	3	4	5	6	7	8	9	10+
2007	0.217	0.294	0.374	0.457	0.542	0.631	0.723	0.818	1.052
2008	0.245	0.318	0.398	0.484	0.577	0.676	0.782	0.894	1.238
2009	0.171	0.311	0.447	0.579	0.707	0.832	0.953	1.070	1.329
2010	0.229	0.318	0.411	0.509	0.612	0.720	0.834	0.952	1.215
2011	0.186	0.295	0.407	0.520	0.635	0.752	0.870	0.991	1.313
2012	0.156	0.259	0.361	0.464	0.567	0.670	0.773	0.876	1.187
2013	0.247	0.291	0.348	0.418	0.501	0.597	0.706	0.828	1.270
2014	0.172	0.243	0.319	0.399	0.484	0.573	0.666	0.763	1.119
2015	0.217	0.274	0.342	0.422	0.513	0.616	0.730	0.856	1.181
2016	0.259	0.301	0.350	0.409	0.475	0.550	0.633	0.725	0.948
2017	0.252	0.289	0.333	0.383	0.441	0.505	0.577	0.655	0.881
2018	0.203	0.239	0.29	0.357	0.44	0.539	0.653	0.784	1.097

Table 23.5. Plaice in 7.e. Tuning fleet data available. Not all years and ages as shown here are used in the assessment.

```
W.CHANNEL PLAICE 2017 WGCSE
103
FSP-7e 2003 2018
1 1 0.75 0.80 1 27
1             0.0211067846  0.3436960076  0.3437074251  0.2157251992  0.0410941273
              0.0420394907  0.050922775   0.0336197547  0.0218671506  0.0021727333
              0.0009159771  0.0005058883  8.53924e-05   3.84779e-05   0
              3.84779e-05   0             3.84779e-05   0.000191009   0             0
              0             0             0             0             0             0
1             0.0070373856  0.2187967247  0.8383814292  0.1674465544  0.2811175442
              0.0295976308  0.0181115034  0.0456505471  0.0115076586  0.0024680729
              0.0008236371  0.0002105587  0.0001693488  0             0.0001996527  0
              0             0             0.0001228108  0             0             0
              0             0             0             0             0
1             0.0084930716  0.3271099173  0.4255951803  0.2404409927  0.0900371664
              0.0395287705  0.0127361504  0.0174592138  0.0371790541  0.0070178609
              0.0043464537  0             0             0             0.0006865187
              0.0006011272  0.0005708894  0             0.0005994339  0.0014134667  0
              0             0             0             0             0             0
1             0.0264706605  0.6225976144  0.4203687415  0.1868514656  0.100069074
              0.0443691462  0.0214152594  0.0045769523  0.0063647949  0.0140975761
              0.0015007319  0.0043230363  0             0             0.0005854935  0
              0             0.0006888159  0             0             0             0
              0             0             0             0             0
1             0             0.1142361312  0.2784062648  0.1592710836  0.0656092046
              0.0262748838  0.0084052832  0.0060075138  0.0055495566  0.0045378496
              0.0019644854  0.002332567   0.0023474203  0             0             0
              0             0             0             0             0             0
              0             0             0             0             0
1             0.0017564806  0.4944510666  0.2125971983  0.1238164242  0.0317108691
              0.0193389072  0.0147284753  0.0047131194  0.0019406773  0.0004673808
              0.0001707341  0.0001513458  5.99338e-05   2.84557e-05   3.14781e-05
              2.84557e-05   0             3.14781e-05   3.14781e-05   3.14781e-05   0
              0             0             0             0             0             0
1             0.0217107087  0.4400684216  0.4456831091  0.1533401761  0.0607307496
              0.033556666   0.0229918674  0.0080215597  0.0033998957  0.0013018772  0
              0.0026037544  0             0             0             0             0
              0             0             0             0             0             0
              0             0             0             0
1             0.0647388571  0.7402133171  0.5829812879  0.3845761643  0.0479189382
              0.0415029509  0.0119952249  0.0061701869  0.0023009922  0.0047470993
              0.0011504961  0.006622702   0             0             0             0
              0             0             0             0             0             0
              0             0             0             0             0
1             0.0063827045  1.0367978347  0.8009990763  0.3141066371  0.1105303872
              0.0103585886  0.0181600726  0.0132274793  0.0020264885  0.0020542202
              0.0016210483  0.0001080726  6.98109e-05   0.0029870594  0
              0.0011887579  0             3.82617e-05   0             0             0
              0             0             0             0             0             0
1             0.0501727567  0.321434098   1.2428329551  0.5819792183  0.1364891814
              0.1347918963  0.0121371085  0.0144254043  0.0115270917  0.0025913556
              0.0051989993  0.0049471333  0             0             0             0
              0             0             0             0             0             0
              0             0             0             0             0
1             0             0.2266890224  1.4641865697  1.2671043524  0.4403084123
              0.2032552981  0.0755061094  0.0275649015  0.0077368789  0.0037886636  0
              0.0012684957  0.0012684957  0             0             0             0
              0.0012684957  0             0             0             0             0
              0             0             0             0
1             0.03548275    1.319797284   1.6647790616  2.1308293497  0.8328568122
              0.6237114226  0.1572964824  0.0350538578  0.0371484109  0
              0.0035336667  0.00265025    0             0             0.0011778889  0
              0             0             0             0             0             0
              0             0             0             0             0
1             0.0016784148  0.8264615004  1.252881835   0.9145923083  1.0102330934
              0.5068745617  0.1213252742  0.0127476628  0.055649506   0.0022378864
              0.0089704641  0             0             0             0             0
              0             0             0             0             0             0
              0             0             0             0             0
1             0.0033568296  0.3887210579  1.50073462    0.8157445965  0.3896522219
              0.3426977969  0.2351356472  0.0186050167  0.056730528   0
              0.0098937394  0             0.0028762403  0             0             0
              0             0             0             0             0             0
              0             0             0             0             0
1             0.0083920741  0.2734688532  0.5985856837  1.5809798468  0.3446727423
              0.4536494278  0.2886734237  0.0563499887  0.1485529321  0.013814645
              0.0264081583  0.0106433051  0.0054248655  0             0.0033568296  0
```

```
	0	0	0	0	0	0
	0	0	0	0	0
1	0	0.2730774994	0.765289223	0.9806866884	0.6563497784
	0.1850327432	0.1112903326	0.0873483927	0.0302633863	0.0263229229
	0.0030350849	0.0017983016	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0
Q1SWBeam
2006 2018
1 1 0  0.25
1 27
1	1.46029	31.1894	24.244	19.115	5.3835
	2.6963	0.1513	0.11942	0.2388	0.56317	0
	0.34656	0.1976	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0
1	0.86782	14.7809	34.368	28.319	4.9883
	5.5958	1.9261	4.75535	0.2503	3.992
	0.2503	2.29854	0.99913	0.2503	0	0
	0	0	0	0	0	0
	0	0	0	0	0
1	0.95099	33.5532	17.429	9.116	5.4635
	0.9659	1.5218	2.21499	1.979	0
	0.87797	0.12102	0.18772	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0
1	1.2131	45.2746	46.545	15.717	10.7145
	3.0017	4.1608	0.32375	0.2043	0.32375
	0.32375	0	1.78752	0	1.23777	0
	0	0	0	0	0	0
	5.27731	0	0	0	0
1	0.97592	45.0547	39.746	27.094	4.3481
	1.8618	2.7469	0.76424	0.3754	0	0
	0.18772	0	2.29257	0	0	0
	0	0.11942	0	0	0	0
	0	0	0	0
1	1.80958	53.1512	75.65	27.139	7.0529
	6.2411	2.9599	0.46795	0.5277	0.11377
	0.35757	0	0.11919	0.11919	0.11919
	0.64983	0	0	0	0	0
	0	0	0	0	0	0
1	0	9.1228	59.258	30.977	14.8202
	5.2353	7.4435	0.48139	3.1713	0	0
	0.18772	0	0	0.14385	0	0
	0	0	0	0	0	0
	0	0	0.11942	0
1	0.30036	18.0403	91.824	65.429	12.689
	3.9641	2.5307	2.00951	0.8034	0	0
	0	0.12571	0	0	0
	0.11374	0	0	0	0	0
	0	0	0	0	0
1	1.01423	65.9025	148.705	178.597	63.2579
	10.6805	1.3356	2.33955	0.9387	0.48829
	0.28101	0.15884	0.1706	0	0	0
	0.15884	0	0	0	0	0
	0	0	0	0	0
1	0	36.3433	46.731	27.17	40.4109
	30.2577	4.3911	5.31769	0.9476	2.08315	0
	0.99022	0	0.18772	0	0.1976	0
	0	0	0	0	0	0
	0	0	0	0
1	0.22085	20.8393	190.215	56.534	34.9048
	37.2433	26.557	7.92202	11.0153	1.75709
	6.95574	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0
1	0	14.2514	68.17	151.523	32.551
	31.4779	14.6612	2.65757	5.4495	0.37686
	5.39347	0	0.30715	0	0.18772	0
	0	0	0	0	0	0
	0	0	0	0	0
1	0	11.2905	37.574	27.32	45.9335
	22.3257	10.4298	9.19479	9.1063	1.1739
	1.07603	0.11942	0	0.11942	0	0
	0	0	0	0	0	0
	0	0	0	0	0
FSP-7e-biomass
2003 2018
1 1 0.75 0.80
1 27
```

1	0	0.017016728	0.068867092	0.096605209	0.026719823	
	0.030511966	0.039428295	0.023136956	0.02121698	0.003105212	
	0.001649358	0.00101558	0.000129111	6.16112e-05	0	
	6.16112e-05	0	6.16112e-05	0.000412429	0	0
	0	0	0	0	0	0
1	0	0.009253684	0.14719821	0.077734516	0.142615388	
	0.019093729	0.013918673	0.045087957	0.009428396	0.004482924	
	0.001121228	0.000215559	0.000182454	0	0.000304188	0
	0	0	0.000240839	0	0	0
	0	0	0	0	0	
1	0	0.015621844	0.073065687	0.101896379	0.05382426	
	0.027075454	0.010259167	0.017859677	0.034554905	0.007686843	
	0.006065153	0	0	0	0.001218691	
	0.000962531	0.001353022	0	0.001294305	0.002771882	0
	0	0	0	0	0	0
1	0	0.026371445	0.068631235	0.085981713	0.059904288	
	0.029057905	0.015892962	0.00406511	0.006358017	0.015281921	
	0.002559487	0.003623002	0	0	0.000347422	0
	0	0.001102939	0	0	0	0
	0	0	0	0	0	
1	0	0.004778692	0.047412485	0.063290284	0.03830767	
	0.020106321	0.007997441	0.003733733	0.005285688	0.005281424	
	0.002276312	0.004246414	0.001312233	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.02303336	0.042696327	0.06099742	0.022717433	
	0.016696799	0.014316446	0.006020215	0.001612963	0.000686571	
	0.000219825	0.000258466	9.83678e-05	3.66375e-05	6.17303e-05	
	3.66375e-05	0	6.17303e-05	6.17303e-05	6.17303e-05	0
	0	0	0	0	0	0
1	0	0.021783708	0.089427434	0.071486272	0.040609123	
	0.031037596	0.018685442	0.00724396	0.005443947	0.00255305	0
	0.003877076	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0		
1	0	0.031128145	0.108246974	0.176676563	0.032028353	
	0.028385365	0.011556535	0.006137064	0.002962591	0.00716298	
	0.002042332	0.003041061	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.039626333	0.124140706	0.126023141	0.065743914	
	0.006395157	0.01993035	0.010885693	0.002822451	0.002837335	
	0.002214251	0.000167923	0.000106658	0.004218814	0	
	0.001542561	0	6.12651e-05	0	0	0
	0	0	0	0	0	0
1	0	0.01139495	0.180226935	0.207399701	0.07492458	
	0.080259232	0.013262699	0.009394429	0.011571324	0.002465811	
	0.005859429	0.004732132	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.006907976	0.180758085	0.410553109	0.202774124	
	0.108655459	0.054254917	0.020215075	0.010110847	0.003552844	0
	0.001455044	0.001455044	0	0	0	0
	0.003290293	0	0	0	0	0
	0	0	0	0		
1	0	0.041444759	0.205551436	0.631560929	0.333907762	
	0.261575403	0.079435747	0.025108143	0.029091589	0	
	0.004970024	0.001837137	0	0	0.000926584	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.025917135	0.177782812	0.309264643	0.41997488	
	0.249988758	0.076811998	0.012487193	0.03663801	0.001327924	
	0.012810427	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.012422358	0.194476531	0.290658509	0.183274879	
	0.180552834	0.125276737	0.013959313	0.045946967	0	
	0.00886356	0	0.001943963	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.008907602	0.07598728	0.484763131	0.149260328	
	0.207245338	0.155649866	0.03381067	0.09188589	0.012446502	
	0.019714288	0.010609453	0.005307667	0	0.003212512	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.00926128	0.095714846	0.287166203	0.277926644	
	0.105983836	0.068842772	0.069157464	0.022306102	0.023142302	
	0.003509849	0.003526564	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	

Table 23.6. Plaice in 7.e. Fishing mortality-at-age. The values in the table are rounded to three digits.

	Fishing mortality-at-age								
year/age	2	3	4	5	6	7	8	9	10+	F(3–6)
1980	0.12	0.419	0.457	0.423	0.766	0.407	0.341	0.507	0.507	0.516
1981	0.107	0.503	0.562	0.378	0.309	0.553	0.54	0.469	0.469	0.438
1982	0.104	0.461	0.67	0.502	0.481	0.401	1.073	0.655	0.655	0.528
1983	0.128	0.436	0.803	0.616	0.342	0.392	0.389	0.375	0.375	0.549
1984	0.187	0.433	0.71	0.591	0.375	0.525	0.469	0.458	0.458	0.527
1985	0.095	0.438	0.676	0.318	0.571	0.474	0.261	0.437	0.437	0.501
1986	0.144	0.58	0.504	0.498	0.358	0.585	0.39	0.446	0.446	0.485
1987	0.08	0.508	0.727	0.748	0.427	0.477	0.425	0.445	0.445	0.602
1988	0.174	0.523	0.493	0.52	0.341	0.348	0.361	0.351	0.351	0.469
1989	0.033	0.392	0.656	0.789	0.602	0.452	0.501	0.521	0.521	0.61
1990	0.101	0.593	0.746	0.572	0.566	0.616	0.531	0.574	0.574	0.619
1991	0.164	0.568	0.784	0.594	0.463	0.409	0.376	0.418	0.418	0.602
1992	0.184	0.631	0.757	0.62	0.548	0.408	0.476	0.48	0.48	0.639
1993	0.154	0.594	0.657	0.608	0.511	0.515	0.453	0.495	0.495	0.593
1994	0.162	0.548	0.804	0.537	0.481	0.397	0.32	0.401	0.401	0.593
1995	0.159	0.59	0.726	0.581	0.472	0.453	0.47	0.467	0.467	0.592
1996	0.181	0.517	0.636	0.668	0.528	0.414	0.577	0.509	0.509	0.587
1997	0.17	0.646	0.687	0.63	0.531	0.666	0.361	0.522	0.522	0.623
1998	0.065	0.446	0.709	0.508	0.442	0.392	0.367	0.402	0.402	0.526
1999	0.172	0.356	0.655	0.559	0.58	0.458	0.425	0.49	0.49	0.538
2000	0.155	0.473	0.615	0.617	0.472	0.457	0.286	0.406	0.406	0.544
2001	0.142	0.548	0.624	0.593	0.331	0.351	0.389	0.358	0.358	0.524
2002	0.325	0.576	0.659	0.671	0.577	0.39	0.293	0.421	0.421	0.621
2003	0.215	0.528	0.498	0.537	0.607	0.605	0.347	0.522	0.522	0.543
2004	0.175	0.538	0.619	0.622	0.641	0.54	0.566	0.538	0.538	0.605
2005	0.22	0.518	0.61	0.639	0.545	0.634	0.78	0.619	0.619	0.578
2006	0.31	0.642	0.597	0.623	0.545	0.415	0.76	0.661	0.661	0.602

	Fishing mortality-at-age									
year/age	2	3	4	5	6	7	8	9	10+	F(3–6)
2007	0.172	0.586	0.738	0.717	0.716	0.713	0.351	0.652	0.652	0.689
2008	0.212	0.476	0.645	0.608	0.621	0.728	0.735	0.264	0.264	0.588
2009	0.154	0.451	0.343	0.315	0.34	0.326	0.334	0.321	0.321	0.362
2010	0.122	0.333	0.491	0.407	0.379	0.314	0.243	0.511	0.511	0.403
2011	0.124	0.325	0.403	0.275	0.22	0.259	0.273	0.255	0.255	0.306
2012	0.022	0.229	0.385	0.339	0.437	0.47	0.416	0.327	0.327	0.347
2013	0.022	0.143	0.295	0.292	0.28	0.454	0.357	0.806	0.806	0.253
2014	0.02	0.124	0.257	0.271	0.311	0.283	0.362	0.87	0.87	0.241
2015	0.009	0.07	0.162	0.245	0.261	0.315	0.182	0.433	0.433	0.185
2016	0.013	0.101	0.265	0.296	0.362	0.3	0.323	0.269	0.269	0.256
2017	0.024	0.115	0.247	0.433	0.362	0.296	0.228	0.461	0.461	0.289
2018	0.024	0.128	0.318	0.295	0.478	0.298	0.208	0.175	0.175	0.305

Table 23.7. Plaice in 7.e. Stock numbers-at-age. Numbers are rounded to the nearest thousand.

	Stock numbers-at-age [thousands]									
year/age	2	3	4	5	6	7	8	9	10+	sum
1980	7067	2350	707	696	122	199	82	36	364	11623
1981	6961	5558	1371	397	404	50	118	52	265	15175
1982	3004	5545	2981	693	241	263	26	61	266	13080
1983	6382	2402	3102	1353	372	132	156	8	335	14243
1984	5788	4982	1378	1232	648	235	79	94	143	14579
1985	6959	4260	2865	601	605	395	123	44	154	16006
1986	7233	5611	2437	1293	388	303	218	84	180	17748
1987	14731	5555	2786	1306	697	240	150	131	151	25747
1988	12070	12064	2965	1194	548	403	132	87	186	29650
1989	8717	8994	6342	1606	630	346	253	82	259	27228
1990	3645	7478	5389	2920	647	306	195	136	172	20887
1991	3916	2922	3665	2267	1461	326	147	102	156	14961
1992	4420	2949	1469	1484	1110	816	192	89	137	12666
1993	4976	3262	1391	611	708	569	481	106	229	12334
1994	2311	3783	1597	639	295	377	302	271	200	9775
1995	2322	1743	1939	634	332	162	225	194	249	7799
1996	6722	1757	857	832	314	183	91	125	279	11160
1997	5846	4973	929	402	379	165	108	45	257	13104
1998	9109	4374	2313	415	190	197	75	66	194	16933
1999	4367	7574	2484	1009	221	108	118	46	122	16050
2000	2598	3261	4707	1144	512	110	61	69	165	12626
2001	3750	1974	1803	2256	548	283	62	40	131	10847
2002	3891	2885	1012	857	1106	349	177	37	124	10438
2003	4865	2493	1438	465	388	551	210	117	100	10627
2004	3105	3480	1303	775	241	188	267	131	97	9587
2005	4279	2311	1802	623	369	113	97	134	110	9837
2006	3965	3046	1220	868	291	190	53	39	116	9788

	Stock numbers-at-age [thousands]									
year/age	2	3	4	5	6	7	8	9	10+	sum
2007	2641	2579	1422	596	413	150	111	22	110	8044
2008	5116	1971	1273	603	258	179	65	69	134	9669
2009	4804	3673	1086	592	291	123	77	28	65	10738
2010	7030	3652	2075	684	383	184	79	49	60	14196
2011	10343	5521	2322	1127	404	233	119	55	86	20209
2012	9879	8107	3540	1377	759	287	159	80	132	24321
2013	6689	8570	5721	2136	870	435	159	93	68	24741
2014	7089	5803	6589	3777	1414	583	245	99	64	25662
2015	11137	6160	4548	4518	2554	919	390	151	106	30483
2016	5136	9792	5094	3429	3137	1744	595	288	245	29461
2017	4007	4497	7849	3467	2261	1938	1146	382	384	25931
2018	3236	3471	3555	5436	1994	1397	1278	809	751	21927

Table 23.8. Plaice in 7.e. Assessment summary (raw values, not standardised).

Year	Recruitment (age 2) [thousands]	TSB [tonnes]	SSB [tonnes]	Landings [TONNES]	Fbar(3–6)
1980	7067	4428	2512	1178	0.52
1981	6961	5034	2983	1676	0.44
1982	3004	4912	3252	1878	0.53
1983	6382	4410	3139	1714	0.55
1984	5788	4801	3135	1758	0.53
1985	6959	4759	3189	1677	0.50
1986	7233	5858	3747	2078	0.49
1987	14731	8193	4366	2272	0.60
1988	12070	8096	4746	2835	0.47
1989	8717	7805	5153	2742	0.61
1990	3645	6959	4987	2985	0.62
1991	3916	5283	4059	2183	0.60
1992	4420	4810	3447	1882	0.64
1993	4976	4360	2985	1614	0.59
1994	2311	3570	2555	1404	0.59
1995	2322	3104	2308	1247	0.59
1996	6722	3664	2266	1266	0.59
1997	5846	4195	2384	1583	0.62
1998	9109	3974	2463	1346	0.53
1999	4367	4270	2726	1543	0.54
2000	2598	3878	2957	1626	0.54
2001	3750	3481	2655	1310	0.52
2002	3891	3502	2437	1472	0.62
2003	4865	3710	2485	1387	0.54
2004	3105	3522	2276	1337	0.61
2005	4279	3477	2197	1319	0.58
2006	3965	3413	2091	1411	0.60
2007	2641	2668	1805	1146	0.69

Year	Recruitment (age 2) [thousands]	TSB [tonnes]	SSB [tonnes]	Landings [TONNES]	Fbar(3–6)
2008	5116	3228	1928	1112	0.59
2009	4804	3290	2066	1024	0.36
2010	7030	4524	2656	1207	0.4
2011	10343	5785	3448	1417	0.31
2012	9879	7281	4414	1492	0.35
2013	6689	7824	5253	1472	0.25
2014	7089	7567	5693	1490	0.24
2015	11137	9982	7166	1424	0.185
2016	5136	10730	8081	2013	0.26
2017	4007	9476	7739	2128	0.29
2018	3236	8381	7352	1880	0.30
2019	5302*	8367	6938		

*** geometric mean of time-series.**

Table 23.9. Plaice in 7.e. Assessment summary (relative values).

Year	Recruitment (age 2) [relative]	SSB [relative]	Landings [TONNES]	DISCARDS [TONNES]	F_{bar}(3–6) [relative]
1980	1.2	0.68	1178		1.04
1981	1.18	0.81	1676		0.88
1982	0.51	0.88	1878		1.06
1983	1.08	0.85	1714		1.11
1984	0.98	0.85	1758		1.06
1985	1.18	0.86	1677		1.01
1986	1.23	1.01	2078		0.98
1987	2.5	1.18	2272		1.21
1988	2.0	1.28	2835		0.94
1989	1.48	1.39	2742		1.23
1990	0.62	1.35	2985		1.25
1991	0.66	1.10	2183		1.21
1992	0.75	0.93	1882		1.29
1993	0.84	0.81	1614		1.19
1994	0.39	0.69	1404		1.19
1995	0.39	0.62	1247		1.19
1996	1.14	0.61	1266		1.18
1997	0.99	0.64	1583		1.25
1998	1.54	0.67	1346		1.06
1999	0.74	0.74	1543		1.08
2000	0.44	0.80	1626		1.10
2001	0.64	0.72	1310		1.05
2002	0.66	0.66	1472		1.25
2003	0.82	0.67	1387		1.09
2004	0.53	0.62	1337		1.22
2005	0.73	0.59	1319		1.16
2006	0.67	0.57	1411		1.21

Year	Recruitment (age 2) [relative]	SSB [relative]	Landings [TONNES]	DISCARDS [TONNES]	F_{bar}(3–6) [relative]
2007	0.45	0.49	1146		1.39
2008	0.87	0.52	1112		1.18
2009	0.81	0.56	1024		0.73
2010	1.19	0.72	1207		0.81
2011	1.75	0.93	1417		0.62
2012	1.67	1.19	1492	448	0.70
2013	1.13	1.42	1472	351	0.51
2014	1.20	1.54	1490	1133	0.48
2015	1.89	1.94	1424	1276	0.37
2016	0.87	2.2	2013	618	0.52
2017	0.68	2.1	2128	821	0.58
2018	0.55	1.99	1880	624	0.61
2019	0.90*	1.87			

* geometric mean of time-series (before standardisation).

Table 23.10. Plaice in 7e. The basis for the catch options for 2020. Note that one catch option is provided for stocks in ICES data categories 3–6. The values presented here are the values presented during the working group.

Division 7.e plaice stock		
Index A (2018–2019)	1.93	
Index B (2015–2017)	2.1	
Index ratio (A/B)	0.93	
Uncertainty cap	Not applied	-
Advised catch for 2019 issued 2018	3648 tonnes	
Discard rate (2012–2018)	0.30	
Precautionary buffer	Applied	0.8
Catch advice**	2721 tonnes	
Wanted catch corresponding to catch advice^	1909 tonnes	
% Advice change (plaice Division 7.e stock)***	-25	
Plaice in Division 7.e		
Proportion of Division 7.e stock landings taken in Division 7.e (2003–2018)	0.90	
Catch of plaice in Division 7.e corresponding to the advice for the stock	2456 tonnes	
Wanted catch of plaice in Division 7.e corresponding to the advice for the stock	1722 tonnes	

*** The figures in the table are rounded. Calculations were done with unrounded inputs and computed values may not match exactly when calculated using the rounded figures in the table.**

**** [recent advised catch] × [index ratio] x [precautionary buffer].**

***** Advice value 2020 relative to the advice value 2019.**

^ "Wanted catch" is used to describe fish that would be landed in the absence of the EU landing obligation.

Table 23.11. Plaice in 7e. Results of the SPiCT model fit.

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 0.3165488
Euler time step (years):  1/16 or 0.0625
Nobs C: 39,  Nobs I1: 13,  Nobs I2: 16

Residual diagnostics (p-values)
    shapiro   bias    acf   LBox shapiro bias acf LBox
 C   0.1222 0.6342 0.2916 0.4450       -    -   -    -
 I1  0.7154 0.7663 0.4470 0.7332       -    -   -    -
 I2  0.6115 0.6866 0.1542 0.3815       -    -   -    -

Priors
     logn  ~  dnorm[log(2), 2^2]
 logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]

Model parameter estimates w 95% CI
            estimate       cilow        ciupp    log.est
 alpha1 4.350903e+00   0.9472487 1.998457e+01  1.4703833
 alpha2 2.563373e+00   0.4843959 1.356511e+01  0.9413241
 beta   1.696890e-01   0.0385950 7.460640e-01 -1.7737877
 r      2.458745e-01   0.0544256 1.110770e+00 -1.4029339
 rc     1.142545e+00   0.3909006 3.339489e+00  0.1332578
 rold   4.316604e-01   0.0666692 2.794852e+00 -0.8401162
 m      2.145554e+03 1642.3272634 2.802975e+03  7.6711531
 K      1.649977e+04 3391.5439837 8.027095e+04  9.7111018
 q1     2.462392e-01   0.1347400 4.500055e-01 -1.4014520
 q2     8.120000e-04   0.0004560 1.446000e-03 -7.1159624
 n      4.303982e-01   0.2545429 7.277459e-01 -0.8430445
 sdb    8.067320e-02   0.0183604 3.544668e-01 -2.5173493
 sdf    2.049607e-01   0.1480990 2.836540e-01 -1.5849372
 sdi1   3.510011e-01   0.2296525 5.364704e-01 -1.0469660
 sdi2   2.067954e-01   0.1281550 3.336924e-01 -1.5760252
 sdc    3.477960e-02   0.0088949 1.359902e-01 -3.3587249

Deterministic reference points (Drp)
          estimate        cilow        ciupp    log.est
 Bmsyd 3755.7468861 1009.8284196 13968.347888  8.2310424
 Fmsyd    0.5712723    0.1954503     1.669744 -0.5598894
 MSYd  2145.5539830 1642.3272634  2802.974777  7.6711531
Stochastic reference points (Srp)
          estimate        cilow        ciupp    log.est rel.diff.Drp
 Bmsys 3744.1834247 1009.8653832 13881.958675  8.2279588 -0.003088380
 Fmsys    0.5720508    0.1962089     1.667825 -0.5585274  0.001360976
 MSYs  2141.8723080 1641.4053273  2794.932432  7.6694356 -0.001718905

States w 95% CI (inp$msytype: s)
                    estimate       cilow       ciupp    log.est
 B_2018.75      1181.2046995 586.9873935 2376.958275  7.0742901
 F_2018.75         1.5472271   0.7711580    3.104307  0.4364643
 B_2018.75/Bmsy    0.3154773   0.0751756    1.323912 -1.1536687
```

```
F_2018.75/Fmsy    2.7047020   0.8160355   8.964577  0.9949917

Predictions w 95% CI (inp$msytype: s)
                 prediction        cilow       ciupp    log.est
B_2019.00      1169.720514  560.3095162 2441.946892  7.0645201
F_2019.00         1.545162    0.7484009    3.190170  0.4351289
B_2019.00/Bmsy    0.312410    0.0726658    1.343136 -1.1634387
F_2019.00/Fmsy    2.701093    0.8003929    9.115399  0.9936563
Catch_2019.00  1788.193648 1459.6187495 2190.734069  7.4889613
E(B_inf)       1141.814724           NA          NA  7.0403741
```

24.14 Figures

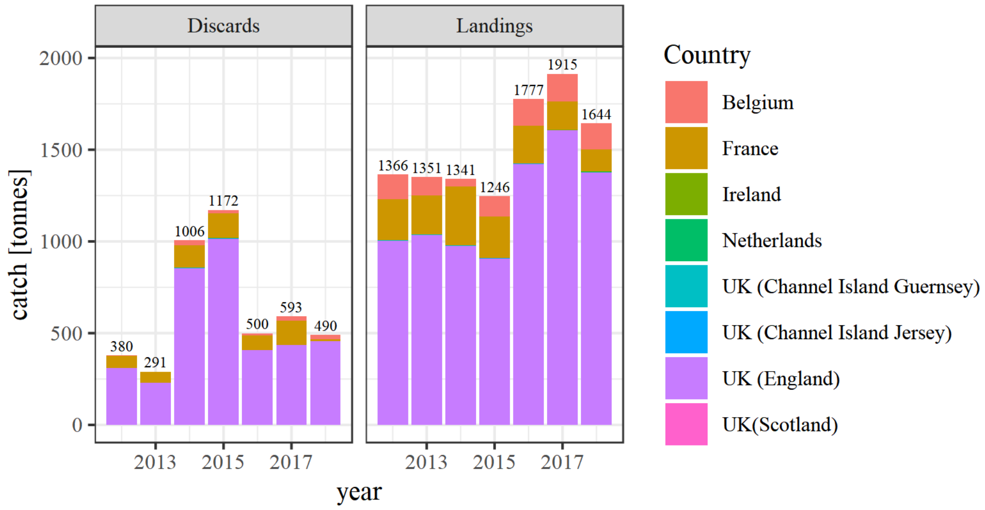


Figure 23.1. Plaice in 7.e. International landings and discards by country as extracted from InterCatch for 2012–2018.

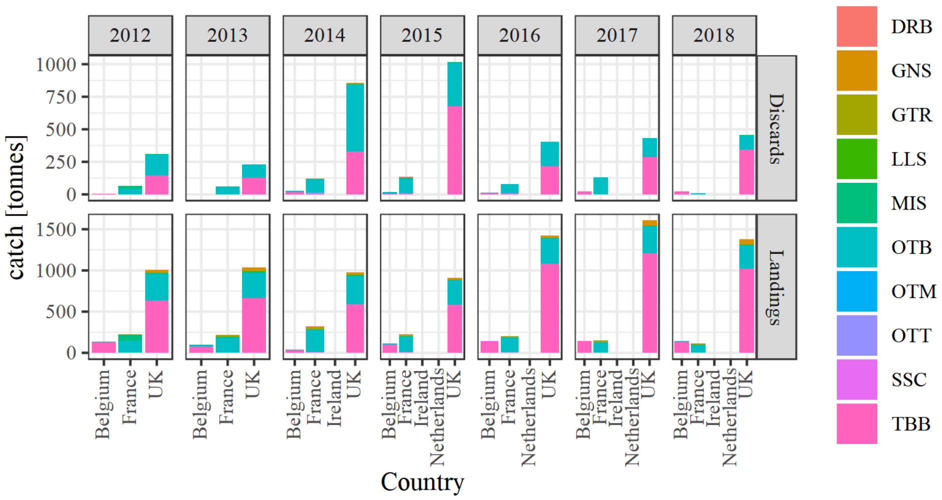


Figure 23.2. Plaice in 7.e. International landings and discards reported to InterCatch per country and fleet for the years 2012–2018.

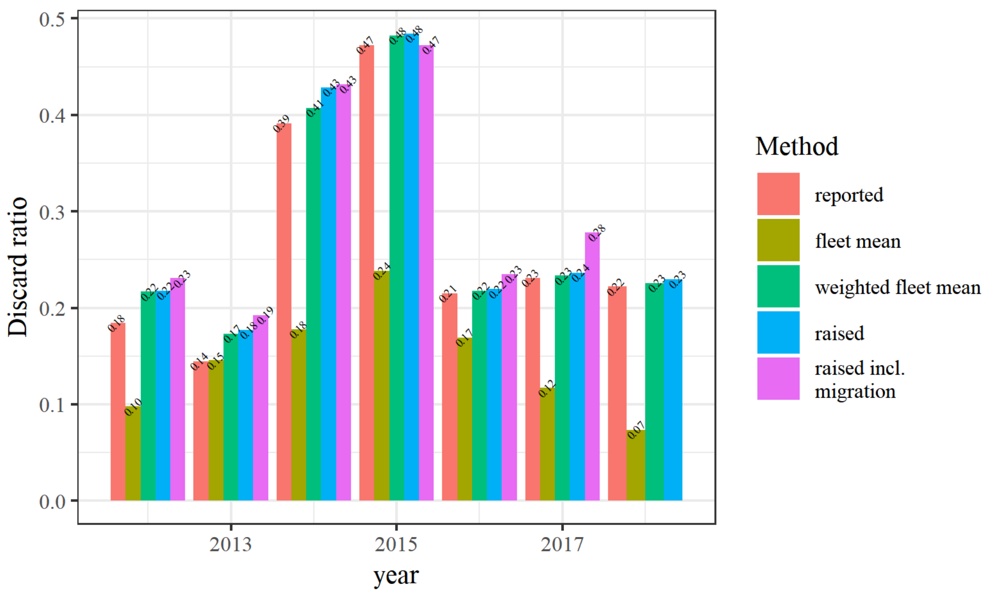


Figure 23.3. Plaice in 7.e. Discard ratios for 2012–2018. "Fleet mean" is the mean of the ratios for all fleets which reported discards, "reported" is the proportion of reported discards in the reported catches, "weighted fleet mean" is the mean of the ratios for all fleets which reported discards weighted by the catch of the individual fleets, "raised" is the proportion of the discards as raised within InterCatch in the total catch for 7.e and "raised incl. migration" includes the catch (discards and landings) from Division 7.d used in the migration correction.

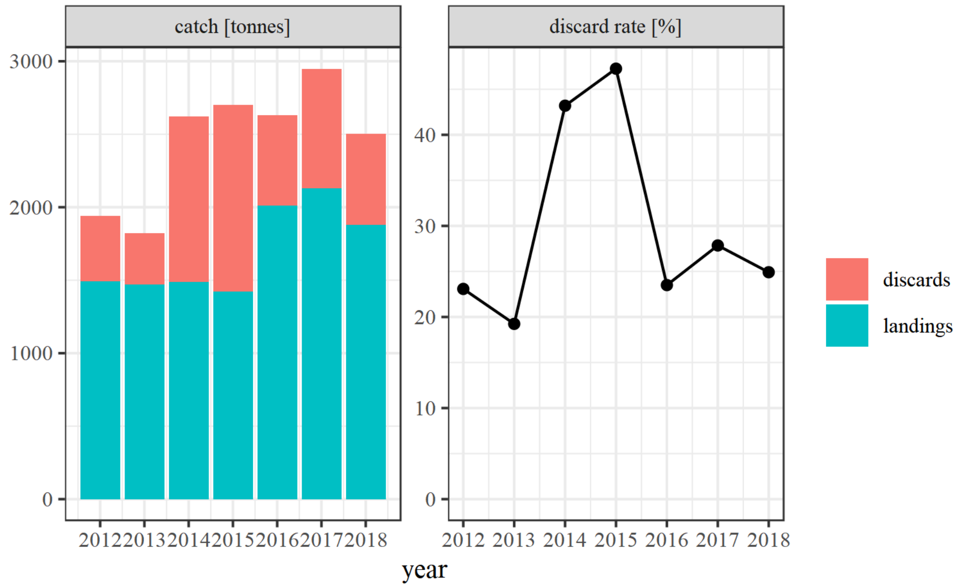


Figure 23.4. Plaice in 7.e. Landings, Discards and discard rate.

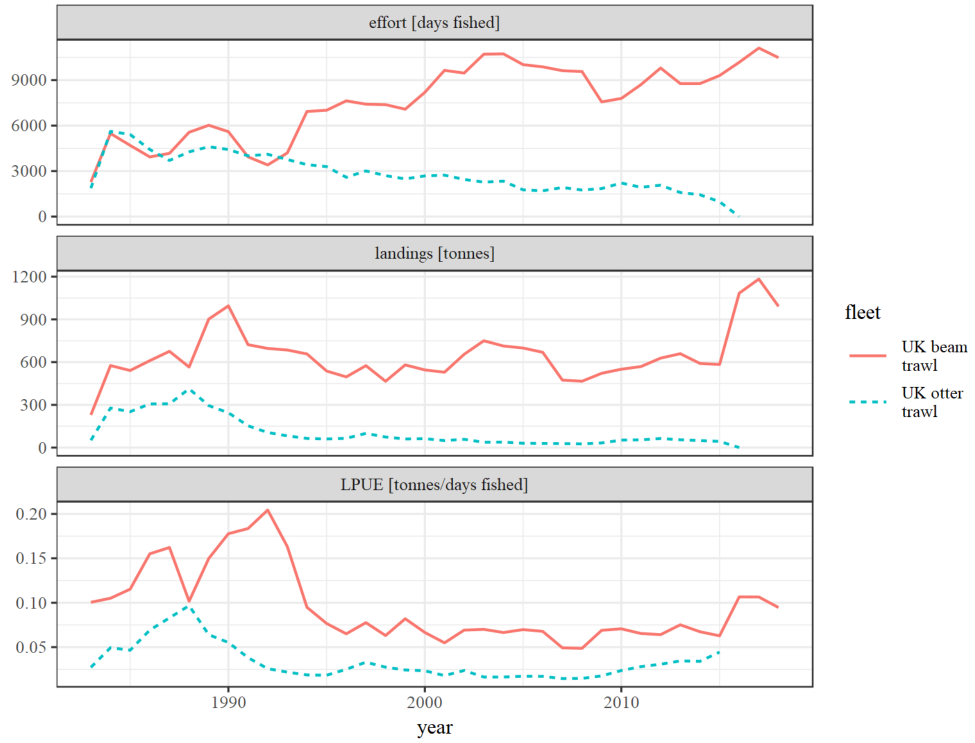


Figure 23.5. UK commercial lpue time-series. Lpue values are only shown for historical reasons but were not used in the assessment.

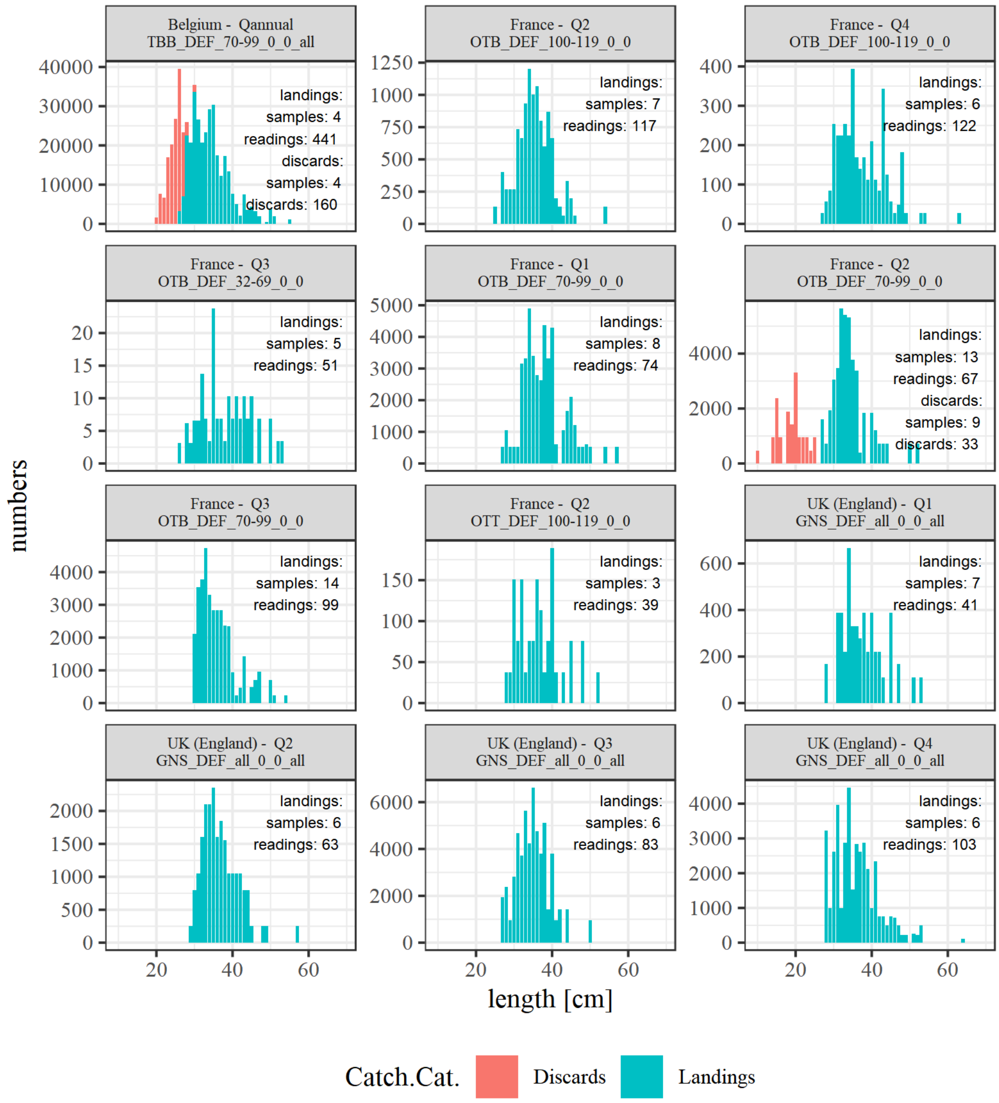


Figure 23.6. Plaice in 7.e. Length samples from InterCatch. The numbers are raised to fleet level.

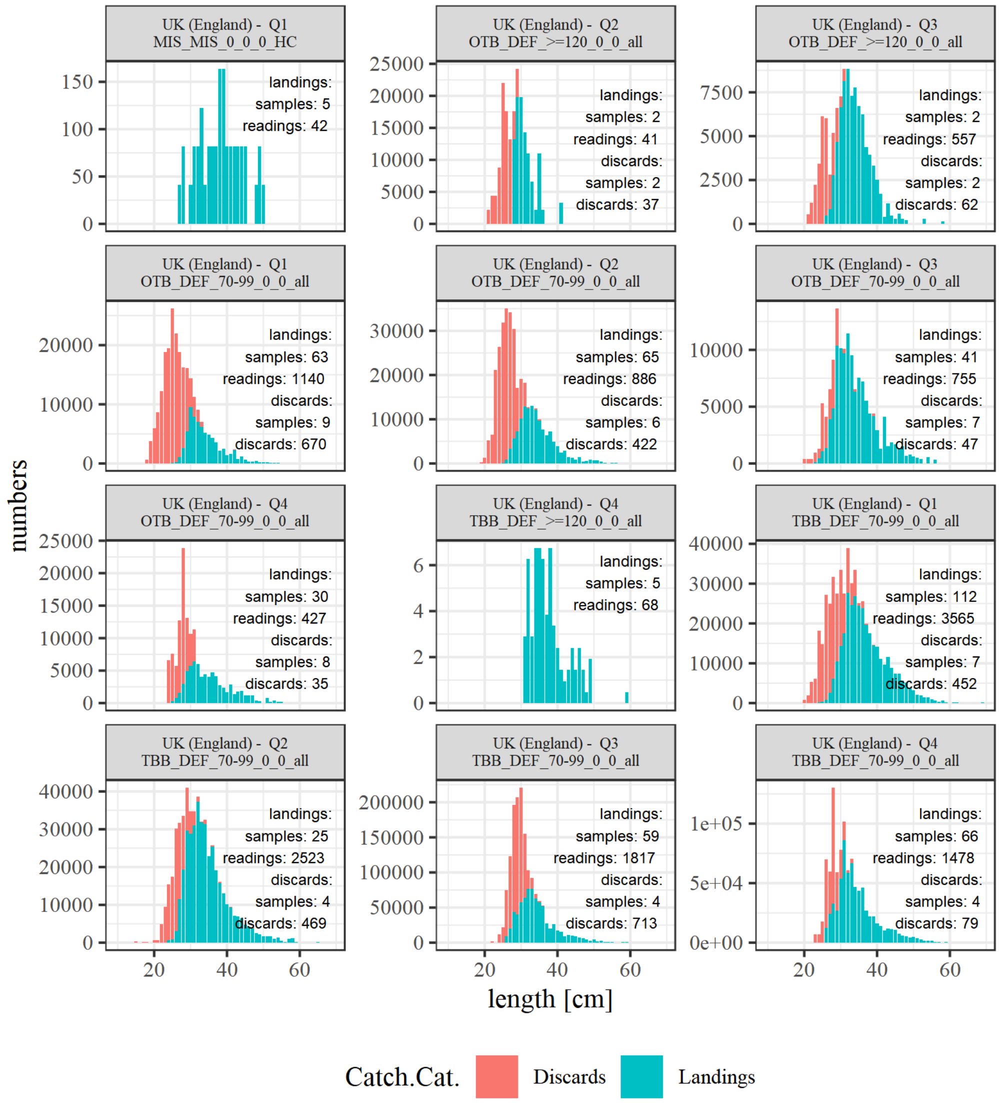


Figure 23.6. Continued. Plaice in 7.e. Length samples from InterCatch. The numbers are raised to fleet level.

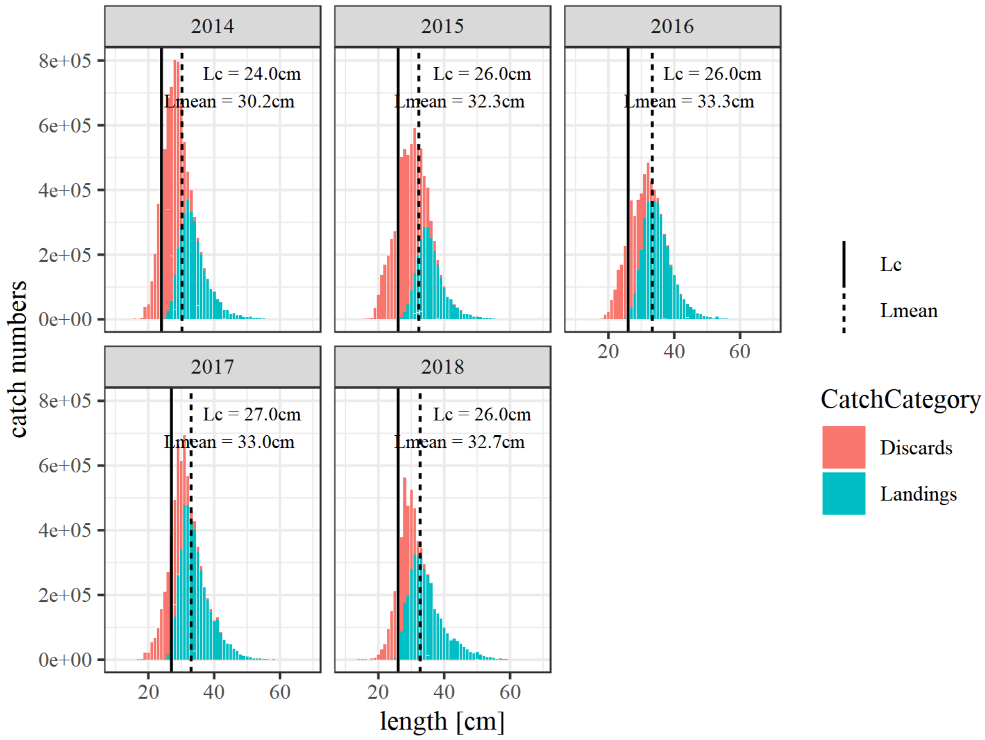


Figure 23.7. Plaice in 7.e. Total international length frequencies for 2014–2018 as raised within InterCatch for landings and discards including Length of first capture (Lc, calculated as first length class where the abundance is bigger or equal to half of maximum abundance) and mean length in the catch (Lmean, mean length above Lc).

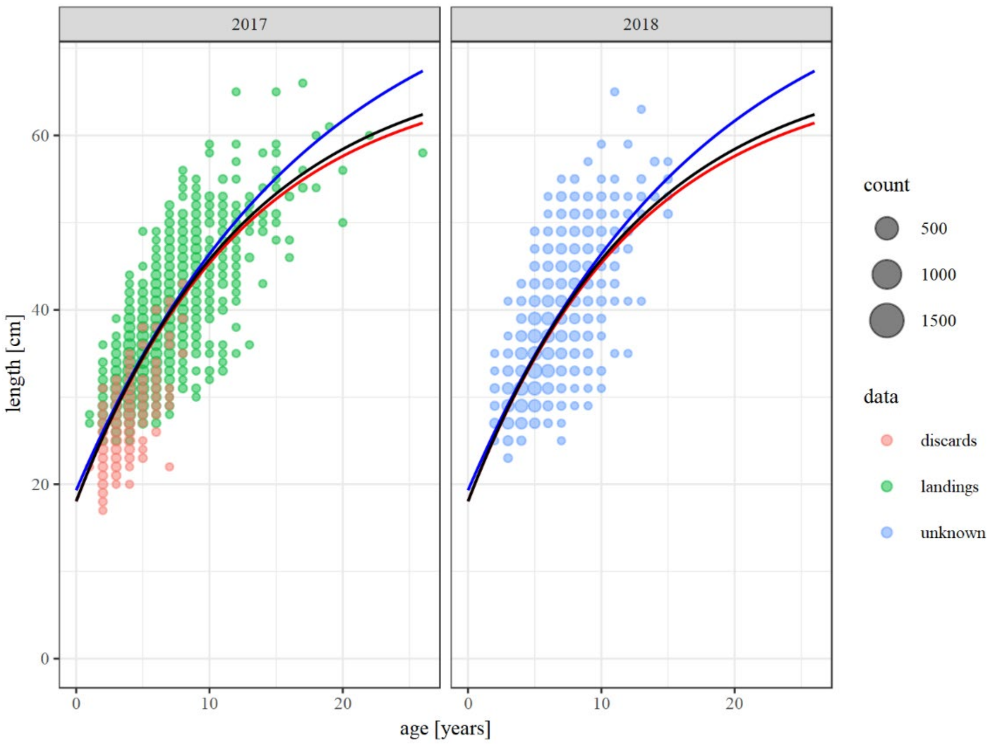


Figure 23.8. Plaice in 7.e. Age–length key derived from samples from commercial UK fishery, split by landings and discards and including fit of von Bertalanffy growth function curves (red for 2017, blue for 2018 and black for all years combined).

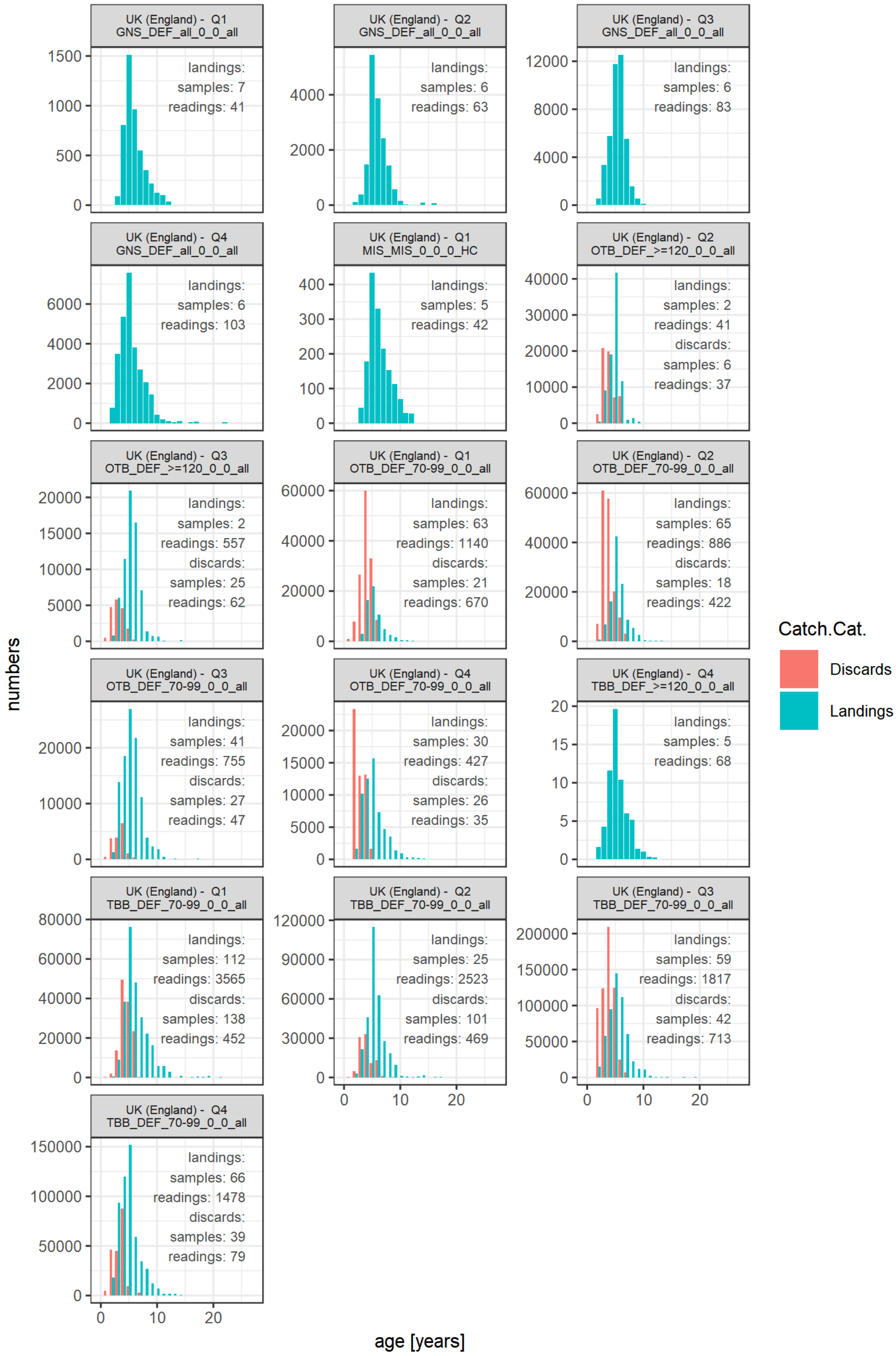


Figure 23.9. Plaice in 7.e. Age samples from InterCatch. The numbers are raised to fleet level.

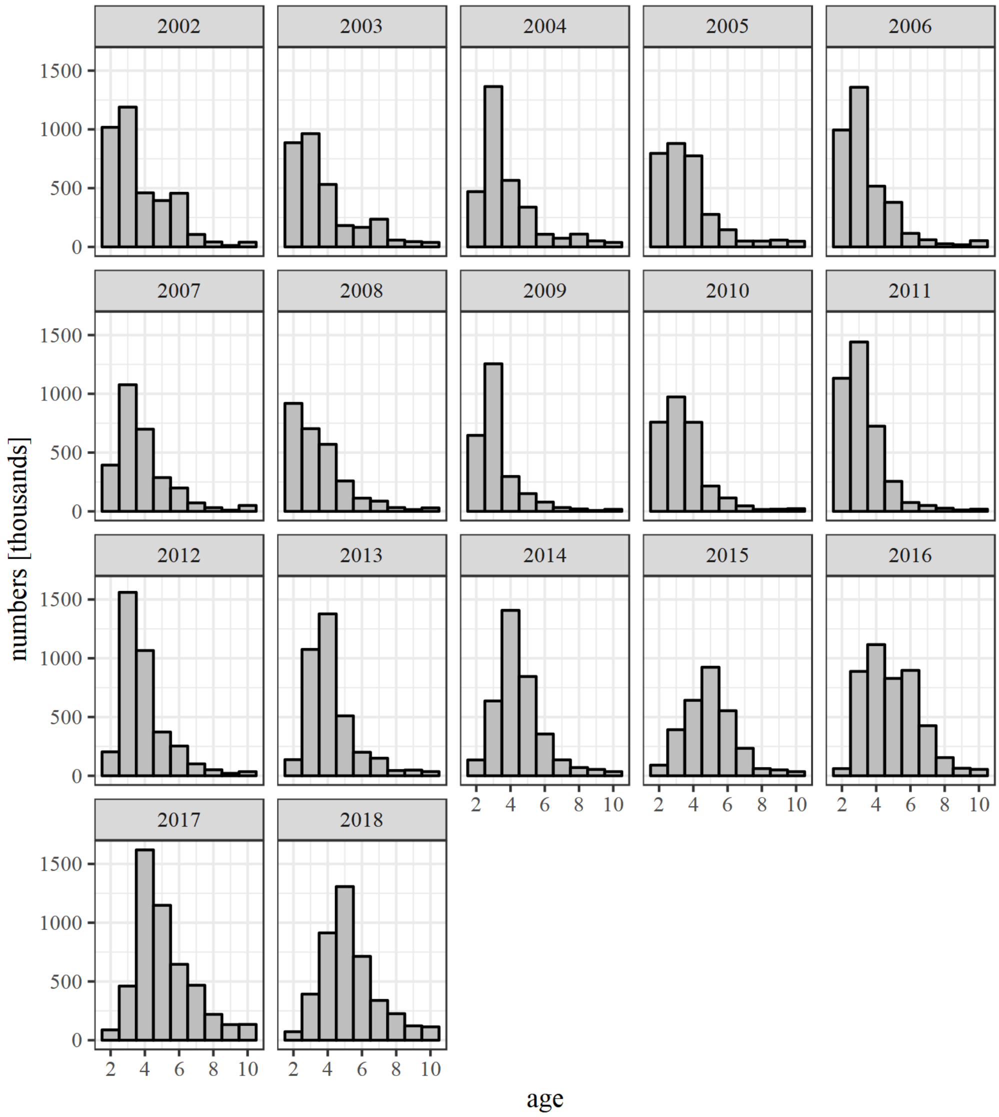


Figure 23.10. Plaice in 7.e. Landings age distribution.

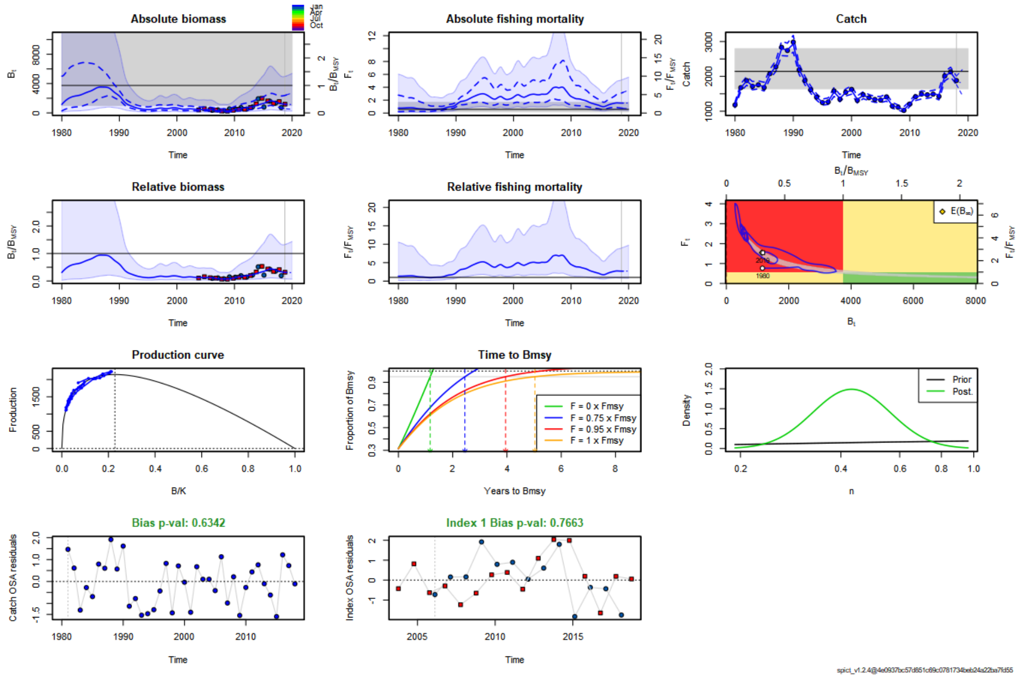


Figure 23.11. Plaice in 7.e. Results of fitting a SPiCT model to the plaice 7.e stock.

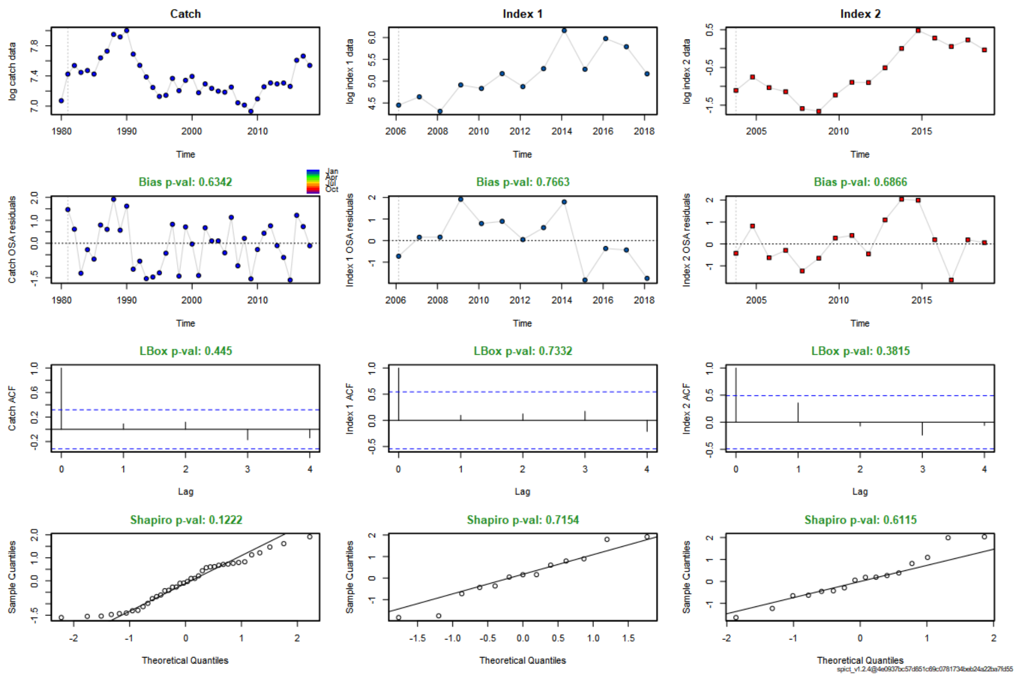


Figure 23.12. Plaice in 7.e. Diagnostic plots of the SPiCT fit.

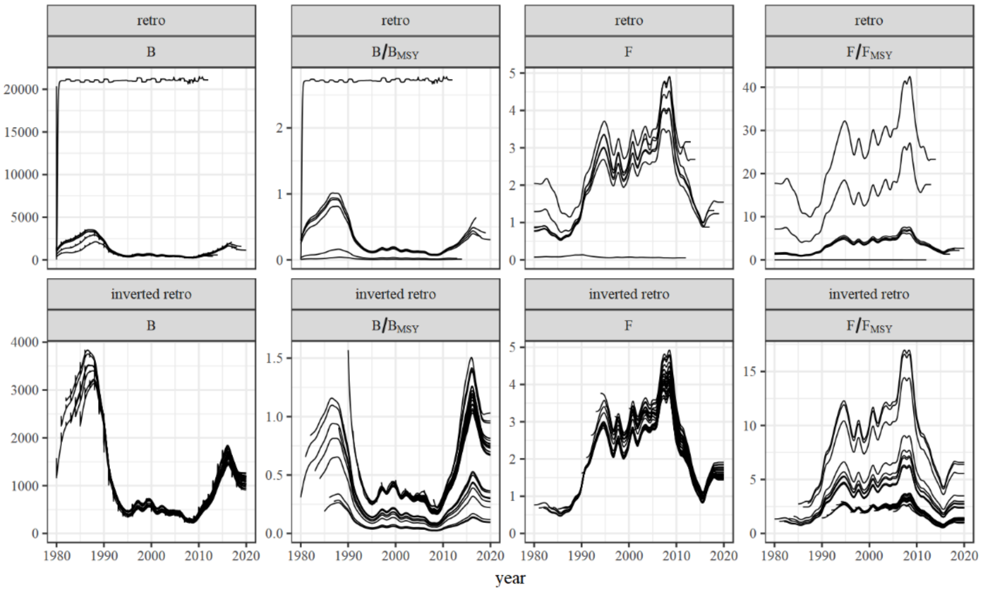


Figure 23.13. Plaice in 7.e. Retrospective and inverted retrospective SPiCT analysis.

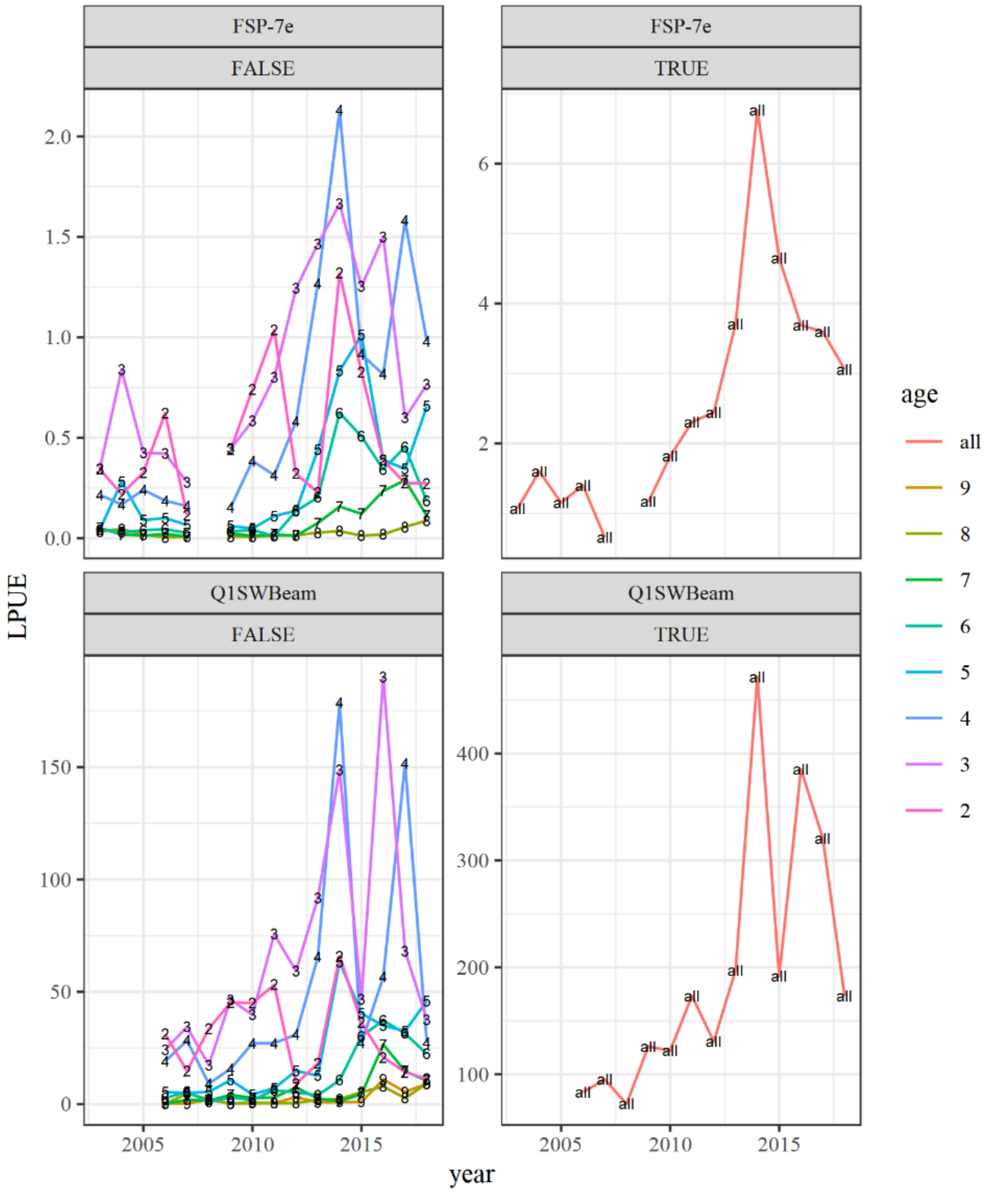


Figure 23.14. Plaice in 7.e. Scientific tuning information used in the assessment including sum over all ages (right side).

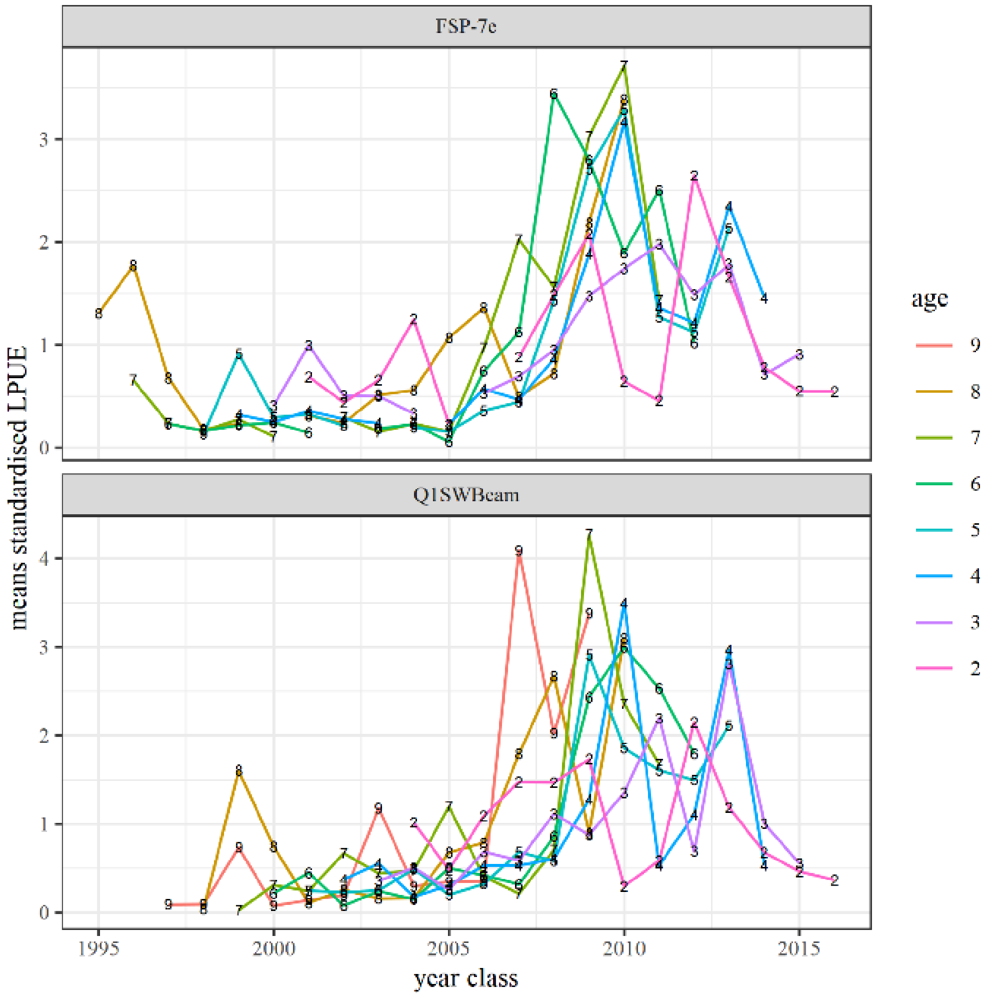


Figure 23.15. Plaice in 7.e. Scientific tuning information used in the assessment standardised and cohort wise.

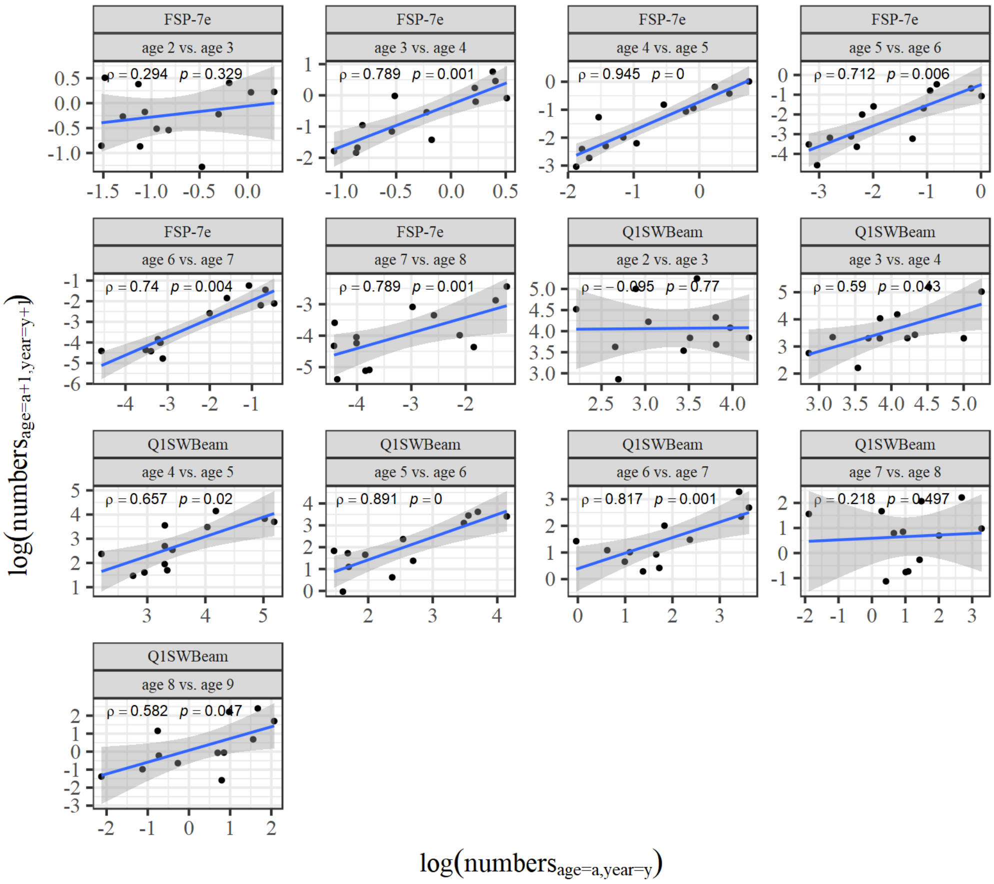


Figure 23.16. Plaice in 7.e. Internal consistency of the two survey time-series including correlation analysis.

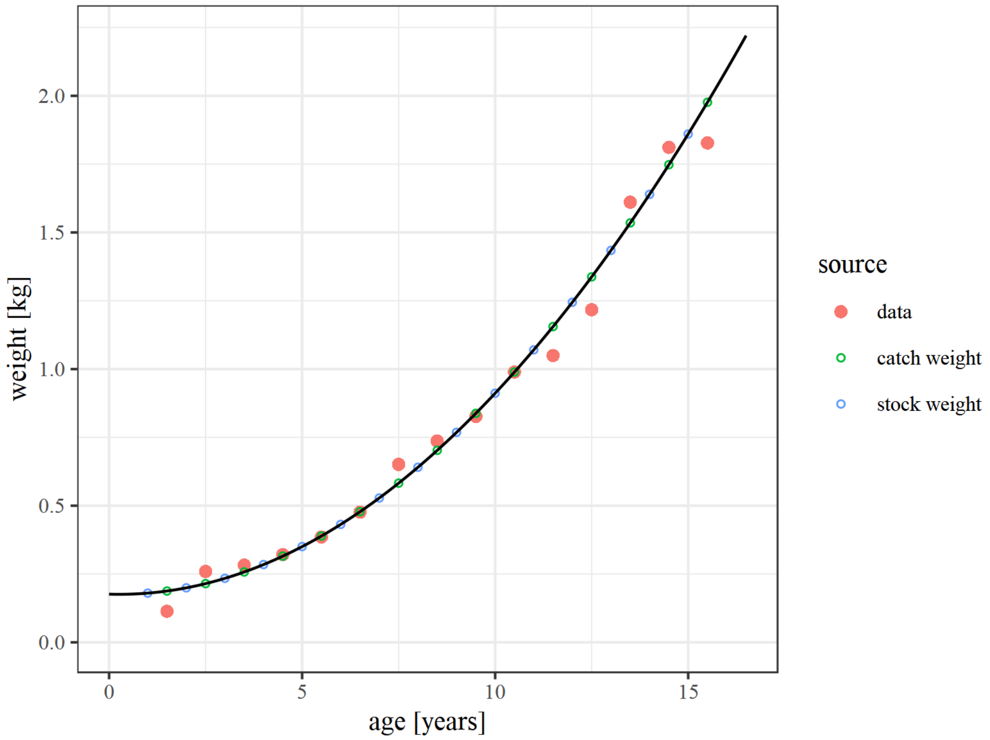


Figure 23.17. Plaice in 7.e. Derivation of the 2018 stock and catch weights by applying a polynomial model to the raw InterCatch weights-at-age.

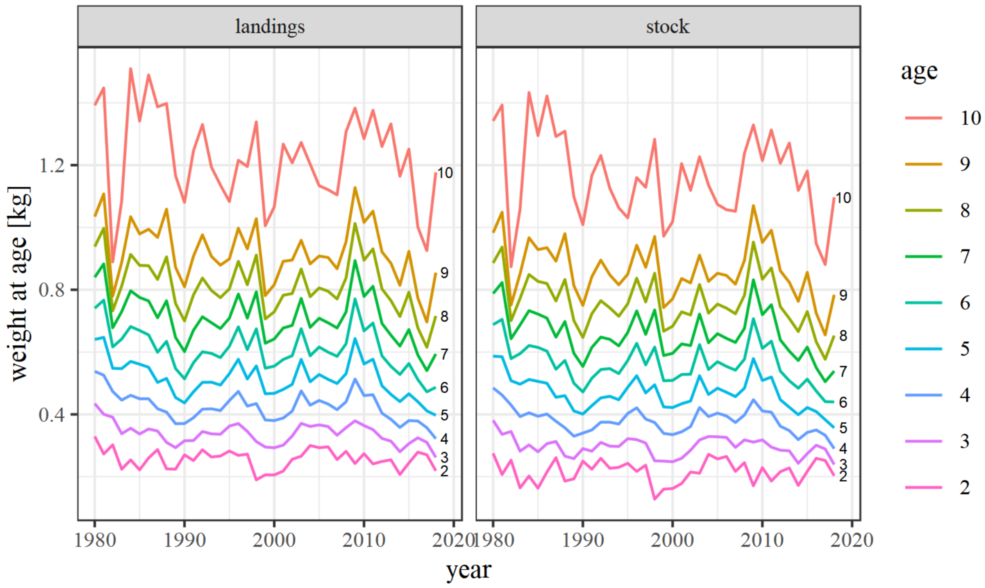


Figure 23.18. Plaice in 7.e. Landings and stock weights-at-age used in the assessment.

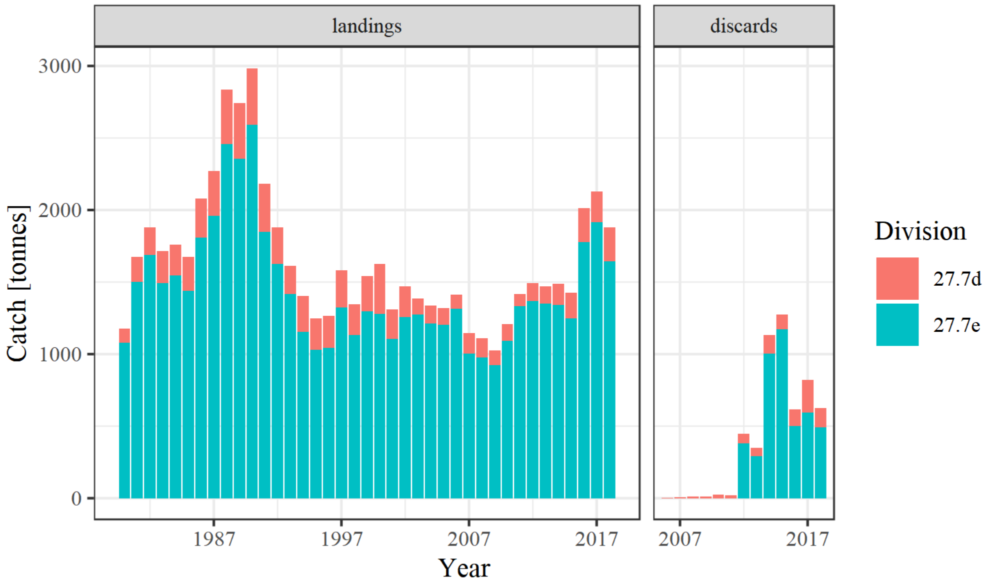


Figure 23.19. Plaice in 7.e. Landings and discards of the plaice 7.e stock disaggregated by the 7.e and the migration component from 7.d. Discard data are only available starting from 2012 for the Division 7.e.

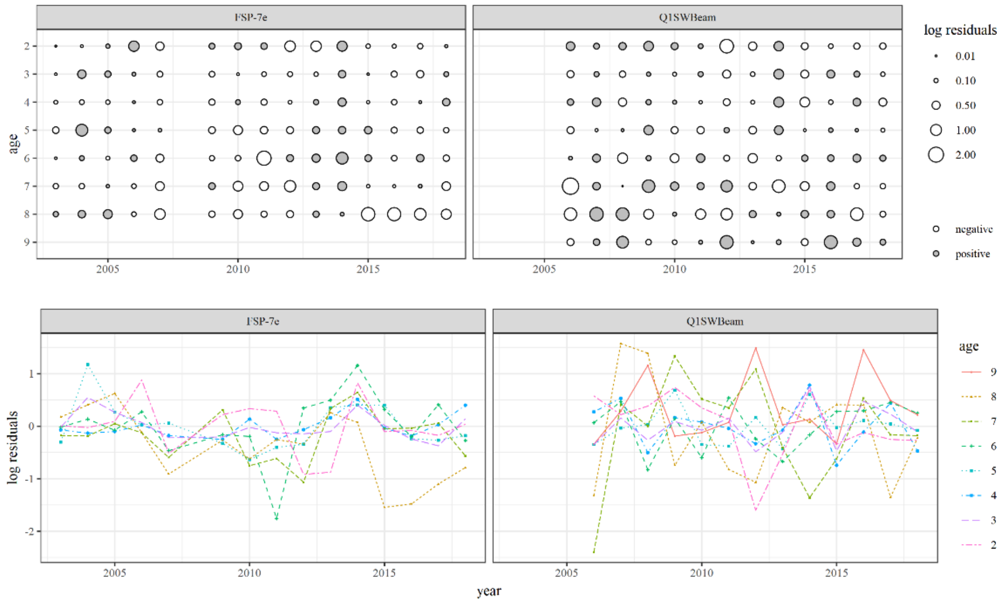


Figure 23.20. Plaice in 7.e. XSA survey log catchability residuals.

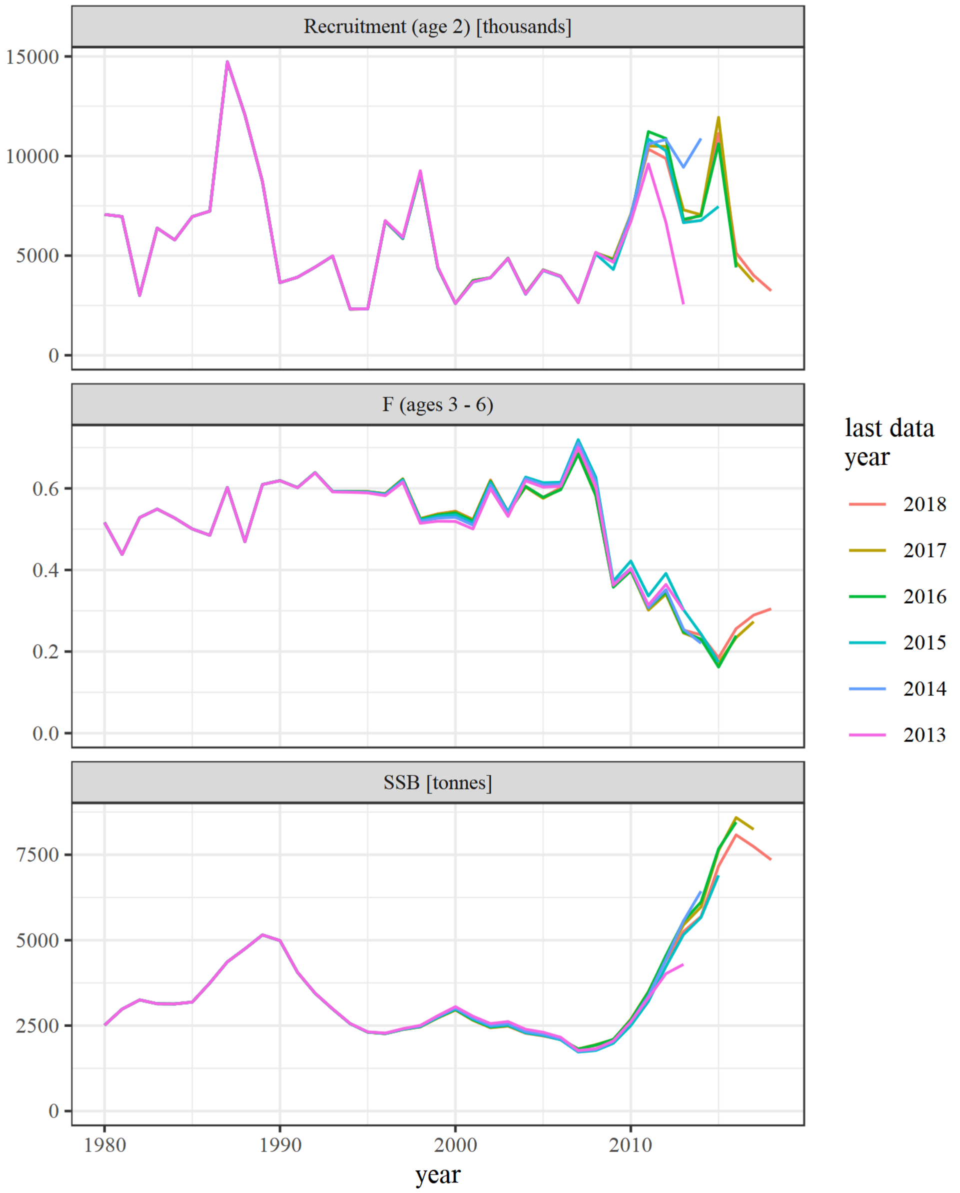


Figure 23.21. Plaice in 7.e. Five-year retrospective of recruitment, spawning–stock biomass and fishing mortality estimates.

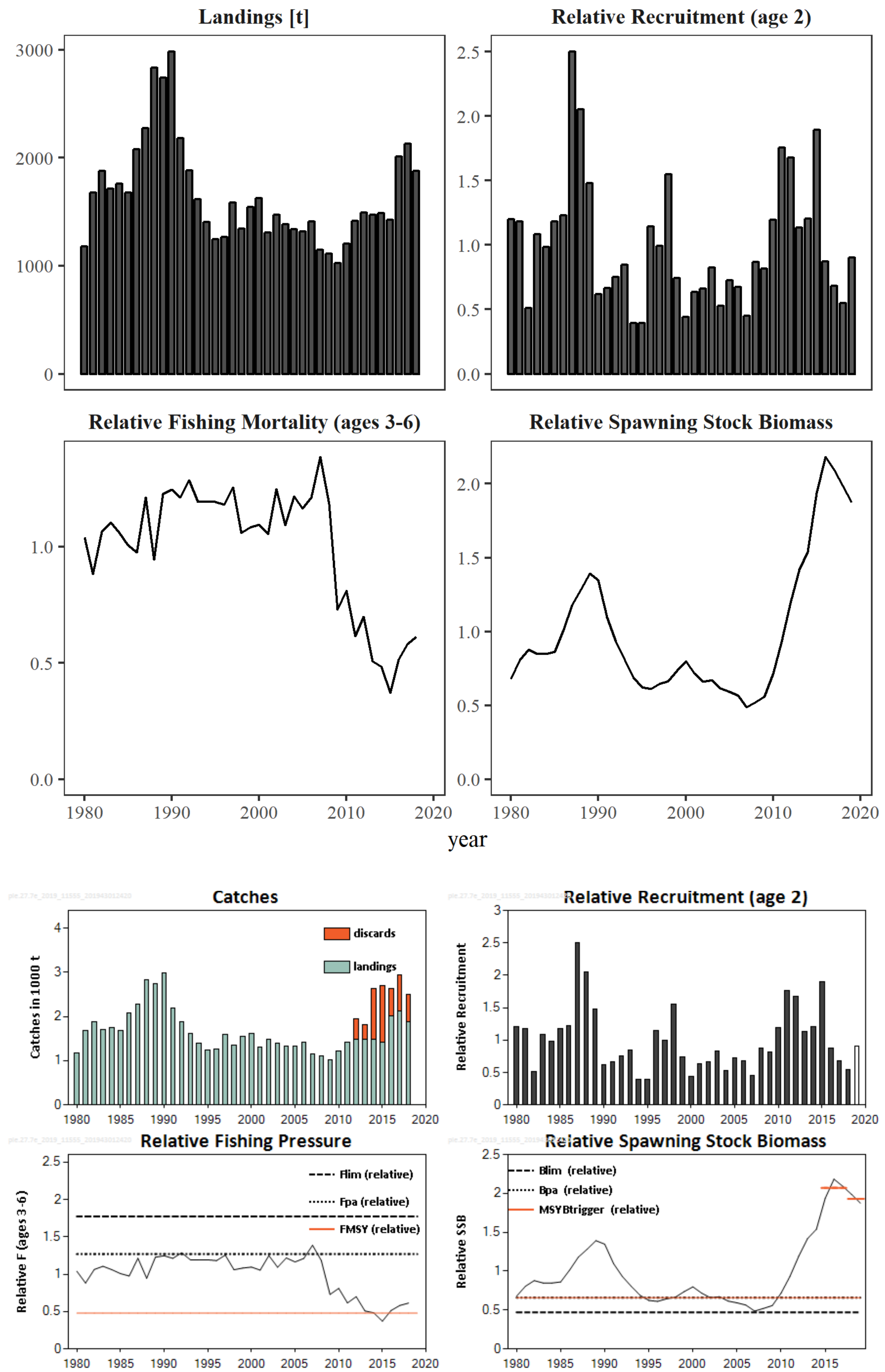


Figure 23.22. Plaice in 7.e. Summary of XSA final assessment. The plots on the top show the absolute values, the plots at the bottom the results relative to the mean of the time-series as used for the advice.

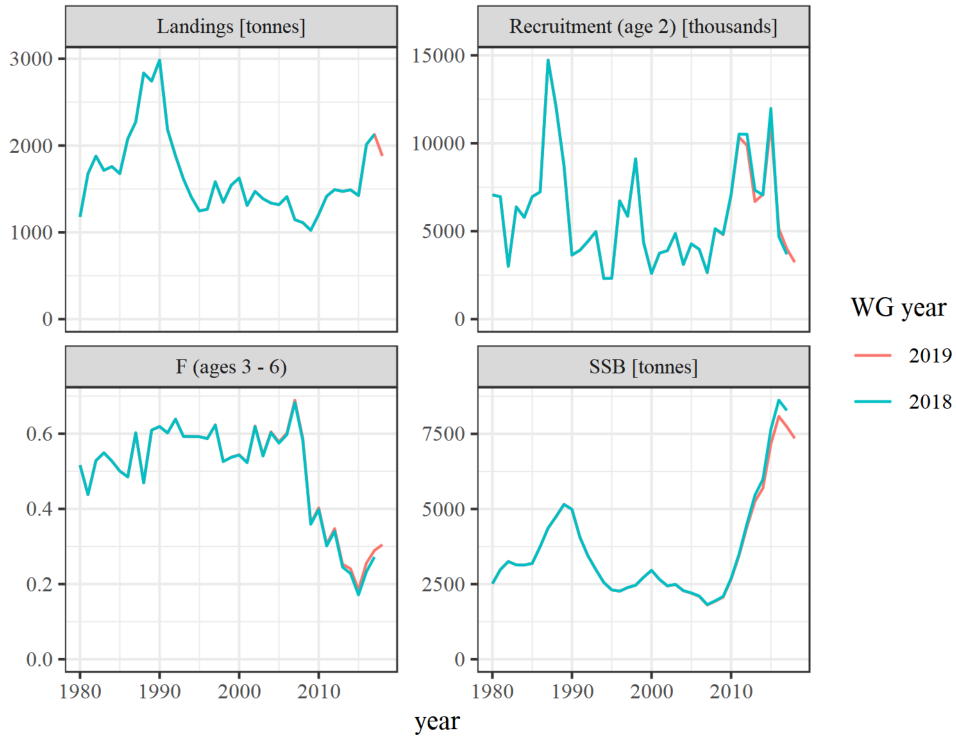


Figure 23.23. Plaice in 7.e. Comparison of the current XSA assessment run with the results from last year's WGCSE.

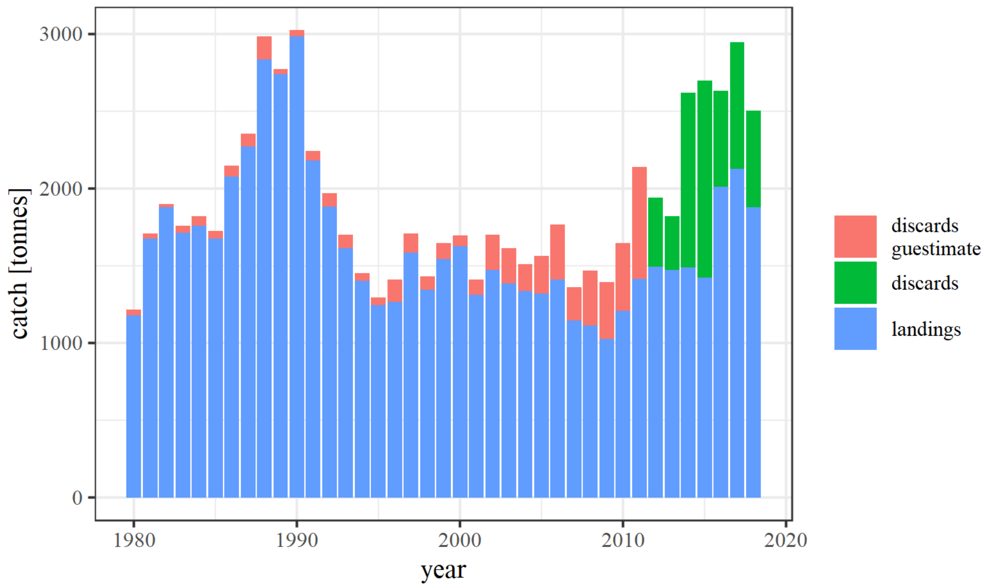


Figure 23.24. Plaice in 7.e. Total historical catches, split into landings and discards, including discard estimations prior to 2012.

Figure 23.25. Plaice in 7.e. Results of an exploratory total catch XSA assessment, in comparison to the landings only assessment and including reference points based on the total catch assessment.

25 Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)

25.1 Type of assessment in 2019

Following the decision of the benchmark meeting WGFLAT 2011 the assessment of plaice stocks in ICES divisions 7.f–g should be carried out with analytic assessment model by Aarts and Poos (2009). This model derives relative trends, which include estimates of discards-at-age and was used for advice since 2012. In 2013 and 2015–2018 the AAP model had difficulties in interpreting the data due to conflicting trends between survey time-series and commercial time-series, particularly after 2010. The data have known issues in the recent years due to changes in effort reporting, as well as changes in discard practice. Therefore, the AAP was not used to provide advice at WGCSE 2015–2018 and advice was based instead on survey trends. As previous ICES advice used a catch/landings and biomass index series for the plaice in divisions 7.f-g, this stock dynamics was investigated in 2018-2019 by applying a biomass dynamic model (SPiCT-Stochastic Production model in Continuous Time), which provides model diagnostics. The diagnostics were found to be acceptable and therefore SPiCT was used as the basis for advice as a support for survey trends.[1]

ICES advice applicable to 2019

Based on the ICES approach for data-limited stocks, ICES advises that catches in 2019 should be no more than 2160 tonnes.

General stock description and management units

A TAC is allocated to ICES areas 7.f–g which corresponds to the stock area.

Management applicable to 2018 and 2019

TACs and quotas set for 2018 (source COUNCIL REGULATION (EU) No 120/2018)

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium	82
France	148
Ireland	204
United Kingdom	77
Total EU	511
Total TAC	511

[1] At the ADGCS 2018, it was agreed to use the SPiCT trends (instead of the survey trends) as an indicator of stock development (see Annex 4 for the review).

TACs and quotas set for 2019 (source COUNCIL REGULATION (EU) No 124/2019).

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium	378
France	684
Ireland	243
United Kingdom	357
Total EU	1662
Total TAC	1662

TAC in 2019 are much higher than in 2018, as from now on they include fish that before was discarded.

Fishery in 2018

As usual, the main fishery was concentrated on the Trevose Head ground off the north Cornish coast and around Land's End. Plaice was harvested throughout the year, with most of the catch landed from Q2 and Q3. The fleets harvesting plaice in the Celtic Sea primarily involved vessels from Belgium, France, Ireland and the UK. In 2018 Belgium reported 48.3% of the landings, France 30.2%, Ireland 12.0% and the UK 9.5%. The contribution of individual countries to total landings was similar to 2013–2017. The Working Group estimated that total international landings for 2018 were 421.7 t, ~17.5% below the TAC of 511 t (Table 28.1). Discards were a significant component of catch (~55% in 2018), with the available time-series extending from 2004 to 2018. Discards have exceeded landings since 2006. Most of the catch (52.7%) were taken by beam trawlers, and 42.4%; by bottom otter trawlers. Other gears accounted for 4.9%. Effort and lpue of fishing fleets are presented in Tables 28.2–28.4.

25.2 Data

Landings

National landings data and estimates of total landings and discards used by the WG are given in Table 28.1.

Discards

Prior to 2010 indications were that discard rates, although variable, were substantial in some fleets/periods. At the ICES WKFLAT (2010) meeting, discard data from the countries participating in the fishery was raised and collated to the total international level for first time, a process that will be continued annually. The total estimates (Table 28.1) confirm the perception of the ongoing significant level of discarding. During the assessment of 2019, the discard information was available as annual summaries for Belgium, and as quarterly information for Ireland, France and the UK. Wherever this information was absent, discards were raised based on similarity of gear and quarter /annual type of data. WG estimates of the level of discards available from 2004 show a steady increase in time to levels higher than landings since 2006; in 2007, a substantial increase occurred in the discarding by all fleets. This is followed by a return to the previously lower levels until 2011 after which discards always exceeded landings. Data from 2018 national discard sampling programmes are summarised in Figures 28.1–28.3.

Biological information

Quarterly or annual age compositions for 2018 were available for Belgium, Ireland, UK(E+W), and France métiers all together representing approximately 77.9% of the total landings (Figure 28.3).

International landings and discard numbers-at-age in years for which both are available (2004–2018) are compared in Figure 28.3; in recent years discards considerably exceeds landing in numbers at most ages. A strong recruitment cohort that appeared first in 2012 as 2-year old, in 2015 attained the age of 5 y.o. and began to predominate in landings, being still important in 2017 as 7 y.o fish. The next moderately strong generation (2 y.o. in 2015) appeared in 2015 and in 2017 represented important part of both landings and discards being the most abundant age group in 2018. Numbers- and weights-at-age for landings, discards and the stock used in the assessment are presented in Tables 28.5–28.9.

Landings weight-at-age

Historically, landings weights-at-age were constructed by fitting a quadratic smoother through the aggregated catch weights for each year. WKFLAT (2011) decided not to continue with this approach following concerns raised by WGCSE that poor fits of the quadratic smoothing curve were resulting in the youngest ages being estimated to have heavier weights than adjacent older ages. WKFLAT (2011) rejected the use of the polynomial smoother for weights-at-age and suggested that raw landings weights are used in future. Raw data back to 1995 was obtained by WKFLAT (2011) and used to update the catch weights and stock weights files (Tables 28.6 and 28.9).

Discard weight-at-age

Discard length and weight-at-age raw data were available for UK(E+W), Belgium and Ireland. The national weight-at-age matrices were averaged to a total international estimate by weighting the individual weights-at-age for each year, by the catch numbers-at-age for each year and age (Tables 28.7 and 28.8).

Stock weight-at-age

Where discard estimates were available from 2004 onwards, a revised set of stock weights-at-age were calculated. The stock weights were derived from the total international landings weights-at-age and the discard weights-at-age averaged by numbers-at-age from the respective datasets. Prior to 2004, a revised set of stock weights-at-age based on international landings data was produced. These new values were based on collected weight data with a SOP correction (Table 28.9).

Natural mortality and maturity

Estimates of natural mortality (0.12 for all years and all ages from tagging studies) were based on the value estimated for Irish Sea plaice. The maturity ogive is based on UK(E&W) 7.f–g survey data for March 1993 and March 1994 (Pawson and Harley, 1997). This maturity ogive was produced in 1997 and applied to all years in the assessment. Data were not used in the current assessment as AP model provided unsatisfactory residuals, so SPiCT was used instead.

Age	1	2	3	4	5+
Maturity	0	0.26	0.52	0.86	1.00

Surveys

Indices of abundance from the UK(E&W)-BTS-Q3 beam trawl survey in 7.f and the Irish IBTS survey (IGFS-WIBTS-Q4) in 7.g are presented in Table 28.10. Both surveys show consistent trends of the stock increases and decreases (Figure 28.4). The UK(E&W)-BTS-Q3 started in 1995 and was always used for tuning the AP model. The Irish Celtic Explorer IBTS survey (IGFS-WIBTS-Q4) time-series started in 2003 and was not used in earlier years. The both survey time-series were used for the stock trends based advice in the years 2015, 2016 and 2017 and for SPiCT in 2018.

Commercial landings per unit of effort

Commercial indices of abundance from the different fisheries provide contradictory trends (Figures 28.5 and 28.6). It occurred because of varying discarding practices from 2011 onwards, when fishermen began to discard substantial numbers of fish of commercial size. Therefore, these lpues, regardless their precision and objectiveness, could not be considered as proxies for adult fish abundance.

During this assessment, data on landings age structure were used up to the year 2010 (inclusive) because of a significant increase in the number of fish above MLS being discarded by fishermen thereafter. Up to the year 2012, the bulk of annual discards (all fleets combined) consisted of 2 or 2–3 y.o. fish, and in 2013–2018 mostly 3–5 y.o. fish (Figure 28.3). The level of discarding of adult fish differs between national fleets operating by the same fishing gear (e.g. beam trawls with mesh size of 70–99 mm (Figure 28.1).

Historically, the commercial lpue data illustrate a general pattern of steep decline since the high levels in the early 1990s, followed by a more gradual decline in the late 1990s. Since 2000, lpue has been relatively stable at a low level with small increases in some métiers, notably, in Belgian beam trawlers, the most important harvesters of the stock (Figure 28.6). Overall, the lpue rates remain at a relatively low level compared to historic catch rates.

Other relevant data

There were no early closures of the fishery for plaice in 2018. The misreporting of landings of this stock is not considered to be a problem. Recent research on discard survival in the English Channel revealed that discard mortality of adult plaice captured by beam trawl varied with season, fish size and other factors like vessel type (Revill *et al*., 2013; Depestele *et al*., 2014; Uhlmann *et al*., 2016 a,b) Therefore significant amounts (4 to 93%, mostly <50% in Belgian beam trawlers and mean 48% in French beam trawlers) might survive discarding which has been confirmed by several (3–15) days of observations in captivity (Depestele *et al*., 2014; Uhlmann *et al*., 2016 a). The survival estimate for the UK otter trawl fishery in the Western Channel was 47–63% and for the trammelnet fishery 71–72%. The discard survival was also estimated as 19–20% for the North Sea UK otter trawl fishery and 4–15% in the Western Channel UK beam trawl fishery (Catchpole *et al*., 2015). Smaller undersized plaice that represent the bulk of discards are likely to have relatively higher mortality as with other flatfish species (review: Hendrikson, Nies, 2007). As discard survival is unknown it might be not adequately be taken into consideration. There is no formal mixed fishery analysis for this area, but plaice in 7.fg is considered to be primarily a bycatch of the targeted sole fishery, so changes in effort in the directed sole fishery as well as multiannual management measures (EU, 2019) will impact fishing mortality on plaice.

25.3 Stock assessment

Assessment model

WKFLAT (2011) agreed that the model that will be used as a temporary basis for the assessment and provision of advice for the Celtic Sea plaice is AP model (Aarts and Poos, 2009). This was selected on the basis that it was the only model available to WKFLAT which reconstructs the historic discarding rates (derived from the survey dataseries).

WKFLAT (2011) concluded that:

1. Due to the change in estimated fishing mortality when discards are included within the model fit, discards should be retained within the assessment model structure.
2. Given that the time-series of discard data, to which the models are fitted, is short and that, consequently, there are likely to be changes in the management estimates as discard data are added in subsequent years, no definitive model structure can be recommended at this stage in the development process.
3. The most flexible of the models TVS_PTVS should be used as the basis for advice; in terms of relative changes in estimated total fishing mortality and biomass.
4. The other two models which provide similar structures should continue to be fitted at the WG to provide sensitivity comparisons.
5. As the dataseries are extended, a final model selection can be then determined.

In 2013, no assessment was presented for this stock given that the "preferred" Aarts and Poos (2009) model failed to converge and other model variants could not provide realistic representations of observed landings and discards. Consequently, WGCSE 2013 decided to avoid the use of the "preferred" TV_PTVS AP model variant and instead focus on assessing the stock using trends derived from the fishery-independent UK(E&W) beam trawl survey. Trends derived from the UK(E&W) beam trawl survey were selected for the basis of advice given that this survey most appropriately covered the spatial extent of the stock and well represented the mean age (2–5) landed in the fishery. The UK(E&W) beam trawl survey was used to infer trends in recruitment, stock size (spawning–stock biomass) and fishing mortality.

In 2014, corrected TV_PTVS Aarts and Poos (2009) model converged and produced realistic results and confirmed conclusions derived in 2013 from the fishery-independent UK(E&W) beam trawl survey. In 2015–2017, all three model variants converged, but only of the "preferred" TV_PTVS AP variant provided estimations consistent with the previous run, observed catches and landings. However, trends of both UK(E&W)-BTS-Q3 beam trawl and IGFS-WIBTS-Q4 surveys on one hand (Table 28.10) and data on lpues of commercial fleets (Table 28.11) produced conflicting signal that resulted in asymmetrical distribution of residuals. Because of this, the ICES stock advice was based on both surveys' cpue trends.

Independently of WGCSE, the stock status was explored in 2015 by WKLIFE using a biomass dynamic model (SPiCT) (ICES, 2016 a). As discard data were not available prior 2004, the group approximated the total catch values from 1977 to 2003. An adjustment was made to the data by applying the 2004 discard ratio back in time (landings prior to 2004 were multiplied by K=1.54). These total catch data were combined with cpue trends of both surveys expressed in two mean-standardized biomass index series of +3-year old plaice, which were considered to reflect "exploitable biomass" for this stock.

Results of modelling were found to be sensitive to truncating the catch to ensure 100% overlap between the survey and catch time-series. In this case, truncation lead to a ~60% increase in B_{MSY} and ~30% decrease in F_{MSY}, whereas CVs were hugely increased (by ~200% and ~75% respectively). Therefore, the time-series was not truncated. Estimation of the observation error corresponding to the catch (β) and survey (α) was tried, but the model did not converge when trying to estimate both of these, so α was fixed at 1, while β was estimated. Under all these assumptions the results indicated current stock status (2015) to be well above the biomass reference point 0.5 B_{MSY}, and F (2015) to be well be F_{MSY} (ICES, 2016a).

In 2017, the ICES framework for category 3.2 stocks was applied (ICES, 2012; 2016 b–d). As the previous ICES advice used both catch/landings and biomass index series, the stock was investigated by applying SPiCT. The SPiCT results were chosen to support the basis for advice using comparison of the two latest biomass index (B/ B_{MSY}) values (index A) with the three preceding values (index B), multiplied by the recent advised catch. The same approach was used in both 2018 and 2019.

Final assessment

The settings and data for the model fits are set out in the table below the same way as in the previous year:

ASSESSMENT YEAR		2017
Assessment model		SPiCT
Catch data		Including discards 1977–2017 (reported and raised discards for 2004–2017, and estimated discards for 1977–2003)
Discard rate		Average (proportion by number) 2004–2010. Calculated as discards/(landings + discards).
Tuning fleets	UK(E&W)-BTS-Q3	1995–2017 ages 3+
	IGFS-WIBTS-Q4	2003–2017 ages 3+
	UK commercial beam trawl	1993–2010 ages 4–8
	UK commercial otter trawl	1993–2010 ages 4–8

Figure 28.7 presents the output plots for the model, and 28.8 it's diagnostics. Tables 28.12 and 28.13 contain information about the model diagnostics, deterministic and stochastic reference points and primary data of the model output.

State of the stock

On the relative scale, the spawning biomass is estimated to have been increasing between 2005 and 2018 and began to decline in 2018, whereas F has been steadily declining from 2001 onwards (Figure 28.11, Table 28.14). The estimated biomass was above B_{MSY} from 2013. Estimated F was below F_{MSY} from 2010, and upper limit of this estimation, from 2013. The observed stock increase was likely based on strong cohorts born in 2010 and 2013. The stock has been increasing from ~2008 after a period of low abundance in ~1995–2007. However, after three years of relatively low recruitment abundance in 2016–2018 (Figure 28.4) the stock size began to decline. As with other plaice stocks around the UK, like in the divisions 7e, 7h–k (ICES, 2017) and North Sea (Dutz *et al*., 2016) this might be caused by some ongoing environmental changes.

25.4 Short-term projections

The short-term projection from the model for 2020 (Table 28.15) forecasts B >B_{MSY} and F <F_{MSY} within 95% confidence intervals.

25.5 Precautionary approach reference points

On the basis of the revision of the assessment data structures and the AP model no MSY reference points were recommended for this stock. Meanwhile, using the SPiCT model at ICES WK Proxy (ICES, 2015) resulted in estimation of $B_{trigger}$ as 3800 t (50% of B_{MSY}) and F_{MSY} = 0.27. In 2019, application of the same model resulted in estimation of B_{MSY} as 4845 t and F_{MSY} = 0.453. A comparison of the two latest B/ B_{MSY} index values with the three preceding values, multiplied by the recent advised catch demonstrated that estimated biomass to have increased by ~6%, so the uncertainty cap was not applied.

25.6 Management plans

The EU has proposed a multiannual management plan for the Western Waters (EU, 2018). However, this stock was excluded from the final version (EU 2019, approved on 05/03/2019 Meeting n°3676 - https://www.consilium.europa.eu/en/meetings/env/2019/03/05/). Therefore, there is no management plan for Celtic Sea plaice.

25.7 Uncertainties in assessment and forecast

Landings

Sampling levels of landed catch (Figure 28.3) in recent years are sufficient to support current assessment approaches.

Discards

Estimates of discarding are included in the assessment. From 2003 onwards, discard sampling for Ireland, Belgium, France and the UK(E&W) has been improved under the Data Collection Regulation. Unknown levels of partial discard survival varying with fishing gear and season bring uncertainty into the assessment, which assumes that all discarded fish die. Discarding remains too high (exceeding landings) in this fishery, thereby compromising the effectiveness of quota management on landings. It is difficult to predict fishing fleet behaviour, as it is a commercial species of a low value taken mostly as a bycatch to fishery for sole, and to lesser extent, to *Nephrops*.

Consistency

In 2015–2017, the advice for this stock was provided on the basis of research survey trends due to unreliability of the AP model results as well as conflicting trends between commercial vessels lpues (due to increasing discarding) and cpues of research surveys. In 2016–2018, the WGCSE decided to use results of the SPiCT model as a support source, output of which was consistent with trends in abundance of commercially sized fish aged 3+ as represented by data of research surveys.

25.8 References

Aarts, G., Poos, J.J. 2009. Comprehensive discard reconstruction and abundance estimation using flexible selectivity functions. ICES journal of marine science, 66: 763–771.

Catchpole, T., Randall, P., Forster, R., Smith, S., Ribeiro Santos, A., Armstrong, F., Hetherington, S., Bendall, V., Maxwell, D. 2015. Estimating the discard survival rates of selected commercial fish species (plaice *Pleuronectes platessa*) in four English fisheries (MF1234), Cefas report, pp 108.

Depestele J., Desender M., Benoît H.P., Polet H., Vincx M. 2014. Short-term survival of discarded target fish and non-target invertebrate species in the “eurocutter” beam trawl fishery of the southern North Sea. Fisheries Research 154: 82–92.

Dutz, J., Støttrup, Stenberg, C, Munk, P. 2016. Recent trends in the abundance of plaice *Pleuronectes platessa* and cod *Gadus morhua* in shallow coastal waters of the Northeastern Atlantic continental shelf - a review. Marine Biology Research 12: 785–796.

EU. 2018. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a multiannual plan for fish stocks in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulation (EU) 2016/1139 establishing a multiannual plan for the Baltic Sea, and repealing Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) 509/2007 and (EC) 1300/2008. COM/2018/0149 final. 30 pp. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018PC0149&from=EN.

EU. 2019. REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. 57 pp. https://data.consilium.europa.eu/doc/document/PE-78-2018-INIT/en/pdf.

Hendrikson, L., Nies, T. 2009. Discard and gear escapement survival rates of some Northeast groundfish species. NOAA Draft Working Paper. Data Meeting GARM 2008, October 29, 2007, 12 pp. (http://www.nefsc.noaa.gov/GARM-Public/1.DataMeeting/B.3%20Disc_survival_GARM2008.pdf).

Revill, A.S., Broadhurst, M.K., Millar, R.B. 2013. Mortality of adult plaice, *Pleuronectes platessa* and sole, *Solea solea* discarded from English Channel beam trawlers. Fisheries Research, 147: 320–326.

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp.

ICES. 2015. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015. ICES CM 2015/ACOM:61.

ICES. 2016a. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

ICES. 2016b. EU request to provide a framework for the classification of stock status relative to MSY proxies for selected category 3 and category 4 stocks in ICES subareas 5 to 10. In Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.4.2.

ICES. 2016c. Advice basis. In Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 1, Section 1.2.

ICES. 2016d. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 4–13 May 2016, ICES Headquarters, Copenhagen, Denmark. ICES CM 2016/ACOM:13.

ICES. 2017. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 9–18 May 2017, ICES Headquarters, Copenhagen, Denmark. ICES CM 2017/ACOM:13.

Uhlmann, S. S., Theunynck, R., Ampe, B., Verkempynck, R., Miller, D. C. M., van Marlen, B., van der Reijden, K., Molenaar, P., Vanderperren, E., Polet, H. 2016 a. Overleving door boomkor gevangen pladijs - survival of beam-trawled European plaice (*Pleuronectes platessa*). ILVO Mededeling 210. Institute for Agricultural and Fisheries Research, Oostende, Belgium. 172 pp.

Uhlmann, S. S., Theunynck, R., Ampe, B., Desender, M., Soetaert, M., and Depestele, J. Injury, reflex impairment, and survival of beam-trawled flatfish. 2016 b. ICES Journal of Marine Science, 73: 1244–1254.

Table 28.1. Plaice in divisions 7.f–g. Nominal landings (t) as reported to ICES, and total landings as used by ICES WG CSE

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	214	196	171	372	365	341	314	283	357	665
UK (Engl. & Wales)	150	152	176	227	251	196	279	366	466	529
France	365	527	467	706	697	568	532	558	493	878
Ireland	28	0	49	61	64	198	48	72	91	302
N. Ireland										
Netherlands										9
Scotland	0	0	0	7	0	0	0	0	0	1
Total reported	757	875	863	1373	1377	1303	1173	1279	1407	2384
Discards	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unallocated	0	0	0	0	0	0	-27	-69	345	-693
Landings used by WG	757	875	863	1373	1377	1303	1146	1210	1752	1691
Catch as used by WG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Belgium	581	617	843	794	836	371	542	350	346	410
UK (Engl. & Wales)	496	629	471	497	392	302	290	251	284	239
France	708	721	1089	767	444	504	373	298	254	246
Ireland	127	226	180	160	155	180	89	82	70	83
N. Ireland		1								
Scotland				1		5	9	1	2	
Total reported	1912	2194	2583	2219	1827	1362	1303	982	956	978
Discards	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unallocated	-11	-78	-432	-137	-326	-174	-189	88	72	-26
Landings used by WG	1901	2116	2151	2082	1501	1188	1114	1070	1028	952
Catch as used by WG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	594	540	371	224	241	248	221	212	168	172
UK (Engl. & Wales)	258	176	170	134	136	105	127	87	55	88
France	329	298		287	262	186	165	145	132	106
Ireland	78	135	115	76	45	79	51	45	44	48
Total reported	1259	1149	656	721	684	618	564	489	399	414
Discards	N/A	N/A	N/A	N/A	N/A	N/A	N/A	274	321	453
Unallocated	-42	-82	312	-3	30	24	30	21	-13	-10
Landings used by WG	1217	1067	968	718	714	642	594	510	386	404
Catch as used by WG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	784	707	857

Table 28.1. Plaice in divisions 7.f–g. Nominal landings (t) as reported to ICES, and total landings as used by ICES WG CSE (continued).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Belgium	194	188	216	188	210	203	185	182	185	243
UK	61	63	55	54	45	45	41	25	25	27
France	104	70	NA	136	98	125	106	155	111	108
Ireland	58	64	63	63	67	76	80	49	59	52
Total reported	417	385	NA	442	420	450	412	411	381	430
Discards	1288	583	608	670	1107	1123	1274	772	778	571
Unallocated	-7	52	-1	-9	7	-8	-2	-1	0	0
Landings used by WG	410	437	481	442	427	442	414	410	381	431
Catch as used by WG	1698	1020	1089	1112	1534	1565	1688	1183	1159	1002

	2017	2018
Belgium	179	204
UK	38	40
France	108	127
Ireland	63	51
Total reported	388	422
Discards	895	508
Unallocated	1	0
Landings used by WG	389	422
Catch as used by WG	1284	930

Table 28.2. Plaice in divisions 7.f–g: lpue and cpue for UK(E&W) fleets.

	LANDINGS PER UNIT EFFORT (LPUE) kg\day										**TRAWL**		**BEAM TRAWL**		**VIIfg EFFORT**	
	RECT. GROUP		RECT. GROUP		VIIg EAST (grp 2)		RECT. GROUP		VIIg WEST (grp 3)		RECT. GROUP		RECT. GROUP			
	VIIf (grp 1)		VIIg EAST (grp 2)		Effort		VIIg WEST (grp 3)		Effort		VIIf (grp 1)		VIIf (grp 1)		TRAWL	BEAM
	Trawl	BEAM	Trawl	BEAM	TRAWL	BEAM	Trawl	BEAM	TRAWL	BEAM	LAND-INGS	EFFORT	LAND-INGS	EFFORT	(000)	(000)
Year		Trawl		Trawl	(Days fished)	(Days fished)		Trawl	(Days fished)	(Days fished)	(t)	(Days fished)	(t)	(Days fished)	(Days fished)	(Days fished)
1983	86.39	30.33	71.84	54.85	82	149	0.00	75.69	0	8	53.96	620	5.62	195	702	353
1984	79.67	99.69	94.50	106.65	316	298	0.00	66.96	0	129	156.33	1723	99.01	901	2039	1328
1985	115.93	122.91	119.63	174.39	206	285	67.62	233.25	23	92	188.60	1493	146.71	1101	1722	1478
1986	119.81	113.62	103.37	183.72	334	180	49.93	380.20	35	29	138.48	1125	91.16	973	1494	1182
1987	131.27	114.34	223.13	291.30	364	187	33.68	446.46	26	26	196.01	1211	148.39	1681	1601	1894
1988	232.51	247.91	217.11	356.02	351	77	48.43	670.38	20	36	200.68	838	205.01	1102	1210	1215
1989	130.84	138.62	137.76	293.89	327	125	86.54	575.30	15	7	129.65	966	96.15	861	1309	994
1990	75.55	88.83	59.00	166.69	435	165	78.13	147.13	24	194	97.39	1229	155.84	1256	1689	1615

	LANDINGS PER UNIT EFFORT (LPUE) kg\day										TRAWL		BEAM TRAWL		VIIfg EFFORT	
	RECT. GROUP		RECT. GROUP		VIIg EAST (grp 2)		RECT. GROUP		VIIg WEST (grp 3)		RECT. GROUP		RECT. GROUP			
1991	48.20	93.83	44.90	73.40	306	483	42.22	109.40	45	104	55.72	1066	190.79	1667	1417	2254
1992	49.33	57.20	41.29	69.80	303	633	45.00	70.04	435	90	44.92	898	91.34	1420	1636	2143
1993	43.85	69.98	23.83	65.14	251	694	56.64	32.85	30	135	38.41	836	109.37	1669	1117	2497
1994	39.67	40.41	31.76	49.39	225	610	10.70	70.61	19	116	23.21	623	86.14	2219	866	2945
1995	41.81	43.01	30.91	54.05	196	694	61.67	37.12	30	128	26.39	580	96.10	2303	807	3125
1996	38.80	33.67	26.25	27.49	341	560	6.15	11.82	105	220	23.68	593	81.19	2391	1038	3170
1997	34.61	31.01	21.37	33.42	370	770	17.47	7.50	122	146	20.76	577	85.13	2661	1069	3578
1998	21.86	26.07	15.53	15.33	385	591	5.12	12.65	94	159	10.97	517	85.15	2846	995	3597
1999	35.60	26.62	20.65	12.00	176	1461	5.14	11.96	235	312	12.06	395	85.55	3058	806	4831
2000	32.09	16.10	40.58	11.64	187	1007	3.35	10.10	160	200	10.99	284	53.59	3133	630	4341
2001	34.02	16.69	32.30	15.26	187	1155	4.66	11.04	179	91	9.82	309	53.47	3172	675	4418
2002	19.78	15.64	48.80	20.81	123	463	7.43	4.81	170	60	6.91	416	38.85	2652	709	3174
2003	23.45	18.24	8.19	20.78	51	772	4.48	1.49	124	158	15.85	696	50.94	2669	871	3599
2004	18.77	15.54	8.66	7.81	198	923	3.09	3.39	125	178	12.45	641	40.72	2503	965	3604
2005	11.20	11.00	2.14	8.25	21	618	0.25	1.33	154	116	9.55	876	23.25	1968	1051	2702
2006	21.21	12.77	5.91	15.19	23	630	0.64	0.58	233	70	19.94	924	14.31	1330	1181	2030
2007	14.79	17.93	20.42	10.58	31	518	1.71	5.90	219	12	12.09	798	18.18	1407	1048	1937

	LANDINGS PER UNIT EFFORT (LPUE) kg\day										TRAWL		BEAM TRAWL		VIIfg EFFORT	
	RECT. GROUP		RECT. GROUP		VIIg EAST (grp 2)		RECT. GROUP		VIIg WEST (grp 3)		RECT. GROUP		RECT. GROUP			
2008	18.01	21.20	21.10	10.22	109	290	0.08	1.72	229	5	13.23	711	18.85	1202	1049	1497
2009	14.40	15.66	11.58	14.77	244	266	1.63	0.76	296	48	8.33	656	24.33	1105	1197	1419
2010	14.09	27.93	12.88	11.82	84	327	0.31	1.06	469	78	7.79	565	19.63	1162	1117	1567
2011	11.11	32.98	5.43	17.11	8	180	2.09	0.76	353	111	6.32	525	18.79	868	887	1158
2012	10.96	17.70	3.11	9.38	138	275	0.67	0.51	487	102	6.11	543	22.18	1408	1168	1785
2013	6.40	12.29	0.89	8.18	72	265	0.44	0.61	37	77	1.47	280	20.68	1611	389	1947
2014	5.76	15.52	7.43	10.61	10	131	0.08	2.50	176	24	0.90	156	10.25	959	165	1114
2015	18.82	11.87	37.87	14.58	3	245	0.00	3.65	165	56	1.39	79	7.80	726	82	1027
2016	0.00	14.91	0.00	9.57	0	396	0.07	0.05	329	34	0.00	136	11.28	915	525	1346
2017 *	24.98	18.57	2.97	10.28	95	514	0.05	2.47	193	74	1.73	93	15.69	986	381	1573
2018 *	11.10	19.53	27.10	7.77	71	440	0.93	10.70	210	15	1.59	127	22.37	1071	407	1527

Table 28.3. Plaice in divisions 7.f–g: lpue and effort for Belgian fleets in 7.f–g.

BELGIAN Beam Trawl 7fg			
Year	Landings (t)	Effort (000 hr)	lpue (kg/h)
1996	356.89	53.27	6.70
1997	474.71	57.36	8.28
1998	443.38	57.79	7.67
1999	410.22	55.11	7.44
2000	230.63	51.34	4.49
2001	274.84	54.90	5.01
2002	259.80	49.60	5.24
2003	215.95	62.73	3.44
2004	207.27	78.73	2.63
2005	153.73	64.50	2.38
2006	134.44	50.28	2.67
2007	139.39	45.72	3.05
2008	106.29	28.71	3.70
2009	140.76	30.84	4.56
2010	127.15	32.74	3.88
2011	159.03	41.41	3.84
2012	165.73	46.25	3.58
2013	155.973	45.159	3.454
2014	155.317	31.271	4.967
2015	165.17	31.792	5.195
2016	212.01	32.34	6.556
2017	169.03	33.35	5.07
2018	186.861	31.48	5.94

Table 28.4. Plaice in Divisions 7.f–g: lpue and effort for Irish otter trawl, beam and seine fleets in 7.g.

	IR-OTB-7G			IR-SCC-7G		
Year	Landings (t)	Effort (000 hr)	lpue (kg/h)	Landings (t)	Effort (000 hr)	lpue (kg/h)
1995	94.23	63.56	1.48	9.55	6.43	1.49
1996	133.66	60.04	2.23	14.20	9.73	1.46
1997	119.84	65.10	1.84	38.79	16.13	2.40
1998	96.72	72.30	1.34	21.38	14.94	1.43
1999	60.05	51.66	1.16	10.40	8.01	1.30
2000	28.78	60.60	0.47	11.40	9.90	1.15
2001	23.82	69.43	0.34	10.93	16.33	0.67
2002	42.30	77.69	0.54	16.42	20.86	0.79
2003	26.35	86.79	0.30	13.80	20.91	0.66
2004	26.62	96.99	0.27	5.04	19.38	0.26
2005	22.78	124.40	0.18	6.47	14.81	0.44
2006	25.17	119.23	0.21	5.10	14.79	0.34
2007	30.99	136.52	0.23	4.76	15.82	0.30
2008	39.17	125.81	0.31	8.38	11.65	0.72
2009	43.81	137.11	0.32	7.98	8.19	0.98
2010	44.29	140.65	0.31	10.71	9.69	1.11
2011	44.68	120.33	0.37	11.12	11.01	1.01
2012	43.21	121.08	0.35	18.41	14.15	1.30
2013	31.91	118.13	0.28	11.10	12.06	0.84
2014	28.00	127.40	0.22	7.60	12.00	0.61
2015	33.34	132.69	0.25	8.36	9.28	0.90
2016	34.80	148.17	0.23	9.37	10.44	0.90
2017	40.86	135.98	0.30	10.49	9.75	1.08
2018	33.89	108.22	0.31	8.13	9.69	0.84

		IR-TBB-7G					
Year	Landings (t)	Effort (000 hr)	lpue (kg/h)	Year	Landings (t)	Effort (000 hr)	lpue (kg/h)
1995	37.92	20.78	1.83	2007	21.18	55.86	0.38
1996	53.02	26.76	1.98	2008	14.18	37.22	0.38
1997	94.59	28.25	3.35	2009	6.96	37.96	0.18
1998	122.13	35.25	3.46	2010	6.56	40.22	0.16
1999	25.80	40.87	0.63	2011	6.71	35.33	0.19
2000	12.62	37.03	0.34	2012	33.63	40.33	0.83
2001	4.80	39.71	0.12	2013	32.32	38.48	0.84
2002	7.08	31.62	0.22	2014	12.50	37.80	0.33
2003	9.37	49.26	0.19	2015	12.10	37.79	0.32
2004	6.17	54.86	0.11	2016	9.83	39.55	0.25
2005	9.49	49.65	0.19	2017	12.39	35.21	0.35
2006	14.46	60.48	0.24	2018	9.62	37.42	0.26

Table 28.5. Plaice in divisions 7.f–g. Landings numbers-at-age.

Landings numbers-at-age					Numbers*10**-3					
AGE\YEAR	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**
1	0	0	0	0	0	0	0	0	0	0
2	989	851	877	1921	822	300	750	704	1461	703
3	426	903	673	1207	2111	1180	560	918	2503	2595
4	411	291	638	658	681	955	827	343	393	1332
5	105	136	72	146	109	443	372	373	102	156
6	72	76	70	21	54	86	92	209	177	59
7	37	47	34	16	53	51	44	70	62	48
8	59	23	8	16	11	14	27	41	25	32
+gp	75	98	46	32	44	60	23	42	38	24
TOTALNUM	2175	2426	2419	4018	3886	3090	2696	2701	4762	4950
AGE\YEAR	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
1	0	0	0	0	0	0	25	100	43	0
2	434	967	797	164	279	800	1019	428	488	812
3	1883	2099	3550	2078	1072	526	1179	936	572	734
4	1812	1568	1807	2427	1193	357	284	730	743	515
5	772	612	741	655	578	471	139	164	334	219
6	156	413	160	242	179	275	185	117	117	137
7	22	65	98	86	94	80	115	86	57	59
8	125	16	24	70	78	21	62	92	48	37
+gp	76	73	23	46	79	96	59	65	132	96
TOTALNUM	5281	5814	7201	5769	3553	2627	3066	2716	2534	2609
AGE\YEAR	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
1	8	17	22	19	75	3	15	6	24	12
2	420	426	243	320	651	170	239	126	201	331
3	1318	921	982	606	371	661	571	578	327	458
4	929	849	802	482	323	543	465	428	265	140
5	272	287	372	203	199	183	150	261	134	134

Landings numbers-at-age					Numbers*10**-3					
6	121	96	116	145	108	113	85	46	73	76
7	60	82	45	53	62	65	34	27	24	50
8	20	39	27	22	23	24	26	15	14	12
+gp	82	56	69	32	28	28	24	17	16	15
TOTALNUM	3231	2773	2678	1881	1838	1789	1608	1504	1078	1229
AGE\YEAR	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1	8	15	2	3	1	2	3	0	0	2
2	130	270	127	135	135	106	64	24	55	20
3	513	341	626	223	326	485	328	123	122	332
4	340	443	345	430	208	288	383	452	231	201
5	104	145	273	191	248	164	192	247	410	182
6	76	47	68	152	130	163	67	109	127	228
7	46	29	20	44	69	65	70	33	43	94
8	26	11	10	8	28	33	29	36	17	42
+gp	13	15	12	8	17	23	31	30	26	37
TOTALNUM	1257	1315	1485	1187	1161	1329	1167	1054	1052	1138
AGE\YEAR	**2017**	**2018**								
1	0	3								
2	33	32								
3	57	143								
4	380	122								
5	167	393								
6	112	160								
7	145	92								
8	56	89								
+gp	35	62								
TOTALNUM	985	1096								

Table 28.6. Plaice in divisions 7.f–g. Landings weights-at-age.

Landings weights-at-age (kg)										
AGE\YEAR	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**
1	0.078	0.194	0.076	0.118	0.185	0.151	0.178	0.276	0.135	0.000
2	0.205	0.258	0.203	0.238	0.255	0.245	0.274	0.324	0.251	0.160
3	0.323	0.323	0.325	0.354	0.330	0.339	0.369	0.384	0.363	0.301
4	0.430	0.389	0.440	0.467	0.412	0.433	0.464	0.455	0.470	0.434
5	0.528	0.457	0.550	0.576	0.500	0.526	0.559	0.538	0.572	0.559
6	0.615	0.525	0.652	0.682	0.595	0.620	0.654	0.633	0.670	0.677
7	0.693	0.595	0.749	0.784	0.695	0.714	0.749	0.739	0.763	0.787
8	0.760	0.666	0.839	0.882	0.802	0.808	0.844	0.857	0.851	0.889
+gp	0.8762	0.8435	1.0653	1.1812	1.1824	1.0948	1.1579	1.2661	1.0036	1.1033
SOPCOFAC	1.0052	1.0262	1.0225	1.0135	1.0042	1.0125	0.9995	1.0000	1.0047	0.9997
AGE\YEAR	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
1	0.129	0.260	0.102	0.240	0.200	0.148	0.171	0.236	0.219	0.000
2	0.208	0.288	0.176	0.270	0.260	0.257	0.263	0.296	0.254	0.247
3	0.288	0.325	0.255	0.309	0.327	0.362	0.314	0.308	0.304	0.295
4	0.368	0.370	0.337	0.358	0.400	0.464	0.405	0.397	0.364	0.349
5	0.449	0.423	0.423	0.416	0.481	0.563	0.500	0.455	0.485	0.512
6	0.530	0.484	0.514	0.483	0.567	0.658	0.598	0.598	0.603	0.553
7	0.612	0.554	0.608	0.560	0.661	0.750	0.643	0.801	0.714	0.523
8	0.694	0.633	0.706	0.646	0.761	0.839	0.728	0.728	0.752	0.947
+gp	0.8632	0.8887	0.9932	0.9097	1.0465	1.0399	0.9886	0.9585	1.0655	1.0667
SOPCOFAC	1.0034	1.0024	1.0006	1.0009	1.0113	1.0022	0.9997	1.0001	1.0004	0.9998
AGE\YEAR	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
1	0.249	0.213	0.213	0.245	0.268	0.246	0.205	0.221	0.237	0.238
2	0.291	0.256	0.268	0.260	0.305	0.284	0.295	0.258	0.260	0.246
3	0.304	0.317	0.278	0.302	0.340	0.281	0.321	0.287	0.295	0.291
4	0.357	0.380	0.332	0.370	0.398	0.343	0.353	0.330	0.356	0.339
5	0.466	0.463	0.440	0.479	0.466	0.433	0.439	0.382	0.425	0.385

Landings weights-at-age (kg)										
6	0.663	0.604	0.538	0.539	0.556	0.484	0.502	0.514	0.525	0.513
7	0.745	0.661	0.618	0.672	0.675	0.541	0.651	0.649	0.631	0.549
8	0.877	0.690	0.839	0.875	0.695	0.859	0.681	0.750	0.714	0.638
+gp	1.1007	1.1886	1.1906	1.2018	1.0905	1.1262	1.0389	0.9919	1.0163	0.8369
SOPCOFAC	1.0002	1.0009	1.0000	1.0007	1.0007	1.0004	0.9994	1.0007	1.0011	1.0008
AGE\YEAR	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1	0.278	0.260	0.279	0.233	0.228	0.235	0.273	0.156	0.15	0.211
2	0.271	0.273	0.267	0.292	0.242	0.246	0.285	0.28	0.24	0.253
3	0.277	0.298	0.275	0.331	0.283	0.280	0.286	0.312	0.275	0.278
4	0.303	0.329	0.329	0.328	0.335	0.307	0.320	0.346	0.3	0.318
5	0.389	0.386	0.376	0.376	0.378	0.345	0.370	0.386	0.365	0.365
6	0.457	0.433	0.469	0.458	0.465	0.418	0.465	0.504	0.467	0.416
7	0.537	0.511	0.499	0.598	0.600	0.498	0.517	0.473	0.514	0.510
8	0.547	0.719	0.605	0.469	0.690	0.570	0.602	0.599	0.609	0.567
+gp	0.9862	0.9042	0.7197	1.0433	1.1810	0.6750	0.6550	0.735	0.946	1.003
SOPCOFAC	1.0005	1.0001	0.9993	1.0002	1.0000	1.0001	0.9994	1.001	1.002	1.005
AGE\YEAR	**2017**	**2018**								
1	0.231	0.198								
2	0.279	0.229								
3	0.289	0.262								
4	0.325	0.297								
5	0.370	0.326								
6	0.426	0.407								
7	0.590	0.468								
8	0.654	0.515								
+gp	0.7620	0.739								
SOPCOFAC	1.0400	0.978								

Table 28.7. Plaice in divisions 7.f–g. Discards numbers-at-age.

Discard numbers-at-age Numbers*10**-3														
AGE\YEAR	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
1	0	0	0	455	572	542	1829	73	671	385	960	142	614	83
2	0	0	0	360	1211	2584	3331	3595	985	2719	2656	2496	1283	987
3	0	0	0	641	441	750	3408	632	2041	1017	1429	1950	3581	1672
4	0	0	0	171	118	74	814	393	761	550	1019	502	1004	3195
5	0	0	0	68	41	47	81	69	399	345	501	179	231	454
6	0	0	0	3	12	12	32	4	44	54	45	163	32	173
7	0	0	0	4	4	1	11	1	4	8	99	58	44	77
8	0	0	0	1	22	1	9	1	5	0	56	25	11	27
+gp	0	0	0	0	0	0	0	0	0	0	0	8	8	36
TOTALNUM	0	0	0	1703	2421	4011	9515	4768	4910	5078	6765	5523	6808	6704
TONSLAND	0	0	0	274	321	453	1288	583	608	670	1107	852	1260	1158
SOPCOFAC	0	0	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AGE\YEAR	**2015**	**2016**	**2017**	**2018**										
0	-	-	0	0										
1	38	29	169	3										
2	1527	224	739	92										
3	1253	1610	1078	587										
4	753	615	1257	444										
5	1106	229	478	668										
6	303	209	312	346										
7	54	34	147	307										
8	33	15	32	11										
+gp	80	9	13	103										
TOTALNUM	5145	2974	4225	2561										
TONSLAND	870	591	895	508										
SOPCOF %	1.03	1.03	0.99	1.00										

Table 28.8. Plaice in divisions 7.f–g. Discards weights-at-age.

Discard weights-at-age (kg)														
AGE\YEAR	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
1	0	0	0	0.123	0.095	0.064	0.088	0.092	0.088	0.085	0.118	0.104	0.097	0.040
2	0	0	0	0.152	0.127	0.107	0.126	0.11	0.127	0.125	0.148	0.124	0.129	0.112
3	0	0	0	0.177	0.154	0.154	0.159	0.154	0.127	0.143	0.173	0.167	0.180	0.160
4	0	0	0	0.194	0.188	0.176	0.163	0.172	0.127	0.149	0.168	0.192	0.233	0.181
5	0	0	0	0.212	0.202	0.201	0.204	0.211	0.143	0.163	0.225	0.239	0.277	0.214
6	0	0	0	0.337	0.344	0.242	0.249	0.282	0.194	0.189	0.304	0.247	0.459	0.227
7	0	0	0	0.23	0.403	0.395	0.368	0.365	0.2	0.445	0.339	0.238	0.380	0.300
8	0	0	0	0.455	0.419	0.349	0.425	0.283	0.257	0.523	0.389	0.337	0.312	0.470
+gp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.713

Discard weights-at-age (kg)				
AGE\YEAR	**2015**	**2016**	**2017**	**2018**
0			0.058	
1	0.12	0.148	0.14	0.105
2	0.124	0.153	0.147	0.126
3	0.143	0.177	0.186	0.150
4	0.171	0.205	0.225	0.188
5	0.219	0.261	0.258	0.182
6	0.315	0.288	0.324	0.207
7	0.208	0.341	0.271	0.324
8	0.204	0.416	0.29	0.350
+gp	0.529	0.462	0.442	0.873

Table 28.9. Plaice in divisions 7.f–g. Stock weights-at-age.

Stock weights-at-age (kg)										
AGE\YEAR	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**
1	0.112	0.086	0.107	0.109	0.082	0.096	0.103	0.256	0.075	0.000
2	0.216	0.170	0.212	0.217	0.167	0.192	0.206	0.298	0.193	0.087
3	0.315	0.252	0.313	0.322	0.257	0.288	0.307	0.352	0.307	0.232
4	0.406	0.334	0.412	0.426	0.350	0.383	0.408	0.418	0.417	0.369
5	0.492	0.414	0.507	0.528	0.447	0.479	0.507	0.495	0.521	0.498
6	0.570	0.493	0.599	0.628	0.548	0.574	0.606	0.584	0.621	0.619
7	0.642	0.570	0.689	0.727	0.653	0.668	0.704	0.685	0.717	0.733
8	0.707	0.646	0.775	0.823	0.762	0.763	0.801	0.797	0.808	0.839
+gp	0.839	0.822	1.015	1.132	1.129	1.049	1.114	1.190	0.965	1.064
AGE\YEAR	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
1	0.089	0.249	0.066	0.228	0.173	0.092	0.171	0.236	0.219	0.000
2	0.168	0.273	0.139	0.254	0.229	0.203	0.263	0.296	0.254	0.247
3	0.248	0.305	0.215	0.288	0.293	0.310	0.314	0.308	0.304	0.295
4	0.328	0.346	0.295	0.332	0.363	0.414	0.405	0.397	0.364	0.349
5	0.408	0.395	0.380	0.386	0.440	0.514	0.500	0.455	0.485	0.512
6	0.489	0.453	0.468	0.448	0.523	0.611	0.598	0.598	0.603	0.553
7	0.571	0.518	0.560	0.520	0.613	0.705	0.643	0.801	0.714	0.523
8	0.653	0.593	0.657	0.602	0.710	0.795	0.728	0.728	0.752	0.947
+gp	0.822	0.837	0.938	0.854	0.987	1.000	0.989	0.959	1.066	1.067
AGE\YEAR	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
1	0.249	0.213	0.213	0.245	0.268	0.246	0.205	0.221	0.237	0.238
2	0.291	0.256	0.268	0.260	0.305	0.284	0.295	0.258	0.260	0.246
3	0.304	0.317	0.278	0.302	0.340	0.281	0.321	0.287	0.295	0.291
4	0.357	0.380	0.332	0.370	0.398	0.343	0.353	0.330	0.356	0.339
5	0.466	0.463	0.440	0.479	0.466	0.433	0.439	0.382	0.425	0.385
6	0.663	0.604	0.538	0.539	0.556	0.484	0.502	0.514	0.525	0.513
7	0.745	0.661	0.618	0.672	0.675	0.541	0.651	0.649	0.631	0.549

Stock weights-at-age (kg)										
8	0.877	0.690	0.839	0.875	0.695	0.859	0.681	0.750	0.714	0.638
+gp	1.101	1.189	1.191	1.202	1.091	1.126	1.039	0.992	1.016	0.837
AGE\YEAR	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1	0.278	0.260	0.279	0.233	0.228	0.106	0.098	0.095	0.129	0.153
2	0.271	0.273	0.267	0.292	0.242	0.129	0.136	0.116	0.128	0.161
3	0.277	0.298	0.275	0.331	0.283	0.190	0.188	0.171	0.155	0.194
4	0.303	0.329	0.329	0.328	0.335	0.234	0.257	0.202	0.202	0.233
5	0.389	0.386	0.376	0.376	0.378	0.290	0.319	0.275	0.259	0.307
6	0.457	0.433	0.469	0.458	0.465	0.332	0.463	0.334	0.36	0.355
7	0.537	0.511	0.499	0.598	0.600	0.375	0.465	0.353	0.343	0.465
8	0.547	0.719	0.605	0.469	0.690	0.470	0.525	0.543	0.339	0.527
+gp	0.986	0.904	0.720	1.043	1.181	0.549	0.654	0.594	0.563	0.998
AGE\YEAR	**2017**	**2018**								
0	0.058									
1	0.14	0.150								
2	0.153	0.152								
3	0.191	0.172								
4	0.248	0.212								
5	0.286	0.235								
6	0.350	0.270								
7	0.429	0.357								
8	0.522	0.498								
+gp	0.675	0.838								

Table 28.10. Plaice in divisions 7.f–g: Survey abundance indices.

IRGFS							
2003	2018						
1	1	0.79	0.92				
1	7						
1	0.0	3.2	6.0	2.7	0.6	0.2	0.1
1	0.1	0.4	1.9	3.1	1.2	0.8	0.1
1	2.8	4.4	5.9	1.3	0.7	0.2	0.2
1	0.2	6.0	4.6	1.2	1.0	0.6	0.7
1	0.1	2.6	8.5	3.5	1.1	0.5	0.4
1	0.4	6.0	5.6	3.8	1.0	0.4	0.2
1	12.5	11.7	32.3	14.6	5.9	1.2	0.9
1	10.1	37.9	13.2	20.8	8.6	3.7	1.0
1	10.8	49.5	30.2	8.4	9.1	3.6	4.6
1	14.6	40.5	36.8	11.3	2.1	2.0	2.9
1	1.5	16.1	37.3	19.7	7.2	1.9	6.2
1	0.4	7.9	14.3	13.6	6.1	3.4	2.2
1	0.8	37.8	28.2	13.0	15.2	3.0	5.0
1	1.1	13.8	33.6	13.9	9.2	9.0	4.2
1	0.8	11.5	12.8	13.0	10.8	3.7	4.6
1	0.1	5.5	9.8	6.6	7.9	3.2	3.2

E+W BT Survey					
1995 2018					
1 1 0.75 0.85					
1 5					
1	239.590	90.480	17.230	2.960	6.840
1	223.690	288.110	30.780	0.990	2.620
1	225.370	102.140	34.540	4.250	1.770
1	237.200	126.220	46.990	8.920	2.000
1	152.590	79.620	29.030	19.670	7.000
1	339.630	63.170	31.250	6.560	5.500
1	211.440	156.140	15.810	8.740	4.230
1	136.740	175.120	80.450	5.930	6.130
1	98.370	80.480	60.950	21.830	2.720
1	258.510	33.410	27.080	13.420	2.190
1	192.500	75.220	20.870	8.060	10.930
1	85.780	101.970	34.160	9.570	1.790
1	150.400	92.250	47.260	15.110	1.670
1	140.690	217.040	46.790	15.700	4.820
1	161.810	55.960	78.580	21.450	10.890
1	331.760	88.540	26.410	39.940	6.680
1	362.260	300.140	55.040	21.860	21.370
1	142.130	430.790	100.570	22.360	9.020
1	329.790	139.060	185.390	46.850	5.770
1	371.760	202.300	64.650	105.700	23.800
1	28.360	454.080	162.340	52.370	76.660
1	12.520	163.100	268.260	102.300	27.500
1	11.490	104.1	137.39	121.110	91.87
1	4.15	45.26	90.2	58.1	75.08

Table 28.11. Plaice in divisions 7.f–g: Commercial fleet abundance indices.

UK (E+W) BEAM TRAWL 7F.						
1990 2010						
1 1 0 1						
4 8						
	1	12.6	3.656	2.103	0.868	0.725
	1	8.372	5.158	1.715	0.894	0.834
	1	2.254	3.289	1.93	0.528	0.162
	1	1.528	0.947	1.498	0.923	0.443
	1	2.245	0.424	0.415	0.347	0.446
	1	1.715	1.289	0.43	0.252	0.278
	1	0.569	0.569	0.535	0.159	0.184
	1	0.909	0.319	0.256	0.169	0.026
	1	2.221	0.618	0.127	0.151	0.095
	1	1.72	0.844	0.252	0.078	0.062
	1	0.858	0.568	0.405	0.156	0.057
	1	0.867	0.558	0.318	0.186	0.076
	1	0.637	0.294	0.279	0.143	0.079
	1	1.349	0.393	0.199	0.135	0.094
	1	1.051	0.711	0.136	0.104	0.08
	1	0.671	0.396	0.269	0.102	0.061
	1	0.353	0.338	0.233	0.12	0.03
	1	0.853	0.227	0.142	0.099	0.043
	1	1.506	0.433	0.158	0.117	0.075
	1	1.375	0.968	0.271	0.09	0.054
	1	1.601	0.62	0.508	0.146	0.009

UK E+W OTTER TRAWL 7F						
1989		2010				
1 1 0 1						
4 8						
	1	6.366	2.37	0.766	0.518	0.041
	1	10.452	2.774	1.074	0.333	0.35
	1	7.29	3.415	1.529	0.413	0.46
	1	1.391	2.059	0.946	0.156	0.045
	1	1.065	0.479	0.754	0.491	0.335
	1	2.407	0.433	0.498	0.225	0.273
	1	2.5	0.948	0.276	0.138	0.121
	1	0.725	0.574	0.422	0.169	0.186
	1	0.953	0.208	0.121	0.069	0.017
	1	1.664	0.387	0.097	0.135	0.039
	1	1.997	0.961	0.228	0.051	0.025
	1	2.327	0.882	0.458	0.141	0.035
	1	1.326	0.809	0.42	0.194	0.065
	1	0.696	0.36	0.264	0.12	0.048
	1	1.335	0.302	0.187	0.129	0.086
	1	1.622	0.905	0.14	0.078	0.047
	1	0.628	0.331	0.171	0.057	0.034
	1	0.736	0.703	0.487	0.26	0.065
	1	0.939	0.276	0.175	0.125	0.063
	1	1.645	0.52	0.197	0.098	0.056
	1	0.731	0.472	0.122	0.046	0.03
	1	1.311	0.496	0.407	0.089	0.018

Table 28.12. Plaice in divisions 7.f–g: Reconstructed annual catches and and abundance indices used for SPiCT modelling.

Year	Catch	IRGFS	E+W BT Survey	UK (E+W) BEAM TRAWL 7F.	UK E+W OTTER TRAWL 7F
1977	1166				
1978	1348				
1979	1329				
1980	2114				
1981	2121				
1982	2007				
1983	1765				
1984	1863				
1985	2698				
1986	2604				
1987	2928				
1988	3259				
1989	3313				
1990	3206				
1991	2312				
1992	1830				
1993	1716				
1994	1648				
1995	1583		30.3	0.065	3.983
1996	1466		35.2	0.074	2.076
1997	1874		43.1	0.075	1.368
1998	1643		59.8	0.078	2.322
1999	1491		57.4	0.058	3.262
2000	1106		44.2	0.033	3.843
2001	1100		33.8	0.043	2.814
2002	989		98.9	0.038	1.488
2003	915	9.6	90.8	0.051	2.039
2004	784	7.1	49.0	0.040	2.792

Year	Catch	IRGFS	E+W BT Survey	UK (E+W) BEAM TRAWL 7F.	UK E+W OTTER TRAWL 7F
2005	707	8.3	44.0	0.027	1.221
2006	857	8.1	57.8	0.033	2.251
2007	1698	14.0	69.9	0.038	1.578
2008	1020	11.0	71.5	0.046	2.516
2009	1089	54.9	117.4	0.065	1.401
2010	1112	47.3	80.8	0.044	2.321
2011	1534	56.0	118.3		
2012	1565	55.0	150.3		
2013	1688	72.3	253.9		
2014	1183	39.5	203.9		
2015	1159	64.2	371.1		
2016	1002	69.9	455.6		
2017	1285	45.0	408.0		
2018	930	30.6	319		

Table 28.13. Diagnostic of the SPiCT model, stochastic and deterministic reference points.

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 56.1174464
Euler time step (years):  1/16 or 0.0625
Nobs C: 42,  Nobs I1: 24,  Nobs I2: 16,  Nobs I3: 16,  Nobs I4: 16

Residual diagnostics (p-values)
   shapiro   bias    acf   LBox shapiro bias acf LBox
 C  0.1432 0.2725 0.1135 0.3794       -    -   -    -
 I1 0.2082 0.6111 0.0106 0.0061       -    -   *   **
 I2 0.4663 0.6075 0.0286 0.0773       -    -   *    .
 I3 0.5064 0.8554 0.4011 0.6277       -    -   -    -
 I4 0.8832 0.9221 0.0742 0.2635       -    -   .    -

Priors
    logn  ~  dnorm[log(2), 2^2]
 logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]

Model parameter estimates w 95% CI
          estimate       cilow        ciupp     log.est
 alpha1    2.6134911    1.2046021 5.670201e+00   0.9606869
 alpha2    2.8521281    1.2578712 6.466985e+00   1.0480654
 alpha3    1.5193237    0.6036848 3.823758e+00   0.4182653
 alpha4    2.6261470    1.1964475 5.764272e+00   0.9655178
 beta      0.5195236    0.2188141 1.233489e+00  -0.6548431
 r         1.1160169    0.3915114 3.181245e+00   0.1097660
 rc        0.9208431    0.5349346 1.585151e+00  -0.0824656
 rold      0.7837734    0.3638339 1.688410e+00  -0.2436353
 m      2288.7388242 1888.8760912 2.773250e+03   7.7357562
 K      9257.2879460 5082.3414368 1.686179e+04   9.1331664
 q1        0.0341978    0.0183075 6.388030e-02  -3.3755948
 q2        0.0079775    0.0042128 1.510610e-02  -4.8311364
 q3        0.0000265    0.0000138 5.080000e-05 -10.5383081
 q4        0.0012099    0.0006185 2.367000e-03  -6.7171884
 n         2.4239025    1.0392869 5.653206e+00   0.8853788
 sdb       0.1577539    0.0791942 3.142438e-01  -1.8467193
 sdf       0.1847780    0.1193396 2.860986e-01  -1.6886004
 sdi1      0.4122883    0.2952552 5.757110e-01  -0.8860324
 sdi2      0.4499342    0.3020011 6.703314e-01  -0.7986539
 sdi3      0.2396792    0.1478028 3.886673e-01  -1.4284540
 sdi4      0.4142848    0.2854585 6.012499e-01  -0.8812016
 sdc       0.0959965    0.0515738 1.786824e-01  -2.3434435

Deterministic reference points (Drp)
         estimate       cilow        ciupp    log.est
 Bmsyd 4970.9637959 2846.8871042 8679.8247193  8.5113690
 Fmsyd    0.4604215    0.2674673    0.7925753 -0.7756128
 MSYd  2288.7388242 1888.8760912 2773.2498864  7.7357562
Stochastic reference points (Srp)
         estimate       cilow        ciupp    log.est
 Bmsys 4846.5466558 2777.7381305 8456.1659101  8.4860217
```

```
 Fmsys    0.4523549    0.2602123    0.7863771 -0.7932882
 MSYs  2191.3556555 1805.5030743 2659.6684752  7.6922757
      rel.diff.Drp
 Bmsys  -0.02567130
 Fmsys  -0.01783255
 MSYs   -0.04443969

States w 95% CI (inp$msytype: s)
                 estimate       cilow       ciupp
 B_2019.00      7514.5969175 4177.7335503 1.351670e+04
 F_2019.00         0.1318512    0.0711697 2.442717e-01
 B_2019.00/Bmsy    1.5505054    1.1940580 2.013359e+00
 F_2019.00/Fmsy    0.2914774    0.2020672 4.204494e-01
                log.est
 B_2019.00       8.924603
 F_2019.00      -2.026081
 B_2019.00/Bmsy  0.438581
 F_2019.00/Fmsy -1.232793

Predictions w 95% CI (inp$msytype: s)
                prediction       cilow       ciupp
 B_2020.00      7688.8436736 4289.3439279 1.378260e+04
 F_2020.00         0.1246514    0.0653057 2.379268e-01
 B_2020.00/Bmsy    1.5864582    1.2025618 2.092907e+00
 F_2020.00/Fmsy    0.2755610    0.1814337 4.185213e-01
 Catch_2020.00   974.4813375  663.2276027 1.431807e+03
 E(B_inf)       7909.1638735          NA           NA
                log.est
 B_2020.00       8.947526
 F_2020.00      -2.082234
 B_2020.00/Bmsy  0.461504
 F_2020.00/Fmsy -1.288946
 Catch_2020.00   6.881905
 E(B_inf)        8.975777
```

Table 28.14. Output of the SPiCT model: B (biomass), F (Fishing mortality), B/ B_{MSY} and F/ F_{MSY}. Estimates (est), upper (upp) and lower (low) 95% CI. Weights are in tonnes.

Year	F/Fmsy low	F/Fmsy (estimate)	F/Fmsy upp	B/Bmsy low	B/Bmsy (est)	B/Bmsy upp	B low	B (est)	B upp	F low	F (est)	F upp
1977	0.492	0.990	1.992	0.239	0.488	1.000	899	2367	6236	0.165	0.448	1.217
1978	0.495	0.979	1.936	0.268	0.590	1.298	1068	2860	7662	0.167	0.443	1.177
1979	0.448	0.912	1.857	0.300	0.672	1.510	1225	3259	8670	0.156	0.412	1.092
1980	0.471	0.943	1.886	0.373	0.821	1.806	1574	3980	10060	0.169	0.426	1.074
1981	0.524	1.042	2.070	0.429	0.932	2.026	1836	4519	11121	0.192	0.471	1.158
1982	0.507	1.009	2.007	0.434	0.934	2.009	1862	4525	10993	0.188	0.456	1.110
1983	0.473	0.927	1.816	0.441	0.925	1.941	1897	4483	10598	0.177	0.419	0.991
1984	0.462	0.863	1.612	0.488	0.962	1.896	2102	4661	10336	0.176	0.390	0.867
1985	0.558	0.944	1.597	0.618	1.090	1.923	2650	5285	10541	0.214	0.427	0.852
1986	0.676	1.059	1.658	0.702	1.134	1.832	2944	5497	10262	0.257	0.479	0.892
1987	0.757	1.125	1.672	0.730	1.111	1.690	3007	5384	9640	0.286	0.509	0.906
1988	0.895	1.277	1.820	0.748	1.092	1.595	3049	5292	9186	0.337	0.578	0.990
1989	1.049	1.462	2.039	0.706	1.012	1.450	2856	4902	8415	0.392	0.662	1.117
1990	1.200	1.673	2.331	0.611	0.882	1.272	2458	4273	7427	0.442	0.757	1.295
1991	1.248	1.753	2.463	0.480	0.696	1.009	1876	3372	6063	0.445	0.793	1.414
1992	1.171	1.644	2.307	0.390	0.562	0.809	1477	2723	5020	0.407	0.744	1.359
1993	1.115	1.575	2.227	0.355	0.509	0.730	1329	2468	4584	0.386	0.713	1.316
1994	1.103	1.569	2.232	0.340	0.487	0.697	1265	2358	4399	0.382	0.710	1.319
1995	1.101	1.574	2.248	0.329	0.468	0.666	1210	2268	4252	0.380	0.712	1.333
1996	1.075	1.537	2.199	0.314	0.445	0.633	1145	2159	4070	0.372	0.695	1.299
1997	1.132	1.618	2.313	0.327	0.464	0.657	1213	2247	4162	0.399	0.732	1.344
1998	1.203	1.726	2.477	0.318	0.456	0.655	1179	2210	4143	0.421	0.781	1.448
1999	1.200	1.733	2.502	0.288	0.417	0.603	1056	2019	3862	0.409	0.784	1.501
2000	1.142	1.679	2.469	0.241	0.349	0.506	855	1693	3352	0.381	0.760	1.516
2001	1.078	1.584	2.329	0.219	0.318	0.459	769	1539	3079	0.357	0.717	1.436
2002	1.042	1.544	2.288	0.211	0.307	0.448	737	1489	3009	0.343	0.698	1.422

Year	F/Fmsy low	F/Fmsy (esti-mate)	F/Fmsy upp	B/Bmsy low	B/Bmsy (est)	B/Bmsy upp	B low	B (est)	B upp	F low	F (est)	F upp
2003	0.976	1.456	2.171	0.206	0.303	0.446	720	1470	3002	0.318	0.658	1.365
2004	0.925	1.398	2.114	0.196	0.286	0.419	675	1388	2852	0.297	0.633	1.346
2005	0.880	1.324	1.992	0.181	0.259	0.371	609	1256	2588	0.283	0.599	1.266
2006	0.858	1.269	1.878	0.194	0.275	0.391	661	1335	2698	0.284	0.574	1.160
2007	1.023	1.511	2.233	0.258	0.360	0.503	904	1745	3367	0.350	0.684	1.334
2008	1.001	1.520	2.309	0.261	0.377	0.545	904	1828	3698	0.337	0.688	1.404
2009	0.783	1.157	1.709	0.282	0.405	0.581	966	1962	3983	0.257	0.523	1.064
2010	0.654	0.984	1.482	0.352	0.513	0.748	1239	2487	4992	0.219	0.445	0.907
2011	0.566	0.859	1.304	0.464	0.686	1.016	1688	3326	6555	0.197	0.389	0.768
2012	0.491	0.758	1.171	0.618	0.935	1.417	2339	4533	8785	0.176	0.343	0.669
2013	0.415	0.643	0.996	0.772	1.158	1.739	2950	5614	10681	0.152	0.291	0.558
2014	0.331	0.503	0.762	0.890	1.281	1.842	3348	6208	11510	0.121	0.227	0.428
2015	0.267	0.392	0.576	0.998	1.361	1.856	3652	6597	11915	0.096	0.177	0.327
2016	0.232	0.332	0.474	1.136	1.496	1.971	4067	7251	12926	0.082	0.150	0.274
2017	0.233	0.324	0.449	1.253	1.630	2.120	4427	7898	14091	0.081	0.146	0.265
2018	0.229	0.326	0.463	1.265	1.643	2.132	4427	7961	14315	0.080	0.147	0.271
2019	0.202	0.291	0.420	1.194	1.551	2.013	4178	7515	13517	0.071	0.132	0.244

Table 28.15. Short-term projection of the SPiCT model, plaice 7.fg for 2020.

Reference Point	Estimate	CI 95% $_{LOW}$	CI 95% $_{UPP}$	CV, %
B/B_{MSYS}	1.586	1.203	2.093	14.2
F/F_{MSYS}	0.276	0.159	0.479	21.6

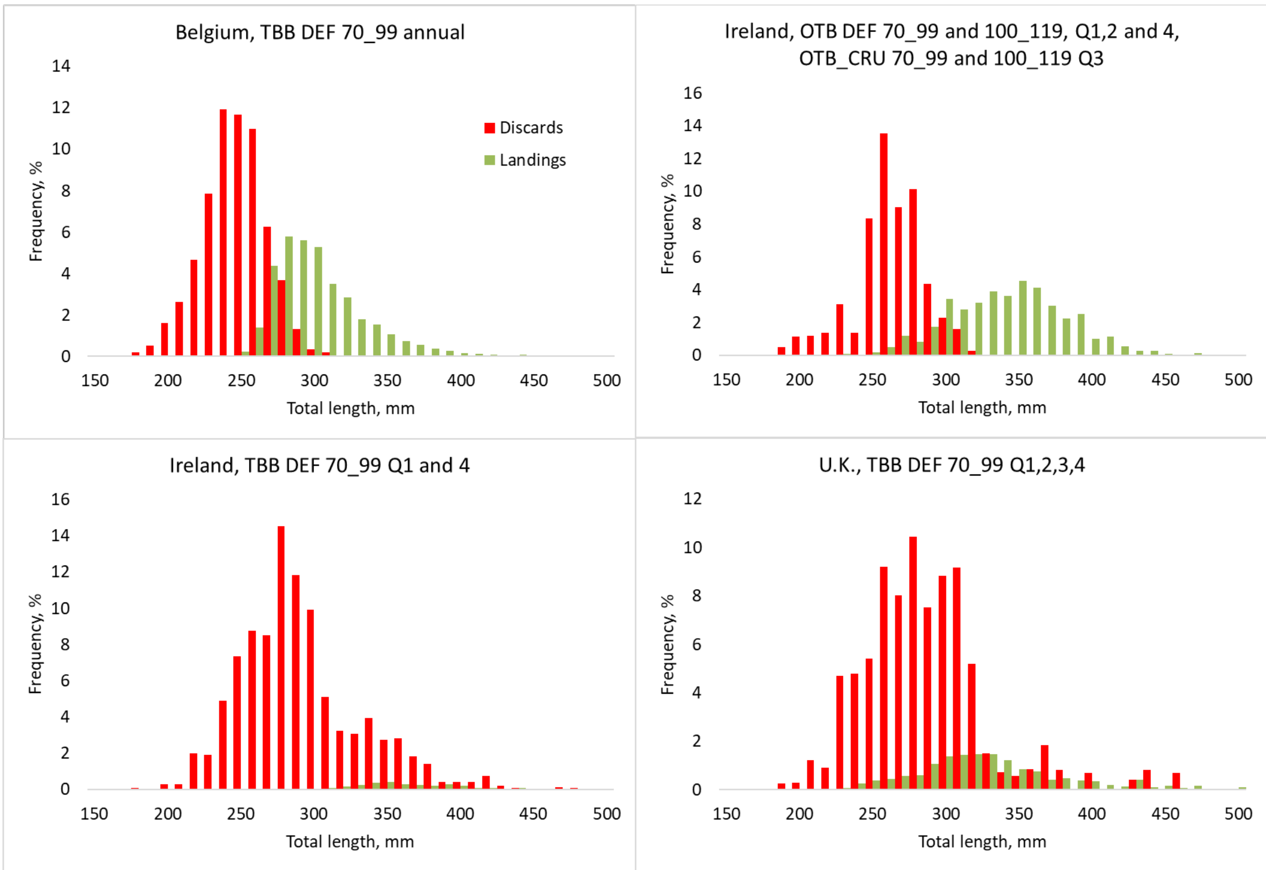


Figure 28.1. Plaice in divisions 7.f–g: Landing and discards by different metiers when both landings and discards were sampled simultaneously.

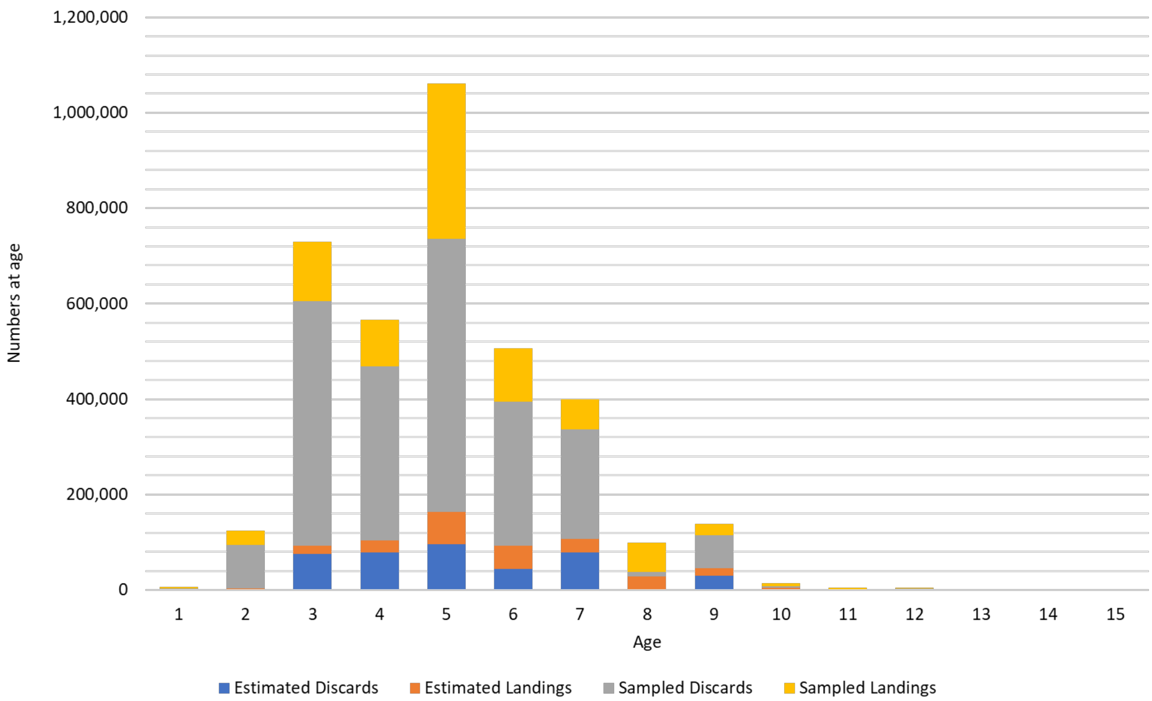


Figure 28.2. Plaice in divisions 7.f–g: Contribution of sampled and unsampled landings and discards to final assessment catch numbers-at-age in 2018.

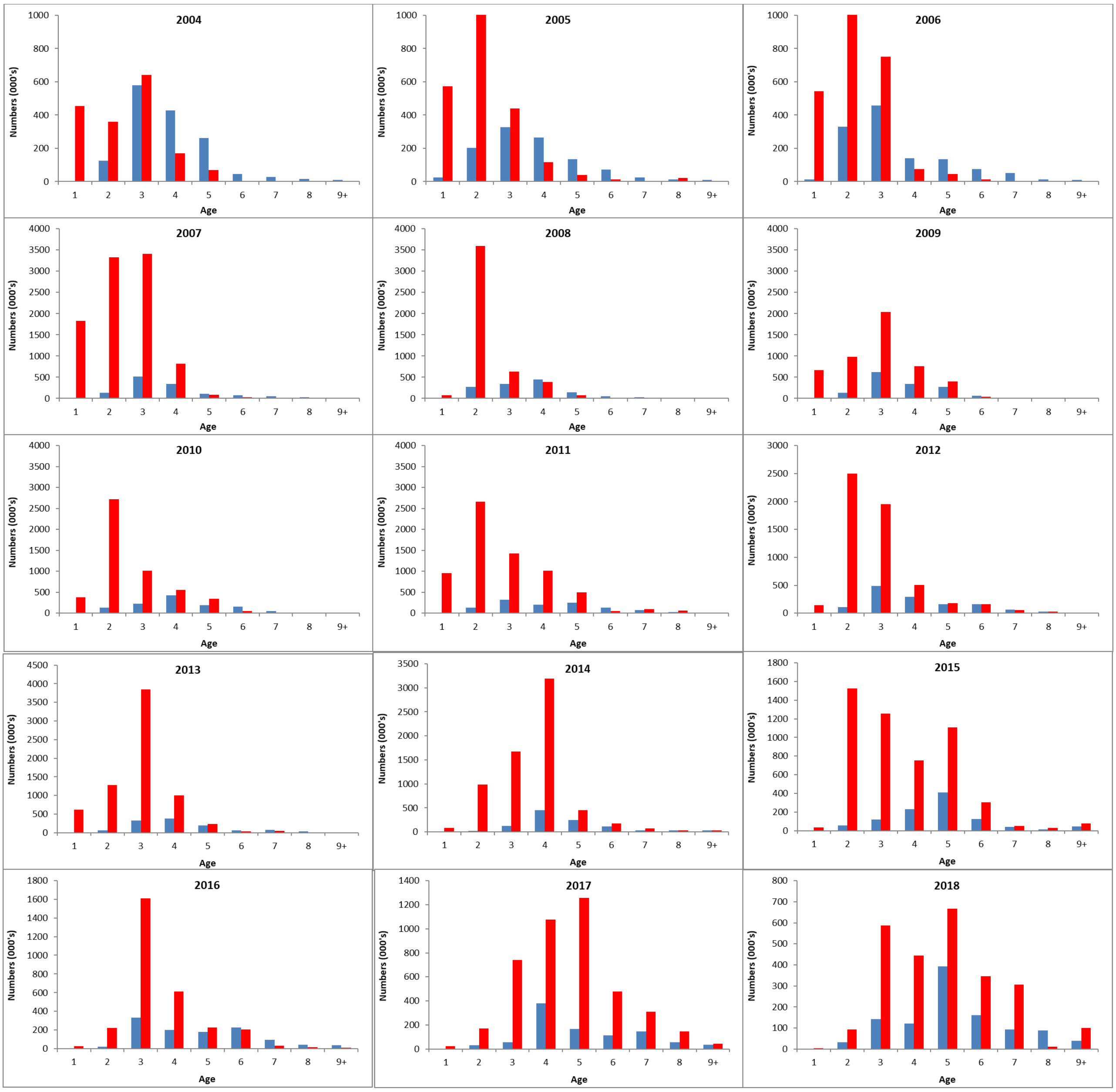


Figure 28.3. Plaice in divisions 7.f–g: Age composition of international landings (blue) and discards (red) from 2004 to 2018.

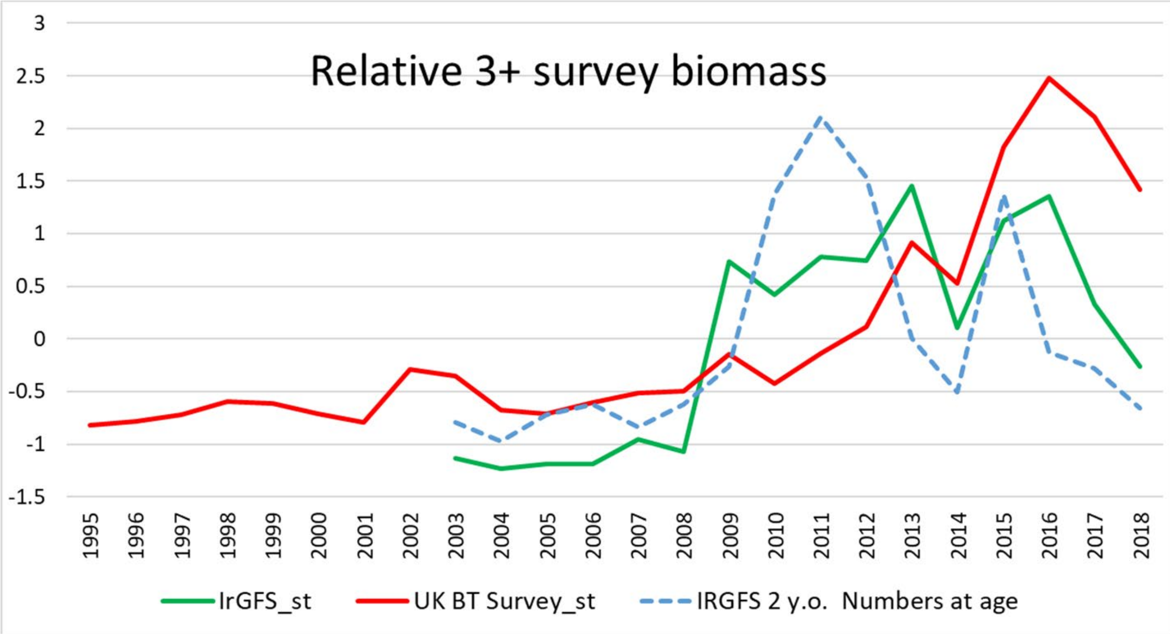


Figure 28.4. Trends cpues of surveys.

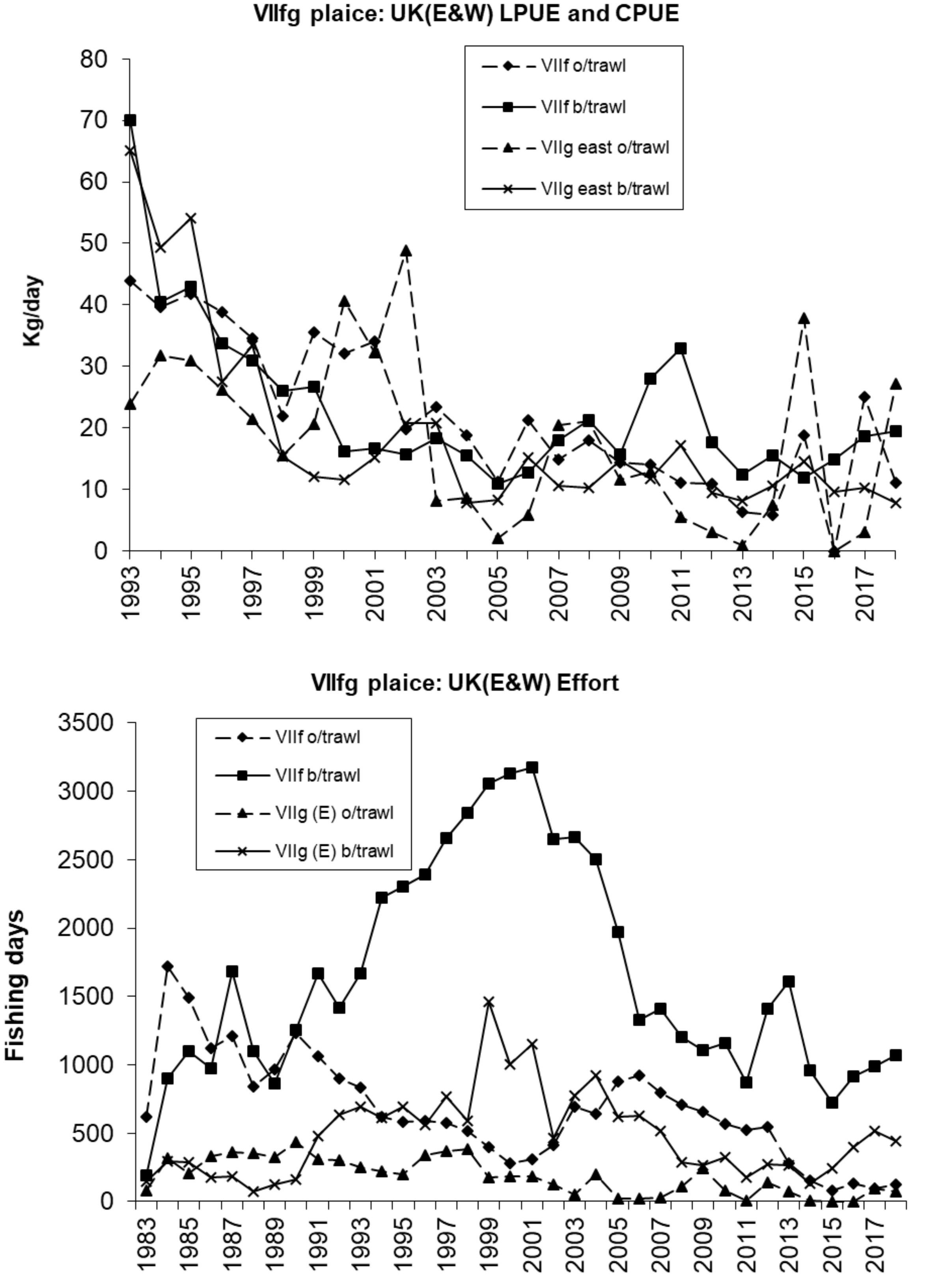
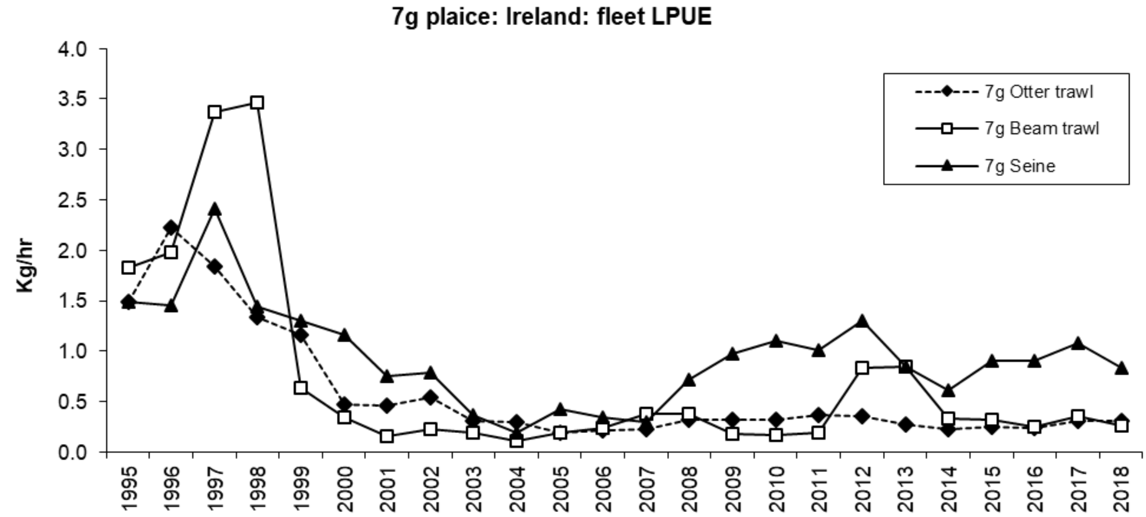
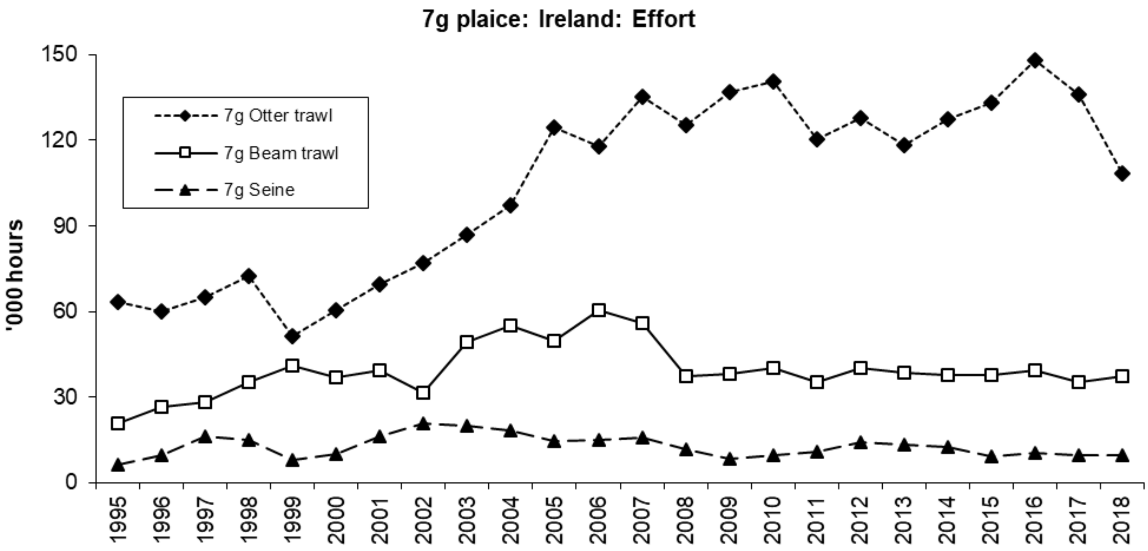


Figure 28.5. Plaice in divisions 7.f–g: UK (E&W) lpue and effort by fleet.





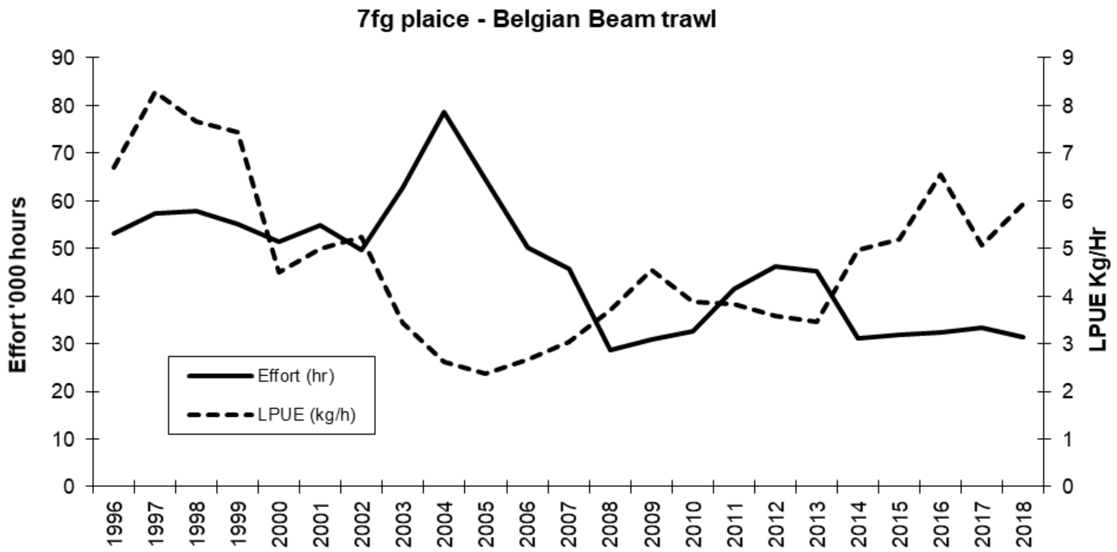


Figure 28.6. Plaice in divisions 7.f–g: Ireland and Belgium: lpue and effort by fleet.

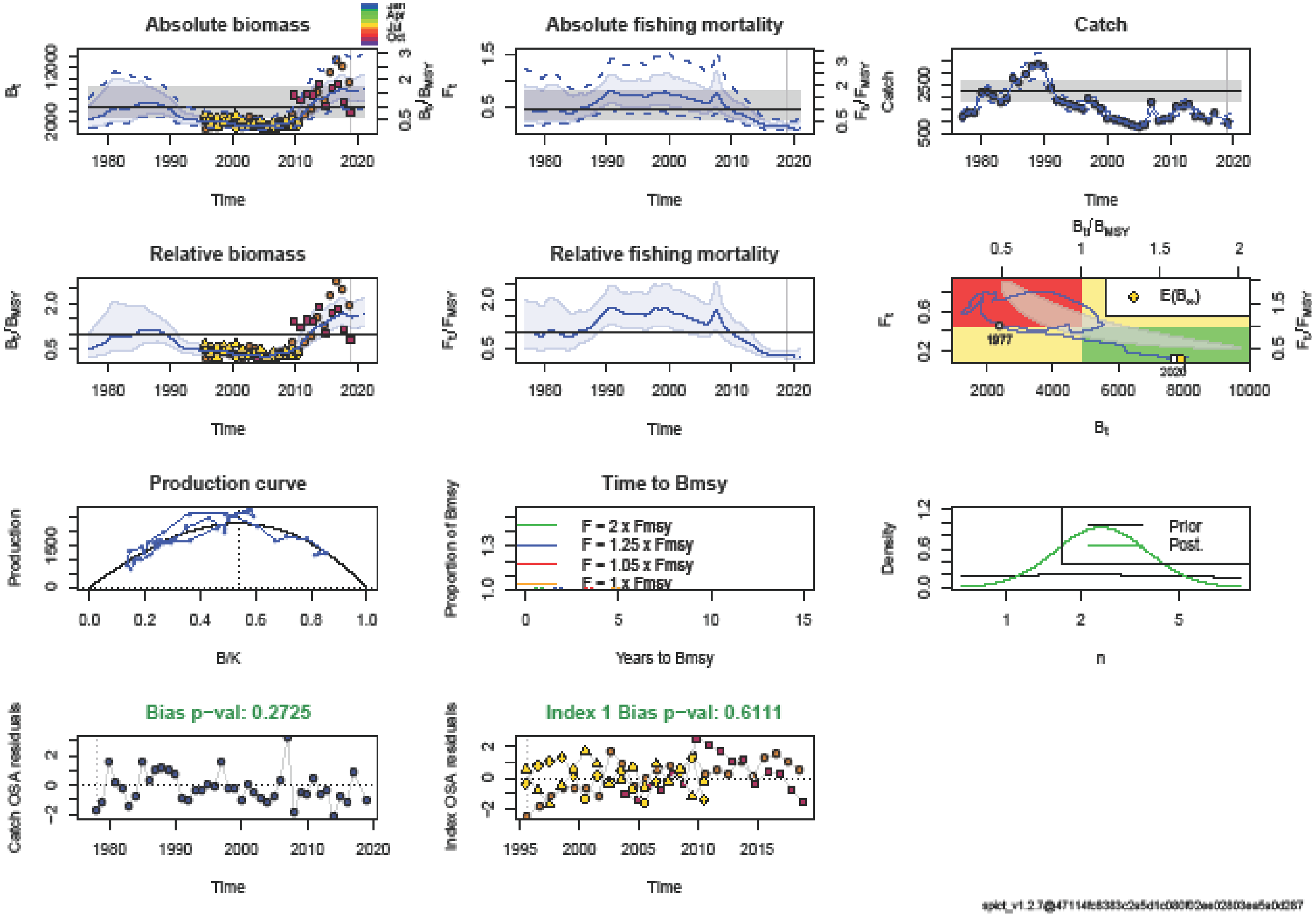


Figure 28.7. Output of the SPiCT model: dynamics of biomass, catch and fishing mortality.

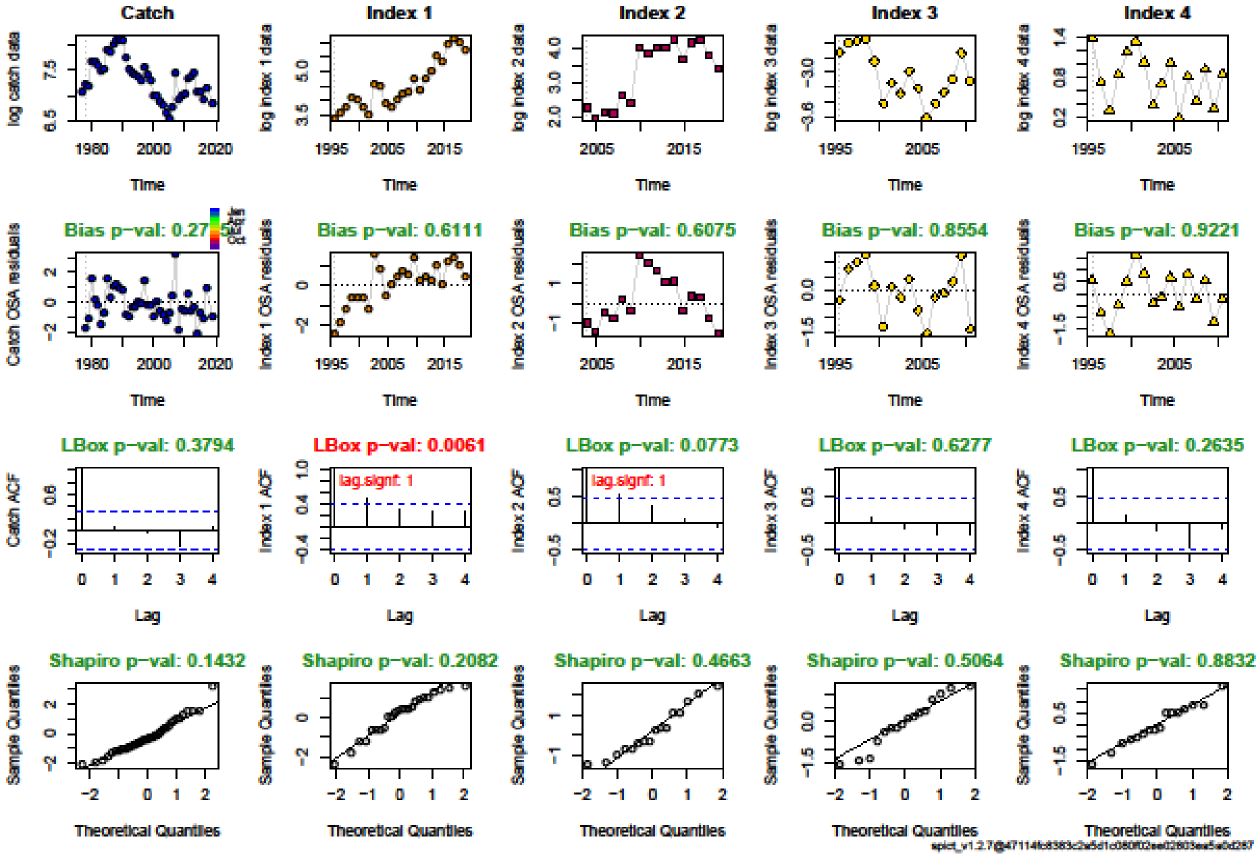


Figure 28.10. Diagnostics of the SPiCT model.

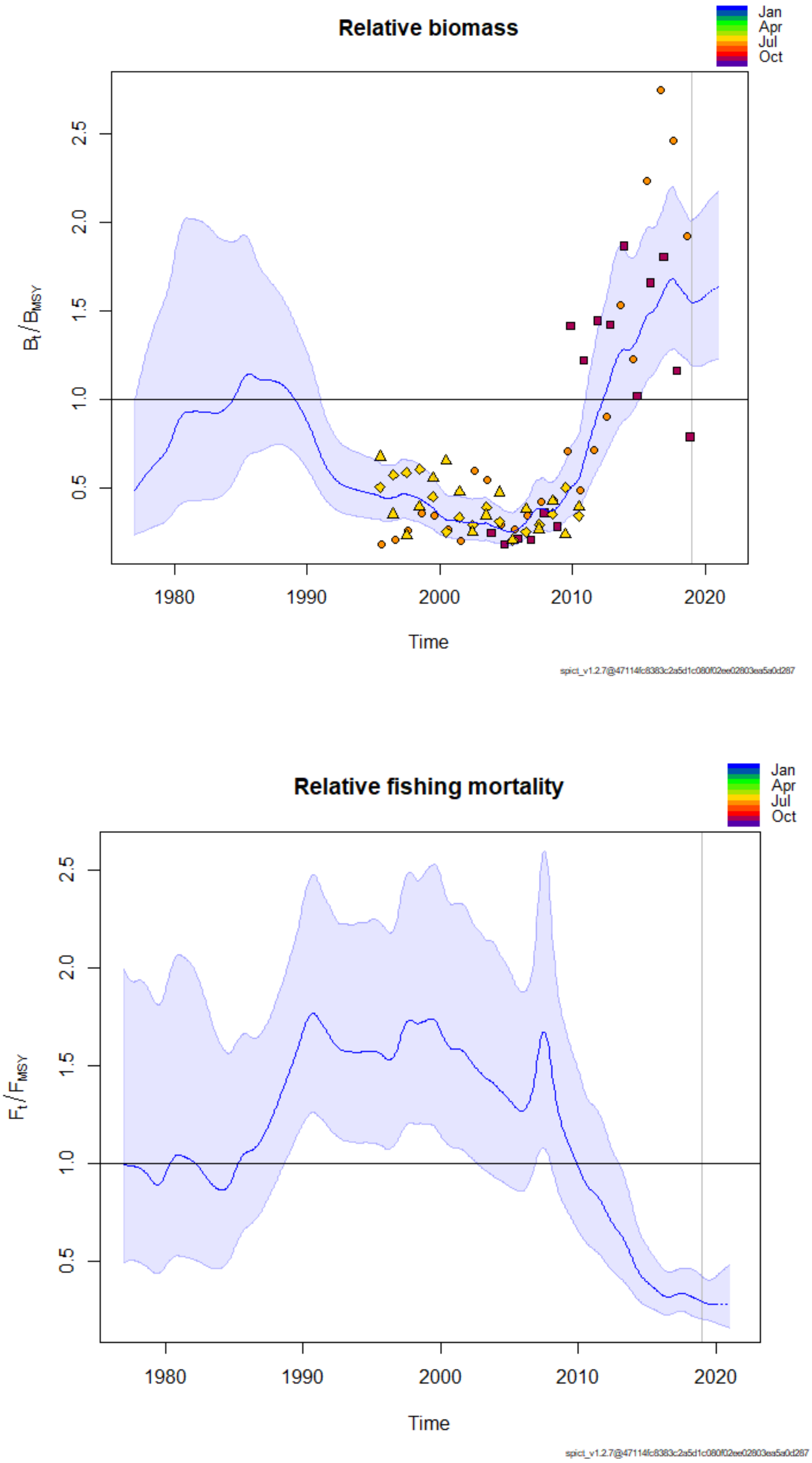


Figure 28.11. Ple 7 f&g. Dynamics of B/B_{MSY} and F/F_{MSY} from SPiCT run.

26 Plaice (*Pleuronectes platessa*) in divisions 7h–k (Celtic Sea South, southwest of Ireland)

Type of assessment in 2019

An update XSA assessment was performed for the 7.jk component of the landings according to the stock annex. MSY and PA reference points were estimated.

ICES advice applicable to 2019

ICES advises that when the precautionary approach is applied, there should be zero catches in 2019. Discards are known to take place but cannot be quantified; therefore, total catches cannot be calculated.

http://ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/ple-7h-k.pdf

ICES advice applicable to 2018

ICES advises that when the precautionary approach is applied, there should be zero catches in 2018. Discards are known to take place but cannot be quantified; therefore, total catches cannot be calculated.

http://ices.dk/sites/pub/Publication%20Reports/Advice/2017/2017/ple.27.7h-k.pdf

26.1 General

Stock description and management units

Plaice in 7.h–k is on the southwestern margins of the species distribution. Although the TAC is set for divisions 7.h,j and k, the assessment is performed for 7.jk only. This separation in assessment and TAC area is driven by two main reason: firstly, age-disaggregated data were not historically available for 7.h, and secondly, there is a wide geographical distance of several hundred miles, between the inshore 7j fishery and the 7h fishery. This distance would suggest that 7.h stock may constitute a spate stock, and may be a continuation of the plaice caught in the western English Channel (7.e).

The assessed part of the fishery focusses mainly on 7.j where Irish vessels operate on sandy grounds off the southwest of Ireland. Irish VMS and logbook data indicate that the landings of plaice in 7.j occur close to shore, and are part of a mixed fishery. With plaice forming only a small component (<5%) of the overall landings per trip (Figure 27.1). Landings in 7.k are minor.

It is the recommendation of this group that plaice in 7h–k be benchmarked to incorporate new datasets, including IBTS survey indices and age-disaggregated data for 7.h.

Management applicable to 2019 and 2018

TAC table 2019

Species:	Plaice *Pleuronectes platessa*	**Zone:**	7h, 7j and 7k (PLE/7HJK.)
Belgium	7 (1)		
France	14 (1)		
Ireland	47 (1)		
The Netherlands	27 (1)		
United Kingdom	14 (1)		
Union	109 (1)		
TAC	109 (1)		Precautionary TAC Article 8 of this Regulation applies Article 13(1) of this Regulation applies

(1) Exclusively for by-catches of plaice in fisheries for other species. No directed fisheries for plaice are permitted under this quota.

TAC table 2018

Species:	Plaice *Pleuronectes platessa*	**Zone:**	7h, 7j and 7k (PLE/7HJK.)
Belgium	8		
France	16		
Ireland	56		
The Netherlands	32		
United Kingdom	16		
Union	128		
TAC	128		Precautionary TAC Article 12(1) of this Regulation applies

***Article 12 refers to the closure of the Porcupine Bank in May and July.**

26.2 Data

Landings and discards

The nominal landings are given in Table 27.1. Historic Belgian landings from 7.j are considered to have been area misreported and have been removed from the total landings. The remainder of Section 27 concerns 7.jk only, as this is the area on which the assessment is run.

Discard and retained catch numbers for the Irish 7.j OTB fleet in 2018 are based on nine observer trips. There is currently no reliable time-series of discards-at-age or discard numbers, therefore they are not included in the assessment. Since 2007, the proportion of the 7.j catch that was discarded varies between 10% and 100%, however the number of trips in some years was very low. Since 2001, the number of trips has ranged from 2–23 per year and with the average proportion of catch being discarded in that period being 38%. Although not included in this assessment, it is important to note here that discarding is part of this fishery, and is considered to be quite high, and on the increase due to limited quota.

Commercial effort and lpue

The commercial effort landings and lpue for the Irish otter trawl fleet in 7.j is shown in Figure 27.1b.

Landings numbers-at-age

Landings numbers-at-age are given in Table 27.3 and Figure 27.3. Figure 27.4 shows a bubble plot of the standardised landings proportions-at-age. There is very little contrast in the numbers-at-age matrix. Figure 27.5 gives the stock weights (which are the same as the landings weights).

Biological

Natural mortality was assumed to be 0.12 for all ages and the proportion mature for age 4 is assumed to be 0.86 and 1 for all older ages.

Surveys and commercial tuning fleets

Historically, there is no survey index available for this stock as the Irish IBTS Q4 Groundfish Survey data were considered to be too noisy to be used. A commercial tuning index is used. This index comes from the Irish VMS data, which are linked to logbook landings (see Gerritsen *et al*., 2011 for details on linking VMS and logbook data). These data were used to identify plaice fishing grounds, which are targeted by OTB vessels (Figure 27.6), and to estimate the effort and landings of the OTB vessels within these fishing grounds (Figure 27.6). The lpue trends identified by Gerritsen *et al*. (2011) in VMS-based, mirrored the lpue of Irish OTB vessels in the whole of 7.j. However, it should be noted that this index is not sensitive to changes in the spatial distribution of the fleet as it assumes that all vessels operating in 7.j are capable of catching plaice. This is not the case, as only vessels close to the shore catch plaice and not those which operate further offshore.

The age composition of the Irish OTB fleet in 7.j is used as a tuning fleet (Table 27.5). Figure 27.7 shows the log standardised numbers-at-age in the tuning index by year and cohort. No year effects are obvious, but cohort tracking is not particularly good either. This is probably results from the lack of contrast in recruitment (see 'Data quality'). Figure 27.8 shows the internal consistency regressions for the tuning fleet.

In years to come, the annual Irish Beam Trawl Ecosystem Survey (IBES) may act as a possible tuning index for this stock, as a number of valid tows occur in the area where the fishery is executed. The first of these surveys took place in 2016 (ICES, 2016c) and was repeated in 2017 and 2018.

Data quality

The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used. Sampling is considered sufficient to establish landings numbers-at-age. The lack cohort tracking in the numbers-at-age matrix is most likely due to an absence of very strong or weak cohorts, rather than poor sampling or ageing.

26.3 Historical stock development

Target category: 3.2.0.

Model used: XSA

Software used: Lowestoft vpa95.exe and FLR with R version 3.5.1 and packages FLXSA_2.6.2 , FLAssess_2.6.3, FLEDA_2.5.2, FLCore_2.6.13.

Exploratory assessment

Several exploratory assessments were carried out by means of a separable VPA and XSA. The initial VPA runs explored the year and age range to be used in the separable and the choices of reference age, final F and S. The XSA runs explored the choices of q-age, F-shrinkage and the minimum SE threshold. The results of these are available on the ICES SharePoint site of WGCSE under data for this stock.

Final assessment

The model was applied to landings numbers for ages 4–8+ for the years 1993–2018. The tuning fleet included ages 4–8 for the years 2007–2018.

Model Options:

Option	Setting
Ages catch dep stock size	None
Q plateau	6
Taper	No
F shrinkage SE	1.0
F shrinkage year range	5
F shrinkage age range	3
Fleet SE threshold	0.3
Prior weights	No

The diagnostics of the final XSA assessment are given in Table 27.6. Age classes 4 to 8+ were included in the model. Younger ages were omitted because significant discarding is expected to take place at these ages. Figure 27.9 shows the residuals. There are some year effects but the absolute values are small. Because the landings and the tuning fleet have nearly identical age compositions, the year effects result from the lpue estimate of the tuning fleet. The retrospective analysis shows no consistent retrospective bias, despite some noise the retrospective seems stable. A summary of relative trends in landings, recruitment, SSB and F is given in Table 27.10 and Figure 27.7.

A Mohn's rho analysis was conducted based on the XSA stock assessment results, i.e. the last data year (2018) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 3–9)	recruitment
Mohn's rho value	-0.2204965	0.1091162	-0.2668708

The SSB and recruitment Mohn's rho values for this assessment are higher than the threshold of 20% imposed by ICES for 2019 assessments, therefore the current assessment indicates a low consistency.

26.4 MSY evaluation

The MSY reference points used were the same as last year. These reference points were estimated using based on WKProxy (ICES, 2016a). F_{MSY} reference point of F = 0.25 was estimated based on $F_{0.1}$ from a Thompson–Bell yield-per-recruit analysis of the landings numbers-at-age. This is a data-limited approach (which was in line with the ToRs of WKProxy) and the resulting reference point is not directly comparable with the outputs from the XSA (only the landings data are used in the Thompson–Bell approach). In 2016, this working group (ICES, 2016d) recommended that it would be more appropriate to move the stock to Category 2 next year and to apply the WKMSYREF4 (ICES, 2016b) methodology for estimating reference points (ICES, 2012).

An exploratory MSY evaluation was conducted in 2017, following WKMSYREF4 guidelines, and is presented here. Details on this evaluation can be found in the working document in appendix xxx. The stock–recruitment graph (Figure 27.11) suggests recruitment has been impaired for most of the time-series. Because there is no obvious stock–recruitment relationship (it appears to be a recruit–stock relationship), it is difficult to specify an appropriate SR model. The SR estimation was carried out on age >= 4 as that is the onset of recruitment using: *fit <- eqsr_fit_shift(stock, nsamp = 1000, models = c("Segreg"), rshift = 4).* From this B_{lim} was estimated to be 203.57 (*B_{lim} <- median(fit$sr.sto$b.b))* and a B_{pa} at 282.88 (*B_{pa} <- B_{pa}(B_{lim}, 0.2)*. The following settings were used to estimate the MSY reference points using the eqsim_run{msy} function in the msy package in R (full code available on SharePoint):

```
stockSetup <- list(data = stock,
        bio.years = c(2007, 2016),
        bio.const = FALSE,
        sel.years = c(2007, 2016),
        sel.const = FALSE,
        Fscan = seq(0,0.8,by=0.005),
        Fcv = 0.212,
        Fphi = 0.423,
        Blim = Blim,
        Bpa = Bpa,
        verbose = TRUE,
        extreme.trim=c(0.05,0.95))
```

Where F_{cv} and F_{phi} were the same as those used by WKMSYREF4 for plaice in 7e (ICES, 2016b), which was calculate during WKMSYREF3 (ICES, 2014). Figures 7.11.12 and 7.11.13 summarise the MSY evaluation. The analysis resulted in an estimate of F_{MSY} = 0.289 without a $B_{trigger}$ harvest control rule and F_{MSY} = 0.306 with a $B_{trigger}$ = B_{pa} HCR. These values are slightly higher than the F_{MSY} proxy of 0.25 proposed by WKProxy (ICES, 2016a).

Biological reference points

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	282	B_{pa}	ICES (2017)
	F_{MSY}	0.289	Median point estimates of Eqsim with segmented regression S–R relationship	ICES (2017)
Precautionary approach	B_{lim}	203	Break point segmented regression S–R relationship	ICES (2017)
	B_{pa}	282	B_{lim} x esp(1.645 x σ); σ = 0.20	ICES (2017)
	F_{lim}	0.471	F with 50% probability of SSB < B_{lim}	ICES (2017)
	F_{pa}	0.339	F_{lim} x exp(-1.645 x σ); σ = 0.20	ICES (2017)
Management plan	SSB_{mgt}	Not applicable		
	F_{mgt}	Not applicable		

26.5 Uncertainties and bias in the assessment and forecast

The advice is based on an assessment model accepted for trends, used as an indicator of stock size. The uncertainty associated with the index values is not available. The assessment is only based on ages 4 and older; ICES does not have reliable information on younger ages.

The assessment is carried out on the landings in divisions 7.j and 7.k. The trends in this area may not be representative of the whole stock area (7.hjk). Historically, no age information was available for Division 7.h, therefore ICES was unable to assess stock trends in Division 7.h. However, age data for 7.h were submitted to InterCatch in 2017, 2018 and 2019, therefore a benchmark should be considered for this stock. The advice takes into account the reported landings from the full TAC area; divisions 7.h–k.

The apparent reduction in SSB in 2015 is mainly driven by a reduction in relative abundance of young fish in recent years, there is a slight increase in 2016, but is again showing a downward trend in 2018. It is unclear, whether this lack of young fish in the landings (and commercial tuning lpue index) is due to increased discarding or poor recruitment (Table 27.1). There has been an overall decrease in landings, with an increase in landings by Ireland and a reduction in those by France and the UK.

The tuning index only begins in 2006 and there is limited contrast between the cohorts; therefore the assessment is driven mostly by the strong trend in 7.jk landings in the first ten years of the time-series.

Discards in this stock may be considerable but are not presently included in the model as there are insufficient data, and because this might introduce more noise in the catch numbers-at-age matrix, particularly in the early years of the time-series when sampling levels were variable.

The use of a commercial tuning fleet has the potential to introduce bias if the behaviour of the fleet changes; for example, the spatial distribution of effort can change over time, resulting in higher or lower catch rates of certain species. Additionally, changes to the gear, vessel power, towing speed, etc. can influence the catch rates. By limiting the index to an area where plaice are known to be caught, some of this potential bias will be avoided. The working group applied a spatial stratification to check that changes in effort distribution within the plaice area did not affect the index and this did not appear to be the case. Because the stratified estimate is likely to be less precise, the final tuning index was based on the un-stratified estimate. More sophisticated modelling approaches to standardise the commercial index could be investigated for a future benchmark.

26.6 Recommendations for the next benchmark

This stock is scheduled to be benchmarked in 2021.

26.7 Management considerations

Plaice are taken as a minor bycatch in a mixed fishery and should be managed as such. Restricting the landings by TAC is unlikely to reduce the catches. As per ICES guidelines the PA buffer was applied in 2019.

Because plaice are caught in spatially distinct areas, restricting effort in these areas will be more effective than limiting landings. Additionally, management should focus on reducing discards. The recently introduced square mesh panels will be unlikely to effect on catches of undersized plaice. An increase in mesh size could improve selection, but will also affect the catches of marketable fish. The landings obligation is not currently in effect for this stock.

The TAC area includes Division 7.h. However, the landings from divisions 7.jk are taken in the northeastern part of Division 7.j, which is remote from the northern part of Division 7.h, where most of the Division 7.h landings are taken. It is likely that the plaice from Division 7.h are part of the divisions 7.e or 7.fg stocks. Although no further information on stock structure is likely to become available, this stock should be benchmarked.

Historically, only landings data were available for Division 7.h, however age-structured data were available in InterCatch in 2017, 2018 and 2019 for this area, therefore a benchmark should take place to determine how best to incorporate these samples. Landings in Division 7.h have fluctuated around 50% of the total landings of the stock (i.e. in divisions 7.h–k) since 1993.

26.8 References

Gerritsen HD and Lordan C. 2011. Integrating Vessel Monitoring Systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES J Mar Sci 68 (1): 245–252.

ICES. 2012. ICES implementation of advice for data-limited stocks in 2012. Report in support of ICES advice. ICES CM 2012/ACOM:68.

ICES. 2014. Report of the Joint ICES-MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 164 pp.

ICES. 2016a. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

ICES. 2016b. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2016c. Final Report of the Working Group on Beam Trawl Surveys (WGBEAM), 12–15 April 2016, La Rochelle, France. ICES CM 2016/ SSGIEOM:20. 125 pp.

ICES. 2016d. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 4–13 May 2016, Copenhagen, Denmark. ICES CM 2016ACOM:13. 1312 pp.

Table 27.1. Plaice in divisions 7. h–k (Southwest Ireland). Nominal landings (t), 1993–2018, as officially reported to ICES.

	7.jk					**7.h**					**7.jk**	**7.h**	**7.hjk**	**7.hjk**
	BEL	FRA	IRL	UK	OTH	BEL	FRA	IRL	UK	OTH	TOT*	TOT	TOT	WG est
1993	0	8	383	46	0	0	56	0	179	0	437	235	672	655
1994	0	6	251	60	0	0	42	20	199	0	317	261	578	577
1995	0	12	317	90	0	0	48	4	196	0	419	248	667	542
1996	0	3	295	38	0	0	45	10	117	52	336	224	560	453
1997	0	6	337	32	0	0	63	7	106	0	375	176	551	645
1998	0	8	282	16	0	0	41	4	90	13	306	148	454	444
1999	42	0	296	15	0	3	0	3	67	1	311	74	385	406
2000	4	16	195	9	5	0	38	5	67	2	225	112	337	299
2001	0	16	157	6	3	27	34	3	67	0	182	131	313	261
2002	14	21	155	5	2	55	24	0	54	0	183	133	316	313
2003	4	7	125	9	6	16	25	2	47	0	147	90	237	217
2004	0	5	87	6	6	67	27	4	30	0	104	128	232	221
2005	0	4	88	2	0	32	16	2	26	0	94	76	170	164
2006	1	6	63	1	1	22	31	2	17	0	71	72	143	147
2007	2	9	72	2	11	7	21	0	18	2	94	48	142	120
2008	3	5	72	1	1	25	7	0	11	0	79	43	122	135

	7.jk					7.h					7.jk	7.h	7.hjk	7.hjk
	BEL	FRA	IRL	UK	OTH	BEL	FRA	IRL	UK	OTH	TOT*	TOT	TOT	WG est
2009	4	7	71	2	0	1	37	0	30	0	80	68	148	148
2010	5	11	66	1	0	0	44	0	34	0	78	78	156	155
2011	6	11	67	2	0	4	47	6	42	0	80	99	179	178
2012	7	17	93	0	0	2	45	6	36	0	110	89	199	196
2013	0	14	51	0	0	0	35	1	40	0	65	76	141	182
2014	0	11	74	0	0	4	40	4	15	0	85	63	148	169
2015	0	10	23	0	0	5	50	2	17	0	33	73	107	114
2016	0	7	30	0	0	7	39	2	15	0	37	63	100	99
2017	0	12	39	1	0	11	41	3	9	0	52	64	116	115
2018*	1	5	30	0	0	16	30	2	0	11	59	36	95	97

*** Excluding Belgium.**

Table 27.3. Landings numbers-at-age for plaice in 7.jk, 1993–2018.

	2	3	4	5	6	7	8	9	10
1993	92.8	623.6	479.4	115.4	44.8	22.8	10.5	5.9	2.6
1994	103.7	340.2	259.7	82.1	45.5	18.3	8.1	5.0	2.9
1995	207.3	632.8	347.5	106.9	36.3	15.7	7.1	4.8	3.1
1996	76.9	314.5	228.1	127.0	37.1	23.4	4.9	3.0	0.7
1997	166.4	277.0	268.1	118.9	42.3	19.5	4.3	0.0	9.1
1998	46.5	355.2	163.9	102.9	38.3	25.6	10.4	4.0	3.0
1999	143.2	311.7	201.0	64.8	37.4	18.1	11.1	9.4	12.1
2000	73.6	161.0	189.7	63.6	35.5	6.6	4.9	3.5	3.2
2001	55.3	164.8	145.6	47.1	5.9	21.5	2.3	7.4	0.0
2002	53.7	154.8	171.5	54.5	42.1	44.0	12.4	3.6	2.1
2003	73.7	165.8	65.3	29.1	5.9	14.8	10.4	1.5	3.7
2004	30.9	120.8	91.2	26.5	11.9	1.7	2.4	3.9	1.5
2005	25.2	70.9	77.4	47.7	22.4	12.6	3.7	0.0	1.2
2006	16.7	40.7	52.6	38.2	12.4	6.5	1.1	1.1	2.4
2007	47.0	136.0	60.7	22.2	17.1	4.1	2.2	0.4	0.7
2008	54.6	105.9	70.0	20.5	4.8	1.9	1.3	0.1	0.2
2009	13.4	112.0	78.4	30.3	10.7	4.7	0.0	0.8	0.6
2010	55.9	42.2	59.9	43.1	18.2	4.3	1.5	1.5	1.1
2011	18.7	83.2	53.9	35.5	22.2	10.7	3.7	0.8	1.3
2012	12.6	129.5	104.4	37.7	29.8	12.7	6.9	1.9	2.9
2013	4.6	35.3	67.6	25.5	6.2	3.9	2.4	0.9	0.4
2014	8.6	42.9	78.5	63.1	22.0	4.1	3.3	2.0	0.6
2015	4.6	11.3	15.9	13.3	9.6	3.5	0.6	0.7	0.3
2016	1.3	22.7	16.5	10.9	7.9	4.9	2.1	0.3	0.6
2017	8.1	8.5	37.8	20.2	13.0	10.0	7.0	2.5	1.8
2018	2.9	21.0	10.7	21.5	9.5	5.8	3.6	2.2	1.1

Table 27.4. Weight-at-age for plaice in 7.jk, 1993–2016.

	2	3	4	5	6	7	8	9	10
1993	0.196	0.256	0.306	0.417	0.582	0.751	0.939	1.151	1.707
1994	0.222	0.302	0.368	0.460	0.563	0.708	0.873	1.029	1.347
1995	0.228	0.272	0.325	0.391	0.521	0.651	0.840	0.817	1.546
1996	0.298	0.379	0.432	0.463	0.512	0.529	0.493	0.398	2.324
1997	0.295	0.339	0.430	0.483	0.654	0.807	0.937	0.669	1.319
1998	0.249	0.308	0.419	0.529	0.690	0.779	0.757	0.941	1.287
1999	0.289	0.354	0.417	0.596	0.627	0.840	0.882	1.170	1.382
2000	0.273	0.348	0.420	0.486	0.609	0.807	1.107	1.439	1.424
2001	0.243	0.325	0.405	0.537	0.644	0.800	0.550	1.115	0.000
2002	0.211	0.296	0.328	0.415	0.498	0.567	0.701	1.014	1.204
2003	0.274	0.358	0.402	0.482	0.575	0.734	0.876	1.041	1.646
2004	0.259	0.310	0.341	0.448	0.550	0.631	0.637	0.900	1.333
2005	0.238	0.276	0.324	0.381	0.459	0.731	0.949	0.845	1.615
2006	0.272	0.319	0.370	0.438	0.519	0.794	0.895	0.791	1.612
2007	0.239	0.281	0.354	0.433	0.482	0.573	0.727	1.394	1.108
2008	0.239	0.282	0.336	0.358	0.529	0.754	0.399	1.100	1.507
2009	0.224	0.255	0.335	0.403	0.462	0.520	0.569	1.080	1.266
2010	0.257	0.310	0.342	0.369	0.462	0.563	0.739	0.735	0.893
2011	0.257	0.282	0.321	0.355	0.407	0.626	0.625	0.507	0.984
2012	0.244	0.284	0.312	0.364	0.429	0.465	0.562	0.701	1.039
2013	0.256	0.294	0.336	0.400	0.462	0.503	0.609	0.744	1.002
2014	0.250	0.288	0.321	0.377	0.425	0.471	0.526	0.609	0.992
2015	0.295	0.349	0.378	0.439	0.509	0.565	0.645	0.611	0.743
2016	0.344	0.364	0.433	0.484	0.528	0.584	0.677	0.686	0.737
2017	0.320	0.357	0.423	0.491	0.570	0.607	0.685	0.713	0.787
2018	0.324	0.385	0.425	0.501	0.558	0.624	0.748	0.760	0.832

Table 27.5. Tuning data. The ages and years used in the assessment are in bold.

PLE7jk, WGCSE										
101										
IRL-VMS: nos per 1000 hours										
2006	2018									
1	1	0	1							
2	10									
1	250	611	790	573	186	98	17	16	35	#2006
1	482	1394	622	227	176	42	23	5	7	#2007
1	849	1648	1090	319	75	30	20	2	4	#2008
1	146	1219	853	329	116	51	0	8	7	#2009
1	585	441	627	451	191	45	16	15	11	#2010
1	270	1200	777	512	320	154	53	12	19	#2011
1	120	1236	996	360	284	121	66	18	28	#2012
1	61	471	902	340	83	52	32	12	6	#2013
1	114	569	1041	836	291	54	44	27	7	#2014
1	57	139	196	164	119	44	8	8	4	#2015
1	17	296	216	142	103	64	28	3	8	#2016
1	103	109	480	257	165	128	89	32	23	#2017
1	38	271	138	277	123	74	47	29	14	#2018

Table 27.6. XSA diagnostics.

```
FLR XSA Diagnostics 2019-05-26 08:45:33

CPUE data from indices

Catch data for 26 years 1993 to 2018. Ages 4 to 8.

                        fleet first age last age first year last year alpha beta
1 IRL-VMS: nos per 1000 hours         4         7       2006      2018  <NA> <NA>

 Time series weights :

    Tapered time weighting not applied

 Catchability analysis :

     Catchability independent of size for all ages

     Catchability independent of age for ages >   6

 Terminal population estimation :

     Survivor estimates shrunk towards the mean F
    of the final   5 years or the  3 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   1

    Minimum standard error for population
    estimates derived from each fleet =  0.3

    prior weighting not applied

Regression weights
     year
age   2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
  all    1    1    1    1    1    1    1    1    1    1

 Fishing mortalities
   year
age  2009  2010  2011  2012  2013  2014  2015  2016  2017  2018
```

4	0.560	0.512	0.635	0.936	0.524	0.963	0.313	0.316	0.561	0.562
5	0.504	0.626	0.593	1.201	0.556	1.290	0.370	0.334	0.721	0.658
6	0.801	0.587	0.704	1.450	0.564	1.285	0.601	0.357	0.761	0.821
7	0.860	0.812	0.753	1.078	0.657	0.832	0.633	0.642	0.947	0.852
8	0.860	0.812	0.753	1.078	0.657	0.832	0.633	0.642	0.947	0.852

XSA population number (Thousand)

	age				
year	4	5	6	7	8
2009	194	81	21	9	3
2010	159	98	44	8	8
2011	122	84	47	21	12
2012	182	57	41	20	19
2013	176	63	15	9	8
2014	135	92	32	8	11
2015	63	46	23	8	4
2016	65	41	28	11	7
2017	94	42	26	17	19
2018	26	47	18	11	13

Estimated population abundance at 1st Jan 2019

	age				
year	4	5	6	7	8
2019	0	13	22	7	4

Fleet: IRL-VMS: nos per 1000 hours

Log catchability residuals.

	year												
age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4	0.491	0.131	0.230	-0.187	-0.315	0.219	0.191	-0.050	0.549	-0.643	-0.571	-0.032	-0.014
5	0.515	0.078	0.215	-0.414	-0.235	0.031	0.319	-0.111	0.717	-0.594	-0.643	0.100	0.022
6	0.410	0.469	-0.361	-0.086	-0.428	0.072	0.373	-0.224	0.581	-0.238	-0.705	0.021	0.116
7	0.073	-0.029	-0.080	-0.014	-0.108	0.136	0.079	-0.076	0.146	-0.172	-0.119	0.247	0.139

```
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

              4      5      6      7
Mean_Logq 1.9883 2.1083 2.2387 2.2387
S.E_Logq  0.3293 0.3293 0.3293 0.3293

 Terminal year survivor and F summaries:

 ,Age 4 Year class =2014

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.801        13  2014
fshk                            0.199        14  2014

 ,Age 5 Year class =2013

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.747        22  2013
fshk                            0.253        22  2013

 ,Age 6 Year class =2012

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.731         8  2012
fshk                            0.269         9  2012

 ,Age 7 Year class =2011

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.826         5  2011
fshk                            0.174         6  2011
```

Table 27.7. Summary table for ple-7.jk assessment in absolute values. Landings in tonnes. Recruitment (age 4) in thousands. SSB in tonnes.

Year	Land 7h–k	Land 7.jk	Recruit	Fbar	SSB
1993	672	437	726	0.932	400
1994	578	317	508	0.743	355
1995	667	419	650	0.724	362
1996	560	336	485	0.708	374
1997	551	375	480	0.788	409
1998	454	306	378	0.777	352
1999	385	311	392	0.822	383
2000	337	225	361	0.616	314
2001	313	182	234	0.533	277
2002	316	183	265	1.234	203
2003	237	147	151	0.667	154
2004	232	104	181	0.555	126
2005	170	94	158	0.927	116
2006	143	71	101	0.894	96
2007	142	94	115	1.059	73
2008	122	79	166	0.558	78
2009	148	80	194	0.622	106
2010	156	78	159	0.575	114
2011	179	80	122	0.644	104
2012	199	112	182	1.196	110
2013	141	65	176	0.548	93
2014	153	89	135	1.179	96
2015	108	33	63	0.428	59
2016	100	37	65	0.336	70
2017	116	53	94	0.681	94
2018	95	38	26	0.68	60
2019			216		109

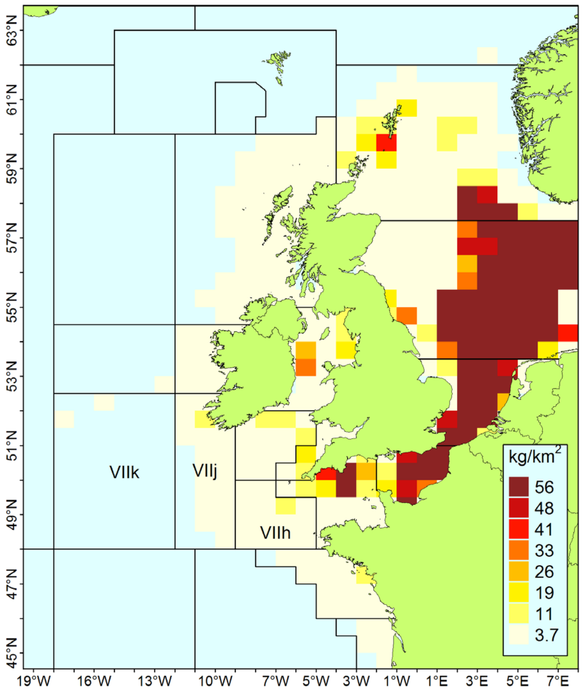


Figure 27.1.a. The spatial distribution of International landings of Plaice (2012 data, all gears combined; data from STECF).

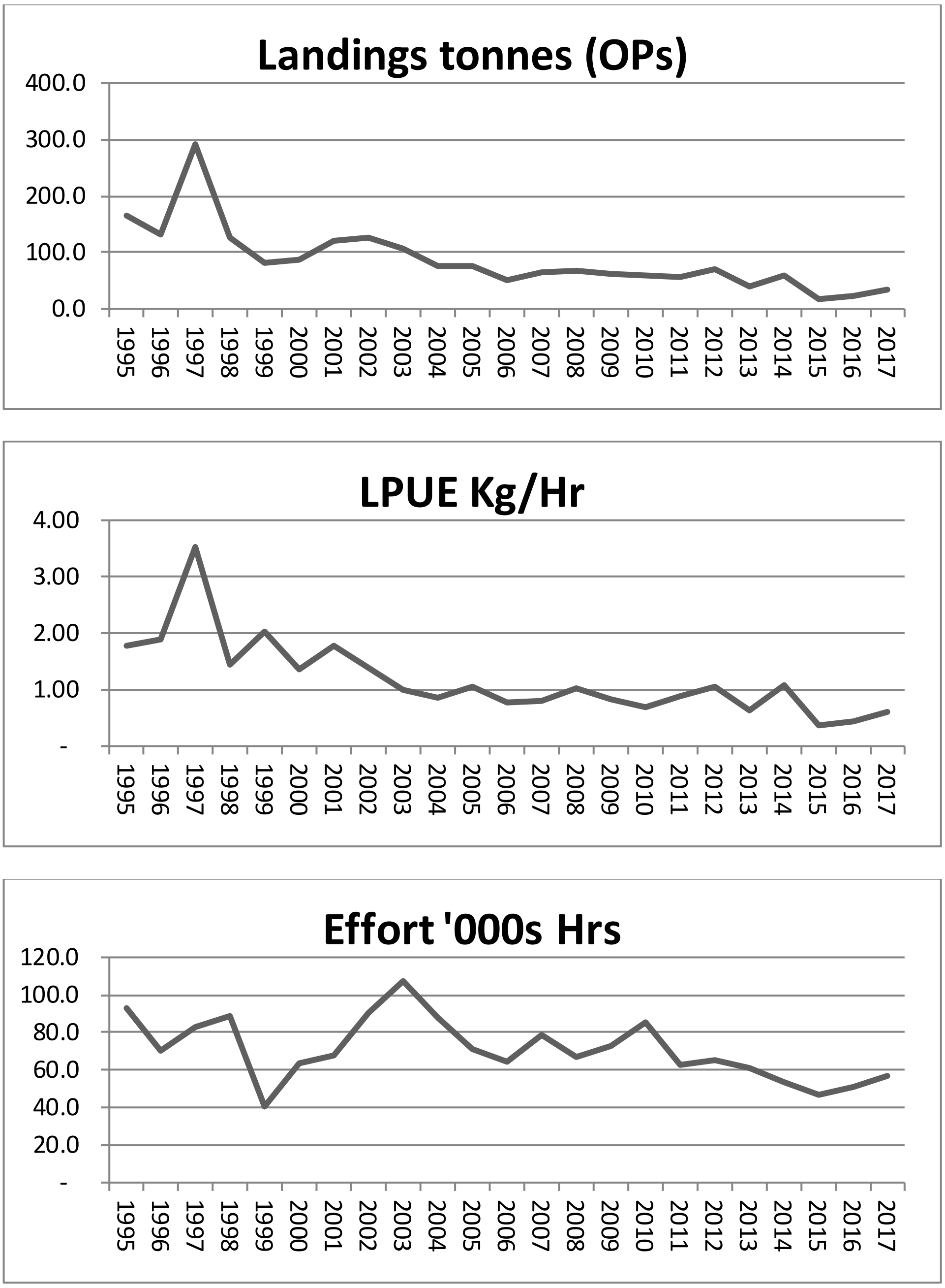


Figure 27.1b. Landings, Lpue and effort for Irish otter trawlers in 7.j.

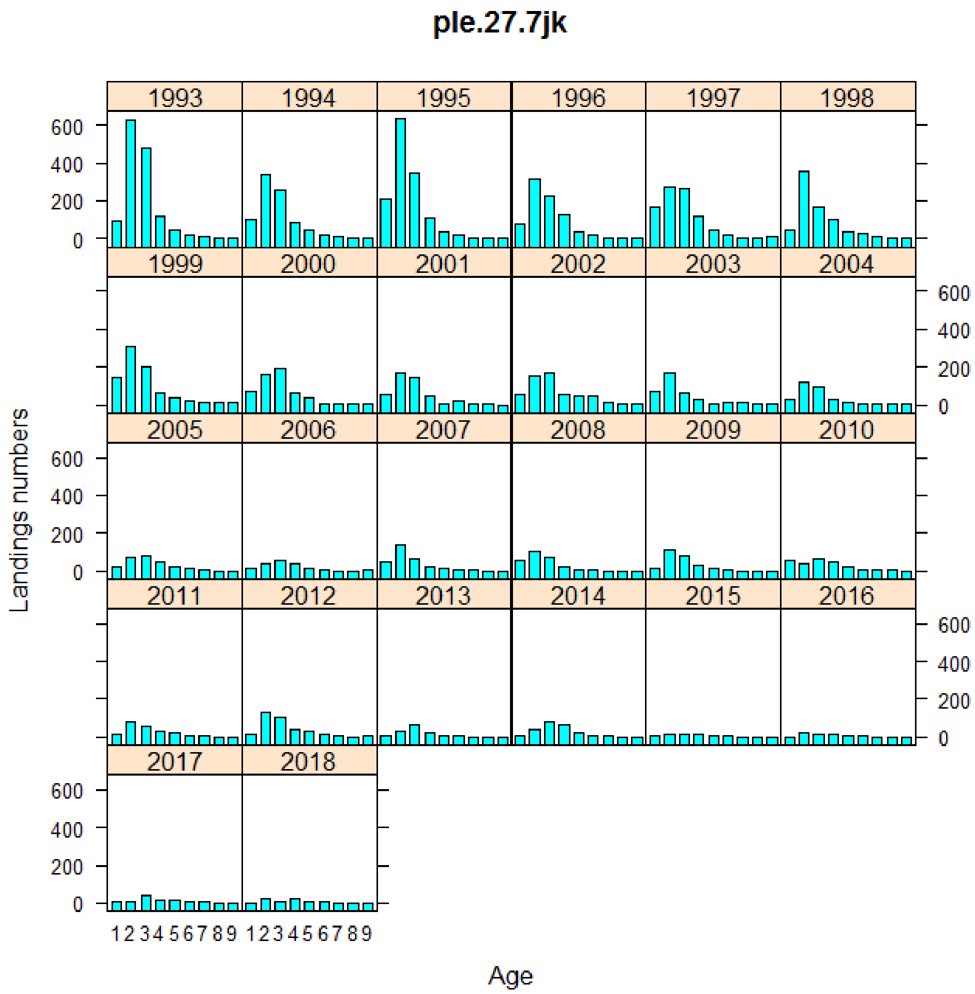


Figure 27.3. Age distribution of plaice landings in 7.jk between 1993 and 2018. All gears and quarters combined. The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used.

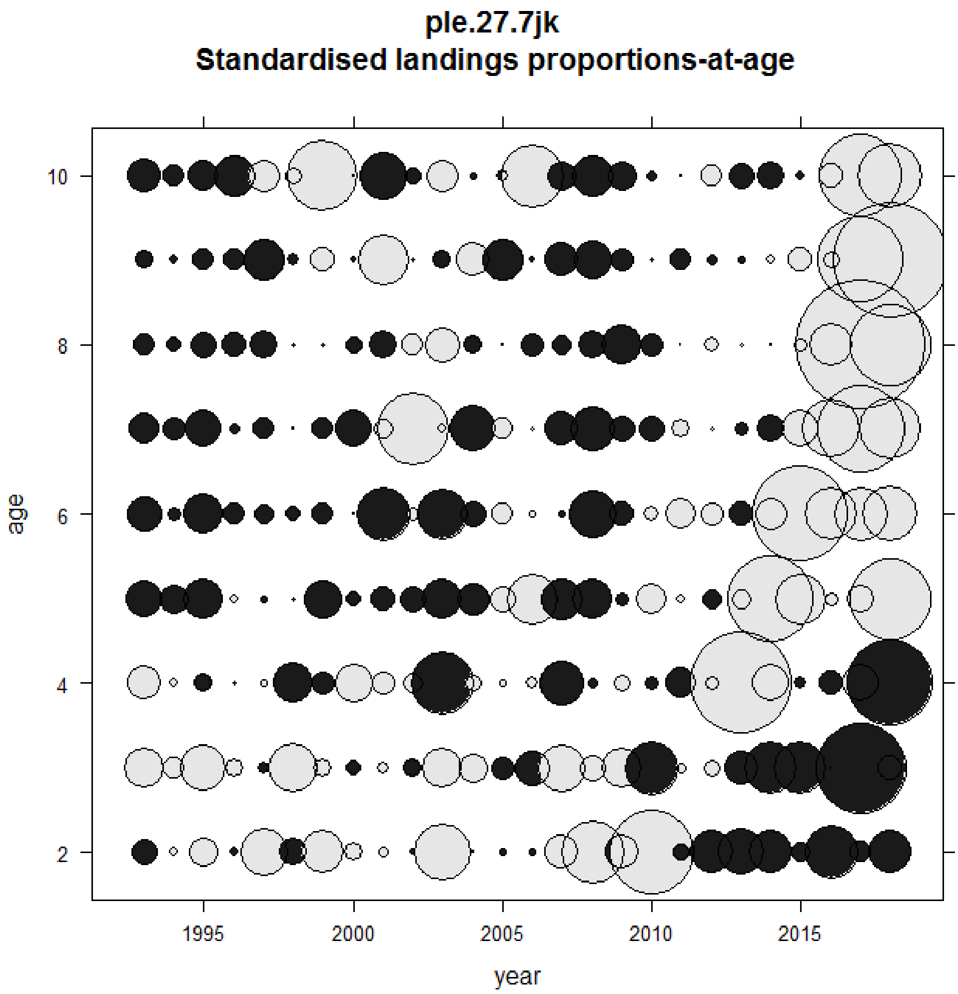


Figure 27.4. Standardised landings proportions-at-age for plaice in 7.jk. Grey bubbles represent higher than average catch-at-age and black bubbles represent lower than average catch-at-age.

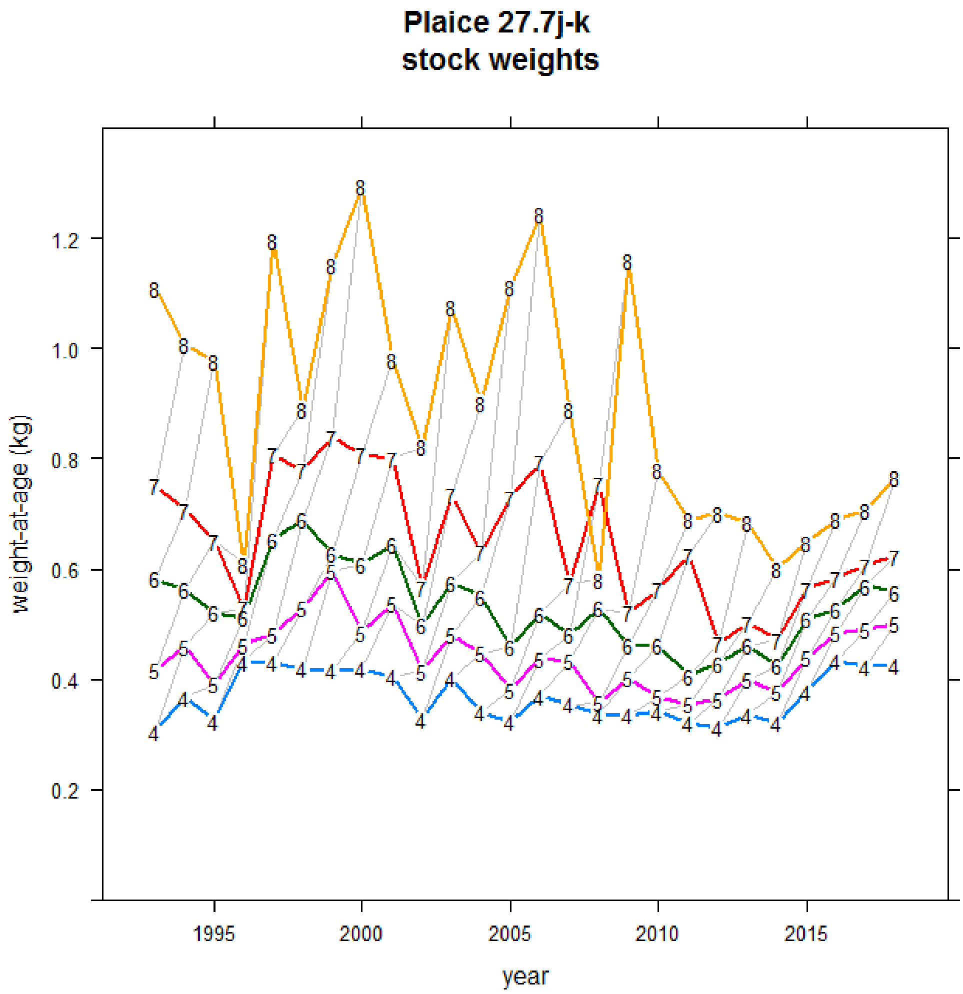
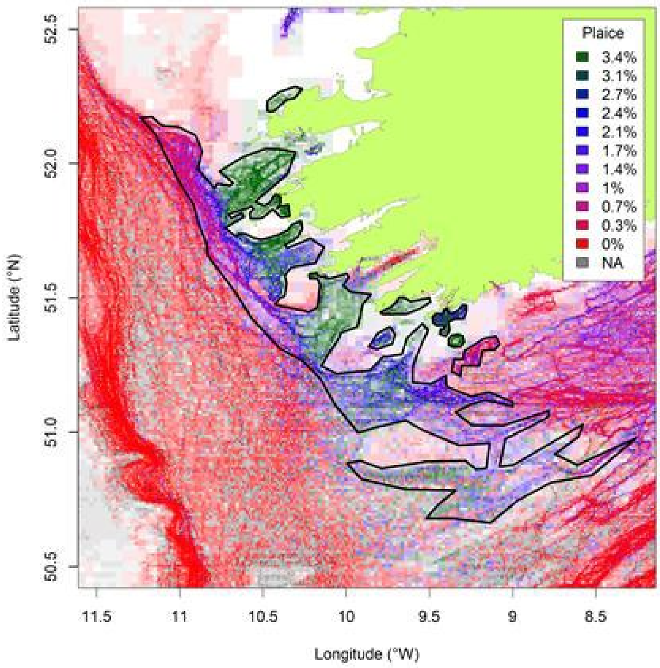


Figure 27.5. Landings weights / stock weights of ple7jk.



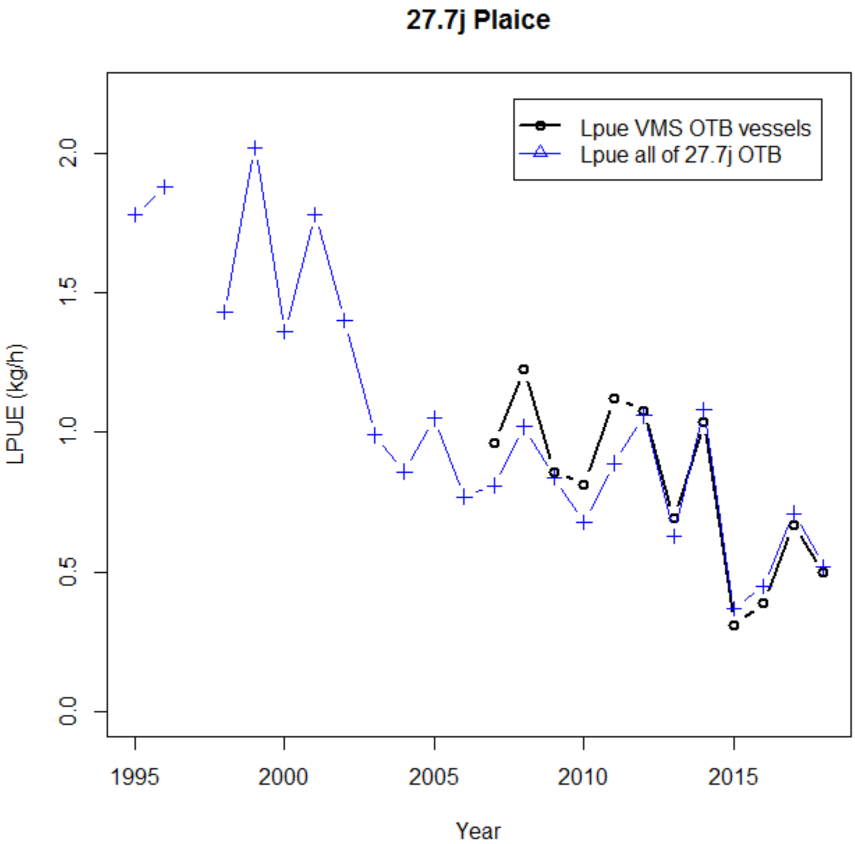
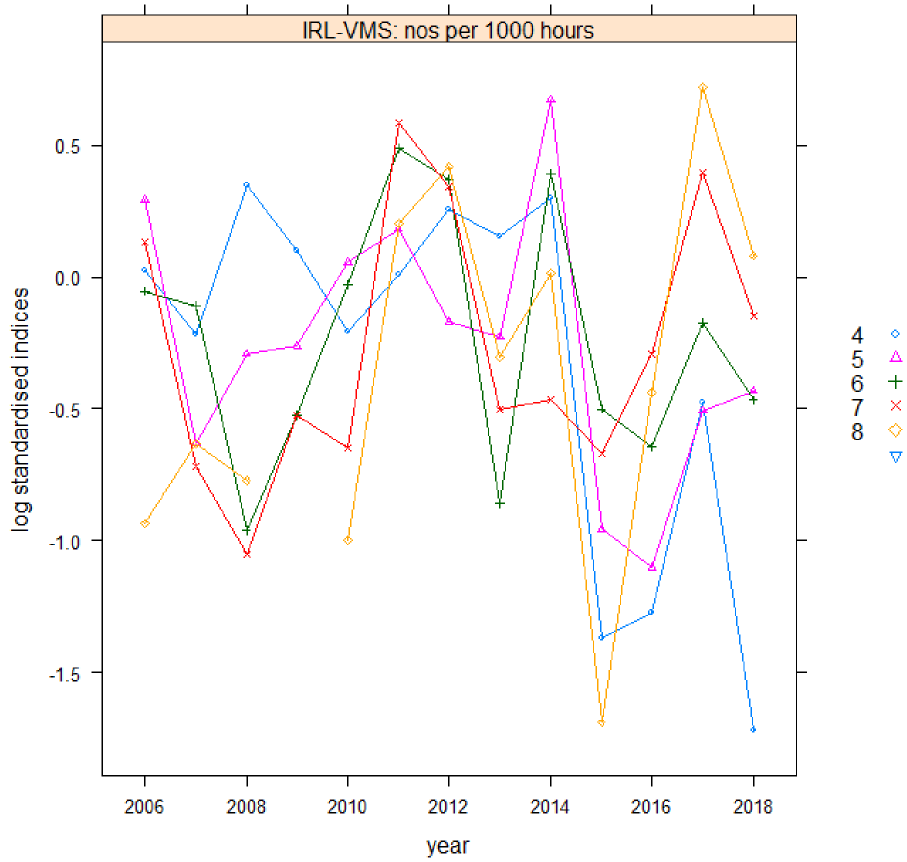


Figure 27.6. Top: the proportion of plaice in landings of Irish vessels with VMS over the years 2006–2016. The black line indicates the polygon inside which plaice are caught. Effort and landings from the VMS/logbooks data inside the polygon were used as a tuning index. Bottom: the VMS lpue index (black line) and the lpue of plaice in the whole of 7.j.


IRL-VMS: nos per 1000 hours
log standardised indices
0.5
0.0
-0.5
-1.0
-1.5
2006
2008
2010
2012
2014
2016
2018
year
4
5
6
7
8

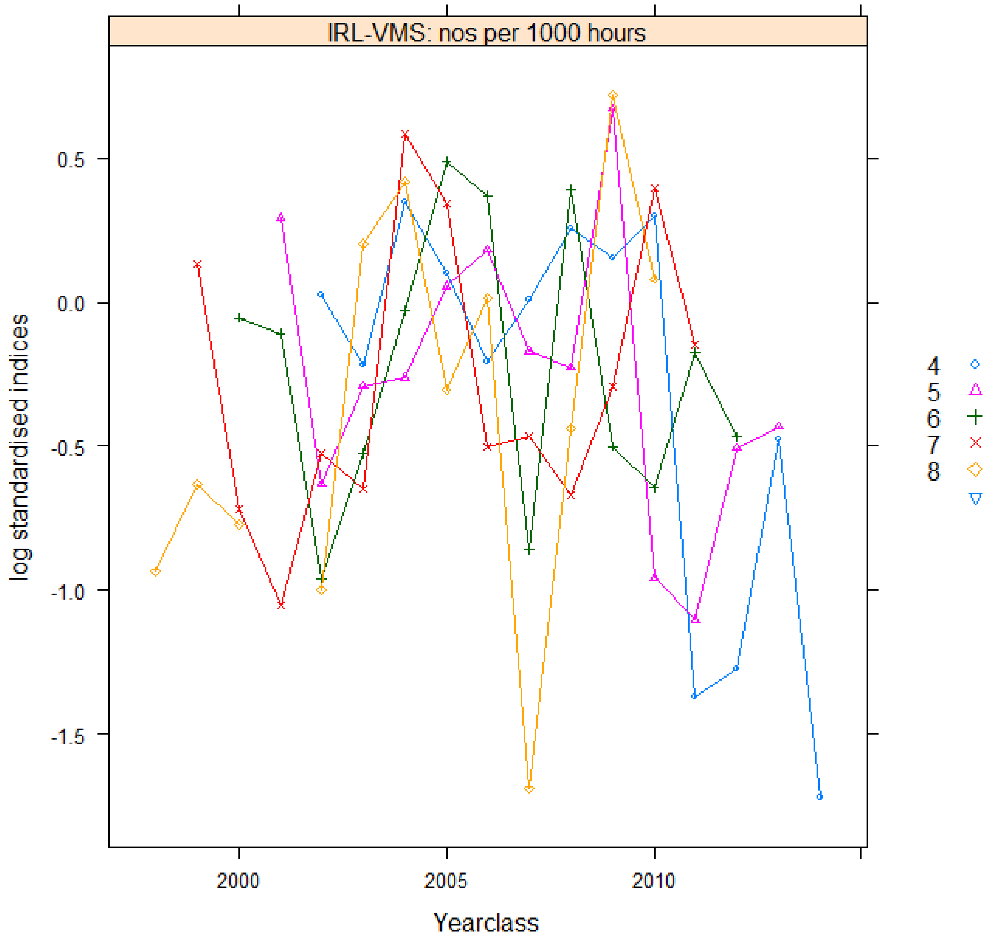


Figure 27.7. The log-standardised tuning index by year (top) and cohort (bottom). Due to the lack of contrast in the numbers-at-age cohorts are not tracked particularly well.

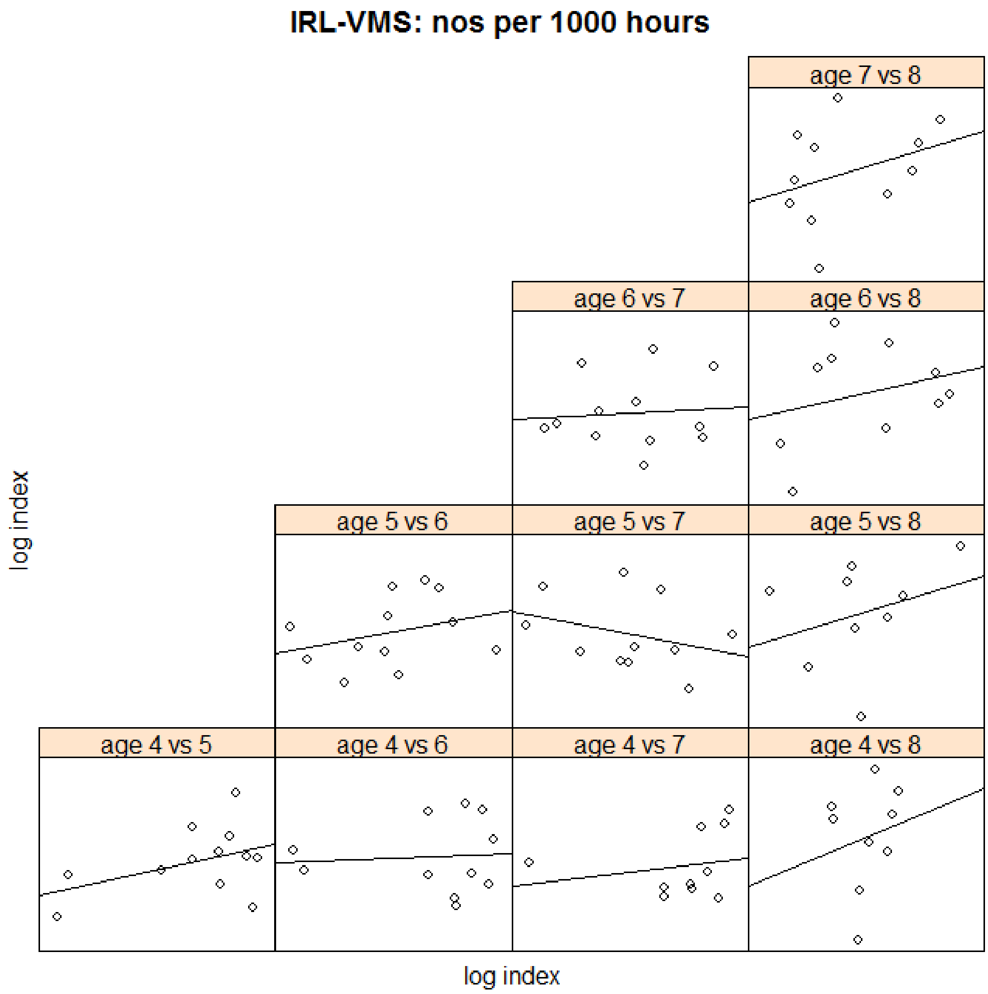


Figure 27.8. Internal consistency of the tuning fleet.

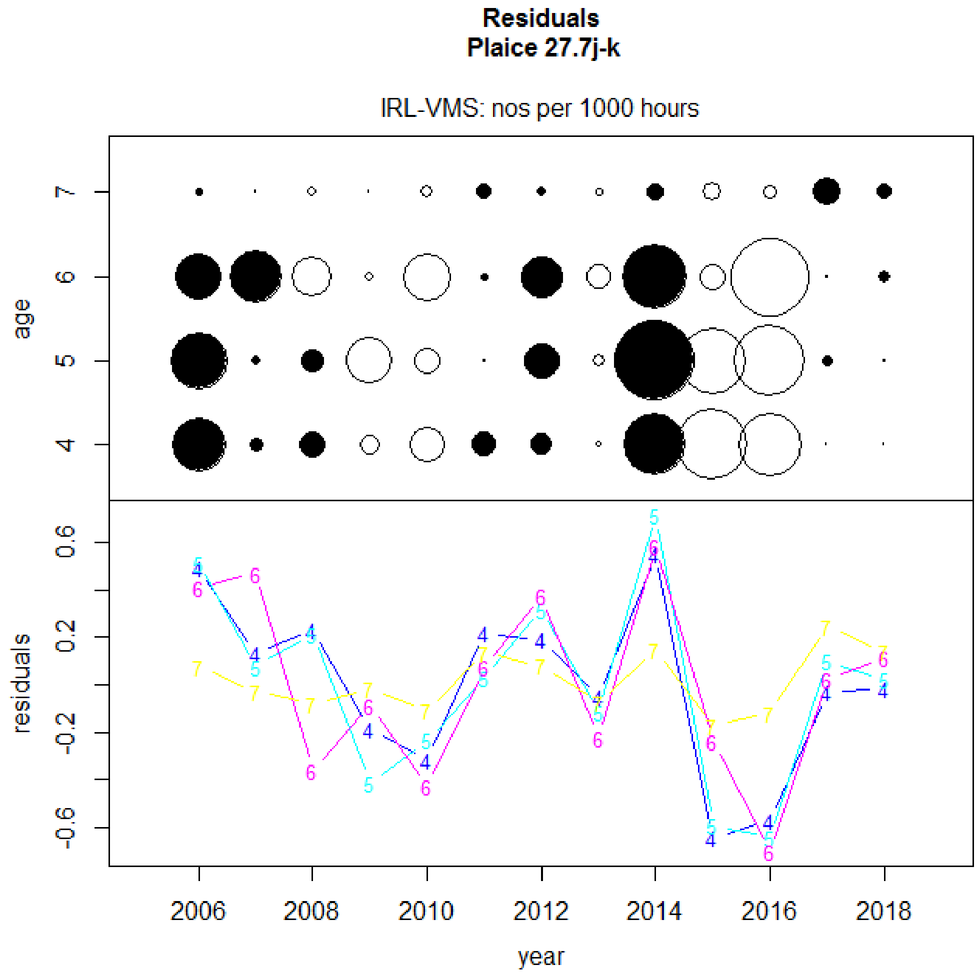


Figure 27.9. Residuals of the index fit.

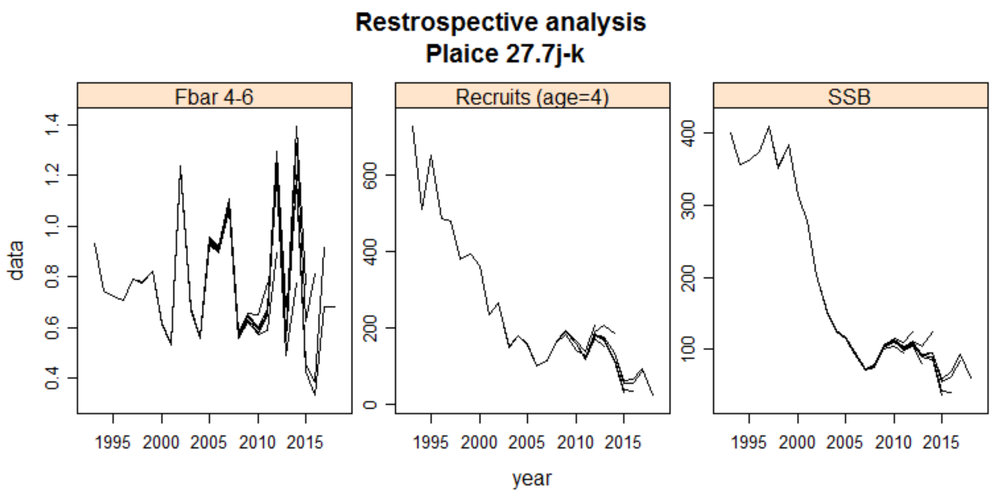


Figure 27.10. Retrospective analysis of the assessment.

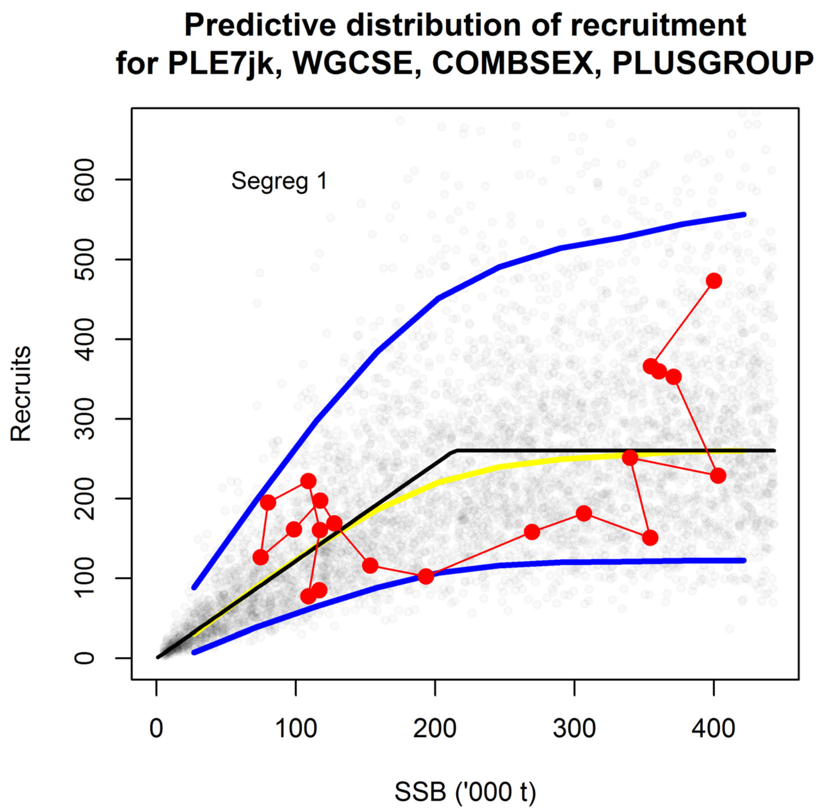


Figure 27.11. Ple7.jk stock–recruit plot, estimated as part of WGCSE 2017. Because recruitment does not appear to be impaired at the lowest stock size, the inflection point of the segmented regression was chosen to be the lowest biomass that generated high recruitment.

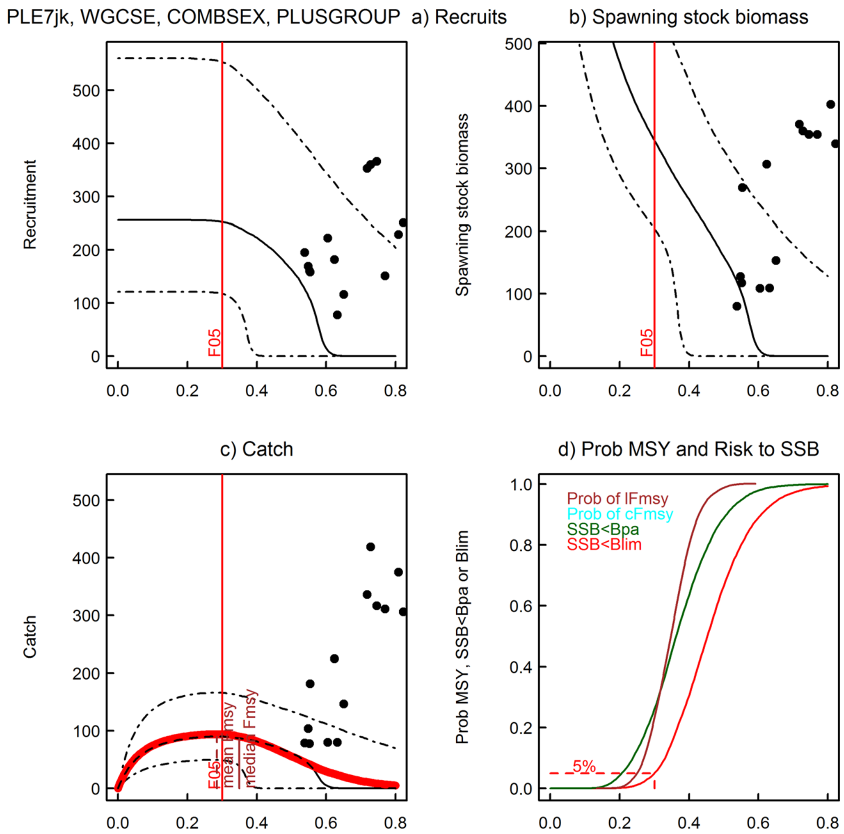


Figure 27.12. Ple7.jk Summary of MSY evaluations (without $B_{trigger}$ harvest control rule), a) simulated and observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}., all estimated as part of WGCSE 2017.

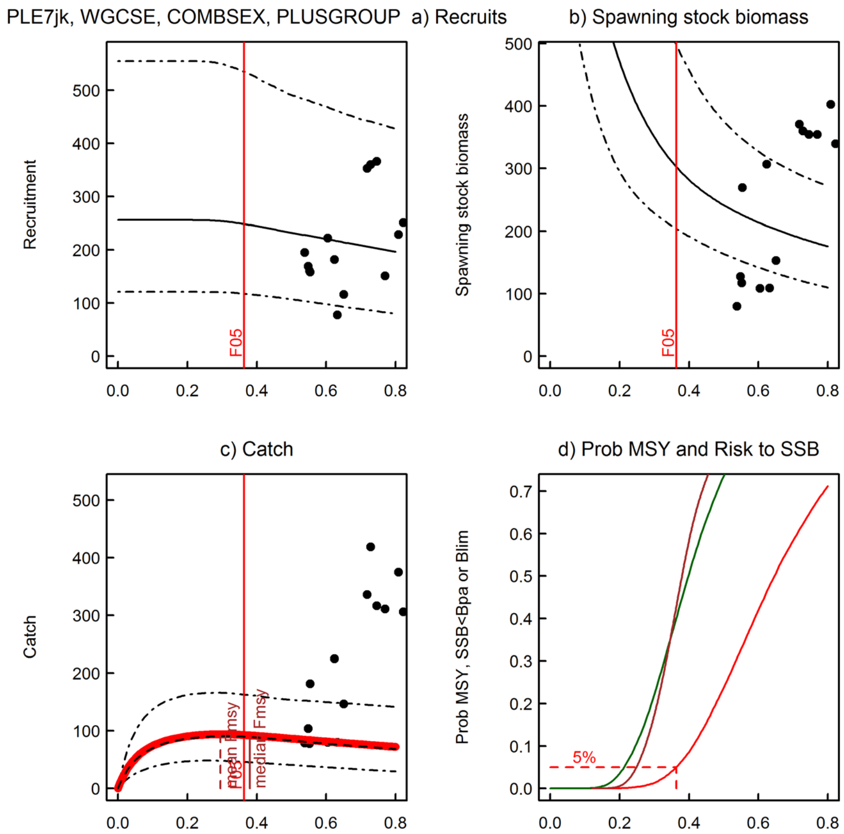


Figure 27.13. Ple7.jk Summary of MSY evaluations (with $B_{trigger}$=B_{lim} harvest control rule), a) simulated and observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}., estimated as part of WGCSE 2017.

27 Pollack (*Pollachius pollachius*) in subareas 6–7 (Celtic Seas and the English Channel)

Type of assessment in 2019

The Celtic Sea and West of Scotland (Subareas 6 and 7) Pollack stock is considered a Data Limited Stock, classified by ICES WKLIFE II (ICES CM2012/ACOM:79) as category 4.1.2. DCAC (Depletion-Corrected Average Catch) method is recommended to assess this stock, which is performed through the NOAA toolbox.

ICES advice applicable to 2020

ICES advices that when the precautionary approach is applied, commercial catches should not exceed 3360 tonnes in 2020.

27.1 General

27.1.1 Stock Identity

This section is not dedicated to a 'stock', it relates to a species in a wider region where data are available. The stock structure of Pollack populations in this ecoregion is not clear. ICES does not necessarily advocate that subareas 6 and 7 constitutes a management unit for Pollack, and further work is required.

27.1.2 Management applicable to 2019

The 2019 TAC for Pollack is set for ICES subareas 6 (and 5a, b; international waters of 12 and 14) and 7 separately.

Species:	Pollack *Pollachius pollachius*	Zone:	6; Union and international waters of 5b; international waters of 12 and 14 (POL/56-14)
Spain	6		
France	190		
Ireland	56		
United Kingdom	145		
Union	397		
TAC	397		Precautionary TAC

Species:	Pollack *Pollachius pollachius*	Zone:	7 (POL/07.)
Belgium	378 (1)		
Spain	23 (1)		
France	8 712 (1)		
Ireland	929 (1)		
United Kingdom	2 121 (1)		
Union	12 163 (1)		
TAC	12 163		Precautionary TAC Article 13(1) of this Regulation applies

(1) Special condition: of which up to 2 % may be fished in: 8a, 8b, 8d and 8e (POL/*8ABDE).

The 2018 TAC uptake for Subarea 6 was low at 16% and varied considerably between countries. France, which holds 48% of the TAC, only utilized 0.03% of their quota. The UK utilized 19.7% of the 37% TAC allocation, Ireland had the largest quota uptake at 60.5% constituting 14% of the TAC allocation and finally Spain utilized 6.8% of the 1% TAC allocation.

In Subarea 7, the uptake was slightly higher at 23% and again varied considerably between countries. France which holds the majority of the TAC allocation (71.6%), only utilized 9% of this. The UK utilized 59% of its 17.4% TAC allocation, Ireland utilized 80% of its 7.6% TAC allocation, Belgium and Spain which hold very low TAC allocations at 3.1% and 0.2%, utilized 5% and 54% respectively.

Fishery in 2018

Landings

2891 tonnes of pollack were landed in 2018, 98% of which came from subarea 7. The nominal landings for ICES subareas 6 and 7 are shown in Tables 28.1 and 28.2 respectively. For Subarea 6, there was a 30.2% increase in landings (63 tonnes) in 2018 compared to the landings in 2017 (44 tonnes). Ireland declared the highest landings (54%) followed by the UK (46%), Spain (0.6%) and France (0.1%) respectively There was a 13.8% decrease in landings (2828 tonnes) for Subarea 7 in 2018 compared to 2017 (3260 tonnes). The UK had the highest landings (44%) followed by France (29%), Ireland (26%), Belgium (0.7%) and Spain (0.4%).

Landings by division

In Subarea 6, all landings in 2018 derived from Division 6.a (2% of the overall breakdown). In Subarea 7, the division with the highest proportion of landings derived from 7.e (40%) followed by 7.j (27%), 7.h (13%) and 7.f (9%). Landings in divisions 7.a, b, c, d, g and h were negligible (8.9%).

Landings by gear

The majority of Pollack landings in the Celtic Sea ecoregions are caught by gillnets (43.9%) followed by bottom trawlers (23.4%) trolling lines (16.3%), miscellaneous gears (13.1%), beam trawlers (2.6%) and seiners (0.7%). When separated by subarea, the predominant gears landing pollack in Subarea 6 are bottom trawlers (59.2%) followed by gillnets (32.7%), miscellaneous gears (7.1%) and trolling lines (1%). In Subarea 7, gillnets have the highest landings (44.1%) followed by bottom trawlers (22.6%) trolling lines (16.7%), miscellaneous gears (13.2%), beam trawlers (2.6%) and seiners (0.7%).

Landings by quarter

Pollack are not targeted throughout the entire year, and are mainly targeted during the first quarter which coincides with spawning. The breakdown of landings per quarter shows that the highest landings were in quarter 1 (40%) followed by quarter 2 (27%), quarter 3 (16%) and quarter 4 (17%) respectively. As France, UK and Ireland constitute 99% of the pollack landings, the landings per quarter 1 were (36%, 47%, 32%), quarter 2 (33%, 22%, 30%), quarter 3 (19%, 13%, 19%) and quarter 4 (12%, 19%, 19%) respectively.

Discards

Discarding is negligible at 19.9 tonnes. 91.9% of which coming from gillnetters, followed by bottom trawls at 7.9% and beam trawls at 0.2%.

Landings uncertainty

Pollack is a known recreational fishing species, however; it is unknown as to the quantities exploited by recreational fisheries. A phone study conducted in France in 2011–2013 by Levrel *et al.* (2013) estimated that 3300 tonnes are landed annually through recreational fishing, 2274 tonnes of which are retained. Radford *et al.*, 2018 further suggest that pollack landings may be similar to or above commercial landings.

27.2 Stock assessment

A DCAC (Depleted-Corrected Adjusted Catch) method is used to estimate a yield likely to be sustainable (MacCall, 2009). The DCAC-method was applied during WGCSE 2019 with the same model settings as applied the previous year's assessment (ICES, 2018).

Subareas 6 and 7 are run independently. For Subarea 6; six separate model runs using various parameters are conducted giving an average DCAC value plus an upper and lower 95% confidence interval and for Subarea 7; nine separate model runs using various parameters are conducted given an average DCAC value plus an upper and lower 95% confidence interval.

The information provided for the assessment is insufficient to evaluate the exploitation and the trends of pollack in the Celtic Seas ecoregion. Commercial catches have declined since the late 1980s, and in 2018 are the lowest in the time-series.

The input data and parameters used for the assessment are detailed in Tables 28.3, 28.4.

2019 Results

The average DCAC values (Figure 28.1) show that in both subareas 6 and 7, landings are below the average DCAC by 85 tonnes in Subarea 6 and 1182 tonnes in Subarea 7. This suggests that yield in Subarea 6 could be increased up to 148 tonnes and 4010 tonnes in Subarea 7.

Comparison with previous assessment

Table 28.5 compares the results with the previous year's assessment. The results are consistent with the range of DCAC values estimated when the method was previously applied.

Uncertainties in assessment and forecast

The DCAC model relies solely on commercial catch data and does not include any biological or survey data that are available for this stock. The model also cannot estimate reference points.

By construction, the DCAC method only uses long time-series of official landings. As the output is a smoothed value of the landings over the assessed time series, the computations of DCAC are always similar to the previous year's results, even when recruitment or SSB fluctuate. To test the model, during WGCSE 2019, proxy values were used to demonstrate the issues with the model results computed annually. Two separate tests were conducted, the first to substantially increase the landings and the second to crash the stock. In the first test run, 1000 tonnes were added to Subarea 6 timeline which gave an average DCAC of 169 tonnes (increase of 21 tonnes from the actual 2018 of 148 tonnes) and in Subarea 7, 12 000 tonnes were added to the timeline which gave an average DCAC of 4228 tonnes (increase of 218 tonnes from the actual 2018 of 4010 tonnes). The second test run added 0 tonnes to Subarea 6 timeline which gave an average DCAC of 146 tonnes (decrease of 2 tonnes from the actual 2018 of 148 tonnes) and in Subarea 7, 0 tonnes were added to the timeline which gave an average DCAC of 3972 tonnes (decrease of 38 tonnes from the actual 2018 of 4010 tonnes) (Table 28.6). This highlights that the DCAC model will not take any account of the state of the stock.

Recreational catch is unknown and therefore cannot be estimated or incorporated into the assessment. From preliminary data, it seems likely that catches in recreational fisheries are of a similar order of magnitude to, or larger than, commercial landings.

27.3 Management considerations

TAC for Subarea 7 includes ICES Division 7d, which is not in the remit of the Celtic Sea ecoregion. TAC set for both subarea 6 and 7 are not in line with the current estimates of catches and estimated sustainable yields, and therefore are not constraining.

27.3.1 Management plan

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including pollack in ICES subareas 6 and 7.

27.3.2 Recommendations

DCAC continues to be the reference model for the Pollack assessment in the coming year. However; WGCSE considers that pol.27.67 should be assessed using a different model therefore different assessment models shall be explored over the coming year with a purpose to Benchmark in 2021.

27.4 References

ICES. 2012. Report of The Workshop to Finalize the ICES Data-limited Stock (DLS) Methodologies Documentation in an Operational Form for the 2013 Advice Season and to make Recommendations on Target Categories for Data-limited Stocks (WKLIFE II), 20–22 November 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:79. 46 pp.

ICES. 2018. Advice basis. In Report of the ICES Advisory Committee, 2018. ICES Advice 2018, Book 1, Section 1.2. https://doi.org/10.17895/ices.pub.4503.

Levrel H., Bellanger M., Le Goff R. and Drogou M. 2013. La pêche récréative en mer en France métropolitaine (Atlantique, Manche, Mer du Nord, Méditerranée). Résultats de l'enquête 2011–2013. http://archimer.ifremer.fr/doc/00162/27300/.

MacCall, A. D. 2009. Depletion-corrected average catch: a simple formula for estimating sustainable yields in data-poor situations. – ICES Journal of Marine Science, 66: 2267–2271.

Radford Z, Hyder K, Zarauz L, Mugerza E, Ferter K, Prellezo R, *et al*. 2018. The impact of marine recreational fishing on key fish stocks in European waters. PLoS ONE 13(9): e0201666. https://doi.org/10.1371/journal.pone.0201666.

Table 28.1. Landings of Pollack in subarea 6 as officially reported to ICES.

Year	Belgium	Denmark	France	Germany	Ireland	Netherlands	Norway	Portugal	Spain	Sweden	UK	Total Subarea 6
1950	1	-	-	-	-	-	-	-	-	-	295	296
1951	-	-	-	-	-	-	-	-	-	-	484	484
1952	-	-	-	-	-	1	-	-	-	-	503	504
1953	-	-	-	-	-	-	-	-	-	-	422	422
1954	-	-	-	-	-	-	-	-	-	-	452	452
1955	-	-	-	-	-	-	-	-	-	-	566	566
1956	-	-	-	-	-	-	-	-	-	-	528	528
1957	-	-	-	-	-	-	-	-	-	-	547	547
1958	.	-	-	23	-	-	-	-	-	-	710	733
1959	1	-	-	6	-	-	-	-	-	-	607	614
1960	15	-	-	-	-	-	-	-	-	-	441	456
1961	1	-	-	1	125	-	-	-	-	-	259	386
1962	2	-	-	8	197	-	-	-	-	-	235	442
1963	6	-	-	2	204	-	-	-	-	-	320	532
1964	1	-	-	1	130	-	-	-	-	-	368	500
1965	1	-	-	1	402	-	-	-	-	-	496	900
1966	2	-	-	-	200	-	-	-	-	-	428	630
1967	1	-	-	1	263	-	-	-	-	1106	413	1784
1968	5	-	-	2	214	-	148	-	-	1012	500	1881
1969	1	-	-	4	282	-	-	-	-	1224	667	2178
1970	2	-	-	1	398	-	-	-	-	756	447	1604
1971	1	-	-	5	75	-	-	-	-	750	256	1087
1972	1	-	-	1	127	-	-	-	-	779	317	1225
1973	2	-	-	-	-	-	-	-	-	-	503	505
1974	6	-	-	-	-	3	-	-	-	-	359	368
1975	< 0.5	-	-	1	-	1	4	-	-	-	393	399
1976	7	-	-	-	-	1	-	-	-	-	519	527
1977	-	-	196	-	-	1	2	-	-	-	493	692
1978	-	-	196	-	-	-	4	-	-	-	553	753
1979	-	-	310	-	-	-	-	-	-	-	350	660
1980	-	-	36	-	-	-	-	-	-	-	233	269
1981	-	-	342	-	-	-	-	-	55	-	185	582
1982	-	< 0.5	272	-	-	-	-	-	95	-	103	470
1983	-	-	331	-	-	-	-	-	86	-	148	565
1984	-	-	212	-	-	-	-	-	222	-	194	628
1985	< 0.5	-	224	1	-	-	-	-	283	-	328	836
1986	-	-	145	-	223	-	-	-	2217	-	187	2772

Year	Belgium	Denmark	France	Ger-many	Ire-land	Nether-lands	Nor-way	Portu-gal	Spain	Swe-den	UK	Total Subarea 6
1987	-	< 0.5	108	-	103	-	-	-	860	-	259	1330
1988	-	< 0.5	128	-	163	-	-	-	1925	-	221	2437
1989	-	< 0.5	111	1	103	-	-	-	-	-	179	394
1990	-	-	76	-	150	-	1	-	-	-	192	419
1991	-	-	31	-	145	-	-	-	4	-	189	369
1992	-	< 0.5	21	-	23	-	-	-	< 0.5	-	203	247
1993	-	-	39	-	12	-	-	-	-	-	273	324
1994	-	-	34	< 0.5	26	-	< 0.5	-	-	-	276	336
1995	-	-	64	3	83	-	-	-	-	-	354	504
1996	-	< 0.5	29	< 0.5	97	-	1	-	-	-	210	337
1997	-	-	14	1	69	-	2	-	-	-	162	248
1998	-	-	21	-	60	-	-	< 0.5	< 0.5	-	147	228
1999	-	-	-	-	73	-	3	-	< 0.5	-	136	212
2000	-	-	11	2	62	-	-	-	-	-	116	191
2001	-	-	8	-	108	-	-	-	-	-	101	217
2002	-	-	9	-	26	-	-	-	-	-	96	131
2003	< 0.5	-	3	-	88	-	1	-	-	-	111	203
2004	< 0.5	-	2	-	68	-	1	-	-	-	65	136
2005	-	-	23	-	28	-	-	-	-	-	16	67
2006	-	-	3	-	25	-	< 0.5	-	4	-	5	37
2007	-	-	10	-	21	-	6	-	-	-	21	58
2008	-	-	8	-	21	-	1	-	-	-	23	53
2009	-	-	7	-	5	-	< 0.5	-	-	-	25	37
2010	-	-	6	-	34	-	< 0.5	-	-	-	38	78
2011	-	-	3	-	8	-	-	-	-	-	34	45
2012	-	-	2	-	10	-	-	-	-	-	33	45
2013	-	-	1	-	34	-	-	-	-	-	22	57
2014	-	-	1	-	25	-	-	-	-	-	18	44
2015	-	-	< 0.5	-	23	-	< 0.5	-	-	-	25	48
2016	-	-	< 0.5	-	44	-	< 0.5	-	-	-	29	74
2017*	-	-	< 0.5	-	30	-	< 0.5	-	-	-	14	44
2018*	-	-	< 0.5	-	34	-	< 0.5	-	< 0.5	-	28	63

Table 28.2. Landings of Pollack in subarea 7 as officially reported to ICES.

Year	Belgium	Denmark	France	Germany	Ireland	Netherlands	Norway	Spain	UK	Total Subarea 7
1950	93	-	-	-	-	-	-	-	375	468
1951	74	-	-	2	-	-	-	-	380	456
1952	80	-	-	10	-	-	-	-	336	426
1953	34	-	-	-	-	-	-	-	252	286
1954	17	-	-	4	-	-	-	-	365	386
1955	38	-	-	-	-	-	-	-	247	285
1956	67	-	-	1	-	-	-	-	155	223
1957	219	-	-	6	-	-	-	-	367	592
1958	342	-	-	17	-	-	-	-	233	592
1959	158	-	-	32	-	-	-	-	251	441
1960	317	-	-	-	-	-	-	-	267	584
1961	268	-	-	-	360	-	-	-	210	838
1962	367	-	-	1	369	-	-	-	170	907
1963	95	-	-	-	411	-	-	-	176	682
1964	299	-	-	-	342	-	-	-	194	835
1965	362	-	-	-	335	-	-	-	231	928
1966	456	-	-	-	438	-	-	-	175	1069
1967	417	-	-	-	474	-	-	-	202	1093
1968	214	-	-	-	508	-	-	-	167	889
1969	142	-	-	-	794	-	-	-	161	1097
1970	165	-	-	1	724	-	-	-	120	1010
1971	114	-	-	-	673	-	-	-	116	903
1972	142	-	-	-	1073	-	-	-	123	1338
1973	89	-	-	-	-	3	-	-	127	219
1974	299	-	-	-	-	13	-	-	223	535
1975	295	-	-	-	-	17	-	-	290	602
1976	339	-	-	-	-	4	-	-	421	764
1977	157	1	3569	-	-	1	-	-	465	4193
1978	186	21	5496	14	-	8	-	-	515	6240
1979	151	18	5119	76	-	1	-	-	696	6061
1980	237	7	5242	-	-	1	-	1	769	6257
1981	244	-	5814	-	-	3	-	23	780	6864
1982	154	-	4253	-	-	-	-	32	1022	5461
1983	167	-	6214	-	-	-	-	26	1045	7452
1984	207	-	3927	-	-	-	-	486	1100	5720
1985	269	-	3741	-	-	-	-	20	1022	5052

Year	Belgium	Denmark	France	Germany	Ireland	Netherlands	Norway	Spain	UK	Total Subarea 7
1986	241	-	4574	-	1335	-	-	17	1795	7962
1987	149	-	5213	-	848	-	-	19	2010	8239
1988	191	-	5211	-	1066	-	-	22	1740	8230
1989	145	-	3893	-	994	-	-	18	1487	6537
1990	133	-	4831	-	1066	-	-	26	1914	7970
1991	76	-	3211	-	1045	-	-	22	1962	6316
1992	62	-	2849	-	1014	-	-	19	1889	5833
1993	55	-	2325	-	1137	-	-	7	2135	5659
1994	94	-	2621	-	921	-	-	8	2391	6035
1995	88	2	2315	-	1107	-	-	4	2168	5684
1996	94	-	2684	-	1190	6	-	5	2519	6498
1997	99	-	2443	-	984	4	< 0.5	7	2540	6077
1998	92	-	2375	-	886	1	-	11	2347	5712
1999	86	-	-	-	976	-	3	19	1703	2787
2000	71	-	2422	-	1069	-	-	5	1810	5377
2001	100	-	2515	-	1274	-	-	9	1987	5885
2002	117	-	2481	-	1308	-	-	17	1999	5922
2003	113	-	2284	-	1151	-	-	12	1788	5348
2004	104	-	1914	-	1049	1	-	13	1705	4786
2005	98	-	2198	-	728	1	-	16	1684	4725
2006	79	-	2213	-	809	1	-	28	1513	4643
2007	91	-	1970	-	782	3	-	1	1764	4611
2008	76	-	1579	-	738	1	-	14	1453	3861
2009	42	-	1670	-	828	4	-	3	1545	4092
2010	35	-	1846	-	942	2	-	3	1459	4284
2011	28	-	1415	-	912	1	-	-	1716	4072
2012	43	-	1421	-	1165	1	-	3	1835	4468
2013	39	-	1790	-	1249	1	-	11	1838	4928
2014	84	-	2042	-	1096	1	-	14	2122	5359
2015	32	-	1154	-	1070	1	-	13	1469	3739
2016	42	-	1237	-	1073	< 0.5	-	12	1842	4206
2017*	19	-	959	-	891	< 0.5	-	14	1377	3260
2018*	21	-	823	-	741	-	-	12	1231	2828

Table 28.3. Input parameters for the six DCAC runs carried out for Pollack in Subarea 6.

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
sumC	6782	6782	6782	6782	6782	6782
CV sumC	0	0	0	0	0	0
no of years	33	33	33	33	33	33
iterations	10000	10000	10000	10000	10000	10000
M	0.2	0.2	0.2	0.2	0.2	0.2
stdev M	0.4	0.4	0.4	0.4	0.4	0.4
F_{MSY}/M	0.6	0.8	1	0.6	0.8	1
stdev F_{MSY} to M	0.2	0.2	0.2	0.2	0.2	0.2
distr F_{MSY} to M	normal	normal	normal	normal	normal	normal
B_{MSY}/B0	0.5	0.5	0.5	0.5	0.5	0.5
stdev B_{MSY}/B0	0.1	0.1	0.1	0.1	0.1	0.1
up lim B_{MSY}/B0	1	1	1	1	1	1
low lim B_{MSY}/B0	0	0	0	0	0	0
depletion delta Δ	0.8	0.8	0.8	0.9	0.9	0.9
stdev Δ	0.1	0.1	0.1	0.1	0.1	0.1
distr Δ	normal	normal	normal	normal	normal	normal

Table 28.4. Input parameters for the 9 DCAC runs carried out for Pollack in Subarea 7.

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9
sumC	168434	168434	168434	168434	168434	168434	168434	168434	168434
CV sumC	0	0	0	0	0	0	0	0	0
no of years	33	33	33	33	33	33	33	33	33
iterations	10000	10000	10000	10000	10000	10000	10000	10000	10000
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
stdev M	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
F_{MSY}/M	0.6	0.8	1	0.6	0.8	1	0.6	0.8	1
stdev F_{MSY} to M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
distr F_{MSY} to M	normal	normal	normal	normal	normal	normal	normal	normal	normal
B_{MSY}/B0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
stdev B_{MSY}/B0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
up lim B_{MSY}/B0	1	1	1	1	1	1	1	1	1
low lim B_{MSY}/B0	0	0	0	0	0	0	0	0	0
depletion delta Δ	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7
stdev Δ	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
distr Δ	normal	normal	normal	normal	normal	normal	normal	normal	normal

Table 28.5. Comparison of the 2019 DCAC assessment and previous DCAC results.

Year	Subarea 6 landings (tonnes)	Average DCAC value	Subarea 7 landings (tonnes)	Average DCAC value
2018	63	148	2891	4010
2017	44	150	3260	4042
2016	74	152	4131	4063
2015	48	155	3740	4062
2014	44	156	5359	4020
2013	57	158	4468	3953

Table 28.6. Test DCAC runs compared to previous DCAC results.

	Subarea 6 landings (tonnes)	Average DCAC value	Subarea 7 landings (tonnes)	Average DCAC value
Test 1	1000	169	12000	4228
Test 2	0	146	0	3972
2018	63	148	2891	4010
2017	44	150	3260	4042
2016	74	152	4131	4063
2015	48	155	3740	4062
2014	44	156	5359	4020
2013	57	158	4468	3953

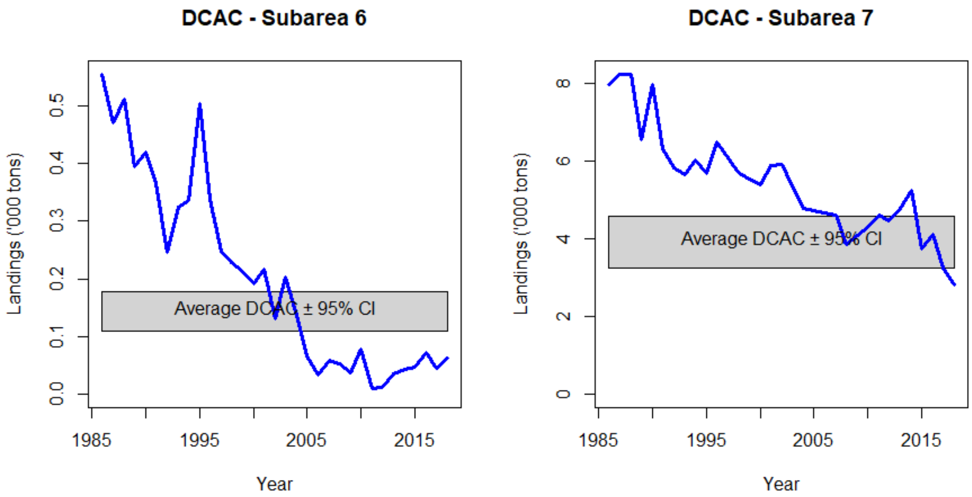


Figure 28.1. Pollack in subareas 6 and 7. The results of the depletion-corrected average catch (DCAC) assessment method as applied to commercial landings data since 1986. The grey box indicates the proxy for the maximum sustainable catch ±95% confidence intervals.

28 Saithe (*Pollachius virens*) in subareas 7–10

Type of assessment in 2019

Saithe was included as a stock for assessment in WGCSE 2019, with the view to provide advice for this stock for 2020. Saithe in subareas 7–10 is currently considered as a data-limited stock as only landings data have been made available over time, and was classified as a category 4.1.2 stock during WGCSE 2019. A DCAC (Depletion-Corrected Average Catch) method was therefore recommended to assess this stock, which is performed through the NOAA toolbox.

ICES advice applicable to 2020

ICES advises that when the precautionary approach is applied, commercial catches should be no more than 586 tonnes in each of the years 2020, 2021 and 2022.

The above advice was established by averaging the catches from 2016–2018 (732 tonnes). Further to this, a 20% precautionary buffer was applied as the stock size is unknown.

28.1 General

28.1.1 Stock Identity

The stock structure of saithe populations in subareas 7–10 is unclear, and suggestions have been forwarded that saithe populations are inclusive of the entire Northeast Atlantic region. Figure 31.1 displays the landings from 27.3a.4.6 and 27.7–10. Further work and consideration is therefore required regarding the management of saithe.

28.1.2 Management applicable to 2019

The 2019 TAC for saithe is set for ICES subareas 7–10.

Species:	Saithe *Pollachius virens*	Zone:	7, 8, 9 and 10; Union waters of CECAF 34.1.1 (POK/7/3411)
Belgium	6		
France	1 245		
Ireland	1 491		
United Kingdom	434		
Union	3 176		
TAC	3 176		Precautionary TAC Article 13(1) of this Regulation applies

The 2018 TAC uptake in subareas 7–10 was low at 15.9% and varied considerably between countries. Ireland, which holds 47% of the TAC, utilised 24% of their quota. France utilised 5% of the 39% TAC allocation, the UK utilised 18 % of their 14% TAC allocation and finally Belgium utilised 23% of the 0.002% TAC allocation.

Fishery in 2018

The ICES preliminary data reported 496 tonnes of saithe were landed in 2018 in ICES subareas 7–10.

The data extracted from InterCatch only contained data from Ireland; 365 tonnes, UK England, Wales and Scotland; 54 tonnes and the Netherlands; 0.31 tonnes. Total weight in InterCatch; 419.3 tonnes. The remaining countries that did not upload data to InterCatch were France, Belgium, Portugal, Spain and parts of the UK; 91.4 tonnes in total.

Therefore, where relevant, the below sections are divided into two sections. The first details data from InterCatch; 419.3 tonnes) and the second (All data) details InterCatch data plus ICES preliminary landings (511 tonnes).

Landings / catches

511 tonnes of saithe were landed in 2018 (All data; Table 31.1). This was a decrease of 31.8% compared to the 2017 ICES preliminary landings.

Ireland declared the highest catch (71%) followed by the UK (16%) and France (13%). For the remaining countries; Belgium, Netherlands, Portugal and Spain, catches were negligible at 1%.

Catches by division

The predominant catches derived from Subarea 7 in 2018 (99.96%), with a further 0.04% coming from Division 8.a (InterCatch data only). The majority of the catches were from Division 7.g (51.3%), followed by 7.j (42.2%). The remaining divisions; 7.a–f, h and 8.a had very low catches and when combined constituted 6.5% of the catch.

Catches by gear

The majority of saithe catches (InterCatch data only) originated from gillnets (71.6%) followed by bottom trawlers (22.1%), miscellaneous gears (2.9%), seiners (2.5%), trolling lines (0.5%) and beam trawlers (0.4%).

When the InterCatch data (419.3 tonnes) plus the unknown gear breakdown from the remaining preliminary data (91.4 tonnes) were combined which was required for Table 6 of the advice sheet, the breakdown of catches by gear type were gillnets (58.8%) followed by bottom trawlers (18.2%), miscellaneous gears (2.4%), seiners (2.1%), trolling lines (0.4%), beam trawlers (0.4%) and unknown (17.9%).

Catches by quarter

The breakdown of catch per quarter (InterCatch data only) shows that the highest landings were in quarter 2 (34%) followed by quarter 1 (30%), quarter 3 (17%) and quarter 4 (19%).

Discards

A discard rate of 0.33% (1.4 tonnes) was reported by the Irish OTB fleet. No other discards were reported in InterCatch. Therefore, discarding is assumed negligible.

28.2 Stock assessment

A DCAC (Depleted-Corrected Adjusted Catch) method was used to estimate a yield likely to be sustainable (MacCall, 2009). The DCAC-method was applied during WGCSE 2019 with the same model settings as was applied to pollack in Subarea 7 (ICES, 2018; 2019), due to the similarities of landings data. The saithe timeline begins in 1986; this is due to misreporting between saithe and pollack prior to 1986.

Nine separate model runs using various parameters (Table 31.2) were conducted, producing an average DCAC value of 3152 tonnes plus upper (3596 tonnes) and lower (2555 tonnes) 95% confidence interval values.

The information provided for the assessment is insufficient to evaluate the exploitation and the trends of saithe in subareas 7–10. Commercial catches have generally declined, and in 2018 is amongst the lowest in the time-series.

2019 Results

The average DCAC values (Figure 31.2) show that landings are well below the average DCAC by 2656 tonnes. This suggests that yield could be increased up to 3152 tonnes in subareas 7–10.

28.2.1 Uncertainties in assessment and forecast

By construction, the DCAC method uses only long time-series of official landings and does not include any biological or survey data that are available for this stock.

The output is a smoothed value of the landings over the assessed time-series; therefore, the computations of DCAC will generate a similar value annually. Furthermore, the model cannot estimate reference points.

28.2.2 Recommendations

Saithe in subareas 7–10 is a new "stock" to WGCSE, and has never been assessed. Therefore, landings/catch data are the predominant source throughout the time-series. Supplementary data are available however, and shall be requested in the 2020 ICES datacall. WGCSE considers that pok.27.7–10 should be assessed using a different model therefore different assessment models shall be explored over the coming year with a purpose to Benchmark in 2021.

28.3 References

ICES. 2018. Advice basis. In Report of the ICES Advisory Committee, 2018. ICES Advice 2018, Book 1, Section 1.2. https://doi.org/10.17895/ices.pub.4503.

ICES. 2019. Working Group for the Celtic Seas Ecoregion (WGCSE). ICES Scientific Reports. 1:29. xx pp. http://doi.org/10.17895/ices.pub.4982.

MacCall, A. D. 2009. Depletion-corrected average catch: a simple formula for estimating sustainable yields in data-poor situations. ICES Journal of Marine Science, 66: 2267–2271.

Table 31.1. Landings of saithe in subareas 7–10 as officially reported to ICES.

Year	Belgium	Denmark	France	Germany	Ireland	Netherlands	Norway	Portugal	Spain	UK	Total landings	Unallocated	ICES landings
1986	25	-	8304	-	1739	-	40	-	-	1777	11885	0	11885
1987	20	-	6256	-	1624	-	2	-	-	2016	9918	0	9918
1988	24	-	6225	124	1400	-	1	-	-	1408	9182	0	9182
1989	16	-	8278	30	2165	-	16	-	-	1293	11798	0	11798
1990	9	-	6625	-	1068	-	24	-	-	2068	9794	0	9794
1991	5	-	7286	-	1495	1	29	-	-	2144	10960	0	10960
1992	2	-	1960	-	1721	-	38	-	-	1931	5652	0	5652
1993	4	-	1808	-	2010	-	-	-	-	2102	5924	0	5924
1994	9	1	3277	-	1915	-	7	-	-	2042	7251	0	7251
1995	8	-	2144	-	2382		14	-	13	1871	6432	0	6432
1996	5	-	2123	-	2062	3	13	-	27	2231	6464	0	6464
1997	9	-	1639	-	1384	2	7	-	23	1524	4588	0	4588
1998	8	-	1838	-	1431	-	-	-	68	983	4328	0	4328
1999	7	-	-	-	1352	-	5	-	35	716	2115	0	2115
2000	4	-	2720	-	1325	-	1	-	38	453	4541	0	4541
2001	7	-	911	-	1644	-	67	-	18	339	2986	0	2986
2002	13	-	578	-	1263	-	3	-	13	296	2166	0	2166
2003	3	-	457	-	754	-		-	9	366	1589	0	1589
2004	1	-	764	-	629	-	3	-	3	343	1743	0	1743
2005	1	-	396	-	394	-	-	-	21	210	1022	0	1022
2006		-	278	-	393	-	-	43	21	116	851	0	851
2007	1	-	326	-	286	-	-	3	4	87	707	0	707
2008	1	-	249	-	163	-	-	2	5	76	496	0	496
2009	1	-	231	-	254	-	-	3	3	112	604	0	604
2010	1	-	250	-	303	-	-	2	7	91	654	0	654
2011	1	-	229	-	685	-	-	4	10	69	998	0	998
2012	2	-	338	-	981	-	1	4	1	148	1475	0	1475
2013	2	-	269	-	1359	-	-	7	-	234	1871	0	1871
2014	2	-	117	-	1037	1	-	8	3	169	1337	0	1337
2015	1	-	93	-	659	1	-	5	1	102.2	862	0	862
2016	<0.5	-	88	-	720	<0.5	-	5	2	119.4	934	0	934
2017*	1	-	94	-	588	<0.5	-	4	<0.5	62	749	0	749
2018*	1	-	62	-	350	<0.5	-	4	<0.5	78	496	15	511

*** Preliminary landings statistics.**

Table 31.2. Input parameters for the nine DCAC runs conducted for Saithe in subareas 7–10.

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9
sumC	132389	132389	132389	132389	132389	132389	132389	132389	132389
CV sumC	0	0	0	0	0	0	0	0	0
no of years	33	33	33	33	33	33	33	33	33
iterations	10000	10000	10000	10000	10000	10000	10000	10000	10000
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
stdev M	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
F_{MSY}/M	0.6	0.8	1	0.6	0.8	1	0.6	0.8	1
stdev F_{MSY} to M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
distr F_{MSY} to M	normal	normal	normal	normal	normal	normal	normal	normal	normal
$B_{MSY}/B0$	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
stdev $B_{MSY}/B0$	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
up lim $B_{MSY}/B0$	1	1	1	1	1	1	1	1	1
low lim $B_{MSY}/B0$	0	0	0	0	0	0	0	0	0
depletion delta Δ	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7
stdev Δ	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
distr Δ	normal	normal	normal	normal	normal	normal	normal	normal	normal

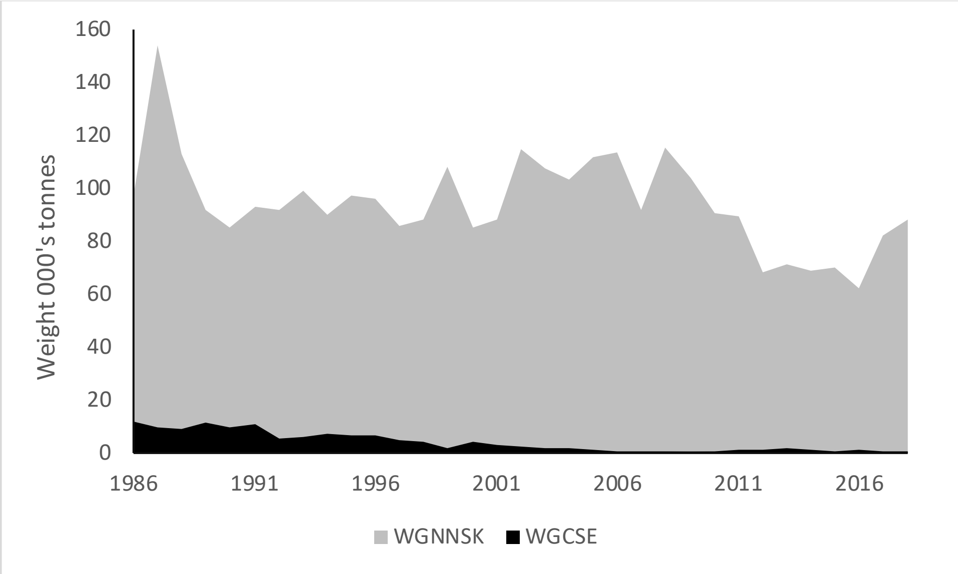


Figure 31.1. Saithe landings from WGNNSK and WGCSE from 1986–2018.

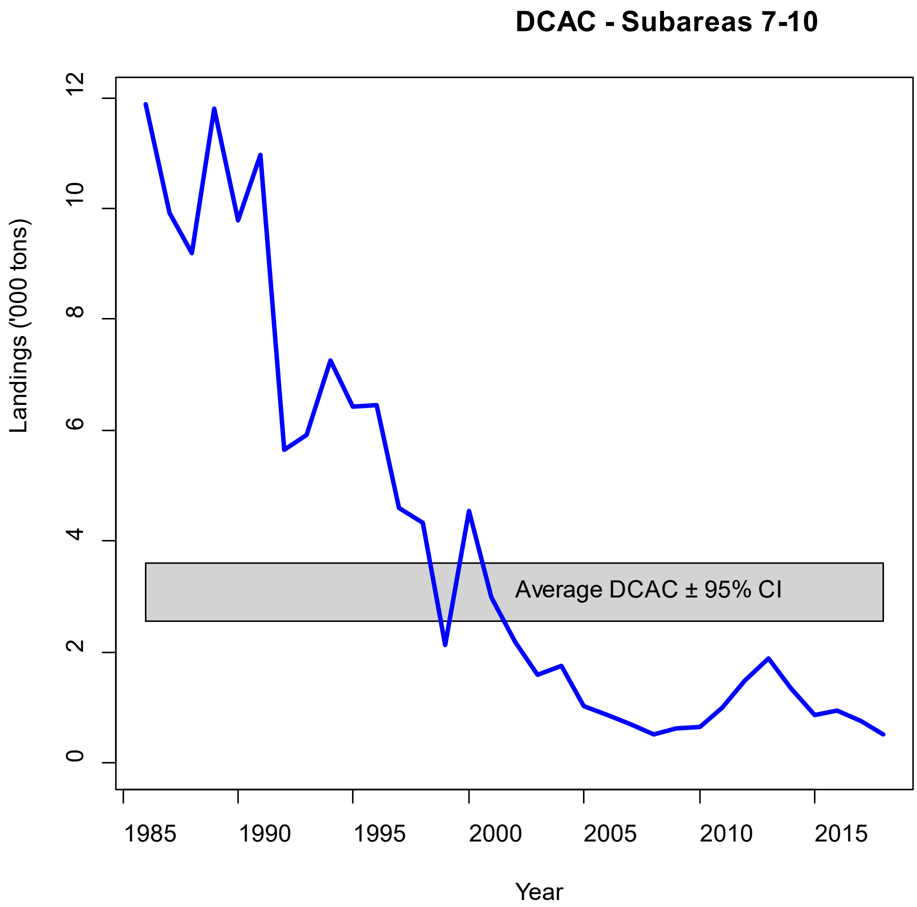


Figure 31.2. Saithe in subareas 7–10. The results of the depletion-corrected average catch (DCAC) assessment method as applied to commercial landings data since 1986. The grey box indicates the proxy for the maximum sustainable catch ± 95% confidence intervals.

29 Seabass (*Dicentrarchus labrax*) in divisions 4.b–c, 7.a, and 7.d–h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel, and Celtic Sea)

Type of assessment

This is an update of the assessment accepted as the agreed methods to use at the benchmark workshop for the seabass: WKBASS (ICES, 2017–2018). The assessment is performed using the Stock Synthesis model implementation (SS3; Methot, 2000; 2011). The stock is treated as Category 1 with a full analytical assessment and forecast.

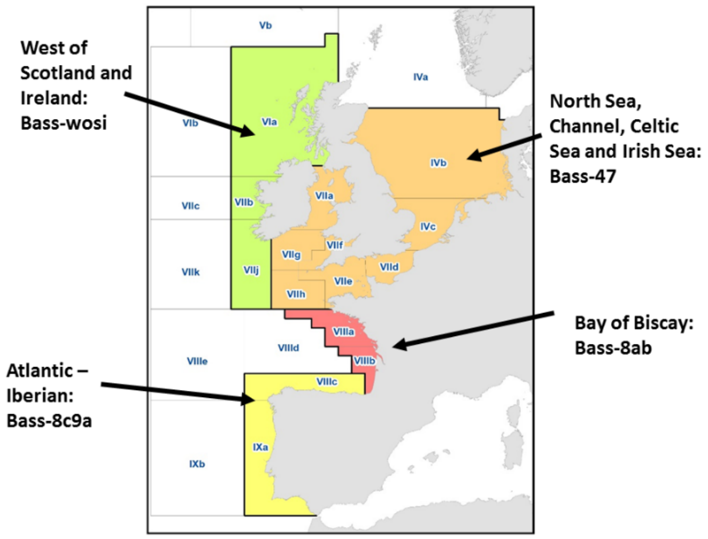
ICES advice applicable to 2019

The ICES advice for management of seabass fisheries in 2019 is available in the ICES Advice released in 2018, and states that "ICES advises that when the MSY approach is applied, total removals (includes commercial catch and recreational removals, taking mortality of released fish into account, estimated at approximately 5%) in 2019 should be no more than 1789 tonnes.

29.1 General

29.1.1 Stock definition and ecosystem aspects

Studies including tagging programs, microchemistry and genetics are underway. These are designed to provide significant information on the movements of sea bass and could indicate the levels of mixing between stocks. Currently Atlantic stock identities are assumed to be as follows (ICES, 2012):



29.1.2 Management

Historical management is described in the Stock Annex.

29.1.2.1 Management applicable to 2018[1]

Council Regulation (EU) 2018/120

1. It shall be prohibited for Union fishing vessels, as well as for any commercial fisheries from shore, to fish for European seabass in ICES divisions 4b and 4c, and in ICES Subarea 7. It shall be prohibited to retain on board, tranship, relocate or land European seabass caught in that area.
2. By derogation from paragraph 1, in January 2018 and from 1 April to 31 December 2018, Union fishing vessels in ICES divisions 4b, 4c, 7d, 7e, 7f and 7h and in waters within 12 nautical miles from baselines under the sovereignty of the United Kingdom in ICES divisions 7a and 7g may fish for European seabass, and retain on board, tranship, relocate or land European seabass caught in that area with the following gears and within the following limits:
   (a) using demersal trawls[2], for unavoidable bycatches not exceeding 100 kilograms per month and 1% of the weight of the total catches of marine organisms on board caught by that vessel in any single day;
   (b) using seines [3], for unavoidable bycatches not exceeding 180 kilograms per month and 1% of the weight of the total catches of marine organisms on board caught by that vessel in any single day;
   (c) using hooks and lines[4], not exceeding 5 tonnes per vessel per year;
   (d) using fixed gillnets[5], for unavoidable bycatches not exceeding 1,2 tonnes per vessel per year. The derogations set out in the first subparagraph shall apply to Union fishing vessels that have recorded catches of European seabass over the period from 1 July 2015 to 30 September 2016: in point (c) with recorded catches using hooks and lines, and in point (d) with recorded catches using fixed gillnets. In the case of a replacement of a Union fishing vessel, Member States may allow the derogation to apply to another fishing vessel provided that the number of Union fishing vessels subject to the derogation and their overall fishing capacity do not increase.
3. The catch limits set in paragraph 2 shall not be transferable between vessels and, where a monthly limit applies, from one month to another. For Union fishing vessels using more than one gear in a single calendar month, the lowest catch limit set in paragraph 2 for either gear shall apply.

Member States shall report to the Commission all catches of European seabass per type of gear not later than 15 days after the end of each month.

4. In recreational fisheries, including from shore, in ICES divisions 4b, 4c, 7a to 7k, only catch-and-release fishing for European seabass shall be allowed. It shall be prohibited to retain on board, relocate, tranship or land European seabass caught in that area.

Council Regulation (EU) 2018/1308, Amended regulation (EU) 2018/120 as regards fishing opportunities for European seabass.

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[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R0120&from=FR.

[2] All types of demersal trawls, including OTB, OTT, PTB, TBB, TBN, TBS, TB.

[3] All types of seines, including SSC, SDN, SPR, SV, SB, SX.

[4] All longlines or pole and line or rod and line fisheries, including LHP, LHM, LLD, LL, LTL, LX and LLS.

[5] All fixed gillnets and traps, including GTR, GNS, FYK, FPN and FIX.

5. In recreational fisheries, including from shore:
(a) from 1 January 2018 to 30 September 2018, in ICES divisions 4.b, 4.c 7.a to 7.k, only catch-and-release fishing for European seabass shall be allowed. During that period, it shall be prohibited to retain on board, relocate, transship or land European seabass caught in that area;
(b) from 1 October to 31 December 2018, in ICES divisions 4.b, 4.c 7.a to 7.k, not more than one specimen of European seabass may be retained per fisherman per day'.

29.1.3 Fishery description

29.1.3.1 Total landings (official)

The history of the fishery is described in the Stock Annex. Table 1 and Figure 1 presents official and total ICES landings. A large decrease in total landings was observed in the area in 2014 owing to poor weather conditions during winter and then from 2015 onwards owing to management measures put in place. Historically the bulk of the landings were made by the French fishery, but since implementation of management measures, landings are shared between French, UK and NL fisheries and to a lesser extent Belgium. In 2018, 912 tonnes were landed (official source): 431 t by UK, 297 t by France, 165 t by Netherland and 18 t by Belgium. Landings from France and UK by gear are given in Figure 2. In 2018, lines are the main gear used by both countries.

29.2 Data

29.2.1 Commercial landings

Landings series for use in the assessment are given in Table 2 for the six fleets for which selectivity is modelled: fleet 1- UK bottom trawls and nets; fleet 2- UK lines; fleet 3- UK midwater pair trawls; fleet 4- French combined fleets; fleet 5- other countries plus UK gears not included in fleet 1, with selectivity based on fleet 4; and fleet 6- recreational fisheries (2012 is the reference year with selectivity based on fleet 2, UK lines. The time-series of recreation fisheries is calculated iteratively so that fishing mortality is constant and equal to the fishing mortality in 2012 over the period 1985–2015) and with the implementation of the management measures a multiplier is applied from 2015 onwards (see chapter below). The landings figures are from census data (EU logbooks and/or sales slips) from several sources:

1. Official statistics recorded in the ICES official landings database since around the mid-1970s (data from 1985 are used in the assessment);
2. French landings for 2000–2018 from a separate analysis by Ifremer of logbook, auction data and VMS data (SACROIS database);
3. Landings for Belgian vessels recorded in ICES database "InterCatch;"
4. Landings for Netherlands recorded in ICES database "InterCatch;"
5. UK landings by gear type recorded in official UK landings databases.

Details of the methodology used to calculate French and UK historical landings can be found in the Stock Annex.

29.2.2 Commercial length compositions

IBPBass 2016 developed the Stock Synthesis model to include both the length and age compositions for the landings of fleets for which selectivity is estimated (Fleet 1: UK combined trawl and nets -1985 onwards; Fleet 2: UK lines -1985 onwards; Fleet 3: UK midwater trawlers -1985 onwards; Fleet 4: French combined gears -2000 onwards). Fitting to length composition data helps the estimation of length-based selectivity, whilst the age compositions (from application of age–length keys to length frequencies according to stratified sampling schemes) provide direct fitting of model estimates of catch-at-age. Since the length data are effectively being used twice, the length and age datasets are down-weighted (lambda values) to avoid over-fitting of the data. The composition data for the fleets are given in the SS3 data file. Input sample sizes for the multinomial composition data are derived from numbers of fishing trips sampled, as proxy for effective sample size. The relative sample sizes between years are maintained in any reweighting.

29.2.2.1 Sampling rates

UK(E&W) sampling rates for age compositions, by gear group, are given in Table 3. Although ALKs are derived by the UK for separate sea areas, the same ALK is applied to all gear groups in an area meaning that the age composition estimates for the different gears are not independent. This was a principal motivating factor for IBPBass (ICES, 2014) to combine UK trawls, nets and lines into a single fleet for estimation of selectivity in Stock Synthesis.

The UK midwater trawl fleet landings were not sampled in 1997, 2013, 2014, 2015, 2016 and 2017 due to the small number of trips targeting bass. The UK at-sea sampling programme selects vessels at random from stratified vessel lists, which includes midwater pair trawlers in the same over 10 m vessel stratum as demersal otter trawlers, nets and lines. Similarly, port sampling is stratified by groups of ports, not métiers. The number of vessels and trips by midwater pair trawlers is very low, and therefore there is a high probability of low or zero numbers of samples. In Stock Synthesis, the missing age compositions for midwater trawls are imputed based on the selectivity parameters and the input landings figure. This has negligible impact on the assessment as this UK métier represented only 1% of total seabass landings in 2013 and landed only 1 t in 2014, less than 1 t in 2015, 2016, 2017 and 2018.

Sampling of seabass in France has also been very variable between areas and gears (Table 4). Numbers of trips are relatively stable from 2013, but numbers of fish sampled decreased from 2015 due to the implementation of management measures and the fact that relatively few fish are now landed.

NB: WGSCE 2018 was made aware of an issue with the sampling level in Q1 and Q2 of 2017 from France (The full explanation can be found in the working document from Quemar, Vigneau *et al*. "Estimation of quarterly length distribution of landings in the context of a six months disruption in the French on-shore sampling"). Because of the lack of market sampling for length (biological and on-board sampling was unaffected), efforts were made to try and fill the deficiency in the number of samples by use of simulation techniques. Both simulated data and actual data were uploaded to InterCatch combined making it impossible to distinguish true samples from those simulated. The simulation was based on commercial landings market categories. Thus for 2017, 4% of simulated samples have been implemented in the Bss 47 assessment model (which corresponds to 13% in term of fish measures).

Numbers of sampled trips for UK trawls, midwater trawls, nets and lines, and French all-gears, were used as proxies for effective sample size for initial development of the Stock Synthesis model for seabass by ICES IBPNew, IBPBass and IBPBass2.

Based on these results, the input effective sample sizes were iteratively adjusted using the Francis method of weighting, reducing the disproportionate effect of the different datasets used. The effective sample size which reflects the goodness-of-fit to the composition data are now fixed and additional data and associated sample sizes adjusted using the effective sample size multiplier for age and length compositions by fleet available in the stock annex.

29.2.2.2 Length composition estimates

Figure 3 and Table 5 gives fleet-raised length compositions for all French gears combined. French numbers-at-length are available from 2000 onwards. In the 2015 assessment (WGCSE 2015) a single fleet called "French fleet" was used. This fleet was the combination of several types of subfleets using various fishing gears: pelagic trawlers, bottom trawlers, netters, liners, Danish seiners and purse seiners. Figure 4 and Figure 5 give fleet-raised length compositions per UK métier used in the assessment (UK OTB-Nets; Lines; Midwater trawls).

29.2.3 Commercial age composition

Following to the IBPBass2 (2016) age compositions for French commercial fishery landings of seabass were used, derived from an annual age–length key (ALK) constructed for the whole area. It is applied to the total landings length frequency for the whole area (Table 6).

Fleet-raised age compositions were obtained for UK fleets from 1985 onwards by application of age–length keys developed for the areas 4.bc, 7.d, 7.e and h, and 7.a,f,g. The annual age compositions for the combined otter and nets fleet and the line fleet are given in Table 7 and Table 8, and the age compositions for the UK midwater pair trawl fleet since 1996 are given in Table 9.

29.2.4 Commercial discards

Data sources for discards estimates and sampling design are described in the Stock Annex. Discarding of seabass by commercial fisheries can occur where:

- Fishing takes place in areas with bass smaller than the minimum landing size (36 cm in most European countries until 2015, then 42 cm), and where mesh sizes <100 mm are in use.
- Vessels catches are not in agreement with management measures.

Sampling rates and estimates of discards were provided to WGCSE from on-board sampling in the UK and France (Table 10, Table 11 and Table 12). The annual estimated quantities discarded by UK and French vessels from 2009 to 2014 has been less than 5% of total landings. In 2016, 2017 and 2018 the level of discarding observed increased to 22%, 27% and 10% respectively from the French fleet in the area (Table 12). This was mainly attributed to bottom trawlers (for which seabass is often a bycatch). For the UK fleet a level of 9% was observed in 2016 and 6% in 2018 mainly due to bottom trawlers. The level of available samples from the UK fleets in 2017 were too low to provide a raised estimate of total discards for this year for use in the model.

NB: Discards estimates from on-board sampling programme seems highly underestimated due to the low level of sampling on board: an extraction of French log book data in 2019 indicated that the level of discards estimated from on-board sampling is much lower. Two sources were used: French electronic logbooks ERSv1 and ERSv3 which progressively replaced ERSv1. The first does not spatialize the information which is reported for the whole fishing trip while the second does. Nevertheless, it is possible for ERSv1 to attribute discards to the stock 4bc–7d–h when the whole fishing trip is carried out in this area (which was the case for almost all the fishing trips observed). Using the different sources of data showed that from logbooks the French fisheries discard levels where in the region of 155.6, 270.9 and 456.4 tonnes as opposed to 152.7, 161.7 and 34.2 tonnes for 2016, 2017 and 2018 respectively from the on-board sampling programme.

The increase in discards in 2018 may be explained by the increase of management measures but also by the fact that French fishermen have been encouraged to report their discards in logbooks with respect to the landings obligation regulation.

In the assessment French discarding values were revised for 2016 and 2017 and updated in 2018 with new estimates from French logbooks.

Most discards are fish below the minimum conservation reference size (MCRS) of 42cm, and mostly from otter trawlers using 80–99 mm mesh in areas such as inshore regions of the English Channel where juvenile bass are most common.

There remains a large potential for bias in the discards estimates and it was recommended by England that the discards data for seabass should be used with caution. Particularly from under 10 m vessels, which take the bulk of the UK seabass catch, which was very infrequent until 2007, and line gears. However, mortality of discards for line gear was previously considered low. Research has recently been initiated on assessing the level of discards and post release mortality for this gear.

Previous assessments have excluded discards on the basis that the proportion discarded at an international level is relatively small (~5% by weight). Discarding has been more of an issue recently since the inception of more restrictive management measures such as an increase in MCRS to 42 cm and bycatch limits for trawls and nets. The recent benchmarks WKBASS (ICES, 2017a; 2018) explored the performance of the Stock Synthesis model including recent (noisy) estimates of commercial discards and length compositions. For the years prior to the availability of discard observations from the observer schemes, a history of discards can be constructed based on the fishery selectivity and discarding ogives estimated for the recent years that have discards observations.

29.2.5 Recreational catches

IBPBass (2014) considered it necessary to have the catch and fishing mortality due to recreational fishing represented in the assessment model. The approach for achieving this has evolved since then through the benchmark process in 2016 (ICES, 2016) and updated during WKBASS in 2017–2018 (ICES, 2017b; 2018). The derivation of the recreational fishing catches is described in detail in Hyder *et al*. (2018), but the key points are summarised below along with some additional information on the generalisation of methods to account for any combination of season length and bag limit.

Two approaches are used to include recreational catches in the assessment:

- **Before management measures (1985–2014)**: only a single year of recreational catches was available, so a constant recreational F is applied in Stock Synthesis overall years. The F is derived from iteratively adjusting the assessment until the total retained recreational catch is equivalent to a value of 1440 t for a reference year of 2012. This value of 1440 t is obtained by summing international survey estimates for France, Netherlands and the UK obtained from surveys between 2009 and 2013. This represents total removals through summing the kept component and applying a 5% post-release mortality to the releases. A composite length–frequency distribution is generated for recreational removals based on survey data.
- **After management measures (2015–present)**: given the management measures introduced for recreational fishers in 2015, it is unlikely that the assumption of constant F is valid as release rates should increase. Limited survey data was available after the implementation of management, so it is not possible to use catch estimates. As a result, a method was developed for estimating the impact of combinations of the MCRS, season length and bag limits on removals by recreational fishing. This is used in both the assessment and forecast.

29.2.5.1 Recreational catches before management measures (1985–2014)

Survey data are available for France, UK and the Netherlands, but no survey data are available for Ireland, Belgium, Germany or Denmark (Table 13). An average of the two UK effort methods was included (Armstrong *et al*., 2013), French data was selected from the 2009–2011 study (Rocklin *et al*., 2014) and Netherlands data from 2010–2011 (van der Hammen and de Graaf, 2013) (Table 13). In addition, the original estimate of 60 t for Belgium was removed as the evidence underpinning this value was not available, but catches are likely to be low.

A study of post-release mortality of sea bass was combined with country-specific information on sea angling practices, the average post-release mortality of sea bass caught by recreational sea anglers in 2012 was 5.0% (95% CI=1.7–14.4%) for BSS-47 (Lewin *et al*., 2018) (Section 27.2.6.7). Removals estimates were reworked for the 2012 reference year as the sum of retained fish and released fish with PRM of 5% applied (Table 14). This gave a total removal of 1440 t for 2012 to be used within the assessment model (Table 14).

A single length composition for fishery removals was estimated for the stock based on the French and English length–frequency distributions from surveys (Armstrong *et al*., 2013; Rocklin *et al*., 2014). The raised length–frequency distributions for each country were binned into 2 cm lengths and summed for the kept and released components. Then a post-release mortality of 5% was applied to the released component before adding to the kept fish to give a total length–frequency distribution for the recreational fishery (Figure 8).

29.2.5.2 Recreational catches after management measures (2015–present)

The implementation of management measures should lead to a reduction in fishing mortality as more and larger fish are released. This means that it is not appropriate to assume constant recreational fishing mortality, so it is necessary to include an estimate of recreational catch or change in fishing mortality from 2015. However, coverage of surveys is patchy for all countries after 2015, with only provisional estimates available for the UK and the Netherlands. As a result, two potential methods are available for estimating catches or changes in fishing mortality:

1. Imputation: impute annual catches (kept and released) for England and France in 2016 by assuming the catches have changed over time to the same relative extent as Netherlands catch estimates between surveys in 2010–2011 or 2012–2013 and the survey in 2016–2017.
2. Reconstruction of change in recreational fishing mortality relative to the 2012 reference year: use the data from recreational surveys carried out by France, England, and Netherlands in 2009–2013 to calculate the reductions in retained catch in the observed trips if bag limits and increased MCRS had been implemented at the time of the surveys (Armstrong *et al*., 2014). The reductions in catch can be used to infer changes in recreational fishing mortality induced by changes in management, assuming full compliance and taking post-release mortality into account.

There are issues with both these methods. The use of imputation has a large uncertainty because: i) there are no time-series data to validate the assumption that national catches change to the same extent between years; ii) the surveys have sampling errors; and iii) the 2016–2017 Netherlands survey data are still provisional. The second method is also very uncertain due to sampling error and limitations in the survey data, assumptions concerning compliance, and dependence of results on the size of year classes present in the stock at the time of the surveys. However, the second method was considered more appropriate as it is based on observed data. As a result, the imputation approach was rejected, and estimation of the expected change in recreational F from in 2015 onwards due to change in MCRS, bag limits and closed seasons was carried out as described in Hyder *et al*. (2018). These reductions were used, along with post-release mortality of

5%, to calculate reductions in recreational F that may have occurred in 2015, 2016 and 2017 in response to the management measures, assuming full compliance (Table 15).

Full details of the methods and assumptions can be found in Hyder *et al*. (2018), but these have been extended to account for any length of season Management measures vary between areas both in terms of the measure implemented and the timing. For the BSS-47 stock, there was an increase to the MCRS to 42 cm and three fish bag limit for six months in 2015; an increase to the MCRS to 42 cm, six months no take, and a one fish bag limit for the remaining six months in 2016–2017; and an increase to the MCRS to 42 cm, nine months no take, and a one fish bag limit for the remaining three months in 2018 (Table 15).

To estimate the total removals (N_t) under different management scenarios, it is necessary to sum the numbers for each country ($N_{t,i}$) calculated from the numbers of retained fish ($N_{h,i}$), additional numbers dead releases of fish that would have been retained if no management were in place ($N_{ar,i}$), and the numbers of dead releases that would have occurred anyway ($N_{or,i}$), so:

$$N_t = \sum_i^n N_{t,i} = \sum_i^n (N_{h,i} + N_{ar,i} + N_{or,i}) \qquad (1)$$

If p is the probability that a released fish dies and r_i is the estimated reduction in retained fish in each country (i) under different management conditions (Table 16) (Armstrong *et al*., 2014) then the calculation of the 2012 equivalent numbers removed for each country under management applied for the whole year for any combination of bag limit and open season length (s) is:

$$N_{t,i} = s(1-r_i) N_{h,i} + p(1-s+sr_i) N_{h,i} + pN_{r,i}. \qquad (2)$$

This applies to the management measures for 2016-17 and 2018, but not for 2015 as the emergency measures were implemented part way through the year. As a result, the reduction in numbers under the 2015 management measures is:

$$N_{t,i} = (1-r_i/2) N_{h,i} + (pr_i N_{h,i})/2 + pN_{r,i}. \qquad (3)$$

For each management scenario, summing across countries gives total recreational removals in numbers that would have been expected in the years of the surveys. The ratio of numbers removed in each scenario to the removals with no management can then be used to infer reductions in recreational fishing mortality in the years when the management measures came into force, for use in the stock assessment. These reductions in fishing mortality are only approximate as the contribution of year classes in the years of the surveys will be different to the composition of catches in the years when management was changed. The reductions in recreational fishing mortality are unlikely to be fully realised due to non-compliance and if post-release mortality is greater than 5% on average. The reductions in terms of numbers implied a potential F multiplier for existing management measures (Table 15) and any combination of management measures (Table 17).

29.2.5.3 Inclusion in the stock synthesis model

For the period 1985–2014 before management measures were introduced, recreational catch was iteratively reconstructed conditioned following previous assessments (ICES 2016; 2018) on the 2012 estimated value of 1440 t (Table 14). The selectivity was based on length–frequency distributions of removals assuming a 5% post-release mortality (Figure 8). Management measures were introduced in 2015, including an increase in the MCRS and various combinations of season length and bag limits. A multiplier was derived from 2012 catches in terms of numbers of fish for the recreational F that related to the reduction in catch due to management. Frec multipliers were applied of 0.832 in 2015, 0.282 in 2016 and 2017, and 0.191 in 2018 (Table 15). Frec multipliers were also calculated for different combinations of bag limit and season length for inclusion in the forecast (Table 17).

29.2.6 Biological data

This section provides biological parameters of growth, maturity and natural mortality required for the stock assessment of seabass. Further information and plots of growth and maturity data can be found in the stock annex and WGCSE 2013, and detailed methods and results are given in IBPNew 2012 (ICES, 2012a) working documents by Armstrong (2012) and Armstrong and Walmsley (2012b,c). Further information of natural mortality data can be found in the WKBASS report (ICES, 2017b).

29.2.6.1 Growth parameters

Growth parameters, standard deviations of length-at-age distributions, and an age error vector are input to the Stock Synthesis model. These are derived from more than 90 000 seabass sampled by Cefas since 1985 from fishery catches around England and Wales as well as from trawls surveys of young bass in the Solent and Thames estuary.

The sampled seabass shows some sexual dimorphism of growth from about seven years of age onwards. It is currently not possible to implement a sex-disaggregated Stock Synthesis assessment as it is impossible to disaggregate commercial fishery catches and survey catches by sex. Therefore, a combined-sex assessment using a combined-sex growth curve is adopted. Mean length-at-age has not shown any trend over time, and length-at-age is also very similar in strong and weak year classes (Armstrong and Walmsley, 2012b). Hence data have been combined over the full series to estimate growth parameters, and the estimated body weights-at-length and age in the Stock Synthesis assessment model are treated as being constant over time.

Von Bertalanffy model parameters were estimated by area using an absolute error model minimizing ∑(obs-exp)^2) in lengths-at-age:

Area	4.bc	7.d	7.e	7.afg	All areas
Linf (cm)	82.98	87.22	92.27	81.87	84.55
K	0.1104	0.09298	0.07697	0.09246	0.09699
t0 (years)	-0.608	-0.592	-1.693	-1.066	-0.730

The “all areas” VBGF parameters are used in the Stock Synthesis model.

29.2.6.2 Standard deviations of length-at-age

As expected, the standard deviation of length-at-age increased with length, and the trend could be described by the linear model SD = 0.1166 * age + 3.5609. The regression estimates of SD by age class are input to the assessment model to generate length-at-age distributions.

29.2.6.3 Age error parameters for Stock Synthesis

Inclusion of age error parameters in the Stock Synthesis model (CVs for ageing error by age class) were derived from results of the ICES seabass scale exchange in 2002 (Mahé *et al.*, 2012). CVs of 12% at-age were specified as increasing values per age class to give a standard error of ~1 year per age class. These are used in the SS3 observation submodel to derive expected values for observed data on age distributions. Further information on ageing precision and calibration between laboratories will become available from an ICES calibration study in 2015.

29.2.6.4 Weight-at-length

Weight-at-length and age was estimated within the Stock Synthesis model according to the following relationship derived from UK sampling:

W(kg) = 0.00001296 L(cm)^2.969

29.2.6.5 Maturity-at-length

Maturity ogives are derived from 590 male and 730 female seabass collected in the UK between 1982 and 2009 immediately prior to and during the spawning season (December to April). The data were modelled using a binomial error structure and logit link function, fitted in R to individual observations (Armstrong and Walmsley, 2012b). The logistic model describing proportion mature by 1 cm length class L was formulated as:

Pmat(L) = 1/(1+e-(a+bL))

defined by the parameters slope *b* and length intercept *a*. These parameters were estimated separately for females and males. This can also be expressed as:

Pmat(L) = 1/(1+e-b(L+c))where c = a/b

Stock Synthesis uses the second formulation, and the parameters required are the slope (b = 0.3335: entered as a negative value) and the length inflection, which is the estimated length at 50% maturity (L50% = 40.65 cm).

The parameters of the model Pmat(L) = 1/(1+e-b(L+c)) are given in Table 18.

The logistic model for females and males is:

Pmat(L) = 1/(1+e-0.3335(L-40.6488)) (females)

Pmat(L) = 1/(1+e-0.4861(L-34.6652)) (males)

The length-based maturity ogive for female seabass is used in the current Stock Synthesis assessment model, which derives proportion mature at age by applying the length-based ogive to the length-at-age distributions defined by the growth parameters and SD of length-at-age (Table 19).

29.2.6.6 Natural mortality

The current assessment uses a value of M=0.24 for all ages and years. This was derived based on methods using information on longevity, growth and maturity. The maximum observed age (tmax) in over 90 000 age readings in the UK since the 1980s was 28 years. Data from 1145 recreationally caught seabass Ireland reported by IBPNew (ICES, 2012) showed a maximum age of 26. The Hoenig (1983) method based only on maximum age for teleosts gave M of 0.15–0.16 for maximum age 26–28 (Table 20). A more recent paper by Then *et al*. (2015) analysed data from 226 studies (including Hoenig, 1993) to evaluate the robustness of life-history based M inferences. They propose maximum age methods as being the most robust. Their equation M = 4.899. $tmax^{-0.916}$ gives M values of 0.23–0.25 for tmax of 28–26 years (Table 31.2.8.6.1). They also give an expression using values of von Bertalanffy parameters K and Linf (M = 4.118.K0.73.Linf-0.33) which predicts M = 0.17 for seabass in areas 4 and 7. The WKBASS Data WK proposed the use of the Then *et al*. tmax method (M=0.24) as being more robust than inferences from any single study.

Natural mortality is high in young fish and declines with age, as shown by multispecies models that include diet data and estimation of size preferences (such as applied by ICES WGSAM for the North Sea, ICES, 2014). Proxy methods to infer age-dependent M in younger fish are given by Lorenzen (1996) and Gislason *et al*. (2010). Values for seabass by age are given in Tables 20 and 21 and Figure 12. The Gislason method gives much lower M for adult fish. Brodziak *et al*. (2009) suggest that methods such as Lorenzen can be used to derive the relative age-dependent patterns for younger fish, but can be re-scaled to give M at older ages more similar to those from methods using (e.g.) tmax. Table 21 and Figure 12 show Lorenzen and Gislason M rescaled to give mean M at ages 10 and older that are equivalent to the Then *et al*. (2015) prediction of 0.24 for tmax 26–28, or rescaled to the previous M value of 0.15. The WKBASS Data WK proposed Lorenzen scaled to 0.24 for the older ages. For the benchmark, the following M options were explored:

1. M = 0.15 at all ages (continuity with previous approach);
2. M = 0.24 at all ages, Then *et al*., 2015;
3. Lorenzen scaled to M=0.24 at ages 10+;
4. Estimation of age-invariant M by model;

M=0.1 and 0.2 at all ages to explore likelihoods in comparison with the other options.

There are no direct estimates of M for seabass. The WKBASS 2017 Data WK reviewed a number of life-history based methods for inferring natural mortality rates in teleost fish based on metrics such as lifespan and growth parameters. The WKBASS 2017 assessment WK adopted the predictions from a recent paper by Then *et al*. (2015) which analysed data from 226 studies to evaluate the robustness of life-history based M inferences. Their equation M = 4.899. $tmax^{-0.916}$ gives M values of 0.23–0.25 for tmax of 26–28 years as observed in the BSS-47 stock. WKBASS 2017 Data WK also considered methods to derive age-dependent M (Gislason *et al*., 2010; Lorenzen, 1996) and to rescale these to match the Then *et al*. (2015) prediction over the age range of mature fish. However this was not adopted for the benchmark assessment which adopted M = 0.24 for all age groups.

29.2.6.7 Post-release mortality

Commercial fisheries

Discarding of seabass below the MCRS occurs in most commercial fisheries to a variable extent. Previously, ICES advice sheets indicate overall international discard rates of only 5% by weight for the BSS.27.4bc7ad–h stock based on data supplied to the Working Group on the Celtic Seas Ecoregion (WGCSE). The WGCSE and WKBASS Data WK 2017 showed that discard rates have typically been highest in bottom otter trawls (OTB) and have increased following the introduction of additional management measures in 2015. Discards are now included in the assessment of this stock and in the absence of any data on post-release survival, this has been assumed to be zero for all commercial fisheries. This will overestimate commercial fishing mortality to some extent although the effect will be small due to the low discard rates.

Survival of fish discarded by commercial line vessels may be similar to survival of recreational angling releases (see next section), but work is needed to establish the typical gear, handling, and condition of fish to be released. Survival of seabass caught by trawls, seines, fixed or driftnets and longlines will depend on many factors including tow duration, soaking times, gear design, deep-hooking, and time on deck. WKBASS identified a need for studies on post-release survival of seabass in different commercial fisheries, particularly in view of the potential inclusion in the Landings Obligation.

Recreational fisheries

Releases of can be mandatory or voluntary and can represent a large proportion (>50%) of the catch, so must be accounted for in the assessment (Ferter *et al*., 2013). Post-release mortality of hook-and-line caught fish is not easy to measure and can vary significantly between species and fisheries. Many factors are also important including water temperature, hooking damage, and handling, so it is important to account for different fishing practices. Recreational fisheries on

European seabass are characterised by relatively high release rates, which appear to have increased following changes in management which increased the MCRS from 36 cm to 42 cm in 2015 and imposed bag limits and closed seasons.

Existing studies of post-release mortality of seabass and other similar species were reviewed (ICES, 2017b). Based on the information provided by Hyder *et al*. (2018), WKBASS agreed on a figure of 5% for PRM in recreational fisheries on BSS.27.4bc7ad–h, which are predominantly sea angling (ICES, 2018). This estimate is based on Lewin *et al*. (2018) in which 144 fish were maintained in an aquaculture facility and then captured by experimental angling using a range of bait and artificial lures. The fish were then released, and held for ten days to assess mortality. The effects of different bait types, air exposure, and deep hooking were investigated, with increased mortality associated with use of natural bait (13.9%, 95% CI=4.7–29.5%) and deep hooking (76.5%, 95% CI=50.0–93.2%). By combining the experimental results with country-specific information on sea angling practices, the average post-release mortality of seabass caught by recreational sea anglers in 2012 was 5.0% (95% CI=1.7–14.4%) for BSS-47 (Lewin *et al*., 2018).

29.2.7 Survey data used in assessment

29.2.7.1 Pre-recruit surveys in UK

An inshore trawl survey in autumn in the vicinity of a major bass nursery area in the Solent (7.d English coast, Figure 9) provides abundance indices at-ages 2 to 4 for the stock assessment. Data are available from 1982, although there are intermittent years when the survey did not take place (Table 22). The stock annex provides details of this survey and of some other pre-recruit survey series not considered appropriate by previous WGs and IBPBass for inclusion in the assessment. A previous assessment of the stock by Pawson *et al*. (2007), using a statistical separable model, indicated that recruitment patterns in 7.afg, 7.eh, 7.d and 4.bc were similar to the trends in the Solent survey. This provides some justification for using the Solent survey in the current assessment despite its extremely localised coverage.

Abundance indices for ages 2–4 in the Solent autumn survey have large interannual variability (Table 22; Figure 10). Strong year classes are apparent in 1989, 1995 and 1997, but in the last decade, year-class strength has been less variable, a pattern also seen in the commercial fishery. The survey indicates a general trend of increasing recruitment since the early 1990s, but weak year classes from 2008 to 2012. There is only one pronounced year-effect, in 2007. The age-2 index appears less consistent than the age 3 and 4 indices.

29.2.7.2 Pre-recruit surveys in France

Similar surveys, carried out by Ifremer, began on the coast of France from 2014. At this stage, the methodology has been set and is starting to produce additional information on seabass age groups 0,1,2,3 providing an early insight into the French coast nursery dynamics and the beginnings of a new time-series. In the Channel, the survey takes place in the Seine estuary and preliminary indices are available from 2017. The survey will continue until 2021 under a European Maritime and Fisheries Fund (EMFF) program (NOURDEM).

29.2.7.3 Channel Groundfish survey CGFS

The Ifremer Channel Groundfish survey, is carried out in October each year since 1988, provides swept-area indices of seabass abundance in the Eastern Channel (7.d) together with length compositions. Details of the survey are given in Coppin *et al*. (2002), which includes a full description of the GOV trawl, sampling stations are shown in Figure 11. The majority of seabass are caught in the coastal waters of England and France (Figure 11).

The abundance indices are calculated applying a stratified-random swept-area based estimator. Strata correspond to ICES statistical rectangles. Swept-area is calculated using wingspread. As this is a stratified swept-area based indicator, uncertainty is based on between haul variance within a strata and summation of variances across strata. Further details are in the stock annex.

The swept-area indices are given in Table 23. The trends in both the index and in the proportion of stations with seabass showed similarities to the trend in total biomass estimates from the ICES, WGCSE 2013 update assessment using Stock Synthesis, before the survey data became available, lending *a priori* support to the use of the index in the assessment (Figure 12).

The precision of the swept-area indices appears unrealistically high in some years (e.g. 0.025 in 1991), which may indicate that the index trends are driven largely by the incidence of positive catches. Modelling of the data using delta lognormal models may provide more realistic precision. During trial Stock Synthesis runs, the use of the CVs in Table 23 resulted in poor fit to length frequencies in many years due to individual years with very low CVs being given far too much weight. Relaxing the CVs to 0.30 for all years except the first three years (set to 0.6 in preliminary runs given the very low incidence of positive stations) allowed the model to fit the length compositions more closely over the series. The final assessment excluded the composition data for 1988–1990 due to the very low sample sizes, but retained the overall index.

NB: The Channel Ground Fish Survey (CGFS) has been conducted since 1988 with a systematic fixed sampling program with a high opening (GOV) bottom trawl (20 mm mesh size codend), using the same Research Vessel Gwen Drez since 1988 to 2015. The RV Gwen Drez was decommissioned in 2015, and survey continue the time-series using the RV Thalassa (a bigger vessel). An inter-calibration exercise was conducted in 2015 by using paired tows, simultaneously with both vessels (see Working Document in WGIBTS 2015 report for description of the inter-calibration results). The original index was calculated as numbers of fish per hour tow. The initial step in calculating the index was numbers per ICES square per hour tow (the stratum in this survey) and then raised to the whole Eastern Channel to compute a number of fish per age class per hour tow. As the surface trawled area differed between the two RVs (difference in trawling speed and width of the gear used) a density index (number of fish per km²) was also calculated in order to create a consistent index over the whole time-series. The index is then computed using the formula:

$$\overline{N} = \frac{\sum_s A_s . \overline{N_s}}{\sum_s A_s}$$

With :

$\overline{N_s}$ mean abundance in the strata *s*, expressed in number/km²

A_s Surface of the strata *s*, in km²

As the vertical opening of the gear used by the RV Thalassa was higher than the previous one, and in order to take into account any vessel effect on catchability, the CPUE were compared for all the species caught. Differences in CPUEs between the new and the old survey setting were found for nine species (mostly pelagic species) and a correction factor applied to continue the time-series. The correction coefficient for seabass used to continue the time-series is R=1.707+/-0.091. In addition to the calculation of the new index, a number of errors were found in the surface calculation of some strata. These errors where corrected and the new indices (expressed in number of fish per km² instead of number of fish per hour fished) take these corrections into account.

As there were significant changes in how the index was calculated along with the introduction of a new vessel and gear the EWG agreed that a full review was needed before the index could be used in the assessment. The review revealed that the index could be used up to and including 2014 and the series from 2015 onward should be considered a new time-series. Therefore the CGFS index discontinues in 2014.

The new time-series from 2020 when five years of data become available.

29.2.8 Commercial landings per unit of effort

Following the recommendation from WKBASS 2018 the French LPUE index is now calculated by modelling the zeros and non-zeros values using a delta-GLM approach (see stock Annex for details). In 2019 a revision to the calculation considering the level fixed to define zeros and non-zeros values used was carried out. It was considered that an error in the threshold to define positive values (used in WGCSE 2018) for modelling positive proportion was incorrect. The threshold should be defined as 0.99 kg and not 0.05 kg (Figure 13). Confidence interval calculated through a bootstrap estimation are presented in Figure 14 with the agreed LPUE series used in the final assessment. Further details of the LPUE update are in WD 06. The outcome of this update to the LPUE has resulted in a change of perception of the stock, see subsequent sections.

29.2.9 Other relevant data

None.

29.3 Stock assessment

29.3.1 Model structure and input data / parameters for update assessment

The assessment was conducted using Stock Synthesis (Methot, 2000; 2011), using version 3.24u (Methot, 2011). The structure and input data / parameters of the SS3 model are summarized below and details are available in previous sections:

29.3.1.1 Model structure

- Temporal unit: annual based data (landings, discards, survey and commercial tuning indices, age– and length–frequencies);
- Spatial structure: One area;
- Sex: Both sexes combined.

29.3.1.2 Fleet definition

Six fleets defined: 1. UK bottom trawls, nets; 2. UK lines; 3. UK midwater trawls; 4. French fleets (combined); 5. Other (other countries and other UK fleets combined); 6. Recreational fisheries.

29.3.1.3 Landed catches

Annual landings in tonnes from 1985 to final year for the Five fleets from ICES subdivisions 4.b and c, 7.a, d–h. French data were as provided by Ifremer and the recreational catch was provide for 2012 with the time-series from 1985 to present iteratively reconstructed conditioned on the 2012 estimated value of 1 440 t.

29.3.1.4 Abundance indices

Channel Groundfish Survey in 7.d in autumn (France), 1988 to 2014: total swept-area abundance index and associated length composition data (Table 23). Number of stations with seabass is used as input effective sample size. Input CV for survey = 0.60 for 1988–1990 and 0.30 for 1991 to 2014. First three years of composition data are excluded due to sampling levels and higher uncertainty in the data.

Cefas Solent Autumn bass survey (7.d), years 1986 to 2009, 2011, 2013 to present, for ages 2–4. Selection was fitted as a function of length using a double normal model, with minimum and maximum ages specified as 2 and 4 in the age selection function (Table 24).

29.3.1.5 Fishery landings age composition data

Age bins: 0 to 15 with a plus group for ages 16 and over. Age compositions for fleets are expressed as fleet-raised numbers-at-age, although they are treated as relative compositions in SS3. Year range for UK trawls/nets and UK lines: 1985 to present; UK midwater pair trawl: 1996 to 2018 (no samples for 1997, 2013–2014, 2016-2017); French all fleets combined were input from 2000 to present.

29.3.1.6 Fishery landings length composition data

The length bin was set from 4 to 100 cm by 2 cm intervals. Length compositions for fleets are expressed as fleet-raised number-at-length. Year range for UK trawls/nets: 1985 to present; UK lines: 1985 to present; UK midwater pair trawl: 1985 to 2012 (no samples for 1997, 2013–2018); French all fleets combined were input from 2000 to present.

29.3.1.7 Model assumptions and parameters

Table 25 summarises key model assumptions and parameters. Other parameter values and input data characteristics are defined in the SS3 control file BassIVVII.ctl, the start.SS file, the forecast file Forecast.SS and the data file BassIVVII.dat.

29.3.1.8 Incorporation of recreational fishery catch estimates

Where catch is not available the vector of recreational fishing catch values, landed plus dead released fish assumed to be 5% of all released fish, was generated using the selectivity from the 2012 length compositions obtained from the recreation survey and a value of F for recreational fishing in 2012. For a given value of F, the recreational harvest was calculated based on catch in 2012 and the recreational F. The F and landings for recreational fishing was adjusted in successive SS3 runs until the recreational F for the time-series was close to the F giving 1440 t in 2012. An F multiplier was applied to the Fs after 2014 to take account of the new management measures. The calculations for the final assessment run are given in Table 28.

29.3.1.9 Final update assessment: diagnostics

The likelihood components (log L * Lambda) for the update SS3 assessment are given below:

Likelihood components	Likelihood
TOTAL	705.0
Catch	5.38e-13
Equilibrium catch	0.0289
Survey	-45.3
Discards	21.82
Length compositions	379.7
Age compositions	325.5
Recruitment	23.26
Forecast Recruitment	1.89e-7
Parameter soft bounds	0.0184
Convergence level	5.31e-4

A range of model outputs and diagnostics are given in Figures 15–33.

Good correspondence was found between the observed and fitted length and age compositions for each fleet (Figures 20–29), although the fit to the French length compositions in 2018 was poorer than for preceding years. Some diagonal residual patterns are noted in the commercial age compositions indicating some problems in fitting extreme variations in recruitment.

Any smearing of age estimates from a strong year class into neighbouring weak ones could be responsible for year-class residuals in the UK age compositions that are apparent in the first half of the series. The age error vector included in the model helps to accommodate this in the fit to age compositions. The combined fit of the age and length composition data aggregated over the series was very close (Figure 23 and 29).

The survey abundance indices both fisheries-independent and fishery-dependent are fit reasonably well (Figure 30 to 32). The UK Solent autumn survey is characterised by a large variability with outliers present in the model fit (Figure 30). The model fits closely to the low indices for recent years because there are few fishery composition data for estimating these recent year classes.

The model is able to fit recruitment deviations with reasonable precision back to around the 1974 year class (Figure 33) allowing a longer term perception of recruitment dynamics. Recruitment is highly variable with no evidence of a reduction in average recruitment at the lower SSB values (Figure 33) although this perception is affected by the imposition of a steepness value of 0.999 for the fitted Beverton–Holt stock–recruit curve. Sensitives to differing values for this parameter carried out during the benchmark workshops found that likelihoods progressively worsened as the steepness value was reduced.

29.3.2 Analytical retrospective analyses

Retrospective analysis with a seven-year peel was carried out and a five-year peel for the calculation of the Mohn's rho. This analysis shows that there is some evidence of a retrospective pattern, see table below and Figure 34, for recruitment, SSB and fishing mortality. However, the retrospective bias is within the tolerance threshold accepted by ICES (-15 to +20) for SSB and fishing mortality, there has been no tolerance threshold set for recruitment.

	Mohn's rho
Spawn–stock biomass	0.152
Fishing mortality (ages 4–15)	-0.125
Recruitment (age 0)	0.796

The model is sensitive to the recent change in selectivity due to management measures where a block change in the selectivity and retention parameter estimates where introduced for data proceeding 2015. The model is also sensitive to the addition of new data and its associated weightings with the recent data having more influence given the higher sampling levels.

29.3.3 Final update assessment: long-term trends

The time-series of estimates of numbers-at-age, combined recreational and commercial F(4–15), are given in Tables 26 and 27, and a summary of SSB, recruitment, F and commercial and recreational catch are given in Table 28 and Figure 35. These series are based on the final SS3 update run with 2018 set as the final year. In order to obtain biomass estimates for 2019 and Fs for 2018 for the forecast the final year is set to 2019.

A sharp increase in F between 2011 and 2013 is generated because the assessment model interprets that landings were maintained despite a rapid decline in biomass. This may be a plausible scenario where aggregations or predictable migration routes of seabass can be targeted, and it is possible for fisheries to maintain landings as total stock size declines, and hence inflict an increasing fishing mortality rate. The F has since decreased in line with sharp reduction in catches due to the discontinuation of the French midwater trawl and the implementation of additional management measures.

WGCSE concludes that strong year classes in 1989 and some subsequent years caused a rapid increase in biomass throughout the stock area, and landings and fishing mortality in the commercial fishery also increased. The combined commercial and recreational fishery F has been well above the F_{MSY} proxies estimated during WKBASS and the recent update of reference points due to the correction to the LPUE series. Recruitment has been declining since the mid-2000s, and has been very poor since 2008, however the recruitment estimated for 2013 and 2014 is above the long-term geometric mean of 16 018. Uncertainties in the assessment are explored in a subsequent section.

29.3.4 Comparison with previous assessments

With the addition of the 2018 data and new LPUE series, the time-series of recreational catch was updated to remain consistent with the assumption of a constant F for the period 1985 to 2014 and an F multiplier reduction for 2015 to present (Figure 36).

With these changes included in the update assessment the perception of the stock has changed with spawning–stock biomass showing a higher biomass level and lower F than that estimated in 2018 for the recent period.

The spawning–stock biomass, fishing mortality and recruitment estimated in 2018 when compared with the recent assessment (Figure 37) is within the 95% confidence intervals. However, as the stock is at its lowest level of the time-series, around B_{lim}, has high uncertainty and a retrospective bias the EWG agreed that reference points would need to be updated with the WGCSE 2019 accepted assessment. The outcome of the analysis to update reference points is discussed in a subsequent section.

29.3.5 The state of the stock

The marked increase in biomass in the 1990s was driven by the very strong 1989 year class and a number of subsequent year classes. The biomass prior to this was declining during a period of poor recruitment, and the recent decline in biomass also coincides with a period of poor recruitment, but under conditions of higher F than estimated for the 1980s. The stock has been characterised by periods of poor recruitment in the 1980s and now again since 2008. These periods of poor recruitment have a major impact on biomass, which is exacerbated by any increase in F. Total biomass reacts more quickly than SSB due to the delayed maturity.

The period of increasing SSB in the 1990s and early 2000s also coincided with expansion of the stock in the North Sea. The enhanced productivity and geographic range of the stock at this time also coincided with a period of elevated sea temperatures (see WGCSE and stock annex for UK inshore sea temperature trends in relation to seabass recruitment).

The assumption of a constant recreational fishing mortality over time implies that recreational harvests were a much larger fraction of total fishery removals in the 1980s compared with the 2000s onwards (Figure 15). It is likely that in the 1970s or earlier, seabass were primarily the target of recreational fishing.

29.4 Biological reference points

The fishing pressure and biomass PA and MSY reference points defined by WKBASS 2018 were updated using the WGCSE 2019 assessment due to the inclusion of additional 2018 data and a new LPUE series which changed the perception of the stock.

WGCSE noted that due to the changes in perception of the stock biomass and fishing pressure and how close the stock is to B_{lim} the reference points would need to be updated to reflect these amendments. Sensitivities to the new input data and an update of reference points using the most recent accepted assessment was carried out and presented in a working document (WD 03). The same method as that carried out by WKBass 2018 using the EqSim R packages was implemented with the only change being that the time-series of selectivity used was increased from two to four years as additional data were available post-implementation of new management measures.

The following table summarises the updated reference points using the most recent accepted assessment:

Stock	Seabass in ICES divisions 4.b,c and 7.a, d–h.		
PA Reference points	Value 2019	Rational	
B_{lim}	10 313	Lowest observed SSB (Type 5 S–R relationship)	
B_{pa}	14 439	B_{lim} × 1.4	
F_{lim}	0.254	In equilibrium gives a 50% probability of SSB>B_{lim}	
F_{pa}	0.1815	$F_{pa} = F_{lim} / 1.4$	
MSY Reference point			
F_{MSY}	0.1713 (0.197)	Reduce as F_{MSY}>F_{PA}>$F_{P.05}$	With WKMSYREF4 default values for assessment/advice error
$F_{MSY\ lower}$	0.142	Reduce as F_{MSY}>F_{PA}>$F_{P.05}$	
$F_{MSY\ upper}$	0.1713	Reduce as F_{MSY}>F_{PA}>$F_{P.05}$	
MSY $B_{trigger}$	14 439	B_{pa}	

29.5 Short-term predictions

Inputs for a short-term forecast are given in Table 29, and their derivation is explained below.

29.5.1 Recruiting year-class strength

Recruitment estimates for seabass are below average from 2008 to 2012 (Table 28). SS3 does not estimate recruit deviations for years with no survey data for that year class. Hence, the model imputes a value from the stock–recruit curve at virgin biomass for year classes 2017 and after. This value (22 031 thousand) differs slightly from the 1985 to 2013 geometric mean (16 018 thousand) which was adopted for subsequent year classes for the forecast. However, this year the working group agreed that recruitment is at a low level and has been since 2005 and agreed to only include 2005 to 2016 for the geometric mean recruitment for the forecast (12 383 thousand). This is summarised in the text table below:

Year class	SS3 (age 0)	GM 2005–2016
2016	13 452 thousand	
2017		12 383 thousand
2018		12 383 thousand
2019		12 383 thousand

WGCSE (2013 and 2014) reviewed some information on environmental influences on seabass recruitment which supports the apparent recent reduction in recruitment from 2008–2012. Survival of 0-gp and 1-gp seabass in nursery areas in estuaries and salt marshes is thought to be enhanced by warmer conditions promoting survival through the first two winters, and increasing the growth rates (Pawson, 1992). Data on coastal sea temperatures in the south of the UK were presented by WGCSE to show that shifts between periods of poor recruitment and periods of above-average recruitment were associated with changes from cooler to warmer sea conditions, and that recent poor recruitment from 2008 onwards coincided with cooler conditions (see stock annex). During 2014, sea temperatures off southern England were exceptionally warm, which may have favoured survival and growth of young bass. The Solent survey in 2017 indicated that numbers of 2-gp bass (2015-year class) was below the average of the time-series. Although the evidence is weak, it is not a critical assumption for short-term forecasts as this year class has very little impact on the short-term forecast.

29.5.2 Numbers of fish in 2019

These were derived from the update Stock Synthesis run with final year set at 2018. The numbers for ages 0–2 in 2019 were adjusted using the ratio of LTGM to SS3 values for 2017–2019 age 0 as explained above.

29.5.3 F-at-age vectors

Status quo F-at-age for the commercial fishery was taken as the average F-at-age as estimated from the last three years scaled to the final year derived from the update Stock Synthesis run with final year set at 2018. This approach was taken to allow for the change in selectivity associated with the implementation of new management measures (Figure 16b).

The recreational F vector was estimated in a similar way using the average of the last three years, however the final F_{bar} was scaled using F multipliers on the 2012 F in Table 17 taking into account the management measures in place. For 2018, this was a three-month open season with a one bag limit and a MCRS of 42 cm. Additional years Fs were scaled taking into consideration management measures in place for 2019 and where management measures are unknown, a partial F proportion based on pre management measures was applied up to the maximum that the F multiplier would allow, 0.663. The F multiplier of 0.663 takes into account the increase in the MCRS to 42 cm.

29.5.4 Weights-at-age

Mean weights-at-age in the stock were taken from the Stock Synthesis output. The commercial fishery weights for 2018 were derived as a weighted mean of the values for French and UK fleets given in the Stock Synthesis output, using the model estimates of catch numbers for the two fleets as weighting factors. The annual weights-at-age for any fleet are time-invariant, as they are derived from length-at-age derived from von Bertalanffy growth curve parameters, with selectivity applied where appropriate. Length at AMAX (30 years) was estimated as 84.12 cm.

29.5.5 Maturity ogive

The proportion mature at-age is the length-based ogive applied to the length-at-age distributions around the input VB growth curve, calculated within Stock Synthesis.

29.5.6 Detailed short-term forecast output at *status quo* F

A detailed short-term forecast is given in Table 30 assuming that F in 2019 and 2020 is the average of the previous three years scaled to 2018 from the assessment for the commercial fleet for the recreation fleet the partial F used is that described in Section 27.5.3.

Fishing at the same fishing mortality as in 2018 for the commercial fleets and a one bag limit for seven months for the recreation fishery will result in a further decline in SSB from 11 413 t in 2020 to 11 338 t in 2021 remaining just above the B_{lim} of 10 313 t.

There is uncertainty in the forecast, as the actual rate of decline in population abundance in recent years is likely to be more uncertain than indicated by the SS3 model confidence limits. Also, the final package of technical and other management measures for seabass in 2015 to present are not fully known at this stage, and information will be needed on their implementation and effectiveness before their impact on fishing mortality can be ascertained. The assumption of constant recreational F is also untested.

29.5.7 Management options

WGCSE provides management options in which F multipliers are applied proportionally to commercial and recreational F-at-age (Table 31). In reality, management may wish to allocate the combined forecasted landings in any way considered appropriate, and this would imply differing F-multipliers applied to each fishery.

The management options table includes options for F multipliers for a number of different scenarios and include the multiplier giving the proposed F_{MSY} of 0.1713 for combined commercial and recreational fishing. With zero F in 2020, SSB is expected to increase from 11 413 t in 2020 to 12 371 t in 2021. At F_{MSY}, the combined commercial and recreational catch in 2019 is expected to be around 2427 t. However, as SSB is predicted to be below MSY $B_{trigger}$ in 2020 and 2021 F_{MSY} is adjusted accordingly and expected catches are thus reduced to 1939 t. When compared with estimated landings for all fisheries of 1248 t in 2019, this represents an eight percent increase in combined commercial and recreational catches. The allocation between commercial and recreational fisheries depends on the balance of controls applied on recreational and commercial fishing in 2019 and 2020.

29.6 Uncertainties and bias in assessment and forecast

29.6.1 Landings and discards data

The historical fishery catch data are subject to several biases. From 2000 to 2015, French landings data from the ICES commercial landings database are replaced by more accurate figures from a separate analysis of logbook, auction data and VMS. From 2011 onwards, the official and scientific French landings use the same analysis of logbook and auction data and VMS data. Prior to 2000 official French landings figures have had to be redistributed between ICES areas, according to the average spatial pattern observed from 2000 onwards.

Historical landings of small-scale national fisheries not supplying EU logbooks or sales slips are known to be inaccurate. IBPBass ran the Stock Synthesis model with and without additional UK landings for nets and lines estimated from a separate Cefas logbook scheme, and found this had relatively little impact on stock trends or fishing mortality, but rescaled the biomass and recruitment due to the additional catch. However, if the extent of non-reporting is changing over time, for example to develop track record in the possible event of a future TAC, then bias will be introduced in the assessment trends.

Discard rates are low in most fisheries other than trawls. Estimates of discards are available only from the early 2000s, but do not cover all fisheries, are imprecise, and are only included for some fleets in the assessment. The overall discard rate by weight is thought to be less than 5% before the implementation of management measures increasing in recent years. Nonetheless, a time-series of discards at-length or -age is needed for all fleets if the impact of technical measures to improve selectivity is to be evaluated as part of any future bass management.

29.6.2 Fishery composition data

The ability to fit selectivity patterns for defined groups of fishery métiers, and to detect changes in selectivity, depends crucially on collection of adequate numbers of independent, representative samples of length and age to sufficiently characterise the length or age compositions of the selected métier groups. What constitutes "sufficient" is impossible to define without simulation studies to examine relationship between precision of input data and the precision of estimates required for management.

The absence of length composition data for French fisheries prior to 2000 is a serious deficiency in the model preventing any evaluation of changes in selectivity that may have occurred, for example due to changes in the mix of gear types. The numbers of trips of each métier group sampled on shore in France and the UK has varied widely over time, and in the UK has declined substantially since the 2000s. Currently there are no composition data supplied by Netherlands and Belgium.

ICES has developed extensive advice on establishing statistically-sound sampling designs for estimating fishery length and age compositions and discard quantities (see reports of ICES Workshops on Practical Implementation of Statistically Sound Catch Sampling Programmes (WKPICS1–3, available on ICES website). Stratified random sampling of fishing vessels or harbours may lead to low sample sizes for species such as seabass for which large fractions of the total catches may be taken in relatively small numbers of fishing trips. The cost–benefit of expanding the sampling in vessel or harbour strata where most seabass landings are recorded, without compromising statistical sampling design, should be investigated. The next benchmark should evaluate if sampling is currently sufficient to support continued application of Stock Synthesis fitting selection parameters to fishery composition data.

The comparative assessment using age compositions for French fleets showed that these data may improve the robustness of the assessment in future, and this should be subject to an inter-benchmark assessment and peer review.

29.6.3 Recreational fishery harvests

Current assessments accommodate an estimate of recreational fishery landings in the assessment and forecasts based on landing from 2012 (ICES, 2016; 2018). This a crude approach based on surveys for only a year or two in France, UK, and the Netherlands, and leads to an assumption of constant recreational fishing mortality over time. Recreational catches have been observed to vary significantly over time in other fisheries, so it is possible that this assumption of constant mortality is unlikely to be true. For example, the estimate of recreational harvest in the Netherlands has varied over time. In addition, no data are currently available after the implementation of management measures, meaning that a reconstruction procedure is needed to estimate the impact of management on recreational catches. Further survey data are needed to confirm the level of recreational catches and releases, and to develop a time-series to evaluate changes in recreational fishing mortality and any changes in selectivity.

Release rates are expected to increase due to bag limits and increases in MLS that are in place or planned. Current studies of post-release mortality are limited, and more studies are needed to develop a better understanding of the fate of released fish given the high incidence of catch-and-release practices in sea angling for seabass. WGCSE must collaborate closely with the ICES Working Group on Recreational Fishery Surveys to identify priorities for future surveys and hooking mortality studies.

A full set of data for the UK, France, Netherlands, and Belgium should be available by 2020, and it is possible that additional information may be available on post-release mortality. As a result, recreational removals should be reviewed and updated once these survey data become available.

29.6.4 Surveys

The Channel Groundfish Survey surveys included in the assessment provides data on a wider range of sizes and ages than the Cefas Solent survey, though with a steeply domed size selection pattern. From 2015 onwards, Ifremer no longer use the scientific vessel "Gwen Drez" which will be replaced by the larger vessel "Thalassa". A calibration exercise was carried out in 2014 to assess the effect of this change to a larger vessel. WGCSE noted a concern that coverage of the coastal waters of 7.d could be altered by the use of this new vessel (the size of the vessel may prevent fishing as close to the coast as was possible with the previous vessel). The results of the calibration exercise where evaluated and it was found that the series could not be extended beyond 2014 and that a new series would need to be created from 2015 onward.

The Cefas pre-recruit surveys are now reduced to just the Solent autumn survey, with the Solent spring and the Thames survey having been removed by previous benchmark assessments as being unsuitable. Recruitment estimates for the most recent years are heavily dependent on the Solent survey, and it is important to maintain this series. However, there is a need for information on recruitment trends in other areas, as it cannot be assumed that the Solent index will in the long term represent overall recruitment patterns throughout areas 4 and 7. A study by France under the EU Framework for Community actions in the field of water policy (Table 32) shows clearly that seabass nurseries in the Channel have asynchronous patterns of abundance of young bass. In the UK, 37 seabass nursery areas such as estuaries and saltmarshes are defined for implementing conservation measures, and there are others that may be added. Similar habitats for young bass also occur in France and the Netherlands. A more robust survey design would treat individual nursery grounds as strata or station clusters in an internationally coordinated, stratified survey design. The possibility for this, and the sampling effort and costs for a desired precision, could be considered as part of a long-term seabass management plan.

29.6.5 Commercial lpue indices

The reliance of the assessment on the Solent and Channel trawl surveys is a potential source of bias because they cover only a part of the stock range, and the selectivity is heavily skewed towards young bass. This is of principle concern in establishing the current rate of decline in spawning–stock biomass and associated trends in fishing mortality. In the absence of relative abundance indices for older bass from surveys or commercial fishing vessels covering the range of the stock, it is difficult for the model to fix the recent stock trends and fishing mortality. Statistical modelling of French LPUE data by vessel and rectangle by Laurec and Drogou (WGCSE 2015, Annex 3, WD 07) is now used in the assessment. In parallel a study on effect of vessel selection has been completed (Bissery, Mahevas and Drogou), but is still under development and cannot be evaluated yet.

Analyses of UK commercial fishery LPUE, based on averaging across ICES rectangles where the bulk of seabass catches have been recorded, was presented to IBPNEW in 2012. There were divergent trends between fleets where seabass are typically a bycatch, and mainly under 10 m vessels where increased targeting has probably been occurring using lines and nets. Future development of UK LPUE indices together with equivalent French data would require careful evaluation of potential for LPUE of each fleet to track abundance.

29.6.6 Stock structure and migrations

The assessment treats all seabass in 4.b,c and 7.a,d–h as a single biological stock. Although there can be extensive migrations, for example between the south of the area and the Bay of Biscay (which is treated separately in the WGBIE group), or between the North Sea and the Channel, there is also strong site fidelity (Pawson *et al*., 2008) resulting in a high proportion of tagged fish being recaptured at the same coastal location, even in subsequent years after migrations to offshore spawning sites. Immature seabass may remain close inshore, and exploitation of young fish in coastal waters (<6 nautical miles offshore) may be predominantly by inshore fleets of that country. Mature fish originating from coastal waters of the UK, France or Netherlands or other countries may become increasingly vulnerable to offshore pelagic pair trawlers fishing mainly on mature fish during December to April. These spatial, ontogenetic patterns may lead to complex responses of length and age compositions to previous fishery catches of each country and fleet. This could potentially be addressed using spatial structuring in Stock Synthesis, but the data demands would increase substantially. Both the UK (England) and France have embarked on major programmes of bass research involving electronic and conventional tagging, and modelling of larval drift patterns, to try and improve knowledge of spatial dynamics.

29.6.7 Biological parameters

The maturity ogive used in the assessment was derived from sampling from the 1980s onwards. There has been no coordinated sampling across the full range of the stock in recent years to determine if the current ogive is still valid. Sporadic recent sampling has suggested that seabass may be spawning at sizes smaller than recorded historically (see stock annex). This would alter the F_{MSY} and could also be associated with changes in growth parameters. Mean length-at-age in UK samples remained more or less constant over several decades of sampling, but this analysis needs updating. Changes in growth, or inappropriate growth parameters, will lead to bias in fitting length-selectivity parameters to the French fishery and survey data.

29.6.8 Intermediate year fishing mortality and catch levels for forecasts

As the Measures introduced by the EU commission to reduce fishing mortality toward F_{MSY}, have the potential to affect the short-term forecast assumptions for this stock. The working group agreed that the fishing mortality in 2019 under the same measures are likely to be similar to those in 2018. In the absence of any data on changes in selectivity, there would be no reason to deviate much from this assumption.

Tables 30 provides a detailed short-term *status quo* forecast and Table 31 provide a range of management options from the forecast run.

29.7 Recommendations

29.7.1 Management considerations

Seabass in this stock are characterised by slow growth, late maturity and low natural mortality on adults, which imply the need for comparatively low rates of fishing mortality to avoid depletion of spawning potential in each year class. Productivity of the stock is affected by extended periods of enhanced or reduced recruitment, which appear to be related to changes in sea temperature. Warm conditions facilitate northward penetration of seabass in the North Sea and Northeast Atlantic and enhance the growth and survival of young fish in estuarine and other coastal nursery habitats. A period of above-average sea temperatures and enhanced recruitment between 1989 and the mid-2000s generated a large increase in biomass and a geographic expansion. Increased abundance and a lack of a TAC or other means to control fishing outside of nursery areas stimulated a growth of fisheries and markets for seabass. Many small-scale artisanal fisheries, especially line fishing and some forms of netting, have developed a high seasonal dependency on seabass, and there is also a significant recreational fishing mortality in inshore waters. The behaviour of bass, forming predictable aggregations for spawning and moving close inshore to feed at other times of year, increase their vulnerability to exploitation by offshore and inshore fisheries. Increased targeting of seabass has resulted in a progressive increase in fishing mortality above values considered appropriate to achieve F_{MSY}. The combination of increasing fishing mortality and environmental conditions causing poor recruitment since 2008 appears responsible for a continuous decline in biomass since 2010. Catches appear to be declining in fisheries where seabass is mainly a bycatch, but some other fisheries such as netting in the UK appear to be expanding and may be exploiting known seasonal migration routes and local aggregations of fish despite a more widespread contraction of the population.

Careful management of fishing pressure on seabass is needed to prevent SSB declining to such an extent that the stock’s ability to produce strong recruitment in more favourable environmental conditions is impaired. Since 2013, the European Commission has been in dialogue with Member States to develop a package of management measures to promote recovery of the stock. This resulted in emergency measures to stop the offshore pelagic trawl fishery on spawning aggregations between January and April 2015, bag limits for recreational fishing, and proposals to increase the MLS to 42 cm. Further measures to restrict catches without resorting to a TAC have been implemented. Any management measures applied to commercial and recreational fisheries should take into account the need for collection of data to demonstrate the effectiveness of the measures, and the ability to enforce the measures adequately.

ICES advice in 2004 recommended that “implementation of 'input' controls, preferably through technical measures aimed at protecting juvenile fish, in conjunction with entry limitations into the offshore fishery in particular should be promoted”, and that “any consideration of catch limitation (output control) would need to take into account that seabass are a bycatch in mixed fisheries to a various extent, depending on gear and country; this incites discarding and should be avoided”. This form of advice has re-occurred in subsequent ICES advice for seabass.

WGCSE notes that protection of juvenile fish through technical measures is good to improve the fishery selectivity and increase the number of seabass that are able to spawn at least once, but this is probably not enough to ensure a sufficient decrease in F. Protection of juveniles already exists to an extent already through designation of 37 UK seabass nursery areas where certain types of fishing on seabass is prevented annually or seasonally. However, catching and discarding of seabass by trawlers fishing close to nursery areas remains an issue. Data available to WGCSE indicate that discarding is mainly by otter trawlers using 80–90 mm mesh in or near areas where juvenile bass are most abundant, for example in UK coastal waters of the eastern

Channel. Improvements to fishery selectivity to successfully achieve a large reduction in fishing mortality on pre-spawning fish without increasing discarding would require changes to gear designs, which could have a strong spatial management component.

Entry limitation can prevent an increase in effort but will not decrease F to the extent needed, unless existing licences are withdrawn. The occurrence of seabass as a small bycatch in many fisheries raises the problem of this becoming a "choke species" if vessel catch limits are introduced under EU legislation and seabass fall under the landings obligation.

ICES also previously advised that "Management of seabass fisheries needs to take into account the distinctive characteristics and economic value of the different fisheries. Seabass is of high social and economic value to the large inshore artisanal fleets and to sea angling and other recreational fishing that contribute substantially to local economies". Data from France indicate that the first sale value of the high-volume and lower quality catches of seabass caught by pelagic trawlers targeting offshore spawning fish during December to March has been up to three times lower per kg than for smaller volume sales of higher-quality fish for métiers fishing inshore (Drogou *et al*., 2011). However, there is at present insufficient information to accurately evaluate the total economic value and impact of seabass fisheries beyond just the first sale value and covering direct incomes from sales and direct as well as indirect and induced costs, employment and added value generated downstream. The interrelationship between markets for wild caught and farmed seabass also needs to be evaluated. A number of studies on the economic value of recreational sea fisheries have been conducted in recent years, and these demonstrate high levels of spend into national economies; for example the total direct, indirect and induced spend of sea angling in England in 2012 was estimated at £2 bn GBP (Armstrong *et al*., 2013) although this cannot be easily allocated to a spend per species.

No bio-economic scenarios are available at present to appreciate the effect of management measures for seabass, based on economic considerations, and work is urgently needed in this area. The importance of seabass to recreational fisheries, artisanal and other inshore commercial fisheries and large-scale offshore fisheries in different regions means that resource sharing is an important management consideration that has implications for the type of scientific evidence needed. WGCSE has estimated that up to 30% of total landings in France, England, the Netherlands and Belgium were attributable to the recreational fisheries in recent years.

The effects of targeting of offshore spawning aggregations of seabass in the English Channel and Celtic Sea are poorly understood, particularly how the fishing effort is distributed in relation to mixing of fish from different nursery grounds or summer feeding grounds in the UK, France and other countries, given the strong site fidelity of seabass. This is a subject of a new scientific study on seabass in the UK.

The current stock structure assumptions are pragmatic and need further evaluation. The seabass population in coastal waters of the Republic of Ireland is currently considered as a separate stock, although it extends into at least one of the ICES divisions defining the 4.bc and 7.a,d–h stock. Further studies are needed to determine if the seabass in Irish coastal waters are indeed functionally separate, or if they also mix with the other stock during spawning time and contribute to commercial catches on the offshore spawning grounds. Moreover, the Bay of Biscay is also currently considered as a separate stock although tagging programme indicates some exchange with the area 4 and 7 stock studied assessed by WGCSE.

As bass is, at present, a non-TAC species, there is potential for continued displacement of fishing effort from other species with limiting quotas. The effort of the pelagic fisheries during winter and spring can shift between the Bay of Biscay and the English Channel and approaches, and there is evidence for such a shift to the Channel in recent years, which is likely to have increased the fishing mortality on seabass in Area 7. The fisheries on seabass have grown in the 1990s and 2000s due to good recruitment, and new markets have been established, competing with farmed bass. Fishing mortality has gradually increased over time and has been above F_{MSY} for many years. With the stock in decline and no effective control on these fisheries, the risk of stock collapse is currently very high unless strong year classes are produced again. Therefore, in addition to technical measures to improve the fishery selection pattern, an overall limitation of total fishing mortality across all ages of seabass needs to be continued through appropriate measures.

29.8 References

Armstrong, M.J. 2012. Life-history estimates of natural mortality of seabass around the UK. Working Document: ICES IBPNew 2012; October 2012. 3 pp.

Armstrong, M., and Walmsley S. 2012b. Age and growth of seabass sampled around the UK. Working Document: ICES IBPNew 2012; October 2012. 15 pp.

Armstrong, M., and Walmsley, S. 2012c. Maturity of seabass sampled around the UK. Working Document: ICES IBPNew 2012; October 2012. 14 pp.

Armstrong, M., and Maxwell, D. 2012. Commercial fleet lpue trends for seabass around the UK. Working Document: ICES IBPNew 2012; October 2012. 29 pp.

Armstrong, M., Le Goff, R., and van der Hammen, T. 2014. Assessment of recreational fisheries for seabass. Request for Services - Sea bass. Commitment No.686192. Paper for Scientific, Technical & Economic Committee for Fisheries of the European Commission, Brussels, Belgium. 36 pp.

Armstrong, M., Brown, A., Hargreaves, J., Hyder, K., Munday, M., Proctor, S., and Roberts, A. 2013. Sea Angling 2012 – a survey of recreational sea angling activity and economic value in England. Crown copyright 2013, London, UK. 16 pp.

Coppin, F., Le Roy, D., Schlaich, Y. 2002. Manuel des protocoles de campagne halieutique: Campagnes CGFS, Système d'information halieutiques - Campagnes à la mer. Ifremer, 09/2001. DRV/RH/DT/AN-NUMERO, 29 pp. (in French).

Drogou, M., Biseau, A., Berthou, P., de Pontual, H., Habasque, J and le Grand, C. 2011. Synthèse des informations disponibles sur le Bar: flottilles, captures, marché. Reflexions autour de mesures degestion. http://archimer.ifremer.fr/doc/00035/14577/11879.pdf.

Ferter, K., Weltersbach, M. S., Strehlow, H. V., Volstad, J. H., Alos, J., Arlinghaus, R., Armstrong, M., *et al*. 2013b. Unexpectedly high catch-and-release rates in European marine recreational fisheries: implications for science and management. ICES Journal of Marine Science, 70: 1319–1329.

Hyder, K., Readdy, L., Drogou, M., Woillez, M., and Armstrong, M. 2018. Recreational catches, post-release mortality and selectivity. WKBASS working document. 18 pp.

ICES. 1998. Report of the study group on the precautionary approach to fisheries management. ICES Copenhagen, 3–6 February 1998. ICES C.M. 1998/Assess:10.

ICES. 2003. Study Group on Precautionary Reference Points for Advice on Fishery Management. Copenhagen, 24–26 February 2003. ICES CM 2003/ACFM:15.

ICES. 2008. Report of the Working Group on the Assessment of New MoU Species (WGNEW). By correspondence, ICES CM 2008/ACOM:25. 77 pp.

ICES. 2012a. Report of the Inter-Benchmark Protocol on New Species (Turbot and Seabass; IBPNew 2012). ICES CM. 2012/ACOM:45.

ICES. 2012b. Report of the Working Group on Assessment of New MoU Species (WGNEW), 5–9 March 2012, ICES CM 2012/ACOM:20. 258 pp.

ICES. 2012c. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2012/ACOM:23. 55 pp.

ICES. 2014. Report of the Working Group for Celtic Seas Ecoregion (WGCSE), 8–17 May 2013, Copenhagen, Denmark. ICES CM 2013/ACOM:12. 1986 pp.

ICES. 2014b. Report of the Inter-Benchmark Protocol for Seabass in the Irish Sea, Celtic Sea, English Channel, and Southern North Sea (IBPBass). By correspondence. ICES CM 2014/ ACOM:46.

ICES. 2014c. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:12.

ICES. 2016. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 4–13 May 2016, Copenhagen, Denmark. ICES CM 2016/ACOM:13. 1312 pp.

ICES. 2017a. Report of the Working Group on Recreational Fisheries Surveys (WGRFS), 12–16 June 2017, Horta, Azores, Portugal. ICES CM 2017/EOSG:20. 113 pp.

ICES. 2017b. Report of the Data Evaluation meeting for the Benchmark Workshop on Sea Bass (DEWKBASS), 10–12 January 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:32. 139 pp.

ICES. 2018. Report of the Benchmark Workshop on Seabass (WKBASS), 20–24 February 2017 and 21–23 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM:44. 287 pp.

Lewin, W.C., Strehlow, H.V., Ferter, K., Hyder, K., Niemax, J., Herrmann, J.-P., and Weltersbach, M.S. 2018. Estimating post-release mortality of European seabass based on experimental angling. ICES J. Mar. Sci. doi:10.1093/icesjms/fsx240/.

Mahé, K., Holmes, A., Huet, J., Sévin, K., Elleboode, R. 2012. Report of the Seabass (*Dicentrachus labrax*) Otolith and Scale Exchange Scheme 2011, 16 pp.

Methot, R.D. 2000. Technical Description of the Stock Synthesis Assessment Program. National Marine Fisheries Service, Seattle, WA. NOAA Tech Memo. NMFS-NWFSC-43: 46 pp.

Methot, R.D. 2011. User Manual for Stock Synthesis, Model Version 3.23b. NOAA Fisheries Service, Seattle. 167 pp.

Pawson, M. G. 1992. Climatic influences on the spawning success, growth and recruitment of bass (*Dicentrarchus labrax* L.) in British Waters. ICES mar. Science Symp. 195: 388–392.

Pawson, M. G., Kupschus, S. and Pickett, G. D. 2007. The status of seabass (*Dicentrarchus labrax*) stocks around England and Wales, derived using a separable catch-at-age model, and implications for fisheries management. ICES Journal of Marine Science 64, 346–356.

Pawson, M.G., Brown, M., Leballeur, J. and Pickett, G.D. 2008. Will philopatry in seabass, *Dicentrarchus labrax*, facilitate the use of catch-restricted areas for management of recreational fisheries? Fisheries Research 93 (2008) 240–243.

Quemar T., Vigneau J., Dubroca L. 2018. Estimation of quarterly length distribution of landings in the context of a 6-months disruption in the French on-shore sampling. Working Document to ICES/WGBIE 2018.

Quirijns, F. and Bierman, S. 2012. Growth and maturity of seabass sampled around the Netherlands. Working Document: ICES IBPNew 2012; October 2012. 9 pp.

Then, A. Y., J. M. Hoenig, N. G. Hall, and D. A. Hewitt. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES Journal of Marine Science 72:82–92.

Van der Hammen, T and de Graaf, M. 2012. Recreational fishery in the Netherlands: demographics and catch estimates in marine and freshwater. IMARES Wageningen UR, Report Number C147/13.

Van der Hammen T, and de Graaf, M. 2015. Recreational fisheries in the Netherlands: analyses of the 2012–2013 logbook survey, 2013 online screening survey and 2013 random digit dialing survey. IMARES C042/15, pp 55.

Table 1. Bss.27.4.bc, 7.a, d–h: Annual landings from 4.b,c and 7.d,e–h (Official landings per country and Total Ices estimates).

Year	Belgium	Denmark	Germany	France*	UK	Netherlands	Channel Is.	Total official	Total ICES
1985	0	0	0	620	105	0	18	743	994
1986	0	0	0	841	124	0	15	980	1319
1987	0	0	0	1226	123	0	14	1363	1980
1988	0	18	0	714	173	8	12	925	1239
1989	0	2	0	675	192	2	48	919	1161
1990	0	0	0	609	189	0	25	824	1063
1991	0	0	0	726	239	0	16	982	1227
1992	0	0	0	721	148	0	36	906	1186
1993	0	1	0	718	230	0	45	994	1255
1994	0	1	0	593	535	0	49	1178	1371
1995	0	1	0	801	708	0	69	1579	1835
1996	0	1	0	1703	563	8	56	2331	3022
1997	0	1	0	1429	561	1	74	2066	2620
1998	0	2	0	1363	488	48	79	1980	2390
1999	0	1	0	NA	685	32	108	826	2670
2000	0	5	0	1522	407	60	130	2124	2407
2001	0	2	0	1619	458	77	80	2236	2500
2002	0	1	0	1580	627	96	73	2377	2622
2003	154	1	0	1903	586	163	84	2891	3459
2004	159	1	0	1883	617	191	159	3010	3731
2005	206	1	0	1937	512	327	220	3203	4430
2006	211	2	0	2116	736	308	23	3396	4377
2007	178	1	0	2075	873	376	18	3521	4064
2008	187	0	0	1506	934	380	20	3027	4107
2009	174	0	0	2904	801	395	15	4288	3889
2010	216	4	0	3441	879	399	14	4952	4562
2011	152	2	0	2688	928	395	17	4183	3858
2012	154	3	0	2492	946	376	12	3982	3987
2013	146	4	2	2868	841	370	12	4243	4137
2014	148	1	1	1322	1080	253	11	2816	2682
2015	40	0	0	1113	701	218	9	2081	2066
2016	23	0	1	545	567	156	7	1300	1295
2017	22	0		423	437	57	11	949	984
2018	18	0	0	297	431	165	0	912	801

Source: Official Landings Statistics. 2018 provisional data; Total ICES, from InterCatch database.

Table 2. Bss.27.4.bc, 7.a, d–h. Landings for the country / fleet components included separately in the assessment model.

Year	Fleet 1 : UK Trawls, nets	Fleet 2 : UK Lines	Fleet 3 : UK pelagic trawlers	Fleet 4 : France combined gears	Fleet 5: Other countries and gears	Fleet 6 : RecFish
1985	70	30	1	870	23	2148
1986	84	33	2	1180	19	1933
1987	96	18	0	1840	25	1753
1988	129	30	8	1028	44	1616
1989	141	29	7	917	67	1490
1990	128	18	22	849	47	1342
1991	152	60	14	971	29	1224
1992	105	23	8	1001	49	1222
1993	146	62	1	979	68	1383
1994	354	154	0	786	76	1640
1995	424	169	4	1057	181	1848
1996	308	128	87	2395	104	1890
1997	335	119	71	1984	111	1819
1998	241	121	85	1773	170	1766
1999	274	148	220	1843	185	1765
2000	236	53	52	1805	261	1816
2001	263	58	97	1883	199	1898
2002	361	75	110	1825	251	1980
2003	353	65	127	2471	443	2035
2004	380	72	131	2604	544	2048
2005	353	59	68	3161	789	2014
2006	359	119	11	3259	629	1955
2007	413	166	37	2771	677	1922
2008	514	163	17	2750	663	1902
2009	486	147	9	2649	598	1859
2010	452	183	42	3236	649	1751
2011	462	143	98	2526	629	1604
2012	564	185	49	2610	579	1440
2013	530	191	39	2871	506	1227
2014	751	236	1	1303	391	1020
2015	440	199	0	1110	317	703
2016	305	210	2	547	231	212
2017	125	147	0	442	270	216
2018*	160	267	0	331	61	156

*Preliminary.

Table 3. Bss.27.4.bc, 7.a, d–h: Sampling of commercial fishery landings of otter, pelagic midwater trawls, lines and nets for length and age by area in the UK (England and Wales). Nsamp = number of landings sampled; Nfish = number of fish.

	UK Otter trawl	UK Pelagic/midwa-ter								
	Age	Length	Landings (t)	Age	Length	Landings (t)				
Year	Nsamp	Nfish	Nsamp	Nfish		Nsamp	Nfish	Nsamp	Nfish	
1985	45	235	15	225	27	3	44	2	43	1
1986	18	216	28	2591	24					2
1987	41	421	54	1181	41	4	42	1	589	0.02
1988	23	257	23	1298	65	2	64	2	1684	8
1989	63	531	44	1595	80	4	126	4	1451	7
1990	63	883	48	773	67	8	19			22
1991	92	983	32	731	39	12	125	1	1490	14
1992	69	699	17	398	41	2	50	2	220	8
1993	118	1219	38	836	80	9	39			1
1994	182	1927	113	3925	125			1	127	0.3
1995	28	529	66	1995	162			1	19	4
1996	49	660	39	1041	122	1	41	3	392	87
1997	59	1660	52	2445	140	1	49			71
1998	28	676	39	1442	133	20	95	4	167	85
1999	24	379	46	1216	138	12	382	9	770	220
2000	92	759	42	1814	133	23	847	14	2463	52
2001	45	851	49	2152	141	3	58	5	691	97
2002	54	523	47	1454	161			4	545	110
2003	48	512	45	1418	207	15	459	4	744	127
2004	33	361	31	1295	173	8	161	5	522	131
2005	35	498	31	2432	181	3	149	2	299	68
2006	15	252	17	810	160	1	43	1	100	11
2007	44	385	21	903	173	1	20	3	355	37
2008	37	580	32	2151	196	6	409	8	1283	17
2009	24	1184	13	807	175	8	317	6	625	9
2010	25	360	28	1312	150	7	153	3	376	42
2011	25	577	49	1903	137	3	103	4	463	98
2012	18	182	41	751	157			1	199	49
2013	15	289	23	859	125					39
2014	14	164	22	523	104					1
2015	28	377	39	1277	100	1	4	1	4	1
2016	19	256	90	527	52					2
2017	38	510	128	915	51	0	0	0	0	0
2018	43	263	43	492	28	1	15	1	33	0

	UK Lines					UK Nets				
	Age		Length		Land-ings (t)	Age		Length		Land-ings (t)
Year	Nsamp	Nfish	Nsamp	Nfish		Nsamp	Nfish	Nsamp	Nfish	
1985	53	395	19	285	30	34	332	15	181	43
1986	60	496	31	894	33	18	251	18	1132	61
1987	92	313	69	557	18	37	528	44	1321	55
1988	66	538	53	1325	30	37	584	40	1397	64
1989	249	652	26	310	29	49	469	45	1248	60
1990	281	918	22	260	18	24	207	11	456	61
1991	346	1468	53	963	60	57	481	30	583	113
1992	418	2905	111	2077	23	40	281	28	1248	64
1993	287	1787	123	1426	62	127	1141	94	1686	66
1994	212	1616	155	3783	154	146	2846	157	5130	229
1995	160	1043	107	1493	169	95	1786	150	6248	262
1996	155	1326	106	1790	128	85	1371	113	3348	186
1997	141	1262	137	2072	119	73	1055	106	2747	195
1998	182	1215	111	2820	121	88	1119	82	2465	108
1999	237	1304	149	3793	148	127	1189	74	2966	137
2000	405	1395	65	1964	53	119	1719	104	5482	103
2001	451	2485	114	2935	58	140	2027	92	3309	122
2002	210	1286	146	3031	75	220	3800	206	6680	201
2003	151	1009	90	3108	65	171	1720	224	5899	146
2004	127	906	66	1980	72	83	974	150	3567	207
2005	87	380	25	921	59	73	768	33	1126	172
2006	54	359	67	989	119	56	598	47	1197	199
2007	94	713	31	1088	166	90	753	40	1811	239
2008	37	552	28	1325	163	100	1444	63	3361	318
2009	49	304	18	915	147	116	1571	100	3247	311
2010	34	418	40	970	183	63	1214	66	2350	302
2011	46	1091	55	2250	143	34	793	41	1433	324
2012	89	1295	100	2215	185	35	909	56	2809	407
2013	41	896	42	1236	191	42	1123	49	2342	405
2014	67	1247	73	1889	236	60	1161	71	2781	647
2015	72	1183	79	3055	199	48	776	67	3985	338
2016	69	1151	110	1236	210	59	1165	83	1974	252
2017	28	303	171	2225	158	0	0	41	727	74
2018	103	1478	123	2166	267	55	694	55	1763	132

Table 4. Bss.27.4.bc, 7.a, d–h. Sampling of commercial fishery landings by area in France, giving numbers of fishing trips sampled, number of fish measures, and the total landings (2017 based on real sampling, not simulated).

Year	FR_lines	FR_nets	FR_bot-tom trawl						
	No. Trips	No.fish	Landings	No. Trips	No.fish	Landings	No. Trips	No.fish	Landings
2000	53	1613	305	2	72	108	2	196	692
2001	101	2659	375	1	5	110	0	0	713
2002	79	2076	349	0	0	128	4	710	911
2003	78	1732	438	1	4	152	8	998	1087
2004	78	1748	381	6	84	150	12	887	1236
2005	34	949	439	4	110	148	14	689	1239
2006	73	1719	554	11	291	140	11	1240	1110
2007	69	2235	560	28	641	158	11	588	1187
2008	41	1280	425	25	496	128	18	1927	1145
2009	33	1339	251	25	159	94	93	1468	1052
2010	10	334	278	49	615	160	64	626	819
2011	17	540	359	156	278	129	151	1955	791
2012	10	681	295	60	408	142	87	1204	824
2013	16	309	291	26	512	126	73	2060	737
2014	10	299	285	29	218	163	137	2139	571
2015	16	326	210	35	242	109	76	1628	642
2016	2	84	156	32	293	64	183	1396	271
2017	9	219	166	18	151	35	126	495	33
2018	8	357	151	49	312	74	79	274	63

Year	FR_pe-lagic trawl	FR_dan-ish seine	FR_other gears						
	No. Trips	No.fish	Landings	No. Trips	No.fish	Landings	No. Trips	No.fish	Landings
2000	2	629	681	0	0	0	0	0	20
2001	0	0	659	0	0	0	0	0	27
2002	3	680	415	0	0	0	0	0	22
2003	4	753	773	0	0	0	0	0	23
2004	6	938	820	0	0	0	0	0	17
2005	11	1239	1319	0	0	0	0	0	17
2006	16	2597	1420	0	0	0	0	0	35
2007	8	1800	841	0	0	0	0	0	24
2008	8	1065	1012	0	0	0	0	0	40
2009	55	899	1098	0	0	27	0	0	127
2010	28	1299	1828	0	0	61	2	2	90
2011	30	2309	1142	2	6	43	36	292	62
2012	9	1649	1143	6	370	112	7	154	91
2013	10	1253	1516	2	28	18	1	1	82
2014	23	455	242	12	23	9	1	1	25
2015	12	158	107	0	12	26	0	0	16
2016	6	48	17	28	78	20	0	0	20
2017	0	0	6	14	42	22	0	0	40
2018	2	2	1	2	3	9	0	0	16

Table 5. Numbers-at-length in French commercial all-gears fishery landings (input to assessment at lengths 14–94 cm).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
20	0	0	0	0	0	0	0	0	0	0	717	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	0
28	0	0	0	3455	0	0	0	0	0	292	0	0	1219	0	0	291	0	0	0
30	0	0	1015	13054	14	0	15689	0	0	473	0	0	0	146	0	346	71	0	0
32	0	0	0	58717	13057	9903	32459	181	8250	2239	9811	1976	1583	0	3076	2678	1481	0	0
34	9931	17962	12469	105655	78811	29872	179130	4715	28986	10714	28290	13885	6518	1504	3620	5102	1440	137	0
36	34932	19809	38249	125326	127801	97890	285704	39335	229758	124925	169311	57121	85760	29667	33532	44175	2814	2646	0
38	85866	68920	46427	180475	124051	128022	217657	102714	263071	211881	177571	87842	172510	88507	68262	75546	4340	2523	91
40	126730	76594	62503	119495	227214	231750	178250	146272	266408	225545	182105	128838	140273	149070	74871	93273	7417	3572	814
42	102836	98008	82461	145456	282390	266905	196868	145122	237160	193030	283064	187586	147895	146130	82684	115713	24816	9257	2444
44	80478	109595	91064	104545	243107	344681	289998	164011	270810	222613	251956	201447	162333	123170	51365	122460	20422	14861	2954
46	93344	106857	86723	130023	188494	270532	285451	130859	228996	238849	230227	199487	180752	140677	61292	95208	22427	9603	4379
48	80934	77694	62163	115806	126685	239265	263272	100043	142650	155222	188149	194697	158490	127136	39844	59668	20653	7367	2606
50	55399	57055	55905	91915	72581	169478	200874	99210	112385	159658	186310	145447	130759	116842	38109	51436	15619	6801	3549
52	52948	51658	46180	93878	82331	115269	119836	75929	74336	114530	109212	124239	107214	99156	29929	37860	10415	4599	2861

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
54	42094	36737	35998	48742	50633	62106	99509	74405	66260	84649	120550	92526	90638	103818	39911	21406	16034	3586	2702
56	26460	35839	26001	60839	60284	67741	99674	55147	48853	96257	71590	72471	78934	89197	32298	20681	9753	1012	2538
58	27357	22762	19019	31614	31334	61132	54522	46087	39689	51578	62211	46869	54869	59004	30016	13591	12328	2519	3581
60	23581	25834	14210	33688	19126	43591	45908	28056	29840	36547	31544	31690	35387	65851	21467	11946	7678	913	2008
62	14295	18773	11129	30691	23996	35774	23763	23057	28335	57472	19076	19998	33085	64579	16797	11776	7506	1120	1669
64	18044	13532	16771	18823	14799	25788	20607	18091	14420	24016	62005	17624	17714	53482	16261	9356	4348	1369	1641
66	10773	11068	11011	13230	10650	12456	14969	8715	12694	21415	26388	14720	15170	37744	8387	6653	2634	510	778
68	9903	9120	5447	7960	8569	13360	13976	8793	9039	27466	9340	7906	9374	23884	5579	2485	4465	315	463
70	5709	11771	4795	5374	4880	8908	9653	4835	6821	20198	8541	6114	8114	32512	8995	1163	1353	345	255
72	5721	5733	4559	5617	2974	8053	4521	2707	4714	12083	29128	2082	4147	14996	3027	660	956	408	47
74	2345	5345	1825	3275	2675	9811	3424	1962	1623	7551	1884	1163	2313	9001	642	628	219	652	0
76	2595	2782	1260	1356	2567	5020	2883	1010	1257	979	2114	1096	1540	2640	773	431	0	92	0
78	2102	1691	357	297	548	2378	731	399	534	1765	182	476	1134	2073	0	9	127	718	0
80	888	583	155	783	425	1365	201	158	261	264	5525	148	282	176	198	16	0	0	0
82	1021	296	109	112	149	107	261	37	8	1004	6097	104	451	1566	0	278	0	92	0
84	548	204	0	148	295	0	30	59	0	0	863	0	29	0	0	0	0	0	0
86	123	0	0	0	0	0	0	0	0	0	0	0	27	1115	0	0	301	0	0
88	0	61	0	0	149	0	0	0	0	0	1207	0	0	0	0	0	0	0	0

Table 6. Numbers-at-age in French commercial fishery landings, 2000–2018, all gears combined.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
age2	0	0	0	2611	3	0	3138	0	1208	315	717	0	0	0	0	47	24	21	0
age3	0	2651	8114	10800	4	24195	74600	5307	79917	23355	1962	0	406	60	603	1394	565	105	0
age4	9440	55640	73892	364427	80483	77794	131099	73224	175402	119979	39409	6087	14357	569	6846	20917	3419	1154	356
age5	222655	47734	125531	241694	627951	253455	564668	135809	545960	282754	221063	172404	65157	52216	11735	116939	23364	5712	1325
age6	273687	298773	90294	318445	438799	735235	361515	460583	401231	473020	515711	252236	262593	96064	123435	139446	25335	16085	4079
age7	139562	211740	236147	96562	297961	352182	841651	124606	456312	238022	411737	312186	346334	609903	149938	125305	22790	11655	6239
age8	79413	90962	86108	254050	65297	443765	146484	139879	143871	408951	437222	303804	308183	377156	133129	191220	29076	11830	5199
age9	47258	44742	31151	114829	131612	39104	253945	79978	147881	100487	200328	314164	264012	367869	143241	88543	38383	7528	4401
age10	43924	21074	23025	57883	77533	161572	13655	69214	40719	200417	172430	125800	214803	481247	39242	67528	26822	3485	4393
age11	49293	39908	17823	26223	25416	69617	132370	33191	57341	73570	109342	89188	83939	245982	39476	24658	18455	3636	3087
age12	20207	36007	14760	19879	14848	26314	84910	65868	17882	37114	75421	34465	50701	158757	12679	17551	4964	3571	2340
age13	10767	17787	15912	14232	14254	17996	22068	68599	35092	32657	46461	28352	24784	43008	7347	5046	3114	1819	1358
age14	4925	4394	9752	18088	13528	19238	6648	11131	12669	55506	21880	12942	8470	21825	3067	5387	1866	1544	638
age15	4927	6838	3743	6600	7628	17974	6999	9034	5518	33537	4806	5585	3191	14812	198	431	381	0	275
age16	10901	8034	1553	4028	5270	22718	16069	5486	6091	23529	16480	337	1583	11520	0	428	429	0	329

Table 7. Bss.27.4.bc, 7.a, d–h. Numbers-at-age in UK(England and Wales) mixed bottom otter trawl, nets.

	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16+
1985	65	11844	30828	6121	9692	1240	3914	9713	2454	2581	1320	343	841	286	892
1986	0	15673	20303	18759	3453	7662	704	3197	10503	1833	1403	2889	1222	1688	3595
1987	0	439	30263	58458	13753	2095	2437	656	726	5731	2565	1889	761	817	2796
1988	0	1930	20862	54472	41710	12803	1721	2315	780	451	5503	2024	1312	801	2589
1989	33394	5411	1223	7659	43911	26891	9002	3076	2901	1878	2896	8914	1499	1286	3436
1990	0	3035	2503	3770	16047	31459	21020	5042	2186	1463	846	1100	4837	353	2703
1991	1533	6933	36938	2381	1283	6576	18064	16248	7033	589	2617	2321	480	6659	3674
1992	0	15982	55550	33557	1183	796	1956	4750	4762	1230	451	433	139	497	3202
1993	0	657	81429	65981	21858	1351	627	1796	4803	3920	1500	710	735	475	2347
1994	2	1328	30970	369416	41472	16079	1130	294	2282	5842	4387	1596	650	646	3717
1995	0	5599	37064	81529	334815	17932	6931	702	415	1046	3440	3215	1846	2699	2680
1996	191	11473	43831	31632	64618	173733	8235	3622	216	315	454	1881	1688	534	1784
1997	0	2490	8501	64000	45238	39229	145407	8105	4456	632	640	294	2689	1712	2235
1998	0	1103	44997	49461	69489	25366	15136	41057	2671	860	96	96	385	623	811
1999	241	82	80414	146338	43841	28582	9612	6192	18072	1112	729	40	270	97	830
2000	0	9528	2584	151515	72747	11772	11046	4992	4636	8323	818	184	14	55	643
2001	614	11085	92408	29064	105169	25329	7388	8742	5811	8136	7522	804	768	69	759
2002	338	11495	43605	240476	16779	67647	16021	7450	8022	2682	3842	10166	645	193	568

	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16+
2003	0	5698	75254	70415	154267	8719	38901	14072	4789	3196	2260	1599	3937	937	756
2004	0	4406	38270	214112	76652	95133	2733	12227	4039	1583	994	802	263	1029	221
2005	0	18910	135210	89202	124422	33796	30175	3112	7357	1390	1123	363	173	650	842
2006	0	20497	141335	144890	54069	56281	17344	24148	2207	3475	2277	859	210	188	1433
2007	0	955	33606	169272	96625	44423	34061	12877	14366	11530	4527	1621	11	254	428
2008	0	9338	110875	296983	139083	47617	19838	17332	8660	6128	852	793	988	317	824
2009	0	2659	73056	169969	172602	64997	19002	14443	9064	8631	3610	2235	1302	0	249
2010	0	319	77100	155258	118179	78410	28938	11821	6979	6043	2645	2083	2273	534	1663
2011	0	845	28630	124625	92582	71094	54338	31775	10438	11227	6347	2933	2203	675	1692
2012	0	1620	14135	166965	219883	61319	39609	31669	15268	9427	4092	3864	2546	538	930
2013	0	0	45016	60547	182858	117821	33448	30222	22727	17473	11825	2908	2687	2429	2133
2014	0	6622	31923	107001	58412	114826	78809	38859	27037	30548	19853	5152	1776	1857	1487
2015	0	50	3716	20172	45807	36830	63272	35025	17302	12685	10431	2917	7265	7308	966
2016	0	0	1591	7863	13991	31088	24925	40386	24807	10618	8218	4788	1960	2098	1528
2017	0	0	39	454	2176	1179	881	928	852	713	107	257	41	144	236
2018	0	130	4361	18582	26874	18792	9488	6826	4615	6186	5377	1562	1164	960	766

Table 8. Bss.27.4.bc, 7.a, d–h: Numbers-at-age in UK(England and Wales) Lines.

	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16+
1986	0	577	8939	3343	933	2354	358	758	5428	960	871	953	573	645	1307
1987	0	108	1052	3719	2132	581	477	432	523	1578	845	211	167	179	1187
1988	0	33	1751	13389	5067	2398	551	1014	209	456	1863	895	715	523	977
1989	22	0	538	8171	36046	1842	371	104	208	58	215	1040	115	87	334
1990	0	305	82	185	1284	3456	2407	897	357	369	193	242	1261	81	828
1991	0	131	8420	471	177	792	4927	4024	1842	89	1229	1685	367	4831	2887
1992	0	1195	5473	5267	294	269	518	1193	1633	563	130	195	169	143	1411
1993	16	526	11652	11776	7569	590	289	931	3941	3344	1367	663	703	643	3789
1994	0	71	4059	119784	18540	9393	943	173	1754	5414	5570	1205	639	274	2790
1995	0	486	6943	21979	97509	7380	5313	480	699	831	5684	3696	1936	840	4733
1996	0	210	8804	12487	15338	57127	4566	4979	127	510	364	2521	1573	1300	2346
1997	59	454	3102	15613	11415	8287	50819	2853	1635	557	354	243	2195	1065	1570
1998	0	3676	8366	10920	22630	10485	6452	28231	2949	1091	138	196	793	1381	1254
1999	479	255	25158	37306	13589	13697	5288	5001	20522	1669	2038	247	777	315	3314
2000	0	421	294	19380	12402	2696	3285	1476	1248	4697	330	258	16	88	559
2001	54	471	7385	1392	17864	7702	2027	3239	1685	1761	3774	440	301	27	420
2002	30	729	2609	14173	2686	17358	7757	2621	5179	1463	1766	3687	322	101	180
2003	0	80	7166	7917	25014	2167	10164	3262	1473	982	796	681	1704	186	166

	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16+
2004	0	279	1697	13884	8601	17310	2398	6365	3626	1181	1189	1172	406	2243	143
2005	0	621	2669	5059	14699	5529	6985	589	5697	1845	236	1307	33	189	606
2006	0	44	16121	35990	13714	22306	5794	12717	1644	3135	1258	305	358	1016	734
2007	0	22	6611	31578	28396	14511	17834	8499	10951	5163	3121	5119	85	344	485
2008	0	199	5010	27319	42071	21561	12265	12566	5458	4960	1372	1032	3431	198	992
2009	0	315	8415	19843	33661	25695	12017	9320	5021	5371	4748	811	1075	0	0
2010	0	814	7029	45515	54766	39716	15835	5147	2395	2910	706	522	359	81	277
2011	0	8	5209	11538	24667	19293	16668	13032	4947	6066	2695	1941	2187	522	657
2012	0	91	1695	18362	28593	23507	22946	17909	10199	7725	2994	2672	2158	596	820
2013	0	0	1187	6979	35135	32251	18057	14762	10333	10543	6106	3730	2886	1957	1938
2014	0	980	4985	26081	20743	39548	28357	15323	12440	12413	8018	4889	1976	1673	1322
2015	0	6	1834	5941	23369	22221	31442	19014	10344	8210	7036	2504	3136	744	798
2016	0	0	742	7020	11858	20142	15479	25838	13362	7406	5904	4674	2548	3894	2567
2017	0	0	1734	4007	5766	2324	2362	1036	4159	993	356	469	202	475	330
2018	0	454	6992	23652	41538	31173	17352	16753	11214	14117	9044	4650	3791	2220	3945

Table 9. Bss.27.4.bc, 7.a, d–h: Numbers-at-age in UK (England and Wales) midwater pair trawl fleet (no samples for 1997, 2013, 2014, 2015, 2016, 2017).

	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16+
1996	0	289	796	3892	71666	5583	1648	21	334	154	622	485	199	559
1998	0	245	5979	11845	8553	8135	25138	2517	345	93	53	119	893	569
1999	0	2983	18409	15106	27147	13818	18060	43097	4389	1686	324	387	308	2689
2000	15	60	2476	7587	3270	4497	1459	2830	7077	634	174	39	96	420
2001	0	179	899	19777	20290	7042	5268	3124	2845	9666	857	636	123	261
2002	3	37	2380	1578	24087	9693	6297	5978	450	5664	9215	0	0	530
2003	0	2689	10619	39257	7971	40551	10293	3162	3254	618	169	4043	77	281
2004	7	1254	12502	14372	48109	3199	20694	8010	353	1797	1141	91	968	18
2005	0	114	2103	15321	14397	17408	1907	5182	0	1831	99	0	40	599
2006	0	227	567	608	4076	1423	3085	254	176	111	0	0	0	53
2007	0	385	2517	7038	5387	6833	2795	1900	631	807	12	37	19	121
2008	45	445	1540	3279	1787	1412	1557	755	960	30	183	490	0	40
2009	0	90	635	2175	2596	843	784	168	298	173	11	169	0	0
2010	9	36	1741	5546	8261	6678	4755	403	3786	152	294	313	551	50
2011	0	255	4397	10231	13640	15909	13642	4424	4233	2773	1688	1003	264	423
2012	0	391	4461	10776	10016	8757	5789	2741	1134	290	433	143	127	226
2015	0	7	23	85	103	137	30	6	3	0	0	0	0	0

Table 10. Bss.27.4.bc, 7.a, d–h: Numbers of trips sampled for discards by Cefas (UK): 2002–2015, by gear group and area.

Division (a) bottom otter trawls	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4	16	34	56	37	41	85	58	49	46	42	54	30	53	45	12	0	1
7.afg	8	15	23	8	11	43	50	28	22	22	22	12	14	16	2	0	0
7.d	1	2	4	3	1	2	1	6	7	9	4	5	7	3	13	1	1
7.eh	9	24	37	31	49	90	87	38	29	32	29	45	73	68	29	0	10
total	34	75	120	79	102	220	196	121	104	105	109	92	147	132	56	1	12
(b) Fixed/driftnets																	
Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4	0	0	2	1	11	31	15	20	15	11	13	18	10	7	0	0	0
7.afg	3	7	5	3	7	8	9	10	7	16	22	16	25	12	3	0	0
7.d	0	0	1	0	0	17	6	4	1	7	10	42	25	17	10	0	0
7.eh	1	5	9	2	3	16	10	14	19	17	25	24	24	15	0	0	0
total	4	12	17	6	21	72	40	48	42	51	70	100	84	51	13	0	0
(c) Lines																	
Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4	0	1	0	0	0	1	2	0	0	0	0	0	1	1	0	0	0
7.afg	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
7.d	0	0	0	0	0	0	0	0	0	0	0	0	1	0	33	2	0
7.eh	0	0	1	0	0	0	0	0	0	0	1	0	8	5	4	0	0

total	0	1	1	0	0	1	2	0	0	0	2	1	10	6	37	2	0

(d) Midwater trawls

Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
7.afg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.d	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
7.eh	0	1	1	1	2	1	0	0	0	0	0	2	1	0	0	0	0
total	1	1	1	3	2	1	0	0	0	0	0	2		0	0	0	0

(e) Other gears

Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4	8	5	10	1	2	1	1	7	6	8	4	10		0	6	0	0
7.afg	4	11	8	4	9	1	2	3	3	1	4	8		0	5	0	0
7.d	0	1	5	2	3	1	1	2	4	1	2	3	1	2	0	0	0
7.eh	10	17	27	16	24	32	18	13	17	27	22	21	14	15	1	0	0
total	22	34	50	23	38	35	22	25	30	37	32	42	15	17	12	0	0

Table 11. Bss.27.4.bc, 7.a, d–h: Estimated annual numbers and weight of seabass retained and discarded by UK using fixed or driftnets, otter trawl, beam trawl and lines fleets in areas 4, 7.d, 7.eh and 7.afg, based on at-sea sampling, and raised from landings in sampled strata to landings in all strata. Numbers of sampled trips are shown.

	Otter trawl	Nets	Beam trawl	Lines	Total OTB, nets, lines and BTS														
	dis-cards	re-tained	rate (%)	No. trips sampled	discards	re-tained	rate %	No. trips sampled	dis-cards	re-tained	rate %	No. trips sampled	dis-cards	re-tained	rate (%)	No. trips sampled	dis-cards	re-tained	rate%
2002	17	161	9	34	0	201	0	4	0.2	24	0.7	-	-	-	-	-	17	386	4
2003	16	207	7	75	0	146	0	12	1.9	21	8.1	-	-	-	-	-	18	374	5
2004	59	173	25	120	0	207	0	17	0.3	24	1.3	-	-	-	-	-	59	404	13
2005	6	181	3	79	90	172	34	6	2.4	15	13.7	-	-	-	-	-	99	368	21
2006	34	160	17	102	19	199	9	21	0.4	14	2.5	-	-	-	-	-	53	373	12
2007	49	173	22	220	1	239	0.4	72	0.0	19	0.0	-	-	-	-	-	50	432	10
2008	5	196	3	196	3	318	0.9	40	1.2	21	5.6	-	-	-	-	-	9	535	2
2009	85	175	33	121	0	311	0.1	48	0.2	10	1.5	-	-	-	-	-	86	495	15
2010	49	150	25	104	1	302	0.3	42	1.2	6	17.1	-	-	-	-	-	51	458	10
2011	8	137	6	105	14	324	4.2	51	0.0	5	0.0	-	-	-	-	-	22	467	5
2012	27	157	15	109	2	407	0.5	70	0.0	5	0.0	-	-	-	-	-	29	569	5
2013	4	125	3	92	2	405	0.4	100	1.1	4	20.1	-	-	-	-	-	6	534	1
2014	1	104	1	147	6	647	0.9	84	0.0	8	0.0	-	-	-	-	-	7	758	1
2015	6	77	7	132	1	340	0.4	51	0.0	8	0.0	-	-	-	-	-	7	425	2
2016	35	52	40	56	8	252	3	13	0.1	23	0.0		8.4	210.0	4.0	37.0	52	537	9
2017*	0	35	1	1	-	74	-	0	-	16	-	0	11	147	7	2		272	-
2018*	11	13	46	5	-	132	-	0	15	13	54	7	-	267	-	0	26	425	6

***Not used in assessment (lack of information. High probability of underestimation considering management measures).**

Table 12. Bss.27.4.bc, 7.a, d–h: Number of fishing trips sampled for retained and discarded weight of seabass on French vessels using different gear types: 2009–2018. (Data are clearly under-estimated from 2015 and are not used in assessment).

pelagic trawl FR	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	0	773	0.00%	NA		
2004	0	820	0.00%	NA		
2005	0	1319	0.00%	NA		
2006	0	1420	0.00%	NA		
2007	0	841	0.00%	NA	12	2
2008	2	1012	0.20%	3.93	21	4
2009	21.2	1098	1.89%	0.05		
2010	7.4	1828	0.40%	0.71	35	106
2011	7.2	1142	0.63%	0.12	9	46
2012	0.9	1143	0.08%	2.38	7	29
2013	0.3	1516	0.02%	2		
2014	0	242	0.00%	NA		
2015	11.7	107	9.86%	0.03	32	5
2016	0.5	17.43081	2.79%	NA	19	2
2017		6		NA	0	0
2018	0.2	1	17%		28	1

bottom trawlFR	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	73.8	1087	6.36%	0.35	18	26
2004		1236	NA	NA	24	3
2005	43.9	1239	3.42%	0.9		
2006	42.9	1110	3.72%	1.07	24	36
2007	9.6	1187	0.80%	0.73		
2008	40.7	1145	3.43%	0.94	57	63
2009		1052	NA	NA	143	102
2010	76.6	819	8.55%	0.32	137	5
2011	27.2	791	3.32%	0.46	122	57
2012	24.5	824	2.89%	0.23	151	118
2013	26.3	737	3.45%	0.37	139	145
2014		571	NA	NA	133	29
2015	35.4	642	5.23%	0.49	189	356
2016	126.9	271	31.86%	NA	512	90
2017	156	178	47%	NA	61	141
2018	32	72	31%		217	71

netsFR	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	31.7	152	17.26%	1.2		
2004	77.6	150	34.09%	0.1		
2005	0	148	0.00%	NA		
2006	125.5	140	47.27%	0.34		
2007	2.2	158	1.37%	0.61	32	2
2008	0.5	128	0.39%	0.79		
2009	6.4	94	6.37%	0.41	196	3
2010	6.1	160	3.67%	0.29	108	5
2011	9	129	6.52%	0.35		
2012	11.8	142	7.67%	0.55	269	9
2013	21.6	126	14.63%	0.18	173	2
2014	21.7	163	11.75%	0.11	118	3
2015	14.7	109	11.88%	0.2	217	8
2016	19.4	64	23.25%	NA	258	209
2017	0.7	34	2%	NA	0	0
2018	2	74	3%		101	17

linesFR	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	0	438	0.00%	NA		
2004	0	381	0.00%	NA		
2005	0	439	0.00%	NA		
2006	0	554	0.00%	NA		
2007	0	560	0.00%	NA		
2008	100.3	425	19.09%	0.35		
2009	5.6	251	2.18%	0.71	17	21
2010	3.9	278	1.38%	1.24		
2011	13.1	359	3.52%	0.35		
2012	15.8	295	5.08%	0.26		
2013	14.2	291	4.65%	0.45		
2014	15.8	285	5.25%	0.4		
2015	7.4	210	3.40%	0.32	28	21
2016		156		NA		
2017		166		NA	0	0
2018		151			0	0

OtherFR	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	0	23	0.00%	NA		
2004	6.6	17	27.97%	NA		
2005	0	17	0.00%	NA		
2006	0	35	0.00%	NA		
2007	0	24	0.00%	NA		
2008	0	40	NA	NA		
2009	0	127	NA	NA		
2010	0	90	0.00%	NA		
2011	44.8	62	41.95%	5.97		
2012	1.1	91	1.19%	0.25	6	9
2013	0	82	0.00%	NA		
2014	0	25	0.00%	NA	130	96
2015	11	11	50.00%	0.58		
2016	5.9	19.82406	22.94%	NA	64	9
2017	5	58	8%	NA	0	0
2018		15			0	0

FR_ALL	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	105.5	2473	4%		18	26
2004	84.2	2604	3%		24	3
2005	43.9	3162	1%		0	0
2006	168.4	3259	5%		24	36
2007	11.8	2770	0%		44	4
2008	143.5	2750	5%		78	67
2009	33.2	2622	1%		356	126
2010	94	3175	3%		280	116
2011	101.3	2483	4%	7.25	131	103
2012	54.1	2495	2%	3.67	433	165
2013	62.4	2752	2%		312	147
2014	37.5	1286	3%		381	128
2015	80.2	1079	7%	1.62	466	390
2016	152.7	529	22%		853	310
2017	161.7	442	27%		61	141
2018	34.2	313	10%			

Table 13. Bss.27.4.bc, 7.a, d–h: Estimates of recreational catches of seabass in different countries and years in numbers and weight of fish for retained and released components of the catch, and release rates. The relative standard error (RSE) is provided where available and expressed as a percentage.

			Numbers (thousands)	**Weight (tonnes)**													
Country	Year	Area	Retained	RSE	Re-leased	RSE	To-tal	RSE	% re-leased	Re-tained	RSE	Re-leased	RSE	Total	RSE	% re-leased	Source
Belgium	2012	BSS-47								60							Unknown
France	2009–2011	BSS-47	781		796		1578	>26	50	940		332		1272	>26	26	ICES (2014b)
	2009–2011	BSS-8AB	1168		1190		2357	>26	50	1405		496		1901	>26	26	Calculated
	2009–2011	Both	1949		1986		3935	26	50	2345		828		3173	26	26	Rocklin *et al*. (2014)
	2011–2012	BSS-47	2043		1581		3624		44	2458		659		3117		21	Ifremer
	2011–2012	BSS-8AB	572		281		852		33	688		117		805		15	Ifremer
	2011–2012	All	2615		1861		3935		47	3146		776		3922		20	Ifremer
Nether-lands	2010–2011	BSS-47	234	38	131	27	366	30	36	138	37						van der Hammen and de Graaf (2013)
	2012–2013	BSS-47	335	26	332	21	667		50	229	26						van der Hammen and de Graaf (2015)
	2014–2015	BSS-47	176	19	499	20	675		74	138	20						van der Hammen and de Graaf (2017)
UK	2012–2013	BSS-47	367		576		943		61	230–440		150–250		380–690	26–38	36–39	Armstrong *et al*. (2013)

Table 14. Bss.27.4.bc, 7.a, d–h: Recreational removals (tonnes) by country for 2012. PRM indicates fish that die after release, applying post release mortality of 5% as used in the WKBASS assessment WK 2018.

Country	Year	Retained	PRM	Removals
France	2009–2011	940	17	957
Netherlands	2010–2011	138	3	141
England	2012	332	10	343
Total	2012	1410	29	1440

Table 15. Bss.27.4.bc, 7.a, d–h: Values of expected recreational F reductions associated with management measures applied to Bss.27.4bc7ad–h since 2015. Frec multiplier represents the recreational F relative to 2012.

Year	MANAGEMENT SCENARIO	Frec Multiplier		
	MCRS	Bag limit	Open season	
Pre-2015	36 cm	none	none	1.000
2015	42 cm for 6 months	three-fish for 6 months	none	0.832
2016 & 2017	42 cm	one fish	6 months	0.282
2018	42 cm	no fish	3 months	0.191

Table 16. Bss.27.4.bc, 7.a, d–h: Country specific proportion reduction in retained catch numbers obtained by applying bag limits and increased MRS from 36 to 42 cm to catch numbers in fishing trips observed in national recreational fishing surveys taking place before the new management measures were introduced (Armstrong *et al.*, 2014). The mean weights in kg of retained and released fish from surveys are shown. BL represents bag limit and MCRS is the increase from 36 cm to 42 cm.

	Management measure	Weights (kg)						
Country	BL1	BL2	BL3	BL4	BL5	MCRS only	Retained	Released
France (all)	0.61	0.46	0.39	0.36	0.35	0.35	1.20	0.42
Netherlands	0.64	0.64	0.64	0.64	0.64	0.64	0.59	0.40*
UK	0.52	0.32	0.23	0.23	0.23	0.23	1.09	0.39

*** Average of French and UK release weights.**

Table 17. Bss.27.4.bc, 7.a, d–h: Values of expected recreational F reductions associated with management measures applied to Bss.27.4bc7ad–h reflecting any combination of bag limit (BL) and open season length (months).

Open Season	BL 1 fish	BL 2 fish	BL 3 fish	BL 4 fish	BL 5 fish	No BL
0	0.099	0.099	0.099	0.099	0.099	0.099
3	0.191	0.221	0.235	0.239	0.240	0.240
6	0.282	0.343	0.371	0.379	0.381	0.381
7	0.312	0.383	0.416	0.426	0.428	0.428
9	0.373	0.464	0.506	0.519	0.522	0.522
10	0.404	0.505	0.552	0.566	0.569	0.569
12	0.465	0.586	0.642	0.659	0.663	0.663

Table 18. Estimated length-based maturity ogive parameters.

	Females	Males
Intercept (a)	-13.556	-16.851
Slope (b)	0.3335	0.4861
c = a/b	-40.6488	-34.6652
L25%	37.35	32.41
L50%	40.65	34.67
L75%	43.95	36.93

Table 19. Proportion mature-at-age (females) derived by Stock Synthesis model.

Age	0	1	2	3	4	5	6	7	8	9
Pmat	0.000	0.000	0.000	0.000	0.186	0.419	0.638	0.792	0.885	0.937
Age	10	11	12	13	14	15	16	17	18	19+
Pmat	0.965	0.980	0.989	0.993	0.996	0.998	0.998	0.999	0.999	1.000

Table 20. Inferences on natural mortality rate from a range of life-history based methods (WKBASS Data WK update of table provided by ICES, IBPNEW 2012 seabass benchmark; see data WK report for full list of references).

Source	Formulation	Combined sex M		
		tmax28	tmax 27	tmax26
Hoenig 1983	variety of taxa ln(M) = 1.44-0.982*ln(tmax);	0.160	0.166	0.160
	teleosts ln(M) = 1.46-1.01*ln(tmax)	0.149	0.154	0.160
	M= 4.899*tmax^-.916 (from 226 species)	0.231	0.239	0.248
Then *et al* 2015	M= 4.118*K^0.73. Linf^-0.33		0.173	
Alverson and Carney 1975	M = 3k/(exp(0.38*tmax*k)-1)	0.161	0.171	0.181
Pauly 1980	M=exp(-0.0152+0.6543*ln(k)-0.279*ln(Linf,cm)+0.4634*lnT(oC))	0.196	TdegC=	12
		0.211	TdegC=	14
		0.224	TdegC=	16
Ralston 1987	M=0.0189+2.06*k	0.219		
Beverton 1992	M=3k/(exp(*am* *k)-1) am = age at 50% maturity	0.369	female *am* ; comb sex k	
		0.614	male *am* , comb sex k	
Jensen (1997)	M=1.5K	0.146		
			Gislason	Lorenzen
Gislason 2010	M = exp(0.55-1.61*Ln(L) + 1.44* Ln (Linf)+ Ln(K))	age 1	1.599	1.210
Lorenzen	M=3*W^-0.288	age 3	0.539	0.644
		age 5	0.312	0.482
	Gislason: L = length at age from VBGF	age 7	0.221	0.402
	Lorenzen: W = mean wt at age from 2016 WGCSE SS3 run	age 9	0.175	0.355
		age 15	0.117	0.287
		age 20	0.100	0.262

Life history parameters	
VBGF K (combined sex)	0.097
VBGF Linf (combined sex)	84.55
VBGF to (combined sex	-0.73
Age at 50% maturity females (L50% converted to age)	6
Age at 50% maturity males (L50% converted to age)	4
Max age (combined sex)	28
Length at 50% mat females	40.65
Length at 50% mat males	34.67

Table 21. Bss-47: Inferences on natural mortality rate by age class using the Gislason *et al*. (2010) and Lorenzen (2006) methods. Values are given unscaled, and scaled to a mean M of 0.24 at ages 10–20 (based on Then *et al*., 2015 for maximum age of 27 years) and mean M of 0.15 at ages 10–20 (from Hoenig, 1983 using maximum age of 27–28 years).

	Gislason method M	**Lorenzen method M**						
age class	L	Not scaled	Scaled to 0.24 at ages 10–20	Scaled to 0.15 at age 5–20	W (kg)	Not scaled	Scaled to 0.24 at ages 10–20	Scaled to 0.15 at age 5–20
1	13.1	1.599	3.145	1.966	0.023	1.210	0.995	0.622
2	19.7	0.827	1.627	1.017	0.096	0.807	0.663	0.415
3	25.7	0.539	1.060	0.662	0.209	0.644	0.530	0.331
4	31.1	0.395	0.778	0.486	0.369	0.547	0.450	0.281
5	36.1	0.312	0.613	0.383	0.570	0.482	0.397	0.248
6	40.5	0.258	0.508	0.317	0.807	0.436	0.359	0.224
7	44.6	0.221	0.435	0.272	1.073	0.402	0.331	0.207
8	48.3	0.195	0.383	0.239	1.359	0.376	0.309	0.193
9	51.6	0.175	0.344	0.215	1.659	0.355	0.292	0.182
10	54.7	0.159	0.314	0.196	1.968	0.338	0.278	0.174
11	57.5	0.147	0.290	0.181	2.279	0.324	0.266	0.166
12	60.0	0.138	0.270	0.169	2.588	0.312	0.257	0.160
13	62.2	0.130	0.255	0.159	2.893	0.302	0.249	0.155
14	64.3	0.123	0.242	0.151	3.190	0.294	0.242	0.151
15	66.2	0.117	0.231	0.144	3.476	0.287	0.236	0.147
16	67.9	0.113	0.222	0.138	3.751	0.280	0.231	0.144
17	69.4	0.109	0.214	0.134	4.013	0.275	0.226	0.141
18	70.8	0.105	0.207	0.129	4.262	0.270	0.222	0.139
19	72.1	0.102	0.201	0.126	4.498	0.266	0.219	0.137
20	73.2	0.100	0.196	0.122	4.719	0.262	0.216	0.135
21	74.3	0.097	0.192	0.120	4.926	0.259	0.213	0.133
22	75.2	0.095	0.188	0.117	5.119	0.256	0.211	0.132
23	76.1	0.094	0.184	0.115	5.299	0.254	0.209	0.130
24	76.9	0.092	0.181	0.113	5.464	0.252	0.207	0.129
25	77.6	0.091	0.179	0.112	5.616	0.250	0.205	0.128
26	78.2	0.090	0.176	0.110	5.755	0.248	0.204	0.127
27	78.8	0.089	0.174	0.109	5.882	0.246	0.203	0.127
28	79.3	0.088	0.172	0.108	5.996	0.245	0.201	0.126
mean over ages 10–20		0.122	0.240	0.150	3.422	0.292	0.240	0.150

Table 22. Updated time-series of Cefas Solent autumn survey of juvenile seabass, including 2013 survey results. Indices for 2000 are revised. A change in trawl design took place in 1993, and calibration factors are applied.

Year	Solent Index
1986	5.84
1987	2.6
1989	7.05
1990	3.98
1991	3.32
1992	19.7
1993	14.63
1994	5.46
1995	10.24
1996	6.06
1997	38.2
1998	7.34
1999	20.91
2000	17.46
2001	39.91
2002	11.7
2003	13.55
2005	21.93
2006	19.73
2007	5.5
2008	25.52
2009	19.83
2011	4.05
2013	1.52
2014	1.4
2015	7.44
2016	6.03
2017	3.54
2018	2.66

Table 23. Seabass indices of abundance 2000–2014 (swept area) from the Channel Groundfish Survey. The relative standard error CV is the log-transformed value used in SS3 (sqrt(loge (1+CV^2)).

year	Total hauls	No. hauls with seabass	Percentage of hauls with seabass	Mean no. seabass per positive haul	Swept-area abundance index	CV
1988	68	6	9	2	245776	0.15
1989	61	3	5	1	77716	0.58
1990	75	8	11	8	1129914	0.12
1991	79	19	24	9	4250636	0.03
1992	60	23	38	13	2617986	0.11
1993	65	21	32	8	2299919	0.10
1994	86	19	22	5	1097828	0.11
1995	166	17	10	5	1021741	0.09
1996	134	26	19	3	1224238	0.13
1997	169	31	18	6	1817599	0.12
1998	82	38	46	8	2531043	0.08
1999	102	37	36	8	1642271	0.12
2000	100	36	36	9	2570994	0.08
2001	109	39	36	9	3150674	0.14
2002	100	44	44	12	3872427	0.11
2003	94	41	44	20	8739056	0.11
2004	94	44	47	8	3598436	0.10
2005	105	40	38	7	3005315	0.08
2006	110	36	33	14	5518000	0.12
2007	103	33	32	8	3661314	0.14
2008	105	40	38	10	6468839	0.15
2009	102	26	26	7	2564694	0.09
2010	101	30	30	4	1804538	0.10
2011	108	27	25	4	1513742	0.12
2012	96	25	26	5	2034552	0.11
2013	96	19	20	4	995987	0.13
2014	98	20	20	3	669931	0.13

Table 24. Numbers-at-age in Solent Survey1986–2015: updated time-series of Cefas Solent autumn survey of juvenile seabass (2015 revised).

AGE CLASS	2	3	4
1986	0.27	4.26	1.31
1987	0.05	0.28	2.27
1989	6.68	0.37	0
1990	2.81	1.15	0.02
1991	3.1	0.2	0
1992	0.95	18.6	0.16
1993	6.65	3.59	4.39
1994	3.33	1.84	0.29
1995	4.83	4.69	0.72
1996	5.52	0.43	0.11
1997	33.6	4.52	0.06
1998	1.22	5.5	0.61
1999	19.4	0.67	0.87
2000	6.07	11.4	0.03
2001	34.4	3.92	1.57
2002	7.42	3.87	0.4
2003	8.37	4.6	0.59
2005	13.1	7.98	0.84
2006	9.51	9.21	1.02
2007	3.42	1.78	0.3
2008	18.5	6.66	0.34
2009	13.3	6.25	0.33
2011	2.3	1.4	0.4
2013	1.34	0.08	0.1
2014	1.17	1.02	0.11
2015	6.95	0.44	0.05
2016	3.75	2.17	0.11
2017	0.858	2.562	0.118
2018	2.168	0.316	0.18

Table 25. Key model assumptions and parameters from the WGCSE 2019 update assessment.

Characteristic	Settings
Starting year	1985
Ending year	Assessment year-1 (2018)
Equilibrium commercial catch for starting year	0.82* landings in 1985 by fleet.
Equilibrium recreational catch for starting year	Constant F estimated using 2012 survey results 1985–2014; 2015–present Frec multiplier on F 2012 survey results
Number of areas	1
Number of seasons	1
Number of fishing fleets	6
Number of surveys	2: CGFS; Solent autumn survey.
Number of commercial tunning fleets	1
Individual growth	von Bertalanffy, parameters fixed, combined sex
Number of active parameters	111
Population characteristics	
Maximum age	30
Genders	1
Population length bins	4–100, 2 cm bins
Ages for summary total biomass	0–30
Data characteristics	
Data length bins (for length structured fleets)	6–94, 2 cm bins
Data age bins (for age structured fleets)	0–16+
Minimum age for growth model	2
Maximum age for growth model	30
Maturity	Logistic 2-parameter – females; L50 = 40.65 cm
Fishery characteristics	
Fishery timing	-1 (whole year)
Fishing mortality method	Hybrid
Maximum F	2.9
Fleet 1: UK Trawl/nets selectivity	Double normal, length-based
Fleet 2: UK Line selectivity	Asymptotic, length-based
Fleet 3: UK Midwater trawl selectivity	Asymptotic, length-based
Fleet 4: Combined French fleet selectivity	Asymptotic 1985–2014, Double normal 2015–present, length-based
Fleet 5: Other fleets/gears selectivity	Mirrors French fleet
Fleet 6: Rrecreational fishery	Double normal, length-based
Blocks: Selectivity and Retention	Fleets 1, 2, 4, 5 and 6 2015 to present
Survey characteristics	
Solent autumn survey timing (yr)	0.83
CGFS survey timing (yr)	0.75

Characteristic	Settings
French LPUE timing (yr)	-1
Catchabilities (all surveys)	Analytical solution
Survey selectivities: Solent autumn:	Double normal, length-based constrained by Min–Max age selectivity, age-based
Survey selectivities: CGFS	Double normal, length-based
Tunning fleet: French LPUE	Mirrors French fleet
Fixed biological characteristics	
Natural mortality	0.24
Beverton–Holt steepness	0.999
Recruitment variability (σR)	0.9
Weight–length coefficient	0.00001296
Weight–length exponent	2.969
Maturity inflection (L50%)	40.649 cm
Maturity slope	-0.33349
Length-at-age Amin	19.6 cm at Amin=2
Length-at-Amax	80.26 cm
von Bertalanffy k	0.09699
von Bertalanffy Linf	84.55 cm
von Bertalanffy t0	-0.730 yr
Std. Deviation length-at-age (cm)	SD = 0.1166 * age + 3.5609
Age error matrix	CV 12% at-age
Other model settings	
First year for main recruitment deviations for burn-in period	1955
Last year for recruit deviations	2016 (last year class with survey indices-2)
Last year no bias adjustment	1974.5
First year full bias adjustment	1881.7
Last year full bias adjustment	2014.9
First year recent year no bias adjustment	2016.8
Maximum bias adjustment	0.907

Table 26. Final seabass update assessment: model estimated stock numbers-at-age (thousands of fish).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1985	862	1258	20430	8597	4948	1675	1524	1302	1794	4213	1581	984	722	549	401	278	619
1986	2469	678	988	15984	6658	3764	1245	1108	932	1271	2971	1112	692	507	386	282	631
1987	20458	1943	533	772	12343	5035	2772	894	780	648	878	2047	765	476	349	266	629
1988	16119	16093	1525	415	593	9230	3642	1941	610	523	430	580	1349	504	314	230	590
1989	93569	12680	12640	1191	320	447	6767	2600	1357	421	359	294	396	922	345	215	561
1990	7374	73604	9959	9874	918	241	327	4823	1816	936	289	245	201	271	630	236	531
1991	14562	5800	57809	7779	7609	691	176	233	3361	1249	640	197	167	137	185	430	524
1992	22786	11455	4554	45103	5976	5689	500	124	159	2264	835	427	131	111	91	123	637
1993	10557	17924	8993	3552	34645	4471	4117	350	84	107	1509	554	283	87	74	61	505
1994	32088	8305	14073	7017	2731	25966	3244	2896	241	57	72	1009	370	189	58	49	378
1995	51030	25241	6523	10995	5407	2052	18906	2297	2011	165	39	49	688	252	129	40	293
1996	2914	40142	19823	5092	8453	4045	1484	13263	1577	1363	111	26	33	462	170	87	225
1997	56168	2292	31495	15424	3886	6238	2859	1006	8702	1012	865	70	16	21	291	107	197
1998	18334	44183	1799	24526	11791	2876	4432	1954	667	5663	652	554	45	11	13	187	195
1999	54392	14422	34677	1402	18775	8754	2053	3044	1303	437	3666	420	357	29	7	9	246
2000	27423	42786	11318	27004	1072	13905	6213	1396	2002	839	278	2323	266	226	18	4	162
2001	29225	21572	33579	8815	20668	796	9939	4278	933	1313	544	179	1497	171	145	12	107

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2002	47319	22990	16930	26156	6748	15351	569	6840	2858	611	851	351	116	963	110	94	77
2003	45959	37223	18044	13190	20022	5010	10964	391	4571	1875	397	550	227	75	623	71	110
2004	34346	36153	29200	14031	10051	14738	3529	7392	255	2908	1177	248	343	141	46	388	113
2005	22710	27018	28358	22697	10682	7385	10349	2369	4788	161	1815	730	153	212	87	29	311
2006	25061	17864	21181	22000	17201	7781	5116	6821	1499	2947	98	1090	437	92	127	52	204
2007	27150	19714	14005	16432	16671	12522	5384	3369	4315	923	1784	59	653	262	55	76	153
2008	15775	21357	15460	10878	12486	12195	8729	3582	2160	2699	569	1093	36	399	160	34	141
2009	13076	12409	16750	12010	8265	9130	8500	5813	2302	1356	1671	350	671	22	245	98	107
2010	3423	10286	9734	13019	9137	6060	6392	5696	3765	1458	847	1038	217	416	14	152	128
2011	13192	2692	8064	7551	9858	6635	4174	4184	3581	2303	878	506	619	129	248	8	167
2012	5831	10377	2112	6263	5732	7194	4607	2763	2668	2228	1413	535	308	377	79	151	107
2013	16744	4587	8136	1638	4736	4146	4924	2995	1727	1624	1337	843	319	183	225	47	155
2014	18780	13171	3594	6297	1231	3385	2784	3118	1812	1013	937	765	481	182	105	129	116
2015	3661	14773	10334	2792	4763	887	2304	1808	1962	1120	621	573	468	295	112	65	152
2016	13452	2880	11614	8087	2145	3503	612	1500	1142	1228	700	389	361	296	187	71	139
2017	22031	10581	2265	9114	6284	1626	2552	429	1029	779	838	479	267	248	204	130	147
2018	22019	17330	8322	1778	7087	4779	1197	1825	302	722	546	588	337	188	175	144	196
2019	22020	17321	13631	6537	1389	5465	3596	876	1314	217	517	392	423	242	136	126	246

Table 27. Final seabass update assessment: model estimated fishing mortality-at-age.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1985	0.000	0.001	0.005	0.016	0.034	0.056	0.078	0.095	0.105	0.110	0.112	0.112	0.112	0.112	0.112	0.112	0.112
1986	0.000	0.001	0.007	0.019	0.039	0.066	0.091	0.111	0.123	0.130	0.133	0.134	0.134	0.134	0.134	0.133	0.133
1987	0.000	0.002	0.009	0.024	0.051	0.084	0.117	0.143	0.160	0.170	0.175	0.177	0.178	0.178	0.177	0.177	0.177
1988	0.000	0.002	0.007	0.020	0.042	0.070	0.097	0.117	0.130	0.137	0.140	0.140	0.141	0.140	0.140	0.139	0.138
1989	0.000	0.002	0.007	0.020	0.043	0.072	0.099	0.119	0.131	0.138	0.140	0.141	0.141	0.141	0.140	0.140	0.138
1990	0.000	0.002	0.007	0.021	0.044	0.073	0.100	0.121	0.134	0.140	0.143	0.144	0.144	0.143	0.142	0.142	0.141
1991	0.000	0.002	0.008	0.024	0.051	0.085	0.117	0.140	0.155	0.163	0.166	0.167	0.166	0.166	0.165	0.164	0.163
1992	0.000	0.002	0.009	0.024	0.050	0.083	0.115	0.140	0.157	0.166	0.170	0.171	0.171	0.171	0.171	0.170	0.169
1993	0.000	0.002	0.008	0.023	0.048	0.081	0.112	0.136	0.151	0.159	0.163	0.164	0.164	0.164	0.164	0.163	0.162
1994	0.000	0.001	0.007	0.021	0.046	0.077	0.105	0.125	0.136	0.142	0.143	0.143	0.143	0.142	0.141	0.140	0.138
1995	0.000	0.002	0.008	0.023	0.050	0.084	0.115	0.136	0.149	0.155	0.158	0.158	0.157	0.156	0.155	0.154	0.152
1996	0.000	0.003	0.011	0.030	0.064	0.107	0.149	0.181	0.203	0.215	0.220	0.222	0.223	0.222	0.222	0.221	0.219
1997	0.000	0.002	0.010	0.029	0.061	0.102	0.141	0.171	0.190	0.200	0.205	0.206	0.206	0.205	0.204	0.203	0.201
1998	0.000	0.002	0.010	0.027	0.058	0.097	0.136	0.165	0.185	0.195	0.200	0.201	0.201	0.201	0.200	0.200	0.198
1999	0.000	0.002	0.010	0.028	0.060	0.103	0.146	0.179	0.200	0.211	0.216	0.218	0.218	0.218	0.217	0.216	0.215
2000	0.000	0.002	0.010	0.027	0.058	0.096	0.133	0.163	0.182	0.193	0.198	0.200	0.200	0.200	0.199	0.199	0.197
2001	0.000	0.002	0.010	0.027	0.057	0.096	0.134	0.164	0.183	0.194	0.198	0.200	0.200	0.200	0.199	0.199	0.197
2002	0.000	0.002	0.010	0.027	0.058	0.097	0.134	0.163	0.182	0.191	0.196	0.197	0.197	0.196	0.196	0.195	0.192

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2003	0.000	0.003	0.012	0.032	0.066	0.110	0.154	0.189	0.212	0.225	0.231	0.233	0.234	0.233	0.233	0.232	0.231
2004	0.000	0.003	0.012	0.033	0.068	0.114	0.158	0.194	0.218	0.231	0.238	0.240	0.240	0.240	0.239	0.239	0.237
2005	0.000	0.003	0.014	0.037	0.077	0.127	0.177	0.218	0.245	0.262	0.270	0.273	0.274	0.274	0.273	0.273	0.272
2006	0.000	0.003	0.014	0.037	0.077	0.128	0.178	0.218	0.245	0.262	0.270	0.273	0.274	0.273	0.273	0.272	0.271
2007	0.000	0.003	0.013	0.035	0.073	0.121	0.167	0.204	0.229	0.243	0.250	0.253	0.253	0.253	0.252	0.251	0.250
2008	0.000	0.003	0.013	0.035	0.073	0.121	0.167	0.202	0.226	0.239	0.246	0.248	0.248	0.247	0.246	0.245	0.243
2009	0.000	0.003	0.012	0.033	0.070	0.117	0.160	0.194	0.217	0.230	0.236	0.238	0.238	0.237	0.236	0.235	0.233
2010	0.000	0.003	0.014	0.038	0.080	0.133	0.184	0.224	0.252	0.267	0.275	0.278	0.278	0.277	0.277	0.276	0.274
2011	0.000	0.003	0.013	0.036	0.075	0.125	0.173	0.210	0.235	0.248	0.255	0.257	0.257	0.256	0.255	0.254	0.252
2012	0.000	0.003	0.014	0.039	0.084	0.139	0.191	0.230	0.256	0.271	0.277	0.279	0.278	0.277	0.276	0.274	0.271
2013	0.000	0.004	0.016	0.045	0.096	0.158	0.217	0.263	0.293	0.310	0.318	0.321	0.320	0.319	0.317	0.316	0.313
2014	0.000	0.003	0.013	0.039	0.088	0.145	0.192	0.223	0.242	0.250	0.252	0.250	0.247	0.244	0.241	0.238	0.232
2015	0.000	0.001	0.005	0.024	0.067	0.131	0.189	0.220	0.229	0.229	0.226	0.223	0.219	0.215	0.211	0.208	0.202
2016	0.000	0.000	0.002	0.012	0.037	0.077	0.116	0.137	0.143	0.142	0.140	0.137	0.135	0.132	0.129	0.126	0.121
2017	0.000	0.000	0.002	0.012	0.034	0.066	0.095	0.110	0.114	0.114	0.113	0.112	0.110	0.109	0.107	0.106	0.102
2018	0.000	0.000	0.001	0.007	0.020	0.044	0.073	0.088	0.093	0.093	0.092	0.090	0.089	0.087	0.086	0.084	0.082

Table 28. Final seabass update assessment: stock summary table.

Year	Recruitment (Age 0, thousands)	High	Low	SSB (Tonnes)	High	Low	F(4-15)	High	Low	Commercial landings	Commercial discards*	Recreational removals
1985	862	1649	74	24810	31019	18600	0.096	0.122	0.07	994		1713
1986	2469	4506	433	21938	27485	16390	0.113	0.143	0.083	1318		1550
1987	20458	26382	14534	19651	24584	14719	0.149	0.188	0.11	1979		1412
1988	16119	23124	9114	17849	22272	13426	0.119	0.15	0.089	1239		1305
1989	93569	107559	79578	17065	21150	12979	0.12	0.151	0.09	1161		1204
1990	7374	12533	2215	15593	19422	11764	0.122	0.155	0.09	1064		1082
1991	14562	20522	8602	13634	17179	10088	0.142	0.181	0.103	1226		988
1992	22786	29774	15797	11894	15123	8665	0.145	0.183	0.106	1186		998
1993	10557	15661	5453	12117	15075	9160	0.139	0.171	0.107	1256		1150
1994	32088	41332	22843	14699	17500	11898	0.124	0.148	0.099	1370		1378
1995	51030	61438	40622	18556	21444	15668	0.136	0.161	0.111	1835		1551
1996	2914	5397	432	20666	23735	17597	0.188	0.22	0.153	3022		1570
1997	56168	67277	45059	19884	22991	16778	0.175	0.21	0.142	2620		1496
1998	18334	27674	8994	18670	21713	15627	0.17	0.2	0.138	2390		1448
1999	54392	66880	41905	18052	20997	15107	0.184	0.22	0.149	2670		1449
2000	27423	36891	17955	18133	21016	15250	0.169	0.2	0.136	2407		1496
2001	29225	41198	17253	19119	22062	16176	0.169	0.2	0.137	2500		1572
2002	47319	62144	32494	19937	22970	16904	0.167	0.198	0.135	2622	17	1655

Year	Recruitment (Age 0, thousands)	High	Low	SSB (Tonnes)	High	Low	F(4-15)	High	Low	Commercial landings	Commercial discards*	Recreational removals
2003	45959	58899	33020	21075	24227	17922	0.197	0.23	0.159	3459	16	1727
2004	34346	44995	23697	21776	25056	18495	0.2	0.24	0.163	3731	59	1771
2005	22710	30466	14954	22343	25749	18937	0.23	0.27	0.183	4430	96	1782
2006	25061	32603	17519	22078	25586	18571	0.23	0.27	0.182	4377	53	1777
2007	27150	35712	18588	21925	25455	18395	0.21	0.25	0.17	4064	50	1798
2008	15775	22582	8968	22552	26048	19057	0.21	0.25	0.168	4107	8	1824
2009	13076	18068	8083	23102	26555	19649	0.2	0.24	0.163	3889	151.2	1812
2010	3423	6296	549	22973	26363	19583	0.23	0.28	0.189	4562	147.9	1726
2011	13192	17646	8739	21351	24607	18095	0.22	0.26	0.175	3858	22	1592
2012	5831	8876	2787	19794	22871	16716	0.24	0.28	0.19	3987	156.6	1440
2013	16744	23902	9586	17758	20665	14851	0.27	0.33	0.21	4137	53.4	1241
2014	18780	28344	9215	14982	17763	12200	0.22	0.27	0.17	2682	24.7	1048
2015	3661	6468	854	12885	15595	10174	0.199	0.25	0.149	2066	39.5	737
2016	13452	24605	2298	11025	13689	8360	0.122	0.153	0.088	1295	198.6	228
2017	12383**			10353	13020	7685	0.101	0.127	0.071	984	271.102	223
2018	12383**			10313	13068	7559	0.079	0.101	0.055	801	482.4	156
2019	12383**											

***Partial discards, discard data are not available for all fleets in some years.**

****Geometric mean recruitment 2005–2016.**

Table 29. Inputs for short-term forecast. Fishing mortality is the estimates for 2015, which takes into account a change in overall selectivity due to the reduction in French landings. Numbers-at-ages 0–2 in 2015 are adjusted by replacing Stock Synthesis values for 0-group in 2014–2015 (years with no recruit deviations estimated) with the long-term GM, adjusted for natural mortality.

age	2018	weight in stock	Proportion mature (female)	H.Cons retained mean F (2017)	H.Cons Discarded mean F (2017)	H.Cons retained mean weights	H.Cons discarded mean weights	H.Cons proportion retained	Recreational F	Recreational removals mean weight	M
0	12383	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.24
1	9741	0.024	0.000	0.000	0.000	0.103	0.103	0.304	0.000	0.077	0.24
2	7661	0.096	0.000	0.000	0.001	0.220	0.220	0.164	0.001	0.188	0.24
3	6537	0.209	0.000	0.005	0.001	0.367	0.368	0.790	0.001	0.338	0.24
4	1389	0.369	0.089	0.009	0.008	0.563	0.548	0.509	0.003	0.526	0.24
5	5465	0.570	0.291	0.025	0.012	0.806	0.749	0.668	0.007	0.746	0.24
6	3596	0.806	0.575	0.061	0.005	0.991	0.968	0.922	0.006	0.989	0.24
7	876	1.071	0.798	0.074	0.003	1.239	1.220	0.962	0.012	1.248	0.24
8	1314	1.356	0.916	0.085	0.001	1.506	1.504	0.994	0.007	1.524	0.24
9	217	1.655	0.966	0.082	0.000	1.802	1.804	0.997	0.011	1.816	0.24
10	517	1.962	0.986	0.082	0.000	2.105	2.109	0.999	0.010	2.120	0.24
11	392	2.271	0.994	0.079	0.000	2.407	2.415	1.000	0.012	2.427	0.24
12	423	2.579	0.997	0.077	0.000	2.707	2.717	1.000	0.012	2.732	0.24
13	242	2.882	0.999	0.077	0.000	3.002	3.011	1.000	0.010	3.030	0.24
14	136	3.176	0.999	0.075	0.000	3.285	3.294	1.000	0.011	3.320	0.24
15	126	3.461	1.000	0.073	0.000	3.557	3.565	1.000	0.011	3.598	0.24
16+	246	4.072	1.000	0.071	0.000	4.149	4.149	1.000	0.012	3.865	0.24

Age 0,1,2 over-written as follows:

2019 yc	**2019 age 0 replaced by 2005–2016 LTGM (12 383);**
2018 yc	**2019 age 1 from SS3 survivor estimate at-age 1, 2019 * LTGM / SS3 estimate of age 0 in 2018;**
2017 yc	**2019 age 2 from SS3 survivor estimate at-age 2, 2019 * LTGM / SS3 estimate of age 0 in 2017.**

Table 30. Bss.27.4.bc, 7.a, d–h: Detailed short-term *status quo* forecast.

Year:	Intermediate year	2019					
	H.Cons Retained F mult:	1	F(4-15):	0.067 combined	0.088	Based on F rec in 2012	**0.0604**
	H.Cons Discarded F mult	1	F(4-15):	0.002		Frec 2018	0.0093 0.019
	Recreational F mult	2.031	F(4-15):	0.019		Fmult on 2012	0.312 7 month 1 bag limit

Age	F(4-15): Commercial Retained	F(4-15): Commercial Discarded	F(4-15): Recreational	Catch Nos: Commercial Retained	Catch (t): Commercial Retained	Catch Nos: Commercial Discards	Catch (t): Commercial Discards	total commercial catch	Catch Nos: Recreational	Yield (t): Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12383	35	0	0
1	0.000	0.000	0.000	0.1	0.0	0.3	0.0	0.0	1.8	0.1	9741	231	0	0
2	0.000	0.001	0.001	0.9	0.2	4.4	1.0	1.2	8.1	1.5	7661	737	0	0
3	0.005	0.001	0.001	27.6	10.1	7.3	2.7	12.8	6.8	2.3	6537	1368	0	0
4	0.009	0.008	0.006	10.4	5.9	10.0	5.5	11.4	7.8	4.1	1389	512	124	46
5	0.025	0.012	0.013	119.2	96.0	59.2	44.3	140.3	63.9	47.7	5465	3114	1590	906
6	0.061	0.005	0.013	188.2	186.5	15.9	15.3	201.8	39.5	39.0	3596	2899	2067	1666
7	0.074	0.003	0.024	54.9	68.0	2.2	2.7	70.7	17.4	21.8	876	938	699	748
8	0.085	0.001	0.015	94.9	142.9	0.6	0.8	143.8	16.3	24.9	1314	1782	1203	1631
9	0.082	0.000	0.022	15.0	27.1	0.0	0.1	27.2	4.0	7.3	217	358	209	346
10	0.082	0.000	0.020	35.9	75.5	0.0	0.1	75.6	8.9	18.9	517	1015	510	1001
11	0.079	0.000	0.023	26.2	63.1	0.0	0.0	63.1	7.8	18.9	392	891	390	885
12	0.077	0.000	0.024	27.7	74.9	0.0	0.0	75.0	8.4	23.0	423	1090	422	1087
13	0.077	0.000	0.021	15.8	47.5	0.0	0.0	47.5	4.4	13.2	242	699	242	698
14	0.075	0.000	0.022	8.6	28.4	0.0	0.0	28.4	2.5	8.3	136	431	135	430
15	0.073	0.000	0.023	7.8	27.9	0.0	0.0	27.9	2.5	8.9	126	437	126	437
16+	0.071	0.000	0.025	14.8	61.5	0.0	0.0	61.5	5.2	20.0	246	1003	246	1003
Total				648	**915**	100	**73**	988	205	**260**	51261	17540	7963	10884

Year:	Intermediate year + 1		2020					
	H.Cons Retained F mult:		1	F(4-15):	0.067 combined	0.088	Based on F rec in 2012	**0.0604**
	H.Cons Discarded F mult		1	F(4-15):	0.002			0.0093 0.019
	Recreational F mult	2.03	1.000	F(4-15):	0.019			0.312

Age	Commercial Retained	Commercial Discarded	F(4-15) Recreational	Commercial Retained	Commercial Retained	Commercial Discards	Commercial Discards	commercial catch	Catch Nos: Recreational	Yield (t): Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12383	35	0	0
1	0.000	0.000	0.000	0.1	0.0	0.3	0.0	0.0	1.8	0.1	9741	231	0	0
2	0.000	0.001	0.001	0.9	0.2	4.4	1.0	1.2	8.1	1.5	7660	737	0	0
3	0.005	0.001	0.001	25.4	9.3	6.8	2.5	11.8	6.3	2.1	6015	1259	0	0
4	0.009	0.008	0.006	38.2	21.5	36.9	20.2	41.7	28.5	15.0	5105	1882	455	168
5	0.025	0.012	0.013	23.3	18.8	11.6	8.7	27.4	12.5	9.3	1068	608	311	177
6	0.061	0.005	0.013	213.8	211.8	18.0	17.4	229.2	44.8	44.3	4085	3293	2348	1893
7	0.074	0.003	0.024	163.7	202.9	6.5	8.0	210.9	52.1	65.0	2614	2798	2085	2232
8	0.085	0.001	0.015	45.0	67.8	0.3	0.4	68.2	7.7	11.8	623	845	571	774
9	0.082	0.000	0.022	64.9	116.9	0.2	0.3	117.2	17.4	31.6	935	1547	903	1495
10	0.082	0.000	0.020	10.6	22.4	0.0	0.0	22.4	2.6	5.6	153	301	151	297
11	0.079	0.000	0.023	24.6	59.1	0.0	0.0	59.1	7.3	17.7	367	835	365	829
12	0.077	0.000	0.024	18.2	49.4	0.0	0.0	49.4	5.6	15.2	278	718	278	716
13	0.077	0.000	0.021	19.6	58.9	0.0	0.0	58.9	5.4	16.4	301	867	300	865
14	0.075	0.000	0.022	11.0	36.2	0.0	0.0	36.2	3.2	10.6	173	549	173	549
15	0.073	0.000	0.023	6.0	21.4	0.0	0.0	21.4	1.9	6.8	97	335	97	335
16+	0.071	0.000	0.025	16.0	66.5	0.0	0.0	66.5	5.6	21.7	266	1085	266	1084
Total				681	963	85	59	1022	211	275	51864	17925	8302	11413

Year:	Intermediate year + 2	2021				
	H.Cons Retained F mult:	1	F(4-15):	0.067	combined	0.088
	H.Cons Discarded F mult	1	F(4-15):	0.002		
	Recreational F mult	1.00	F(4-15):	0.019		

Age	Commercial Retained	Commercial Discarded	F(4-15): Recreational	Commercial Retained	Commercial Retained	Commercial Discards	Commercial Discards	commercial catch	Catch Nos: Recreational	Yield (t): Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12383	35	0	0
1	0.000	0.000	0.000	0.1	0.0	0.3	0.0	0.0	1.8	0.1	9741	231	0	0
2	0.000	0.001	0.001	0.9	0.2	4.4	1.0	1.2	8.1	1.5	7660	737	0	0
3	0.005	0.001	0.001	25.4	9.3	6.8	2.5	11.8	6.3	2.1	6014	1259	0	0
4	0.009	0.008	0.006	35.2	19.8	33.9	18.6	38.4	26.2	13.8	4697	1732	419	154
5	0.025	0.012	0.013	85.6	69.0	42.5	31.8	100.8	45.9	34.2	3924	2236	1141	650
6	0.061	0.005	0.013	41.8	41.4	3.5	3.4	44.8	8.8	8.7	798	643	459	370
7	0.074	0.003	0.024	185.9	230.4	7.4	9.1	239.5	59.1	73.8	2969	3178	2368	2535
8	0.085	0.001	0.015	134.3	202.2	0.8	1.2	203.4	23.1	35.3	1860	2521	1703	2308
9	0.082	0.000	0.022	30.8	55.4	0.1	0.1	55.6	8.3	15.0	443	734	428	709
10	0.082	0.000	0.020	46.0	96.7	0.0	0.1	96.8	11.4	24.2	663	1300	653	1282
11	0.079	0.000	0.023	7.3	17.5	0.0	0.0	17.5	2.2	5.2	109	248	108	246
12	0.077	0.000	0.024	17.1	46.2	0.0	0.0	46.3	5.2	14.2	261	673	260	671
13	0.077	0.000	0.021	12.9	38.8	0.0	0.0	38.8	3.6	10.8	198	571	198	570
14	0.075	0.000	0.022	13.7	44.9	0.0	0.0	44.9	4.0	13.1	214	681	214	681
15	0.073	0.000	0.023	7.7	27.2	0.0	0.0	27.2	2.4	8.7	123	427	123	427
16+	0.071	0.000	0.025	11.6	48.1	0.0	0.0	48.1	4.1	15.7	193	785	193	784
Total				656	947	100	68	1015	220	277	52251	17991	8268	11388

Table 31. Management options table. The F-at-age in 2015, when the French pelagic fishery was substantially reduced, was assumed as *status quo* for 2016 when the pelagic fishery was closed in spring, and assumed to continue in 2017. F-Multipliers for 2017 are applied to both the commercial and recreational fishery. Note that the combined total commercial and recreational forecasted catch could be allocated in different ways.

2019		Commercial fishery						Recreational fishery			Total fishery	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Discards	Fmult	Fbar	Catch	Total Fbar	Total catch
17540	10884	1.000	0.067	915	1.000	0.002	73	2.031	0.019	260	0.088	1248

2020		Commercial fishery						Recreational fishery			Total fishery		**2021**	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Discards	Fmult	Fbar	Catch	Total Fbar	Total catch	Biomass	SSB
17925	11413	1.901	0.127	1757	1.901	0.005	109	2.125	0.040	561	0.171	2427	16946	10475
		1.901	0.127	1757	1.901	0.005	109	2.125	0.040	561	0.171	2427	16946	10475
		1.470	0.098	1379	1.470	0.004	85	2.125	0.040	569	0.142	2033	17311	10794
		0.000	0.000	0	0.000	0.000	0	0.317	0.006	91	0.006	91	19109	12371
		2.049	0.136	1885	2.049	0.005	117	2.125	0.040	558	0.182	2560	16824	10367
		3.100	0.206	2753	3.100	0.008	173	2.125	0.040	540	0.254	3466	15988	9638
		2.189	0.146	2009	2.189	0.005	124	1.878	0.035	492	0.187	2625	16762	10313
		1.000	0.067	963	1.000	0.002	59	1.000	0.019	275	0.088	1296	17991	11388
		1.370	0.091	1290	1.370	0.003	79	2.125	0.040	571	0.135	1939	17397	10870
		1.370	0.091	1290	1.370	0.003	79	2.125	0.040	571	0.135	1939	17397	10870
		1.040	0.069	990	1.040	0.003	60	2.125	0.040	577	0.112	1627	17687	11123

Table 32. Annual average cpue bars Group 0 (1000 minutes trawling) and annual deviations from the time-series average per site. The sites are listed from north to south.

	annual LPUE (number of age 0 for 1000minutes of trawling								average annual deviation					
	area	2005	2006	2007	2009	2010	2011	average per area	2005	2006	2007	2009	2010	2011
East Channel	seine aval		4			133	15	51		-91			161	-70
	Ome		206			164	268	213		-3			-23	26
	Baie des Veys	0	167			96	4	89	-100	88			7	-95
West Channel	Mont St Michel		567			836	252	551		3			52	-54
	Morlaix			664	182	535	456	459			45	-60	16	-1
South Britanny	Laita			0	2	278	17	74			-100	-98	275	-78
	Blavet			25	42	19	58	36			-32	17	-46	61
	Vilaine			301	19	23	101	111			171	-83	-79	-9
Bay of Biscay	Loire		151		192	0	30	93		62		106	-100	-68
	Sevre Niortaise			3772	2133	460	74	1610			134	32	-71	-95
	Charente				28	14	6	16				76	-12	-65
	Seudre	0			127	0	11	35	-100			268	-100	-68
	Gironde aval					87	7	47					86	-86
	Gironde	3			72			38	-91			91		
	Adour aval	4	22		12	0	0	8	-45	191		54	-100	-100
								mean	-84	42	44	40	5	-50
SD >-20%								SD	26.2	96	112.6	108.1	109.6	49.8
-20%<SD>20%														
SD >+20%														

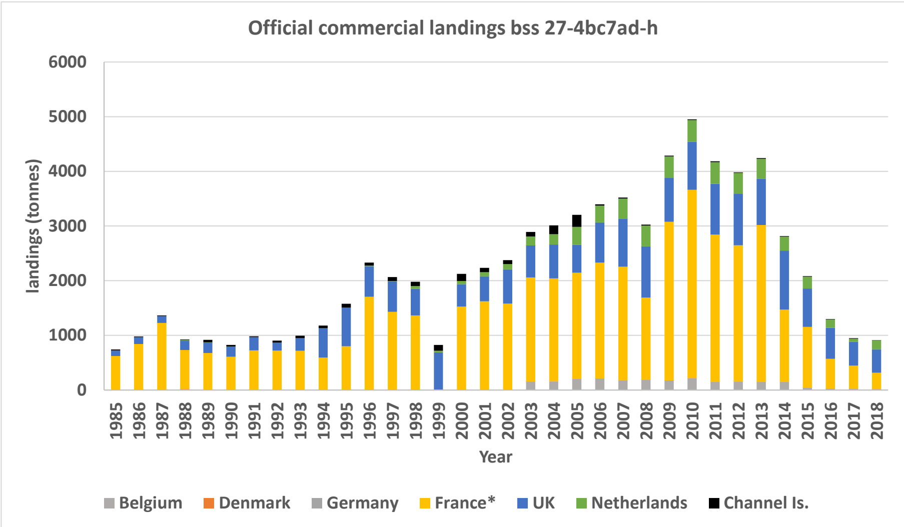
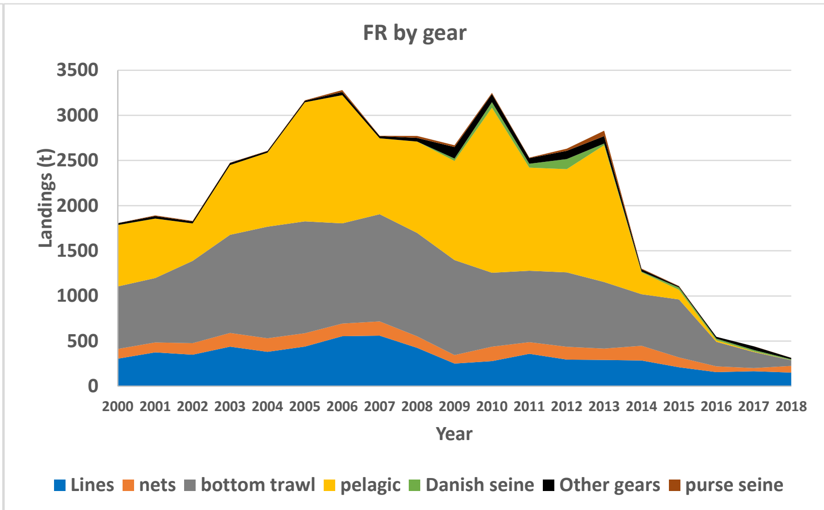


Figure 1. Bss.27.4.bc, 7.a, d–h. Trends in Official landings by country.



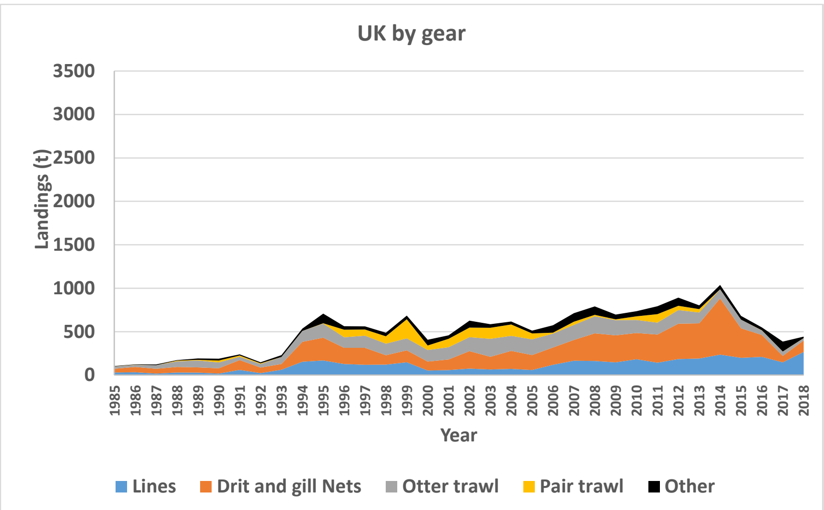


Figure 2. Bss.27.4.bc, 7.a, d–h. Trends in ICES estimates landings by gear (France-top and UK-bottom).

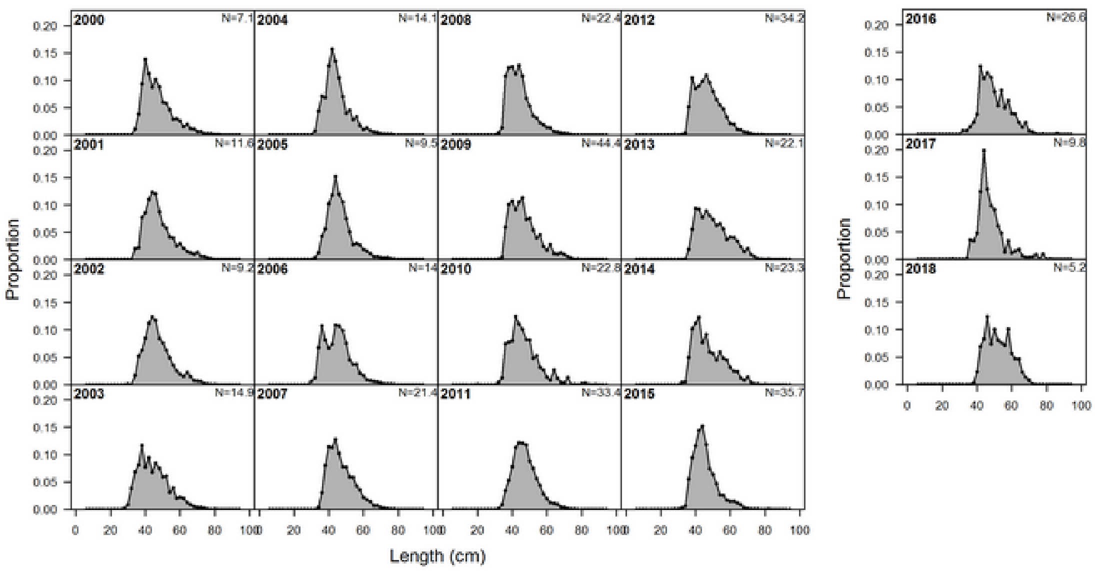
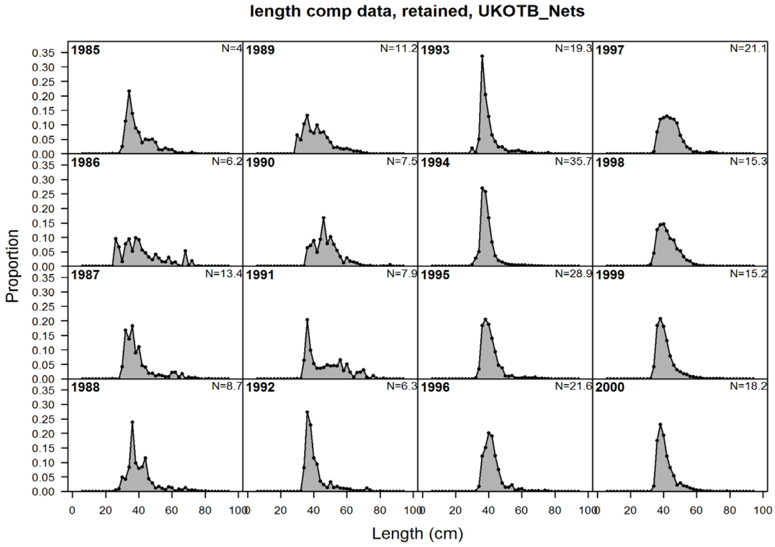
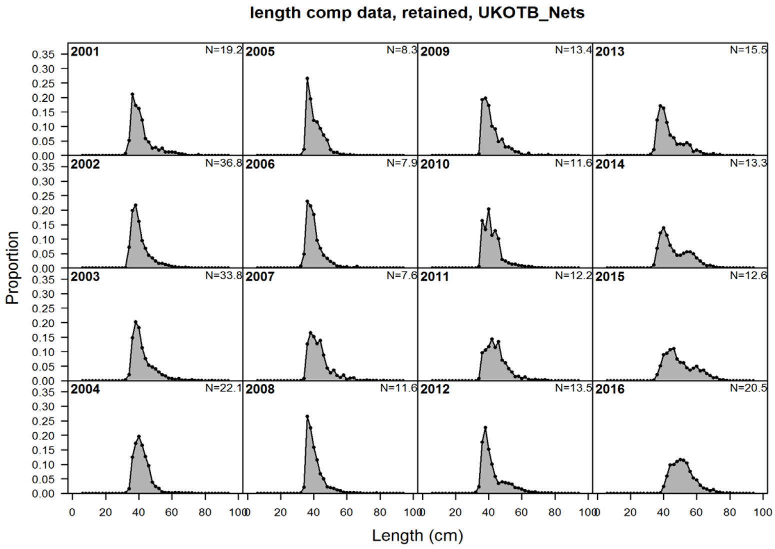


Figure 3. Bss.27.4.bc, 7.a, d–h. Length composition all French fleet combined from 2000 onwards.





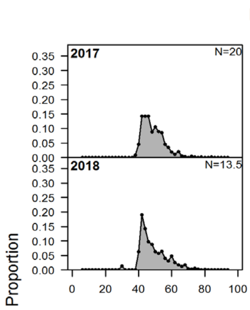


Figure 4. Bss.27.4.bc, 7.a, d–h. Length composition of UKOTB_Nets fleets landings from 1985 onwards.

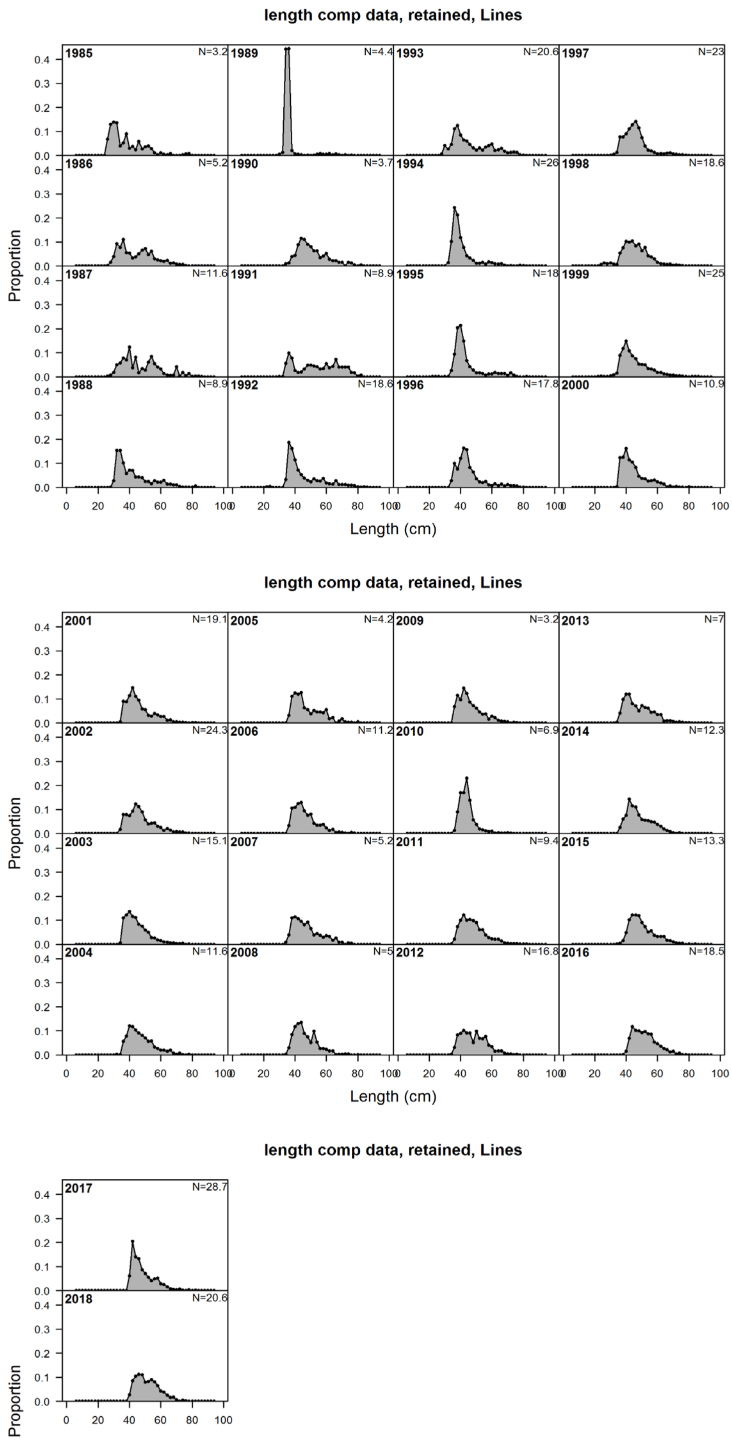


Figure 5. Length composition of UK Lines fleet landings from 1985 onwards.

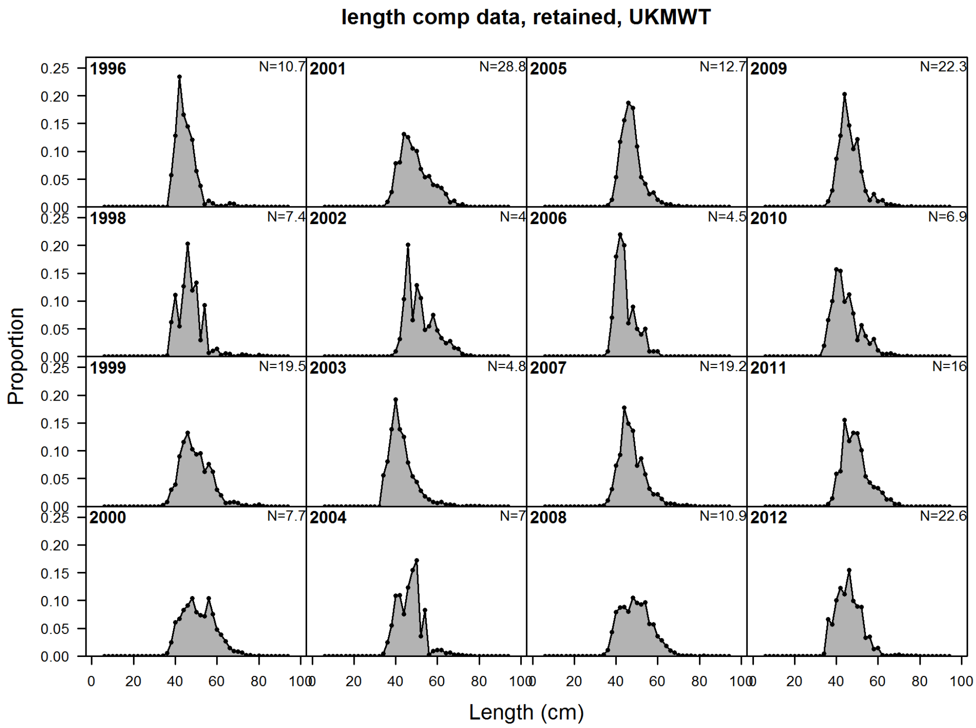


Figure 6. Available length composition of UK Midwater pair trawl fleet landings.

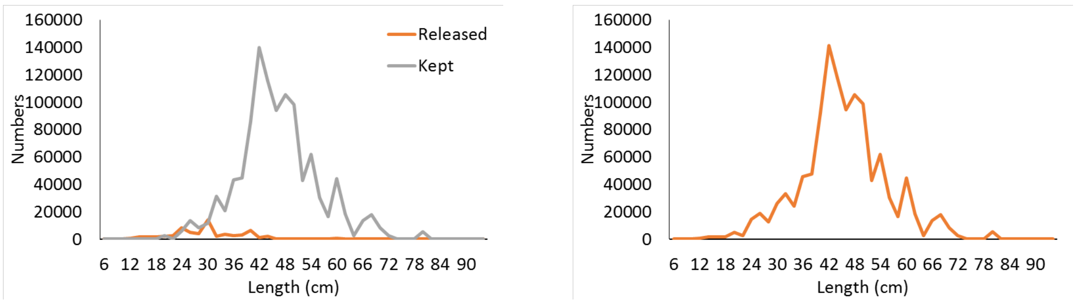


Figure 7. Length frequency of recreational fishery removals for the 2012 reference year, derived from surveys in France, Netherlands and England. PRM are total released catch with post-release mortality of 5% applied. Right hand plot is the total removals used in the Stock Synthesis model to estimate selectivity.

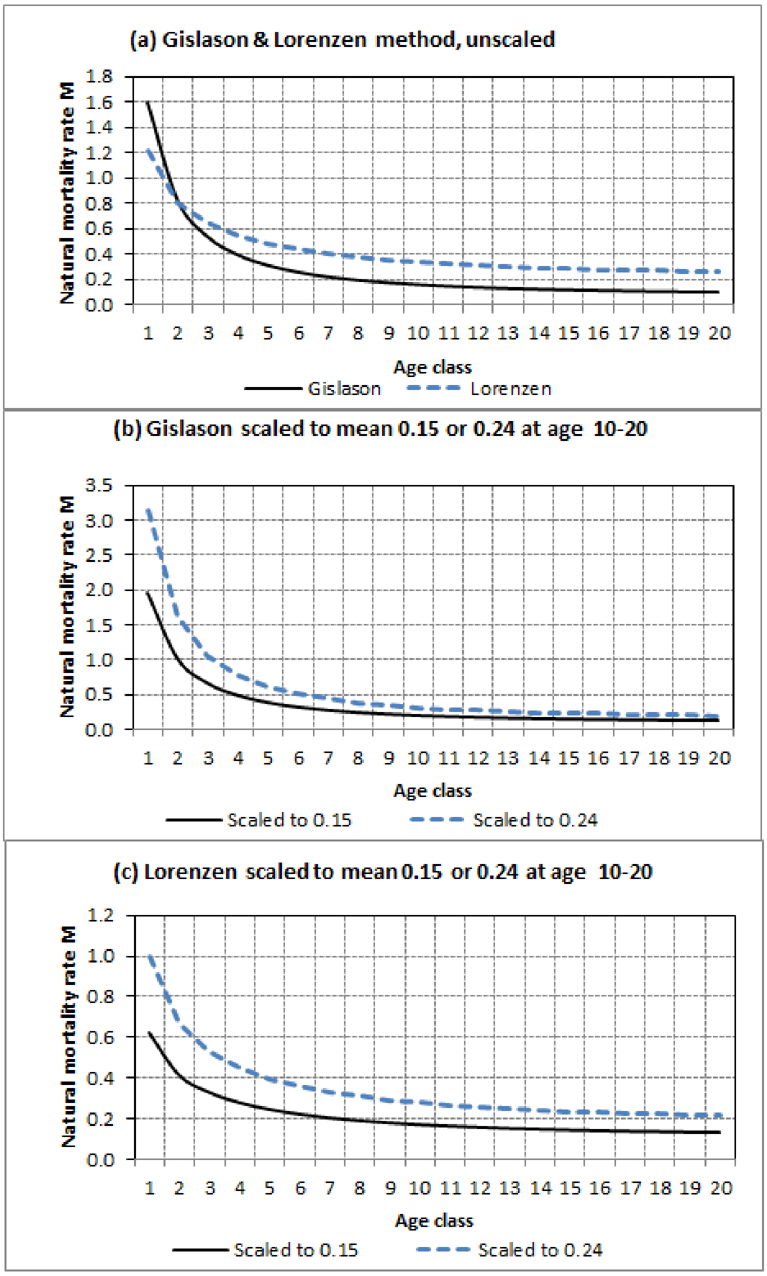


Figure 8. Bss-47 stock: (a) Natural mortality values inferred from Gislason *et al.* (2010) and Lorenzen (1996); (b) Gislason M values rescaled to average M=0.15 or 0.24 at ages 10–20); (c) Lorenzen M values rescaled to average M=0.15 or 0.24 at ages 10–20).

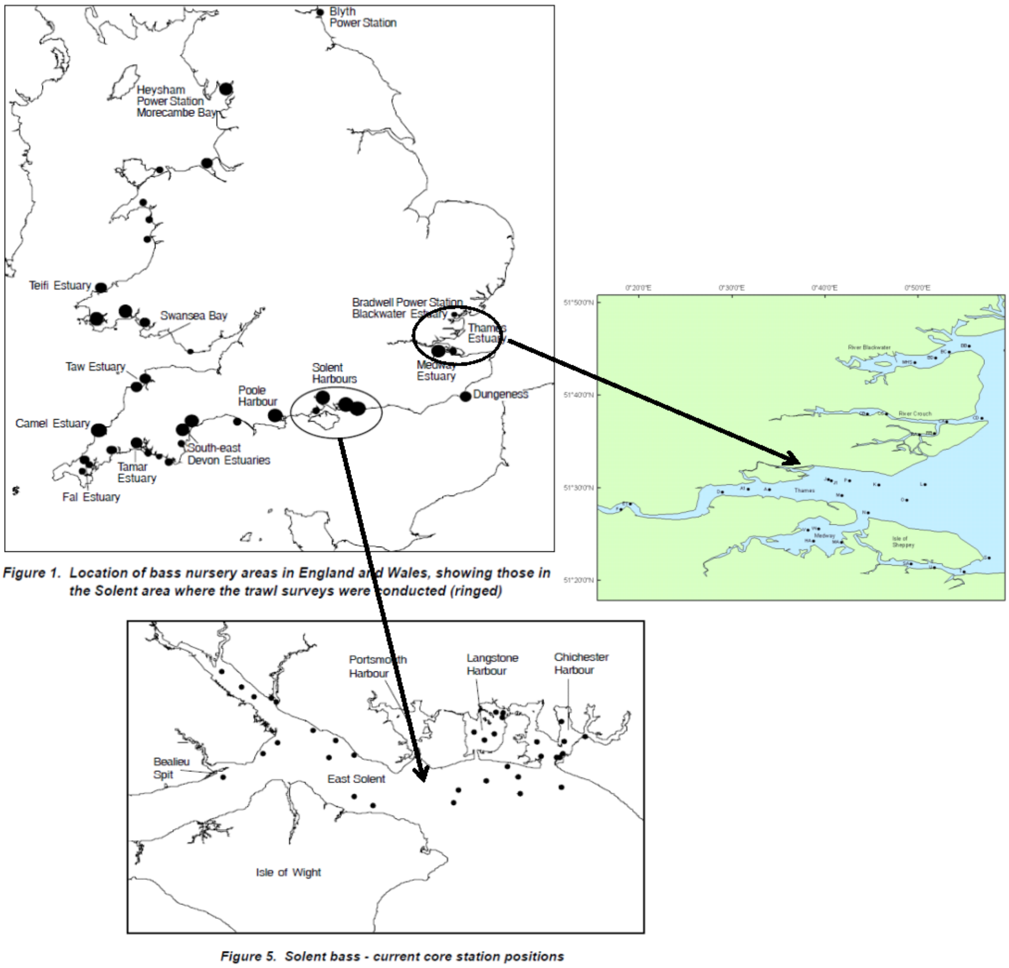


Figure 9. Location of Cefas Solent and Thames juvenile seabass surveys.

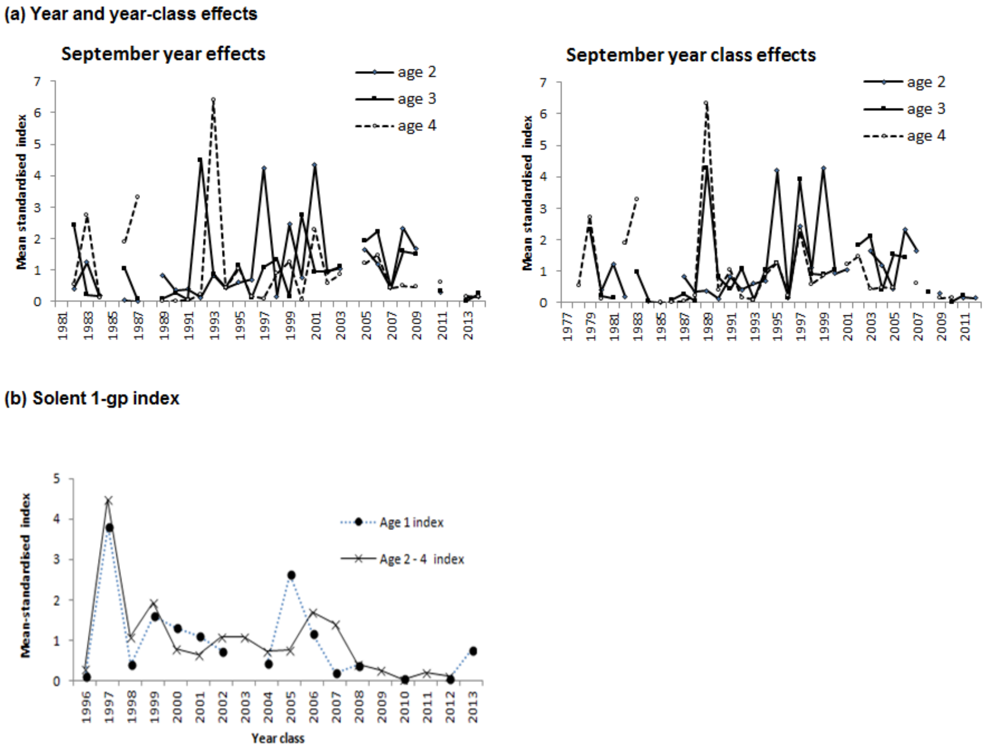


Figure 10. Cefas Solent survey in autumn: (a) year and year-class effects in indices; (b) 1-gp index from 1996 onwards compared with a composite year-class index derived from the age 2–4 indices.

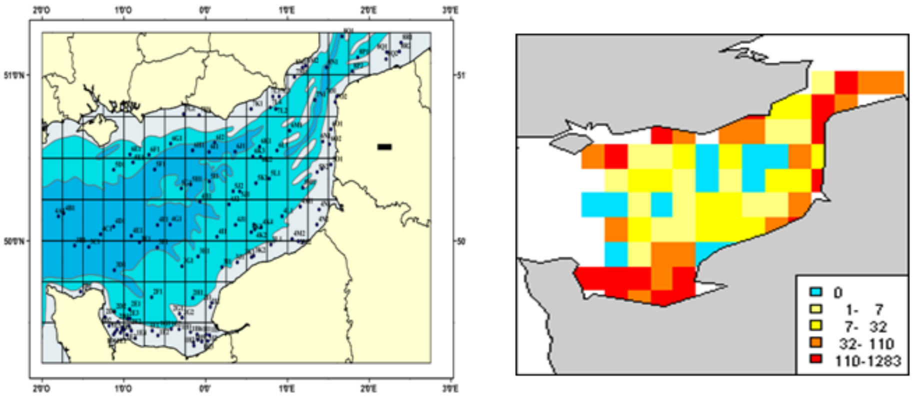


Figure 11. Left: stations fished during the Channel Groundfish Survey carried out annually by France. Right: distribution of total catches of seabass over the survey series.

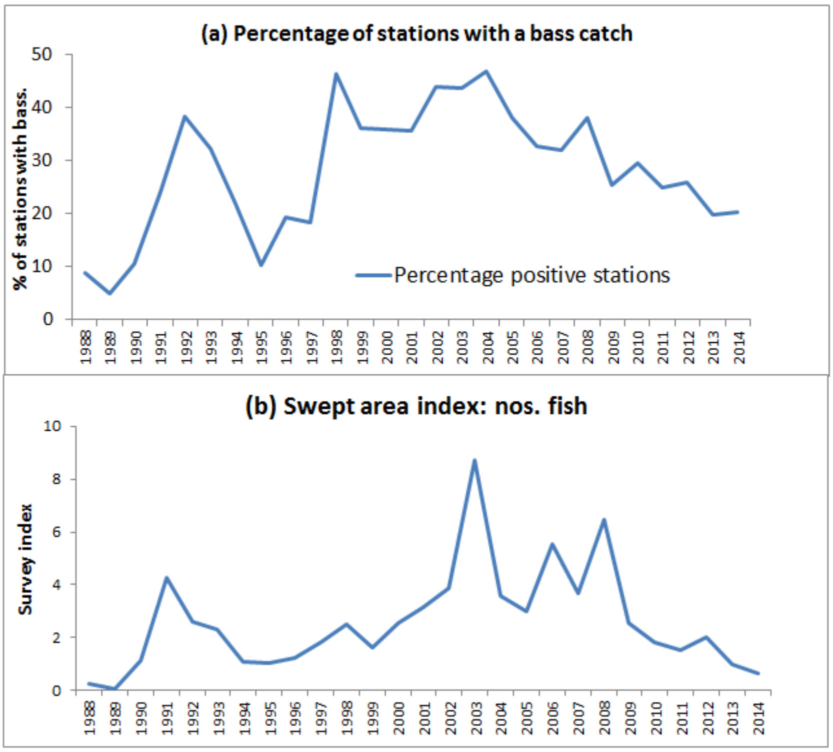


Figure 12. Mean standardised time-series of (a) percentage of stations with seabass, and (b) swept-area abundance indices (millions of fish) from the Ifremer Channel Groundfish Survey.

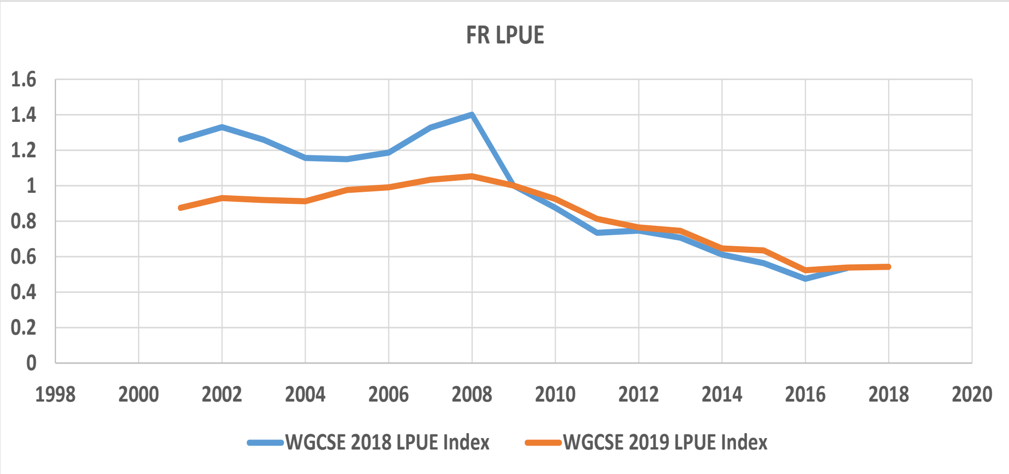


Figure 13. Comparison in trends in commercial lpue index for French fleets for European seabass in ICES divisions 4bc and 7a,d–h (WGCSE 2019 lpue corrected and updated in assessment)

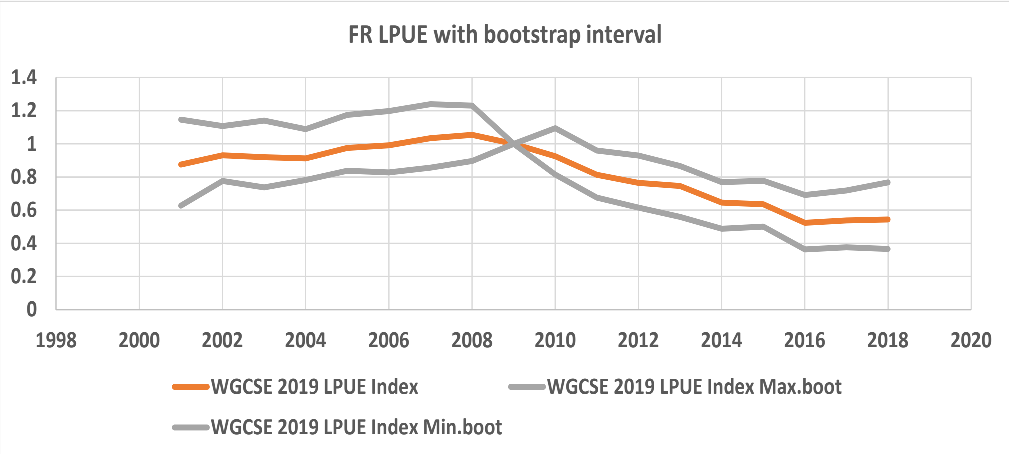


Figure 14. Commercial lpue index for French fleet used in assessment with bootstrap intervals.

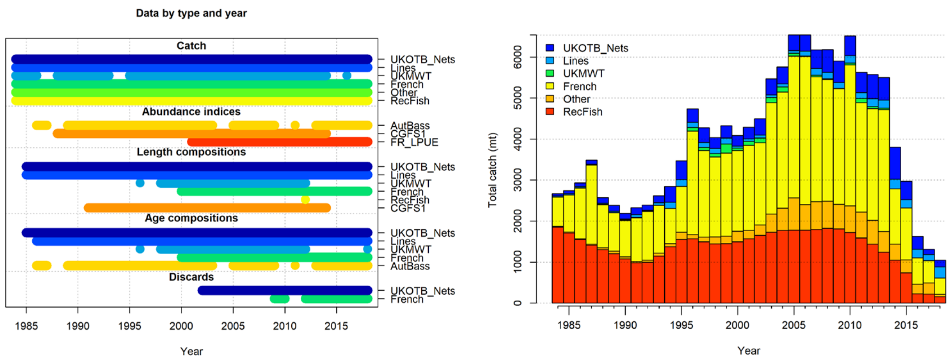
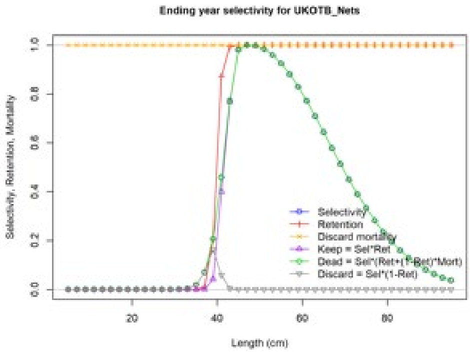
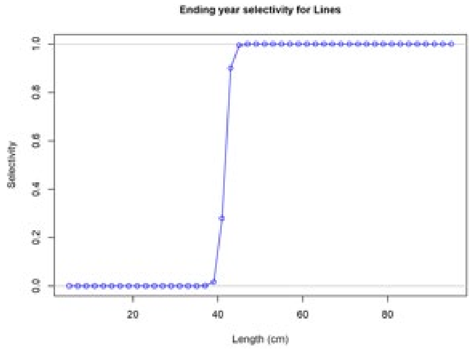
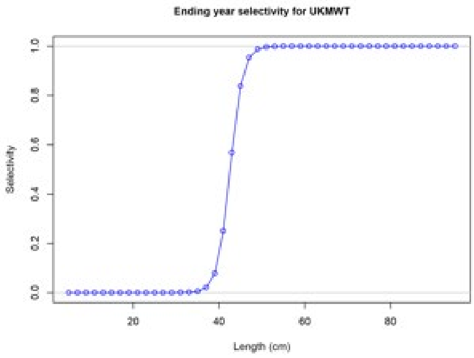
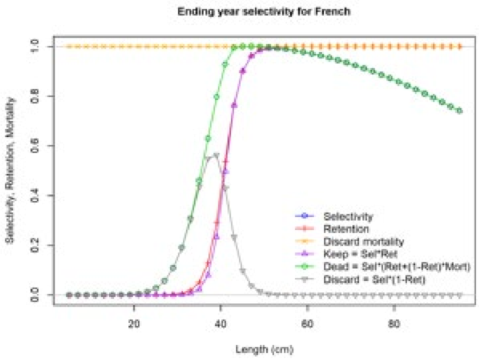


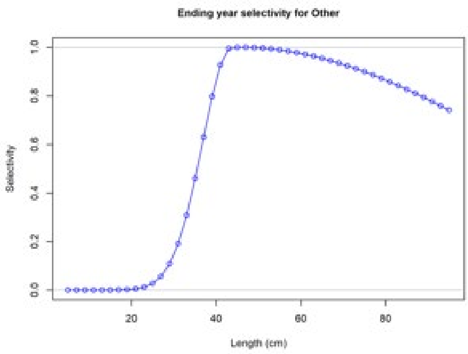
Figure 15. Left: Datasets used in the final seabass update assessment. Right: Catch series for the six fleets.

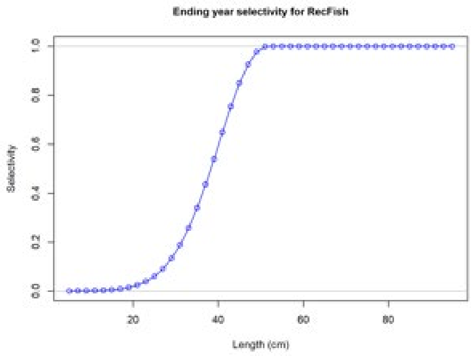

Ending year selectivity for UKOTB_Nets
Selectivity, Retention, Mortality
Selectivity
Retention
Discard mortality
Keep = Sel*Ret
Dead = Sel*(Ret+(1-Ret)*Mort)
Discard = Sel*(1-Ret)
Length (cm)


Ending year selectivity for Lines
Selectivity
Length (cm)


Ending year selectivity for UKMWT
Selectivity
Length (cm)


Ending year selectivity for French
Selectivity, Retention, Mortality
Selectivity
Retention
Discard mortality
Keep = Sel*Ret
Dead = Sel*(Ret+(1-Ret)*Mort)
Discard = Sel*(1-Ret)
Length (cm)


Ending year selectivity for Other
Selectivity
Length (cm)


Ending year selectivity for RecFish
Selectivity
Length (cm)

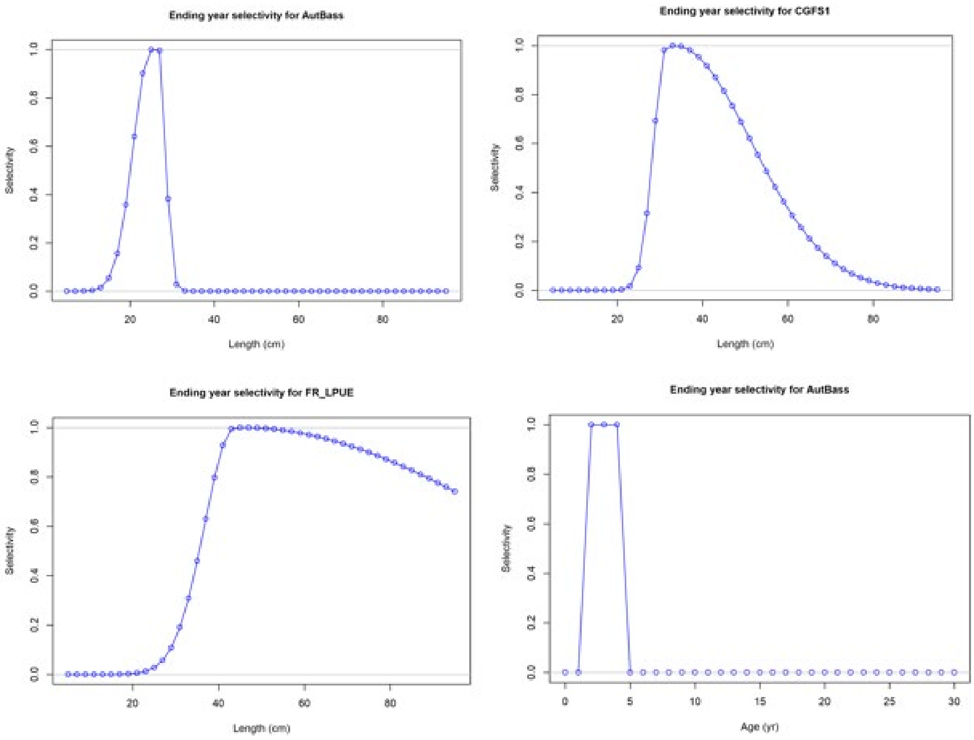


Figure 16a. Final seabass update assessment: Fitted length-based and age-based selectivity curves.

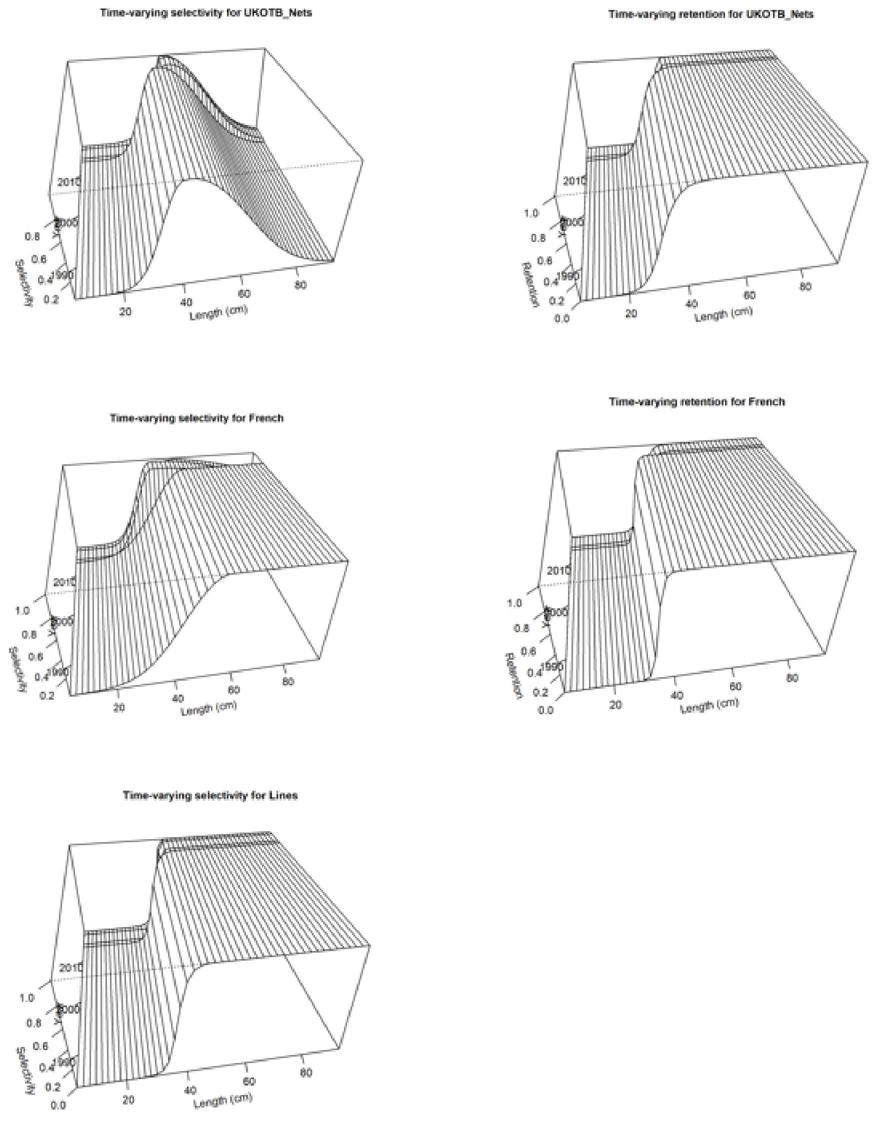


Figure 16b. Final seabass update assessment: Fitted time-series of length-based and age-based selectivity and retention curves for fleets with blocks.

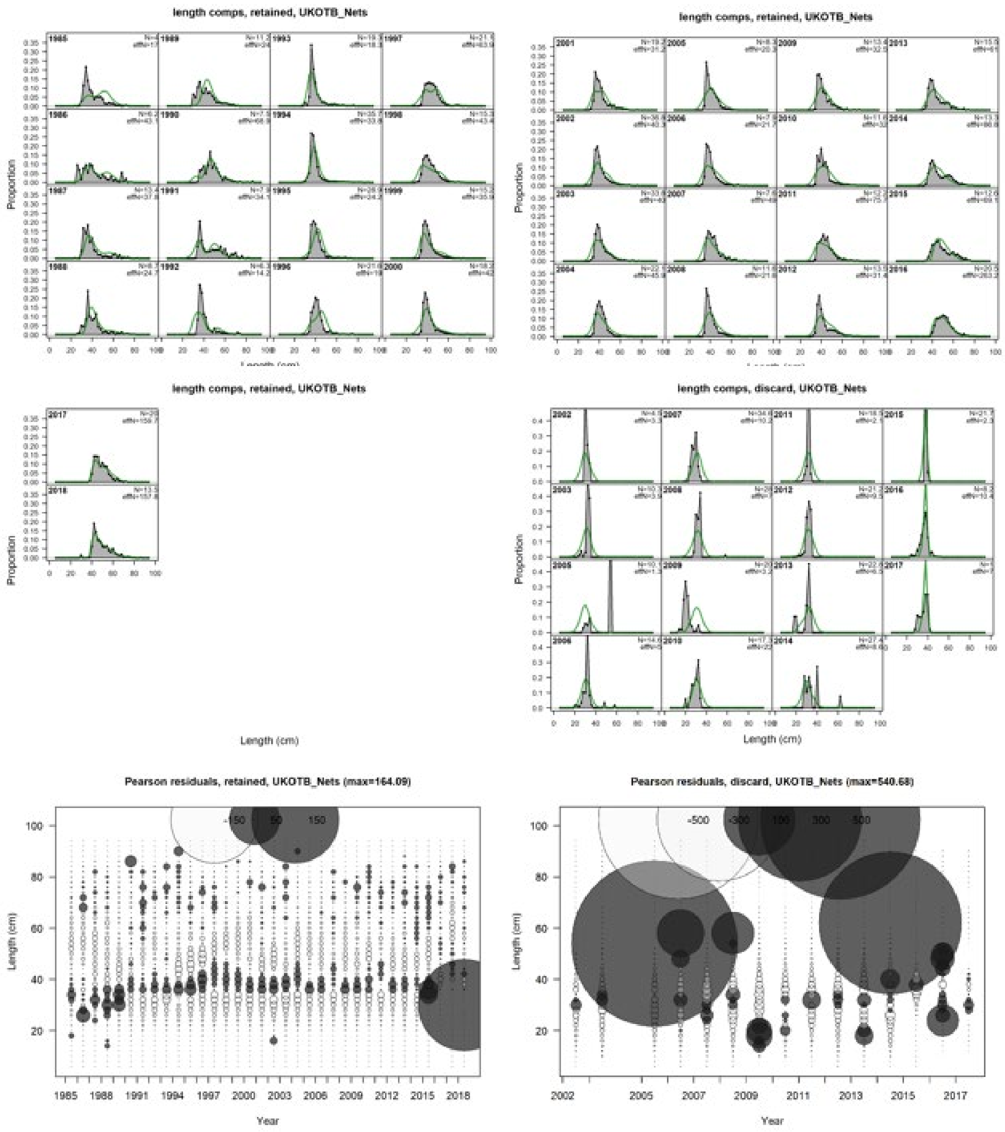


Figure 17. Final seabass update assessment: fit to UK trawl and net fishery-length composition data for the retained and discarded catch components.

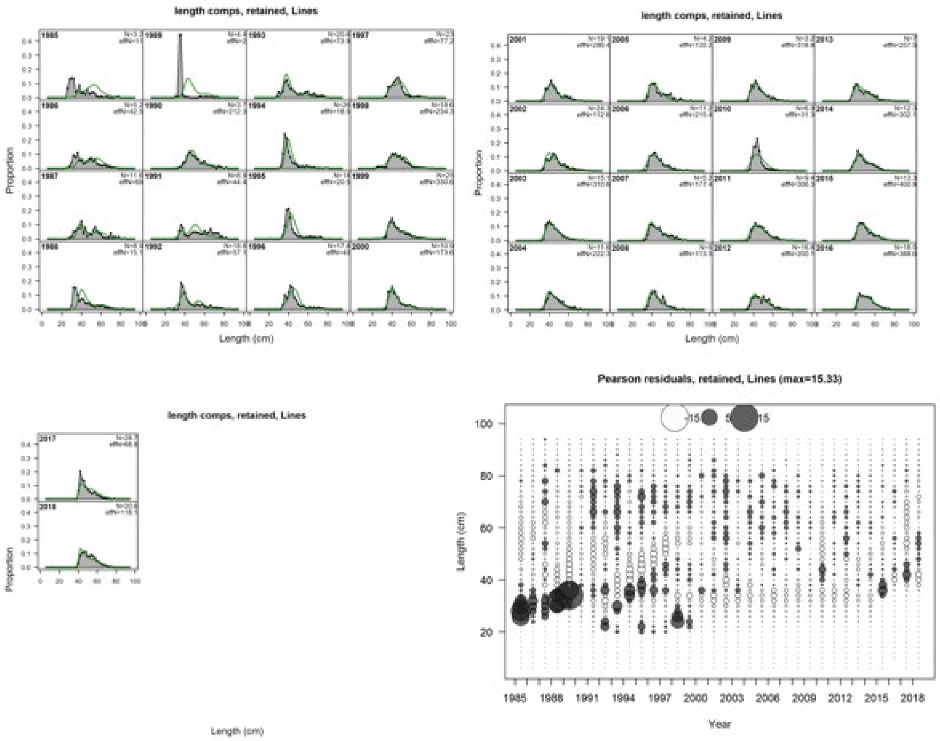


Figure 18. Final seabass update assessment: fit to UK lines length-composition data for the retained catch components.

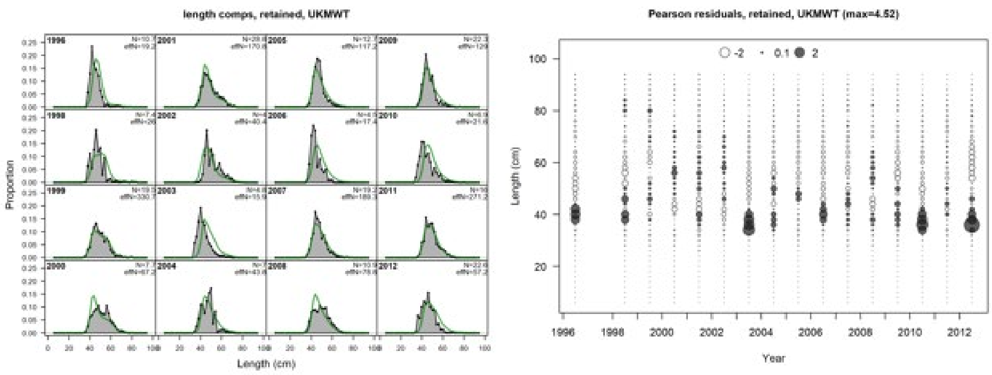


Figure 19. Final seabass update assessment: fit to UK midwater trawl fishery length-composition data for the retained catch components.

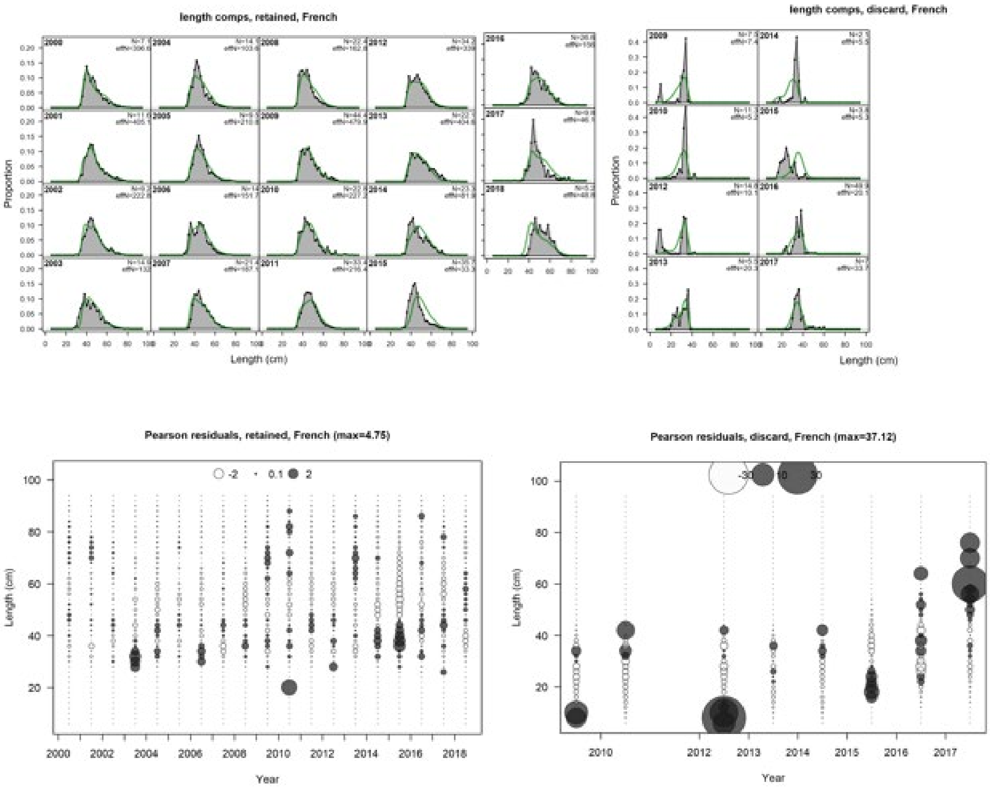


Figure 20. Final seabass update assessment: fit to French fishery length-composition data for the retained and discarded catch components.

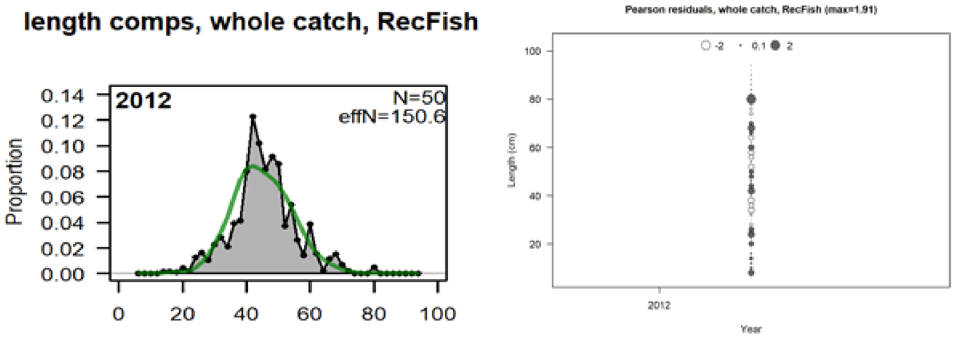


Figure 21. Final seabass update assessment: Fit to recreational length-compositions data.

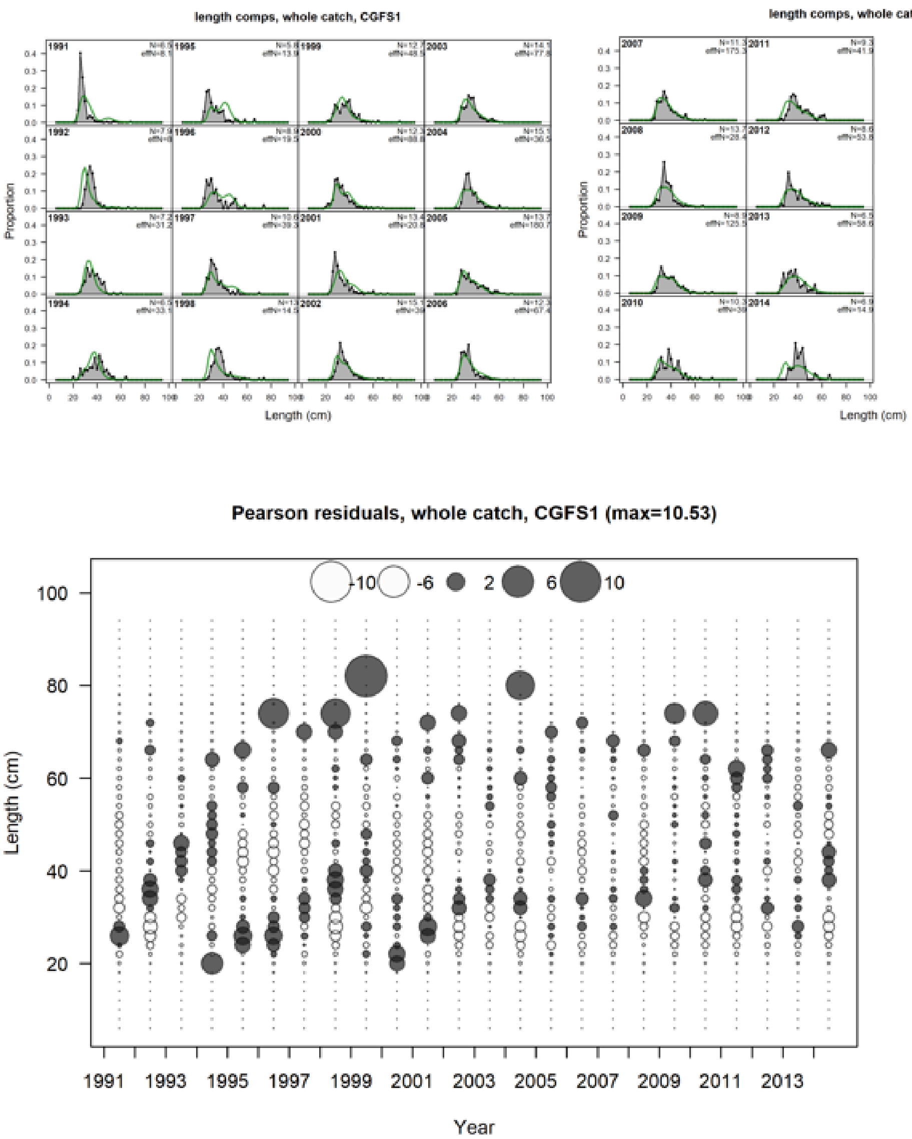


Figure 22. Final seabass update assessment: Fit to Channel groundfish survey length-compositions.

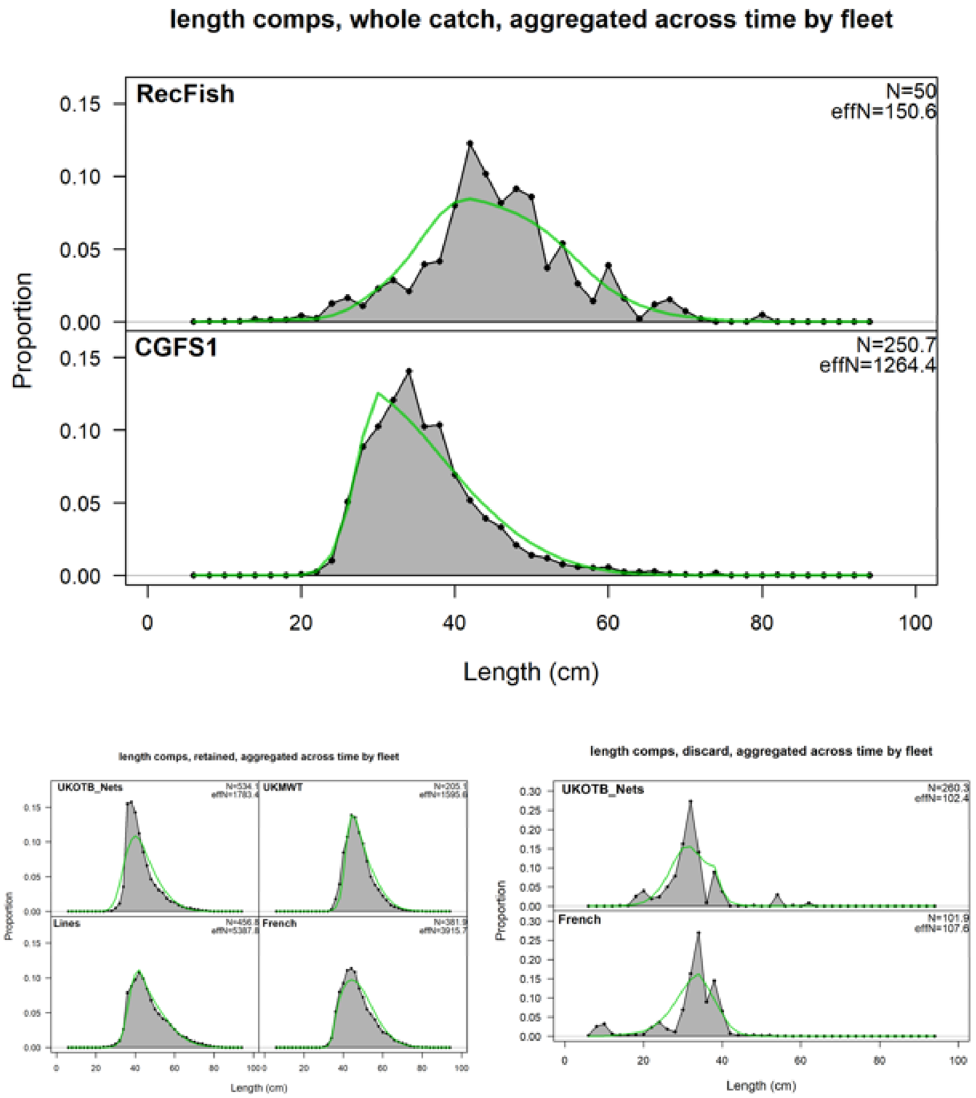


Figure 23. Final seabass update assessment: Fit to the commercial fisheries and Channel groundfish survey length compositions, aggregated across time for the retained and discarded catch components.

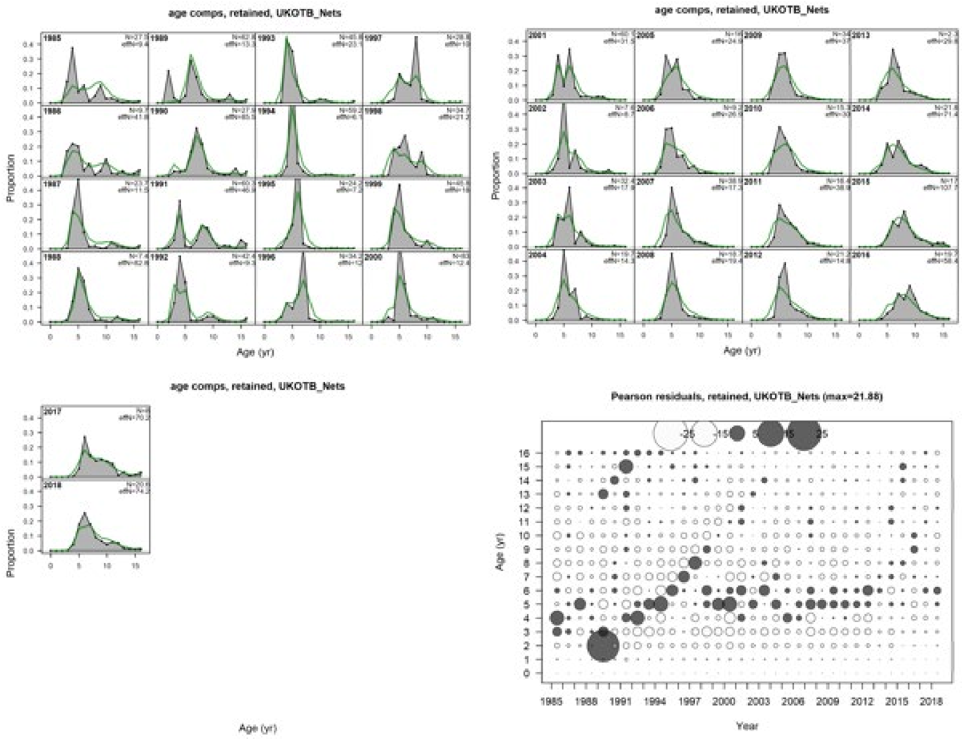


Figure 24. Final seabass update assessment: Fit to age composition data for the combined UK otter trawl and nets fleets.

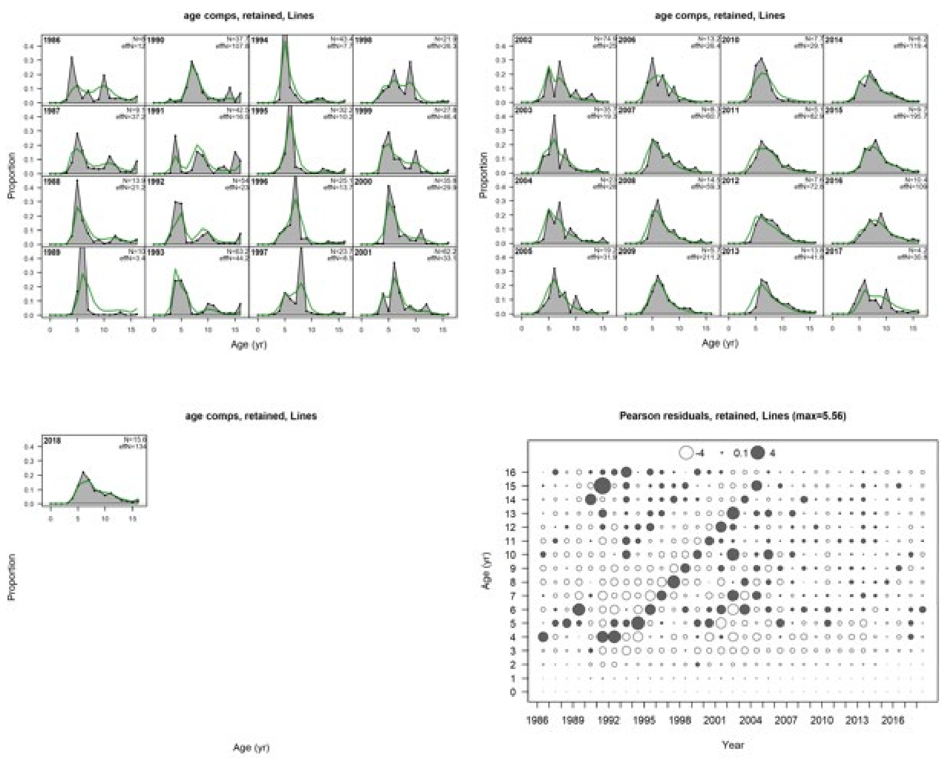


Figure 25. Final seabass update assessment: Fit to age composition data for the combined UK lines fleet.

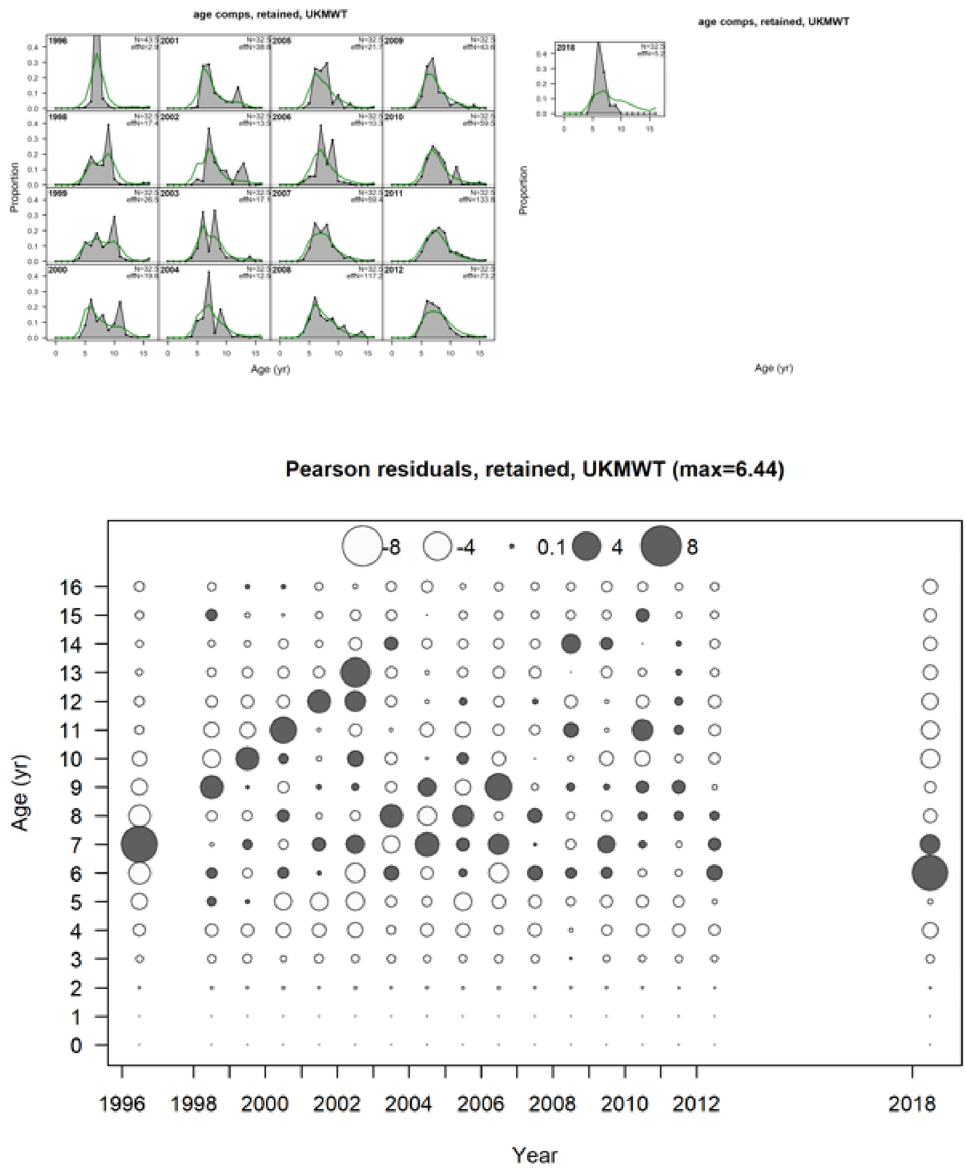


Figure 26. Final seabass update assessment: Fit to age composition data for the UK midwater trawl fleet.

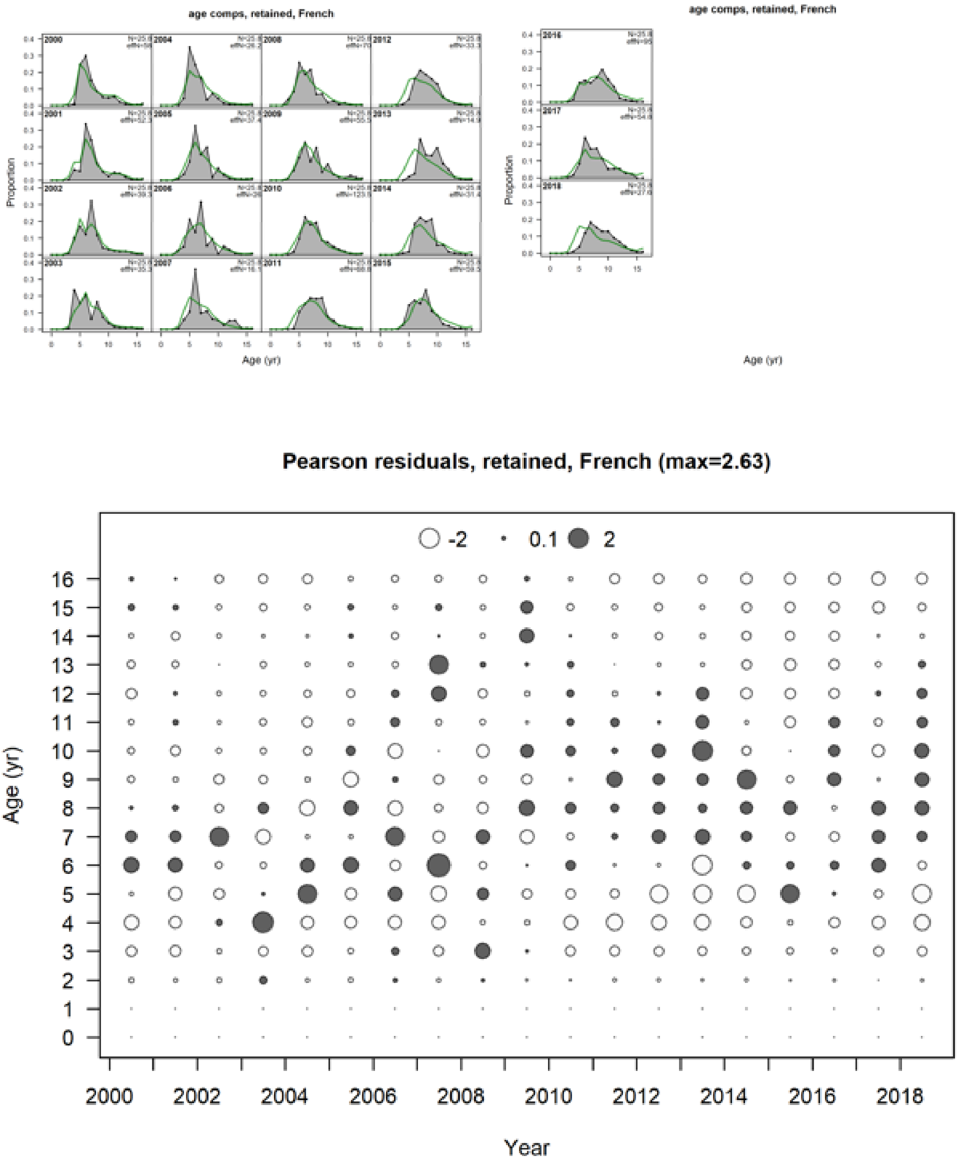


Figure 27. Final seabass update assessment: Fit to age composition data for the combined French fleets.

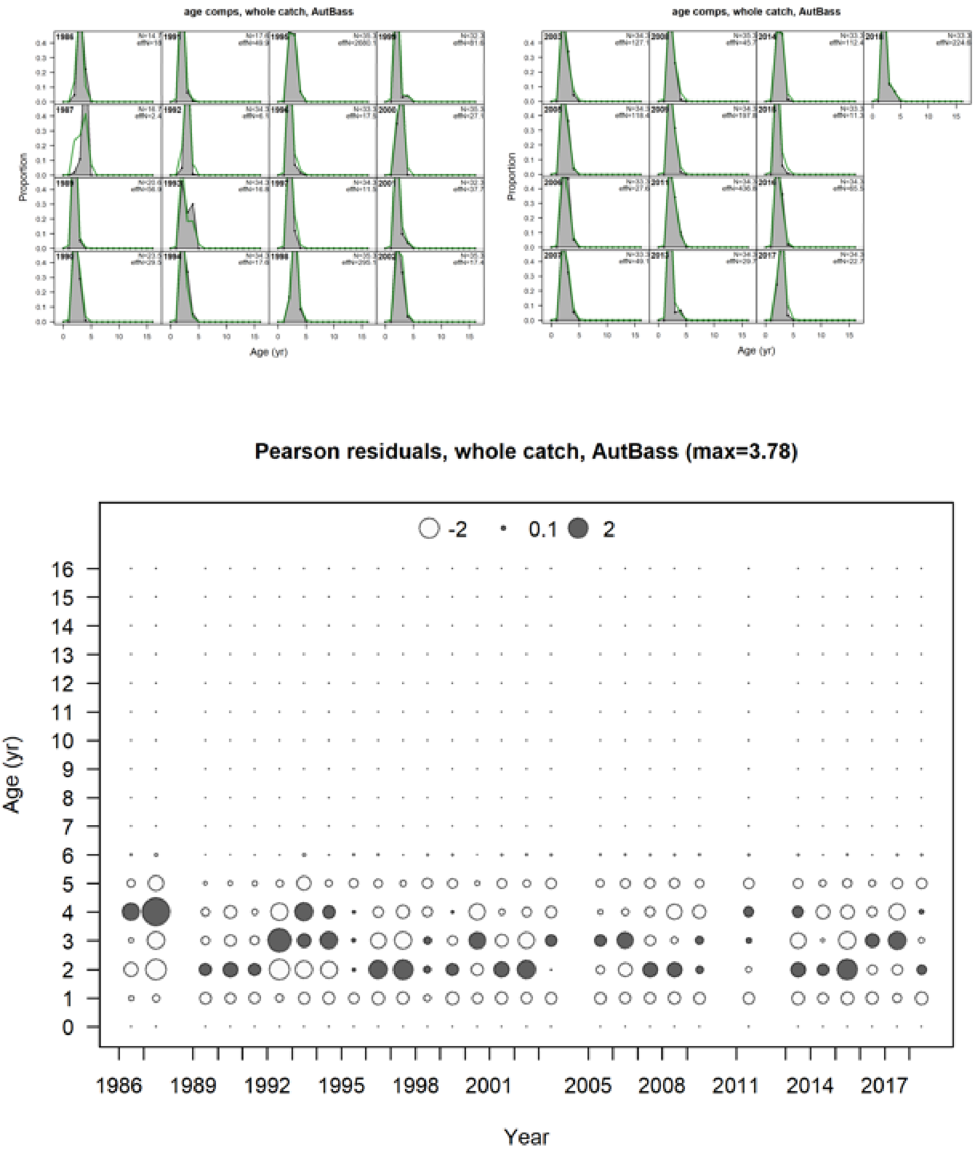


Figure 28. Final seabass update assessment: Fit to age composition data for the Solent Autumn bass survey.

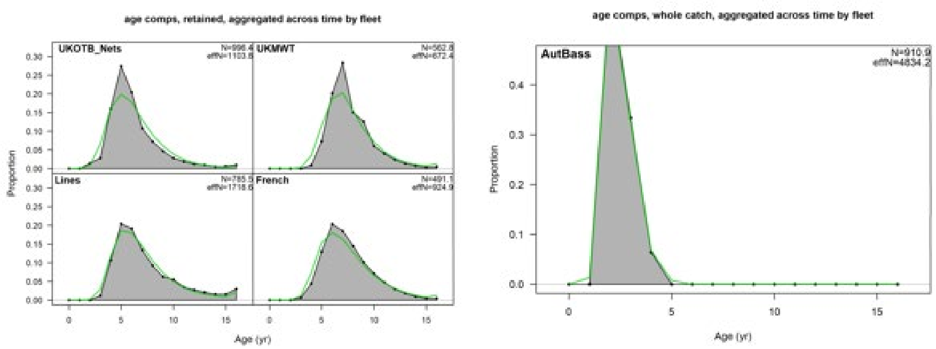


Figure 29. Final seabass update assessment: Fit to UK fleets age compositions, aggregated across time.

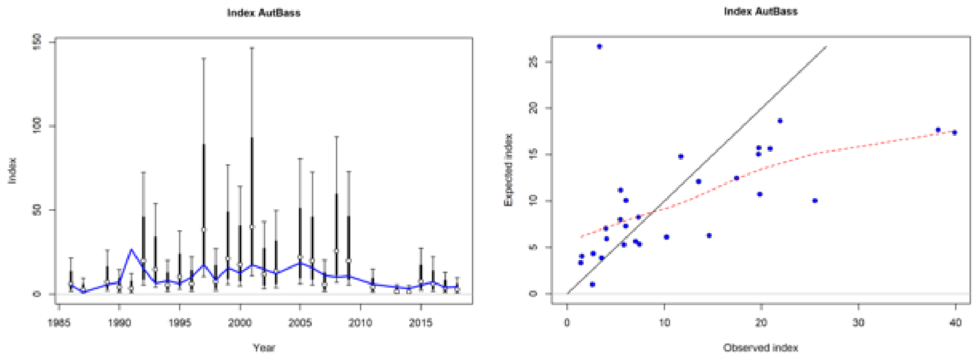


Figure 30. Final seabass update assessment: Fit to Solent Autumn bass survey total abundance index, accounting for age and length-based selectivity.

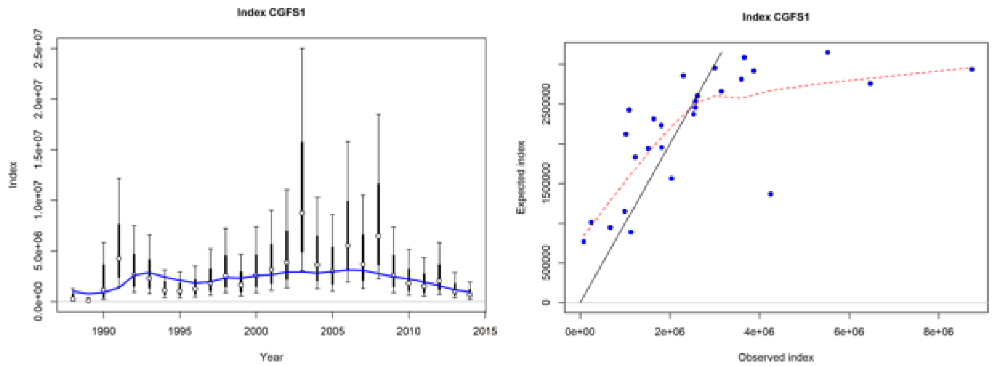


Figure 31. Final seabass update assessment: Fit to Channel groundfish survey total abundance index, accounting for length-based selectivity.

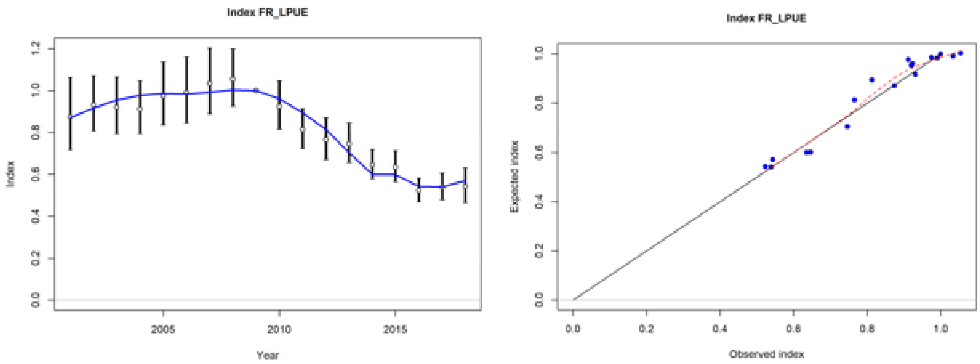


Figure 32. Final seabass update assessment: Fit to the French landings per unit of effort commercial index, accounting for length-based selectivity.

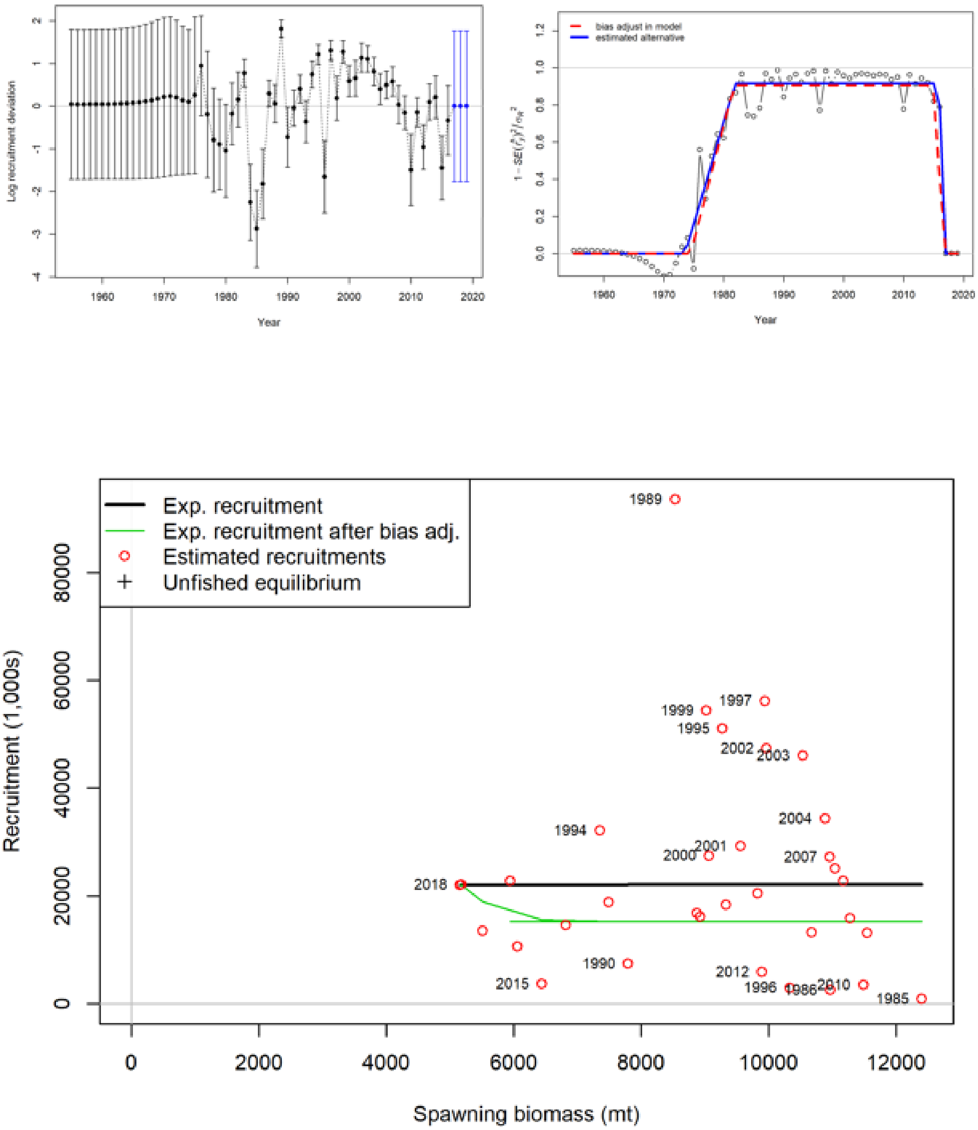


Figure 33. Final seabass update assessment: Top: time-series of log-recruit deviations (deviations for 1965–1984 precede the period of input catch data). Below: stock–recruit scatter (model is fitted assuming Beverton–Holt stock–recruit model and steepness = 0.999).

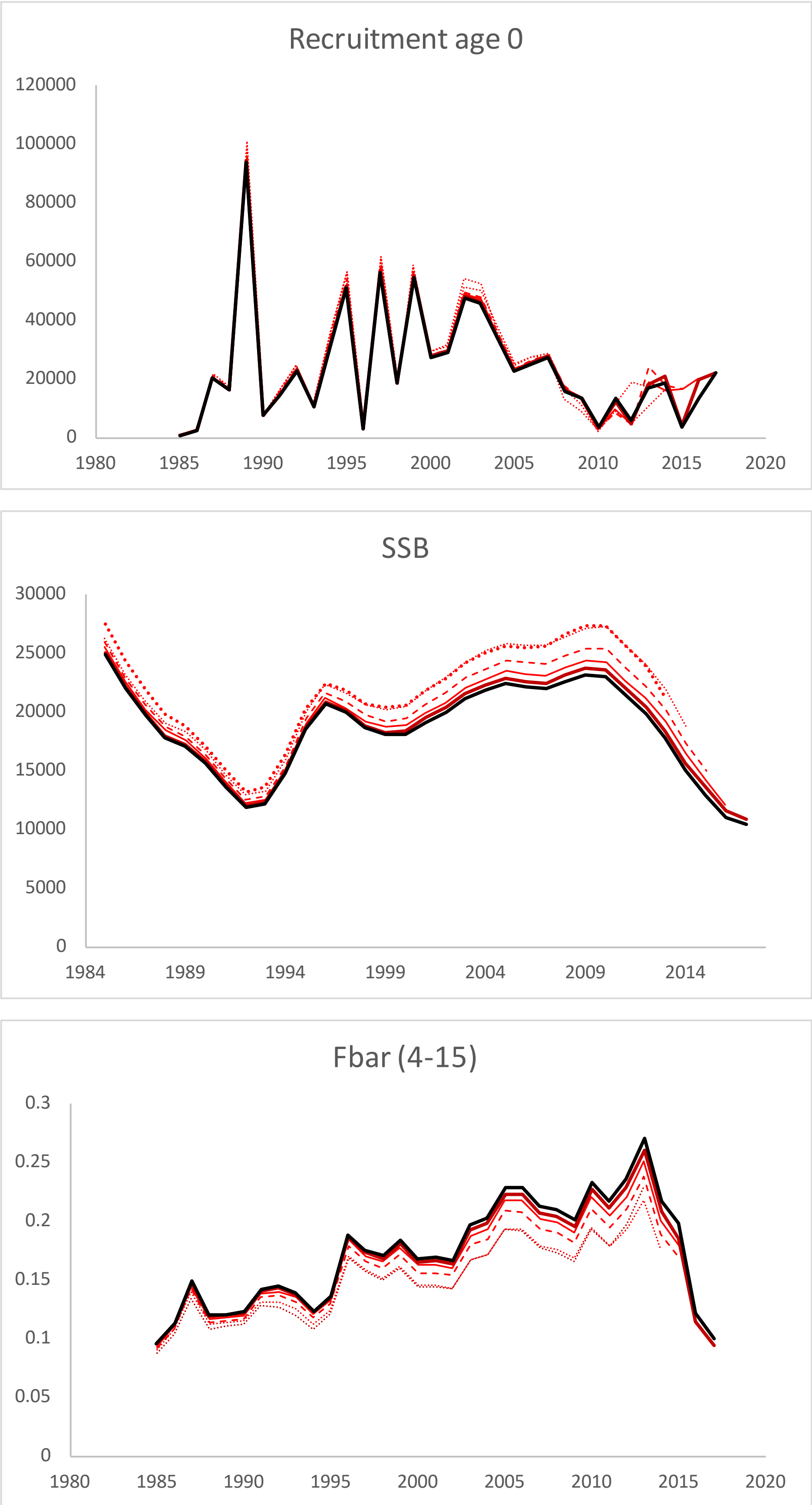


Figure 34. Retrospective analysis of stock trends from final update assessment, based on Stock Synthesis run final year set to 2015 and peeling back five years (for the final run, terminal F is for 2018 and SSB and total biomass terminate in 2019).

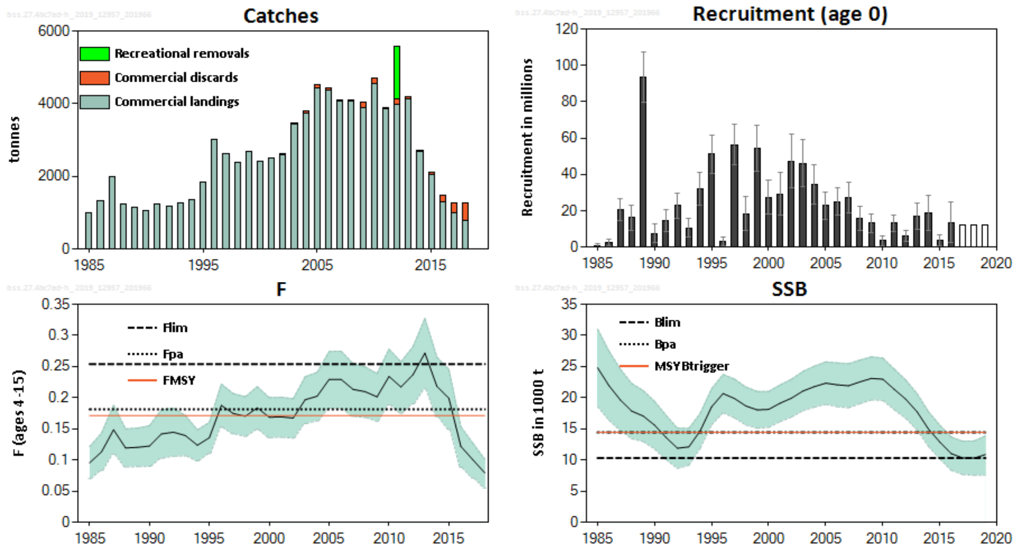


Figure 35. Stock trends from final update assessment, based on Stock Synthesis run final year set at 2018 to give 2019 numbers and biomass and 2018 F. Recruitment in 2017-2019 is the geometric mean 2005–2016. Recruitment, F and SSB are shown with 95% confidence intervals.

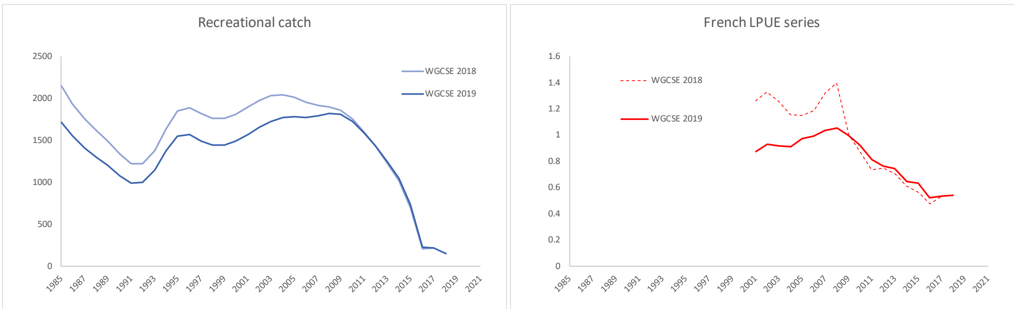


Figure 36. Comparison between LPUE and recreational catch vector from this year's final update assessment and the 2018 WGCSE assessment.

Figure 37. Comparison between stock trends from this year's final update assessment and the 2018 WGCSE assessment.

30 Seabass (*Dicentrarchus labrax*) in divisions 6.a,7.b and 7.j (West of Scotland, West of Ireland, eastern part of southwest of Ireland)

Type of assessment

There is no assessment for this stock component.

ICES advice applicable to 2018, 2019 & 2020

"Based on ICES approach to data-limited stocks, ICES advises that when the precautionary approach is applied, commercial landings should be no more than 4 tonnes in each of the years 2018, 2019 and 2020. ICES cannot quantify total catches. No information on discards is available, therefore it is not possible to provide commercial catch advice. Also, recreational catches cannot be quantified. Therefore, total catches cannot be calculated.

ICES advice applicable to 2016

"The revised landings data do not change the perception of the stock but result in a revision of the advised landings. Therefore, ICES advises based on the data-limited stocks approach, but cannot quantify the resulting catches. The implied commercial landings should be no more than 5 tonnes.

Currently, there is no TAC for this species in this area, and it is not clear whether this should constitute a separate management unit. ICES does not necessarily advocate the introduction of a TAC for sea bass in this area."

30.1 General

Stock description and management units

At IBP-NEW (2012a), it was agreed that sea bass in the North Sea (4.b&c) and in the Irish Sea, Channel and Celtic Sea (7.a,d,e,f,g&h) would be treated as a functional stock unit as there is no clear basis from fishery data, tagging and genetics studies to subdivide the populations in the Irish Sea, Celtic Sea, Channel and North Sea into independent stock units. It was proposed based on previous ICES bass study group reports to allocate sea bass in 6.a, 7.b and 7.j to a separate stock, although it is recognised that sea bass in Irish coastal waters of 7.g and 7.a are likely to be from the same stock as in 7.j. As there are negligible commercial fishery catches of sea bass in Irish coastal waters due to the moratorium on commercial fishing for bass by Irish vessels, the splitting of the stock between 7.g and is not likely to have any impact on the bass assessment in 4.b,c and 7.a,d–h. Supporting information can be found in the IBP-NEW (ICES, 2012a) report.

Management applicable to 2016, 2017 and 2018

Sea bass are not subject to EU TACs and quotas. A moratorium on commercial fishing for sea bass has been in place for Irish vessels fishing in areas 6 and 7 since 1990, and a minimum landing size of 40 cm applies to Irish fisheries. The official minimum landing size for non-Irish vessels is 36 cm (EC regulation 850/98). In addition, a variety of national restrictions on commercial sea bass fishing are also in place for non-Irish commercial vessels, including licensing, individual landings limitations, larger MLS and seasonal/ area closures. Recreational fishing for sea bass in Ireland is prohibited from 15 May to 15 June, and a bag limit of two fish per 24 hours is in place.

Previous advice from ICES, showing a rapid decline in sea bass biomass in the North Sea, Channel, Celtic Sea and Irish Sea caused by poor recruitment and over-fishing, has resulted in the European Commission working with Member States to identify more effective control measures to reduce fishing mortality towards F_{MSY}. It shall be prohibited for Union fishing vessels to fish for sea bass in ICES divisions 7.b, 7.c, 7.j and 7.k, as well as in the waters of ICES divisions 7.a and 7.g that are more than 12 nautical miles from the baseline under the sovereignty of the UK. It shall be prohibited for Union fishing vessels to retain on board, tranship, relocate or land sea bass caught in that area. Depending on the true stock structure of sea bass in areas 6 and 7, very restrictive measures introduced in 2016, 2017 and 2018 may have some effect on sea bass in 6.a, 7.b and 7.j.

Fishery in 2018

Landings data used by the WG are given in Table 32.2.1. Due to the Irish sea bass moratorium, official landings reports are by other countries, historically mainly by France, although the landings are less than 10 tonnes per year and only 2 tonnes or less since 2012. No landings have been recorded for 2017 and only 1 tonne in 2018 (source: official landings).

30.2 Data

Commercial landings data

Landings data are given in Table 32.2.1. No other data for sea bass in this area were provided to WGCSE.

Commercial discards

No estimates of sea bass discards are available.

Recreational catches

Recreational marine fishery surveys in Europe are still at an early stage in development and are described by the ICES Working Group on Recreational Fishery Surveys (ICES, 2012b). A survey was conducted in Ireland in 2010 and 2011 (O'Reilly and Roche, 2012). Domestic shore bass anglers are estimated at 11 600 individuals and these anglers harvested and estimates of 30 t and 44 t of bass in 2010 and 2011. The 2010 estimate was considered to be more robust. In addition between 75% and 80% of bass caught were returned to the water. The survey doesn't disaggregate the angling catch estimates by ICES division.

The IBP-NEW meeting report (ICES, 2012a) includes some data supplied by a stakeholder on trends in recreational catch rates from an angling club on the southern Irish coast, as well as age compositions of sea bass caught by anglers, which may be applicable also to trends in 7.j.

Biological data

Data on growth and maturity for this stock component were not reviewed by WGCSE.

Survey data

No survey data were available to WGCSE for this stock.

Other relevant data

None.

30.3 Historical stock development

No information is available for this stock area.

30.4 Management plans

There are no existing management plans for European sea bass.

30.5 Management considerations

Sea bass grow slowly, do not mature until 4–7 years of age, and have been recorded at up to 28 years of age. Juvenile bass up to three years of age, occupy nursery areas in estuaries whilst adults undertake seasonal migrations from inshore habitats to offshore spawning sites. It is not known to what extent adults from the stock in 7.b,j and 6.a are caught by pelagic trawlers targeting mature sea bass on spawning sites in divisions 7.e–h. After spawning, sea bass tend to return to the same coastal sites each year. The combination of slow growth, late maturity, spawning aggregation and strong site fidelity, increase the vulnerability of sea bass to overexploitation and localized depletion.

ICES advice sheets for sea bass in the Northeast Atlantic have previously recommended that “implementation of 'input' controls (preferably through technical measures aimed at protecting juvenile fish, in conjunction with entry limitations into the offshore fishery in particular) should be promoted (ICES, 2004)” and that “Any consideration of catch limitation (output control) would need to take into account that sea bass are a bycatch in mixed fisheries to a various extent, depending on gear and country; this incites discarding and should be avoided”.

Management of sea bass fisheries needs to take into account the distinctive characteristics and economic value of the different fisheries. Sea bass is of high social and economic value to sea angling in Ireland which contributes substantially to local economies.

The current stock structure assumptions are pragmatic, and need further evaluation. Further studies are needed to determine if the sea bass in Irish coastal waters are indeed functionally separate, or if they also mix with the other stock during spawning time and contribute to commercial catches on the offshore spawning grounds.

As bass is, at present, a non-TAC species, there is potential for displacement of fishing effort by non-Irish fleets from other species with limiting quotas.

30.6 Data needs

Time-series of relative abundance indices need to be developed throughout the range of the stock, for both the adult and pre-recruit components of the stock.

There is a need to develop a time-series of recreational fishery catch, effort, and catch composition.

Catch locations and composition of significant commercial landings should be monitored to help establish the stock affiliation.

Further studies using tagging, genetics, and other stock and individual markers are needed to more accurately define stock boundaries suitable for assessment and management purposes. A tagging programme has been undertaken by the Marine Institute of Ireland to investigate the distribution of the European sea bass in Irish waters. This project is being carried out in conjunction with the Beaufort Scientific Group and University College Cork. No results were available for WGCSE 2019.

Studies are needed to document the survival of recreationally caught and released sea bass. IBP-NEW (ICES, 2012a) noted that a range of studies on striped bass in the USA indicated hooking mortalities of around 20% on average, although a lower value of around 9% from one specific study is currently considered most appropriate for inclusion in the assessments.

30.7 References

ICES. 2012a. Report of the Inter-Benchmark Protocol on New Species (Turbot and Sea bass; IBPNew 2012). ICES CM 2012/ACOM:45.

ICES. 2012b. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2012/ACOM:23. 55 pp.

O'Reilly, S. and Roche, W. 2012. Pilot study to estimate recreational angling landings of bass in Ireland. Inland Fisheries Ireland report IFI/2012/1-4099. http://www.miextranet.ie/fss/sites/DCMAP/Annual%20Report/Annex_2_DCF_Bass_Landings_2010_11.pdf .

Table 32.2.1. European sea bass in Divisions 6.a, 7.b and 7.j. Official landings: all countries (predominantly France).

Year	Official landings
2000	1
2001	4
2002	4
2003	2
2004	8
2005	4
2006	2
2007	5
2008	5
2009	4
2010	9
2011	7
2012	1
2013	0
2014	2
2015	0.8
2016	0.1
2017	0
2018*	1

***Preliminary. Source Official landings.**

31 Sole in Division 7.a (Irish Sea)

Type of assessment in 2019

This assessment is an update assessment.

ICES advice applicable to 2019

In the advice for 2019, the stock status was presented as follows:

		Fishing pressure				Stock size			
		2015	2016	2017			2016	2017	2018
Maximum sustainable yield	F_{MSY}	✔	✔	✔	Below	MSY $B_{trigger}$	✖	✖	✖ Below trigger
Precautionary approach	F_{pa},F_{lim}	✔	✔	✔	Harvested sustainably	B_{pa},B_{lim}	✖	✖	✖ Reduced reproductive capacity
Management plan	F_{MGT}	–	–	–	Not applicable	B_{MGT}	–	–	– Not applicable

"ICES advises that when the MSY approach is applied, catches in 2019 should be no more than 414 tonnes".

Comments made by the audit of last year's assessment

No major deficiencies for the sole assessment in the Irish Sea were reported.

31.1 General

Stock description and management units

The sole fisheries in the Irish Sea are managed by TAC (see text tables below) and technical measures, with the assessment area corresponding to the stock area. Technical measures in force are minimum mesh sizes and minimum landing size (24 cm). In addition beam trawlers, fishing with mesh sizes equal to or greater than 80 mm, are obliged to have 180 mm mesh sizes in the entire upper half of the anterior part of their net. More details can be found in Council Regulation (EC) N°254/2002 and the Stock Annex.

Since 2000, a spawning closure for cod has been in force. The first year of the regulation the closure covered the western and eastern Irish Sea. Since then, closure has been mainly in the western part whereas the sole fishery takes place mainly in the eastern part of the Irish Sea (Liverpool Bay and Cardigan Bay). No direct impact on the sole stock is expected from this closure.

For 2009 Council Regulation (EC) N°43/2009 allocates different amounts of kW*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The areas are Kattegat, part of 3.a not covered by Skaggerak and Kattegat, ICES zone 4, EC waters of ICES zone 2.a, ICES zone 7.d, ICES zone 7.a, ICES zone 6.a and EC waters of ICES zone 5.b. The grouping of fishing gear concerned are: bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≥100 mm)–TR2 (≥70 and <100 mm)–TR3 (≥16 and <32 mm); beam trawl of mesh size: BT1 (≥120 mm)–BT2 (≥80 and <120 mm); gillnets excluding trammelnets: GN1; trammelnets: GT1 and Longlines: LL1.

For 2010–2016, Council Regulation (EC) N°53/2010, Council Regulation (EC) N°57/2011, Council Regulation (EC) N°43/2012, Council Regulation (EC) N°40/2013, Council Regulation (EC) N°43/2014, Council Regulation (EC) N°2015/104 and Council Regulation (EC) N°2016/72 were updates of the Council Regulation (EC) N°43/2009 with new allocations, based on the same effort groups of vessels and areas as stipulated in Council Regulation (EC) N°43/2009.

Management applicable to 2018 and 2019

TAC 2018

Species:	Common sole *Solea solea*	**Zone:**	7a (SOL/07A.)
Belgium	10 (1)		
France	0 (1)		
Ireland	17 (1)		
The Netherlands	3 (1)		
United Kingdom	10 (1)		
Union	40 (1)		
TAC	40 (1)		Analytical TAC Article 3 of Regulation (EC) No 847/96 shall not apply Article 4 of Regulation (EC) No 847/96 shall not apply

(1) Exclusively for by-catches. No directed fisheries are permitted under this quota.

TAC 2019

Species:	Common sole *Solea solea*	**Zone:**	7a (SOL/07A.)
Belgium	192		
France	2		
Ireland	74		
The Netherlands	60		
United Kingdom	86		
Union	414		
TAC	414		Analytical TAC Article 3 of Regulation (EC) No 847/96 shall not apply Article 4 of Regulation (EC) No 847/96 shall not apply

Fishery in 2018

A full description of the fishery is provided in the Stock Annex, Section A2.

An overview of the landings data provided and used by the Working Group (WG) is shown in Table 29.1. The landings reached a level of 2808 t in the mid-1980s due to good recruitments in 1982–1984, but then subsequently dropped to a lowest of 818 t in 2000. After a small increase to 1090 t in the beginning of the 2000s, the landings have fallen to under 350 t in 2008–2012. From 2013 onwards the landings continued to decrease as they dropped to under 150 t.

The WG estimated the total international landings at 36 t in 2018, of which Belgium landed 40% (14.3 t), Ireland 46% (16.5 t), 9% (3.2 t) by the UK (England & Wales) and the remainder by Northern Ireland, the Netherlands, Scotland, Isle of Man and France. These landing-figures are among the lowest in the time-series, corresponding to an international uptake of 90% of the agreed TAC in 2018 (40 t) and last year's forecast.

The WG estimate of the 2017 landings was not revised.

In 2018, 66% of the landings were taken by beam trawls, 30% by otter trawls, 4% by other gears.

31.2 Data

Landings

Quarterly age compositions for 2018 were available from the countries that take the major part of the international landings (95%) (Belgium, UK(E&W) and Ireland). The raw age data were combined for the three countries without weighting. The combined ALK was applied to the raised length distribution of the national catches to obtain a combined age distribution. This distribution was applied to the landings from Northern Ireland, Scotland, Isle of Man and France to obtain the catch numbers-at-age for 2018 (Table 29.2, Figure 29.1). The standardised catch proportion-at-age is presented in Figure 29.2. Annual length distributions of the three major countries involved are given in Table 29.3. Because of the substantial reduction of the TAC in the last four years, sampling levels are also substantially reduced.

Catch weights-at-age for 2018 were taken from the combined age–weight key (Table 29.4).

Stock weights-at-age for 2000–2018 were derived from the mean catch weights by cohort interpolation to the first of January (Rivard weight calculator) (Table 29.5).

Further details on raising methods are given in the stock annex.

As last year, the combined age data (calculated outside InterCatch) as well as the landings from Northern Ireland, Scotland, Isle of Man and France were uploaded to InterCatch. It should be noted that the international age distribution is uploaded as “BE” as no international country code is available in InterCatch at present.

Discards

The available discard information (Table 29.6) suggests that discarding is not a major problem in the Irish Sea sole fishery. Belgian beam trawl length distributions of retained and discarded catches of sole for 2018 (Figure 29.3a) indicate that predominantly 3 and 4-year old fish are discarded. Observer information from UK and Irish otter trawl fleets also suggest low discard rates. The working group decided not to include discards in the assessment at this stage due to the scarcity of the data but will monitor the situation in the future.

As an attempt, estimating an overall discard rate for the stock, individual discard estimates for 2016–2018 from the main métiers and countries were averaged to obtain an overall discard rate (Table 29.6b). The percent of the métiers with discard information covering the total international landings is 65%, 63% and 66% for 2016, 2017 and 2018 respectively. Assuming that discard rates do not change from the average of the last three years (2016–2018) and a fixed proportion of discards survive, a discard rate of around 3.5% (of the catch) could be assumed for this stock at the moment.

Biological

Natural mortality, maturity and proportions of natural mortality and fishing mortality before spawning were set as in previous years, details of which can be found in the Stock Annex Section B2.

Surveys

Lpue and effort series were available from the UK(E&W) September beam trawl survey (UK(E&W)-BTS-Q3) (1988–2018) and the UK(E&W) March beam trawl survey (UK(E&W)-BTS-

Q1) (1993–1998) (Table 29.7b and Figure 29.4c). From 2006 until 2010 the two UK beam trawl surveys have been used as tuning indices in the Irish Sea sole assessments. Following the outcome of WKFLAT 2011, the March survey (UK(E&W)-BTS-Q1) was omitted from the following assessments. The lpue from the UK(E&W)-BTS-Q3 has fluctuated since the beginning of the time-series (1988) between 90 and 200 kg/100 Km fished. Since 2000, it has dropped gradually to the lowest value in 2012 (26.47 kg/100 Km fished). Thereafter, it slowly increased to 78.51 kg/100 Km fished in 2018.

Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

Commercial lpue

Trends in lpue and effort are given in Table 29.7 and Figure 29.4–29.5.

Commercial lpue and effort data were available for Belgian beam trawlers, UK(E&W) beam and otter trawlers and Irish otter and beam trawlers. It should be noted that the most recent lpue values of the UK(E&W) beam trawlers (2013–2018) and the UK(E&W) otter trawlers (2014–2018) are not available as the effort values for those years are missing. In 2013, the UK administration switched to the EU electronic logbook system. Therefore, a lot of the reported effort is missing and the 2013 value cannot be used as an absolute number. Details of the 2013 UK beam trawl were unavailable due to reduced numbers of trips reporting this gear specific effort information via the newly introduced e-logbook system. The otter trawl fleet effort reporting was unaffected by this as these vessels were not reporting their landings via this method in 2013. However, from 2014 onwards, both the UK beam trawl and otter trawl effort values are unavailable because of the reporting issues.

Effort from both Belgian and UK commercial beam trawl fleets increased from the early seventies until the beginning of the nineties. Since then UK beam trawl effort has shown a continuing declining trend. Inspection of an alternate effort indicator (days fished) suggests that the declining trend continues in the period 2013-2018. In contrast, the Belgian beam trawl effort has shown a fluctuating pattern. After the decline in the early nineties, it reached its highest level in 2002 and decreased again afterwards. For the period 2008–2012, it remained stable at a very low level but in 2013, it continued to decrease and in 2016 it dropped to the lowest level in the time-series. In 2017–2018, there is a slight increase. The effort of the Irish beam trawlers shows a slow decline since 2004 and reached the lowest level in the time-series in 2013. Since 2014, the Irish beam trawl effort has slightly increased. In 2008 all beam trawl fleets showed a substantial reduction in effort compared to 2007.

The effort from the UK otter trawlers remained stable until the beginning of the nineties. Since then, the UK otter trawl effort has continuously declined and is at the lowest level in 2013. As, in 2015 and 2016 all otter trawl vessels active in the Irish Sea were under 12 m, no effort (days fished) was recorded. In 2017, the otter trawl effort (days fished) is similar to the level observed in the period 2009–2010 and in 2018 it further increased. The Irish otter trawlers have shown a striking reduction in effort since 2000, followed by a slight increase in the period 2010–2012. In 2017 and 2018, the Irish otter trawl effort fell back to the lowest observed levels in the time-series.

Nearly all effort time-series show a substantial decrease in the last six years, in line with the substantial reductions of the TAC.

Lpue for both UK and Belgian beam trawlers was at a high level in the late seventies and early eighties but since early 2000s, lpue for these fleets has fluctuated at a lower level. In the period 2007–2009 there has been a small increase in the UK beam trawl lpue. However, in 2012 the lpue has dropped to a remarkable low level in the time-series (4.3 kg/hour fished). An update for 2013–2017 was not available. However, the alternate lpue indicator (kg/days fished) suggests that the UK beam trawl lpue increased in 2015. For 2016–2018 no catches of sole and/or no effort were recorded therefore the lpue is zero. The Belgian beam trawlers hold on to a higher lpue value (18–20 kg/hour fished) for the period 2008–2012. However, in 2013 the lpue decreased (12.7 kg/hour fished) and in 2017 it dropped to the lowest level in the time-series (3.6 kg/hour fished). In 2018, there's a slight increase to 5.4 kg/hour fished. The Irish beam trawl lpue shows a gradually diminishing trend over the whole time-series. After the slight increase in 2013, it fell back to a record low level in 2016–2018.

The UK otter trawl lpue remained stable until the beginning of the 2000s but is at the record low level in 2012. The alternative lpue indicator (kg/days fished) suggests that the declining trend continues after 2012. In 2018 there is a slight increase to the level observed in the period 2011–2012 (12.6 kg/days fished). In 2012–2016, the lpue of Irish otter trawlers is fluctuating at a lower level. In 2017–2018 a higher value was recorded.

Historical stock development

In 2010, the Irish Sea sole assessment was based on XSA with two survey tuning indices (UK(E&W)-BTS-Q3 and UK(E&W)-BTS-Q1 (Table 29.8). The UK(E&W)-BTS-Q1 indices only provide information for the years 1993 up to 1999 and therefore no longer contribute to the final survivor estimates. At WKFLAT 2011, the exclusion of the UK(E&W)-BTS-Q1 from the assessment was investigated and it was found that there was little effect on the catchability residuals and that the retrospective pattern was slightly improved. WKFLAT 2011 therefore decided to omit this survey from the assessment.

31.3 Stock assessment

Data screening

The age range for the analysis was 2–8+.

The screening of the tuning indices (UK(E&W)-BTS-Q3) showed good cohort tracking (Figure 29.6) and consistency between ages for year-class strength (Figure 29.7).

Final update assessment

The model settings for the final assessment are summarized below:

Assmnt Year	:2010	:2011–2019
Assmnt Model	: XSA	:XSA
Fleets	:	:
Bel Beam Trwl	: omitted	:omitted
UK Trawl	: omitted	:omitted
UK Sept BTS	:1988–2009 2–7	:1988–2018 2–7
UK Mar BTS	:1993–1999 2–7	:omitted
Time Ser. Wts	: linear 20 yrs	:no taper weighting
Power Model	: none	:none
Q plateau	: 7	:4
Shk se	:1.5	:1.5
Shk age-yr	: 5 yrs 3 ages	: 5 yrs 3 ages
Pop Shk se	: 0.3	: 0.3
Prior Wting	: none	: none
Plusgroup	: 8	: 8
Fbar	: 4–7	: 4–7

The final XSA output is given in Table 29.9 (diagnostics), Table 29.10 (fishing mortalities) and Table 29.11 (stock numbers). Log catchability residuals for the final assessment are given in Figure 29.8. A summary of the XSA results is given in Table 29.12 and trends in yield, fishing mortality, recruitment and spawning stock biomass are shown in Figure 29.9. Retrospective patterns for the final run are shown in Figure 29.10.

Adding the 2018 data to the time-series did not cause any additional anomalies compared to last year. The log catchability residual pattern showed no trends apart from the year effect in 2016. The positive residuals (higher estimates from the UK(E&W)-BTS-Q3 fleet compared to the VPA estimates) in 2016 are likely due to the fact that de age composition in the catch is flattened.

The survivor estimates and fishing mortality estimates are almost entirely determined by the UK(E&W)-BTS-Q3 survey as it gets a high weighting (>96%) at all ages.

A Mohn's rho analysis was conducted based on the XSA stock assessment results, i.e. the last data year (2018) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 4–7)	recruitment
Mohn's rho value	0.042	-0.04	-0.025

The Mohn's rho values for this assessment are very low and well below the threshold of 20% imposed by ICES for 2019 assessments, i.e. the current assessment indicates a high consistency.

Comparison with previous assessments

A comparison of the estimates of this year's assessment with last year's is given in Figure 29.11.

Trends in fishing mortality, SSB and recruitment are very similar. In last year's assessment, F and SSB for 2017 were estimated to be 0.0188 and 1941 t respectively; this year's estimates for 2017 are 0.0193 and 1891 t, an upward revision of 3% for F and a downward revision of 3% for SSB. The estimated recruitment by XSA in 2017 (1362 thousand fish) was revised upward by 14% in this year's assessment (1553 thousand fish).

State of the stock

Estimated trends of Irish Sea sole landings, SSB, fishing mortality and recruitment are presented in Table 29.12 and Figure 29.9. Since the late eighties the landings of Irish Sea sole have been declining to the lowest level of the time-series (34 t) in 2017. SSB has been at a higher level until the late eighties. Since then SSB has been fluctuating between B_{pa} and B_{lim} and since 2004, it dropped below B_{lim}. After the record low value in 2014 (883 t), SSB gradually increased again to 2627 t in 2018. High fishing mortalities were observed during the late eighties until the mid-nineties. Thereafter fishing mortality declined to a level fluctuating just above F_{lim}. From 2013 onwards, fishing mortality has dropped under the level of F_{pa}/F_{MSY}. In 2018 the lowest level of the time-series was recorded (0.014). The decline in F is supported by a substantial reduction of the TAC in the most recent years. Since 2001 recruitment has been well below the mean (5538 thousand fish) and the 2011 recruitment (year class 2009) is estimated to be the lowest in the time-series (638 thousand fish). The 2016 recruitment (4422 thousand fish, year class 2014) is estimated to be seven times higher than the record low recruitment in 2011. The lower 2017 recruitment (1553 thousand fish) is followed by a higher incoming recruitment (year class 2016), estimated to be 3670 thousand fish.

31.4 Short-term projections

Estimating year-class abundance

The 2016 year class is now estimated at 3670 thousand fish at age 2, which is 162% higher than the short-term GM (2008–2016 (1402 thousand fish) used in the last year's forecast. The age 2 estimates are almost solely coming from the UK(E&W)-BTS-Q3. From 2010 to 2014, the UK(E&W)-BTS-Q3 abundance for age 2 fluctuated around the level of the lowest abundance in 2011 (0.29). In 2016 the UK(E&W)-BTS-Q3 abundance for age 2 increased to the higher level of early 2000 (2.97). In 2017, there is a decrease (0.8), followed by an increase in 2018 (2.18).

Given the consecutive low recruitments in recent years, the WG decided to assume the short-term GM for the 2017 year class instead of the long-term GM (1970–2016, 4087 thousand fish). The short-term GM (2009–2017, 1339 thousand fish) recruitment was also assumed for the 2018 and subsequent year classes.

The working group estimates of year-class strength used for prediction can be summarised as follows:

Year Class	XSA	GM 70-16	GM 09-17
2016 (age 3 in 2019)	3318	3595	-
2017 (age 2 in 2019)	-	4087	1339
2018 & 2019 (recruits)	-	4087	1339

Fishing mortality was calculated as the mean of 2016–2018. Catch and stock weights-at-age were also averages for the years 2016–2018. Population numbers at the start of 2019 for ages 3 and older, were taken from the XSA output.

In line with last year's forecast, the working group agreed to use a TAC constraint (400 t landings) for the intermediate year (2019). Because of the restricted fishing opportunities by the main countries fishing for Irish Sea sole, it seemed reasonable that the landings in 2019 would be in line with the agreed TAC of 414 t catch and 400 t landings.

The input for the short-term catch predictions and sensitivity analysis is given in Table 29.13, the short-term management option table is given in Table 29.14 and a detailed output is presented in Table 29.15.

Assuming a TAC constraint for 2019 of 414 t (400 t landings), implies a fishing mortality in 2019 of 0.133. The assumed landings using a *status quo* fishing mortality in 2020 is 73 t. This results in a SSB of 3218 t in 2020 and 3481 t in 2021. The proportional contributions of recent year classes to the predicted landings and SSB are given in Figure 29.12. The assumed short-term GM recruitment accounts for about 5% of the landings in 2020 and about 15% of the 2021 SSB.

31.5 MSY explorations

Investigations for possible F_{MSY} candidates for this stock were carried out at WGCSE 2010. ACOM adopted an F_{MSY} value of 0.16, based on stochastic simulations using a Ricker model (PLOTMSY program). $B_{trigger}$ was set to the B_{pa} value of 3100 t.

Exploratory analysis investigating possible revisions of MSY estimates were conducted at WGCSE 2014 with a recent version of PLOTMSY (Cefas, 2014). The simulations indicated the use of equally weighting for the stock–recruitment relationships and the resulting F_{MSY} value was in line with the F_{MSY} of 0.16 used at that moment for this stock.

In response to the EC long-term management plans for western EU waters (ICES subareas 5 to 10), ICES WKMSYREF4 (October 2015, Brest (France)) used long-term stochastic simulations (Eqsim) to estimate F_{MSY} and appropriate ranges. The methodology used for stocks with age-based assessments follows the approaches developed in ICES WKMSYREF2 (ICES, 2014b) and WKMSYREF3 (ICES, 2014c) and is documented in the report of WKMSYREF4 (ICES, 2016c). Estimates of reference points B_{lim}, B_{pa}, F_{lim} and F_{pa} were provided, and the F_{MSY} ranges [F_{lower}, F_{upper}] deliver no more than 5% reduction in long-term yield compared with MSY.

The sole 7.a stock is at a low level and mean recruitment has been seen to be reduced at current biomass, simulations were conducted with S–R function (Beverton–Holt and Ricker models) that followed the mean of the recruitment data, giving some reduction in recruitment at B_{lim}. The revised MSY reference points are less restrictive (F_{MSY}=0.20 instead of 0.16 and MSY $B_{trigger}$=3500 t instead of 3100 t).

In order to be consistent with the ICES precautionary approach, F_{upper} is capped, so that the probability of SSB < B_{lim} is no more than 5%. Two approaches have been used to derive the values of the cap on F_{upper}. One conforms to the ICES MSY advice rule (AR), and requires reducing F linearly towards zero when SSB is below MSY $B_{trigger}$. The second uses a constant F without an advice rule; i.e. no reduction in F with SSB less than MSY $B_{trigger}$. Although the first often provides a wider F_{MSY} range, it requires the ICES MSY advice rule to be used (ICES, 2016d).

Stock code	MSY F_{lower}	F_{MSY}	MSY F_{upper} with AR	MSY F_{upper} with no AR
Sol.7.a	0.16	0.20	0.24	0.22

31.6 Biological reference points

Precautionary approach reference points

The Working Group's current approach to reference points is outlined in Section 33.5. Current biological reference points are given in the text table below:

Reference points	ACFM 2007 onwards	2016 onwards
F_{MSY}	0.16 (PLOTMSY, WG2010)	0.20 (Eqsim, WKMSYREF 4)
F_{lim}	0.4 (based on F_{loss})	0.29 (based on simulated recruitment to give median biomass = B_{lim})
F_{PA}	0.3 (high probability of avoiding F_{lim})	0.21 (F_{lim}*1.4)
B_{lim}	2200 t (B_{loss} estimated in 2007)	2500 t (lowest value with above average recruitment)
B_{PA}	3100 t (B_{pa}~B_{lim}*1.4)	3500 t (B_{lim} *1.4)
$B_{trigger}$	B_{PA}	3500 t

31.7 Management Plans

No management plan is currently in place for Irish Sea sole.

31.8 Uncertainties and bias in assessment and forecast

Sampling

The deteriorating quality of the historic catch numbers-at-age data was considered to be a consequence of the low biological sampling intensity, and in particular the limited sampling in the first quarter. Therefore the combined age distribution was introduced in 2000 as an alternative method for raising the international catch numbers-at-age. The mean catch weights from this combined key were taken and the stock weights-at-age were obtained using a cohort interpolation method from the catch weights-at-age. Under the DCF there is an initiative to co-ordinate sampling across the three countries involved in the fishery. However, as the TAC is substantially reduced in the most recent years, sampling levels are also significantly reduced.

Landings

There is no reliable information on the accuracy of the landing statistics. For the period 2005–2012, the total TAC uptake was only in the range of 50–98%. In this context, misreporting was not considered to be a major problem. In the most recent years, the TAC was substantially reduced and was restrictive in 2013 and 2014. In 2015–2018, 84%–90% of the TAC has been taken.

Discards

The absence of discard data is unlikely to affect the quality of the assessment as information from recent years indicates that the average discarding by weight is 3.5% of the catch.

Effort

There are no indications of Irish Sea sole fisheries misreporting effort. Effort in beam trawl fisheries that target sole has declined substantially in the last few years in accordance with the significant reductions in TAC.

Surveys

The UK(E&W)-BTS-Q3 survey appears to track year-class strength well. As previously investigated, this tuning fleet is also consistent in estimating year-class strength of the same year class at different ages. Therefore the Working Group had confidence in using the UK(E&W)-BTS-Q3 survey as the only tuning fleet. The bias problem in the assessment maybe the result of the precise survey and less precise catch-at-age data.

Model formulation

At present XSA is used to assess Irish Sea sole. In the WG of 2007 the model settings were changed which had a considerable impact on the estimates of SSB and fishing mortality. Due to these major revisions, ACFM changed the biomass reference points at its meeting of 2007. In the next two update assessments (2008–2009) no major changes were apparent. In the assessment of 2011, the settings were changed according to the outcome of WKFLAT 2011. The following assessments were update assessments. In 2016, the reference points were updated (see Section 33.5–33.6).

31.9 Recommendations for next Benchmark

The assessment diagnostics indicate a good correlation between the catch data and the survey tuning series. Therefore, at present there are no recommendations for a single stock Benchmark. However, in the recent years there has been great uncertainty from the fishing industry on the actual status of the sole stock in the Irish Sea. Fishermen are concerned that due to ecosystem changes and the changing fishing behaviour in the Irish Sea, science is no longer capturing the current situation. Because of this mismatch an EU action plan for the Irish Sea fisheries was set up. First, a comparative fishing study was suggested to compare the catch efficiency between the UK-BTS-Q3 and a Belgian commercial vessel. Secondly, a pilot industry-science beam trawl survey should reveal the spatial distribution of sole. The outcome of those work packages will indicate whether the data gathered by the UK-BTS-Q3 is still representative for the current situation or whether the implementation of an additional (annual) industry-science industry survey is needed. Thirdly, stock identification techniques (i.e. genetic fingerprinting and otolith shape analysis) will be performed to give insight on the origin and potential migration routes of sole that is caught in the Irish Sea.

The industry survey was not able to identify other areas of importance for sole in the Irish Sea than is already covered by the UK-BTS-Q3. Also, catchability and composition of catches in both surveys were comparable. These results suggest that the UK-BTS-Q3 gives a good representation of sole abundance and that an annual industry survey additional to this survey would not be of added value to the assessment. With regards to the stock identification study, the combination of otolith shape analysis and genetic markers (SNPs) show subtle differences between the Irish Sea, Celtic Sea and Bristol Channel populations. However more samples from the different areas and from different years need to be analyzed to reveal what is driving these differences. Also, in the attempt to effectively reassign adult sole to their place of origin, it would be preferable to include a third stock identification technique: micro-chemical fingerprinting. Despite many questions yet unsolved, the pilot industry survey delivered valuable information that can be added to an ecosystem model for the Irish Sea (one of the aims of WKIrish: an ecosystem benchmark for the Irish Sea). Moreover, the survey was an example of a fruitful cooperation between fishermen and fisheries scientists and gave useful insights on how to cooperate with the fishing industry and to gain their trust in the collection of fisheries-independent data.

31.10 Management considerations

There is a stock–recruitment relationship for this stock and evidence of reduced recruitment at low levels of SSB. However, the recruitment for higher levels of SSB is less well defined (Figure 33.13).

Recruitment at-age 2 has been well below average since 2001. In the last four years, recruitment is estimated to be higher than the record low levels in 2011–2014. SSB is below B_{lim} since 2004. XSA indicates that fishing mortality has fallen over the last couple of years (as did effort for most fleets fishing for Irish Sea sole), and is now well below F_{MSY}.

It is difficult for the stock to reach $B_{pa/}$ MSY $B_{trigger}$ in one year. A management plan for effort reduction that can be phased in over a number of years and implemented in conjunction with technical conservation measures should be considered.

Sole is caught in a mixed fishery with other flatfish as well as gadoids. Information from observer trips indicates that discarding of sole is relatively low.

31.11 Ecosystem considerations

Sole and plaice are primarily targeted by beam trawl fisheries. Beam trawling, is known to have an impact on the benthic communities, although less so on soft substrates and in areas which have been historically exploited by this fishing method. Some beam trawlers are using benthic drop-out panels that release about 75% of benthic invertebrates from the catches. Full square mesh codends are being tested in order to reduce the capture of benthos further and improve the selection profile of gadoids (Connolly, P.L. *et al*., 2009).

A complete ecosystem overview can be found in the stock annex Section A.3

31.12 References

Connolly, P.L., Kelly, E., Dransfeld, L., Slattery, N., Paramor, O.A.L., and Frid, C.L.J. 2009. MEFEPO North Western Waters Atlas. Marine Institute.

ICES. 2014a. Report of the Workshop to consider reference points for all stocks (WKMSYREF2), 8–10 January 2014, ICES Headquarters, Copenhagen, Denmark. ICES CM 2014/ACOM:47. 91 pp.

ICES. 2014b. Report of the Joint ICES–MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 147 pp.

ICES. 2016b. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 183 pp.

ICES. 2016c. EU request to ICES to provide FMSY ranges for selected stocks in ICES subareas 5 to 10, ICES special request advice. 5 February 2016 Version 2; 13 May 2016.

Table 29.1. Sol.27.7a - Nominal landings (tonnes) as officially reported by ICES, and working group estimates of the landings. Last year's landings are preliminary.

[1] **1989 onwards: N. Ireland included with England & Wales**

Year	Belgium	France	Ireland	Netherlands	UK (E+W)	UK (Isle of Man)	UK (N. Ireland)[1]	UK (Scotland)	Officially reported	Unallocated	Total used by WG	TAC
1973	793	12	27	281	258	-	46	11	1428	0	1428	
1974	664	54	28	320	218	-	23	-	1307	0	1307	
1975	805	59	24	234	281	-	24	15	1442	-1	1441	
1976	674	72	74	381	195	-	49	18	1463	0	1463	
1977	566	39	84	227	160	-	49	21	1146	1	1147	
1978	453	65	127	177	189	-	57	30	1098	8	1106	
1979	779	48	134	247	290	-	47	42	1587	27	1614	
1980	1002	41	229	169	367	-	44	68	1920	21	1941	
1981	884	13	167	186	311	-	41	45	1647	20	1667	
1982	669	9	161	138	277	-	31	44	1329	9	1338	
1983	544	3	203	224	219	-	33	29	1255	-86	1169	
1984	425	10	187	113	230	-	38	17	1020	38	1058	
1985	589	9	180	546	269	-	36	28	1657	-511	1146	
1986	930	17	235	-	637	1	50	46	1916	79	1995	
1987	987	5	312	-	599	3	72	63	2041	767	2808	2100
1988	915	11	366	-	507	1	47	38	1885	114	1999	1750
1989	1010	5	155	-	613	2	.	38	1823	10	1833	1480
1990	786	2	170	-	569	10	.	39	1576	7	1583	1500
1991	371	3	198	-	581	44	.	26	1223	-11	1212	1500
1992	531	11	164	-	477	14	.	37	1234	25	1259	1350
1993	495	8	98	-	338	4	.	28	971	52	1023	1000
1994	706	7	226	-	409	5	.	14	1367	7	1374	1500
1995	675	5	176	-	424	12	.	8	1300	-34	1266	1300
1996	533	5	133	149	194	4	.	5	1023	-21	1002	1000

Year	Belgium	France	Ireland	Netherlands	UK (E+W)	UK (Isle of Man)	UK (N. Ireland)[1]	UK (Scotland)	Officially reported	Unallocated	Total used by WG	TAC
1997	570	3	130	123	189	5	.	7	1027	-24	1003	1000
1998	525	3	134	60	161	3	.	9	895	16	911	900
1999	469	<1	120	46	165	1	.	8	810	53	863	900
2000	493	3	135	60	133	1	.	8	833	-15	818	1080
2001	674	4	135	-	195	+	.	4	1012	41	1053	1100
2002	817	4	96	-	165	+	.	3	1085	5	1090	1100
2003	687	4	103	-	217	+	.	3	1014	0	1014	1010
2004	527	1	77	-	106	+	.	1	712	-3	709	800
2005	662	3	85	-	103	+	.	1	854	1	855	960
2006	419	1	85	-	69	+	.	2	576	-7	569	960
2007	305	1	115	-	66	<1	.	4	491	1	492	820
2008	216	1	66	-	37	n/a	.	n/a	320	12	332	669
2009	257	n/a	47	-	19	1	.	1	325	0	325	502
2010	217	<1	47	-	12	<1	.	n/a	277	0	277	402
2011	250	<1	48	-	31	<1	.	n/a	330	0	330	390
2012	222	<1	51	-	23	<1	-	n/a	296	0	298	300
2013	96	<1	40	-	12	<1	-	n/a	148	0	148	140
2014	43	n/a	43	-	10	<1	-	n/a	96	0	99	95
2015	37	n/a	32	-	7	n/a	-	n/a	76	0	76	90
2016	14	n/a	15	-	6	n/a	-	n/a	35	0	35	40
2017	14	n/a	14	-	4	n/a	-	n/a	32	2	34	40
2018	14	n/a	16		6	n/a	-	n/a	36	0	36	40

Table 29.2. Sol.27.7a - Catch numbers-at-age (in thousands).

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	29	113	31	368	25	262	29	221	65
3	895	434	673	363	891	733	375	416	958
4	1009	2096	730	2195	576	2386	1331	1292	649
5	467	1130	1538	557	1713	539	2329	774	1009
6	1457	232	537	815	383	842	247	1066	442
7	289	878	172	267	422	157	544	150	638
+gp	2537	1886	1501	1143	971	1006	739	648	587

Age/Year	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	108	187	70	8	37	651	154	141	189
3	1027	940	580	346	165	786	1600	3334	3347
4	3432	1969	1668	1241	998	380	1085	3465	4104
5	829	3057	1480	1298	758	610	343	960	3184
6	637	521	1640	711	757	343	334	235	844
7	326	512	114	641	416	424	164	277	307
+gp	620	1146	865	397	709	557	739	848	808

Age/Year	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	32	179	564	1316	363	83	122	132	60
3	444	771	1185	1269	2431	543	1343	920	469
4	4747	775	986	841	917	1965	1070	1444	1188
5	2100	3979	598	300	556	559	1579	737	741
6	1309	1178	2320	226	190	251	394	1010	430
7	203	552	592	1172	156	199	133	179	509
+gp	515	255	466	459	928	686	524	350	347

Age/Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	790	167	301	178	240	148	437	299	536
3	714	1728	1069	906	1438	930	825	862	1052
4	475	466	1259	907	822	1623	966	342	626

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978
5	711	256	297	600	717	740	795	368	271
6	409	315	115	150	511	575	302	304	314
7	258	191	136	55	80	254	217	139	279
+gp	532	423	232	258	272	217	345	181	368

Age/Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	112	171	99	92	22	17	17	23	12
3	670	356	353	414	336	225	148	99	49
4	649	348	190	333	233	401	311	75	59
5	203	243	195	146	177	176	274	106	37
6	113	86	156	132	65	97	116	78	38
7	151	41	56	127	72	54	52	34	51
+gp	379	298	209	162	158	122	115	82	56

Age/Year	2015	2016	2017	2018
2	15	1	2	4
3	36	18	41	22
4	37	22	19	46
5	30	14	15	14
6	17	10	5	9
7	21	7	6	3
+gp	74	32	13	10

Table 29.3. Sol.27.7a - Annual length distributions by country (2018).

	UK (England & Wales)	Belgium	Ireland
Length (cm)	All gears	All gears	All gears
21			
22			
23	54		
24	215	908	185
25	430	3650	436
26	859	4971	586
27	1386	5850	1740
28	2106	6111	2068
29	1833	4685	2078
30	1118	5097	4756
31	613	3400	4272
32	871	2704	6051
33	796	2220	3143
34	344	1797	3872
35	161	1532	3925
36	420	1089	3382
37	134	865	2018
38	27	830	1437
39	0	566	828
40	183	787	887
41		225	306
42		246	335
43		80	316
44		130	83
45		154	33
46		51	33
47		0	
48		22	
49		15	
50			
Total	11550	47985	42770

Table 29.4. Sol.27.7a - Catch weights-at-age (kg).

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	0.13	0.152	0.126	0.151	0.138	0.13	0.12	0.085	0.093
3	0.153	0.178	0.164	0.178	0.174	0.172	0.161	0.146	0.147
4	0.178	0.204	0.201	0.204	0.209	0.21	0.2	0.202	0.197
5	0.204	0.23	0.237	0.23	0.241	0.244	0.239	0.251	0.243
6	0.232	0.257	0.272	0.256	0.272	0.275	0.276	0.293	0.286
7	0.26	0.284	0.306	0.283	0.301	0.303	0.313	0.33	0.326
+gp	0.377	0.419	0.417	0.392	0.396	0.367	0.457	0.387	0.429

Age/Year	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	0.134	0.146	0.162	0.112	0.189	0.191	0.144	0.122	0.135
3	0.165	0.169	0.183	0.171	0.212	0.225	0.189	0.164	0.164
4	0.199	0.193	0.207	0.225	0.238	0.257	0.231	0.203	0.196
5	0.234	0.219	0.234	0.275	0.266	0.288	0.272	0.241	0.231
6	0.271	0.247	0.264	0.321	0.298	0.318	0.31	0.277	0.268
7	0.311	0.275	0.296	0.362	0.332	0.347	0.346	0.311	0.308
+gp	0.451	0.380	0.452	0.456	0.458	0.408	0.430	0.407	0.462

Age/Year	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	0.111	0.125	0.135	0.133	0.149	0.102	0.175	0.129	0.156
3	0.147	0.163	0.162	0.172	0.177	0.156	0.198	0.182	0.193
4	0.183	0.201	0.192	0.208	0.207	0.205	0.227	0.232	0.228
5	0.218	0.237	0.227	0.241	0.239	0.248	0.261	0.277	0.263
6	0.252	0.271	0.265	0.272	0.274	0.285	0.301	0.318	0.296
7	0.286	0.304	0.307	0.3	0.31	0.318	0.346	0.356	0.327
+gp	0.419	0.389	0.414	0.345	0.379	0.370	0.509	0.451	0.410

Age/Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.154	0.187	0.179	0.14	0.175	0.162	0.16	0.17	0.16
3	0.197	0.209	0.217	0.189	0.18	0.172	0.187	0.219	0.203
4	0.237	0.234	0.252	0.25	0.271	0.211	0.247	0.289	0.256

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978
5	0.275	0.263	0.285	0.311	0.293	0.283	0.294	0.338	0.286
6	0.311	0.295	0.314	0.368	0.326	0.328	0.342	0.371	0.312
7	0.345	0.331	0.341	0.428	0.42	0.333	0.326	0.383	0.326
+gp	0.407	0.440	0.399	0.504	0.438	0.375	0.415	0.444	0.352

Age/Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	0.179	0.172	0.148	0.141	0.166	0.215	0.187	0.17	0.17
3	0.194	0.224	0.189	0.195	0.193	0.213	0.22	0.213	0.196
4	0.224	0.296	0.248	0.229	0.266	0.276	0.26	0.278	0.269
5	0.297	0.36	0.279	0.279	0.285	0.362	0.311	0.32	0.328
6	0.293	0.38	0.291	0.277	0.321	0.413	0.331	0.347	0.369
7	0.318	0.429	0.386	0.261	0.308	0.368	0.368	0.353	0.397
+gp	0.349	0.479	0.392	0.277	0.335	0.364	0.335	0.354	0.441

Age/Year	2015	2016	2017	2018
2	0.18	0.187	0.177	0.186
3	0.221	0.223	0.239	0.24
4	0.309	0.269	0.323	0.31
5	0.342	0.356	0.386	0.389
6	0.381	0.332	0.495	0.476
7	0.4	0.414	0.493	0.485
+gp	0.384	0.436	0.457	0.472

Table 29.5. Sol.27.7a - Stock weights-at-age (kg).

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	0.13	0.152	0.126	0.151	0.138	0.13	0.12	0.085	0.093
3	0.153	0.178	0.164	0.178	0.174	0.172	0.161	0.146	0.147
4	0.178	0.204	0.201	0.204	0.209	0.21	0.2	0.202	0.197
5	0.204	0.23	0.237	0.23	0.241	0.244	0.239	0.251	0.243
6	0.232	0.257	0.272	0.256	0.272	0.275	0.276	0.293	0.286
7	0.26	0.284	0.306	0.283	0.301	0.303	0.313	0.33	0.326
+gp	0.377	0.419	0.417	0.392	0.396	0.367	0.457	0.387	0.429
Age/Year	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**
2	0.134	0.146	0.162	0.112	0.189	0.191	0.144	0.122	0.135
3	0.165	0.169	0.183	0.171	0.212	0.225	0.189	0.164	0.164
4	0.199	0.193	0.207	0.225	0.238	0.257	0.231	0.203	0.196
5	0.234	0.219	0.234	0.275	0.266	0.288	0.272	0.241	0.231
6	0.271	0.247	0.264	0.321	0.298	0.318	0.31	0.277	0.268
7	0.311	0.275	0.296	0.362	0.332	0.347	0.346	0.311	0.308
+gp	0.451	0.380	0.452	0.456	0.458	0.408	0.430	0.407	0.462
Age/Year	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
2	0.111	0.125	0.135	0.133	0.149	0.102	0.175	0.129	0.156
3	0.147	0.163	0.162	0.172	0.177	0.156	0.198	0.182	0.193
4	0.183	0.201	0.192	0.208	0.207	0.205	0.227	0.232	0.228
5	0.218	0.237	0.227	0.241	0.239	0.248	0.261	0.277	0.263
6	0.252	0.271	0.265	0.272	0.274	0.285	0.301	0.318	0.296
7	0.286	0.304	0.307	0.3	0.31	0.318	0.346	0.356	0.327
+gp	0.419	0.389	0.414	0.345	0.379	0.370	0.509	0.451	0.410
Age/Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
2	0.154	0.187	0.179	0.124	0.151	0.145	0.144	0.15	0.144
3	0.197	0.209	0.217	0.158	0.159	0.174	0.174	0.187	0.186
4	0.237	0.234	0.252	0.23	0.226	0.195	0.207	0.232	0.237

Age/Year	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**
5	0.275	0.263	0.285	0.303	0.271	0.277	0.249	0.289	0.288
6	0.311	0.295	0.314	0.345	0.318	0.31	0.311	0.331	0.325
7	0.345	0.331	0.341	0.41	0.393	0.33	0.327	0.362	0.348
+gp	0.407	0.440	0.399	0.530	0.450	0.397	0.383	0.419	0.383

Age/Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2	0.152	0.156	0.134	0.129	0.158	0.167	0.156	0.149	0.111
3	0.177	0.2	0.181	0.17	0.165	0.188	0.218	0.2	0.183
4	0.213	0.24	0.236	0.208	0.228	0.231	0.235	0.248	0.24
5	0.276	0.284	0.288	0.263	0.256	0.31	0.293	0.288	0.302
6	0.289	0.336	0.324	0.278	0.3	0.343	0.346	0.329	0.343
7	0.315	0.354	0.383	0.276	0.292	0.344	0.39	0.342	0.371
+gp	0.348	0.419	0.424	0.319	0.305	0.340	0.345	0.358	0.399

Age/Year	**2015**	**2016**	**2017**	**2018**
2	0.153	0.127	0.152	0.149
3	0.194	0.2	0.212	0.206
4	0.246	0.244	0.268	0.272
5	0.303	0.332	0.322	0.355
6	0.353	0.337	0.42	0.429
7	0.384	0.397	0.405	0.49
+gp	0.397	0.411	0.443	0.462

Table 29.6a. Sol.27.7a - Discard rates for the main fleets operational in the Irish Sea (Belgian, UK and Irish beam trawl, UK and Irish otter trawl, UK and Irish *Nephrops* trawl).

	BEL	UK						IRL		
Gear	TBB	TBB	OTB	TWIN OTB	NEPH OTB	TWIN NEPH	Other	TBB	NEPH OTB	OTB DEF
Landings (t)	716	284	61	4	25	6	Na	427	/	/
Discard ratio	0.05	0.08	0.05	0.01	0.08	0.02	Na	0.02	/	/
years	2007–2009	2002, 2005–2007	2002–2009	2003,2004,2007	2003, 2006–2009	2002,2003,2008	Na	2003–2009	/	/
Landings (t) 2010	210.917	1.721	1.071	0.014	3.329	0.501	0.741	38.283	5.327	3.632
Discard ratio 2010	0.04	Na	0.00	Na	0.05	Na	Na	0.05	0.16*	0.39*
Landings (t) 2011	239.483	13.662	2.866	0.05	5.201	0.414	0.821	32.514	10.116	5.581
Discard ratio 2011	0.04	Na	0.02	Na	0.00	Na	Na	0.003	0.16*	0.00

*** It should be noted that the 16% discard rate for 2010–2011 of the Irish *Nephrops* fleet and the 39% discard rate for 2010 of the Irish otter trawl fleet only accounts for respectively 1.9%, 3.1% and 1.3% of the total international landings.**

Table 29.6b. Sol.27.7a - Discard rates.

Country	Year	Landings (L) (t)			Discards (D) (t)
		TBB	OTB	other	
BE	2012	213.392	8.301	0	16.222
	2013	93.009	3.028	0	8.538
	2014	36.144	7.288	0	2.286
	2015	32.2	3.995	0	2.343
	2016	12.533	1.538	0	0.336
	2017	11.047	2.154	0	0.436
	2018	13.2	1.085	0	0.5
UK	2012	7.278	5.459	1.229	0
	2013	0.168	5.108	1.258	0
	2014	0.149	3.579	1.582	1.404
	2015	0.164	3.505	0.491	0
	2016	0.110	2.700	0.641	0.029
	2017	0.06	1.449	1.004	0
	2018	0.099	2.259	0.877	0.000
IR	2012	38.79	8.162	3.824	1
	2013	30.934	9.23	0.009	0

Country	**Year**	**Landings (L) (t)**			**Discards (D) (t)**	
		TBB	OTB	other		
	2014	37.007	6.016	0.1613	0.4	
	2015	24.306	7.19	0.031	1.394	
	2016	9.205	5.842	0.037	0.273	
	2017	7.214	6.493	0.961	0.205	
	2018	9.079	7.041	0.376	0.474	
		total L	L corresponding with discard info	% coverage of L	total D	rate
	2012	286.44	227.01	0.79	17.22	0.071
	2013	142.74	107.35	0.75	8.54	0.074
	2014	91.93	45.74	0.50	4.09	0.082
	2015	71.88	42.89	0.60	3.74	0.080
	2016	32.61	21.08	0.65	0.64	0.029
	2017	30.38	18.99	0.63	0.64	0.033
	2018	34.02	22.50	0.66	0.97	0.041
	average 16–18					0.035

Table 29.7a. Sol.27.7a - Effort series.

	Belgium	UK(E&W)				Ireland	
	beam[1]	beam [2]	beam[3]	otter[2]	otter[3]	otter[4]	beam[4]
Year	Whole year	Whole year	Whole year	Whole year	Whole year	Whole year	Whole year
1972	-	-	-	128.4	-	-	-
1973	-	-	-	147.6	-	-	-
1974	-	-	-	115.2	-	-	-
1975	28.4	-	-	130.7	-	-	-
1976	24.9	-	-	122.3	-	-	-
1977	22.1	-	-	101.9	-	-	-
1978	17.5	0.9	-	89.1	-	-	-
1979	20.4	1.7	-	89.9	-	-	-
1980	32.0	4.3	-	107.0	-	-	-
1981	36.5	6.4	-	107.1	-	-	-
1982	26.5	5.5	-	127.2	-	-	-
1983	28.7	2.8	0.0	88.1	1716.5	-	-
1984	17.5	4.1	263.0	103.1	7932.1	-	-
1985	27.0	7.4	428.1	102.9	6930.8	-	-
1986	44.5	17.0	1122.9	90.3	6693.2	-	-
1987	51.6	22.0	1178.5	130.6	9008.9	-	-
1988	38.2	18.6	1019.2	132.0	8292.4	-	-
1989	42.2	25.3	1344.5	139.5	16161.4	-	-
1990	42.4	31.0	1473.1	117.1	7724.5	-	-
1991	17.1	25.8	1211.3	107.3	7081.1	-	-
1992	25.1	23.4	908.1	96.8	6671.8	-	-
1993	23.9	21.5	826.9	78.9	6013.1	-	-
1994	32.5	20.1	1451.6	43.0	3060.0	-	-
1995	28.6	20.9	1429.4	43.1	3357.0	80.3	8.64
1996	23.2	13.3	894.3	42.2	3085.1	64.8	6.26
1997	30.7	10.8	784.4	39.9	2903.3	92.2	9.86

	Belgium	UK(E&W)				Ireland	
	beam[1]	beam [2]	beam[3]	otter[2]	otter[3]	otter[4]	beam[4]
Year	Whole year	Whole year	Whole year	Whole year	Whole year	Whole year	Whole year
1998	24.7	10.4	696.0	36.9	2620.6	93.5	11.58
1999	22.7	11.0	778.9	22.9	1803.5	110.3	14.7
2000	26.0	6.3	410.7	27.0	2034.9	82.7	11.4
2001	36.8	12.5	767.4	32.8	2352.9	77.5	13.1
2002	47.0	8.0	535.1	24.8	1774.0	77.9	17.7
2003	43.6	14.0	863.7	23.9	1728.3	73.9	18.7
2004	32.0	7.4	419.9	23.5	1727.0	72.5	14.2
2005	37.5	11.4	627.8	16.7	1313.6	68.3	14.7
2006	24.6	4.6	280.1	5.2	478.5	66.2	12.2
2007	19.4	3.2	193.5	4.4	397.2	74.1	14.2
2008	9.6	1.3	98.0	2.7	320.4	58.8	9.5
2009	11.1	0.5	24.9	1.5	157.7	42.8	7.6
2010	11.1	0.2	10.2	1.4	151.0	45.8	9.4
2011	12.5	1.6	91.2	0.7	72.7	54.5	8.1
2012	10.9	0.9	60.7	0.4	85.0	58.3	7.2
2013	7.0	0.0	1.3	0.3	31.9	42.6	5.0
2014	3.9	-	0.4	-	16.1	47.7	6.0
2015	3.5	-	0.9	-	0.0	39.8	8.3
2016	1.8	-	3.9	-	0.0	33.4	7.9
2017	3.0	-	0.0	-	160.7	12.1	7.5
2018	2.5	-	0.0	-	238.1	13.6	9.6

All the trawlers fishing in the Irish Sea (UK fleet) are below 12 meters in length.

[1] 000' hours fishing.

[2] 000'hours fished (GRT corrected >40' vessels).

[3] days fished.

[4] 000'hours.

[7] days fished.

*** Provisional.**

Table 29.7b. Sol.27.7a – Lpue.

	Belgium	**UK(E&W)**				**UK**		**Ireland**	
	beam[1]	beam[3]	beam[2]	otter[3]	otter[2]	beam survey[4]		otter	beam
Year	Whole year	Whole year	Whole year	Whole year	Whole year	Sept	March	Whole year	Whole year
1972	-	-	-	1.06	-	-	-	-	-
1973	-	-	-	1.06	-	-	-	-	-
1974	-	-	-	1.09	-	-	-	-	-
1975	21.4	-	-	1.39	-	-	-	-	-
1976	23.1	-	-	0.94	-	-	-	-	-
1977	19.8	-	-	0.80	-	-	-	-	-
1978	18.1	34.32	-	1.04	-	-	-	-	-
1979	33.4	32.01	-	1.43	-	-	-	-	-
1980	28.2	31.70	-	1.01	-	-	-	-	-
1981	22.2	21.32	-	0.75	-	-	-	-	-
1982	22.0	29.94	-	0.53	-	-	-	-	-
1983	13.9	37.31	0.0	0.57	150.2	-	-	-	-
1984	22.5	16.24	2851.4	0.71	119.3	-	-	-	-
1985	20.6	17.34	2956.3	0.56	135.7	-	-	-	-
1986	19.1	19.23	3925.7	0.84	174.9	-	-	-	-
1987	17.7	14.82	3726.9	0.77	144.9	-	-	-	-
1988	21.3	11.81	2673.3	0.46	80.3	161.9	-	-	-
1989	21.9	9.17	1750.6	0.70	138.9	150.0	-	-	-
1990	17.5	9.52	2300.9	0.61	119.7	196.9	-	-	-
1991	18.7	10.43	2420.9	1.12	177.4	175.7	-	-	-
1992	19.2	9.50	2763.0	1.02	126.0	162.6	-	-	-
1993	20.0	7.60	1879.8	0.54	69.1	100.1	104.7	-	-
1994	19.1	11.76	1479.9	0.74	88.1	110.7	91.9		-
1995	18.1	14.96	1721.1	0.95	142.3	92.04	79.3	0.38	12.69
1996	17.7	9.44	1471.7	0.53	47.7	89.48	-	0.25	14.94
1997	16.6	10.49	961.8	0.73	103.2	155.7	63.3	0.23	8.53
1998	19.0	8.42	907.8	0.48	50.5	144.9	89.3	0.38	7.77
1999	19.5	9.94	1124.9	0.60	64.8	116.0	-	0.29	9.22
2000	15.5	12.90	1604.7	0.44	34.6	130.7	-	0.29	8.49
2001	15.0	11.72	1537.4	0.15	23.4	96.87	-	0.38	7.86
2002	15.0	16.73	1484.3	1.48	98.8	76.73	-	0.32	4.67
2003	14.8	13.20	1351.6	0.15	340.4	88.55	-	0.34	4.20
2004	15.4	13.86	941.7	0.17	27.6	98.92	-	0.14	4.31
2005	16.7	9.14	1199.9	0.19	21.3	48.91	-	0.16	4.70
2006	15.2	7.83	826.1	0.52	34.8	52.63	-	0.16	6.00

	Belgium	UK(E&W)				UK		Ireland	
	beam[1]	beam[3]	beam[2]	otter[3]	otter[2]	beam survey[4]		otter	beam
Year	Whole year	Whole year	Whole year	Whole year	Whole year	Sept	March	Whole year	Whole year
2007	13.7	16.38	1629.9	0.42	21.4	53.05	-	0.37	6.37
2008	19.5	15.25	887.4	0.30	16.4	50.67	-	0.20	6.08
2009	20.2	18.88	1201.2	0.22	13.6	45.75	-	0.28	4.53
2010	18.0	13.90	262.3	0.46	17.8	27.80	-	0.19	4.09
2011	17.6	4.45	322.5	0.18	13.7	36.97	-	0.30	4.13
2012	18.9	4.27	99.9	0.08	10.5	26.47	-	0.14	5.41
2013	12.7	-	27.7	0.10	3.4	31.65	-	0.22	6.27
2014	8.9	-	0.0	-	0.0	41.14	-	0.14	5.40
2015	8.9	-	146.1	-	0.0	58.88	-	0.18	3.14
2016	6.5	-	0.0	-	0.0	69.35	-	0.18	1.17
2017	3.6	-	0.0	-	5.6	64.24	-	0.36	1.23
2018	5.4	-	0.0	-	12.6	78.51	-	0.28	1.49

All lpue values in Kg/hr.

[1] Kg/000'hr.

[2] Kg/day.

[3] Kg/000'hr fished (GRT corrected >40' vessels).

[4] Kg/100 km fished.

*** Provisional.**

Table 29.8. Sol.27.7a - Tuning series (values in bold are used in the assessment).

BE-CBT		Belgium Commercial Beam trawl (Effort = Corrected formula)										
	1975	2005										
	1	1	0	1								
	4	14										
12.3		1045	275	393	69	105	94	61	72	11	15	64
11.8		568	1066	80	263	64	58	35	5	56	5	5
10.7		434	307	509	76	93	45	23	20	2	35	32
9.9		169	304	155	258	41	90	12	29	12	7	17
11.2		1455	510	323	193	162	37	36	9	41	0	0
16.7		958	1644	296	268	247	210	30	64	31	14	7
22.6		909	721	998	62	92	44	161	13	92	10	8
19.5		451	608	378	394	52	64	11	29	24	5	0
20.5		259	310	394	238	216	44	38	28	49	3	26
12		107	204	143	188	91	121	2	1	4	14	0
19.6		606	171	186	99	150	125	83	27	13	4	23
38		1531	468	138	135	90	104	69	69	20	8	21
43.2		1527	881	297	167	69	39	54	59	40	13	9
30.5		2027	1012	480	21	33	37	34	42	35	0	7
34		376	2423	751	250	59	15	9	2	14	0	1
36.1		307	223	1263	276	142	13	9	11	11	8	5
13.8		253	78	60	588	115	40	16	1	1	11	3
23.9		298	330	68	40	203	93	36	12	0	0	0
24.5		862	253	149	89	79	160	66	77	0	0	0
31		680	786	164	103	39	117	58	19	15	0	7
26.2		729	366	410	52	27	6	28	15	6	11	3
21.6		537	334	241	219	53	13	11	14	9	7	2
28.5		270	376	180	162	134	28	27	15	9	8	1
23.3		248	146	142	89	73	62	20	20	9	10	3
21.7		693	199	65	50	37	21	17	9	6	4	6
18.6		685	220	107	31	15	33	13	7	9	0.6	8
30.5		600	284	248	39	35	44	33	1	3	0.2	4
38.6		1138	814	349	109	30	9	2	1	1	1	0
24.45		724	436	196	84	20	7	2	1	0	2	1
25.58		313	197	159	47	12	11	6	3	0	0	0
32.15		505	342	156	71	87	9	7	1	13	2	1
UK(E&W)-BTS-Q3			September beam trawl survey									
	1988	2018										
	1	1	0.75	0.85								
	1	9										
100.062		118	**196**	**180**	**410**	**76**	**40**	**4**	0	4		
129.71		218	**304**	**180**	**74**	**284**	**56**	**32**	8	6		
128.969		1712	**534**	**122**	**42**	**88**	**194**	**40**	20	6		
123.78		148	**1286**	**122**	**26**	**16**	**14**	**55**	19	7		
129.525		220	**309**	**657**	**142**	**34**	**22**	**7**	75	17		
131.192		83	**330**	**143**	**211**	**40**	**17**	**7**	16	36		
124.892		60	**408**	**203**	**73**	**132**	**49**	**11**	13	6		
126.004		246	**154**	**253**	**110**	**30**	**67**	**12**	5	5		
126.004		886	**126**	**32**	**76**	**46**	**23**	**31**	8	2		
126.004		1158	**577**	**72**	**24**	**55**	**27**	**16**	30	7		
126.004		539	**716**	**292**	**18**	**6**	**24**	**23**	5	18		
126.004		385	**293**	**255**	**203**	**29**	**8**	**26**	5	6		
126.004		354	**464**	**147**	**219**	**91**	**13**	**2**	13	6		
126.004		91	**284**	**192**	**65**	**96**	**63**	**6**	3	12		
126.004		205	**61**	**121**	**126**	**42**	**79**	**49**	2	1		
126.004		242	**210**	**51**	**97**	**81**	**40**	**43**	26	1		
126.004		406	**240**	**119**	**27**	**77**	**45**	**41**	17	19		
122.298		53	**165**	**69**	**25**	**13**	**35**	**25**	4	6		
126.004		107	**110**	**90**	**45**	**36**	**9**	**16**	15	10		
126.004		125	**93**	**49**	**57**	**41**	**11**	**4**	6	12		
122.298		126	**126**	**60**	**21**	**43**	**23**	**6**	2	9		
126.004		60	**150**	**68**	**40**	**19**	**30**	**12**	7	1		
126.004		26	**60**	**74**	**37**	**17**	**5**	**9**	9	3		
122.298		88	**35**	**62**	**68**	**35**	**12**	**4**	13	6		
122.298		22	**49**	**16**	**46**	**25**	**12**	**11**	2	6		
126.004		75	**57**	**36**	**21**	**33**	**18**	**21**	9	1		
126.004		172	**43**	**22**	**35**	**14**	**26**	**21**	14	6		
126.004		421	**150**	**41**	**20**	**23**	**5**	**15**	29	8		
122.298		129	**363**	**91**	**29**	**20**	**24**	**8**	8	9		
126.004		237	**101**	**177**	**56**	**24**	**15**	**9**	7	7		
126.004		268	**275**	**75**	**144**	**38**	**21**	**9**	6	9		

Table 29.8. Sole in 7.a - Continued (values in bold are used in the assessment).

UK(E&W)-BTS-Q1			March beam trawl survey											
	1993	1999												
	1	1	0.15	0.25										
	1	9												
126.931		18	337	147	332	73	15	17	10	41				
115.442		8	354	208	69	151	51	14	11	9				
126.189		24	96	186	140	30	104	27	10	8				
134.343		651	114	49	110	78	32	54	10	12				
121.742		130	417	33	17	69	23	11	46	17				
130.081		47	421	330	39	19	48	27	12	37				
130.822		45	227	284	177	14	4	34	12	7				
UK(E&W)-CBT			UK Commercial Beam trawl											
	1991	2013												
	1	1	0	1										
	2	14												
25.838		267	426	212	84	58	218	53	34	4	1	2	1	0
23.399		36	460	176	68	37	32	121	34	38	3	1	0	0
21.503		11	74	355	98	36	48	25	34	13	22	5	2	4
20.145		24	228	150	234	87	17	25	19	42	10	17	1	0
20.392		47	239	231	130	199	55	11	22	5	34	10	11	3
13.32		0	13	109	98	49	100	37	9	8	6	14	8	3
10.76		0	111	50	81	58	24	46	34	12	12	0	8	1
10.386		43	219	40	28	49	31	12	22	11	9	2	1	0
11.016		53	115	134	12	15	25	10	9	14	9	0	1	2
6.275		16	90	84	82	9	6	10	5	5	7	2	1	1
12.495		33	184	100	145	107	12	4	17	12	10	6	4	2
8.017		4	63	152	50	79	47	5	4	6	3	1	1	1
13.996		28	63	178	149	78	52	72	7	5	8	3	7	14
7.396		54	61	29	43	25	12	10	5	1	1	4	0	1
11.406		10	81	44	16	45	37	17	10	17	3	0	3	3
4.649		7	28	33	11	5	10	12	7	9	5	2	0	1
3.197		22	20	34	17	6	1	7	7	6	3	2	1	1
1.302		1	11	5	7	12	1	2	4	3	4	0	3	1
0.462		0	0	0	0	0	0	0	0	0	0	0	0	0
0.186		0	0	0	0	0	0	0	0	0	0	0	0	0
1.564		0	3	6	3	3	1	1	1	0	0	0	0	0
0.849		0	0	0	0	0	0	0	0	0	0	0	0	0
0.003		0	0	0	0	0	0	0	0	0	0	0	0	0

Table 29.8. Sole in 7.a. Continued (values in bold are used in the assessment).

UK(E&W)-C0T UK Commercial Otter trawl

1991 2013
1 1 0 1
2 14

107.3	265	155	63	29	19	71	20	11	2	0	1	1	1
96.8	16	224	69	22	16	10	36	10	10	1	0	0	0
78.9	9	27	77	19	3	7	4	5	1	2	0	0	0
43	4	66	34	50	20	3	4	4	7	1	2	0	0
43.1	17	50	34	15	24	7	1	2	0	2	1	1	0
42.2	2	5	18	12	7	12	4	1	1	1	1	1	1
39.9	14	15	7	14	9	3	7	3	1	1	0	1	0
36.9	5	24	5	3	5	3	2	2	1	1	0	0	0
22.8	5	15	12	2	0	2	1	1	1	1	0	0	0
27	2	12	9	8	1	0	1	1	0	0	0	0	0
32.9	3	10	6	8	5	0	0	0	0	0	0	0	0
24.8	0	8	16	3	5	3	1	0	1	0	0	0	0
23.9	1	2	6	4	2	1	2	0	0	0	0	0	0
23.5	3	5	3	4	3	2	1	1	0	0	0	0	0
16.7	2	4	2	1	2	2	1	1	1	0	0	0	0
5.2	1	2	4	1	1	1	1	1	1	1	0	0	0
4.4	1	1	2	2	0	0	1	1	1	0	0	0	0
2.7	0	1	1	1	1	0	0	0	0	0	0	0	0
1.54	0	0	0.2	0.3	0.1	0.2	0.2	0	0	0.1	0	0	0
1.42	0	0.1	0.2	0.3	0.1	0.1	0.2	0.1	0	0.1	0.1	0.1	0
0.686	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0
0.241	0	0	0	0	0	0	0	0	0	0	0	0	0
0.272	0	0	0	0	0	0	0	0	0	0	0	0	0

IR-COT Irish Commercial Otter trawl

1995 2005
1 1 0 1
2 10

70682	6.8	17.7	25.5	9.2	25.8	3.6	0.8	1.5	1.9	1995
58166	0	5.7	12.9	12.7	4.7	4.7	2.2	0.2	0	1996
75029	27.8	10.2	4.1	9.2	6.4	3.5	3.9	1	0.2	1997
81073	5.5	40.7	14.7	6.6	12.3	5.4	2.7	4.1	1	1998
93221	26.6	36.8	30.9	5.1	3.8	5.3	2.4	0.5	1.2	1999
64320	1.6	13.2	13.4	11	3.4	1.1	1	0.4	0	2000
77541	0.2	6.1	18.6	18.6	10.8	2.1	4.1	1.3	0.3	2001
39996	20.3	20	30.2	16.4	8.2	2.9	2.4	1.4	0.5	2002
73854	0.9	35.9	21.7	9.8	3.3	0.5	0.8	0.2	0.2	2003
72507	9	15.1	4.1	3.2	1.9	1.6	0.3	0.2	0.1	2004
##										
31142	4	1.7	1.6	1.6	0.6	0.1	0	0	0	2005
##										

Please note the 2005 data are based only on Q3 and Q4 data and has not been raised to annual effort.
It should not be included as part of this time-series.

Table 29.9. Sol.27.7a – Diagnostics.

```
FLR XSA Diagnostics 2019-05-21 10:57:56

CPUE data from indices
Catch data for 49 years. 1970 to 2018. Ages 2 to 8.
            fleet first age last age first year last year alpha beta
1 UK (E&W)-BTS-Q3         2        7       1988      2018  0.75 0.85

 Time series weights :
   Tapered time weighting not applied

Catchability analysis :
    Catchability independent of size for all ages
    Catchability independent of age for ages >   4

Terminal population estimation :
    Survivor estimates shrunk towards the mean F
    of the final   5 years or the  3 oldest ages.
    S.E. of the mean to which the estimates are shrunk =   1.5
    Minimum standard error for population
    estimates derived from each fleet =  0.3
    prior weighting not applied

Regression weights
     year
age   2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
   year
age  2009  2010  2011  2012  2013  2014  2015  2016  2017  2018
  2 0.043 0.014 0.028 0.020 0.038 0.015 0.009 0.000 0.001 0.001
  3 0.299 0.197 0.179 0.325 0.143 0.096 0.053 0.012 0.011 0.017
  4 0.405 0.245 0.339 0.357 0.242 0.107 0.088 0.036 0.014 0.014
  5 0.476 0.348 0.263 0.363 0.176 0.162 0.066 0.038 0.030 0.011
  6 0.263 0.357 0.290 0.248 0.148 0.080 0.094 0.025 0.016 0.020
  7 0.387 0.201 0.500 0.223 0.096 0.123 0.052 0.045 0.017 0.011
  8 0.387 0.201 0.500 0.223 0.096 0.123 0.052 0.045 0.017 0.011


 XSA population number (Thousand)
      age
year      2    3    4    5   6   7    8
  2009 2278 1681 1050  405 599 416  528
  2010 1615 1974 1128  633 228 417  912
  2011  638 1440 1467  799 405 144  324
  2012  883  561 1089  946 556 274  604
  2013  648  783  367  690 595 392  945
  2014  831  564  614  261 523 464  509
  2015 1807  741  464  499 200 437 1539
  2016 4422 1621  636  384 423 165  778
  2017 1553 4000 1450  555 335 374  809
  2018 3670 1403 3580 1293 487 298  993


 Estimated population abundance at 1st Jan  2019
      age
year   2    3    4    5    6   7   8
  2019 0 3318 1249 3198 1158 433 267



 Fleet:  UK (E&W)-BTS-Q3
```

```
 Log catchability residuals.

   year
age   1988   1989   1990   1991   1992   1993   1994   1995   1996   1997
  2  0.044  0.027  0.411  0.509 -0.051 -0.273  0.162  0.178 -0.279  0.095
  3  0.587  0.369 -0.124 -0.292  0.473 -0.271 -0.043  0.295 -0.674 -0.072
  4  0.007  0.070 -0.240 -0.923  0.451 -0.098 -0.284  0.051 -0.245 -0.161
  5 -0.383 -0.018  0.969 -0.611 -0.017 -0.312  0.031 -0.579 -0.219  0.033
  6 -0.231 -0.234  0.302 -0.198  0.173 -0.068  0.540 -0.017 -0.172 -0.156
  7 -0.118  0.086  0.192 -0.190 -0.195 -0.077  0.192 -0.337 -0.149  0.281

   year
age   1998   1999   2000   2001   2002   2003   2004   2005   2006   2007
  2  0.443 -0.150  0.000 -0.043 -0.901  0.139  0.040  0.000  0.276 -0.234
  3  0.110  0.007 -0.207 -0.222 -0.225 -0.173  0.421 -0.365  0.149  0.251
  4 -0.765  0.322  0.325 -0.484  0.070  0.237 -0.098 -0.216 -0.091  0.266
  5 -0.753  0.339 -0.116 -0.137 -0.387  0.206  0.447 -0.065  0.720  0.268
  6 -0.279  0.360  0.155 -0.094  0.077  0.005  0.043  0.177  0.250 -0.028
  7  0.206  0.189 -0.116 -0.014 -0.013 -0.230  0.355 -0.024 -0.203 -0.025

   year
age   2008   2009   2010   2011   2012   2013   2014   2015  2016   2017   2018
  2  0.015  0.002 -0.593 -0.163 -0.158  0.287 -0.262  0.206 0.218 -0.044  0.097
  3  0.028  0.048 -0.110  0.044 -0.251  0.051 -0.152  0.164 0.175 -0.093  0.100
  4  0.050  0.210 -0.068  0.383  0.304  0.487  0.374  0.080 0.125 -0.089 -0.049
  5  0.395  0.475 -0.186  0.266 -0.159  0.255  0.360  0.128 0.258  0.037 -0.365
  6  0.128  0.370 -0.379 -0.103 -0.454 -0.226  0.215 -0.462 0.333  0.061  0.025
  7 -0.202 -0.082 -0.521 -0.001  0.147  0.302  0.156 -0.177 0.192 -0.558 -0.338


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2       3       4       5       6       7
Mean_Logq -7.4440 -7.7724 -7.9097 -7.9097 -7.9097 -7.9097
S.E_Logq   0.2943  0.2943  0.2943  0.2943  0.2943  0.2943



Terminal year survivor and F summaries:

Age =  2 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2016

Fleet =  fshk
                  2
Survivors   294.000
Raw weights   0.444


Fleet =  UK (E&W)-BTS-Q3
                   2
Survivors   3656.000
Raw weights   11.098


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "fshk"            "294"        "1.499"   "Inf"     "Inf"     "1" "0.039"     "0.013"
[2,] "UK (E&W)-BTS-Q3" "3656"       "0.3"     "Inf"     "Inf"     "1" "0.961"     "0.001"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "3318"   ""       ""       ""        "0.001"


Age =  3 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2015

Fleet =  fshk
                  3
```

```
Survivors   321.000
Raw weights   0.444


Fleet =  UK (E&W)-BTS-Q3
                   3        2
Survivors   1381.000 1195.000
Raw weights   10.929   10.914


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "fshk"            "321"        "1.488"   "Inf"     "Inf"     "1" "0.02"      "0.063"
[2,] "UK (E&W)-BTS-Q3" "1285"       "0.212"   "0.072"   "0.34"    "2" "0.98"      "0.016"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "1249"   ""       ""       ""        "0.017"


Age =  4 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2014

Fleet =  fshk
                  4
Survivors   425.000
Raw weights   0.444


Fleet =  UK (E&W)-BTS-Q3
                   4        3        2
Survivors   3043.000 2912.000 3974.000
Raw weights    8.899   10.844   10.841


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "fshk"            "425"        "1.49"    "Inf"     "Inf"     "1" "0.014"     "0.098"
[2,] "UK (E&W)-BTS-Q3" "3293"       "0.179"   "0.099"   "0.553"   "3" "0.986"     "0.013"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "3198"   ""       ""       ""        "0.014"


Age =  5 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2013

Fleet =  fshk
                  5
Survivors   134.000
Raw weights   0.444


Fleet =  UK (E&W)-BTS-Q3
                  5        4        3        2
Survivors   803.000 1058.000 1379.000 1421.000
Raw weights   6.295    8.793   10.706   10.613


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "fshk"            "134"        "1.491"   "Inf"     "Inf"     "1" "0.012"     "0.094"
[2,] "UK (E&W)-BTS-Q3" "1189"       "0.163"   "0.123"   "0.755"   "4" "0.988"     "0.011"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "1158"   ""       ""       ""        "0.011"


Age =  6 .  Catchability constand w.r.t. time and dependant on age
```

```
 Year class =  2012

Fleet =  fshk
                  6
Survivors   113.000
Raw weights   0.444


Fleet =  UK (E&W)-BTS-Q3
                  6       5       4       3      2
Survivors   443.000 449.000 490.000 510.000 333.00
Raw weights  10.896   6.063   8.283   9.678   9.53


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "fshk"            "113"        "1.485"   "Inf"     "Inf"     "1" "0.01"      "0.073"
[2,] "UK (E&W)-BTS-Q3" "438"        "0.143"   "0.077"   "0.538"   "5" "0.99"      "0.019"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "433"    ""       ""       ""        "0.02"


Age =  7 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2011

Fleet =  fshk
                  7
Survivors   190.000
Raw weights   0.444


Fleet =  UK (E&W)-BTS-Q3
                  7       6       5      4      3       2
Survivors   190.000 284.000 345.000 289.00 229.00 356.000
Raw weights  10.994  10.817   5.966   7.74   8.66   8.337


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "fshk"            "190"        "1.492"   "Inf"     "Inf"     "1" "0.008"     "0.015"
[2,] "UK (E&W)-BTS-Q3" "268"        "0.13"    "0.1"     "0.769"   "6" "0.992"     "0.011"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "267"    ""       ""       ""        "0.011"
```

Table 29.10. Sol.27.7a - Fishing mortality.

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	0.0083	0.0117	0.0103	0.0299	0.0045	0.0421	0.0079	0.0148	0.0076	0.0129	0.0396	0.0165
3	0.1196	0.1480	0.0810	0.1436	0.0847	0.1575	0.0704	0.1350	0.0743	0.1427	0.1335	0.1488
4	0.2956	0.3987	0.3520	0.3621	0.3158	0.3033	0.4192	0.3255	0.2866	0.3645	0.3931	0.3289
5	0.4445	0.5543	0.5060	0.4394	0.4723	0.4845	0.4816	0.4072	0.4036	0.6321	0.5673	0.5109
6	0.4292	0.3670	0.4932	0.4874	0.5436	0.3973	0.3792	0.3752	0.3815	0.4260	0.9493	0.6028
7	0.3909	0.4415	0.4519	0.4310	0.4454	0.3962	0.4281	0.3704	0.3583	0.4759	0.6393	0.4826
+gp	0.3909	0.4415	0.4519	0.4310	0.4454	0.3962	0.4281	0.3704	0.3583	0.4759	0.6393	0.4826
FBAR 4-7	0.3901	0.4404	0.4508	0.4300	0.4443	0.3953	0.4270	0.3696	0.3575	0.4746	0.6373	0.4813

Age/Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	0.0034	0.0070	0.0452	0.0100	0.0063	0.0591	0.0097	0.0440	0.1127	0.1155	0.0801	0.0142
3	0.0953	0.0813	0.1808	0.1343	0.2755	0.1800	0.1719	0.2992	0.3990	0.3520	0.2876	0.1483
4	0.4772	0.3835	0.2429	0.3602	0.4215	0.5647	0.3699	0.4498	0.6796	0.4849	0.4109	0.3532
5	0.4078	0.5321	0.3794	0.3205	0.5519	0.7603	0.5606	0.5354	0.6625	0.3958	0.6085	0.4186
6	0.4370	0.3922	0.4328	0.3273	0.3370	1.2558	0.7284	0.6275	0.6094	0.4978	0.4152	0.5414
7	0.4422	0.4374	0.3527	0.3370	0.4383	0.8648	1.0992	0.6924	0.6634	0.6326	0.6772	0.9061
+gp	0.4422	0.4374	0.3527	0.3370	0.4383	0.8648	1.0992	0.6924	0.6634	0.6326	0.6772	0.9061
FBAR 4-7	0.4411	0.4363	0.3520	0.3362	0.4372	0.8614	0.6895	0.5763	0.6537	0.5028	0.5280	0.5548

Age/Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.0247	0.0717	0.0256	0.1044	0.0258	0.0621	0.0272	0.0569	0.0693	0.1626	0.0903	0.2112
3	0.2952	0.2340	0.3452	0.4165	0.3090	0.2043	0.2397	0.2829	0.2887	0.5809	0.4866	0.4572
4	0.4283	0.5242	0.4723	0.6183	0.4662	0.3446	0.2390	0.3169	0.5238	0.4853	0.4471	0.6987
5	0.4721	0.5225	0.4959	0.5096	0.7134	0.5421	0.2442	0.2689	0.4636	0.4666	0.3051	0.6809
6	0.5200	0.5558	0.5846	0.4961	0.3936	0.7278	0.5121	0.3017	0.3192	0.3098	0.2895	0.4097
7	0.5468	0.4187	0.5347	0.7495	0.4032	0.2616	0.8314	0.5024	0.2148	0.1710	0.2037	0.4158
+gp	0.5468	0.4187	0.5347	0.7495	0.4032	0.2616	0.8314	0.5024	0.2148	0.1710	0.2037	0.4158
FBAR 4-7	0.4918	0.5053	0.5219	0.5934	0.4941	0.4690	0.4567	0.3475	0.3804	0.3582	0.3114	0.5513

Age/Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2	0.0930	0.1009	0.0543	0.0433	0.0144	0.0284	0.0205	0.0381	0.0154	0.0088	0.0002	0.0014
3	0.3928	0.4203	0.2773	0.2993	0.1972	0.1793	0.3250	0.1428	0.0961	0.0527	0.0115	0.0108
4	0.5028	0.3230	0.3695	0.4054	0.2449	0.3386	0.3571	0.2422	0.1069	0.0881	0.0363	0.0142
5	0.4507	0.3150	0.2701	0.4761	0.3480	0.2632	0.3634	0.1764	0.1624	0.0656	0.0383	0.0295
6	0.5949	0.3094	0.3060	0.2633	0.3571	0.2901	0.2480	0.1484	0.0797	0.0939	0.0246	0.0162
7	0.3133	0.3955	0.3014	0.3872	0.2005	0.5003	0.2228	0.0956	0.1232	0.0521	0.0447	0.0174
+gp	0.3133	0.3955	0.3014	0.3872	0.2005	0.5003	0.2228	0.0956	0.1232	0.0521	0.0447	0.0174
FBAR 4-7	0.4654	0.3357	0.3118	0.3830	0.2876	0.3481	0.2978	0.1656	0.1181	0.0749	0.0360	0.0193

Age/Year	2018	FBAR 16-18
2	0.0011	0.0009
3	0.0165	0.0130
4	0.0135	0.0213
5	0.0114	0.0264
6	0.0195	0.0201
7	0.0106	0.0242
+gp	0.0106	0.0242
FBAR 4-7	0.0138	

Table 29.11. Sol.27.7a - Stock numbers-at-age (start of year, in thousands).

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	3695	10177	3186	13133	5870	6680	3857	15772	9041	8848	5071	4498	2462
3	8349	3316	9101	2853	11533	5288	5795	3462	14061	8118	7904	4410	4003
4	4145	6703	2588	7594	2236	9588	4087	4887	2737	11812	6369	6258	3439
5	1368	2791	4071	1647	4784	1475	6406	2432	3193	1859	7423	3890	4075
6	4389	794	1451	2221	960	2699	822	3581	1464	1930	894	3809	2112
7	939	2585	498	802	1234	504	1642	509	2227	905	1140	313	1886
+gp	8212	5534	4321	3418	2828	3220	2221	2192	2042	1713	2536	2365	1163
TOTAL	31097	31900	25214	31667	29446	29455	24830	32835	34765	35186	31338	25543	19140

Age/Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	5559	15479	16250	23752	3462	3498	4374	5564	12686	4955	6191	5250	2006
3	2220	4995	13387	14557	21357	2952	3135	3788	4497	10227	4138	5523	4635
4	3293	1852	3772	10591	10000	16141	2250	2103	2300	2862	6941	3228	3720
5	1931	2031	1314	2381	6287	5145	10089	1298	964	1281	1717	4412	1903
6	2453	1026	1257	863	1240	2660	2658	5344	606	587	631	1022	2490
7	1234	1499	602	820	557	320	1162	1284	2629	333	351	332	550
+gp	2095	1963	2705	2501	1456	805	533	1005	1023	1972	1200	1302	1071
TOTAL	18784	28844	39288	55464	44360	31520	24200	20385	24705	22217	21170	21070	16375

Age/Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	2499	8383	6899	5256	6968	4560	2332	3059	3644	2959	1321	1871	1962
3	1689	2204	6833	6083	4470	6136	3898	1969	2352	3013	2167	1090	1531
4	3319	1082	1315	4539	4487	3182	4184	2643	997	1308	1726	1324	648
5	1993	1872	528	746	2910	3197	2097	2242	1472	577	589	945	867
6	1021	1098	1018	234	393	2063	2211	1194	1272	982	264	339	624
7	1292	515	605	621	102	213	1380	1454	792	862	590	132	225
+gp	877	1053	1335	1057	476	721	1176	2300	1027	1132	1477	955	843
TOTAL	12690	16208	18533	18538	19806	20071	17278	14860	11557	10832	8134	6655	6700

Age/Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	**GMST 70-16**
2	2278	1615	638	883	648	831	1807	4422	1553	3670	4087
3	1681	1974	1440	561	783	564	741	1621	4000	1403	
4	1050	1128	1467	1089	367	614	464	636	1450	3580	**GMST 2009-2017**
5	405	633	799	946	690	261	499	384	555	1293	1339
6	599	228	405	556	595	523	200	423	335	487	
7	416	417	144	274	392	464	437	165	374	298	
+gp	528	912	324	604	945	509	1539	778	809	993	
TOTAL	6957	6907	5216	4913	4420	3766	5687	8428	9074	11725	

Table 29.12. Sol.27.7a – Summary.

	RECRUITS Age 2	SSB	BIOMASS	LANDINGS	FBAR 4- 7	YIELD/SSB
1970	3695	6436	1785	1785	0.39	0.28
1971	10177	6222	1882	1882	0.44	0.30
1972	3186	5011	1450	1450	0.45	0.29
1973	13133	5123	1428	1428	0.43	0.28
1974	5870	5068	1307	1307	0.44	0.26
1975	6680	5359	1441	1441	0.40	0.27
1976	3857	4888	1463	1463	0.43	0.30
1977	15772	4490	1147	1147	0.37	0.26
1978	9041	5092	1106	1106	0.36	0.22
1979	8848	5685	1614	1614	0.47	0.28
1980	5071	5514	1941	1941	0.64	0.35
1981	4498	5166	1667	1667	0.48	0.32
1982	2462	4331	1338	1338	0.44	0.31
1983	5559	4096	1169	1169	0.44	0.29
1984	15479	4604	1058	1058	0.35	0.23
1985	16250	5642	1146	1146	0.34	0.20
1986	23752	6956	1995	1995	0.44	0.29
1987	3462	7165	2808	2808	0.86	0.39
1988	3498	5519	1999	1999	0.69	0.36
1989	4374	4633	1833	1833	0.58	0.40
1990	5564	3628	1583	1583	0.65	0.44
1991	12686	3189	1212	1212	0.50	0.38
1992	4955	3452	1259	1259	0.53	0.36
1993	6191	3231	1023	1023	0.55	0.32
1994	5250	4051	1374	1374	0.49	0.34
1995	2006	3521	1266	1266	0.51	0.36
1996	2499	2712	1002	1002	0.52	0.37
1997	8383	2500	1003	1003	0.59	0.40
1998	6899	3027	911	911	0.49	0.30
1999	5256	3320	863	863	0.47	0.26
2000	6968	3132	818	818	0.46	0.26
2001	4560	3565	1053	1053	0.35	0.30
2002	2332	3578	1090	1090	0.38	0.30
2003	3059	3213	1014	1014	0.36	0.32
2004	3644	2299	709	709	0.31	0.31
2005	2959	2076	855	855	0.55	0.41
2006	1321	1640	569	569	0.47	0.35

	RECRUITS Age 2	SSB	BIOMASS	LANDINGS	FBAR 4- 7	YIELD/SSB
2007	1871	1398	492	492	0.34	0.35
2008	1962	1334	332	332	0.31	0.25
2009	2278	1081	325	325	0.38	0.30
2010	1615	1204	277	277	0.29	0.23
2011	638	1103	330	330	0.35	0.30
2012	883	1166	298	298	0.30	0.26
2013	648	1099	148	148	0.17	0.13
2014	831	883	99	99	0.12	0.11
2015	1807	1316	76	76	0.07	0.06
2016	4422	1247	35	35	0.04	0.03
2017	1553	1891	34	34	0.02	0.02
2018	3670	2627	36	36	0.01	0.01
Arith. Mean	5538	3581		1054	0.41	0.28
Units	(Thousands)	(Tonnes)		(Tonnes)		

Table 29.13. Sole in 7.a.

	Input for catch forecast and F_{MSY} analysis							
Input:	F 2019: TAC constraint for 2019 (414 t)							
	F 2020-2021: mean 16–18							
	Catch and stock weights are mean 16–18							
	Recruits age 2 in 2019–2021 GM(09-17)							
2019								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	1339	0.1	0.38	0	0	0.142667	0.0053	0.183333
3	3317	0.1	0.71	0	0	0.205667	0.07459	0.234
4	1249	0.1	0.97	0	0	0.261333	0.12291	0.300667
5	3196	0.1	0.98	0	0	0.336333	0.15195	0.377
6	1157	0.1	1	0	0	0.395333	0.11586	0.434333
7	432	0.1	1	0	0	0.430667	0.13952	0.464
+gp	1156	0.1	1	0	0	0.44038	0.1395	0.454563
fbar 4–7							0.13256	
2020								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	1339	0.1	0.38	0	0	0.142667	0.0009	0.183333
3	1205	0.1	0.71	0	0	0.205667	0.0130	0.234
4	2785	0.1	0.97	0	0	0.261333	0.0213	0.300667
5	999	0.1	0.98	0	0	0.336333	0.0264	0.377
6	2484	0.1	1	0	0	0.395333	0.0201	0.434333
7	932	0.1	1	0	0	0.430667	0.0242	0.464
+gp	1250	0.1	1	0	0	0.44038	0.0242	0.454563
fbar 4–7							0.023024	
2021								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	1339	0.1	0.38	0	0	0.142667	0.0009	0.183333
3	1210	0.1	0.71	0	0	0.205667	0.0130	0.234
4	1076	0.1	0.97	0	0	0.261333	0.0213	0.300667
5	2467	0.1	0.98	0	0	0.336333	0.0264	0.377
6	881	0.1	1	0	0	0.395333	0.0201	0.434333
7	2203	0.1	1	0	0	0.430667	0.0242	0.464
+gp	1927	0.1	1	0	0	0.44038	0.0242	0.454563
fbar 4–7							0.023024	

Table 29.14. Sol.27.7a - Management option table.

F 2019: TAC constraint for 2019 (414 t)
F 2020-2021: mean 16-18
Catch and stock weights are mean 16-18
Recruits age 2 in 2019-2021 GM (09-17)
Fbar age range: 4-7

2019				
Biomass	SSB	FMult	FBar	Landings
3427	3079	5.757593	0.1330	400

2020				2021
SSB	FMult	FBar	Landings	SSB
3218	0.0000	0	0	3552
3218	0.1000	0.0023	7	3545
3218	0.2000	0.0046	15	3537
3218	0.3000	0.00691	22	3530
3218	0.4000	0.00921	29	3523
3218	0.5000	0.01151	37	3516
3218	0.6000	0.01381	44	3509
3218	0.7000	0.01612	51	3502
3218	0.8000	0.01842	59	3495
3218	0.9000	0.02072	66	3488
3218	1.0000	0.02302	73	3481
3218	1.1000	0.02533	80	3474
3218	1.2000	0.02763	88	3467
3218	1.3000	0.02993	95	3460
3218	1.4000	0.03223	102	3453
3218	1.5000	0.03454	109	3446
3218	1.6000	0.03684	116	3439
3218	1.7000	0.03914	123	3432
3218	1.8000	0.04144	130	3426
3218	1.9000	0.04375	138	3419
3218	2.0000	0.04605	145	3412

Input units are thousands and kg - output in tonnes

2020			2021	2021-2020	2020-2019	
FMult	Landings	FBar	SSB	SSB change	TAC change	Basis
7.987	542	0.184	3028	-5.90	36.00	MSY approach
8.6867	585	0.200	2987	-7.20	46.00	Fmsy
6.3895	441	0.147	3126	-2.90	10.33	MSY approach upper
9.5844	640	0.221	2934	-8.90	60.00	MSY approach lower
5.76	400	0.133	3165	-1.70	0.00	TACstable
6.6866	460	0.154	3107	-3.50	15.00	TACplus15
4.8467	340	0.112	3223	0.10	-15.00	TACminus15
9.121	612	0.210	2961	-8.00	53.00	Fpa
12.596	815	0.290	2766	-14.10	104.00	Flim
5.7575	400	0.133	3165	-1.70	0.00	F2019
0.7292	53	0.0168	3500	8.70	-87.00	Btrigger
17.783	1091	0.409	2500	-22.30	173.00	Blim

Table 29.15. Sol.27.7a - Detailed results.

F 2019: TAC constraint for 2019 (414 t)							
F 2020–2021: mean 16–18							
Catch and stock weights are mean 16–18							
Recruits age 2 in 2019–2021 GM (09-17)							
Fbar age range: 4–7							
Year:	**2019**	F multiplier:	5.97312	Fbar:	0.13752		
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
2	0.00530	7	1	1339	191	509	73
3	0.07459	227	53	3317	682	2355	484
4	0.12291	138	41	1249	326	1211	317
5	0.15195	429	162	3196	1075	3132	1053
6	0.11586	121	52	1157	457	1157	457
7	0.13952	54	25	432	186	432	186
8	0.13952	143	65	1156	509	1156	509
Total	0.13256	1119	400	11846	3427	9952	3079
Year:	**2020**	F multiplier:	1.00000	Fbar:	0.02302		
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
2	0.00092	1	0	1339	191	509	73
3	0.01295	15	3	1205	248	856	176
4	0.02135	56	17	2785	728	2702	706
5	0.02639	25	9	999	336	979	329
6	0.02012	47	20	2484	982	2484	982
7	0.02423	21	10	932	402	932	402
8	0.02423	28	13	1250	550	1250	550
Total	0.02302	193	73	10994	3437	9712	3218
Year:	**2021**	F multiplier:	1.00000	Fbar:	0.02302		
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
2	0.00092	1	0	1339	191	509	73
3	0.01295	15	3	1210	249	859	177
4	0.02135	22	7	1076	281	1044	273
5	0.02639	61	23	2467	830	2418	813
6	0.02012	17	7	881	348	881	348
7	0.02423	50	23	2203	949	2203	949
8	0.02423	44	20	1927	849	1927	849
Total	0.02302	210	84	11103	3697	9841	3481

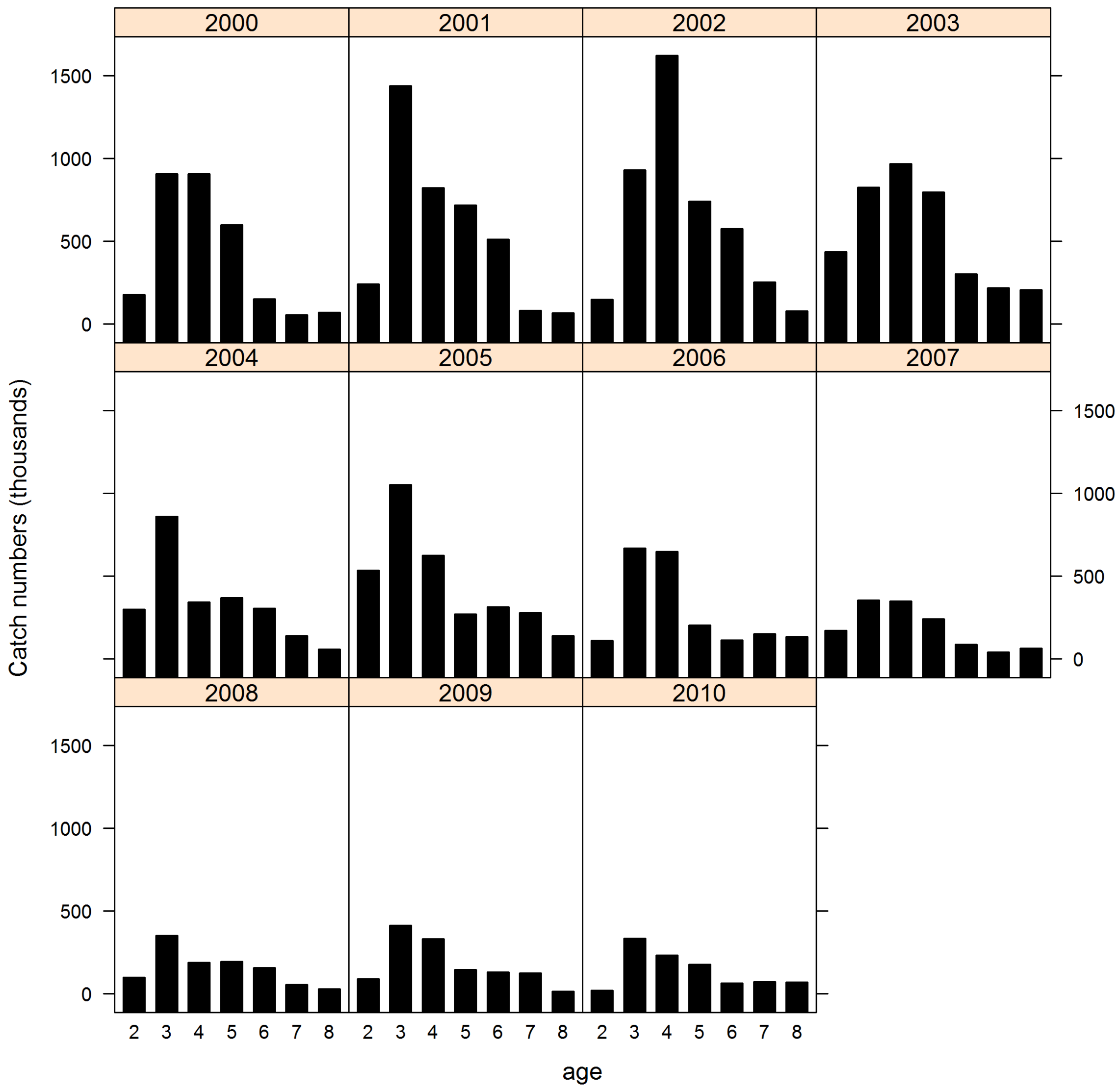


Figure 29.1a. Sol.27.7a - Age composition of landings.

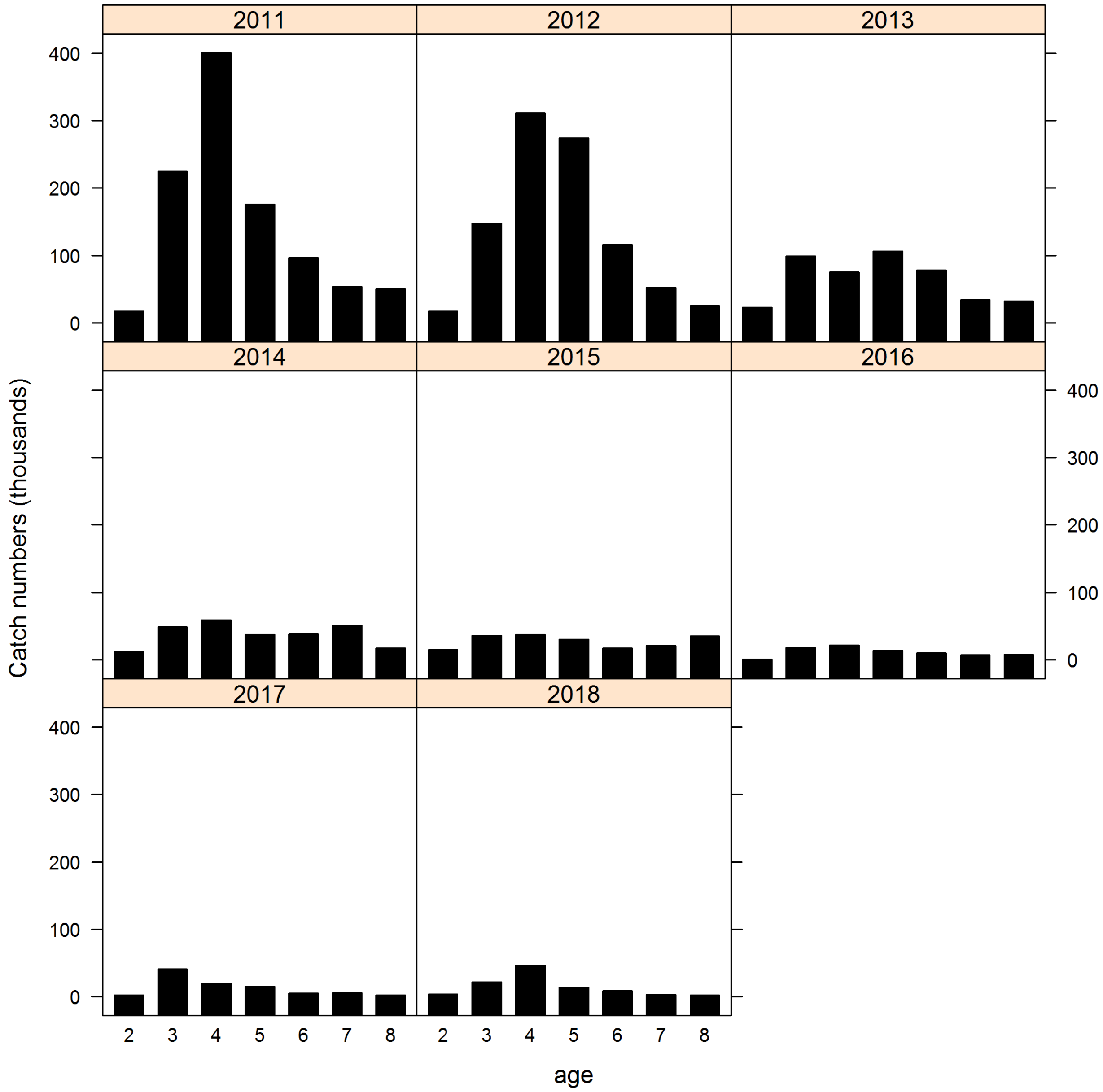


Figure 29.1b. Sol.27.7a - Age composition of landings.

Figure 29.2. Sol.27.7a - Standardized catch proportion.

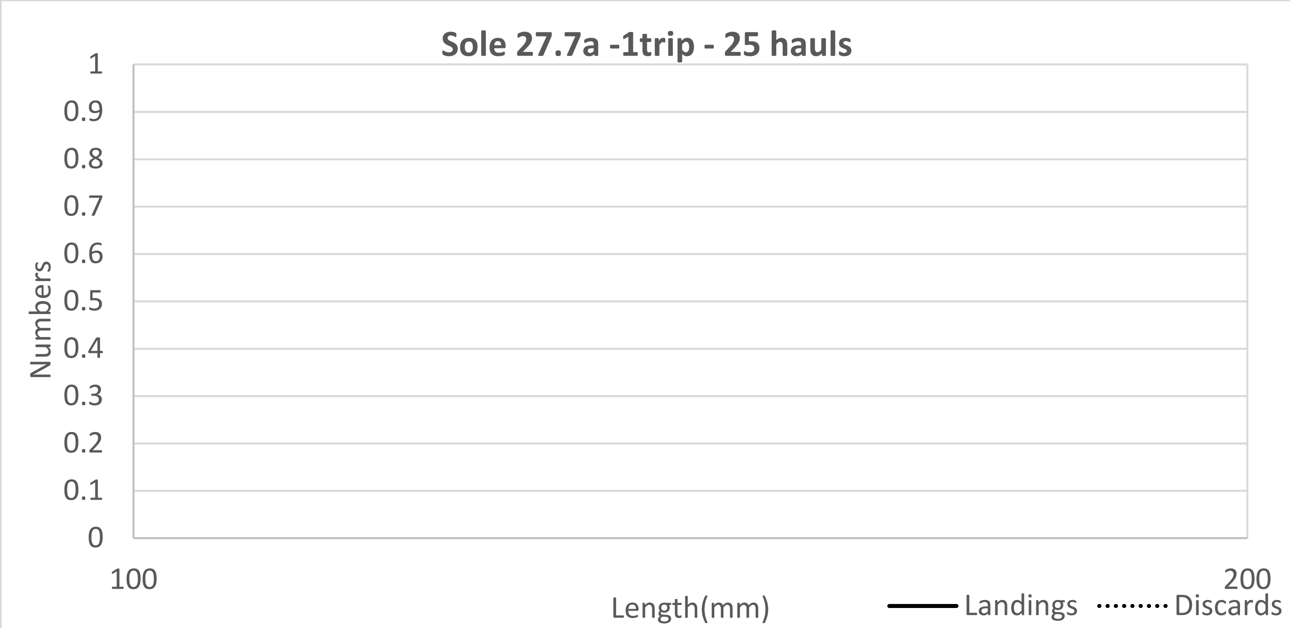


Figure 29.3a. Sol.27.7a - BE Length distributions of discarded and retained fish from discard sampling studies (Beam trawl).

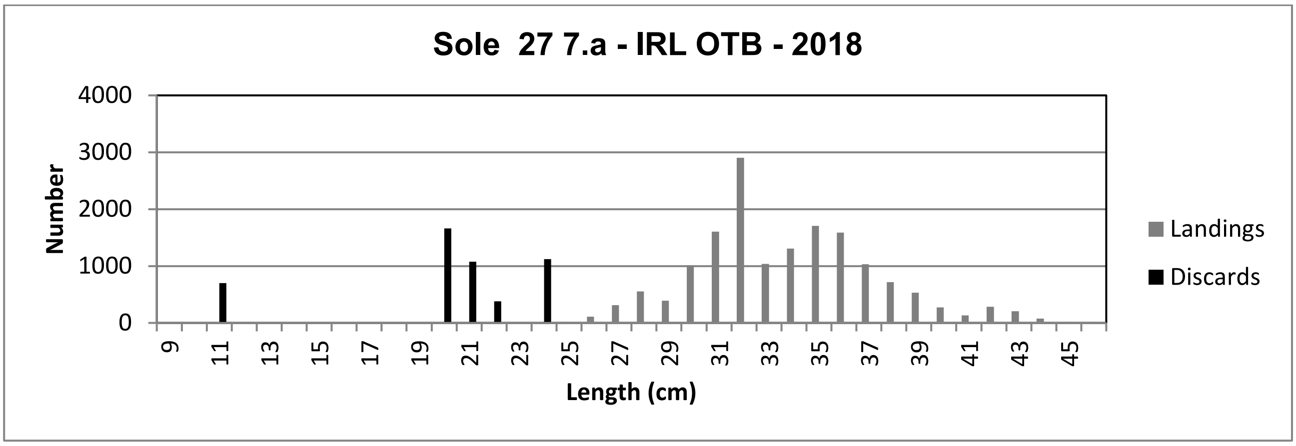


Figure 29.3b. Sol.27.7a - IR Length distributions of discarded and retained fish from discard sampling studies (Otter trawl).

Figure 29.4a Sole in 7.a - Effort series

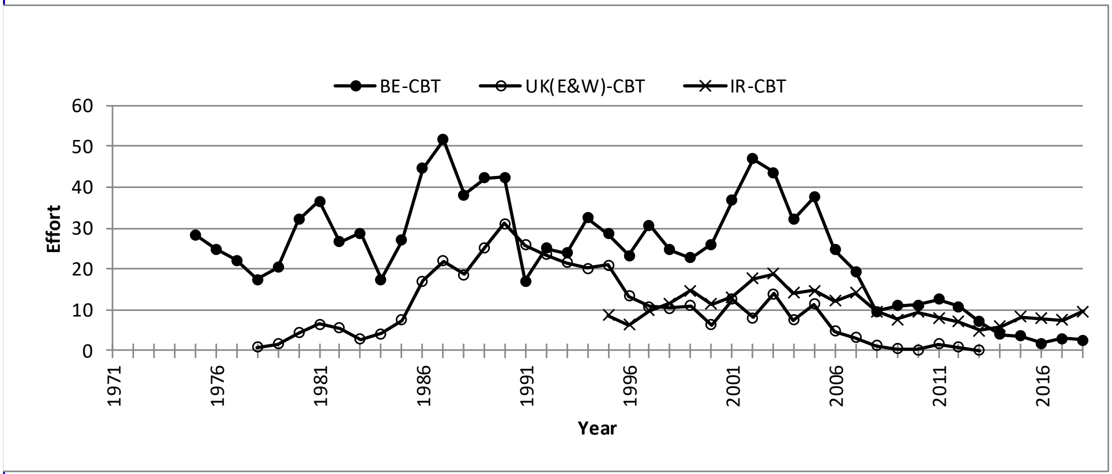


Figure 29.4b Sole in 7.a - Relative effort series

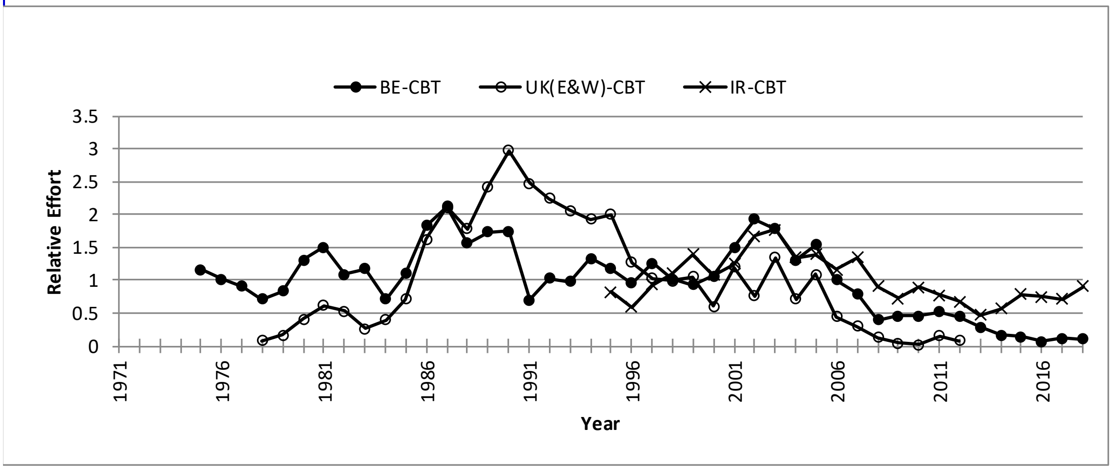


Figure 29.4c Sole in 7.a - Relative LPUE series

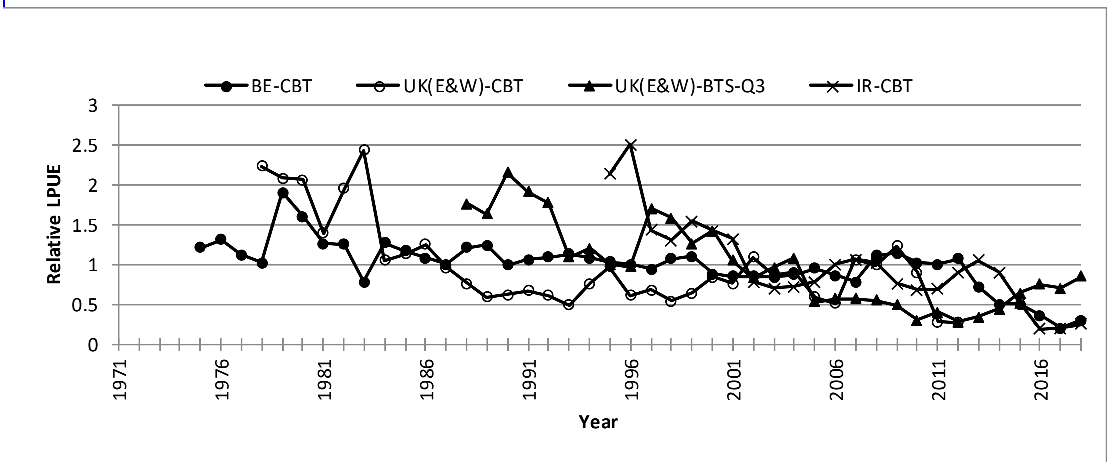


Figure 29.5b Sole in 7.a. Relative effort series

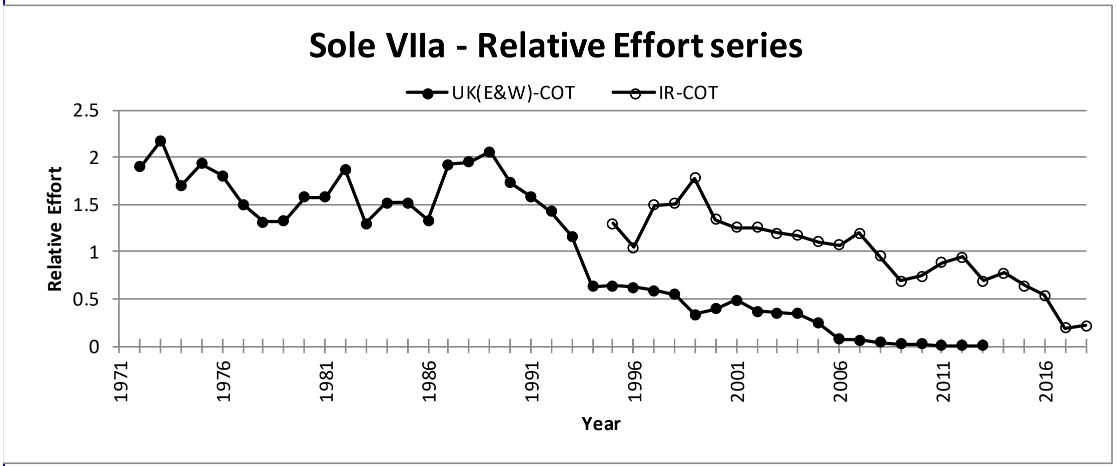


Figure 29.5c Sole in 7.a. Relative LPUE series

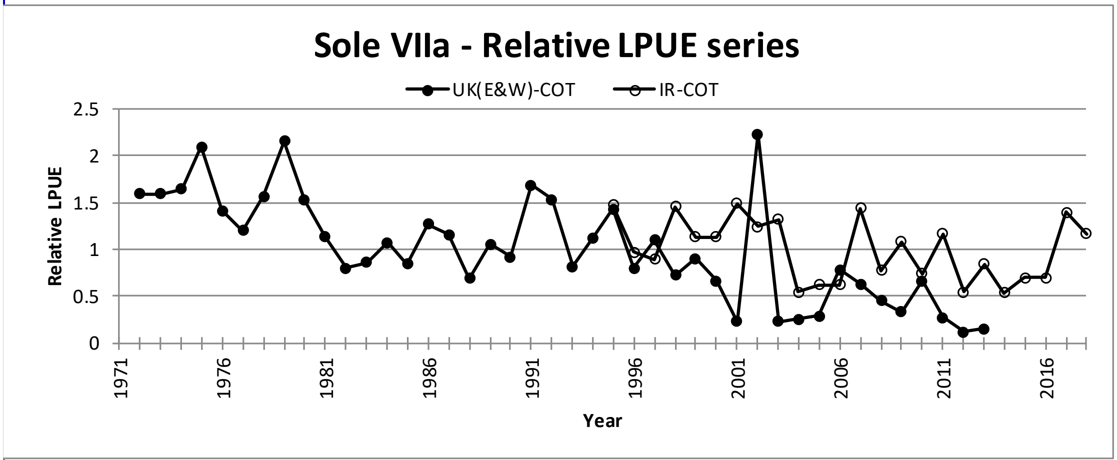


Figure 29.6 - Sol.27.7.a - Mean-standardised indices

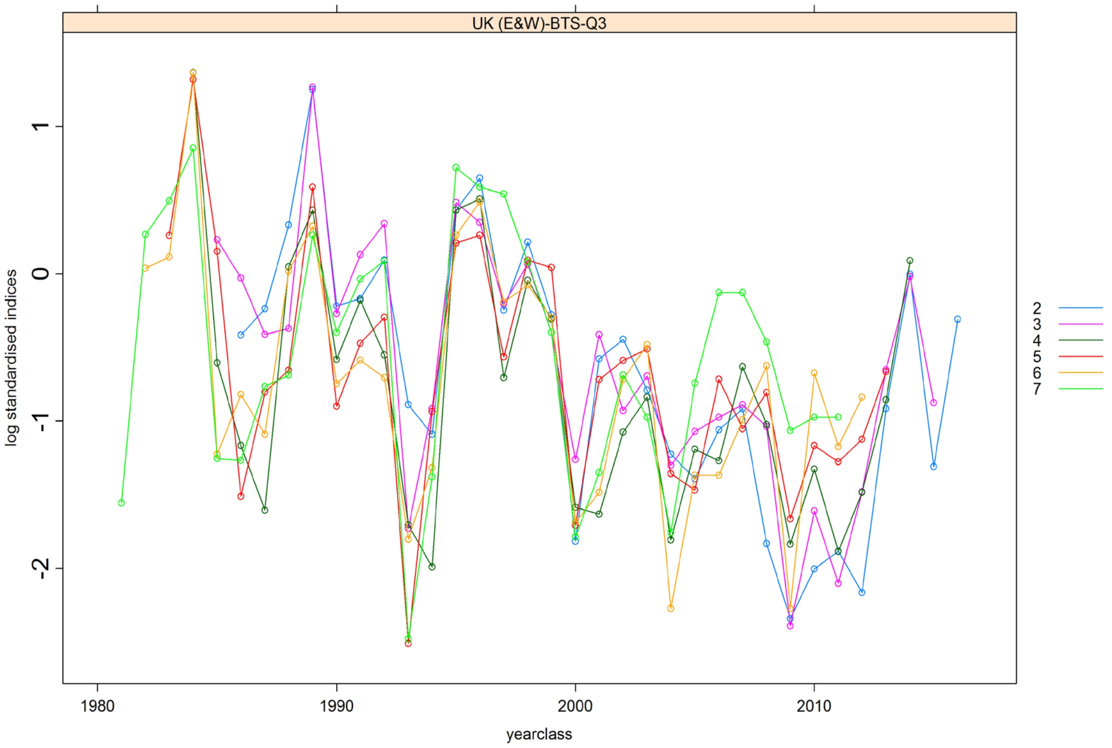


Figure 29.7 - Sol.27.7a - Consistency plot UK(E&W)-BTS-Q3 survey

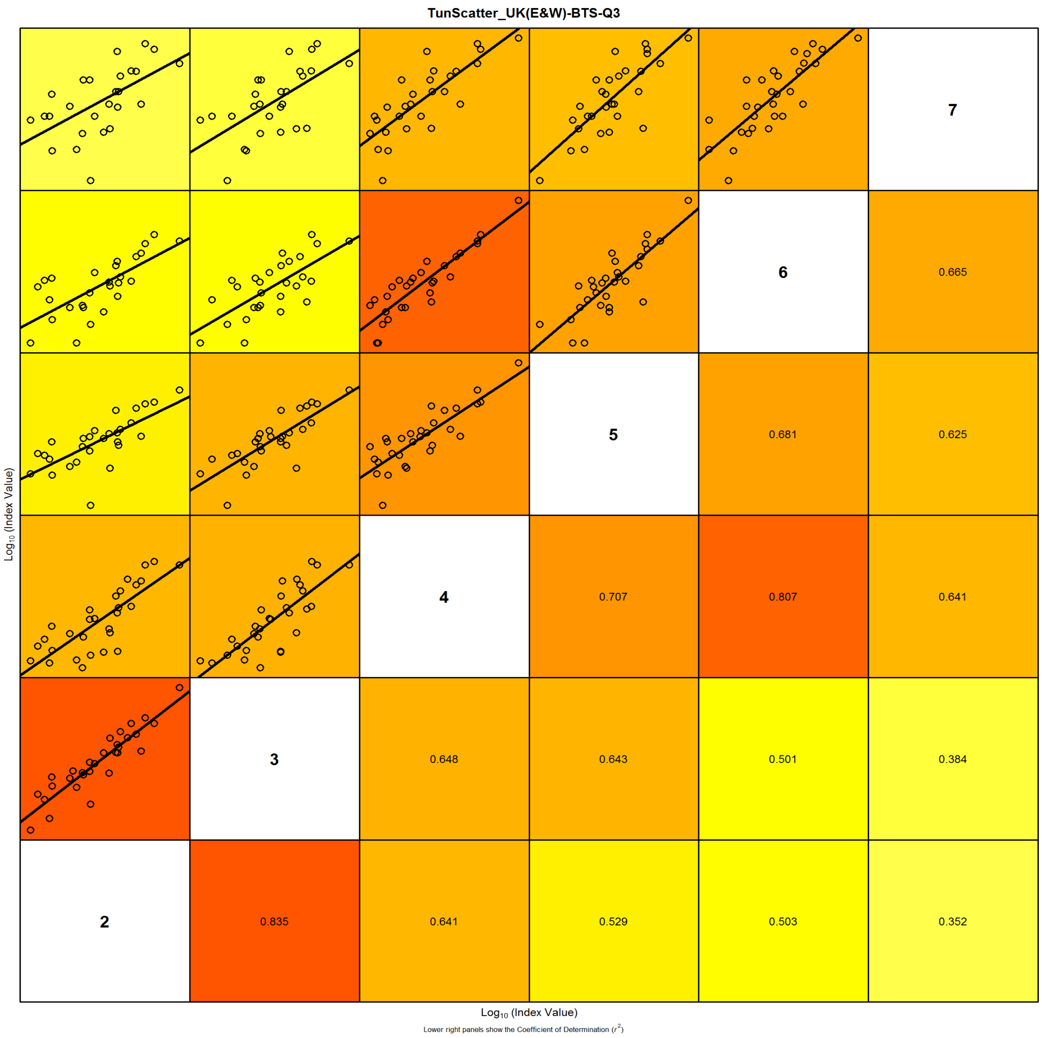


Figure 29.8 - Sol.27.7a - LOG CATCHABILITY RESIDUAL PLOTS - Final XSA

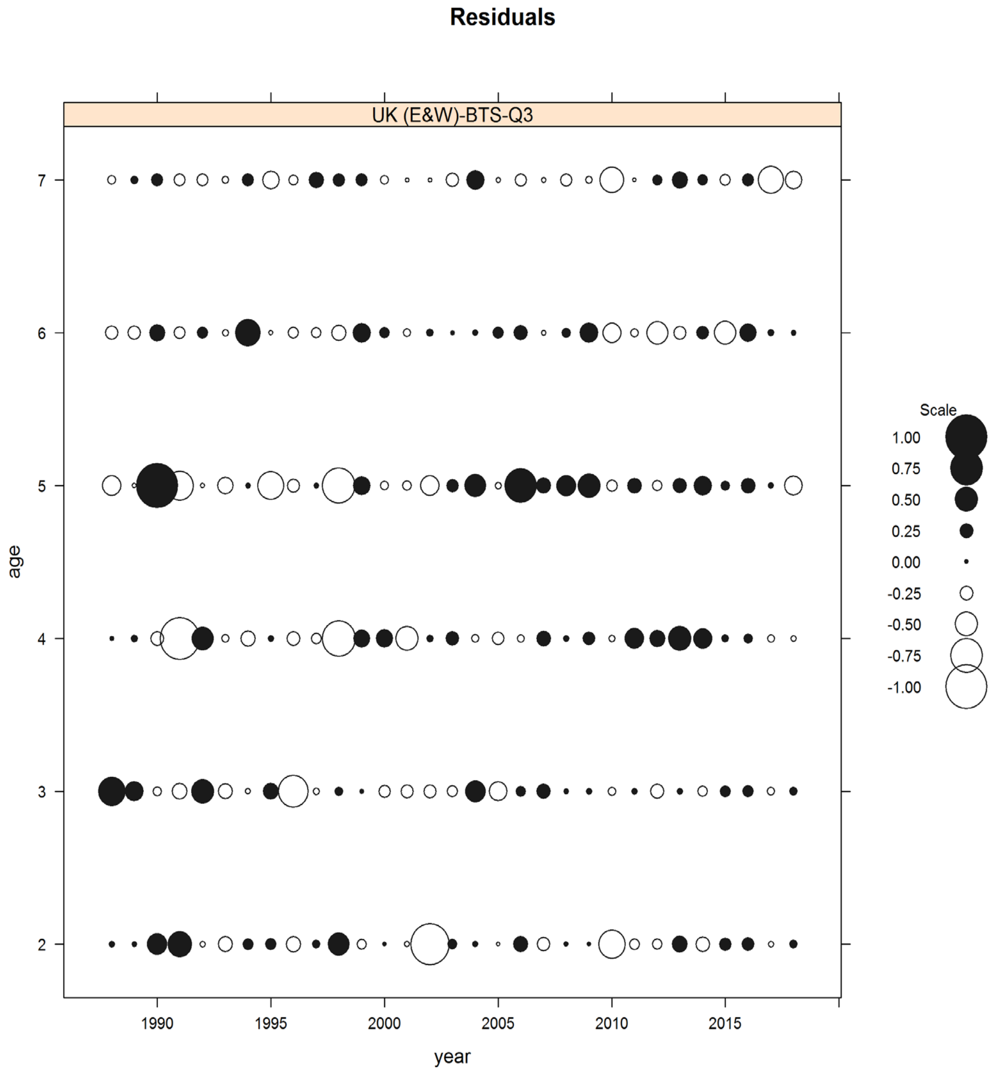


Figure 29.9 - Sol.27.7a - Summary plots

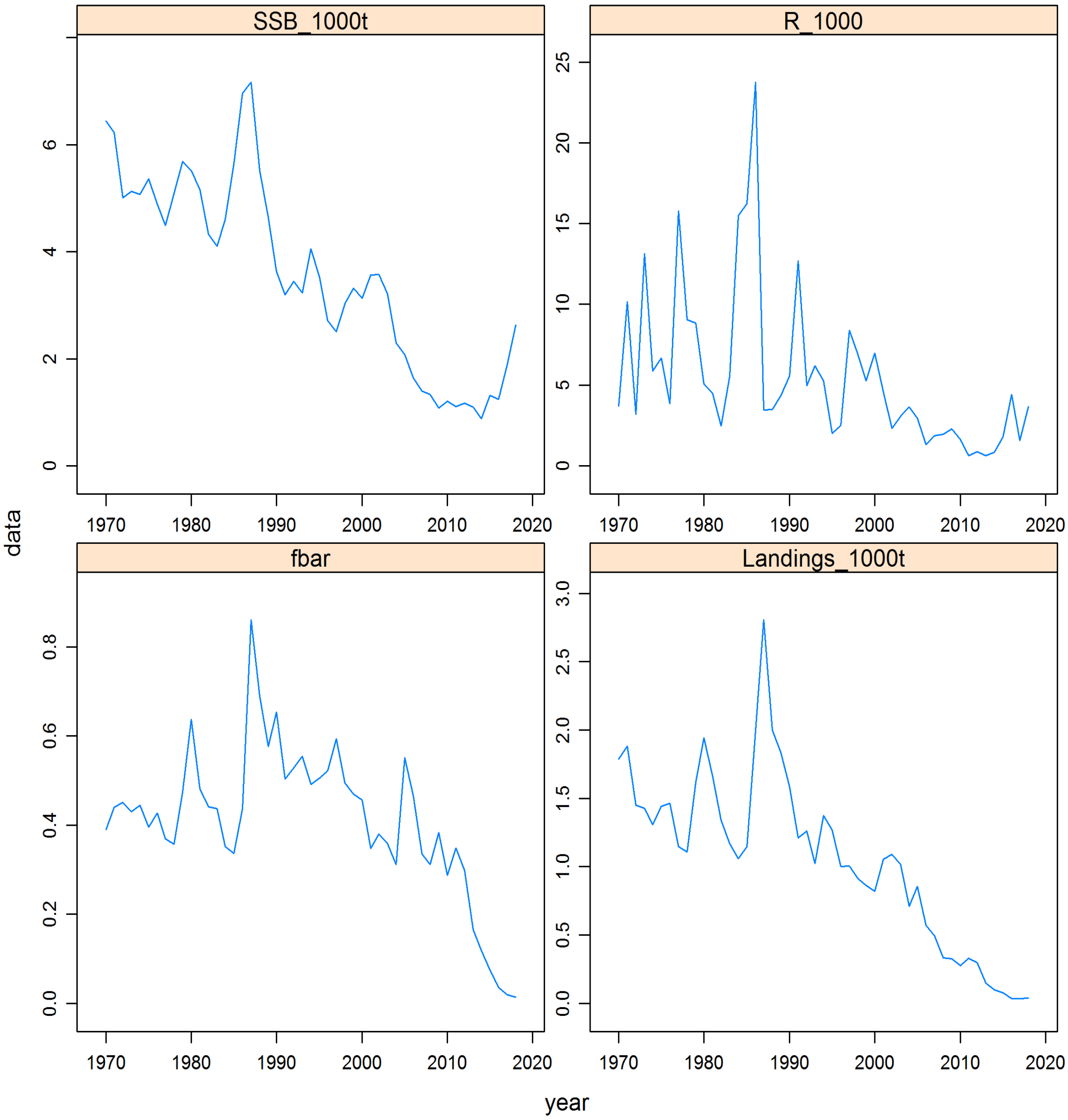


Figure 29.10 - Sol.27.7a - Retrospective XSA analysys (shinkage SE=1.5)

Figure 29.11 - Sol.27.7a - comparison with last year's assessment

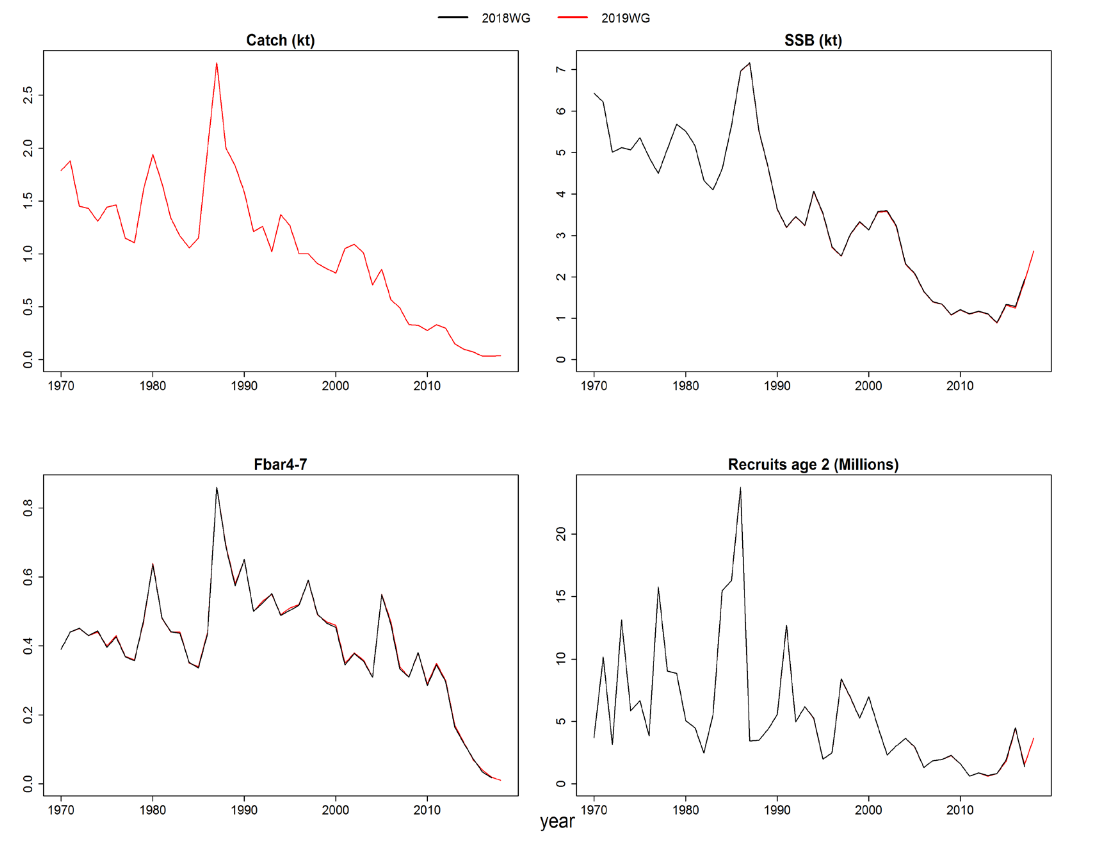


Figure 29.12 - Sol.27.7a -
Year-class sources and contributions for the short-term forecast

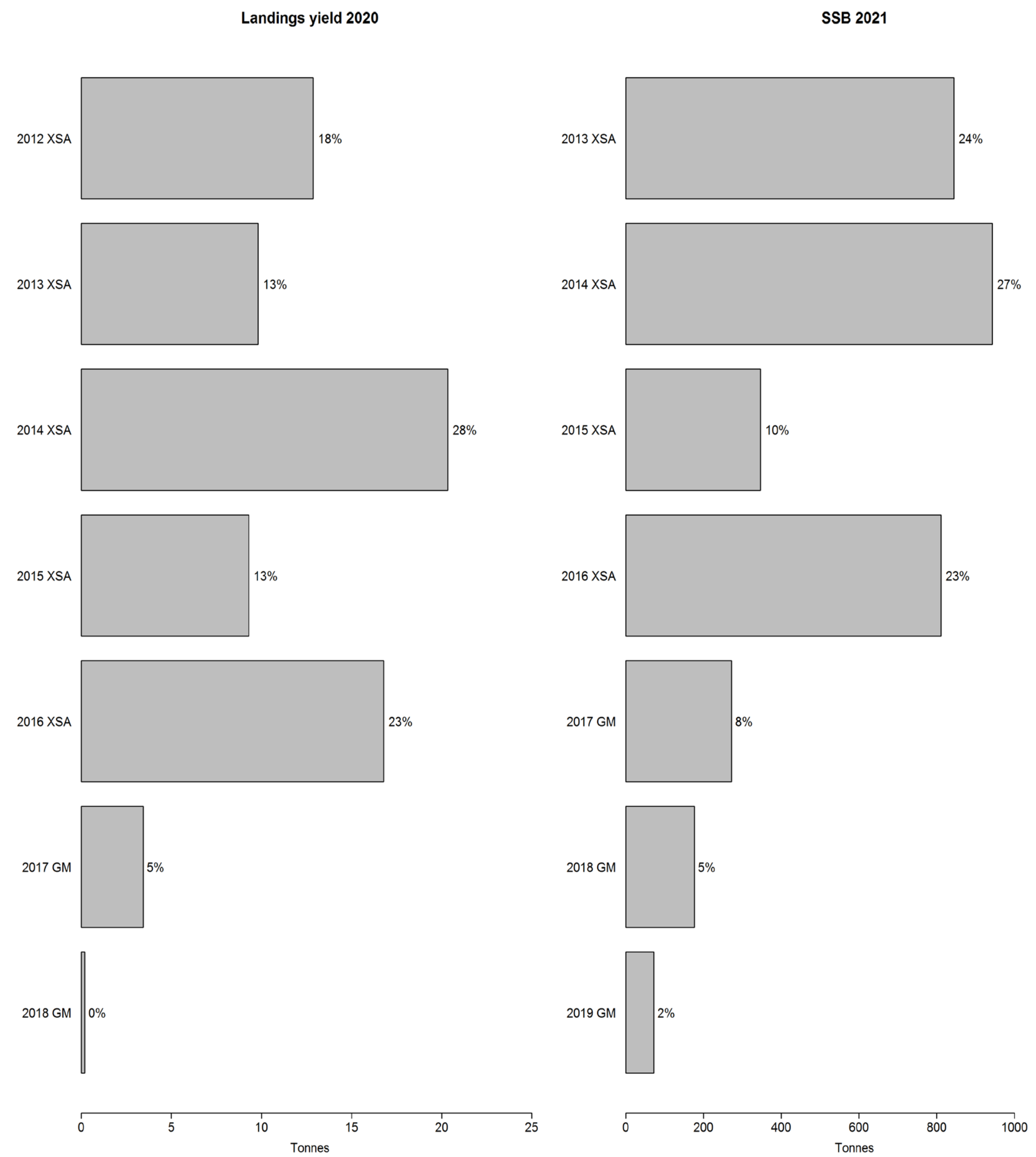
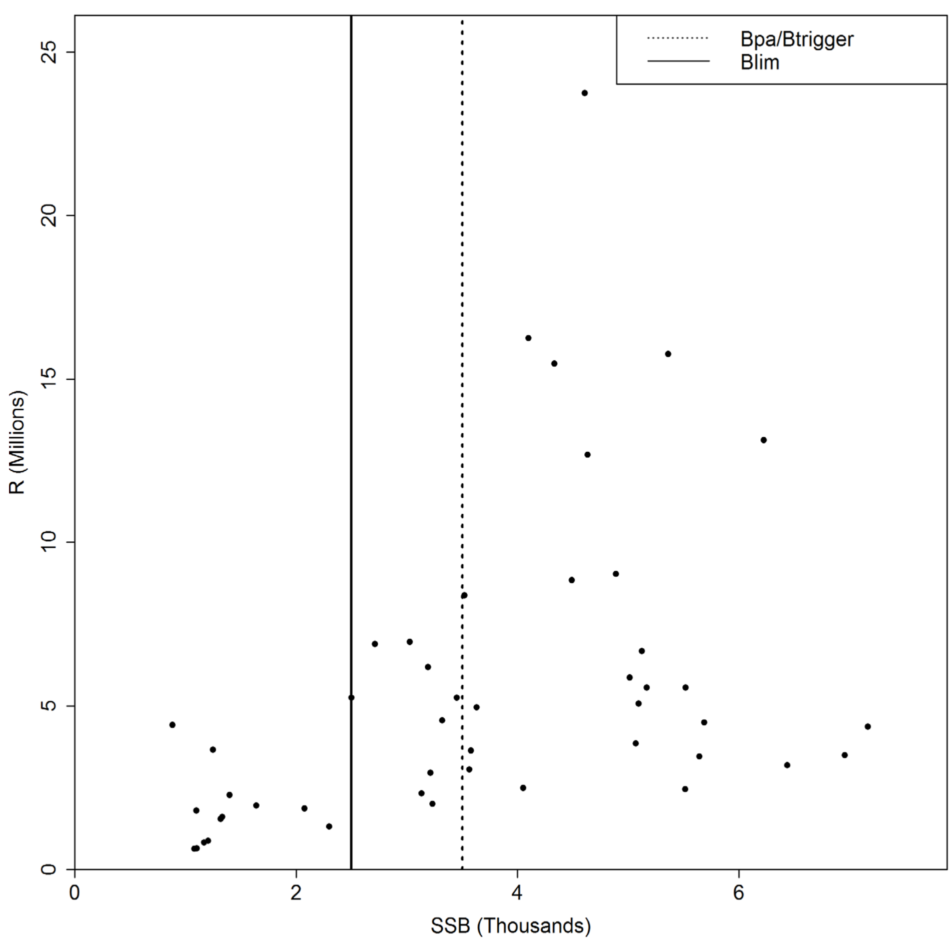


Figure 29.13. Sol.27.7a - Stock–recruitment plot



32 Sole (*Solea solea*) in divisions 7.b and 7.c (West of Ireland)

Type of assessment in 2019

No assessment was performed.

32.1 General

32.1.1 Stock identity

Sole in 7.b are mainly caught by Irish vessels on sandy grounds in coastal areas. Sole catches in 7.c are negligible. In 7.b there are two distinct areas where sole are caught: an area around Galway Bay and an area in the north of 7.b which extends into 6.a (the Stags and Broadhaven Ground). The landings and lpue of sole in 7.bc appear to have been more or less stable since the start of the logbooks' time-series in 1995 (WD1, WGCSE 2009). It is not known how much exchange there is between sole on the Aran Grounds and those on the Stags Ground.

32.1.2 Data

The time-series of official landings is presented in Table 30.1 and Figure 30.1.

The time-series of otter-trawl landings effort and lpue since 1995 are shown in Figure 30.2. Lpue shows no trend over the time-series but has fluctuated more in recent years.

Sampling is carried out in Ireland but numbers of samples varies over time due to the low landings levels and varying encounter probability and is not sufficient to generate a time-series of annual length or age distributions. Sampling in 2018 comprised of 12 length samples, totalling 938 fish measured, and eight discard trips. The length distribution for the eight discard trips is shown in Figure 30.3.

32.1.3 Historical stock development

No analytical assessment was performed.

Table 30.1. Landings of Sole in 7.bc as officially reported to ICES.

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1908	0	0	1	37	0	38	**1963**	0	172	0	19	0	191		
1909	0	0	0	32	0	32	**1964**	0	159	1	24	0	184		
1910	0	0	0	28	0	28	**1965**	0	95	5	24	0	124		
1911	0	0	1	22	0	23	**1966**	0	0	1	11	0	12		
1912	0	0	1	22	0	23	**1967**	0	78	0	11	0	89		
1913	0	0	1	25	0	26	**1968**	0	121	0	8	0	129		
1914	0	0	1	43	0	44	**1969**	0	86	1	9	0	96		
1915	0	0	1	12	0	13	**1970**	0	3	0	8	0	11		
1916	0	0	0	14	0	14	**1971**	0	0	2	5	0	7		
1917	0	0	0	6	0	6	**1972**	0	4	0	13	0	17		
1918	0	0	0	7	0	7	**1973**	0	0	0	12	0	12		
1919	0	0	0	6	0	6	**1974**	0	25	0	12	0	37		
1920	0	0	9	5	0	14	**1975**	0	7	0	19	0	26		
1921	0	0	10	9	0	19	**1976**	0	6	0	44	0	50		
1922	0	0	4	9	0	13	**1977**	0	3	0	14	0	17		
1923	0	0	2	10	0	12	**1978**	0	3	0	16	0	19		
1924	0	0	15	64	0	79	**1979**	0	6	0	13	0	19		
1925	0	0	11	18	0	29	**1980**	0	9	0	24	0	33		
1926	0	7	10	18	0	35	**1981**	0	6	0	47	0	53		
1927	0	47	11	19	0	77	**1982**	0	5	1	55	0	61		
1928	0	49	8	16	0	73	**1983**	0	9	0	40	0	49		
1929	0	74	11	18	0	103	**1984**	0	3	0	17	0	20		
1930	0	52	5	22	0	79	**1985**	0	6	0	44	0	50		
1931	0	82	9	29	0	120	**1986**	0	8	0	29	0	37		
1932	0	122	10	27	0	159	**1987**	0	2	0	39	0	41		
1933	0	411	10	10	0	431	**1988**	0	2	1	34	0	37		
1934	0	217	10	13	0	240	**1989**	0	0	0	38	0	38		
1935	0	40	7	11	0	58	**1990**	0	0	0	41	0	41		

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1936	0	43	20	9	0	72	**1991**	0	5	0	46	0	51		
1937	0	32	25	14	0	71	**1992**	0	2	0	43	0	45		
1938	0	44	21	7	0	72	**1993**	0	1	0	59	0	60	0	60
1939	0	0	0	13	0	13	**1994**	0	1	0	60	0	61	9	70
1940	0	0	0	19	0	19	**1995**	0	2	0	59	0	61	-2	59
1941	0	0	0	14	0	14	**1996**	0	2	0	52	0	54	3	57
1942	0	0	0	8	0	8	**1997**	0	3	1	51	0	55	0	55
1943	0	0	0	11	0	11	**1998**	0	0	0	49	0	49	17	66
1944	0	0	0	16	0	16	**1999**	0	0	0	68	0	68	4	72
1945	0	0	0	20	0	20	**2000**	0	12	0	65	0	77	-9	68
1946	0	0	12	10	0	22	**2001**	0	7	0	53	0	60	0	60
1947	15	0	6	8	0	29	**2002**	0	14	0	50	0	64	-3	61
1948	0	0	11	14	0	25	**2003**	0	19	0	50	0	69	-5	64
1949	0	41	12	12	0	65	**2004**	0	18	0	49	0	67	2	69
1950	0	24	9	6	0	39	**2005**	0	7	0	38	0	45	-1	44
1951	0	27	7	6	0	40	**2006**	0	12	0	31	0	43	0	43
1952	0	40	2	6	0	48	**2007**	0	7	0	34	0	41	1	42
1953	0	99	2	4	0	105	**2008**	0	6	0	31	0	37	3	40
1954	0	116	1	7	0	124	**2009**	0	5	0	46	0	51	0	51
1955	0	66	1	9	0	76	**2010**	0	8	0	35	0	43	0	43
1956	0	161	1	6	0	168	**2011**	0	5	0	22	0	27	-5	22
1957	0	94	1	4	0	99	**2012**	0	7	0	38	0	45	-2	43
1958	0	163	2	6	0	171	**2013**	0	3	0	30	0	33	0	33
1959	0	327	1	8	0	336	**2014**	0	3	0	23	0	26	1	27
1960	0	80	1	9	0	90	**2015**	0	3	0	31	0	34	0	34
1961	0	110	1	12	0	123	**2016**	0	6	0	36	0	42	0	42
1962	0	100	0	8	0	108	**2017**	0	5	0	22	0	27	0	27
							2018	0	5	1	22	0	28	0	18

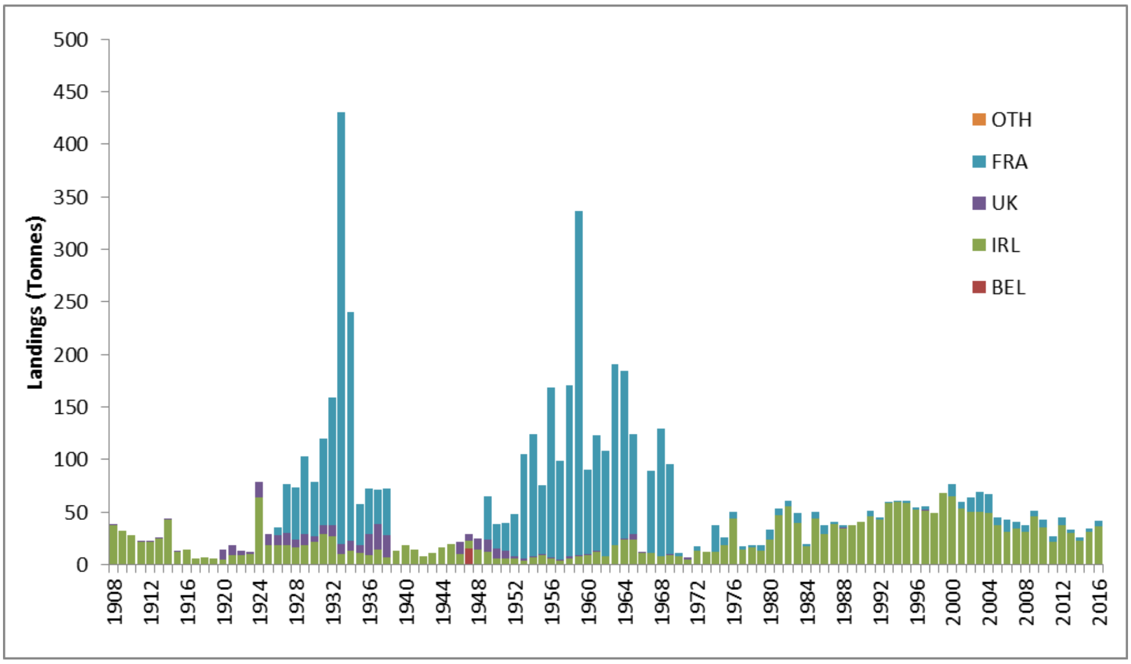


Figure 30.1. Landings of Sole in 7.bc as officially reported to ICES (1908–2017).

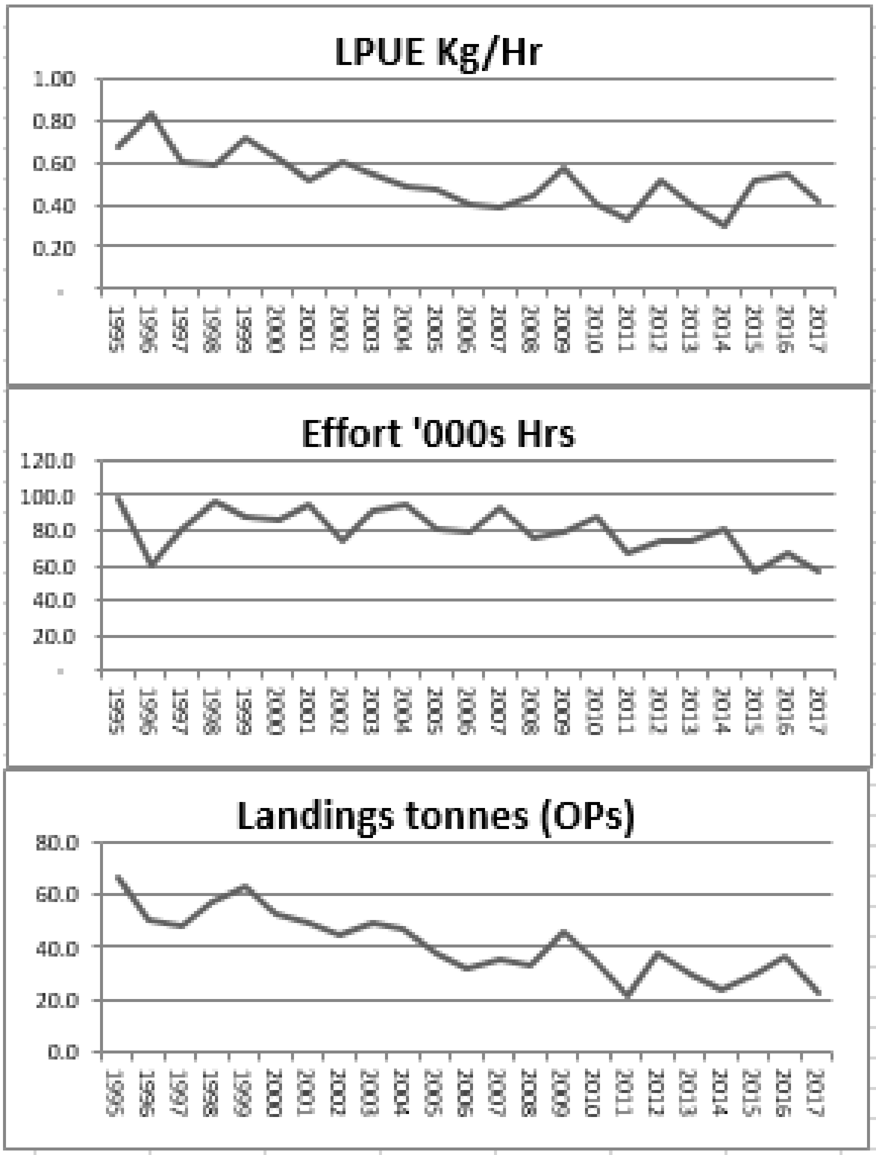


Figure 30.2. Sole in 7.b Irish otter trawl landings effort and lpue since 1995.

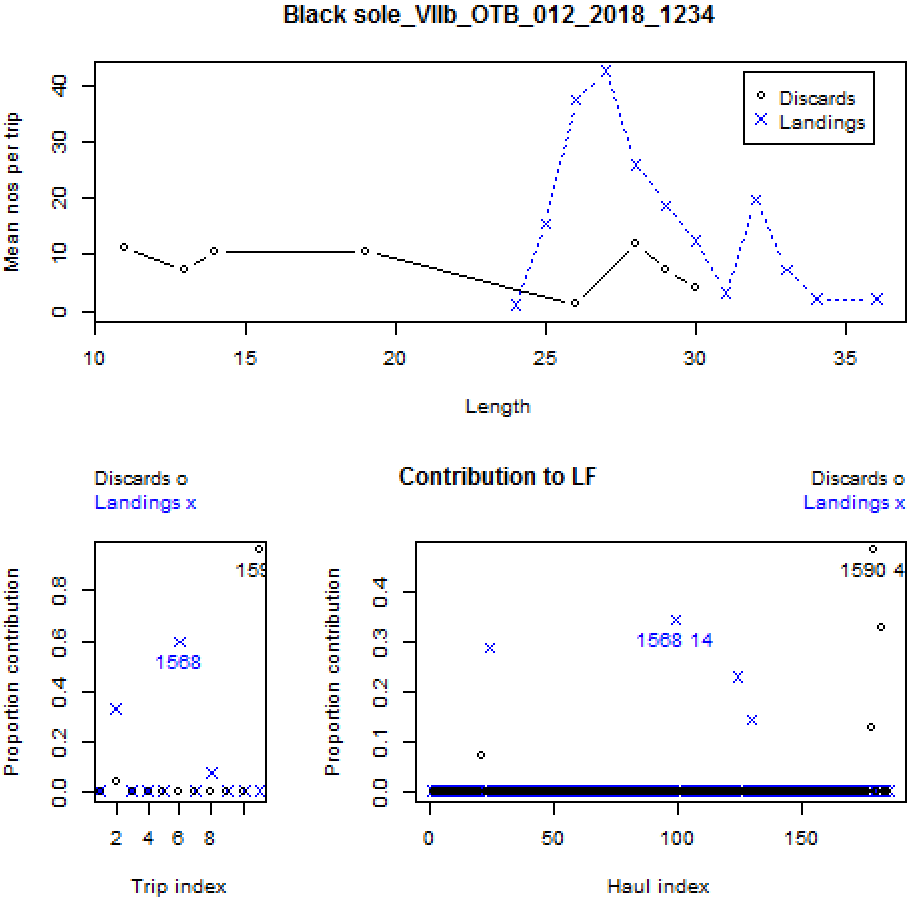


Figure 30.3. Estimated age distribution of sole 7.bc catches in 2018 vessels, at sea sampling on OTB based on Irish sampling.

33 Sole (*Solea solea*) in Division 7.e (western English Channel)

Type of assessment in 2018

Last year's assessment report is available at:

http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2018/WGCSE/35_Sole_7e_2018.pdf

ICES advice applicable to 2019

Last year's advice is available at:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/sol.27.7e.pdf

33.1 General

Stock description and management units

The TAC specified for ICES Division 7.e is consistent with the assessment area.

Official national landings data as reported to ICES and the landings estimates as used by the Working Group are given in Table 31.1.

Official landings in 2018 were 1074 t, a 10.7% undershoot of the TAC (1202 t).

The TAC and the national quotas by country for 2018

Species:	**Sole** ***Solea solea***	**Zone**	**7.e** **(Sol/07E.)**
Belgium	42		
France	453		
United Kingdom	707		
Union	1202		
TAC	1202		Analytical TAC Article 7(2) of this Regulation applies

Article 7(2): "2. The stocks of non-target species within safe biological limits referred to in Article 15(8) of Regulation (EU) No 1380/2013 are identified in Annex I to this Regulation for the purposes of the derogation from the obligation to count catches against the relevant quotas provided for in that Article."

(Source: Council Regulation (EU) 2018/120, ANNEX IA, EU, 2018b)

The TAC and the national quotas by country for 2019

Species:	**Sole** *Solea solea*	**Zone**	**7.e** (Sol/07E.)
Belgium	44		
France	468		
United Kingdom	730		
Union	1242		
TAC	1242		Analytical TAC Article 7(2) of this Regulation applies

Article 7(2): "2. The stocks of non-target species within safe biological limits referred to in Article 15(8) of Regulation (EU) No 1380/2013 are identified in Annex I to this Regulation for the purposes of the derogation from the obligation to count catches against the relevant quotas provided for in that Article."

(Source: Council Regulation (EU) 2019/124, EU, 2019a)

Maximum number of days a vessel may be present within the area by category of regulated gear per year for 2018 and 2019

Regulated gear	Maximum number of days	
Beam trawls of mesh size ≥80 mm	BE	176
	FR	188
	UK	222
Static nets with mesh size ≤220 mm	BE	176
	FR	191
	UK	176

(Source: Council Regulation (EU) 2018/120, ANNEX IIC, EU, 2018b and Council Regulation (EU) 2019/124, EU, 2019a)

Landing obligation

As of 2019, the landing obligation fully applies to sole in 7.e.

The landing obligation was phased in between 2016–2019 (Commission Delegated Regulations (EU) 2015/2438, 2016/2375, 2018/46, EU, 2015, 2016, 2018a). During the phasing in, the landing obligation applied to all catches of sole in 7.e with trammel and gillnets (gear codes GNS, GN, GND, GNC, GTN, GTR, GEN) and all beam trawls. However, a *de minimis* exemption applied, allowing up to 3% discards of annual catches for all trammel and gillnets and for beam trawls with mesh size of 80–199 mm with increased selectivity. In 2016, the first year of the application, the landing obligation applied only to vessels for which the total landings consisted of more than 10% sole during two reference years (2013 and 2014, Commission Delegated Regulation (EU) 2015/2438, EU, 2015). This threshold was tightened for 2017 and the landing obligation applied to vessels landing more than 5% in the reference years 2014 and 2015 (Commission Delegated

Regulation (EU) 2016/2375, EU, 2016). Subsequently, this restriction was lifted altogether and for 2018 (Commission Delegated Regulation (EU) 2018/46, EU, 2018a), the landing obligation applied to all vessels using trammel and gillnets and beam trawls, as described above.

Given the low discards observed in the fishery the landing obligation is unlikely to have a significant impact on this stock or the advice.

33.2 Data

InterCatch

International catch data are collated using the ICES InterCatch platform. For 2018, data for Belgium, France, Ireland, the Netherlands and the UK (England, Scotland and the Channel Islands Guernsey and Jersey) were uploaded into InterCatch (Figures 31.1 and 31.2). All submitted age samples are presented in Figures 31.8 and 31.9, and length samples in Figures 31.10 and 31.11. The raising procedure is described in the stock annex.

Landings

Landings of sole in Division 7.e were below 500 t at the beginning of the time-series in the 1970s, increased and stayed around 1500 t in the 1980s and have been around 1000 t in the 1990s and 2000s (Table 31.1). The landings dropped in the late 2000s below 750 t and increased since 2015 to 1075 t in 2018.

Only the UK and France provided age-structured landings samples in InterCatch (Figures 31.8 and 31.9).

Total international landings numbers-at-age (Table 31.2 and Figure 31.5) and landings and stock weights-at-age (Tables 31.3 and 31.4 and Figure 31.6) as used in the assessment were derived in accordance with the procedures outlined in the stock annex.

The fleets for which age-distributions were submitted, accounted for 83.1% of the total international landings.

Discards

Discards for this stock are low and not included in the assessment.

For 2017, discards data were provided by Belgium, France, Ireland (zero discards) and the UK (zero discards) for some fleets in InterCatch based on discard sampling. Age samples were provided by France for two fleets. As discard are considered to be low, discards were not raised to an international level or allocated with an age structure from sample data.

Discards data are only available from InterCatch for the years 2012–2018. In general, the discard rates are low (Figure 31.3). The discards provided in InterCatch accounted for 0.44% in 2016 and 0.26% in 2018 of the total catches. The three-year average (2016–2018) discard rate is 0.61%. The reduction in the discard rate might potentially be linked to the introduction of the landing obligation in 2016.

The discard rate by fleet and country is shown in Figure 31.3 (shown are only discards submitted to InterCatch).

No discard information is included in the assessment given that it is currently not possible to provide discard estimates for the entire time-series. Nevertheless, excluding discard estimates from the assessment is unlikely to have any major impact on the perception of stock status given the minor scale of the problem.

Revisions

No revision to previous years were submitted.

Biological

Natural mortality was assumed to be constant over ages and years at 0.1. The maturity ogive from divisions 7.f and 7.g was used in accordance with the procedures outlined in the stock annex and adopted in previous assessments.

In agreement with the stock annex stock and catch and stock weights-at-age were derived by fitting a 2nd degree polynomial model to the raw landings weights-at-age extracted from InterCatch (Figure 31.7). For 2018 data, the youngest age for which data (catch numbers and weights) was provided was age 0. In previous years, this data was only provided for ages 1 and older. For historical consistency and a better model fit, age 0 was removed from the smoothing process for catch and stock weights.

Survey indices

Abundance estimates derived from the surveys as used in the assessment are given in Table 31.6 and shown in Figures 31.13, 31.14 and 31.15, and internal consistencies in Figures 31.16 and 31.17. In general, cohort tracking and internal consistency are better in the commercial tuning fleets and less pronounced in the scientific surveys.

The UK-FSP survey

The UK Fisheries Science Partnership (UK-FSP) conducted another survey of sole and plaice abundance in the Western English Channel, 2018 being its 16th year (the first years is not used for sole due to data issues). The results indicate that sole continue to be widespread in the area and that a large number of cohorts contribute to the stock. The total cpue increased from 2010 until 2014, dropped subsequently until 2016 and increased again since then. The index is mainly driven by ages 3, 4 and 5. The internal consistency in the survey is good for ages 3+. Some year and cohort effects are visible.

The Q1SWBeam survey

Abundance estimates for the Quarter 1 South West Beam trawl (Q1SWBeam) survey started in 2006 and have been included in the assessment since 2014. The landings per unit of effort (lpue) numbers-at-age as well as aggregated over all ages are variable without particular trends or patterns. As for the UK-FSP, the index mainly consisted of fish age 3, 4 and 5 in 2018. Internal consistency is mediocre and no particular good cohort tracking is evident.

Commercial fleets effort and lpue

Two commercial tuning series from the UK are used (commercial beam trawl UK-CBT and commercial otter trawl UK-COT).

Effort for under 24 m UK beam trawlers in days fished steadily increased from 1992 reaching the highest levels on record in 2012, and stayed around this level until the end of the time-series (Figure 31.12). Currently the effort is well above the long-term average. In contrast, effort for over 24 m UK beam trawlers increased from 1992 to 2004 and then decreased to below the average of the time-series, reaching a minimum in 2013. Since then, the effort increased again slightly and is currently around the long-term average. When the effort of all UK beam trawl vessels is combined, the effort stayed almost constant since the early 2000s.

UK otter trawl (UK-COT) effort has been in continual decline since the early-1970s and was at the lowest levels on record in 2015. For 2016, this fleet reported zero effort and landings. This could be explained by a shift in the size of fishing vessels to smaller vessels. Since 2017, a new database is being used for recording, but the data are not consistent with historical data and are therefore not used in the stock assessment.

Age-disaggregated commercial abundance indices for the UK-CBT-late (UK-CBT values from 2003 onwards) and UK-COT fleets as used in the assessment are given in Table 31.5 and plotted mean standardised by cohort and year in Figures 31.13 and 31.14.

Information from the fishing industry

No comments were received regarding the assessment or management of this stock beyond the information from the UK fisheries–science partnership already formally included in the assessment process.

33.3 Stock assessment

Model used: Extended Survivors Analysis (XSA) as outlined in the stock annex by IBPWCFlat2 2015.

Software used: FLR – FLXSA.

Model options chosen: Data included in the assessment were identical to previous years.

Assessment input data characteristics: catch numbers-at-age excluding discards and with four tuning fleets (two fishery-independent surveys: UK-FSP and Q1SWBeam; and two commercial lpue time-series: UK-CBT-late and UK-COT).

Data screening

Data screening procedures identified no major anomalies in the catch numbers-at-age, weights or tuning information used in the 2019 assessment.

The landings numbers-at-age 3 were exceptionally high in 2017 but returned to usual levels in 2018 (Figure 31.5). This anomaly was evident in age samples from the UK and from France and in various fleets (see WGCSE 2018 report), i.e. does not seem to be a sampling issue.

Tuning information consisted of four fleets: two UK commercial time-series (UK-CBT-late and UK-COT) and two UK standardised research surveys (UK-FSP and Q1SWBeam).

The UK commercial otter trawl fleet (UK-COT) reported zero effort in 2016 and therefore there is no lpue value for this fleet for 2016. Consequently, this tuning index only influences the assessment up to and including 2015.

Details of the derivation of the tuning fleets are presented in the stock annex, and the tuning information available for this assessment is shown in Table 31.6 and Figures 31.13, 31.14 and 31.15.

Final update assessment

The working group fitted the XSA model developed by WKFLAT 2012 (ICES, 2012) using the updated assessment settings agreed at IBPWCFlat2 (ICES, 2015).

The XSA assessment settings used at the last three working groups are shown in the table below, and more historical settings have been included in the stock annex.

	WGCSE 2017	WGCSE 2018	WGCSE 2019
Assessment age range	2–12+	2–12+	2–12+
Fbar age range	F(3–9)	F(3–9)	F(3–9)
Assessment method	XSA	XSA	XSA
Tuning Fleets:			
Q1SWBeam	2006–2016 Ages 2–11 (non-offset)	2006–2017 Ages 2–11 (non-offset)	2006–2018 Ages 2–11 (non-offset)
UK-FSP	2004–2016 Ages 2–11	2004–2017 Ages 2–11	2004–2018 Ages 2–11
UK combined beam (late)	2003–2016 Ages 3–11	2003–2017 Ages 3–11	2003–2018 Ages 3–11
UK otter trawl	1988–2016 Ages 3–11	1988–2016 Ages 3–11	1988–2016 Ages 3–11
Time taper	Yes	Yes	Yes
Power model	Tricubic	Tricubic	Tricubic
Taper range	15 years	15 years	15 years
P shrinkage	No	No	No
Q plateau age	7	7	7
F shrinkage S.E	0.5	0.5	0.5
Number of years	3	3	3
Number of ages	5	5	5
Fleet S.E.	0.4	0.4	0.4

Figure 33.18 shows the results from the final XSA model fit, Figure 31.19 the residuals, Figure 31.20 a comparison of the current assessment with the assessment from the last two years, Figure 31.21 XSA survivor weightings for the last years and Figure 31.22 a five-year retrospective.

The WGCSE 2018 assessment showed a rescaling (downwards revision of SSB). A similar rescaling occurred for the current (WGCSE 2019) assessment, but in the opposite direction, i.e. the absolute levels are now again close to the ones from WGCSE 2016. This rescaling can most likely be attributed to the landings data from 2017, which had a high number of landings-at-age three, which returned again to normal in the 2018 data.

A Mohn's rho analysis was conducted based on the XSA stock assessment results, i.e. the last data year (2018) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 3-9)	recruitment
Mohn's rho value	-0.00759231890293091	0.0406781290651195	0.00784258485351308

The Mohn's rho values for this assessment are very low and well below the threshold of 20% imposed by ICES for 2019 assessments, i.e. the current assessment indicates a high consistency.

XSA diagnostic tables, stock numbers-at-age and fishing mortalities-at-age for the final assessment are shown in Tables 31.7, 31.8, 31.9 and 31.10.

State of the stock

Stock trends are shown in Table 31.10 and plotted in Figure 31.18. The stock is in a desirable state, both in term of spawning–stock biomass and fishing mortality.

SSB is estimated to have increased between 1972 and 1980 following successive strong recruitment events. Subsequently, SSB declined from 1980 to 1993 and remained relatively stable until 2008. After this period, SSB has been increasing and is currently well above MSY $B_{trigger}$.

The base level of recruitment has remained relatively stable throughout the time-series, fluctuating without major temporal trend at around 4 million recruits. Recruitment variability has decreased since 1991. Recruitment has been at or above the long-term geometric mean in the last four years.

Fishing mortality was relatively stable at a low level between 1969 and 1978, after which it increased sharply until 1983 and fluctuated at a higher level before peaking briefly in 1989–1990. After a period of temporal variability, F decreased abruptly to below the F_{MSY} target of 0.29 in 2009 and has remained below this level ever since and stayed around 0.2–0.25. Fishing mortality was estimated to be well below all reference points.

The age structure of sole in 7.e continues to be more extended than other sole stocks in European waters, implying low mortality rates, with the plus group at-age 12 containing a high proportion of the catches and including some individuals aged 33–38 in recent years.

33.4 Short-term projections

Forecast assumptions

Figure 31.23 shows three different targets for the intermediate year (F = F_{2018}, F = $F_{2016–2018}$ and landings = TAC_{2019}). F estimates in 2016–2018 fluctuated around 0.2 but are slightly higher in 2018. Consequently, F_{2018} (0.23) is used for the intermediate year. Landings were below the TAC in the last three years (10.7% below in 2018) and consequently, the selected F is an appropriate target for the intermediate year.

Weights-at-age were calculated as the average of three last three historical years.

Recruitment was forecast using a long-term geometric mean (1969–2018) due to temporal variability in the time-series and the lack of distinct periods of successive high or low recruitment in recent years.

The forecast was conducted with FLR's FLash using the output from the landings only XSA assessment. The resulting yield was obtained by adding discards to the landing with an average discard rate of the last three historical years (2016–2018, 0.61%).

The complete input data for the short-term forecast are shown in Table 31.11.

MSY forecast

Table 31.12 shows a detailed output of the forecast targeting F_{MSY} for the years 2019–2021 and Table 31.13 the year classes contributing to the yield in 2020 and SSB in 2021.

Figure 31.24 shows the results of the forecast for F_{MSY}, and Figures 31.25 and 31.26 the forecast including F_{MSY} ranges.

Additional options

A full management options table is provided in Tables 31.14 and 31.15 shows the additional options.

Implementing the previous (now outdated) management plan for this stock with F_{MGT} = 0.27 leads to a total yield (catch) of 1391 t in 2020, and an SSB of 4418 t in 2021. Implementing the MSY approach with F_{MSY} = 0.29 leads to a total yield of 1478 t in 2020, and an SSB of 4334 t in 2021.

33.5 Biological reference points

The most recent reference points for this stock were developed by WKMSYREF4 in 2015 (ICES, 2016b) and are presented in the table below.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	2900 t	The 5th percentile of the distribution of SSB when fishing at F_{MSY} (0.29) with no error.	ICES (2016a)
	F_{MSY}	0.29	The peak of the median landings yield curve.	ICES (2016a)
	F_{MSY} lower	0.16	Minimum F which produces at least 95% of maximum yield.	ICES (2016a)
	F_{MSY} upper	0.34	Maximum F which produces at least 95% of maximum yield.	ICES (2016a)
Precautionary approach	B_{lim}	2000 t	Rounded B_{pa}/1.4.	ICES (2016a)
	B_{pa}	2900 t	Rounded B_{loss} (1999 year class). Lowest SSB with high recruitment.	ICES (2016a)
	F_{lim}	0.44	Segmented regression simulation of recruitment with B_{lim} as the breakpoint and no error.	ICES (2016a)
	F_{pa}	0.32	$F_{lim} \times \exp(-1.645 \times \sigma)$; $\sigma = 0.2$.	ICES (2016a)
Previous management plan	SSB_{MGT}	Not defined		
	F_{MGT}	0.27		EU (2007)

33.6 Management plan

The European Commission implemented a management plan for the recovery of the stock early in 2007 (Council Regulation (EC) No 509/2007). The management plan has not been formally evaluated, but the working group concluded that: The long-term management target (F_{MGT} = 0.27) is precautionary in the sense that it ensures that there is a less than 5% chance of SSB declining below previously observed levels, as well as maintaining yield within 10% of MSY (*WGCSE note: long-term yield at* F_{MAX}) (working group, 2005; working group, 2006).

This management plan has not been used in recent years and the ICES advice has been based on the MSY approach, targeting F_{MSY}.

The management plan (Council Regulation (EC) No 509/2007) is no longer in force since 2019 and has been repealed by an EU multiannual plan for stocks fished in the Western Waters and adjacent waters (Regulation (EU) 2019/472, EU, 2019b) which aims at targeting MSY.

33.7 Uncertainties in assessment and forecast

The methodology provided is as robust as possible, and does not currently appear to suffer from a serious retrospective pattern.

Discarding

Discarding is considered to be negligible in this fishery, averaging only 0.26% of total international catch weight in 2018. Nevertheless, a time-series of available discards information raised to the fleet level should be developed to deal with potential future discard issues effectively and improve estimates of total mortality. The landings obligation was implemented during 2016–2018 with a discard plan, and seemed to have reduced the already low discards even more. The landings advice has been topped up with the available discard information to give catch advice so developing a time-series of discard information appears to be less urgent than in the past.

Surveys

The assessment methodology includes two survey indices. The UK-Q1SWBeam survey added to the assessment in 2012 covers the entire management area, providing fishery-independent tuning information for the entire age range used in the assessment. Therefore, the assessment now relies much less on the commercial tuning information and is less susceptible to localised exploitation by the fishery. However, there is still some uncertainty with respect to the precision of this information. Consequently, commercial tuning information is still used in the assessment to maintain the balance between accuracy and precision required by management. Survey information for the recruiting year class remains temporally variable and is not used in the forecast for this reason.

Sampling

Age and length sampling for this stock is mostly adequate. Age data from the largest two sectors operating in this fishery (UK and France, together taking 95% of landings) are included in the assessment and the sampled fleets comprise 93% of total landings. French age data between 2009 and 2014 were insufficient at older ages to raise the length compositions, and therefore UK age data were used to cover the larger fish.

There are only very limited discard age samples but due to very low discarding this does not impose a problem on the assessment or forecast.

Consistency

The assessment for this stock was last benchmarked in 2012 and an inter-benchmark was held in 2015. The 2019 assessment is consistent with the previous assessment conducted in recent years. Temporal trends in recruitment, SSB and F estimates were virtually identical.

33.8 Recommendation for the next benchmark

There is no requirement to benchmark this stock in the short term.

The XSA assessment uses a taper range of 15 years for the tuning indices, effectively down-weighting older tuning data and removing data older than 15 years altogether. As tuning time-series get longer, potentially important information, in particular from the scientific surveys, might get lost in the process. Therefore, a re-evaluation of assessment parametrisation should be considered.

Lpue estimates for the UK-CBT and UK-COT fleets should be closely monitored to avoid the recurrence of inaccuracies in commercial tuning information observed at the 2014 and 2015 working groups. Minor retrospective patterns in stock status and fishing mortality estimates have begun to re-merge but are expected to stabilise as the duration of the lpue time-series increases in future. The rescaling observed in the 2018 and 2019 assessments can be explained by underlying data. Consequently, the next benchmark should evaluate the temporal stability of the retrospective patterns and determine whether the assessment settings need to be revised.

The UK-COT effort has been in continuous decline and reported no activity in 2016 and subsequently, due to a new data base system cannot be replicated anymore. Consequently, a benchmark could investigate the removal of commercial tuning information altogether from the assessment.

As the time-series on discards is increasing a future benchmark might look into including discard estimates in the assessment and estimating historical discards. As of now, discards are very low and due to the implementation of the landing obligation in 2016 unlikely to become a problem in the future.

33.9 Management considerations

France provided discard estimates for the first time at the 2016 working group. Discard estimates from France are higher than from the other countries.

Plaice is taken as bycatch in this fishery, and therefore management advice for sole must also take into account the advice for plaice. Anglerfish, cuttlefish, and lemon sole are also important bycatches in this fishery.

33.10 Ecosystem considerations and changes in the environment

See stock annex.

33.11 Regulations and their effects

Management of this stock is mainly by TAC. In 2005, effort restrictions were implemented for beam trawlers and entangling gears targeting sole in this fishery to enforce the TAC and improve data quality. The effort restrictions were included in the 2007 management plan (EU, 2007) and are continued in the EU multiannual plan (EU, 2019b). The effort restrictions limit the numbers of days at sea for vessels in 7.e using beam trawls (≥80 mm mesh size) and static nets (≤120 mm mesh size). The limits for effort are set annually in the EU council with the TAC and apply only for vessels which catch more than 300 kg of sole annually.

Mesh restrictions for towed gears are set to 80 mm codends, which correspond well with the minimum landing size of sole at 24 cm (25 cm for Belgian vessels since December 2017).

33.12 References

EC. 2007. Council Regulation (EC) No. 509/2007 of 7 May 2007 establishing a multi-annual plan for the sustainable exploitation of the stock of sole in the Western Channel. Official Journal of the European Union, L 122/7. http://data.europa.eu/eli/reg/2007/509/oj.

EU. 2015. Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters. OJ L 336, 23.12.2015, p. 29–35. http://eur-lex.europa.eu/eli/reg_del/2015/2438/oj.

EU. 2016. Commission Delegated Regulation (EU) 2016/2375 of 12 October 2016 establishing a discard plan for certain demersal fisheries in North-Western waters. C/2016/6439, OJ L 352, 23.12.2016, p. 39–47. http://eur-lex.europa.eu/eli/reg_del/2016/2375/oj.

EU. 2018a. Commission Delegated Regulation (EU) 2018/46 of 20 October 2017 establishing a discard plan for certain demersal and deep sea fisheries in North-Western waters for the year 2018. C/2017/6990, OJ L 7, 12.1.2018, p. 13–20. http://data.europa.eu/eli/reg_del/2018/46/oj.

EU. 2018b. Council Regulation (EU) 2018/120 of 23 January 2018 fixing for 2018 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2017/127. OJ L 27, 31.1.2018, p. 1–168. http://data.europa.eu/eli/reg/2018/120/oj.

EU. 2019a. Council Regulation (EU) 2019/124 of 30 January 2019 fixing for 2019 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters. ST/15733/2018/INIT. OJ L 29, 31.1.2019, p. 1–166. http://data.europa.eu/eli/reg/2019/124/oj.

EU. 2019b. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. PE/78/2018/REV/1. OJ L 83, 25.3.2019, p. 1–17. http://data.europa.eu/eli/reg/2019/472/oj.

ICES. 2012. Report of the Benchmark Workshop on Flatfish Species and Anglerfish (WKFLAT), 1–8 March 2012, Bilbao, Spain. ICES CM 2012/ACOM:46. 283 pp.

ICES. 2015. Report of the Second Inter-Benchmark Protocol on West of Channel Flatfish (IBPWCFlat2), June–September 2015, By correspondence. ICES CM 2015/ACOM:55. 142 pp.

ICES. 2016a. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. In Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.4.1.

ICES. 2016b. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

Table 31.1. Sole in Division 7.e. History of commercial catch and landings. All weights are in tonnes.

Year	Landings							Discards*
	Belgium	France	Netherlands	Ireland	UK and Channel Islands	Unallocated*	Total*	
1974		323				104	427	
1975	3	271			217		491	
1976	4	352			260		616	
1977	3	331			272		606	
1978	4	384			453	20	861	
1979	1	515			665		1181	
1980	45	447		13	764		1269	
1981	16	415	1		788	−5	1215	
1982	98	321			1028	−1	1446	
1983	47	405	3		1043		1498	
1984	48	421			901		1370	
1985	58	130			911	310	1409	
1986	62	467			840	50	1419	
1987	48	432			632	168	1280	
1988	67	98			784	495	1444	
1989	69	112	6		613	590	1390	
1990	41	81			636	556	1315	
1991	35	325			477	15	852	
1992	41	267			468	119	895	
1993	59	236			498	111	904	
1994	33	257			546	−38	800	
1995	21	294			565	−24	856	
1996	8	297			428	91	833	
1997	13	348		1	496	91	949	
1998	40	343			389	108	880	
1999	13				396	548	957	
2000	4	241			413	256	914	

Year	Landings							Discards*
	Belgium	France	Netherlands	Ireland	UK and Channel Islands	Unallocated*	Total*	
2001	19	224			407	419	1069	
2002	33	198			309	566	1106	
2003	1	363		1	255	458	1078	
2004	7	302			185	581	1075	
2005	26	406			527	80	1039	
2006	32	357			572	61	1022	
2007	34	384			536	61	1015	
2008	28	312		0	472	96	908	
2009	17	386			381	−83	701	
2010	17	375			370	−64	698	
2011	22	424			431	−76	801	
2012	39	325		0	506	2	872	2
2013	30	319			540	−6	883	1
2014	25	351			509	−1	884	10
2015	42	245		0	490	−3	774	54
2016	46	245			623	−1	913	10
2017	56	198		< 1	746	7	1007	4
2018^	68	217	0	<1	789	1	1075	3

***ICES estimate.**

^Preliminary.

Table 31.2. Sole in Division 7.e. Landings numbers-at-age (thousands).

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12+	TOTAL
1969	89	322	80	148	210	21	50	26	20	9	63	1037
1970	53	232	322	90	83	112	13	35	52	22	113	1127
1971	51	200	246	198	65	80	156	10	35	54	113	1207
1972	146	412	167	115	112	14	25	134	38	54	106	1323
1973	71	396	433	89	99	120	17	52	30	4	136	1446
1974	45	349	220	178	71	80	43	32	24	55	106	1202
1975	82	567	170	199	115	28	53	26	22	24	171	1456
1976	167	419	472	161	135	92	46	58	51	14	213	1830
1977	426	318	384	206	102	70	74	10	24	32	159	1804
1978	250	1123	347	214	189	103	72	77	38	27	203	2644
1979	227	803	811	250	229	174	103	90	104	28	290	3108
1980	175	559	497	630	126	183	140	65	56	130	342	2902
1981	245	806	651	467	389	179	126	76	58	55	211	3262
1982	128	1451	916	553	352	240	136	113	81	61	294	4324
1983	91	753	1573	583	351	267	294	119	73	37	262	4401
1984	333	663	826	758	325	204	129	152	54	28	255	3727
1985	287	1700	756	469	585	179	97	103	85	29	125	4414
1986	246	1618	971	421	321	336	84	75	90	74	127	4363
1987	487	808	1090	427	204	224	229	47	50	41	162	3770
1988	443	1438	596	728	374	153	162	109	39	50	171	4262
1989	390	871	1233	497	509	225	110	107	113	48	214	4316
1990	341	902	581	553	244	264	143	103	75	85	235	3525
1991	450	415	482	289	220	93	111	68	37	31	145	2341
1992	316	1434	417	297	115	112	61	74	26	23	90	2964
1993	209	704	1107	350	219	151	78	60	56	31	79	3045
1994	97	657	558	558	112	106	49	57	44	50	99	2388
1995	95	308	629	427	411	131	101	61	33	18	142	2356
1996	365	445	364	298	235	257	68	61	49	37	143	2321

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12+	TOTAL
1997	216	831	724	325	180	194	173	44	20	40	88	2835
1998	265	606	536	336	209	151	80	127	35	34	162	2543
1999	280	915	500	398	255	114	103	54	107	25	123	2874
2000	307	599	751	367	229	107	53	68	51	88	91	2710
2001	145	1401	531	497	268	178	100	55	43	42	159	3419
2002	332	1251	843	387	322	129	105	94	33	18	85	3599
2003	598	835	953	645	130	74	50	58	63	14	61	3482
2004	398	1080	448	445	526	164	116	61	54	35	85	3412
2005	258	468	834	449	366	293	113	80	45	24	96	3027
2006	500	786	472	606	250	224	185	85	56	31	87	3282
2007	201	852	755	293	362	179	130	110	55	27	99	3062
2008	281	752	678	376	163	184	105	71	67	39	89	2805
2009	166	540	385	333	202	66	74	37	50	35	65	1955
2010	68	348	394	329	204	127	49	71	20	34	78	1723
2011	91	499	476	405	233	156	80	39	34	28	93	2136
2012	31	227	525	400	355	231	137	67	44	39	124	2180
2013	120	324	483	595	280	214	147	98	48	23	110	2441
2014	198	320	466	426	410	168	112	79	61	27	97	2364
2015	177	329	395	336	261	206	115	78	45	30	82	2054
2016	92	420	469	276	249	242	189	67	50	33	107	2194
2017	123	1188	334	307	277	130	94	41	36	129	78	2737
2018	80	446	410	272	339	156	242	99	82	221	154	2501

Table 31.3. Sole in Division 7.e. Landings weights-at-age (kg).

year\age	2	3	4	5	6	7	8	9	10	11	12+
1969	0.188	0.245	0.332	0.329	0.367	0.522	0.455	0.463	0.606	0.648	0.661
1970	0.188	0.224	0.295	0.315	0.355	0.436	0.5	0.444	0.514	0.53	0.596
1971	0.151	0.222	0.296	0.367	0.35	0.359	0.431	0.455	0.476	0.388	0.654
1972	0.194	0.227	0.272	0.369	0.408	0.458	0.496	0.402	0.454	0.509	0.601
1973	0.203	0.224	0.262	0.311	0.382	0.415	0.46	0.467	0.538	0.655	0.562
1974	0.183	0.224	0.281	0.379	0.434	0.372	0.465	0.476	0.488	0.475	0.732
1975	0.178	0.21	0.293	0.351	0.395	0.427	0.487	0.58	0.638	0.525	0.663
1976	0.17	0.218	0.287	0.324	0.391	0.455	0.414	0.476	0.479	0.585	0.629
1977	0.197	0.249	0.303	0.357	0.4	0.503	0.464	0.518	0.485	0.553	0.683
1978	0.178	0.239	0.3	0.387	0.435	0.374	0.482	0.485	0.484	0.535	0.665
1979	0.189	0.239	0.33	0.427	0.464	0.472	0.481	0.57	0.527	0.574	0.732
1980	0.189	0.254	0.343	0.389	0.525	0.56	0.609	0.646	0.655	0.6	0.783
1981	0.174	0.225	0.321	0.381	0.477	0.514	0.533	0.598	0.619	0.708	0.66
1982	0.214	0.209	0.278	0.347	0.426	0.498	0.51	0.523	0.526	0.564	0.663
1983	0.187	0.25	0.271	0.306	0.388	0.417	0.473	0.53	0.608	0.551	0.665
1984	0.21	0.243	0.306	0.381	0.391	0.481	0.542	0.562	0.604	0.726	0.643
1985	0.163	0.226	0.298	0.36	0.391	0.472	0.523	0.534	0.522	0.588	0.822
1986	0.174	0.237	0.297	0.354	0.407	0.456	0.502	0.544	0.583	0.618	0.703
1987	0.174	0.245	0.31	0.37	0.425	0.474	0.518	0.557	0.59	0.618	0.665
1988	0.17	0.244	0.312	0.375	0.432	0.484	0.531	0.572	0.608	0.639	0.694
1989	0.167	0.222	0.275	0.326	0.375	0.422	0.467	0.51	0.551	0.59	0.692
1990	0.217	0.272	0.324	0.372	0.419	0.461	0.501	0.538	0.571	0.601	0.669
1991	0.182	0.255	0.323	0.386	0.445	0.499	0.549	0.594	0.634	0.669	0.741
1992	0.166	0.238	0.305	0.366	0.423	0.474	0.52	0.561	0.597	0.627	0.683
1993	0.146	0.209	0.268	0.324	0.376	0.425	0.47	0.513	0.551	0.587	0.672
1994	0.183	0.241	0.295	0.347	0.396	0.442	0.484	0.524	0.561	0.595	0.671
1995	0.192	0.248	0.301	0.351	0.397	0.441	0.481	0.518	0.552	0.583	0.652
1996	0.214	0.262	0.308	0.354	0.399	0.442	0.484	0.524	0.564	0.602	0.694

year\age	2	3	4	5	6	7	8	9	10	11	12+
1997	0.186	0.244	0.3	0.354	0.406	0.455	0.503	0.548	0.592	0.633	0.734
1998	0.191	0.247	0.3	0.35	0.397	0.441	0.482	0.52	0.555	0.586	0.661
1999	0.208	0.257	0.303	0.347	0.389	0.429	0.468	0.503	0.536	0.567	0.637
2000	0.202	0.258	0.31	0.358	0.401	0.441	0.476	0.508	0.535	0.558	0.647
2001	0.203	0.245	0.287	0.326	0.365	0.402	0.438	0.472	0.505	0.537	0.616
2002	0.181	0.236	0.29	0.342	0.391	0.439	0.485	0.529	0.57	0.61	0.706
2003	0.173	0.241	0.306	0.367	0.425	0.479	0.53	0.577	0.62	0.66	0.746
2004	0.176	0.23	0.282	0.334	0.385	0.435	0.485	0.534	0.582	0.629	0.757
2005	0.18	0.236	0.29	0.343	0.394	0.444	0.493	0.54	0.586	0.63	0.747
2006	0.169	0.228	0.282	0.333	0.381	0.424	0.464	0.501	0.533	0.562	0.672
2007	0.183	0.244	0.299	0.35	0.395	0.436	0.471	0.501	0.526	0.546	0.616
2008	0.197	0.245	0.292	0.337	0.382	0.425	0.468	0.509	0.549	0.588	0.652
2009	0.176	0.252	0.322	0.385	0.443	0.494	0.54	0.579	0.612	0.639	0.703
2010	0.169	0.258	0.339	0.412	0.476	0.532	0.58	0.619	0.65	0.673	0.699
2011	0.2	0.261	0.319	0.375	0.428	0.48	0.528	0.575	0.618	0.66	0.749
2012	0.162	0.24	0.311	0.373	0.428	0.476	0.516	0.548	0.572	0.589	0.664
2013	0.172	0.228	0.283	0.337	0.389	0.439	0.489	0.536	0.583	0.628	0.74
2014	0.191	0.254	0.313	0.366	0.415	0.459	0.499	0.533	0.563	0.588	0.709
2015	0.182	0.25	0.313	0.37	0.423	0.471	0.513	0.551	0.583	0.611	0.697
2016	0.215	0.282	0.345	0.401	0.453	0.499	0.541	0.576	0.606	0.631	0.72
2017	0.225	0.279	0.331	0.382	0.432	0.479	0.525	0.568	0.61	0.651	0.763
2018	0.205	0.264	0.321	0.374	0.425	0.473	0.518	0.56	0.6	0.636	0.768

Table 31.4. Sole in Division 7.e. Stock weights-at-age (kg).

year\age	2	3	4	5	6	7	8	9	10	11	12+
1969	0.125	0.2	0.27	0.33	0.38	0.425	0.46	0.49	0.52	0.55	0.609
1970	0.12	0.195	0.255	0.305	0.355	0.395	0.43	0.465	0.49	0.51	0.541
1971	0.09	0.17	0.24	0.295	0.345	0.39	0.42	0.445	0.47	0.49	0.544
1972	0.13	0.2	0.265	0.325	0.38	0.42	0.46	0.49	0.52	0.54	0.558
1973	0.105	0.17	0.235	0.29	0.34	0.39	0.435	0.475	0.51	0.54	0.585
1974	0.125	0.2	0.265	0.32	0.37	0.41	0.455	0.49	0.515	0.53	0.571
1975	0.144	0.221	0.267	0.327	0.385	0.435	0.479	0.516	0.545	0.569	0.628
1976	0.146	0.198	0.247	0.294	0.338	0.38	0.417	0.456	0.491	0.523	0.595
1977	0.156	0.221	0.278	0.332	0.382	0.425	0.462	0.497	0.527	0.553	0.629
1978	0.156	0.217	0.276	0.33	0.38	0.425	0.463	0.498	0.526	0.555	0.63
1979	0.141	0.216	0.287	0.352	0.414	0.463	0.502	0.539	0.574	0.608	0.719
1980	0.125	0.206	0.288	0.36	0.436	0.513	0.575	0.62	0.65	0.674	0.714
1981	0.119	0.197	0.276	0.358	0.427	0.49	0.543	0.582	0.616	0.645	0.699
1982	0.117	0.195	0.265	0.335	0.398	0.455	0.506	0.536	0.562	0.585	0.632
1983	0.12	0.195	0.25	0.307	0.365	0.42	0.475	0.52	0.57	0.615	0.709
1984	0.108	0.192	0.268	0.339	0.4	0.453	0.501	0.545	0.577	0.607	0.696
1985	0.15	0.204	0.258	0.311	0.364	0.416	0.468	0.52	0.571	0.621	0.79
1986	0.14	0.206	0.268	0.326	0.381	0.432	0.48	0.524	0.564	0.601	0.691
1987	0.137	0.21	0.278	0.341	0.398	0.45	0.497	0.538	0.574	0.605	0.659
1988	0.131	0.208	0.278	0.344	0.404	0.459	0.508	0.552	0.591	0.624	0.687
1989	0.139	0.195	0.249	0.3	0.35	0.398	0.444	0.488	0.531	0.571	0.675
1990	0.187	0.243	0.296	0.346	0.393	0.437	0.478	0.516	0.551	0.583	0.654
1991	0.144	0.219	0.29	0.355	0.416	0.473	0.524	0.572	0.614	0.652	0.731
1992	0.128	0.202	0.272	0.336	0.395	0.449	0.498	0.542	0.58	0.613	0.677
1993	0.114	0.178	0.239	0.296	0.35	0.401	0.448	0.492	0.532	0.57	0.659
1994	0.153	0.212	0.268	0.322	0.372	0.419	0.463	0.505	0.543	0.578	0.659
1995	0.163	0.221	0.275	0.326	0.374	0.419	0.461	0.5	0.536	0.568	0.641
1996	0.189	0.238	0.285	0.331	0.376	0.42	0.463	0.504	0.544	0.583	0.677

year\age	2	3	4	5	6	7	8	9	10	11	12+
1997	0.156	0.215	0.272	0.327	0.38	0.431	0.48	0.526	0.57	0.612	0.717
1998	0.162	0.22	0.274	0.325	0.374	0.419	0.462	0.501	0.537	0.571	0.65
1999	0.183	0.233	0.28	0.326	0.369	0.41	0.448	0.485	0.519	0.551	0.624
2000	0.172	0.23	0.284	0.333	0.379	0.421	0.458	0.492	0.521	0.546	0.643
2001	0.181	0.224	0.266	0.307	0.346	0.384	0.42	0.455	0.489	0.521	0.602
2002	0.152	0.209	0.263	0.316	0.367	0.415	0.462	0.507	0.55	0.591	0.688
2003	0.137	0.207	0.274	0.337	0.396	0.452	0.505	0.554	0.599	0.641	0.732
2004	0.149	0.203	0.256	0.308	0.36	0.41	0.46	0.509	0.557	0.605	0.734
2005	0.152	0.208	0.263	0.316	0.368	0.419	0.468	0.516	0.562	0.607	0.726
2006	0.138	0.197	0.254	0.306	0.355	0.4	0.442	0.479	0.514	0.544	0.661
2007	0.151	0.214	0.272	0.325	0.373	0.416	0.454	0.486	0.514	0.536	0.614
2008	0.172	0.221	0.268	0.315	0.36	0.404	0.447	0.489	0.529	0.569	0.64
2009	0.136	0.215	0.287	0.354	0.415	0.469	0.518	0.56	0.596	0.626	0.698
2010	0.121	0.215	0.3	0.376	0.445	0.505	0.557	0.6	0.636	0.663	0.696
2011	0.169	0.231	0.29	0.347	0.402	0.454	0.504	0.552	0.597	0.639	0.738
2012	0.12	0.202	0.276	0.343	0.402	0.453	0.497	0.532	0.561	0.581	0.664
2013	0.144	0.2	0.256	0.31	0.363	0.414	0.464	0.513	0.56	0.606	0.729
2014	0.157	0.223	0.284	0.34	0.391	0.438	0.48	0.517	0.549	0.576	0.706
2015	0.147	0.217	0.282	0.342	0.397	0.448	0.493	0.533	0.568	0.598	0.692
2016	0.178	0.248	0.313	0.373	0.427	0.476	0.519	0.557	0.59	0.617	0.714
2017	0.197	0.252	0.305	0.357	0.407	0.455	0.501	0.546	0.588	0.630	0.749
2018	0.174	0.235	0.293	0.348	0.400	0.450	0.496	0.540	0.580	0.618	0.760

Table 31.5. Sole in Division 7.e. Landings, effort and mean standardised lpue for the UK commercial fleets.

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
UK-CBT<24 m	1988	2527	293	115.97	1.96
	1989	1956	162	83.06	1.4
	1990	1958	179	91.51	1.54
	1991	1458	134	92.22	1.56
	1992	1342	142	106.22	1.79
	1993	1432	154	107.71	1.82
	1994	2241	161	71.97	1.21
	1995	2017	134	66.28	1.12
	1996	1999	106	52.99	0.89
	1997	1991	132	66.3	1.12
	1998	2357	99	42.12	0.71
	1999	2518	115	45.7	0.77
	2000	2913	134	45.85	0.77
	2001	3746	148	39.57	0.67
	2002	3482	110	31.55	0.53
	2003	3785	93	24.44	0.41
	2004	3512	64	18.12	0.31
	2005	3305	191	57.72	0.97
	2006	3277	224	68.27	1.15
	2007	4027	225	55.77	0.94
	2008	4629	213	45.94	0.78
	2009	4040	185	45.85	0.77
	2010	4727	201	42.42	0.72
	2011	5913	258	43.65	0.74
	2012	7188	314	43.65	0.74
	2013	6322	329	52.02	0.88
	2014	5870	308	52.54	0.89
	2015	6260	310	49.54	0.84
	2016	6114	355	58.1	0.98
	2017	6556	400	61.07	1.03
	2018	6366	386	60.66	1.02
UK-CBT>24 m	1988	2971	391	131.77	2.92
	1989	3938	340	86.37	1.91
	1990	3518	314	89.12	1.97
	1991	2412	206	85.47	1.89
	1992	1993	197	98.63	2.18
	1993	2678	194	72.54	1.61

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	1994	4574	236	51.5	1.14
	1995	4917	257	52.3	1.16
	1996	5592	178	31.84	0.7
	1997	5377	199	37.1	0.82
	1998	4945	164	33.19	0.73
	1999	4512	141	31.32	0.69
	2000	5237	151	28.84	0.64
	2001	5874	142	24.11	0.53
	2002	5957	104	17.51	0.39
	2003	6810	94	13.78	0.31
	2004	7100	69	9.66	0.21
	2005	6684	236	35.27	0.78
	2006	6595	236	35.79	0.79
	2007	5594	196	35.1	0.78
	2008	4924	154	31.36	0.69
	2009	3523	115	32.66	0.72
	2010	3064	94	30.64	0.68
	2011	2790	92	32.95	0.73
	2012	2609	86	33.01	0.73
	2013	2444	93	38.13	0.84
	2014	2900	104	35.95	0.8
	2015	3039	101	33.12	0.73
	2016	4064	166	40.79	0.9
	2017	4556	207	45.41	1.01
	2018	4116	231	56.17	1.23
UK-CBT	1988	5497	684	124.51	2.43
	1989	5894	503	85.27	1.66
	1990	5476	493	89.97	1.76
	1991	3870	341	88.02	1.72
	1992	3334	339	101.69	1.99
	1993	4111	349	84.79	1.66
	1994	6814	397	58.23	1.14
	1995	6935	391	56.37	1.1
	1996	7591	284	37.41	0.73
	1997	7368	331	44.99	0.88
	1998	7302	263	36.07	0.7
	1999	7031	256	36.47	0.71
	2000	8150	285	34.92	0.68

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	2001	9620	290	30.13	0.59
	2002	9439	214	22.69	0.44
	2003	10596	186	17.59	0.34
	2004	10612	132	12.46	0.24
	2005	9990	427	42.7	0.83
	2006	9873	460	46.57	0.91
	2007	9621	421	43.75	0.85
	2008	9552	367	38.42	0.75
	2009	7563	300	39.7	0.78
	2010	7791	294	37.79	0.74
	2011	8703	350	40.22	0.79
	2012	9797	400	40.82	0.8
	2013	8767	422	48.15	0.94
	2014	8769	413	47.05	0.92
	2015	9298	411	44.17	0.86
	2016	10178	521	51.19	1
	2017	11112	607	54.65	1.07
	2018	10482	617	58.9	1.14
UK-COT	1988	4265	29	6.77	1.43
	1989	4607	28	6.18	1.31
	1990	4423	26	5.97	1.27
	1991	4004	14	3.39	0.72
	1992	4108	12	3.02	0.64
	1993	3761	15	3.95	0.84
	1994	3423	18	5.27	1.12
	1995	3294	13	3.99	0.84
	1996	2589	12	4.83	1.02
	1997	3011	15	4.96	1.05
	1998	2699	11	4.22	0.89
	1999	2486	13	5.16	1.09
	2000	2681	11	4.11	0.87
	2001	2732	13	4.9	1.04
	2002	2448	9	3.66	0.78
	2003	2273	8	3.31	0.7
	2004	2334	6	2.46	0.52
	2005	1762	12	6.86	1.45
	2006	1699	8	4.57	0.97
	2007	1917	9	4.9	1.04

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	2008	1750	7	4.26	0.9
	2009	1847	10	5.36	1.14
	2010	2213	10	4.53	0.96
	2011	1930	8	4.08	0.86
	2012	2068	12	5.96	1.26
	2013	1587	8	4.96	1.05
	2014	1440	8	5.56	1.18
	2015	978	5	4.98	1.06
	2016	0	0	NA	NA

Note that the lpue time-series for the UK commercial beam-trawl fleet was revised at IBPWCFlat2 due to modifications in the UK e-logbook effort recording system in 2012.

Table 31.6. Sole in Division 7.e. Tuning data file. Not all tuning time-series, years and ages shown here were used in the assessment.

W CHANNEL SOLE 2017 WGCSE, 2–11, SEXES COMBINED,

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UK-CBT-late

2003 2018

1 1 0 1

3 14

10.66126	130.7	168.87	129.96	21.43	18.32	10.28	13.49	6.67	2.19	2.06	3.35	2.82
10.61079	146.5	61.53	53.46	75.23	11.35	14.96	7.49	5.98	4.27	2.12	1.18	1.89
9.99213	210.39	326.3	132.94	155.21	132.09	27.41	32.6	22.54	14.24	8.3	5.95	4.84
9.89192	376.87	186.46	243.45	85.59	108.34	106.98	37.22	20.67	13.69	13.61	6.68	2.99
9.61475	456.04	261.42	105.82	103.55	54.21	62.07	51.47	15.34	11.12	10.41	8.44	8.17
9.55107	294.03	286.06	126.1	67.89	65.42	42.34	39.54	36.27	14.54	11.8	4.3	6
7.56283	190.03	182.63	152.83	89.59	26.02	27.9	13.23	16.1	12.91	4.85	3.74	1.92
7.78378	80.09	179.7	157.57	101.24	51.98	25.24	22.59	8.23	16.75	25.39	7.42	3.88
8.70071	243.76	148.58	186.66	121.43	81.66	35.56	15.79	20.25	10.83	14.11	8.26	2.1
9.78759	129.79	307.88	139.02	143.59	91.49	66.22	30.49	17.81	14.83	8.55	12.25	11.03
8.75236	81.92	242.49	288.92	134.34	93.18	72.27	44.15	24.5	10.73	9.84	8.14	9.84
8.7411	111.72	201.15	169.62	201.19	99.91	67.46	43.84	30.63	15.94	7.71	9.34	4.9
9.27543	137.05	178.21	198.83	135.74	117.19	65.74	45.95	31.78	20.59	11.01	5.52	5.96
10.17804	263.46	217.34	158.93	161.88	118.88	102.14	49.07	45.22	21.3	23.14	13.03	5.69
11.13423	454.27	353.27	177.37	142.06	120.28	81.72	72.95	42.23	28.03	16.59	11.97	9.63
10.48248	217.63	454.82	260.75	116.59	118.4	76.79	51.54	49.36	33.91	24.42	21.84	10.92

UK-COT

1988 2016

1 1 0 1

3 11

4264.71	30.97	15.73	19.29	8.63	2.55	2.55
	1.83	0.35	0.76			
4607.04	15.09	18.34	9.22	11.75	4.72	2.42
	2.36	2.01	1.4			
4422.52	18.3	12.56	9.21	6.09	5.53	2.08
	1.83	1.12	0.9			
4004.37	10.04	7.03	4.12	2.46	0.96	1.44
	0.42	0.41	0.23			
4107.71	26.24	6	3.6	1.19	1.14	0.48
	0.65	0.17	0.09			
3761	12.45	17.56	5.38	3.44	2.49	1.26
	1	0.92	0.56			
3423.03	12.42	11.46	12.35	2.5	2.6	1.23
	1.35	1.03	1.18			
3294.06	5.25	9.75	6.34	6.17	1.89	1.49
	0.91	0.52	0.25			
2589.38	9.47	6.54	4.37	3.15	3.54	0.95
	0.76	0.68	0.45			
3010.66	15.16	8.81	4.78	2.83	2.9	2.53
	0.63	0.28	0.43			
2698.6	8.74	7.58	4.25	2.49	1.53	0.93
	1.47	0.31	0.44			
2486.17	11.56	5.84	4.91	2.89	1.45	1.46
	0.74	1.49	0.39			

2680.63	6.67	8.41	4.03	2.64	1.24	0.59
	0.81	0.62	0.99			
2731.54	18.02	5.27	4.96	2.69	2.01	1.12
	0.7	0.51	0.5			
2448.37	9.88	6.12	2.39	2.67	1.27	0.82
	0.33	0.2	0.25			
2272.9	4.61	5.87	4.8	1.04	0.85	0.49
	0.54	0.27	0.13			
2334.16	6.05	2.58	2.23	3.25	0.46	0.57
	0.3	0.24	0.18			
1762.36	6.44	9.56	3.53	4.13	3.44	0.74
	0.9	0.58	0.45			
1699.49	6.93	3.27	4.13	1.36	1.63	1.75
	0.6	0.31	0.2			
1916.84	9.32	5.44	2.3	2.32	1.19	1.41
	1.13	0.36	0.21			
1750.36	5.61	4.85	2.08	1.15	1.18	0.75
	0.75	0.7	0.32			
1847.2	7.97	5.47	3.92	2.17	0.64	0.83
	0.39	0.52	0.45			
2212.85	2.71	5.85	4.74	3.15	1.63	0.81
	0.74	0.3	0.6			
1930.5	6.51	3.32	3.89	2.46	1.64	0.58
	0.31	0.37	0.19			
2068.16	4.24	9.16	3.97	4.06	2.3	1.76
	0.82	0.49	0.46			
1586.58	2.01	4.55	5.64	2.66	1.74	1.49
	0.89	0.56	0.26			
1440.22	2.13	3.57	2.99	3.56	1.8	1.29
	0.9	0.68	0.34			
977.63	1.62	1.98	1.86	1.59	1.35	0.7
	0.5	0.42	0.25			
0	0	0	0	0	0	0
	0	0	0			

Q1SWBeam-nonoffset

2006 2018

1 1 0.1 0.25

1 27

1	0	13.9827	17.7418	9.8877	19.4529	
	11.9525	9.8066	10.4549	4.74613	3.23665	
	7.00007	0.86644	1.50309	0.42807	0.86046	
	3.98914	0.83462	0.39699	0	0	0
	0	0	0	0	0	0
1	0.21454	12.3291	36.7717	16.2021	2.0082	
	7.3474	2.5642	2.7218	6.92397	5.55754	
	4.41774	0.14217	1.50318	1.22386	0.42963	0
	0.81319	0.36316	0	0	0	
	0.40667	0	0	0.09932	0	0
1	0	11.9556	27.2521	26.915	11.617	
	8.7491	3.3699	10.2461	9.66501	5.70182	
	2.42857	1.65195	1.89138	1.44948	0.9786	
	0.12415	0.9035	1.85437	2.84543	0	0
	0	0	0	0	0	0

1	0	3.3789	24.1601	18.2609	15.6175	
	6.4364	2.5672	2.8808	1.45679	4.30936	
	5.37546	0.83462	1.0417	0.17687	0.93002	0
	1.16367	1.35555	2.13469	0	0	0
	0	0	0.10455	1.05699	1.05699	
1	0	21.1326	26.0624	27.4407	19.3966	
	11.162	11.8984	2.0858	1.94805	2.06037	
	1.40477	1.26444	1.18208	1.11282	0.60453	0
	0.56543	0	1.65612	0	1.11282	0
	0	0	0	0	0	
1	0	13.6486	24.6563	23.7656	19.809	
	9.1065	4.0748	7.1824	2.24506	0.30904	
	1.9532	1.05653	0.3958	0.48413	0.15127	
	0.09459	0.41663	0	0.15892	0	0
	0.09459	0	0	0	0	0
1	0	2.3036	23.2228	26.7927	11.0111	
	9.7258	11.4579	5.9073	3.97145	0.13376	
	1.82684	2.35364	0.36751	2.05882	0.09932	
	0.67124	0	0.09932	1.10408	0	0
	0	1.00247	0	0	0	0
1	0	3.7142	12.4853	23.6131	21.5683	
	14.7024	11.8911	8.5158	7.77601	6.54977	
	1.0211	6.06254	1.10408	4.6406	1.12071	0
	0	0	0	0	0	
	2.42532	1.00247	0	0	0	0
1	1.2565	5.2342	25.2683	31.1232	13.363	
	19.2418	13.2925	24.9744	7.5189	2.67556	
	3.84886	1.54683	1.32124	1.05685	1.5451	
	1.02614	1.23376	0	0	1.02614	
	0.21026	0	0	0	0	0
	0					
1	0.56543	5.0564	10.4716	13.1777	16.4052	
	13.1156	12.5791	7.5394	7.55054	3.25374	
	3.63526	1.02121	2.84755	3.7998	0	
	3.83094	0.3368	1.03257	0.18197	0.2225	
	1.67078	0	0	0	0	0
	0					
1	0.20429	14.2613	29.7948	14.0505	14.3579	
	10.8978	9.6971	12.9744	2.26091	2.49797	
	4.98397	2.59738	1.21161	0.08277	0	
	0.37593	0	0	0	1.20179	0
	0.17698	0	0	0	0	0
1	1.41071	5.7822	20.1244	19.6491	11.0867	
	8.3659	7.942	2.5658	2.48221	2.40893	
	1.51529	5.46344	1.19731	1.9858	0.15863	
	0.29223	0	0	1.98612	0.3958	
	0.19391	0	0	0	0	0
	0					
1	0	11.7026	23.6762	28.3671	21.9248	
	7.6216	11.5812	6.8262	6.37338	5.55139	
	1.41046	3.92975	4.62352	5.81395	0.83888	0
	0	0	0	0.49328	0	0
	0	0	0	0	0	

FSP-UK
2003 2018
1 1 0.7 0.75
1 27

1	0.000374783	0.16425357	0.333157743	0.342104285	0.307789686	
	0.027687761	0.043434988	0.001216353	0.060658762	0.045237007	
	0.076077736	0.004223941	0.004487331	0.001602123	0.000293308	
	0.001509661	0	0	0.000146654	0.000146654	0
	0.000293308	0.000146654	0	0.000146654	0	0
1	0.000167383	0.152985608	0.54713534	0.313153971	0.258367807	
	0.125306132	0.057695467	0.087452431	0.035445215	0.015927246	
	0.016567547	0.010042336	0.006018962	0.006226747	0.004546988	
	0.001033787	0.001162246	0.000662934	0.003393134	0.001437831	
	0.000199344	0.001241386	0.0022483	0.000732909	0.000824522	0
	0					
1	0	0.103329518	0.19641048	0.241991372	0.109126628	
	0.156802612	0.145326301	0.036140277	0.029396359	0.014350801	
	0.015371889	0.007192957	0.006752774	0.001868139	0.009940521	
	0.00740716	0.002378835	0.002716705	0.002140931	0.001742275	
	0.000590406	0.003395581	0.000675262	0	0	
	0.00023526	0				
1	0.00361101	0.153691116	0.340745611	0.155260454	0.213275765	
	0.09839317	0.115716826	0.133528151	0.026403531	0.025886412	
	0.018344075	0.013299442	0.009312048	0.001825551	0.004269052	
	0.003885913	0.003547444	0.002248216	0.002021527	0.001306935	
	0.000573667	0.000776348	0.000582087	0.000884103	3.84393e-05	
	3.84393e-05	0				
1	0.000949919	0.119241548	0.44701361	0.204189719	0.077363475	
	0.090584633	0.059564942	0.048392134	0.103423228	0.018747854	
	0.026135604	0.00518708	0.014899006	0.004306601	0.004122799	
	0.003789578	0	0.000313876	0.000511068	0.000980892	
	0.00080048	0.001114356	0.00167399	0.000972199	0	0
	0					
1	2.92679e-05	0.21902938	0.304310597	0.264563006	0.247311278	
	0.043037336	0.037404414	0.014603872	0.056648435	0.032857499	
	0.002040635	0.010387516	0.005144875	0.000344659	0.001847508	
	0.001254609	0.000256856	0.002322059	0.001753791	0.000123486	
	0.001947411	0.00147103	4.7289e-05	0.000111018	0.001606173	
	1.16069e-05	0				
1	0	0.087175684	0.299624141	0.311159869	0.161288882	
	0.060718142	0.039957338	0.028000462	0.015193089	0.017913114	
	0.047375509	0.007065787	0.002906977	0.002808564	0.003424814	0
	0.002300992	0	0	0	0.001448773	0
	0	0	0	0	0	
1	0	0.119863413	0.196874246	0.245797705	0.181168944	
	0.127269974	0.035676999	0.020992322	0.027191027	0.017568869	
	0.023533383	0.011131766	0.004017553	0.002867057	0.009837834	
	0.006157131	0	0	0.001716561	0	
	0.00143812	0.001962611	0.00143812	0	0	0
	0					
1	0	0.08434561	0.454242063	0.099822858	0.198143553	
	0.092413349	0.051026632	0.004545029	0.013054823	0.007279282	
	0.010694232	0.012408527	0.013283726	0.001237655	0.003758948	

	8.71588e-05	0.00473127	5.22953e-05	0.001237655	1.74318e-05	
	3.48635e-05	6.9727e-05	3.48635e-05	1.74318e-05	1.74318e-05	
	0.003450553	0				
1	0	0.046242932	0.366107405	0.375112338	0.171327639	
	0.117372943	0.033525922	0.044415235	0.02758615	0.003097558	
	0.00634757	0.000149266	0.009066842	0.010184099	0.00645961	
	0.006363419	0.001980647	0	7.46331e-05	7.46331e-05	
	0.001299247	0.000149266	7.46331e-05	0	7.46331e-05	0
	0					
1	0	0.049788133	0.358433744	0.430170523	0.361132406	
	0.16996429	0.091513266	0.052297487	0.037267927	0.006358564	0
	0.01556828	0.016922984	0.015048851	0	0.006532924	
	0.006501552	0	0	0	0.000575248	0
	0	0	0	0	0	
1	0	0.099297931	0.313276906	0.404824384	0.318775666	
	0.21442343	0.120233411	0.07079201	0.034672021	0.042728627	
	0.002009867	0.012245331	0.003551656	0.009166747	0.003977015	
	0.00808277	0.003958027	0.005994639	0.000105782	0.001513503	
	0.000105782	0	0	0.000105782	0	0
	0					
1	0.00493241	0.109960059	0.242341369	0.344948703	0.18515098	
	0.128097028	0.109022188	0.07705002	0.058290808	0.023876194	
	0.025259617	0.009434441	0.003756752	0.011310497	0.002822915	
	0.003197127	0.003518369	0.004765096	0.001177889	0	0
	0	0	0	0.001499131	0	0
1	0	0.106692296	0.462891223	0.153264215	0.144225902	
	0.123064161	0.078114192	0.102312786	0.030107449	0.047801647	
	0.014684173	0.016803794	0.005019413	0.003399759	0.002195601	
	0.006350848	0.004855703	0.003975375	0.001124349	0.002722653	0
	0.001756481	0	0	0	0	0
1	0	0.12886873	0.488723752	0.330434722	0.096066931	
	0.085846721	0.072699959	0.039112856	0.058953755	0.020059822	
	0.012297402	0.018004926	0.011984588	0.003981553	0.002796106	0
	0.002424763	0.005117608	0.00599441	0.001124349	0	0
	0	0	0	0	0	
1	0	0.158670978	0.293300367	0.415342056	0.247676214	
	0.090760139	0.069480734	0.092220308	0.027101621	0.061098385	
	0.036947864	0.038026107	0.012013594	0.007304685	0.001917494	0
	0	0.001150496	0.00143812	0.002693207	0.002405583	0
	0	0	0.001150496	0	0	
UK-CBT-early						
1988 2002						
1 1 0 1						
3 11						
5.50	660.36	337.83	439.11	199.29	63.46	62.34
	58.95	13.18	21.70	13.33	27.52	6.95
5.89	334.92	420.18	206.01	239.87	86.59	36.69
	36.30	34.02	21.23	13.23	14.64	8.91
5.48	330.59	249.78	187.83	120.79	118.15	45.22
	34.04	22.00	18.96	10.14	16.62	8.71
3.87	169.69	178.00	138.03	89.94	39.06	50.15
	27.73	13.14	9.08	16.74	3.98	7.26

3.33	569.33	159.31	112.20	42.39	44.18	21.30
	30.70	7.94	5.60	5.48	5.88	5.21
4.11	276.52	436.07	135.24	82.61	58.75	29.82
	23.11	22.81	11.35	3.31	8.58	5.80
6.81	347.00	282.99	271.57	54.29	49.16	24.17
	27.27	20.69	23.17	11.03	8.54	4.49
6.93	139.39	287.26	193.06	187.53	57.49	45.54
	26.86	14.72	8.08	17.93	7.45	5.17
7.59	146.04	118.70	100.89	81.14	87.63	23.24
	21.23	16.83	12.69	13.77	12.60	5.11
7.37	300.18	244.82	114.67	60.06	66.02	58.33
	14.54	6.74	13.71	5.51	6.41	4.75
7.30	188.05	166.31	103.86	61.72	44.52	23.65
	35.65	9.80	9.76	8.10	8.57	3.78
7.03	264.75	137.13	101.88	64.10	27.00	25.49
	13.29	26.52	5.87	9.91	2.81	2.98
8.15	194.23	235.47	112.00	69.45	33.41	16.90
	19.70	14.88	26.19	2.84	4.35	1.86
9.62	400.24	142.06	135.26	69.22	46.01	25.81
	13.47	11.17	10.68	12.43	4.64	3.50
9.44	280.20	169.83	62.21	62.54	27.88	19.67
	8.64	3.97	4.69	2.63	4.92	2.28
UK-WEC-BTS						
1988 2013						
1 1 0.75 0.8						
1 9						
128.20	2.00	39.00	129.00	52.00	75.00	22.00
	0.00	12.00	3.00			
165.70	5.00	56.00	120.00	107.00	34.00	40.00
	17.00	5.00	7.00			
175.70	23.00	52.00	76.00	31.00	24.00	7.00
	15.00	3.00	6.00			
171.70	11.00	231.00	79.00	51.00	23.00	21.00
	5.00	17.00	4.00			
196.60	5.00	140.00	316.00	44.00	36.00	12.00
	7.00	5.00	11.00			
189.20	5.00	54.00	115.00	105.00	14.00	10.00
	9.00	3.00	3.00			
205.90	6.00	47.00	106.00	62.00	44.00	5.00
	5.00	2.00	3.00			
187.20	14.00	37.00	44.00	42.00	26.00	31.00
	4.00	5.00	5.00			
184.40	28.00	112.00	67.00	25.00	32.00	20.00
	17.00	3.00	2.00			
184.70	11.00	130.00	126.00	43.00	14.00	16.00
	13.00	14.00	5.00			
185.50	11.00	141.00	114.00	76.00	22.00	10.00
	14.00	6.00	8.00			
187.90	11.00	97.00	128.00	47.00	23.00	8.00
	4.00	4.00	4.00			
180.40	12.00	136.00	70.00	52.00	23.00	16.00
	5.00	3.00	5.00			

178.00	9.00	197.00	162.00	52.00	31.00	12.00
	12.00	4.00	1.00			
180.00	6.00	37.00	113.00	48.00	27.00	6.00
	3.00	2.00	0.00			
170.70	23.00	124.00	78.00	56.00	28.00	6.00
	1.00	1.00	2.00			
164.90	16.00	110.00	120.00	24.00	15.00	10.00
	16.00	9.00	4.00			
186.60	8.00	110.00	39.00	53.00	12.00	12.00
	6.00	2.00	4.00			
184.70	5.00	120.00	95.00	26.00	37.00	10.00
	7.00	9.00	0.00			
181.00	7.00	188.00	135.00	50.00	11.00	23.00
	3.00	3.00	1.00			
174.70	10.00	85.00	158.00	77.00	40.00	2.00
	14.00	3.00	6.00			
172.00	11.00	104.00	126.00	96.00	49.00	13.00
	13.00	12.00	1.00			
179.90	20.00	175.00	154.00	84.00	59.00	31.00
	20.00	7.00	12.00			
176.20	9.00	156.00	231.00	62.00	39.00	25.00
	24.00	8.00	2.00			
179.70	3.00	47.00	162.00	125.00	40.00	27.00
	13.00	3.00	6.00			
181.60	4.00	36.00	100.00	106.00	80.00	21.00
	9.00	6.00	3.00			

Table 31.7. Sole in Division 7.e. Detailed XSA survivor diagnostics.

FLR XSA Diagnostics 2019-05-10 11:00:52

CPUE data from indices

Catch data for 50 years 1969 to 2018. Ages 2 to 12.

	fleet	first age	last age	first year	last year	alpha	beta
1	UK-CBT-late	3	11	2003	2018	<NA>	<NA>
2	UK-COT	3	11	1988	2015	<NA>	<NA>
3	Q1SWBeam-nonoffset	2	11	2006	2018	<NA>	<NA>
4	FSP-UK	2	11	2004	2018	<NA>	<NA>

Time series weights :

Tapered time weighting applied
Power = 3 over 15 years

Catchability analysis :

Catchability independent of size for all ages

Catchability independent of age for ages > 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 0.5

Minimum standard error for population
estimates derived from each fleet = 0.4

prior weighting not applied

Regression weights

age \ year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
all	0.482	0.61	0.725	0.82	0.893	0.944	0.976	0.993	0.999	1

Fishing mortalities

age \ year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2	0.045	0.014	0.026	0.009	0.039	0.067	0.044	0.017	0.032	0.017
3	0.165	0.113	0.124	0.076	0.112	0.126	0.136	0.124	0.281	0.141
4	0.183	0.156	0.201	0.167	0.204	0.208	0.203	0.261	0.124	0.132
5	0.229	0.211	0.213	0.231	0.258	0.249	0.204	0.191	0.243	0.127
6	0.261	0.191	0.203	0.261	0.225	0.254	0.212	0.205	0.265	0.408
7	0.191	0.232	0.196	0.283	0.221	0.183	0.175	0.277	0.140	0.210
8	0.209	0.190	0.200	0.236	0.260	0.155	0.164	0.216	0.148	0.370
9	0.204	0.281	0.204	0.231	0.235	0.194	0.139	0.121	0.060	0.204
10	0.197	0.147	0.191	0.329	0.231	0.203	0.144	0.111	0.080	0.145
11	0.158	0.176	0.276	0.302	0.252	0.176	0.131	0.135	0.408	0.836
12	0.158	0.176	0.276	0.302	0.252	0.176	0.131	0.135	0.408	0.836

XSA population number (Thousand)

year \ age	2	3	4	5	6	7	8	9	10	11	12
2009	3943	3738	2418	1713	926	398	414	213	294	253	467
2010	5038	3410	2868	1822	1233	645	298	304	157	218	507
2011	3725	4493	2754	2220	1336	922	463	223	208	122	404
2012	3597	3283	3591	2039	1624	987	685	343	164	155	500
2013	3260	3225	2755	2749	1464	1132	673	490	246	107	518

2014	3215	2836	2610	2033	1921	1058	821	469	350	177	633
2015	4354	2721	2262	1919	1435	1349	797	636	350	259	705
2016	5735	3771	2149	1671	1416	1050	1024	612	501	274	889
2017	4061	5102	3013	1499	1249	1044	720	747	491	406	243
2018	5018	3557	3487	2409	1064	867	821	562	637	410	284

Estimated population abundance at 1st Jan 2019

age

year	2	3	4	5	6	7	8	9	10	11	12
2019	0	4464	2794	2765	1920	640	636	513	415	498	161

Fleet: UK-CBT-late

Log catchability residuals.

year

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
3	-0.264	-0.472	0.592	0.771	0.893	0.542	0.218	-0.608	0.123	-0.335	-0.648
4	-0.554	-1.197	0.239	0.313	0.295	0.251	0.046	-0.182	-0.422	-0.092	0.063
5	-0.766	-1.347	-0.025	0.365	0.172	-0.035	0.156	0.088	-0.051	-0.369	0.188
6	-1.646	-0.949	0.114	-0.050	-0.006	0.122	0.186	-0.040	-0.044	-0.162	-0.030
7	-1.262	-1.919	0.161	0.234	0.040	0.078	-0.195	0.005	-0.028	-0.060	-0.095
8	-1.351	-1.129	-0.604	0.368	0.098	0.292	-0.156	0.036	-0.169	-0.040	0.189
9	-0.667	-1.350	0.143	0.100	0.047	-0.006	-0.237	-0.053	-0.247	-0.125	0.002
10	-1.174	-1.029	0.192	0.156	-0.359	0.048	-0.369	-0.464	0.065	0.118	0.099
11	-1.280	-1.157	0.360	0.100	-0.003	-0.002	-0.458	-0.071	0.008	-0.021	0.116

year

age	2014	2015	2016	2017	2018
3	-0.200	-0.009	0.219	0.446	0.065
4	-0.067	-0.106	0.078	0.071	0.242
5	-0.046	0.090	-0.095	0.059	-0.025
6	0.117	-0.064	0.029	-0.037	0.052
7	0.025	-0.121	0.098	-0.039	0.225
8	-0.127	-0.179	-0.057	-0.050	-0.079
9	0.019	-0.323	-0.321	-0.243	-0.176
10	-0.043	-0.092	-0.207	-0.360	-0.372
11	-0.025	-0.231	-0.345	-0.424	0.005

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	3	4	5	6	7	8	9	10	11
Mean_Logq	-5.0907	-4.5145	-4.4365	-4.3698	-4.4145	-4.4145	-4.4145	-4.4145	-4.4145
S.E_Logq	0.4482	0.4482	0.4482	0.4482	0.4482	0.4482	0.4482	0.4482	0.4482

Fleet: UK-COT

Log catchability residuals.

year

age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	1.008	0.647	0.919	0.645	0.610	0.568	0.801	0.244	0.684	1.012	0.672
4	0.651	0.467	0.464	0.010	-0.033	0.203	0.457	0.539	0.525	0.333	0.337
5	0.584	0.464	0.349	-0.213	-0.372	0.317	0.244	0.234	0.353	0.393	0.064
6	0.455	0.412	0.572	-0.459	-1.241	-0.005	-0.018	-0.143	0.117	0.084	0.256
7	-0.144	0.374	0.284	-0.624	-0.778	0.006	0.294	0.218	-0.008	0.422	0.104
8	0.047	0.105	0.096	-0.580	-0.996	-0.265	-0.298	0.146	0.183	-0.174	-0.195
9	-0.335	0.348	0.312	-0.941	-1.099	0.211	0.219	-0.299	0.115	-0.015	-0.295
10	-1.061	0.059	0.129	-0.655	-1.528	-0.372	0.804	-0.399	-0.040	-0.721	-0.244
11	-0.170	0.623	-0.236	-0.911	-1.883	0.069	0.285	-0.137	0.010	-0.314	0.151

year

age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	0.771	0.346	0.706	0.397	0.126	0.044	1.029	0.725	0.804	0.468	0.645
4	0.227	0.306	-0.044	-0.385	-0.103	-0.590	0.708	0.294	0.299	0.134	0.211
5	0.316	0.109	0.150	-0.404	-0.271	-0.761	0.330	0.298	0.204	-0.194	0.151

6	0.080	-0.036	0.069	0.070	-0.895	-0.345	0.454	-0.199	0.040	-0.028	0.107
7	0.379	-0.373	0.212	-0.015	-0.496	-1.319	0.539	0.090	0.125	0.051	-0.199
8	0.618	-0.195	-0.170	-0.120	-0.558	-0.591	-0.189	0.308	0.217	0.247	0.030
9	-0.015	0.472	0.364	-0.883	-0.048	-0.762	0.579	0.025	0.132	0.017	-0.060
10	0.132	0.088	0.554	-0.309	-0.544	-0.439	0.559	0.009	-0.207	0.088	-0.100
11	0.468	0.020	0.288	0.482	-0.267	-0.517	0.932	-0.074	-0.068	0.169	-0.114

year						
age	2010	2011	2012	2013	2014	2015
3	-0.547	0.195	-0.013	-0.459	-0.168	-0.009
4	-0.086	-0.454	0.211	0.059	-0.031	-0.092
5	0.090	-0.168	-0.122	0.208	-0.033	-0.083
6	-0.021	-0.206	0.058	-0.013	0.117	-0.029
7	0.092	-0.139	0.103	-0.077	0.103	-0.044
8	0.146	-0.487	0.178	0.306	0.010	-0.180
9	0.078	-0.381	0.105	0.097	0.228	-0.303
10	-0.226	-0.141	0.371	0.320	0.245	0.123
11	0.149	-0.238	0.351	0.395	0.222	-0.100

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	3	4	5	6	7	8	9	10
Mean_Logq	-14.1872	-13.6861	-13.5925	-13.5089	-13.6137	-13.6137	-13.6137	-13.6137
S.E_Logq	0.4363	0.4363	0.4363	0.4363	0.4363	0.4363	0.4363	0.4363

	11
Mean_Logq	-13.6137
S.E_Logq	0.4363

Fleet: Q1SWBeam-nonoffset

Log catchability residuals.

year											
age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2	0.566	0.580	0.460	-0.692	0.891	0.758	-0.989	-0.408	-0.046	-0.388	0.368
3	-0.122	0.511	0.296	0.083	0.242	-0.088	0.157	-0.439	0.397	-0.441	0.277
4	-0.199	-0.100	0.294	-0.043	0.189	0.093	-0.058	0.087	0.418	-0.299	-0.174
5	0.337	-1.308	0.073	0.163	0.315	0.138	-0.361	0.018	-0.161	0.094	0.097
6	0.520	-0.162	0.583	-0.151	0.101	-0.180	-0.300	0.211	0.213	0.115	-0.059
7	0.193	-0.704	-0.573	-0.382	0.677	-0.758	0.223	0.112	0.284	-0.015	-0.007
8	0.408	-0.683	1.180	-0.302	-0.299	0.499	-0.083	0.305	1.164	-0.003	0.298
9	0.405	0.389	0.943	-0.318	-0.372	0.068	0.211	0.527	0.529	0.220	-0.951
10	0.645	0.964	0.550	0.441	0.323	-1.848	-2.427	1.043	-0.210	-0.023	-0.652
11	1.794	1.417	0.534	0.805	-0.387	0.539	0.239	0.021	0.833	0.387	0.646

year		
age	2017	2018
2	-0.186	0.304
3	-0.391	0.108
4	-0.200	0.022
5	-0.044	0.143
6	-0.187	-0.095
7	-0.225	0.350
8	-0.982	-0.096
9	-1.067	0.185
10	-0.674	-0.088
11	-0.889	-0.897

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9	10
Mean_Logq	-6.3448	-5.0782	-4.7932	-4.8029	-4.7550	-4.6117	-4.6117	-4.6117	-4.6117
S.E_Logq	0.5783	0.5783	0.5783	0.5783	0.5783	0.5783	0.5783	0.5783	0.5783

	11
Mean_Logq	-4.6117
S.E_Logq	0.5783

Fleet: FSP-UK

Log catchability residuals.

age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	0.885	0.089	0.378	0.229	0.756	-0.067	-0.016	-0.057	-0.635	-0.441	0.283
3	0.368	-0.028	0.115	0.290	-0.017	-0.177	-0.543	0.025	0.088	0.111	0.115
4	0.401	-0.124	0.061	-0.041	0.054	0.192	-0.234	-1.062	-0.028	0.401	0.397
5	0.315	-0.166	0.287	-0.127	0.634	-0.054	-0.012	-0.119	-0.166	0.301	0.471
6	-0.138	0.357	0.316	0.079	-0.148	-0.267	0.135	-0.256	-0.170	0.277	0.259
7	0.137	0.637	0.670	0.498	-0.136	0.304	-0.261	-0.286	-0.712	0.111	0.423
8	1.080	0.043	0.956	0.179	-0.418	-0.077	-0.049	-2.013	-0.100	0.099	0.127
9	0.634	0.427	0.124	1.072	0.661	-0.025	0.255	-0.224	0.113	0.060	0.000
10	0.418	0.115	0.768	0.178	0.261	-0.190	0.383	-0.748	-1.268	-1.023	0.509
11	0.645	0.812	0.759	1.184	-1.631	0.904	0.365	0.227	-0.514	0.002	-1.884

age	2015	2016	2017	2018
2	0.065	-0.260	0.285	0.271
3	-0.093	0.219	0.085	-0.166
4	0.377	-0.342	-0.010	0.078
5	-0.047	-0.168	-0.428	-0.039
6	0.005	-0.027	-0.218	0.102
7	0.077	0.067	-0.098	0.093
8	0.247	0.318	-0.341	0.547
9	0.176	-0.459	-0.031	-0.419
10	-0.115	0.196	-0.674	0.226
11	0.234	-0.363	-0.735	0.665

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9	10	11
Mean_Logq	-10.5476	-9.0621	-8.9453	-8.9788	-9.1030	-9.3004	-9.3004	-9.3004	-9.3004	-9.3004
S.E_Logq	0.4863	0.4863	0.4863	0.4863	0.4863	0.4863	0.4863	0.4863	0.4863	0.4863

Terminal year survivor and F summaries:

,Age 2 Year class =2016

source

	scaledWts	survivors	yrcls
Q1SWBeam-nonoffset	0.209	6053	2016
FSP-UK	0.479	5852	2016
fshk	0.312	2401	2016

,Age 3 Year class =2015

source

	scaledWts	survivors	yrcls
UK-CBT-late	0.238	2983	2015
Q1SWBeam-nonoffset	0.278	3113	2015
FSP-UK	0.278	2367	2015
fshk	0.205	2145	2015

,Age 4 Year class =2014

source

	scaledWts	survivors	yrcls
UK-CBT-late	0.281	3521	2014
Q1SWBeam-nonoffset	0.281	2827	2014
FSP-UK	0.233	2989	2014

fshk 0.205 1801 2014

,Age 5 Year class =2013

source

	scaledWts	survivors	yrcls
UK-CBT-late	0.268	1872	2013
Q1SWBeam-nonoffset	0.268	2216	2013
FSP-UK	0.268	1846	2013
fshk	0.195	1092	2013

,Age 6 Year class =2012

source

	scaledWts	survivors	yrcls
UK-CBT-late	0.252	675	2012
Q1SWBeam-nonoffset	0.252	582	2012
FSP-UK	0.252	709	2012
fshk	0.243	1261	2012

,Age 7 Year class =2011

source

	scaledWts	survivors	yrcls
UK-CBT-late	0.271	796	2011
Q1SWBeam-nonoffset	0.245	902	2011
FSP-UK	0.271	698	2011
fshk	0.214	681	2011

,Age 8 Year class =2010

source

	scaledWts	survivors	yrcls
UK-CBT-late	0.385	474	2010
Q1SWBeam-nonoffset	0.136	466	2010
FSP-UK	0.122	887	2010
fshk	0.357	1194	2010

,Age 9 Year class =2009

source

	scaledWts	survivors	yrcls
UK-CBT-late	0.317	348	2009
Q1SWBeam-nonoffset	0.117	499	2009
FSP-UK	0.317	273	2009
fshk	0.249	832	2009

,Age 10 Year class =2008

source

	scaledWts	survivors	yrcls
UK-CBT-late	0.458	343	2008
Q1SWBeam-nonoffset	0.055	456	2008
FSP-UK	0.147	625	2008
fshk	0.339	658	2008

,Age 11 Year class =2007

source

	scaledWts	survivors	yrcls
UK-CBT-late	0.345	161	2007
Q1SWBeam-nonoffset	0.092	66	2007
FSP-UK	0.054	313	2007
fshk	0.509	683	2007

Table 31.8. Sole in Division 7.e. Estimated stock numbers-at-age (thousands).

year\age	2	3	4	5	6	7	8	9	10	11	12+	total
1969	1874	2380	625	966	1513	159	507	572	262	90	636	9585
1970	1343	1611	1848	490	732	1170	124	412	494	218	1123	9564
1971	3826	1164	1237	1365	358	584	952	100	340	397	821	11144
1972	2568	3414	863	885	1047	262	452	713	81	274	542	11102
1973	2264	2185	2698	621	691	840	224	386	518	37	1222	11687
1974	3107	1981	1600	2029	478	532	646	187	300	440	850	12150
1975	2967	2769	1461	1238	1667	365	406	544	138	248	1756	13559
1976	2792	2607	1966	1160	931	1399	304	317	468	105	1598	13645
1977	6557	2367	1960	1330	897	714	1178	230	231	375	1866	17703
1978	4658	5527	1839	1408	1007	714	580	995	199	186	1385	18498
1979	4389	3976	3933	1334	1070	732	548	456	827	144	1493	18902
1980	4703	3755	2834	2787	970	751	497	397	327	650	1702	19374
1981	8131	4089	2866	2092	1923	758	506	316	298	243	934	22156
1982	4680	7124	2933	1974	1448	1370	516	337	214	214	1035	21846
1983	3867	4113	5066	1782	1260	976	1011	337	198	117	828	19557
1984	5969	3413	3006	3088	1058	806	629	635	192	110	982	19888
1985	6984	5084	2457	1934	2073	649	535	446	430	123	532	21247
1986	3766	6046	2982	1504	1304	1320	417	392	306	309	529	18876
1987	5850	3174	3932	1775	961	874	874	298	283	191	755	18967
1988	3881	4830	2103	2520	1200	676	578	573	224	208	713	17507
1989	3738	3091	3002	1336	1588	730	466	369	415	166	744	15645
1990	2820	3012	1968	1544	736	953	446	317	233	268	740	13037
1991	7176	2227	1867	1227	871	434	611	268	189	139	657	15667
1992	3910	6065	1621	1230	836	579	305	447	178	136	529	15836
1993	3356	3238	4124	1070	831	647	417	218	335	136	345	14716
1994	2386	2837	2261	2678	635	543	442	303	140	250	489	12963
1995	3469	2066	1943	1515	1893	468	391	353	219	85	649	13049
1996	3966	3048	1576	1159	964	1321	299	258	261	167	653	13674

year\age	2	3	4	5	6	7	8	9	10	11	12+	total
1997	3374	3242	2335	1080	766	649	951	206	175	190	415	13382
1998	4450	2847	2142	1424	668	522	403	696	145	139	654	14091
1999	3616	3774	2000	1428	969	405	328	288	509	98	484	13900
2000	6647	3005	2545	1334	914	634	258	200	209	358	372	16477
2001	5476	5722	2150	1589	858	609	472	183	116	141	529	17845
2002	3864	4817	3845	1440	965	522	382	331	113	64	297	16641
2003	5456	3180	3169	2678	935	567	350	245	210	72	317	17179
2004	2896	4368	2083	1960	1809	722	442	269	167	130	314	15161
2005	4068	2242	2925	1459	1351	1137	497	289	186	100	394	14647
2006	4698	3436	1583	1853	893	874	750	342	186	126	351	15091
2007	4039	3775	2361	983	1100	569	578	503	228	115	426	14680
2008	4426	3464	2606	1418	611	651	345	400	351	154	348	14773
2009	3943	3738	2418	1713	926	398	414	213	294	253	467	14778
2010	5038	3410	2868	1822	1233	645	298	304	157	218	507	16500
2011	3725	4493	2754	2220	1336	922	463	223	208	122	404	16870
2012	3597	3283	3591	2039	1624	987	685	343	164	155	500	16968
2013	3260	3225	2755	2749	1464	1132	673	490	246	107	518	16620
2014	3215	2836	2610	2033	1921	1058	821	469	350	177	633	16124
2015	4354	2721	2262	1919	1435	1349	797	636	350	259	705	16786
2016	5735	3771	2149	1671	1416	1050	1024	612	501	274	889	19093
2017	4061	5102	3013	1499	1249	1044	720	747	491	406	243	18575
2018	5018	3557	3487	2409	1064	867	821	562	637	410	284	19115

Table 31.9. Sole in Division 7.e. Estimated fishing mortality-at-age.

year\age	2	3	4	5	6	7	8	9	10	11	12+	Fbar(3–9)
1969	0.051	0.153	0.144	0.176	0.157	0.151	0.108	0.048	0.084	0.11	0.11	0.134
1970	0.043	0.164	0.202	0.213	0.126	0.106	0.115	0.093	0.118	0.112	0.112	0.146
1971	0.014	0.2	0.234	0.165	0.212	0.155	0.188	0.109	0.113	0.156	0.156	0.181
1972	0.062	0.136	0.228	0.147	0.12	0.059	0.059	0.219	0.69	0.23	0.23	0.138
1973	0.034	0.212	0.185	0.163	0.163	0.162	0.081	0.151	0.063	0.124	0.124	0.16
1974	0.015	0.205	0.156	0.097	0.17	0.171	0.072	0.199	0.089	0.14	0.14	0.153
1975	0.029	0.243	0.13	0.185	0.075	0.083	0.147	0.051	0.181	0.108	0.108	0.131
1976	0.065	0.185	0.291	0.158	0.166	0.072	0.176	0.216	0.122	0.151	0.151	0.18
1977	0.071	0.152	0.23	0.178	0.128	0.108	0.069	0.048	0.114	0.093	0.093	0.13
1978	0.058	0.24	0.221	0.174	0.22	0.165	0.14	0.085	0.226	0.167	0.167	0.178
1979	0.056	0.239	0.244	0.219	0.254	0.287	0.221	0.232	0.142	0.228	0.228	0.242
1980	0.04	0.17	0.204	0.271	0.147	0.295	0.352	0.188	0.198	0.236	0.236	0.232
1981	0.032	0.232	0.273	0.268	0.239	0.285	0.305	0.289	0.229	0.27	0.27	0.27
1982	0.029	0.241	0.398	0.349	0.295	0.203	0.325	0.433	0.503	0.353	0.353	0.321
1983	0.025	0.214	0.395	0.421	0.347	0.34	0.365	0.461	0.489	0.402	0.402	0.363
1984	0.06	0.229	0.341	0.298	0.389	0.309	0.244	0.29	0.35	0.317	0.317	0.3
1985	0.044	0.433	0.391	0.294	0.352	0.342	0.212	0.277	0.232	0.284	0.284	0.329
1986	0.071	0.33	0.419	0.348	0.3	0.312	0.238	0.226	0.37	0.29	0.29	0.31
1987	0.092	0.312	0.345	0.292	0.252	0.313	0.322	0.182	0.205	0.256	0.256	0.288
1988	0.128	0.375	0.354	0.362	0.397	0.272	0.348	0.223	0.201	0.289	0.289	0.333
1989	0.116	0.352	0.565	0.496	0.411	0.392	0.285	0.363	0.337	0.359	0.359	0.409
1990	0.136	0.378	0.372	0.472	0.428	0.345	0.41	0.416	0.413	0.404	0.404	0.403
1991	0.068	0.218	0.317	0.284	0.308	0.255	0.211	0.311	0.23	0.264	0.264	0.272
1992	0.089	0.286	0.315	0.293	0.156	0.228	0.236	0.19	0.166	0.196	0.196	0.244
1993	0.068	0.259	0.332	0.422	0.325	0.282	0.22	0.34	0.193	0.273	0.273	0.311
1994	0.044	0.279	0.301	0.247	0.205	0.229	0.125	0.222	0.403	0.238	0.238	0.23
1995	0.029	0.171	0.416	0.352	0.259	0.348	0.316	0.201	0.17	0.259	0.259	0.295
1996	0.102	0.167	0.278	0.315	0.296	0.229	0.273	0.286	0.22	0.261	0.261	0.263

year\age	2	3	4	5	6	7	8	9	10	11	12+	Fbar(3–9)
1997	0.07	0.314	0.394	0.381	0.284	0.378	0.212	0.252	0.131	0.252	0.252	0.316
1998	0.065	0.253	0.305	0.285	0.399	0.363	0.234	0.213	0.292	0.301	0.301	0.293
1999	0.085	0.294	0.305	0.347	0.324	0.352	0.398	0.22	0.251	0.31	0.31	0.32
2000	0.05	0.235	0.371	0.341	0.306	0.196	0.242	0.441	0.295	0.297	0.297	0.305
2001	0.028	0.298	0.301	0.399	0.397	0.366	0.254	0.38	0.492	0.379	0.379	0.342
2002	0.095	0.319	0.262	0.332	0.432	0.3	0.342	0.353	0.36	0.359	0.359	0.334
2003	0.122	0.323	0.38	0.292	0.159	0.149	0.162	0.285	0.379	0.227	0.227	0.25
2004	0.156	0.301	0.256	0.272	0.365	0.273	0.323	0.27	0.418	0.334	0.334	0.295
2005	0.069	0.248	0.357	0.391	0.335	0.316	0.274	0.343	0.292	0.296	0.296	0.323
2006	0.119	0.275	0.376	0.421	0.35	0.313	0.3	0.303	0.378	0.301	0.301	0.334
2007	0.054	0.271	0.41	0.375	0.425	0.401	0.269	0.261	0.295	0.278	0.278	0.344
2008	0.069	0.259	0.319	0.326	0.328	0.352	0.385	0.208	0.226	0.313	0.313	0.311
2009	0.045	0.165	0.183	0.229	0.261	0.191	0.209	0.204	0.197	0.158	0.158	0.206
2010	0.014	0.113	0.156	0.211	0.191	0.232	0.19	0.281	0.147	0.176	0.176	0.196
2011	0.026	0.124	0.201	0.213	0.203	0.196	0.2	0.204	0.191	0.276	0.276	0.192
2012	0.009	0.076	0.167	0.231	0.261	0.283	0.236	0.231	0.329	0.302	0.302	0.212
2013	0.039	0.112	0.204	0.258	0.225	0.221	0.26	0.235	0.231	0.252	0.252	0.216
2014	0.067	0.126	0.208	0.249	0.254	0.183	0.155	0.194	0.203	0.176	0.176	0.196
2015	0.044	0.136	0.203	0.204	0.212	0.175	0.164	0.139	0.144	0.131	0.131	0.176
2016	0.017	0.124	0.261	0.191	0.205	0.277	0.216	0.121	0.111	0.135	0.135	0.199
2017	0.032	0.281	0.124	0.243	0.265	0.14	0.148	0.06	0.08	0.408	0.408	0.18
2018	0.017	0.141	0.132	0.127	0.408	0.21	0.37	0.204	0.145	0.836	0.836	0.227

Table 31.10. Sole in Division 7.e. Assessment summary.

Year	Recruitment Age 2 [thousands]	TSB [tonnes]	SSB [tonnes]	Landings [tonnes]	Yield/SSB	Fbar (Ages 3–9)
1969	1874	2927	2437	353	0.14	0.134
1970	1343	3023	2652	391	0.15	0.146
1971	3826	2838	2390	432	0.18	0.181
1972	2568	3091	2395	437	0.18	0.138
1973	2264	3266	2778	459	0.17	0.16
1974	3107	3512	2896	427	0.15	0.153
1975	2967	4429	3670	491	0.13	0.131
1976	2792	4102	3403	616	0.18	0.18
1977	6557	5340	4098	606	0.15	0.13
1978	4658	5429	4074	861	0.21	0.178
1979	4389	6015	4865	1181	0.24	0.242
1980	4703	6387	5338	1269	0.24	0.232
1981	8131	5957	4572	1215	0.27	0.27
1982	4680	5917	4575	1446	0.32	0.321
1983	3867	5378	4374	1498	0.34	0.363
1984	5969	5463	4431	1370	0.31	0.3
1985	6984	5569	4010	1409	0.35	0.329
1986	3766	5259	4015	1419	0.35	0.31
1987	5850	5312	4113	1280	0.31	0.288
1988	3881	5123	4045	1444	0.36	0.333
1989	3738	4321	3445	1390	0.4	0.409
1990	2820	4227	3290	1315	0.4	0.403
1991	7176	4226	2996	852	0.28	0.272
1992	3910	4109	2943	895	0.3	0.244
1993	3356	3588	2818	904	0.32	0.311
1994	2386	3798	3064	800	0.26	0.23
1995	3469	3892	3081	856	0.28	0.295
1996	3966	4176	3071	833	0.27	0.263

Year	Recruitment Age 2 [thousands]	TSB [tonnes]	SSB [tonnes]	Landings [tonnes]	Yield/SSB	Fbar (Ages 3–9)
1997	3374	3861	2941	949	0.32	0.316
1998	4450	3983	2939	880	0.3	0.293
1999	3616	3997	2868	957	0.33	0.32
2000	6647	4375	2916	914	0.31	0.305
2001	5476	4594	2958	1069	0.36	0.342
2002	3864	4280	3091	1106	0.36	0.334
2003	5456	4520	3392	1078	0.32	0.25
2004	2896	4146	3211	1075	0.33	0.295
2005	4068	4121	3231	1039	0.32	0.323
2006	4698	3852	2863	1023	0.36	0.334
2007	4039	3975	2922	1015	0.35	0.344
2008	4426	4000	2832	908	0.32	0.311
2009	3943	4205	3206	701	0.22	0.206
2010	5038	4708	3664	698	0.19	0.196
2011	3725	5048	3825	801	0.21	0.192
2012	3597	4922	4053	872	0.22	0.212
2013	3260	4816	3956	883	0.22	0.216
2014	3215	5162	4277	885	0.21	0.196
2015	4354	5272	4307	774	0.18	0.176
2016	5735	6329	4843	913	0.19	0.199
2017	4061	6018	4502	1007	0.22	0.18
2018	5018	5934	4584	1075	0.23	0.227

Table 31.11. Sole in Division 7.e. Input data for the short-term forecast.

Age	N2019	N2020	N2021	M	Mat	PF	PM	SWt	Sel	CWt
2	3973	3973	3973	0.1	0.14	0	0	0.183	0.025	0.215
3	4464	3507	3483	0.1	0.45	0	0	0.245	0.205	0.275
4	2794	3291	2444	0.1	0.88	0	0	0.304	0.194	0.333
5	2765	2083	2326	0.1	0.98	0	0	0.359	0.21	0.386
6	1920	2028	1442	0.1	1	0	0	0.411	0.329	0.437
7	640	1250	1206	0.1	1	0	0	0.46	0.235	0.484
8	636	458	838	0.1	1	0	0	0.505	0.275	0.528
9	513	437	292	0.1	1	0	0	0.548	0.144	0.568
10	415	402	329	0.1	1	0	0	0.586	0.126	0.605
11	498	331	310	0.1	1	0	0	0.622	0.517	0.639
12	272	416	349	0.1	1	0	0	0.741	0.517	0.751

Table 31.12. Sole in Division 7.e. Single option output of the short-term forecast (targeting F_{MSY}).

Age	F	Catch.No	Yield	Stock.No	Biomass	SSNo	SSB
Year = 2019, F / $F_{2016-2018}$ = 1.183, Fbar = 0.227							
2	0.025	93	20	3973	727	556	102
3	0.205	789	217	4464	1094	2009	492
4	0.194	469	156	2794	849	2459	747
5	0.21	499	193	2765	993	2709	974
6	0.329	514	224	1920	790	1920	790
7	0.235	128	62	640	295	640	295
8	0.275	146	77	636	321	636	321
9	0.144	66	37	513	281	513	281
10	0.126	47	28	415	243	415	243
11	0.517	192	123	498	310	498	310
12	0.517	105	79	272	202	272	202
Total	NA	3047	1216	18891	6104	12628	4756
Year = 2020, F / $F_{2016-2018}$ = 1.183, Fbar = 0.227							
2	0.032	118	25	3973	727	556	102
3	0.261	769	212	3507	859	1578	387
4	0.247	687	228	3291	999	2896	879
5	0.268	467	180	2083	749	2041	734
6	0.419	663	290	2028	834	2028	834
7	0.3	309	150	1250	576	1250	576
8	0.351	129	68	458	231	458	231
9	0.184	70	40	437	239	437	239
10	0.161	57	34	402	236	402	236
11	0.659	153	98	331	206	331	206
12	0.659	192	144	416	308	416	308
Total	NA	3613	1469	18176	5964	12393	4731
Year = 2021, F / $F_{2016-2018}$ = 1.183, Fbar = 0.227							
2	0.032	118	25	3973	727	556	102
3	0.261	764	210	3483	853	1568	384
4	0.247	510	170	2444	742	2151	653
5	0.268	521	201	2326	836	2280	819
6	0.419	472	206	1442	593	1442	593
7	0.3	298	144	1206	555	1206	555
8	0.351	237	125	838	424	838	424
9	0.184	47	27	292	160	292	160
10	0.161	47	28	329	193	329	193
11	0.659	143	91	310	192	310	192
12	0.659	161	121	349	259	349	259
Total	NA	3317	1349	16993	5535	11320	4334

Units are thousands (for numbers) and tonnes (for weights).

Table 31.13. Sole in Division 7.e. Year-class sources and contributions for the short-term forecast (in percent).

cohort	Yield 2019	Yield 2020	SSB 2019	SSB 2020	SSB 2021
2016	17.8	15.5	10.3	18.6	18.9
2017	1.6	14.4	2.1	8.2	15.1
2018		1.7		2.2	8.9
2019					2.3

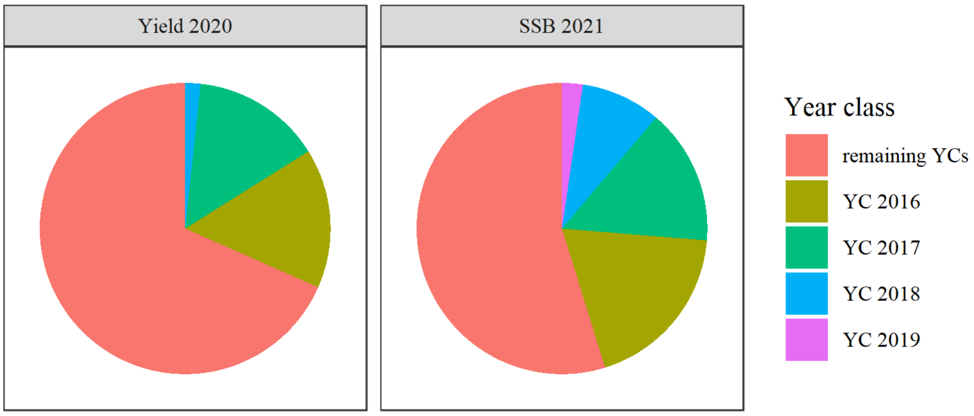


Table 31.14. Sole in Division 7.e. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch^ (2020)	Wanted catch* (2020)	Unwanted catch* (2020)	F_{wanted} (2020)	SSB (2021)	% SSB change **	% TAC change ***	% Advice change ****
ICES advice basis								
MSY approach: F_{MSY}	1478	1469	9	0.29	4334	-8.4	19.0	16.2
$F_{MSY\ lower}$	878	873	5	0.160	4915	3.9	-29	-31
$F_{MSY\ upper}$	1685	1675	10	0.34	4134	-12.6	36	32
Other options								
F = 0	0	0	0	0	5772	22	-100	-100
F_{pa}	1603	1594	10	0.32	4213	-11.0	29	26
F_{lim}	2065	2053	13	0.44	3767	-20	66	62
SSB (2021) = B_{lim}	3930	3906	24	1.20	2000	-58	216	209
SSB (2021) = B_{pa}= MSY $B_{trigger}$	2972	2954	18	0.74	2900	-39	139	134
F = F_{2018}	1201	1194	7	0.23	4602	-2.7	-3.3	-5.6
Management plan: F = 0.27 with 15% TAC constraint	1391	1383	9	0.27	4418	-6.6	12.0	9.4

*** "Wanted" and "unwanted" catch are used to describe fish that would be landed and discarded in the absence of the EU landing obligation, based on discard rate estimates for 2016–2018.**

**** SSB 2021 relative to SSB 2020 (4731 t).**

***** Total catch in 2020 relative to TAC in 2019 (1242 t).**

******Advice value 2020 relative to advice value 2019 (1272 t).**

^ Total catch derived from the wanted catch and the unwanted catches ratio.

Table 31.15. Sole in Division 7.e. Annual catch scenarios (more options and more digits provided, sorted by fishing mortality in intermediate year). All weights are in tonnes.

Basis	Total catch^ (2020)	Wanted catch* (2020)	Unwanted catch* (2020)	F_{wanted} (2020)	SSB (2021)	% SSB change **	% TAC change ***	% Advice change ****
F=0	0	0	0	0	5771.854	21.99769	-100	-100
F_{sq} * 0.6	759.8243	755.1817	4.642591	0.136488	5030.677	6.331692	-38.8225	-40.2654
$F_{MSY\ lower}$	878.4403	873.073	5.367345	0.16	4915.313	3.893278	-29.2721	-30.9402
F=0.17	927.8846	922.2151	5.669454	0.17	4867.254	2.877469	-25.2911	-27.0531
F=0.18	976.741	970.7731	5.967971	0.18	4819.783	1.874107	-21.3574	-23.2122
Fsq0.8	986.3671	980.3403	6.026787	0.181984	4810.433	1.676461	-20.5824	-22.4554
F=0.19	1025.018	1018.755	6.262948	0.19	4772.894	0.88301	-17.4704	-19.4168
TAC*0.85	1062.19	1055.7	6.490072	0.197782	4736.802	0.120146	-14.4774	-16.4945
F=0.2	1072.724	1066.17	6.554435	0.2	4726.576	-0.096	-13.6293	-15.6664
F=0.21	1119.867	1113.024	6.842481	0.21	4680.821	-1.06309	-9.8336	-11.9602
F=0.22	1166.454	1159.327	7.127135	0.22	4635.623	-2.01843	-6.08258	-8.29762
F_{sq}	1200.946	1193.608	7.337883	0.227481	4602.171	-2.7255	-3.30547	-5.586
F=0.23	1212.495	1205.086	7.408445	0.23	4590.972	-2.96219	-2.37564	-4.6781
TAC	1249.635	1242	7.635378	0.238154	4554.965	-3.72327	0.614765	-1.75822
F=0.24	1257.995	1250.309	7.686457	0.24	4546.862	-3.89455	1.287854	-1.10101
F=0.25	1302.964	1295.002	7.961219	0.25	4503.283	-4.81565	4.908507	2.43425
F=0.26	1347.408	1339.175	8.232775	0.26	4460.23	-5.72566	8.486918	5.928264
MP2	1391.334	1382.833	8.501169	0.27	4417.693	-6.62473	12.02368	9.381608
MP	1391.334	1382.833	8.501169	0.27	4417.693	-6.62473	12.02368	9.381608
F=0.27	1391.334	1382.833	8.501169	0.27	4417.693	-6.62473	12.02368	9.381608
F=0.28	1434.75	1425.984	8.766447	0.28	4375.667	-7.51303	15.51936	12.79485
TAC*1.15	1437.081	1428.3	8.780685	0.28054	4373.412	-7.56069	15.70698	12.97804
F_{MSY}	1477.664	1468.635	9.028652	0.29	4334.144	-8.39069	18.97454	16.16854
F=0.3	1520.081	1510.793	9.287825	0.3	4293.116	-9.25788	22.38978	19.50323
F=0.31	1562.009	1552.465	9.544009	0.31	4252.577	-10.1147	25.76563	22.79946
F_{pa}	1603.455	1593.658	9.797245	0.32	4212.521	-10.9614	29.10264	26.05777
F=0.32	1603.455	1593.658	9.797245	0.32	4212.521	-10.9614	29.10264	26.05777
F=0.33	1644.425	1634.377	10.04757	0.33	4172.939	-11.798	32.40133	29.27866
$F_{MSY\ upper}$	1684.925	1674.63	10.29504	0.34	4133.826	-12.6247	35.66224	32.46266
F_{lim}	2065.482	2052.862	12.62027	0.44	3767.091	-20.3763	66.3029	62.38067
B_{pa}	2972.39	2954.229	18.16156	0.735613	2900	-38.7037	139.3229	133.6785
$B_{trigger}$	2972.39	2954.229	18.16156	0.735613	2900	-38.7037	139.3229	133.6785
B_{lim}	3929.8	3905.789	24.01141	1.196931	2000	-57.7267	216.409	208.9465

*** "Wanted" and "unwanted" catch are used to describe fish that would be landed and discarded in the absence of the EU landing obligation, based on discard rate estimates for 2016–2018.**

**** SSB 2021 relative to SSB 2020.**

***** Total catch in 2020 relative to TAC in 2019 (1242 t).**

******Advice value 2020 relative to advice value 2019 (1272 t).**

^ Total catch derived from the wanted catch and the unwanted catches ratio.

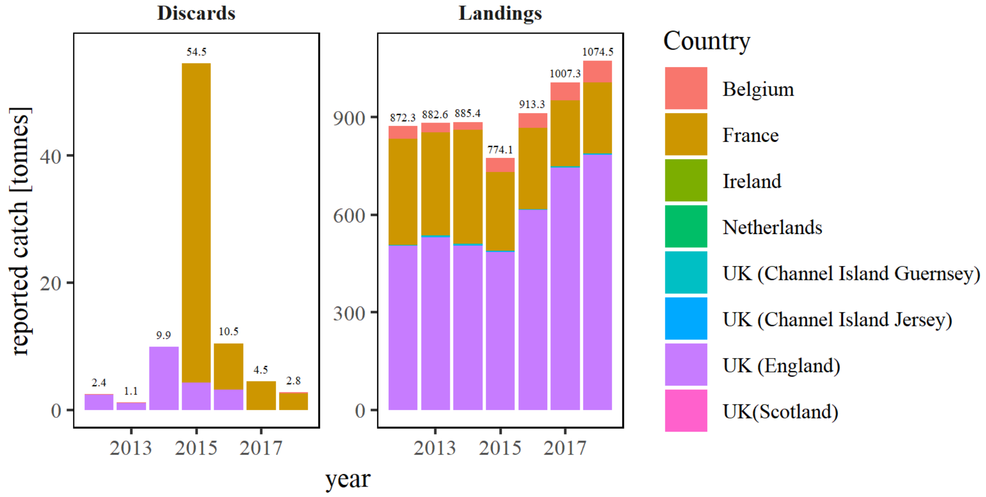


Figure 31.1. Sole in Division 7.e. Reported landings and discards by country.

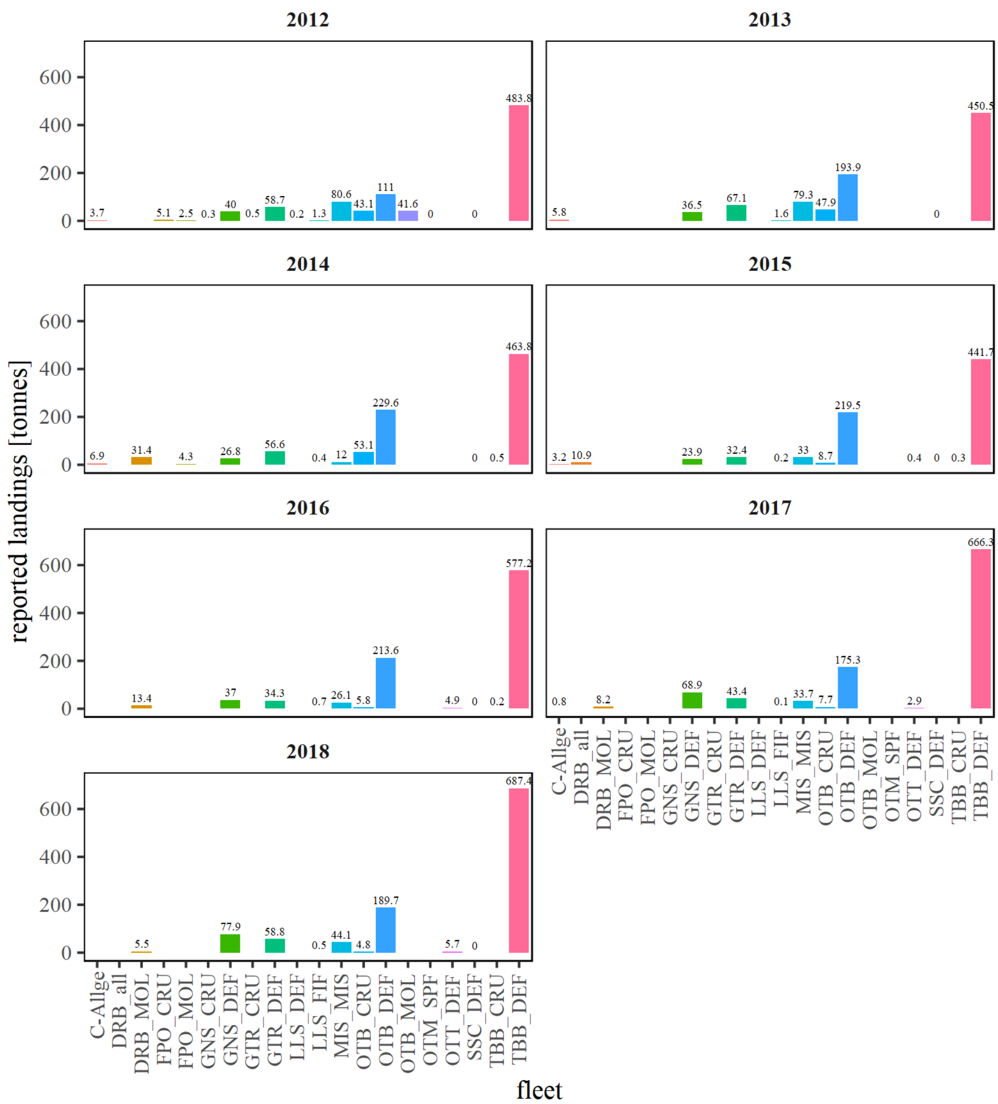


Figure 31.2. Sole in Division 7.e. International landings by fleet and year.

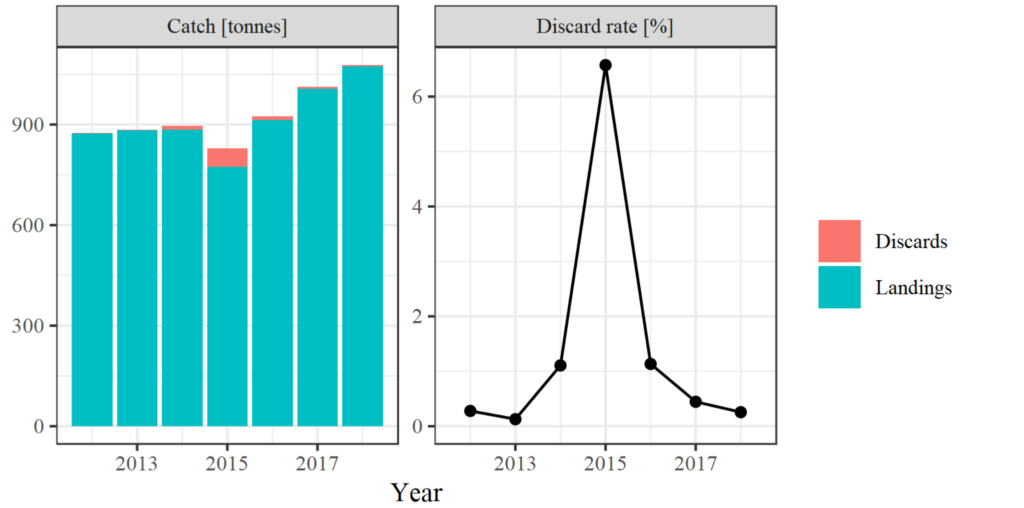


Figure 31.3. Sole in Division 7.e. Discard rates for discards reported in InterCatch.

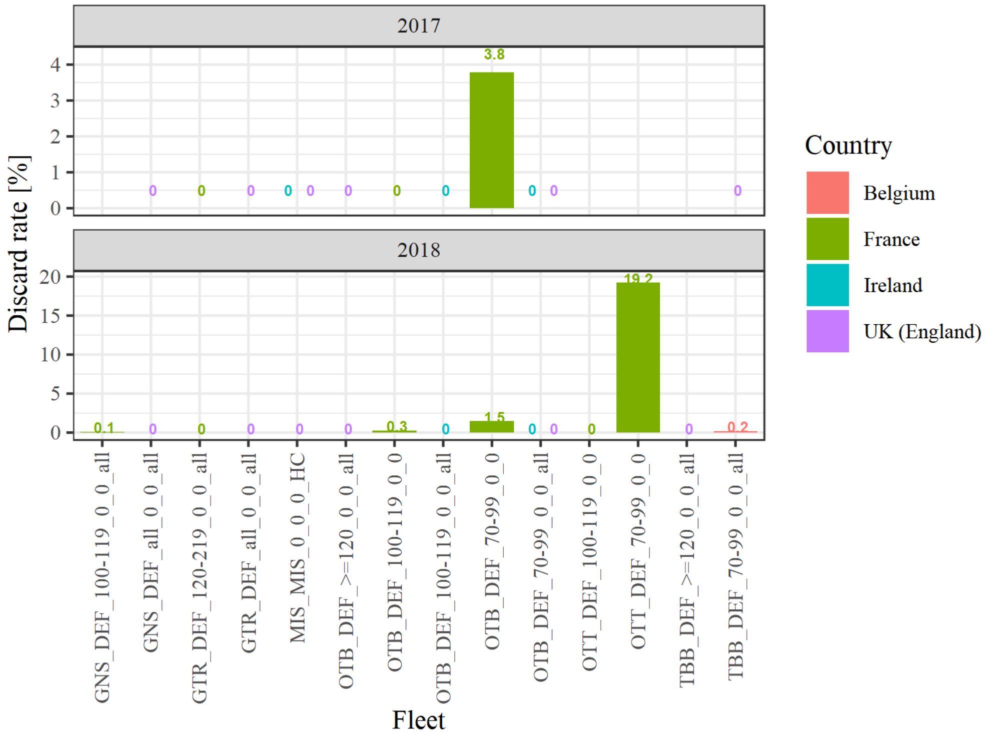


Figure 31.4. Sole in Division 7.e. Annual reported discard rates in InterCatch by fleet and country.

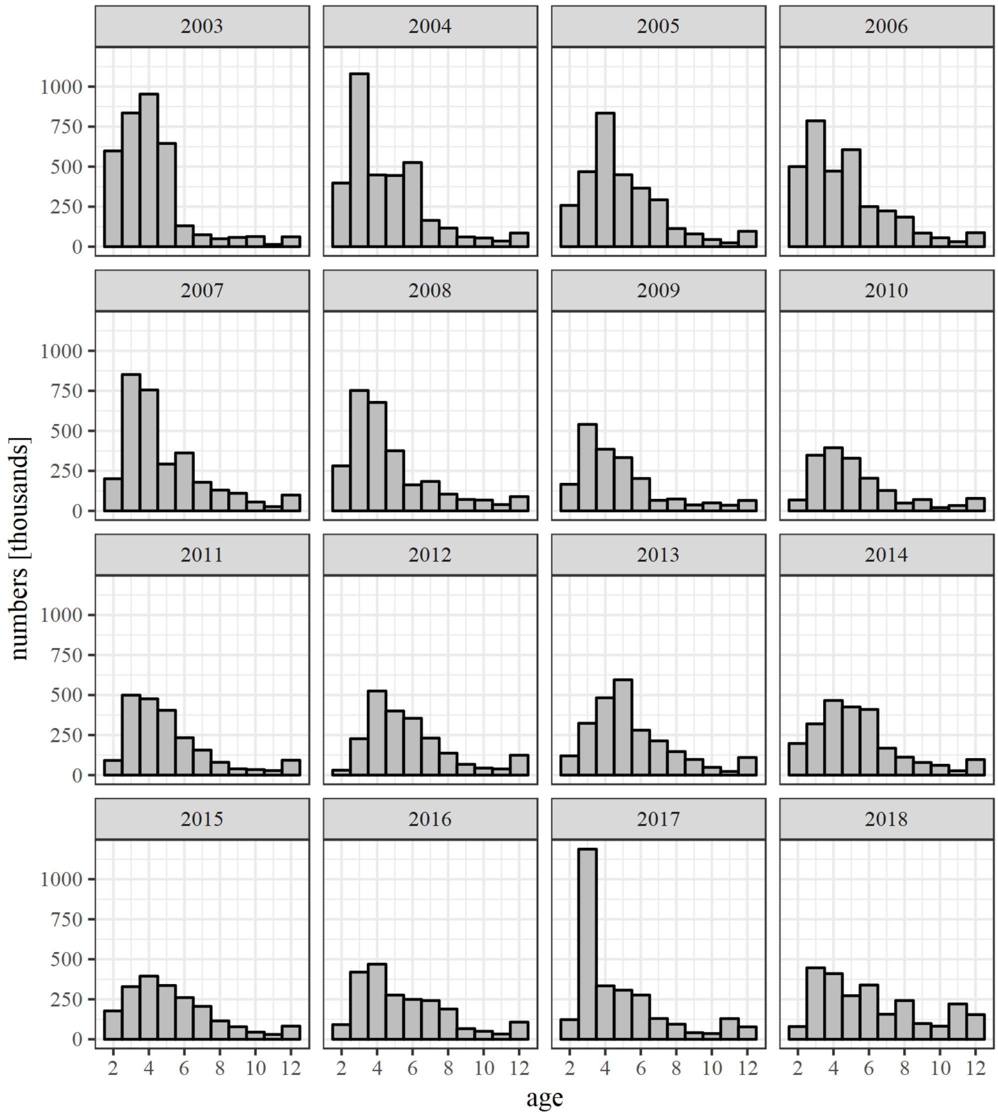


Figure 31.5. Sole in Division 7.e. International landings numbers-at-age (last 16 years).

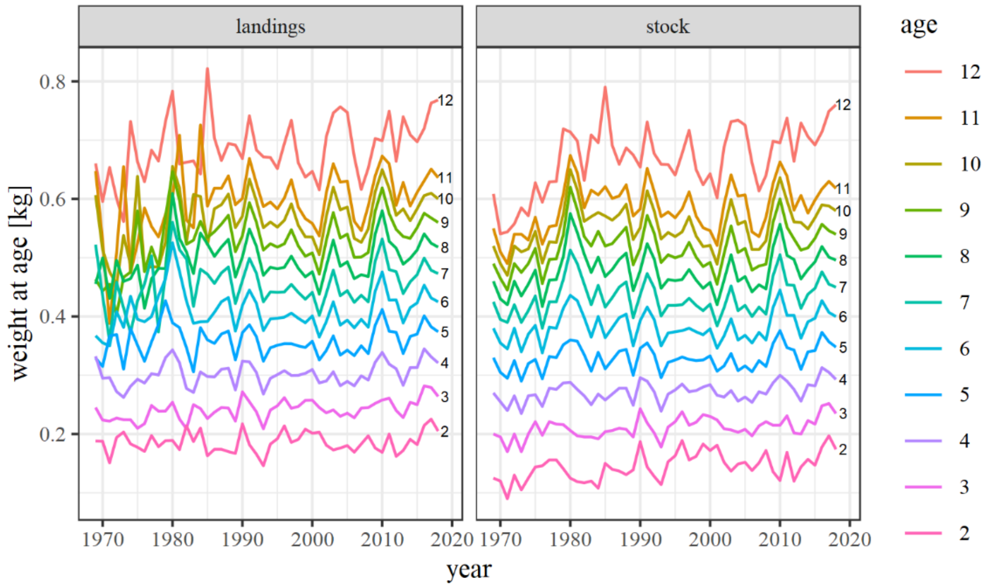


Figure 31.6. Sole in Division 7.e. Catch (landings) and stock weights-at-age.

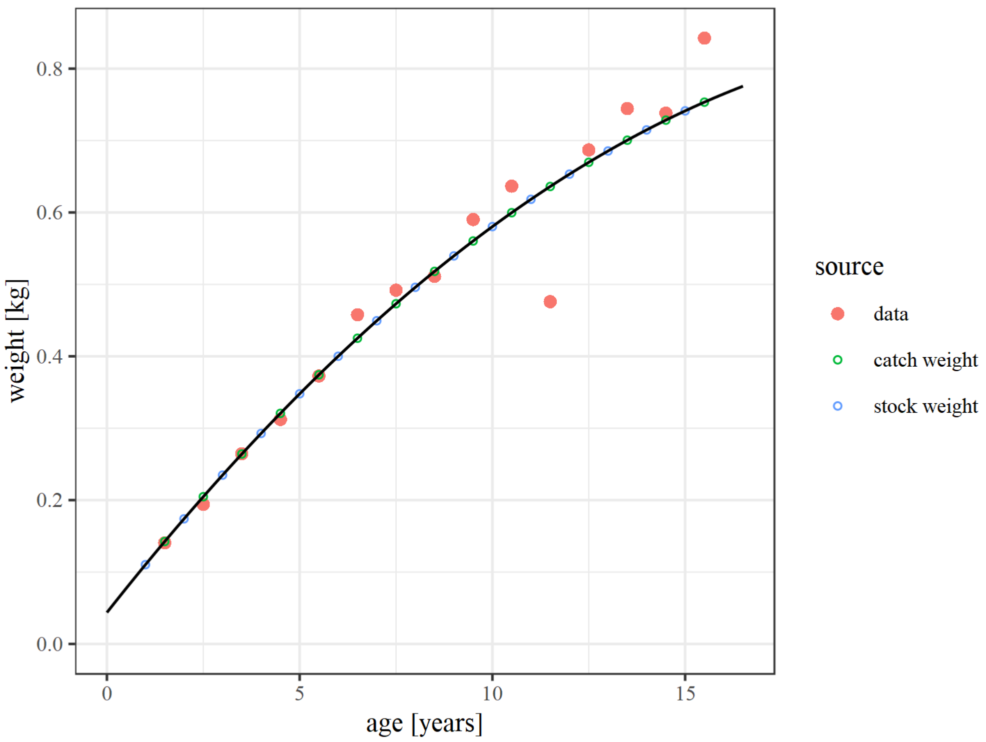


Figure 31.7. Sole in Division 7.e. Generation of stock and catch weights from landings weights-at-age.

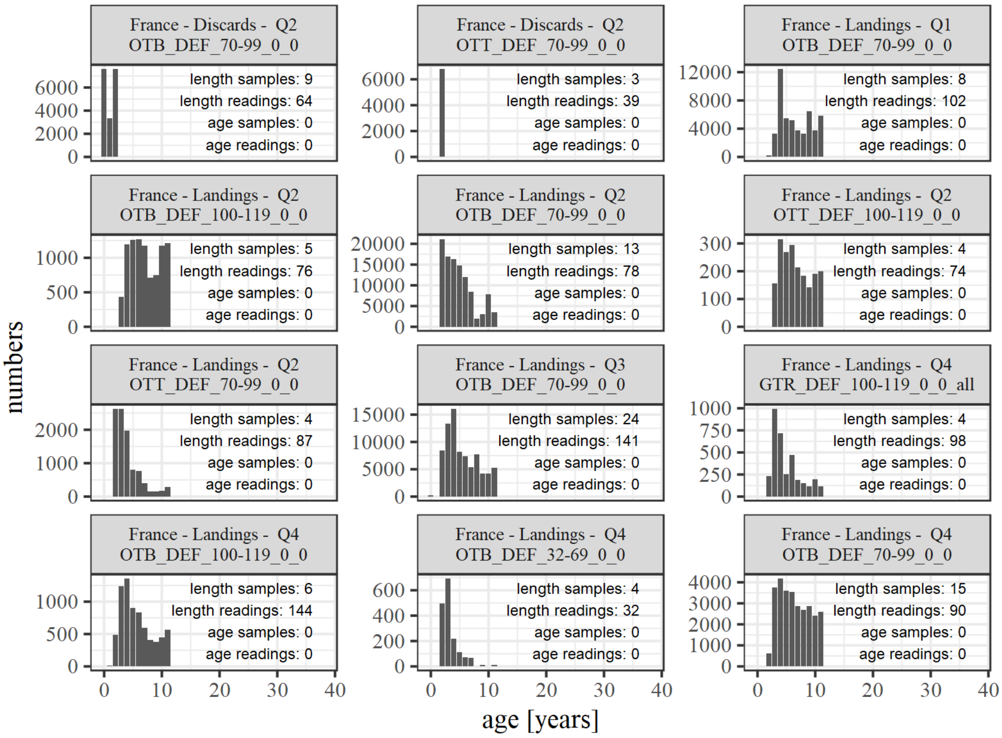


Figure 31.8. Sole in Division 7.e. Landings age distributions from InterCatch provided by France. Numbers are raised to fleet level.

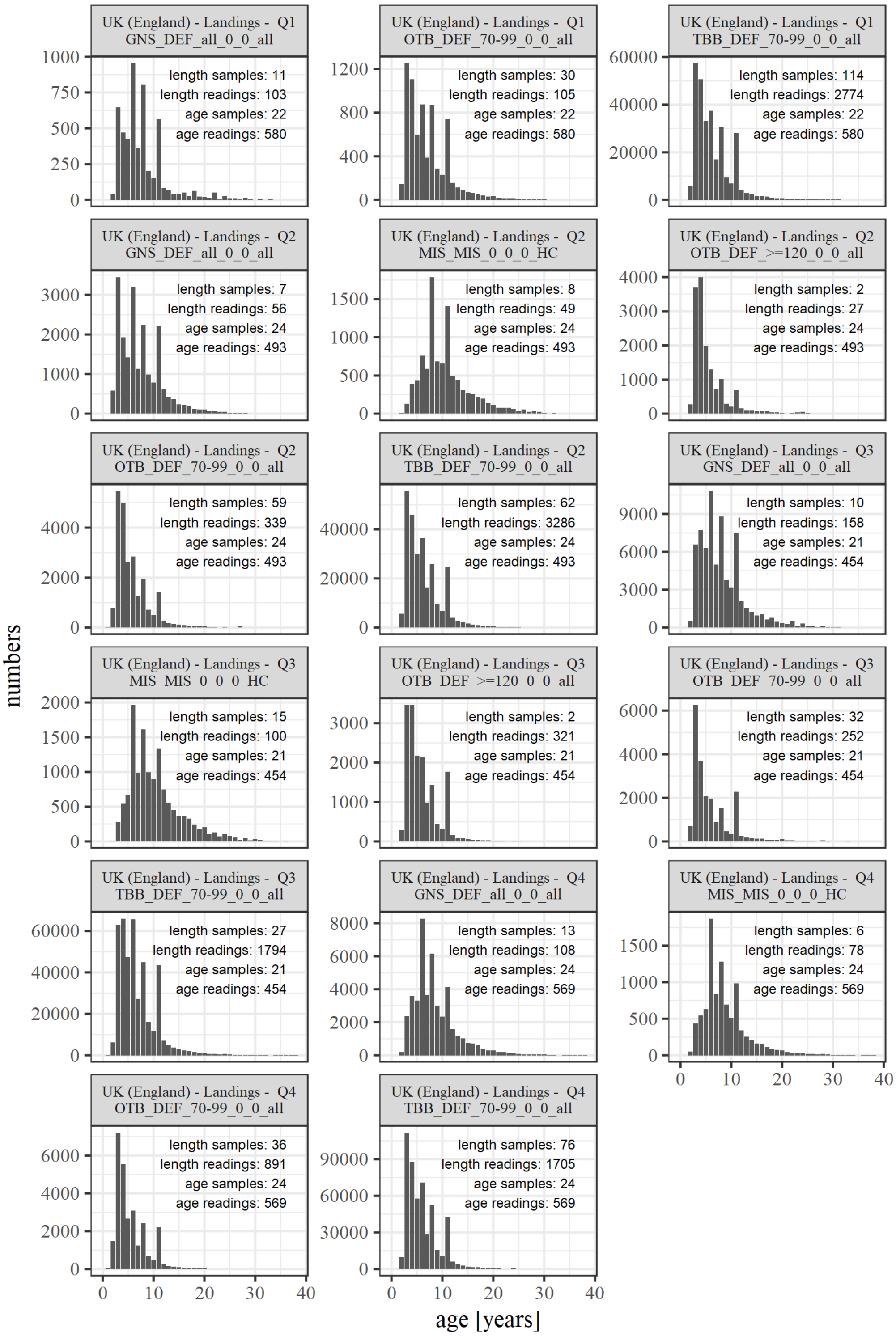


Figure 31.9. Sole in Division 7.e. Landings age distributions submitted to InterCatch. Numbers are raised to fleet level.

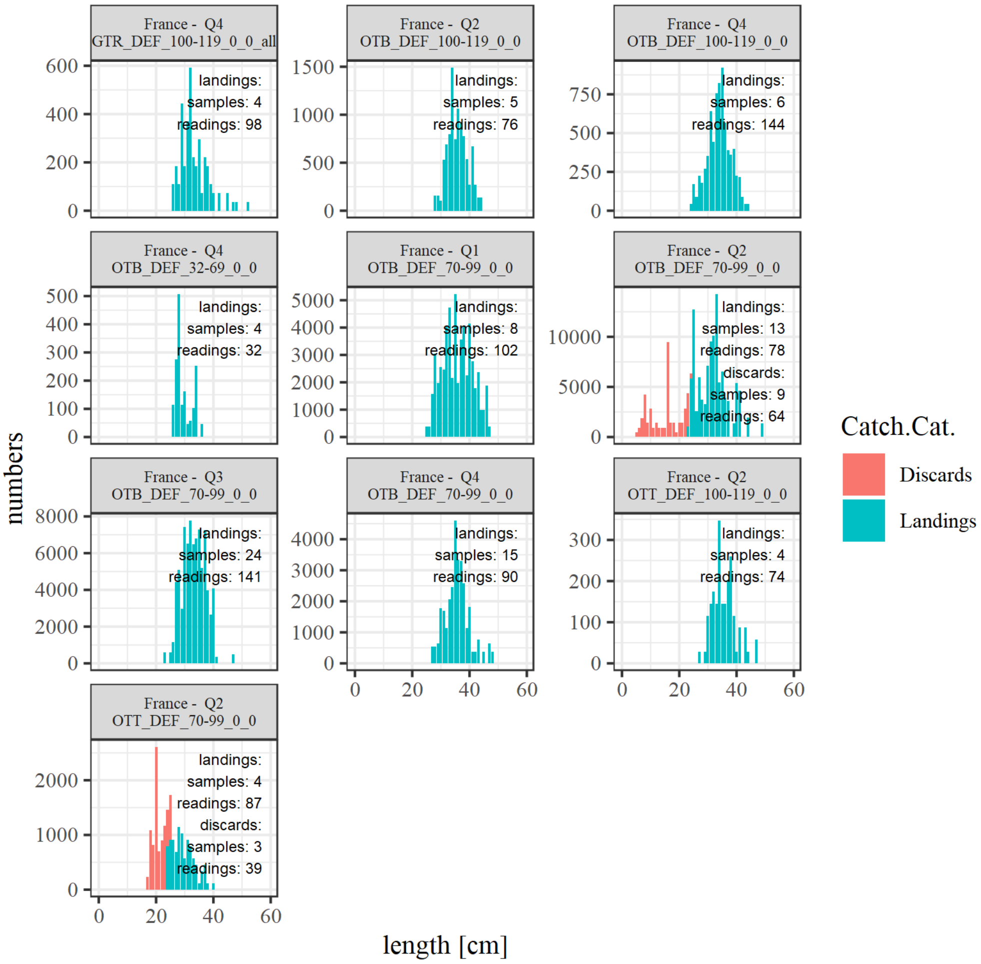


Figure 31.10. Sole in Division 7.e. Length distributions from samples for France. Numbers are raised to fleet level.

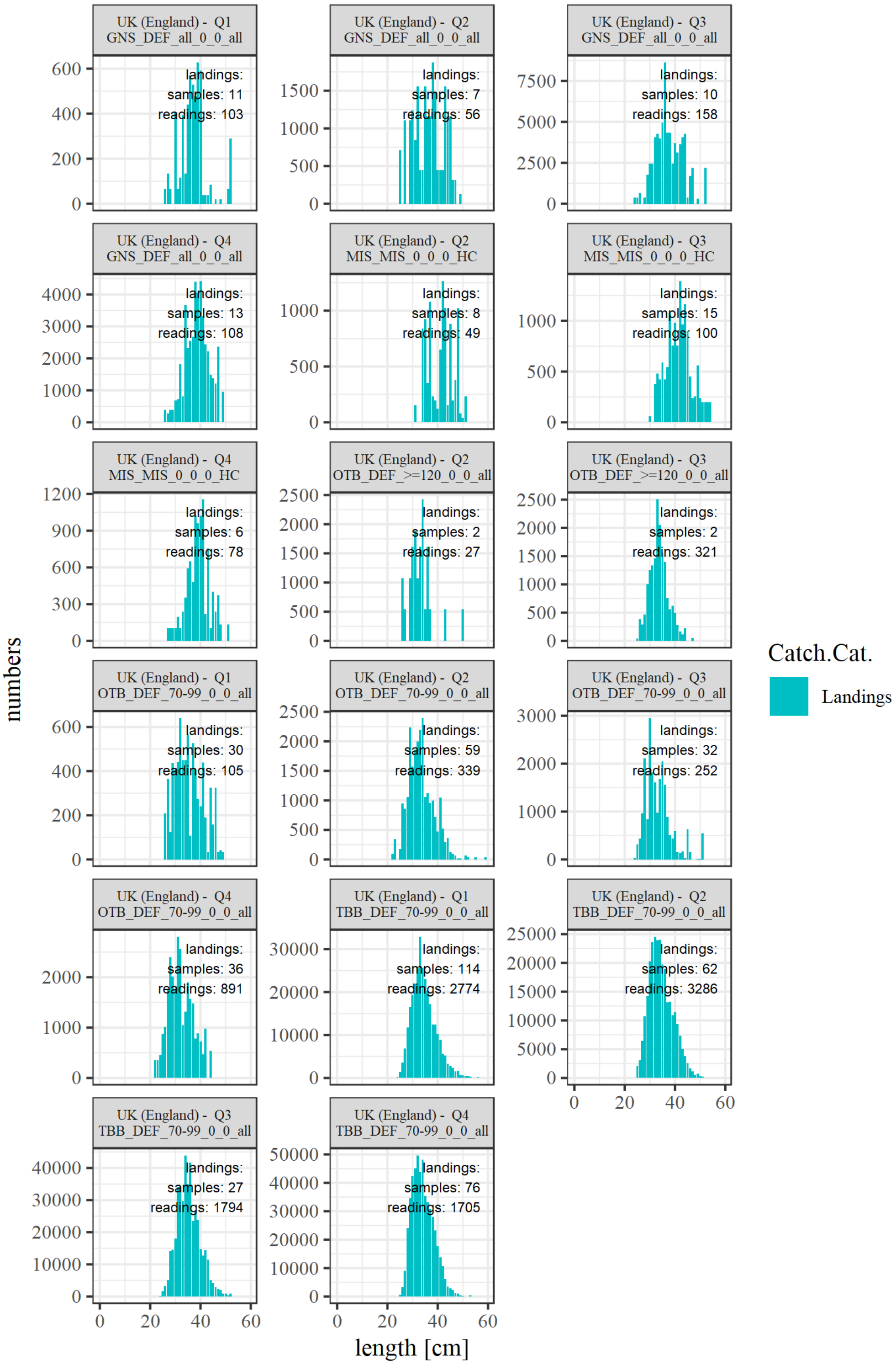


Figure 31.11. Sole in Division 7.e. Length distributions from samples for UK (England). Numbers are raised to fleet level.

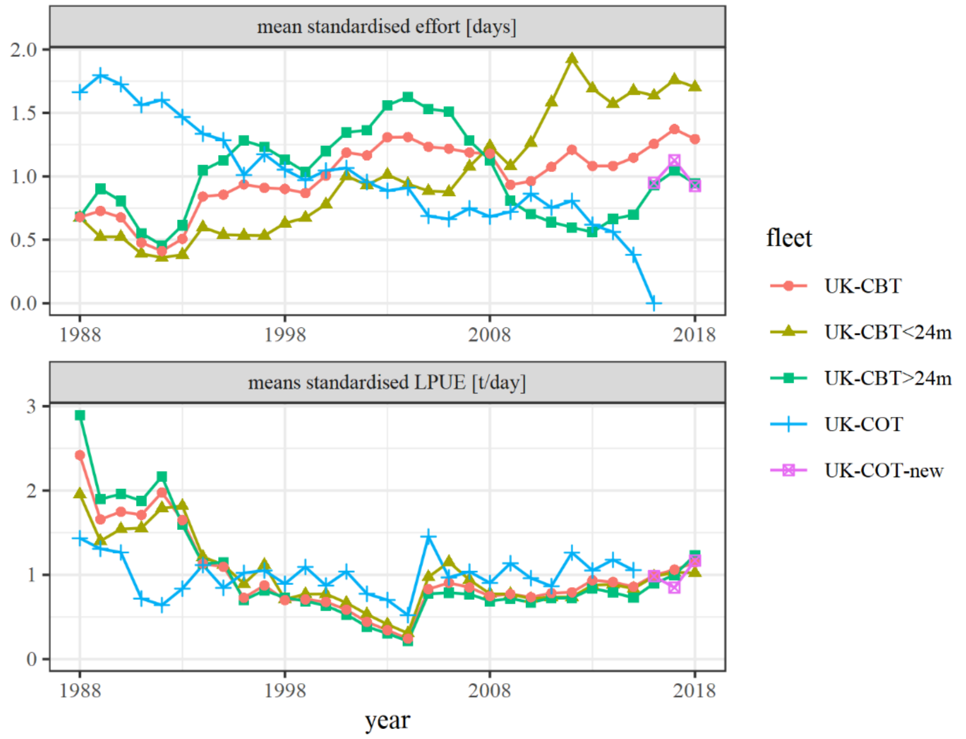


Figure 31.12. Sole in Division 7.e. Means standardised lpue and effort for the UK commercial fleets.

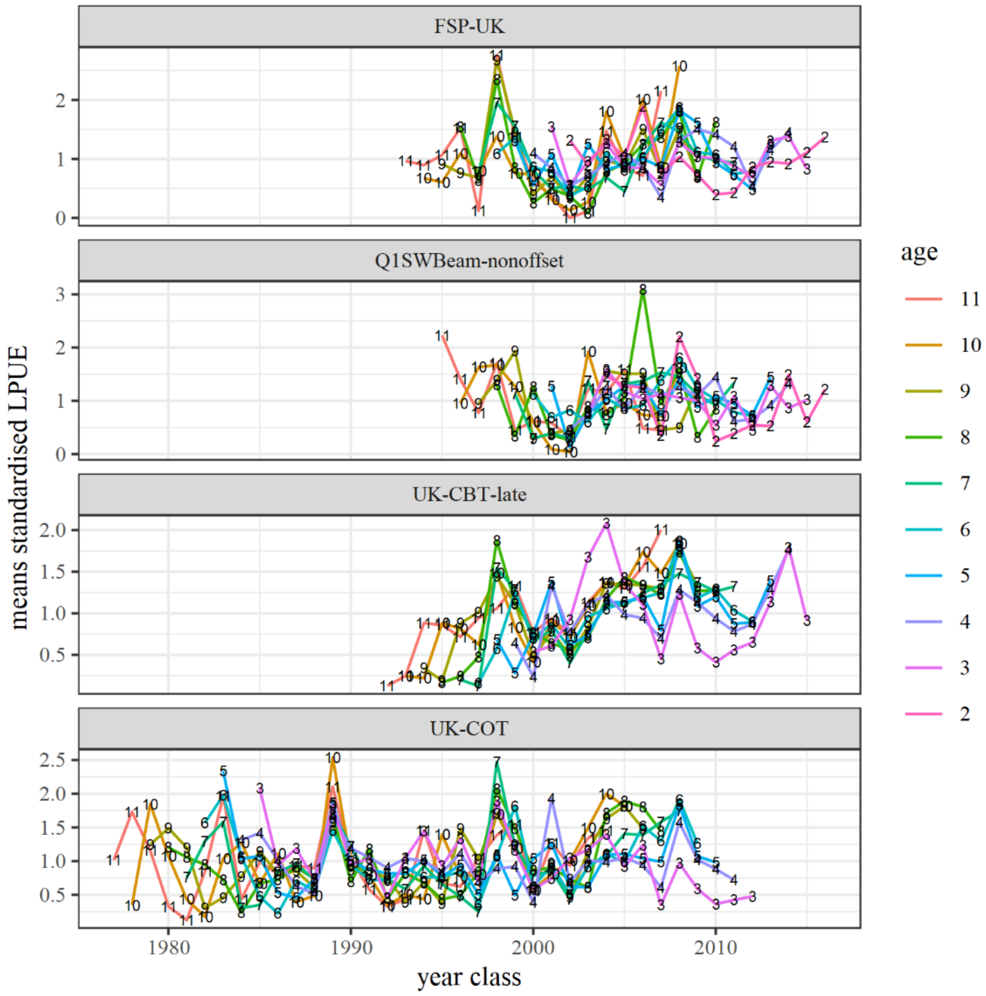


Figure 31.13. Sole in Division 7.e. Means standardised lpue/cpue by year class. Note, the cohorts differ on the x-axes due to the differences in the length and age ranges of the tuning series.

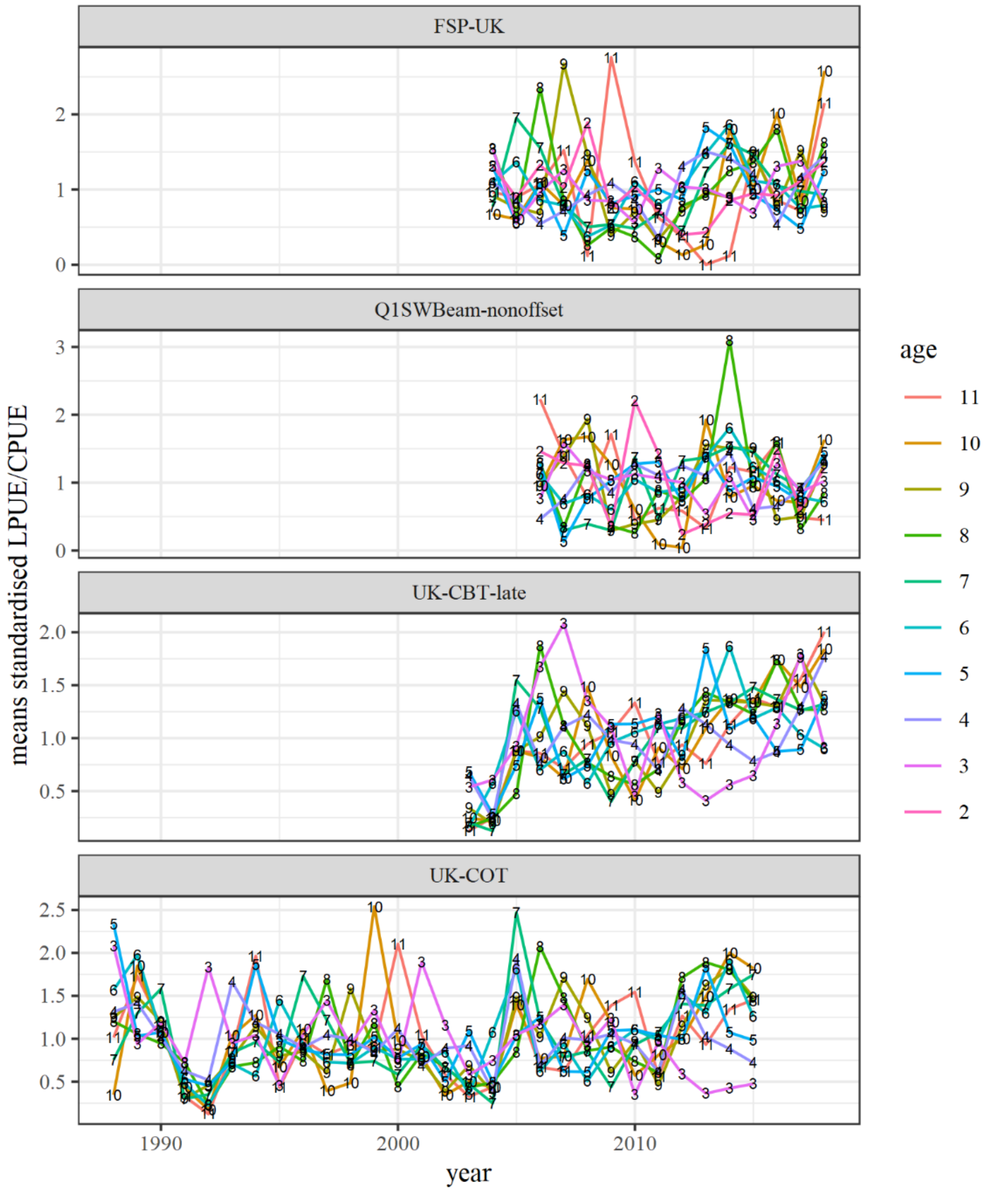


Figure 31.14. Sole in Division 7.e. Means standardised lpue/cpue by year. Note, the lines differ on the x-axes due to the differences in the length and age ranges of the tuning series.

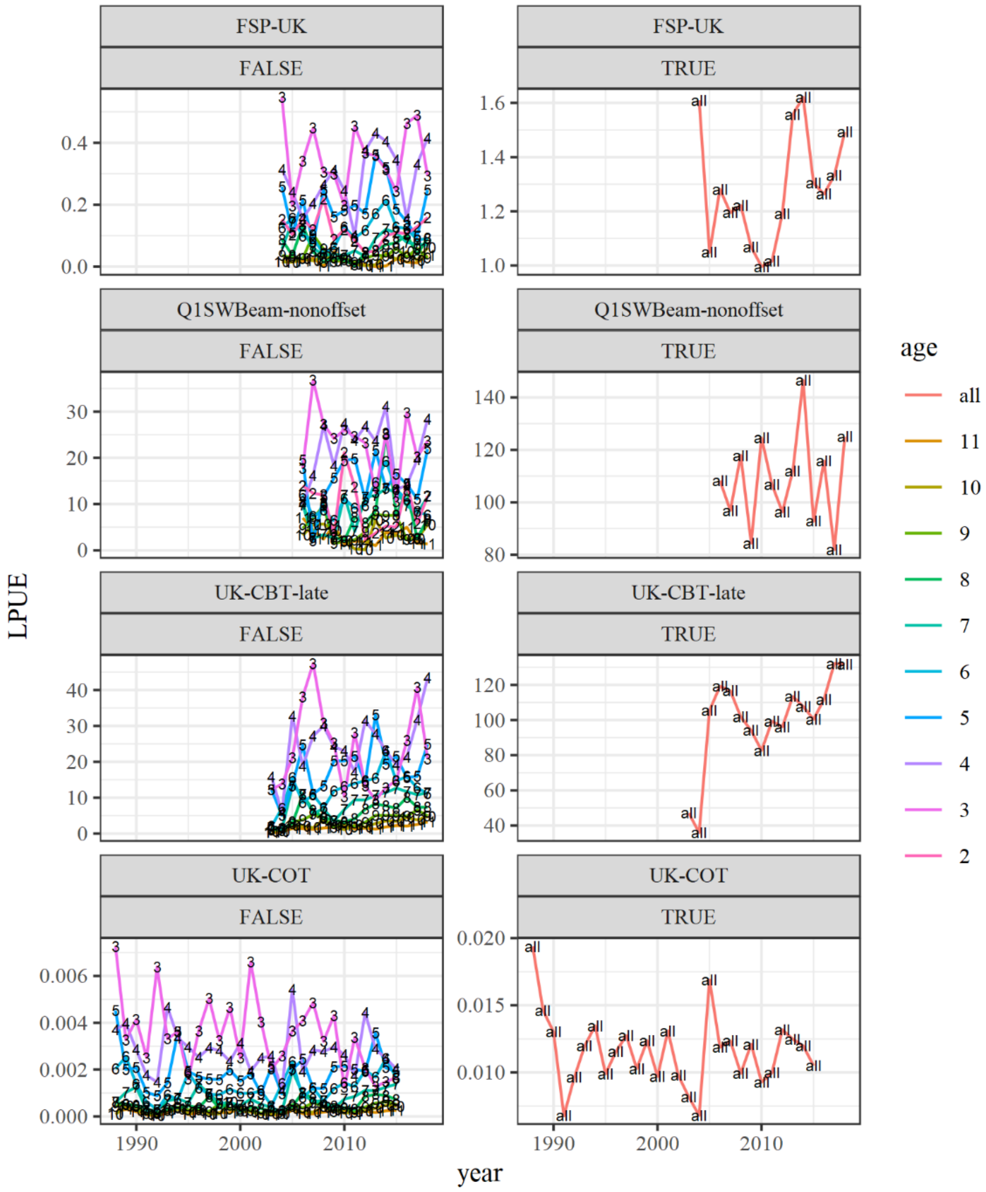


Figure 31.15. Sole in Division 7.e. Survey indices (raw values) for all commercial and scientific surveys. The plots on the left show the index values at age, on the right are the values aggregated over all ages.

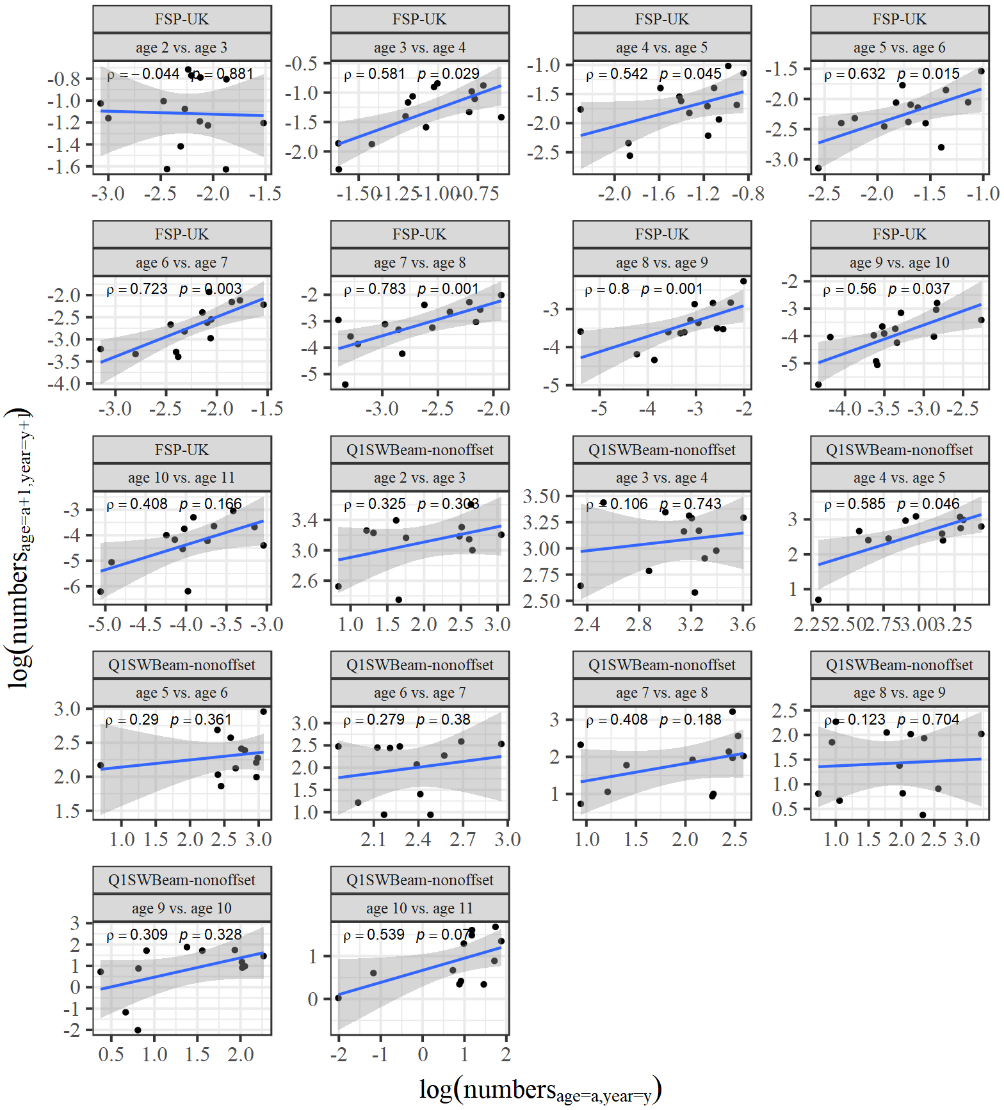


Figure 31.16. Sole in Division 7.e. Internal consistencies in the scientific surveys. Shown is the correlation between numbers-at-age and the numbers of the same cohort one year later, including Pearson correlation coefficient *ρ* and the *p*-value.

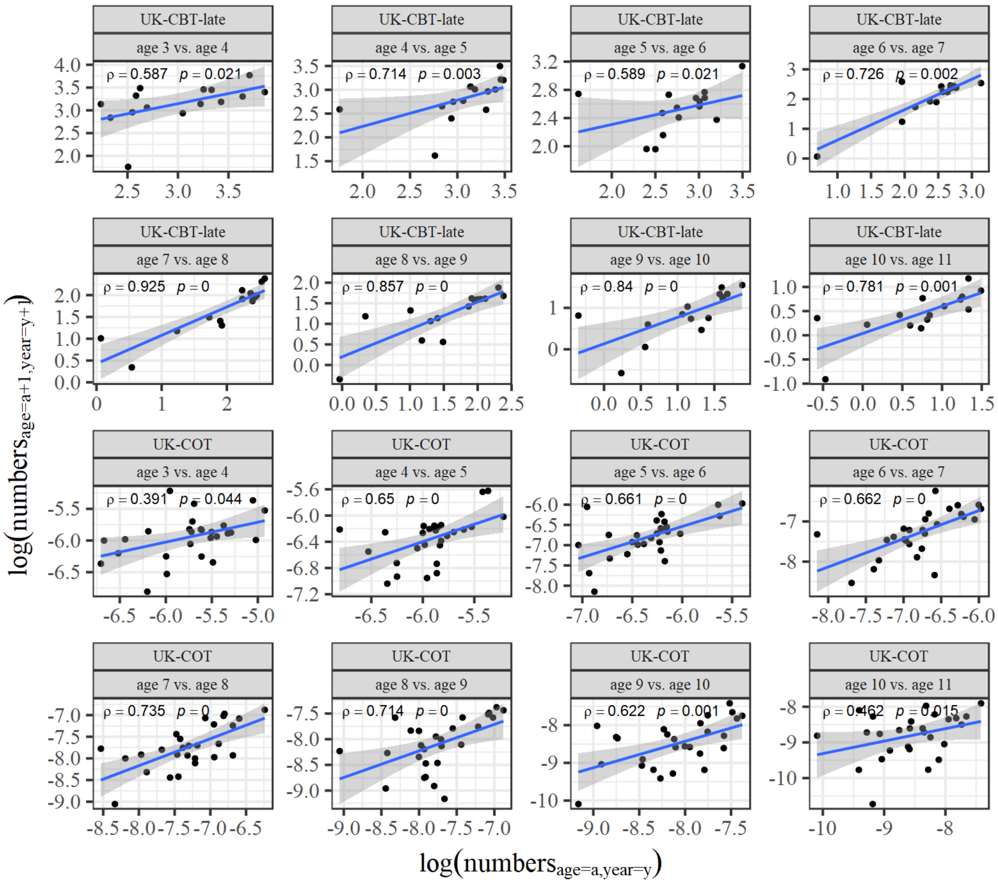


Figure 31.17. Sole in Division 7.e. Internal consistencies in the commercial surveys. Shown is the correlation between numbers-at-age and the numbers of the same cohort one year later, including Pearson correlation coefficient ρ and the p-value.

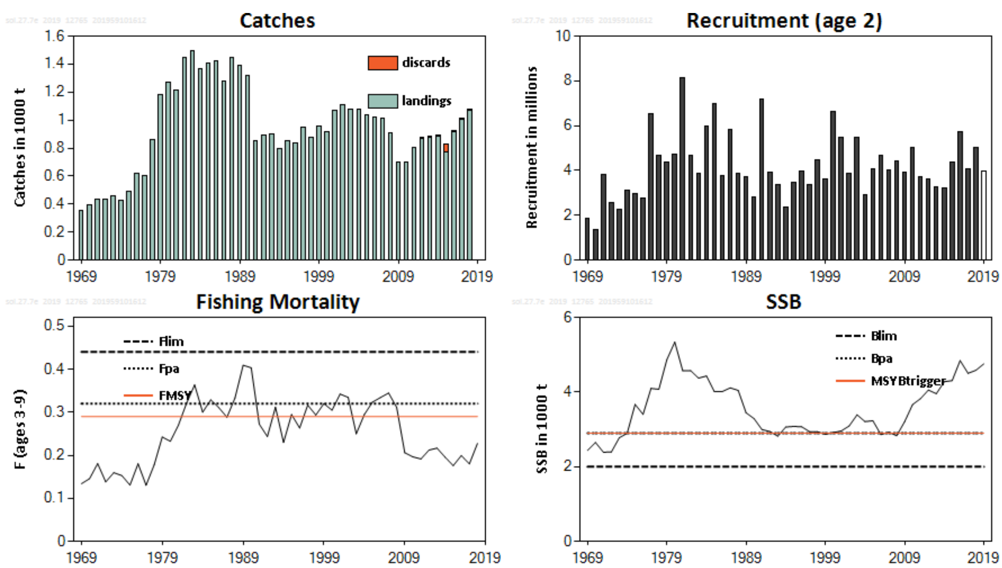


Figure 31.18. Sole in Division 7.e. Results of the final XSA run. ICES estimated catches, recruitment, fishing mortality, and spawning–stock biomass from the summary stock assessment. Assumed recruitment values are not shaded. Discard estimates are only available from 2012 onwards.

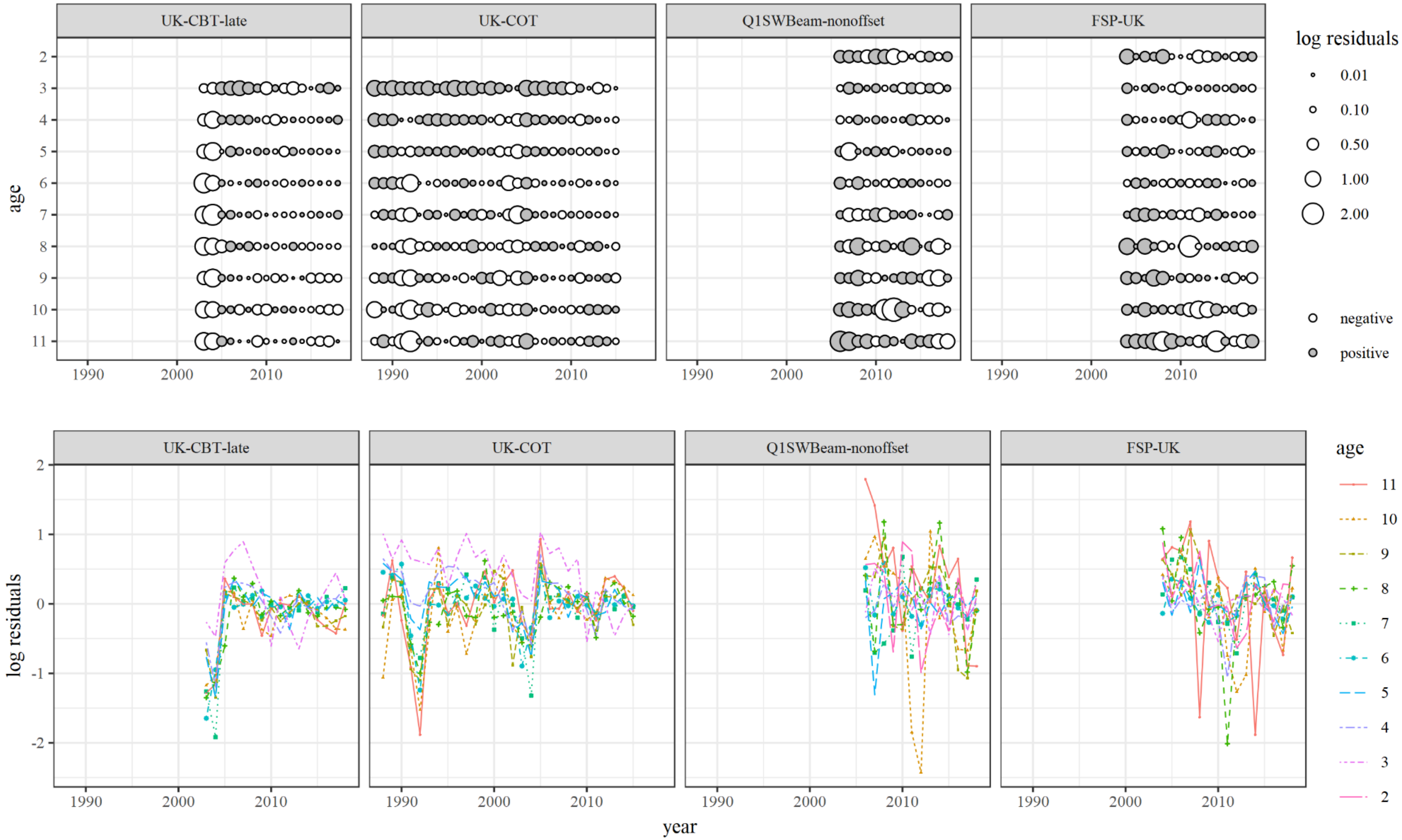


Figure 31.19. Sole in Division 7.e. XSA fleet log catchability residuals. Note that the application of time-series weighting set as a tricubic taper with a range of 15 years excludes log catchability residuals for the UK-COT fleet prior to 2004.

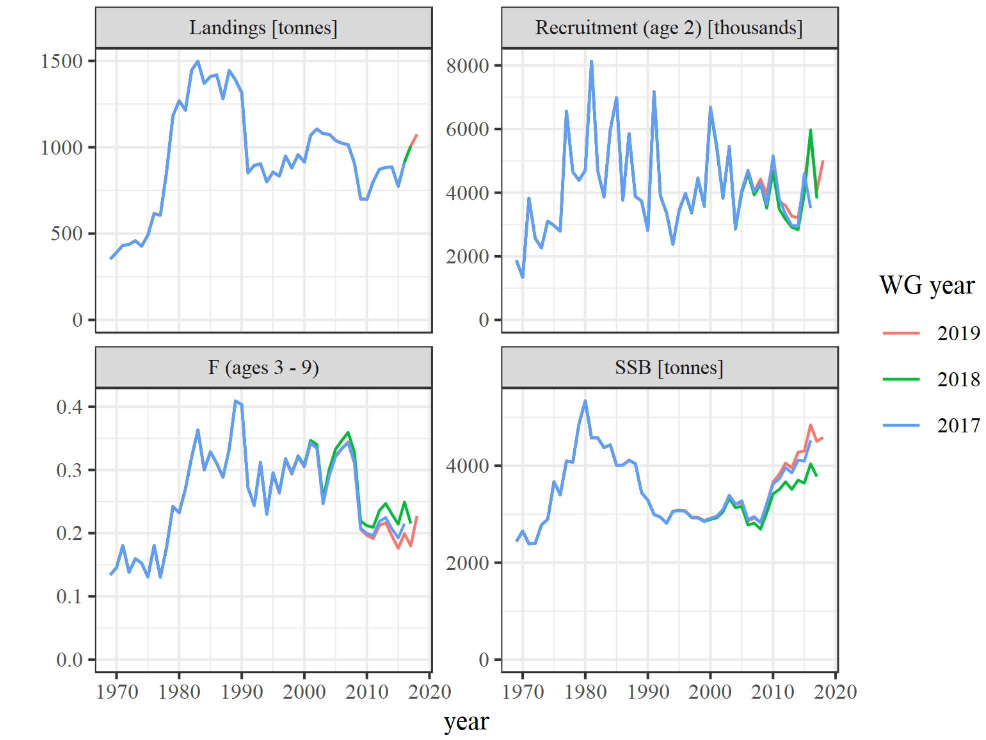


Figure 31.20. Sole in Division 7.e. Comparison of the current XSA assessment with the final assessment runs from the last two years.

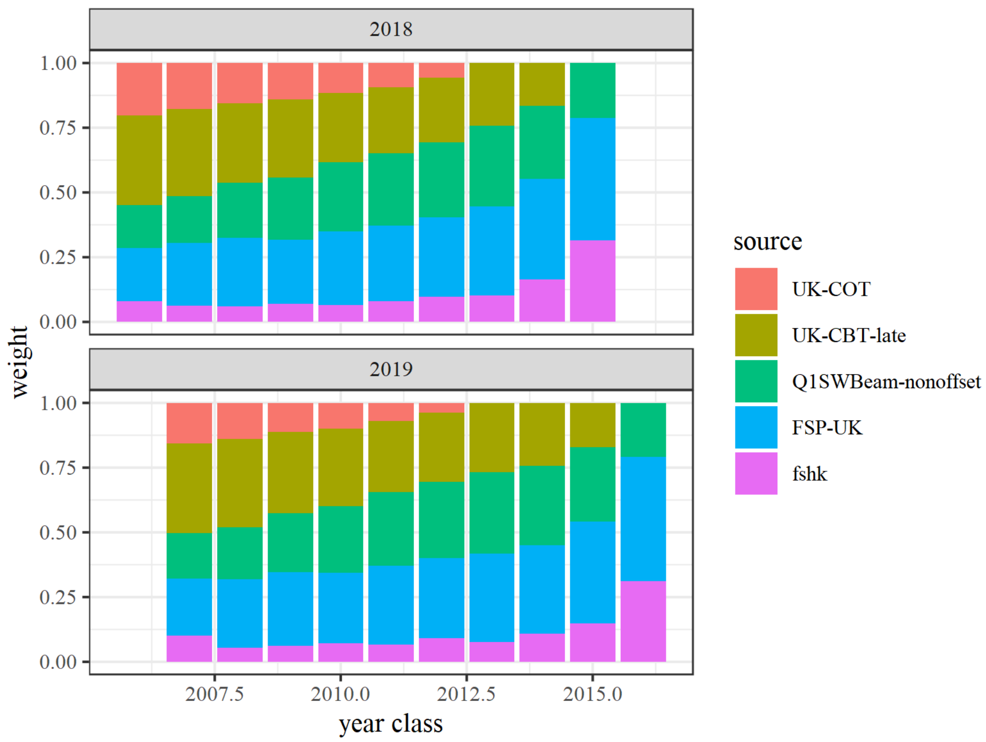


Figure 31.21. Sole in Division 7.e. Scaled weights for the current XSA assessment and the previous XSA assessment conducted at last year's WGCSE.

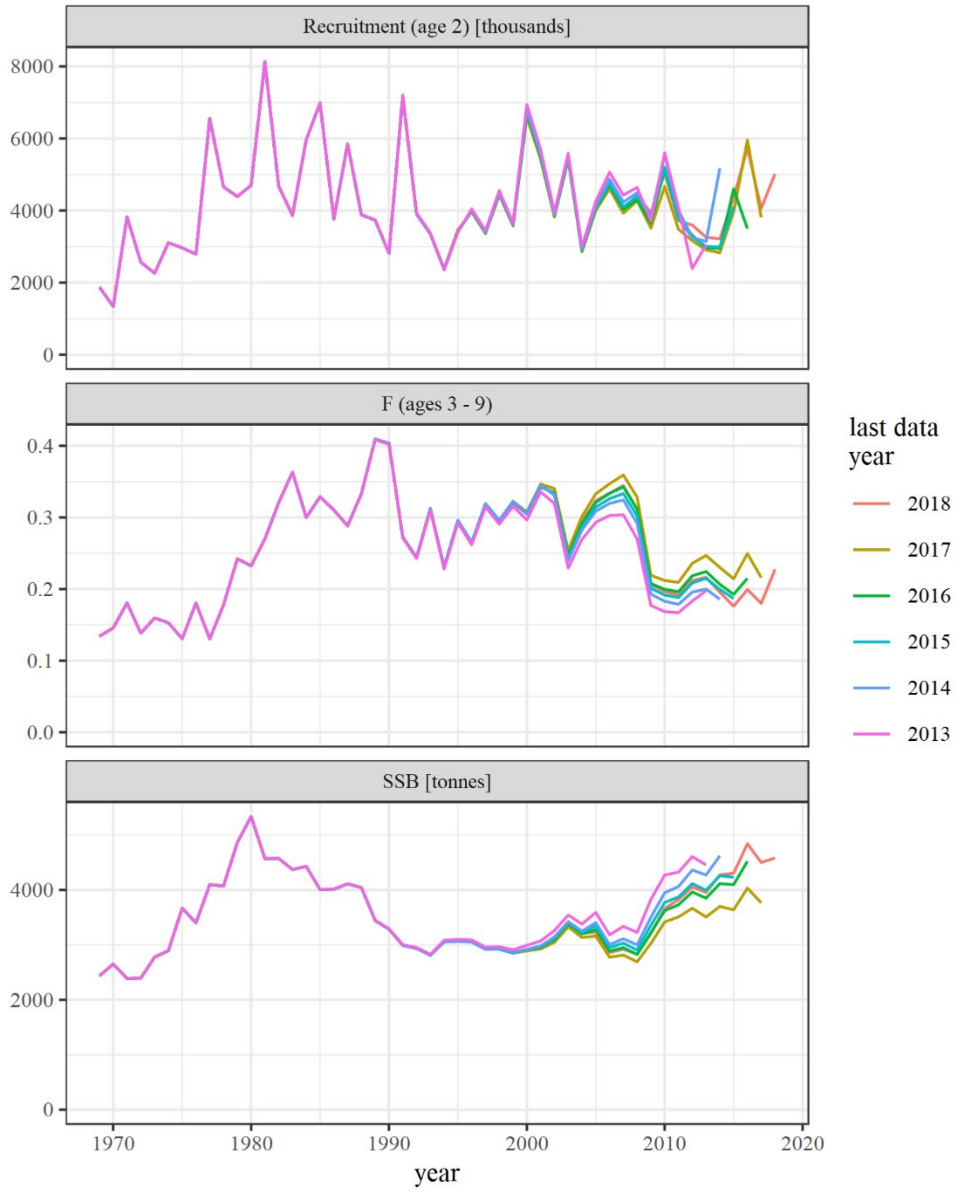


Figure 31.22. Sole in Division 7.e. Five-year retrospective of stock status and fishing mortality estimates.

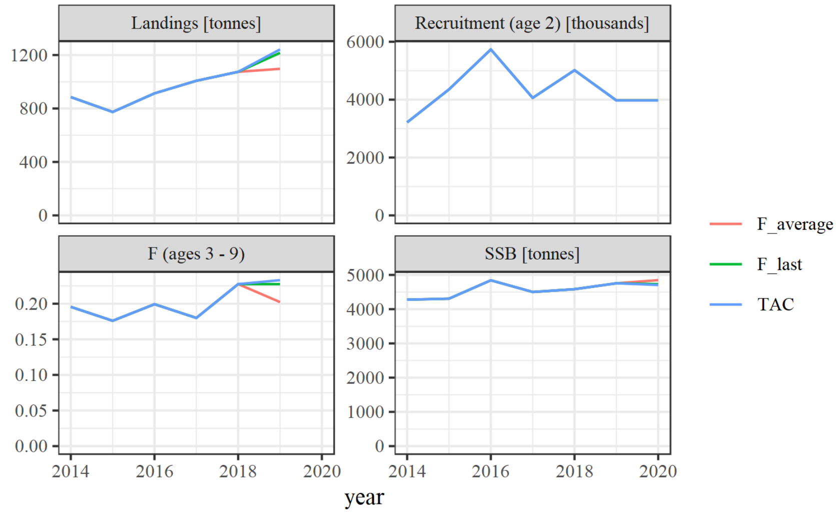


Figure 31.23. Sole in Division 7.e. Options for the intermediate year in the short-term forecast.

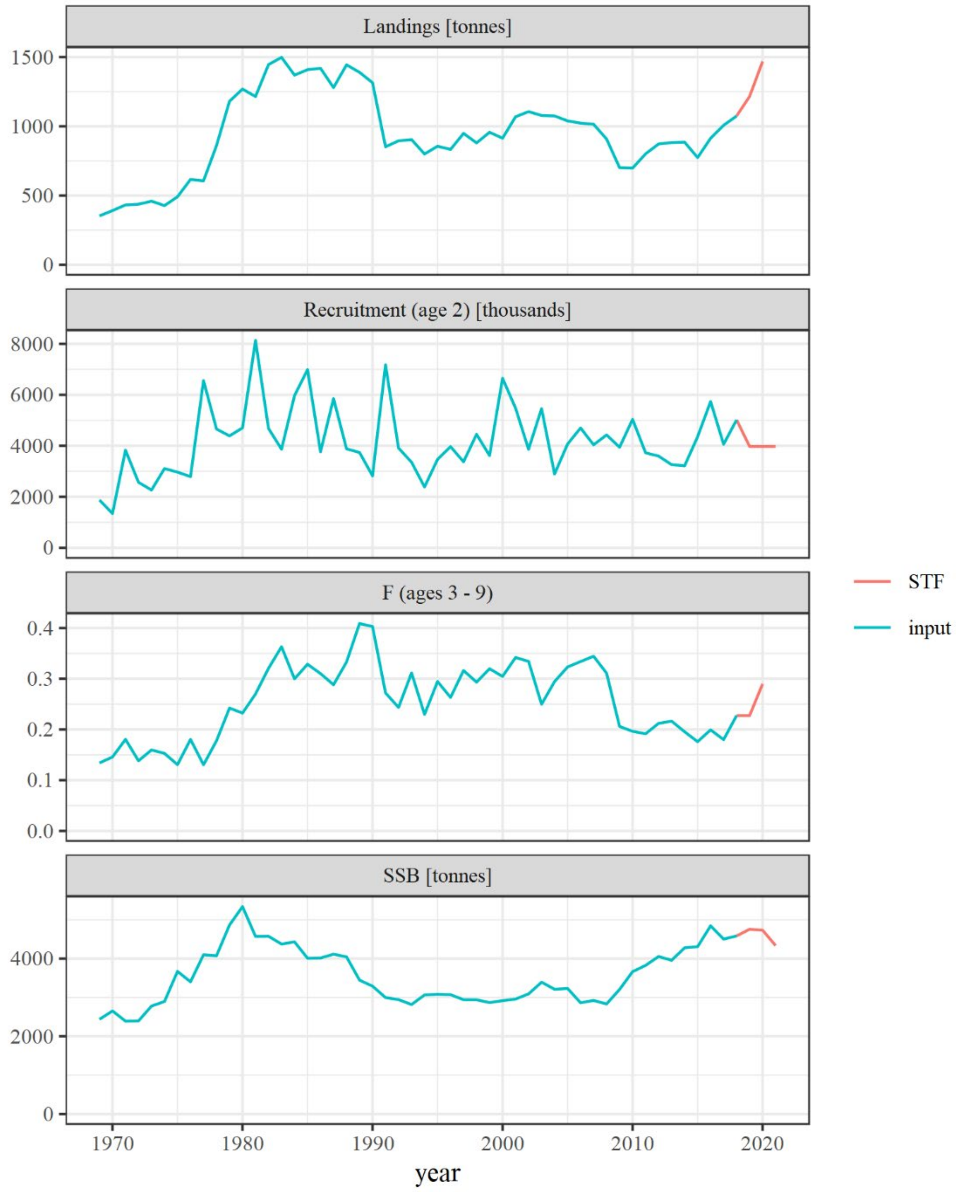


Figure 31.24. Sole in Division 7.e. Output for the short-term forecast under the MSY approach.

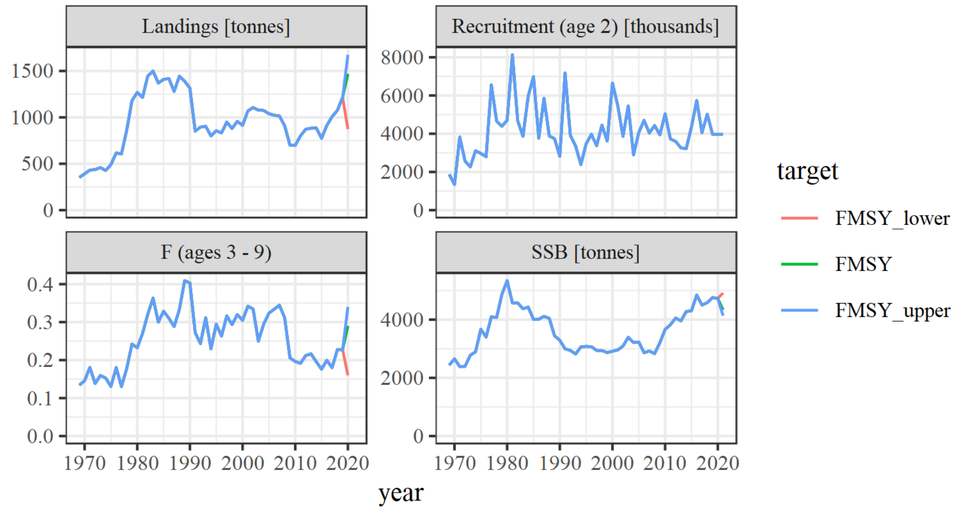


Figure 31.25. Sole in Division 7.e. Output of the short-term forecast of the MSY approach, including F_{MSY} ranges.

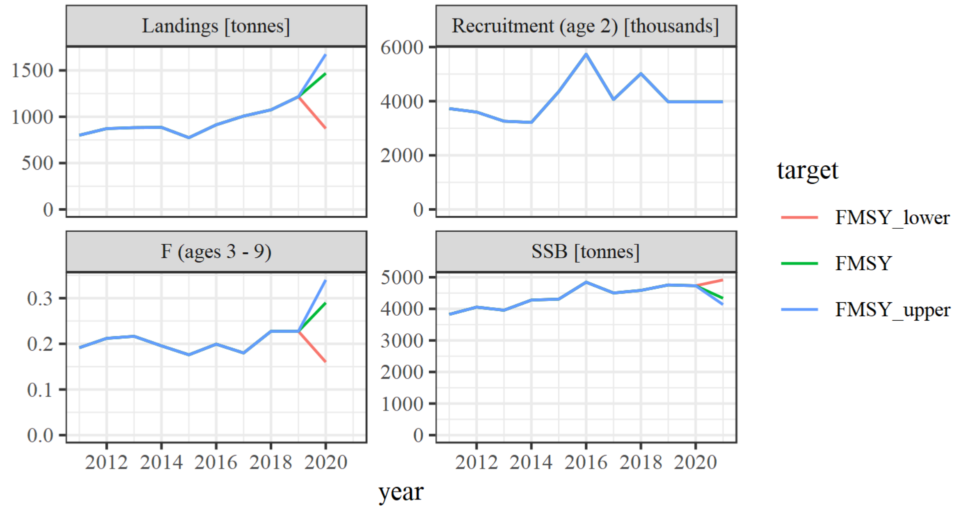


Figure 31.26. Sole in Division 7.e. Output of the short-term forecast of the MSY approach, including F_{MSY} ranges zoomed into the most recent years.

34 Sole in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)

The assessment of sole in division 7.f and 7.g presented at WGCSE 2019 is the first assessment after the Inter-benchmark (IBPBrisol, ICES 2019) in February 2019. The Stock Annex was updated with respect to the outcomes of the Inter-benchmark. Changes include the use one adjusted commercial tuning series and a new selection of ages for the tuning fleets.

Type of assessment in 2019

This assessment is an update assessment.

ICES advice applicable to 2018

In the advice for 2018, the stock status was presented as follows:

	Fishing pressure					Stock size				
		2014	2015	2016			2015	2016	2017	
Maximum Sustainable Yield	F_{MSY}	✗	✗	✗	Above	MSY $B_{Trigger}$	✓	✓	✓	Above trigger
Precautionary Approach	F_{pa}, F_{lim}	O	✓	O	Increased risk	B_{pa}, B_{lim}	✓	✓	✓	Full reproductive capacity
Management plan	F_{MGT}	–	–	–	Not applicable	B_{MGT}	–	–	–	Not applicable

ICES advises that when the MSY approach is applied, catches in 2017 should be no more than 931 tonnes.

ICES advice applicable to 2019

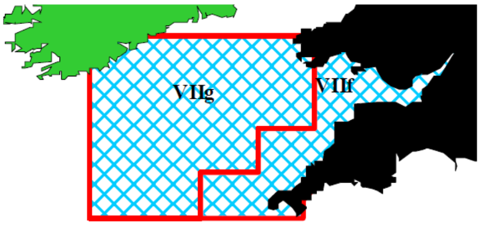
In the advice for 2019, the stock status was presented as follows:

	Fishing pressure					Stock size				
		2015	2016	2017			2016	2017	2018	
Maximum sustainable yield	F_{MSY}	✗	✗	✗	Above	MSY $B_{trigger}$	✗	✗	✓	Above trigger
Precautionary approach	F_{pa},F_{lim}	O	O	O	Increased risk	B_{pa},B_{lim}	O	O	✓	Full reproductive capacity
Management plan	F_{MGT}	–	–	–	Not applicable	B_{MGT}	–	–	–	Not applicable

ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 864 tonnes.

34.1 General

Stock description and management units



A TAC is in place for ICES divisions 7.f and 7.g. These divisions do correspond to the stock area. The basis for the stock assessment area 7.f and 7.g is described in detail in the Stock Annex.

Management applicable to 2018 and 2019

The sole fisheries in the Celtic Sea are managed by TAC and technical measures. The agreed TACs in 2018 and 2019 are presented in the text tables below. Technical measures in force for this stock are minimum mesh sizes and minimum conservation reference sizes (MCRS, 25 cm for Belgian vessels from March 11th 2017 onwards, except vessels with engine power <221 kW and/or volume <70 GT). National regulations also restricted areas for certain types of vessels.

2018 TAC

Species:	Common sole *Solea solea*	Zone:	7f and 7g (SOL/7FG.)
Belgium	574		
France	58		
Ireland	29		
United Kingdom	259		
Union	920		
TAC	920		Analytical TAC

2019 TAC

Species:	Common sole *Solea solea*	Zone:	7f and 7g (SOL/7FG.)
Belgium	525		
France	53		
Ireland	26		
United Kingdom	237		
Union	841		
TAC	841		Analytical TAC

Three rectangles in the Celtic Sea (30E4, 31E4 and 32E3, referred to as the "Trevose Box") were closed during the first quarter of 2005, and in February–March each year from 2006 onwards. A derogation has permitted beam trawlers to fish there in March 2005. The effects of this closure have been discussed in previous WGSSDS meetings and ACFM 2007, and evaluated at WKCELT 2014.

Fishery in 2018

The Expert Group estimated the total international landings at 850 t in 2018 (Table 36.1), of which Belgium landed 71% (607 t), UK 20% (171 t), France 5% (44 t), and 3% by Ireland (28 t). This landing figure corresponds to an international uptake of 92.4% of the agreed TAC in 2018 (920 t).

In 2018, 90% of the landings were taken by beam trawls, 9.3% by otter trawls, 0.59% by other gears.

Early in the time-series officially reported landings included divisions 7.g–k for some countries and their total was higher than the WG estimate. Since 1999, official landings correspond to divisions 7.f and 7.g, and the total is lower than the working group estimate. During the period 2002–2005 the difference between the two estimates was substantial. This was mainly due to area misreporting, which was taken into account in the working group estimates (WKCELT ICES, 2014). In the recent years, the estimates are more similar.

34.2 Data

Landings

Annual length compositions for 2018 are given by fleet in Table 36.2. Length distributions of the total Belgian and UK(E&W) landings for the last nineteen years are plotted in Figure 36.1. Belgian vessels land a greater proportion of small fish compared to the UK(England & Wales).

Belgium, Ireland, France and UK have provided data this year under the ICES InterCatch format on a métier basis. Quarterly/yearly data for 2018 were available for landing numbers and weight-at-age, for most of the Belgian, Irish and UK fleets. These comprise 90% of the international landings. Allocation has been made as follows: seven groups of métiers with age distributions were set up: e.g. OTB_DEF_70-99, OTB_DEF_100-119, OTB_CRU_70-99, OTT_CRU_100-119, OTT_DEF_100-119, GNS_DEF_all and a group of all available métiers with age distributions (Overall). The OTB_DEF_70-99 (1.9% of overall landings), OTB_DEF_100-119 (2.0% of overall landings), OTB_CRU_70-99 (4.9% of overall landings), OTT_CRU_100-119 (0.4% of overall landings), OTT_DEF_100-119 (2.0% of overall landings), and GNS_DEF_all (<1% of overall landings) métiers without age distributions were allocated with the group OTB_DEF_70-99, OTB_DEF_100-119, OTB_CRU_70-99, OTT_CRU_100-119, OTT_DEF_100-119, GNS_DEF_all respectively. The rest of the métiers without age distributions (2.0% of overall landings) were allocated to the group Overall.

For the period 2008–2018, the original total international catch weights-at-age were used. The stock weights were obtained using the Rivard weight calculator (http://nft.nefsc.noaa.gov./), that conducts a cohort interpolation of the catch weights.

Catch numbers-at-age are given in Table 36.3, and weights-at-age in the catch and the stock are given in Tables 36.4–36.5. Age compositions over the last eighteen years are plotted in Figure 36.2. The standardised catch proportion-at-age is presented in Figure 36.3.

The low catch numbers for age 1 in 2014 and 2016 were excluded from the catch numbers-at-age matrix to be consistent with previous years for which age 1 catch numbers are set to zero.

Discards

The available discard data indicate that discarding of sole has increased in 2017 and 2018. The length distributions for 2018 of retained and discarded catches of sole are presented in Figure

36.4a from the Belgium beam trawl fleet, in Figure 36.4b from the UK beam trawlers and in Figure 36.4c from the Irish beam and otter trawlers. It should be noted that the Irish otter trawl landings only amount to about 2.2% of the total international landings.

As an attempt, estimating an overall discard rate for the stock, individual discard estimates for 2016–2018 from the main métiers and countries were averaged to arrive at an overall discard rate by year (Table 36.6). The percent of the métiers with discard information covering the total international landings is, 87%, 90% and 90% for 2016, 2017 and 2018 respectively.

The average discard rate for 2016–2018 is 8.9%, while the discard rate for 2018 is 14.8%. This steep increase is due to Belgian and Irish beam trawlers. The Belgian beam trawl fleet mainly discarded fish of 22 and 23 cm (Figure 36.4a). According to the Belgian age–length samples, these fish were mainly age 2 in 2018. These discarded fish thus belong to the very strong 2016 year class. Given the high recruitment of this year class, it makes sense that there is an increase in discarding. The Irish beam trawl fleet discards sole over the whole length range (Figure 36.4c) due to quota restrictions.

Biological

Natural mortality was assumed to be 0.1 for all ages and years. The maturity ogive is based on samples taken during the UK(E&W) beam trawl survey of March 1993 and 1994 and is applied to all years of the assessment.

The proportion of M and F before spawning was set to zero.

Surveys

Standardised abundance indices for the UK beam trawl survey (UK(E&W)-BTS-Q3)) are shown in Table 36.7 and Figure 36.5. Abundance-at-age 0 is highly variable and not used further on. The UK-survey appears to track the stronger year classes reasonably well. The internal consistency plot indicates also a reasonable fit for most of the ages (Figure 36.6).

Commercial lpue

Available estimates of effort and lpue are presented in Tables 36.8–36.9 and Figure 36.7.

Commercial lpue and effort data were available for Belgian beam trawlers, UK (E&W) beam and otter trawlers and Irish seiners, otter and beam trawlers. It should be noted that the most recent lpue values of the UK (E&W) beam trawlers (2013–2018) and the UK (E&W) otter trawlers (2014–2018) are not available due to reporting issues. In 2013, the UK administration switched to the EU electronic logbook system. Therefore, a lot of the reported effort is missing and the 2013 value cannot be used as an absolute number. Details of the 2013 UK beam trawl were unavailable due to reduced numbers of trips reporting this gear specific effort information via the newly introduced e-logbook system. The otter trawl fleet effort reporting was unaffected by this as these vessels were not reporting their landings via this method in 2013. However, from 2014 onwards both the UK beam trawl and otter trawl effort values are unavailable because of the reporting issues. Therefore, the UK(E&W)-CBT tuning indices for the six most recent years were excluded in this year's assessment.

Belgian beam trawl effort was at highest levels in 2003–2005. During these years effort shifted from the Eastern English Channel (Division 7.d) to the Celtic Sea (divisions 7.fg) because of days-at-sea limitations in the former area. In 2006, these restrictions had been lifted and effort decreased substantially to about half of the values observed in the early 2000s. The sharp effort reduction in 2008 may be a combined result of the unrestricted effort regime in Division 7.d and the high fuel prices. The increase in 2012-2013 is due to the good opportunities of sole catches in the Celtic sea taken by the mobile Belgian fleet. Afterwards, effort decreased again to the lower level recorded in 2010.

The effort from the UK(E&W) beam trawl fleet has declined sharply since the early 2000s to a record low in 2009, and stayed at that level since. Inspection of an alternate effort indicator (days fished) suggests that the beam trawl effort in 2013–2018 remains low.

The effort from the UK(E&W) otter trawlers has shown a gradually declining trend over time and the alternate effort indicator (days fished) suggests that this declining trend continues in the period 2013–2018.

Lpue of the Belgian beam trawlers peaked in 2002. After a sharp decline to its record low in 2004, lpue has been increasing gradually, levelling off in 2010–2013 at around 15 kg/hour. In 2014–2015, lpue increased to around 19–20 kg/hour. In 2016 and 2017, a decrease to 15.63–15.08 kg/hour was recorded. In 2018, lpue increased to 18 kg/hour.

Lpue of the UK beam trawlers was stable in the 1990s and 2000s, but at lower levels compared to the period before. In 2007, lpue increased considerably and gave a similar value for 2008. In 2009, there was a decrease to a level just above the mean of the time-series, followed by similar values for 2010, 2011 and 2012. Inspection of the alternate lpue indicator (kg/days fished) suggests that the beam trawl lpue in 2014–2018 substantially increased.

In the period 1987–2010, the lpue of the UK otter trawlers remains stable at a lower level. In 2011–2013, the lpue increased to the higher level that was recorded in the beginning of the eighties. The alternate lpue indicator (kg/days fished) suggests a similar level in 2018.

Irish effort and lpue data are also presented. The main target species in the Irish fisheries are megrim, anglerfish, etc. The vessels usually operate on fishing grounds in the Western Celtic Sea with lower sole densities and therefore the lpue values are low.

Tuning series

During the 2019 IBP, the Belgian commercial beam trawl tuning fleet (BE-CBT) was substantially revised. Prior to the IBP, the BE-CBT tuning series consisted of two parts, which were included separately in the assessment: one with the original data from 1971 up to 1996 and one series with data from 1997 up to 2017. For the latter, the effort was corrected for engine power, based on a study carried out by IMARES and CEFAS in the mid-1990s (applicable to sole and plaice effort in the beam trawls fisheries). Currently, this method is outdated and during the IBP, a more realistic conversion factor for engine power was investigated to convert nominal fishing effort to effective effort.

To calculate a new Belgian beam trawl tuning series (BE_CBT3), the sales notes and logbooks of the Belgian beam trawl fleet were used to calculate the sole landing rates in the Celtic Sea. To account for misreporting, only the data from vessels with HP >221 Kw and only those fishing trips in which fishing activity was limited to the Celtic Sea were retained for statistical analysis. A GLMM model with all explanatory variables (year, month, ICES statistical rectangle and log-linear effect of a vessel's engine power), a random vessel effect, a variable dispersion parameter governed by monthly, and spatial effects, a logarithmic link function between the linear predictors and response variable, and a Gamma distributed error term showed the best model fit.

The exponent of the estimated coefficients of the year effect were used as landing rate for the tuning series. To convert this landing rate per year to the annual sole age compositions (age 1 to 15 (plus group)) of the Belgian beam trawlers (TBB_DEF_70-99) active in the ICES divisions 27.7.f and 27.7.g, it was standardised by the total weight landed by the pure trips of the large fleet segment per year.

During the IBP, it was decided to include the new Belgian tuning series (BE_CBT3) from 2006 up until the last data year with ages 2–9. The old Belgian CBT from 1971–1996 was trimmed to ages 3–9. The BE_CBT2 series running from 1997 up until the last data year was excluded. Finally, the UK(E&W)-CBT from 1991–2012 was also trimmed to ages 3–8. Due to effort reporting issues, the 2013–2018 UK-CBT indices were not available and could not be used in the assessment. Settings for the UK BTS Q3 survey remained unchanged. More information is provided in the stock annex and the 2019 IBP report (ICES, 2019b).

The internal consistency plots for the main two commercial lpue series, used in the assessment (UK(E&W)-CBT(1991-2012), BEL-CBT(1971-1996) and BEL-CBT3 (2006–2018)), show high consistencies for the entire age range (Figures 36.8–36.9).

Other relevant data

Reports from UK industry suggest that the main issues affecting the fishery in 7.f and 7.g were displacement of effort due to the rectangle closures and the restrictions on the use of 80 mm mesh west of 7°W (Trebilcock and Rozarieux, 2009).

No additional information was received from the Belgian, French and Irish industries.

34.3 Stock assessment

The method used to assess Celtic Sea sole is XSA, using one survey and two commercial tuning-series (Table 36.10). The Belgian commercial beam trawl tuning fleet is now split into two parts (period 1971–1996 and 2006–2018). Table 36.10 also includes tuning indices of the Irish ground fish survey (IGFS-IBTS_Q4), the commercial UK otter trawl fleet (UK(E&W)-COT) and the Belgian commercial beam trawl tuning fleet for 1997–2005 which are not used in this assessment.

Data screening

As mentioned in Section 36.2, the 2013–2018 data from the UK(E&W) commercial tuning series were excluded from the assessment.

There has been a substantial change in perception of the stock due to an Inter-benchmark in which a new Belgian commercial tuning index was constructed focusing on the landings and effort data of trips entirely within divisions 7.f and 7.g. The selected ages of the different tuning series were revised. These changes resulted in a reduced retrospective bias. These changes cause a substantial upward revision of the stock size and a substantial downward revision of the F. In addition, the recruitment of 2015 and 2017 are among the highest in the time-series.

Final update assessment

The final settings used in this year’s assessment are as detailed below:

	2019 assessment		
Fleets:	Years	Ages	α–β
BEL-CBT commercial	1971–1996	3–9	0–1
BEL-CBT3 commercial	2006–2018	2–9	0–1
UK-CBT commercial	1991–2012	3–8	0–1
UK(E&W)-BTS-Q3 survey	1988– 2018	1–5	0.75–0.85
-First data year	1971		
-Last data year	assessment year-1		
-First age	1		
-Last age	10+		
Time-series weights	None		
-Model	Mean q model all ages		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	1.5		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		
Fbar	Ages 4-8		

The catchability residuals for the final XSA are shown in Figure 36.10 and the XSA tuning diagnostics are given in Table 36.11. There may be some indications of a trend in the UK beam trawl fleet (UK(E&W)-CBT) with predominantly positive residuals around 2007.

F shrinkage gets low weights (maximum 4,5%) in determining the survivor estimates for all ages. The weighting of the UK(E&W)-BTS-Q3 decreases for the older ages as only the tuning indices for the younger ages are used in the assessment (age range: 1–5). The estimates for the recruiting age are solely defined by the survey. The commercial fleet BE-CBT3 on the other hand are given more weight (Figure 36.11) for the older ages.

The UK(E&W)-BTS-Q3 is rather consistent in predicting year-class strengths at different ages (Figure 36.5), where the UK and Belgian (new) commercial tuning series have a higher variability in estimating the year-class strength at different ages.

Retrospective patterns for the final run are shown in Figure 36.12. There appears to be a small retrospective bias in estimating F and SSB in the most recent years, at which F was underestimated and SSB was overestimated.

A Mohn's rho analysis was conducted based on the XSA stock assessment results, i.e. the last data year (2018) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 4–8)	recruitment
Mohn's rho value	0.075	-0.038	0.045

The Mohn's rho values for this assessment are low and well below the threshold of 20% imposed by ICES for 2019 assessments, i.e. the current assessment indicates a high consistency.

The final XSA output is given in Table 36.12 (fishing mortalities) and Table 36.13 (stock numbers). A summary of the XSA results is given in Table 36.14 and trends in yield, fishing mortality, recruitment and spawning stock biomass are shown in Figure 36.13.

Comparison with previous assessment

A comparison of the estimates of this year's assessment with last year's is given in Figure 36.14. With Inter-benchmark in 2019 and the addition of the 2018 data, there is a substantial upward revision of the SSB and a strong downward revision of the F.

State of the stock

Trends in landings, SSB, F(4–8) and recruitment are presented in Table 36.14 and Figure 36.13.

During the eighties fishing mortality increased for this stock. In the following decades fishing mortality fluctuated above F_{MSY}. Since 2006, fishing mortality decreased and fluctuated between F_{MSY} and F_{pa}. In 2012 fishing mortality began to increase again, then decreased and is below F_{MSY} since 2017.

Recruitment has fluctuated around 5 million recruits with occasional strong year classes. The 1998 year class is estimated to be the strongest in the time-series and the 2007 year class is also one of the stronger year classes. The 2009 year class is by the lowest in the time-series. The 2014 and 2016 year classes are estimated to be among the highest of the time-series.

SSB has declined almost continuously from the highest value of 7385 t in 1971 to the lowest observed in the time-series in 1998 (1592 t). The exceptional year class of 1998 has increased SSB to above the long-term average. Spawning–stock biomass (SSB) has been above MSY $B_{trigger}$ since 2001. The SSB increased during the last years as a result of the decreasing fishing mortality and continuous good recruitment.

34.4 Short term projections

The long-term GM71-16 recruitment (4975 thousand fish) was assumed for recruitment in 2019 and subsequent years.

Population numbers at the start of 2019, estimated for ages 2 and older, were taken from the XSA output.

Fishing mortality was set as the mean over the last three years scaled to 2018. Weights-at-age in the catch and in the stock are averages for the years 2016–2018. Input to the short-term predictions, the sensitivity analysis and the F_{MSY} analysis are shown in Table 36.15. Results are presented in Table 36.16 (management options) and Table 36.17 (detailed output).

The working group decided to use a TAC constraint for the intermediate year (2019) as recent landings have been close to the TAC or only limited overshot. Moreover, *status quo* fishing mortality gives significantly higher landings (1187 t) in the intermediate year than the agreed TAC (841 t).

Assuming a TAC constraint for 2019 of 841 t (766 t landings), implies a fishing mortality in 2019 of 0.158. The assumed landings using a *status quo* fishing mortality in 2020 is 1252 t. This results in a SSB of 5439 t in 2020 and 5523 t in 2021.

Assuming a TAC constraint for 2019 and a *status quo* F in 2020, the proportional contributions of recent year classes to the predicted landings and SSB are given in Figure 36.15. The assumed GM recruitment accounts for about 2.3% of the landings in 2020 and about 11.3% of the 2021 SSB.

There are no known specific environmental drivers known for this stock.

34.5 MSY explorations

Investigations for possible F_{MSY} candidates for this stock were done at WGCSE 2010. ACOM adopted an F_{MSY} value of 0.31, based on stochastic simulations using a "Ricker" model (PLOT-MSY program). $B_{trigger}$ was set to the B_{pa} value of 2200 t.

Exploratory analysis investigating possible revisions of MSY estimates were conducted at WGCSE 2014 with a recent version of PLotMSY (Cefas, 2014). The simulations indicated that there is no reason for using a particular weighting for any of the stock–recruitment relationships. The resulting F_{MSY} values were in line with the F_{MSY} of 0.31 used at that moment for this stock.

In response to the EC long-term management plans for western EU waters (ICES subareas 5 to 10), ICES WKMSYREF4 (October 2015, Brest (France)) used long-term stochastic simulations (Eqsim) to estimate F_{MSY} and appropriate ranges. The methodology used for stocks with age-based assessments follows the approaches developed in ICES WKMSYREF2 (ICES, 2014b) and WKMSYREF3 (ICES, 2014c) and is documented in the report of WKMSYREF4 (ICES, 2016). Estimates of reference points B_{lim}, B_{pa}, F_{lim} and F_{pa} were provided, and the F_{MSY} ranges [F_{lower}, F_{upper}] deliver no more than 5% reduction in long-term yield compared with MSY.

The full available time-series of sole 7.f and 7.g recruitment was used to fit stock–recruitment models. The simulations indicated that there is no reason for using a particular weighting for any of the stock–recruitment relationships. The workshop decided to use a more conservative approach and to base the analysis on a segmented regression only with a breakpoint set at B_{lim} of 1700 t. B_{lim} was chosen as the lowest value of the SSB time-series (B_{loss}). The revised MSY reference points are more restrictive (F_{MSY}=0.27 instead of 0.31 and MSY $B_{trigger}$=2400 t instead of 2200 t) and demand a larger reduction in F to achieve the MSY objectives as foreseen in the basic regulation.

The Inter-benchmark (IBPBrisol, ICES, 2019) for sole in divisions 27.7f and 27.7g updated MSY and PA reference points according to ICES guidelines. The results of the IBP were presented during the 2019 WGCSE assessment working group. However, the proposed reference points were rejected by the WG and re-estimated during the WG. The F_{MSY} value was perceived too high compared to the value prior to the inter-benchmark. The main reason was that a decreasing trend in recruitment when SSB is high (Ricker model), was not considered realistic for this stock. During the IBP, the F_{MSY} value was estimated based on both the Ricker and Segmented Regression models. The WGCSE 2019 suggested to only consider the segmented regression model.

A working document describes the new calculation of the reference points taking into account the remarks from the WGCSE 2019 (ICES. 2019. WGCSE. ICES Scientific Reports. 1:29. xx pp.).

34.6 Biological reference points

Precautionary approach reference points

The Working Group's current approach to reference points is outlined in Section 7.13.5. Current biological reference points calculated during the WGCSE 2019 are given in the text table below:

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	2228 tonnes	B_{pa}
	F_{MSY}	0.297	EQsim analysis based on the recruitment period 1971–2017
Precautionary approach	B_{lim}	1592 tonnes	B_{loss} estimated in 2018, corresponding to SSB in 1998
	B_{pa}	2228 tonnes	B_{lim} × 1.4
	F_{lim}	0.578	EQsim analysis, based on the recruitment period 1971–2017
	F_{pa}	0.420	$F_{lim} \times \exp(-1.645 \times 0.2) \approx F_{lim} / 1.4$
Management plan*	MAP MSY $B_{trigger}$	2228 tonnes	MSY $B_{trigger}$
	MAP B_{pa}	2228 tonnes	B_{pa}
	MAP B_{lim}	1592 tonnes	B_{lim}
	MAP F_{MSY}	0.297	F_{MSY}
	MAP range F_{lower}	0.165–0.297	Consistent with ranges provided by ICES (2019a), resulting in no more than 5% reduction in long-term yield compared with MSY
	MAP range F_{upper}	0.297–0.499	Consistent with ranges provided by ICES (2019a), resulting in no more than 5% reduction in long-term yield compared with MSY

*** EU multiannual plan (MAP) for the Western Waters (EU, 2019).**

34.7 Management plans

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including sole in ICES divisions 7.f and 7.g.

34.8 Uncertainties and bias in assessment and forecast

Sampling

The major fleets fishing for 7.f and 7.g sole are sampled (approximately 90% of the total landings). Sampling is considered to be at a reasonable level.

Discards

Discard estimates used to be low, but are increasing. Discards are not included in the assessment.

Surveys

The UK(E&W)-BTS-Q3 survey, which is solely responsible for the recruiting estimates, has been able to track year-class strength at-ages greater than 0 rather well in the past. However, the estimates of strong year classes have sometimes been revised downward in previous assessments and may cause bias in the forecast.

Consistency

The assessment provided by the Expert Group shows a substantial upward revision of the SSB and a substantial downward revision of the F. The new assessment shows a low retrospective bias and is thus fairly consistent compared to the assessment of the last year's working group.

Misreporting

Area misreporting is known to have been considerable over the period 2002–2005. This was due to a combination of the good 1998 year class still being an important part of the catch composition and more restrictive TACs. The area misreporting has been corrected for the years 2002–2006 (WGSSDS 2007). At the WKCELT 2014, analysis revealed that there was additional misreporting taking place in 2002–2003 and 2004 which was not accounted for in the first correction done at WGSSDS in 2007. Since 2007 the area misreporting that could be estimated was negligible.

34.9 Recommendation for next Benchmark

Sole in 7.f and 7.g has been benchmarked in February 2014. A new benchmark is scheduled for 2020 (WKFlatC). The issues are listed below.

Tuning series

Problem / Aim	Work needed / Work needed / possible direction of solution	Data needed to be able to do this: are these available / where should these come from?
Commercial UK(E&W)-CBT fleet The UK beam trawl tuning-series is in the current assessment used up to 2012, because of effort reporting issues. A new tuning series was provided with effort in days instead of hours up to 2015. The inclusion of this new tuning series results in a significant upward revision of F and downward revision of SSB from the late 90's up until now, compared to the original tuning series.	*Need to review the new UK-CBT tuning series with effort in days	*UK-CBT tuning series calculations
UK-BTS-Q3 survey The UK-BTS-Q3 survey is the only survey used in the current assessment and is solely providing information on the recruiting age (age 1)	*Investigate if additional survey information (e.g. UK-Q1SWBeam, started in 2006) is available and can be incorporated in the assessment. *Additional survey data can confirm the info provided by the UK-BTS-Q3 survey.	*UK-Q1SWBeam tuning series *other available survey data

Fisheries & ecosystem issues and data:

Trends in mean weights The mean weights have dropped over time (2000–2010) and recently increased again.	*What drives this change? *Is it driven by an ecosystem change? *Is there a similar trend in the weights from other stocks?	*information on the evolution in the Celtic Sea ecosystem

Assessment method

Alternative assessment models to XSA. The current assessment has a developing retrospective pattern that could create issues in the forecast. It would be preferable to use a statistical method and propagated the main uncertainties into the forecasts properly.	*Explore the use of A4A, ASAP and SAM as alternatives to XSA for this stock.	*Standard assessment inputs

34.10 Management considerations

Following the recent strong year classes, SSB is now at its highest level since 1975.

The Celtic Sea is an area without days-at-sea limitations for demersal fisheries. In this context and given that many demersal vessels are very mobile, changes in effort measures in areas other than the Celtic Sea, can influence the effort regime in the Celtic Sea (cfr. increased effort in Celtic Sea for Belgian beamers during 2004–2005 when days-at-sea limitations were in place for the Eastern English Channel).

34.11 Ecosystem considerations

Sole and plaice are predominantly caught by beam trawl fisheries. Beam trawling is known to have an impact on the benthic communities, although less so on soft substrates and in areas which have been historically exploited by this fishing method. Benthic drop-out panels have been shown to release around 75% of benthic invertebrates from the catches. Information from the UK industry (Trebilcock and Rozarieux, 2009) suggests that uptake in 2008 was minimal.

34.12 References

EU. 2019. REGULATION (EU) 2019/472 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. 17pp. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R0472.

ICES. 2009. Report of the Benchmark and Data Compilation Workshop for Flatfish (WKFLAT 2009), 6–13 February 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:31. 192 pp.

ICES. 2014. Report of the Benchmark WKCELT, 3–7 February 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:42. 194 pp.

ICES. 2014b. Report of the Workshop to consider reference points for all stocks (WKMSYREF2), 8–10 January 2014, ICES Headquarters, Copenhagen, Denmark. ICES CM 2014/ACOM:47. 91 pp.

ICES. 2014c. Report of the Joint ICES–MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 147 pp.

ICES. 2016. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 183 pp.

ICES. 2019. Inter-benchmark protocol on Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea) (IBPBrisol). ICES Scientific Reports. 1:ISS NO. 106 pp. http://doi.org/10.17895/ices.pub.4708.

Trebilcock P. and N. de Rozarieux. 2009. National Federation Fishermen's Organisation Annual Fisheries Reports. Cornish Fish Producers Organisation / Seafood Cornwall Training Ltd, March 2009.

Table 36.1 - Sol.27.7fg - Official Nominal landings and data used by the Working Group (t)

Year	Belgium	Denmark	France	Ireland	UK(E.&W,NI.)	UK(Scotland)	Netherlands	Total-Official	Unallocated	Used by WG	TAC
1986	1039 *	2	146	188	611	-	3	1989	-389	1600	
1987	701 *	-	117	9	437	-	-	1264	-42	1222	1600
1988	705 *	-	110	72	317	-	-	1204	-58	1146	1100
1989	684 *	-	87	18	203	-	-	992	0	992	1000
1990	716 *	-	130	40	353	0	-	1239	-50	1189	1200
1991	982 *	-	80	32	402	0	-	1496	-389	1107	1200
1992	543 *	-	141	45	325	6	-	1060	-79	981	1200
1993	575 *	-	108	51	285	11	-	1030	-102	928	1100
1994	619 *	-	90	37	264	8	-	1018	-9	1009	1100
1995	763 *	-	88	20	294	-	-	1165	-8	1157	1100
1996	695 *	-	102	19	265	0	-	1081	-86	995	1000
1997	660 *	-	99	28	251	0	-	1038	-111	927	900
1998	675 *	-	98	42	198	-	-	1013	-138	875	850
1999	604	-	61	51	231	0	-	947	65	1012	960
2000	694	-	74	29	243	-	-	1040	51	1091	1160
2001	720	-	77	35	288	-	-	1120	48	1168	1020
2002	703	-	65	32	318	+	-	1118	227	1345	1070
2003	715	-	124	26	342	+	-	1207	185	1392	1240
2004	735	-	79	33	283	-	-	1130	119	1249	1050
2005	645	-	101	34	217	-	-	997	47	1044	1000
2006	576	-	75	38	232	-	-	921	25	946	950
2007	582	-	85	32	244	-	-	943	2	945	890
2008	466	-	68	28	218	-	-	780	20	800	964
2009	513	-	74	26	194	-	-	807	-2	805	993
2010	620	-	45	27	179	-	-	871	5	876	993
2011	766	-	50	30	168	-	-	1013	16	1029	1241
2012	843	-	48	33	175	-	-	1099	5	1104	1060
2013	789	-	49	42	206	-	-	1086	6	1092	1100
2014	705	-	59	28	252	-	-	1044	-2	1042	1001
2015	671	-	24	27	105	-	-	827	3	830	851
2016	563	-	72	21	175	-	-	831	0	831	779
2017	553	-	49	28	149	-	-	780	-4	776	845
2018 ^	607	-	44	28	171	-	-	849	1	850	920

^Landings are preliminary
* including 7.g-k

Table 36.2 - Sol.27.7fg - Annual length distributions by fleet

	UK (England & Wales)	Belgium	Ireland	
Length (cm)	Beam trawl	Beam trawl	Beam trawl	Otter trawl
17				
18				
19				
20				23
21		111	42	0
22	48	954	70	349
23	0	12489	94	570
24	260	110889	220	1016
25	1253	237907	262	1141
26	6517	272917	828	1958
27	12725	277698	1750	2501
28	17528	256708	1816	5044
29	27843	195191	2181	5417
30	34922	193999	2827	4772
31	44484	137659	2378	6029
32	44758	114111	2804	4836
33	41430	88722	2509	5659
34	31001	72160	1685	3983
35	27989	61220	1306	2751
36	23573	40042	959	2419
37	19241	31740	959	2035
38	14965	26441	903	1072
39	14584	20839	403	581
40	10771	11603	351	549
41	6636	9195	248	723
42	4480	10049	183	341
43	3278	4721	126	210
44	1652	3943	37	0
45	1137	1908	56	12
46	674	1268	37	141
47	292	1303	14	0
48	287	544	13	12
49	75	131		12
50	52	571		0
51	52	108		12
52				
53				
54				
55				
56				
57				
58				
59				
60				
Total	392506	2197139	25063	54166

Table 36.3 - Sol.27.7fg - Catch numbers at age (in thousands)

Age/Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0	0	0	0	0	0	0	0	0	0	0
2	386	541	364	155	119	312	314	317	328	657	602
3	270	903	1883	438	287	833	438	739	561	971	675
4	1341	314	748	863	336	559	349	338	748	875	792
5	625	671	305	411	638	610	271	154	208	584	399
6	433	329	352	209	304	558	244	159	154	180	377
7	537	213	119	239	110	261	404	99	197	62	150
8	763	232	110	97	102	131	120	198	124	96	120
9	376	314	116	109	67	197	28	71	153	100	94
+gp	1220	731	644	541	372	462	365	174	169	352	380
Age/Year	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
1	0	0	0	0	0	0	0	0	0	0	0
2	342	647	671	196	494	318	526	479	277	1458	433
3	830	1078	845	1475	1296	958	464	1163	993	690	1699
4	309	729	605	767	1173	798	878	601	1175	658	644
5	467	284	541	566	526	578	441	621	399	496	409
6	280	349	184	296	358	273	387	237	452	151	253
7	207	225	277	100	193	205	127	188	138	156	61
8	92	192	106	140	87	100	78	82	115	55	59
9	111	52	47	73	103	61	67	24	50	46	28
+gp	326	320	274	240	328	179	268	102	129	162	89
Age/Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
1	0	0	0	0	0	0	0	0	0	0	0
2	354	295	129	177	245	197	608	1721	701	29	132
3	862	790	1154	1036	890	931	1719	1480	1909	1465	776
4	1103	739	1096	905	599	724	834	683	856	2202	1262
5	332	864	419	424	400	297	282	241	434	660	2070
6	186	283	482	229	252	171	143	60	241	249	448
7	161	149	133	192	127	108	80	56	65	95	248
8	63	65	112	57	126	51	31	43	39	54	89
9	83	42	65	43	45	52	23	19	26	36	29
+gp	99	146	109	106	106	87	44	51	81	51	84
Age/Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
1	0	0	0	0	0	0	0	0	0	0	0
2	476	290	684	335	214	607	281	124	160	436	115
3	1927	917	1329	865	452	464	1316	1013	233	1065	629
4	886	897	714	743	559	426	744	1443	1029	343	743
5	889	508	576	474	565	346	347	398	1308	837	217
6	807	426	163	325	277	292	258	273	364	693	430
7	128	373	148	157	198	173	164	194	207	227	421
8	67	51	178	145	76	103	118	133	136	80	138
9	38	44	44	184	109	44	66	66	91	66	84
+gp	55	45	51	70	172	193	118	199	246	166	218
Age/Year	**2015**	**2016**	**2017**	**2018**							
1	0	0	0	0							
2	85	514	228	336							
3	806	428	1067	735							
4	863	607	478	980							
5	382	663	325	272							
6	140	245	326	283							
7	217	86	130	173							
8	117	143	43	88							
9	82	97	68	36							
+gp	132	93	111	134							

Table 36.4 - Sol.27.7fg - Catch weights at age (kg)

Age/Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.039	0.106	0.081	0.063	0.046	0.114	0.098	0.068	0.023	0.048
2	0.106	0.147	0.143	0.137	0.132	0.167	0.169	0.154	0.132	0.144
3	0.167	0.186	0.202	0.205	0.212	0.218	0.235	0.234	0.232	0.234
4	0.222	0.226	0.258	0.270	0.286	0.268	0.297	0.309	0.321	0.316
5	0.272	0.264	0.311	0.329	0.355	0.316	0.355	0.378	0.401	0.392
6	0.315	0.302	0.361	0.385	0.417	0.363	0.409	0.441	0.471	0.461
7	0.352	0.340	0.408	0.436	0.473	0.409	0.460	0.499	0.531	0.523
8	0.383	0.376	0.452	0.483	0.523	0.453	0.506	0.551	0.581	0.579
9	0.408	0.413	0.493	0.525	0.567	0.496	0.548	0.598	0.622	0.627
+gp	0.440	0.538	0.602	0.624	0.672	0.665	0.668	0.720	0.664	0.720

Age/Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.078	0.061	0.085	0.019	0.089	0.046	0.048	0.074	0.013	0.049
2	0.154	0.156	0.173	0.131	0.170	0.144	0.146	0.157	0.109	0.134
3	0.225	0.243	0.255	0.235	0.246	0.236	0.236	0.235	0.198	0.214
4	0.292	0.324	0.330	0.330	0.317	0.321	0.320	0.309	0.280	0.291
5	0.355	0.397	0.398	0.416	0.383	0.400	0.396	0.378	0.355	0.363
6	0.414	0.462	0.459	0.494	0.444	0.471	0.466	0.442	0.424	0.430
7	0.469	0.521	0.514	0.562	0.500	0.536	0.528	0.502	0.487	0.494
8	0.519	0.572	0.561	0.622	0.552	0.594	0.584	0.557	0.543	0.553
9	0.565	0.617	0.602	0.673	0.598	0.645	0.632	0.608	0.592	0.609
+gp	0.665	0.704	0.679	0.772	0.703	0.748	0.740	0.738	0.691	0.747

Age/Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.054	0.073	0.057	0.081	0.068	0.027	0.074	0.079	0.015	0.078
2	0.150	0.147	0.134	0.151	0.147	0.124	0.156	0.163	0.122	0.166
3	0.239	0.216	0.207	0.216	0.220	0.214	0.234	0.244	0.222	0.248
4	0.320	0.281	0.275	0.276	0.288	0.296	0.307	0.320	0.315	0.322
5	0.393	0.342	0.338	0.331	0.351	0.372	0.376	0.393	0.400	0.390
6	0.459	0.398	0.396	0.380	0.409	0.439	0.440	0.462	0.478	0.451
7	0.516	0.451	0.450	0.425	0.462	0.500	0.500	0.528	0.549	0.506
8	0.566	0.499	0.500	0.465	0.510	0.552	0.555	0.589	0.613	0.553
9	0.608	0.543	0.545	0.500	0.553	0.598	0.605	0.647	0.670	0.594
+gp	0.674	0.640	0.645	0.563	0.643	0.677	0.707	0.781	0.765	0.665

Age/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.066	0.054	0.123	0.066	0.068	0.085	0.075	0.128	0.128	0.127
2	0.148	0.130	0.171	0.130	0.145	0.139	0.139	0.164	0.179	0.160
3	0.225	0.202	0.218	0.194	0.219	0.192	0.200	0.198	0.221	0.186
4	0.296	0.271	0.266	0.256	0.288	0.245	0.258	0.258	0.252	0.230
5	0.363	0.336	0.313	0.317	0.354	0.297	0.313	0.309	0.320	0.310
6	0.425	0.399	0.361	0.377	0.415	0.349	0.365	0.305	0.394	0.346
7	0.482	0.457	0.408	0.435	0.473	0.400	0.414	0.412	0.417	0.404
8	0.533	0.513	0.454	0.493	0.528	0.451	0.460	0.521	0.463	0.404
9	0.579	0.564	0.501	0.549	0.578	0.501	0.503	0.532	0.481	0.530
+gp	0.677	0.704	0.639	0.721	0.690	0.618	0.609	0.536	0.622	0.591

Age/Year	2011	2012	2013	2014	2015	2016	2017	2018
1	0.140	0.110	0.125	0.073	0.134	0.130	0.11	0.124
2	0.162	0.162	0.179	0.170	0.163	0.187	0.181	0.162
3	0.184	0.213	0.205	0.208	0.200	0.211	0.216	0.208
4	0.223	0.247	0.253	0.273	0.254	0.262	0.263	0.258
5	0.272	0.279	0.285	0.366	0.319	0.293	0.323	0.303
6	0.354	0.324	0.334	0.393	0.352	0.353	0.353	0.347
7	0.420	0.341	0.350	0.425	0.443	0.462	0.394	0.398
8	0.447	0.377	0.475	0.484	0.516	0.434	0.504	0.485
9	0.475	0.409	0.412	0.530	0.436	0.476	0.468	0.483
+gp	0.622	0.538	0.576	0.685	0.549	0.604	0.484	0.568

Table 36.5 - Sol.27.7fg - Stock weights at age (kg)

Age/Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
2	0.076	0.113	0.113	0.113	0.113	0.113	0.145	0.113	0.113	0.113	0.113	0.113	0.113
3	0.136	0.157	0.142	0.159	0.141	0.160	0.174	0.167	0.163	0.157	0.159	0.164	0.175
4	0.190	0.222	0.203	0.221	0.215	0.210	0.236	0.257	0.255	0.238	0.232	0.255	0.262
5	0.239	0.298	0.263	0.305	0.295	0.269	0.366	0.360	0.392	0.354	0.306	0.356	0.370
6	0.406	0.351	0.334	0.450	0.353	0.354	0.392	0.413	0.437	0.394	0.385	0.487	0.488
7	0.472	0.352	0.322	0.448	0.593	0.432	0.454	0.521	0.485	0.622	0.462	0.543	0.633
8	0.389	0.593	0.400	0.464	0.423	0.462	0.505	0.508	0.595	0.556	0.551	0.610	0.606
9	0.346	0.417	0.539	0.624	0.465	0.425	0.907	0.560	0.657	0.704	0.737	0.766	0.464
+gp	0.625	0.588	0.613	0.654	0.666	0.620	0.725	0.723	0.692	0.737	0.674	0.799	0.827

Age/Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
2	0.118	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.148	0.113	0.113	0.104
3	0.173	0.175	0.18	0.153	0.158	0.152	0.164	0.179	0.184	0.196	0.135	0.143	0.186
4	0.274	0.268	0.273	0.242	0.233	0.227	0.247	0.23	0.265	0.267	0.227	0.233	0.284
5	0.429	0.472	0.398	0.361	0.363	0.308	0.369	0.356	0.388	0.392	0.329	0.335	0.387
6	0.517	0.433	0.462	0.473	0.466	0.465	0.476	0.536	0.498	0.47	0.43	0.441	0.486
7	0.641	0.462	0.546	0.468	0.687	0.546	0.523	0.376	0.751	0.492	0.521	0.54	0.573
8	0.613	0.48	0.636	0.587	0.687	0.526	0.753	0.859	0.754	0.576	0.599	0.629	0.647
9	0.836	0.944	0.89	0.82	0.676	0.542	0.847	0.735	0.475	0.636	0.661	0.705	0.708
+gp	0.876	0.844	0.861	0.833	0.799	0.745	0.917	0.779	0.869	0.717	0.775	0.866	0.822

Age/Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.108	0.115
2	0.113	0.113	0.11	0.062	0.113	0.113	0.158	0.116	0.149	0.143	0.117	0.141	0.151
3	0.178	0.195	0.204	0.169	0.187	0.189	0.205	0.176	0.213	0.188	0.177	0.176	0.19
4	0.276	0.282	0.317	0.306	0.312	0.289	0.258	0.248	0.275	0.235	0.236	0.232	0.223
5	0.386	0.371	0.433	0.434	0.434	0.403	0.317	0.329	0.337	0.284	0.294	0.274	0.287
6	0.495	0.454	0.541	0.534	0.538	0.512	0.381	0.415	0.399	0.334	0.35	0.261	0.349
7	0.598	0.529	0.635	0.603	0.619	0.609	0.449	0.502	0.459	0.386	0.406	0.389	0.357
8	0.689	0.593	0.712	0.648	0.68	0.691	0.521	0.587	0.52	0.441	0.46	0.542	0.437
9	0.766	0.644	0.772	0.677	0.725	0.757	0.594	0.667	0.579	0.496	0.513	0.526	0.501
+gp	0.926	0.750	0.878	0.709	0.790	0.881	0.850	0.886	0.782	0.709	0.687	0.564	0.620

Age/Year	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	0.112	0.13	0.086	0.107	0.049	0.113	0.11	0.091	0.115
2	0.143	0.143	0.151	0.14	0.146	0.109	0.158	0.153	0.134
3	0.183	0.172	0.186	0.182	0.193	0.184	0.186	0.201	0.194
4	0.226	0.204	0.213	0.232	0.237	0.23	0.229	0.236	0.236
5	0.28	0.25	0.249	0.265	0.304	0.295	0.273	0.291	0.282
6	0.333	0.331	0.297	0.305	0.335	0.359	0.336	0.322	0.335
7	0.399	0.381	0.347	0.337	0.377	0.417	0.403	0.373	0.375
8	0.41	0.425	0.398	0.403	0.412	0.468	0.439	0.483	0.437
9	0.495	0.438	0.428	0.394	0.502	0.459	0.496	0.451	0.493
+gp	0.615	0.638	0.583	0.554	0.640	0.598	0.580	0.574	0.596

Table 36.6 - Sol.27.7fg - Discard rates

Country	Year	Landings (L) (t)				Discards (D) (t)
BE		TBB	OTB	GNS	other	
	2012	786.828	55.767	0	0	21.023
	2013	746.751	40.031	0	1.475	19.061
	2014	666.183	36.317	0	0.604	12.08
	2015	640.168	33.623	0	0	12.729
	2016	525.63	37.865	0	0	18.765
	2017	522.954	26.169	0	0	28.803
	2018	569.601	37.147	0	0	60.106
UK	2012	153.388	21.528	4.346	1.138	0
	2013	177.3898	22.156	2.421	2.258	7.325
	2014	240.910	7.825	2.699	0.7851	2.950
	2015	87.039	13.878	2.917	0.7047	0.195
	2016	157.221	11.584	4.284	0.279	6.597
	2017	129.651	12.923	4.425	1.211	6.895
	2018	146.459	19.136	2.897	1.640	7.896
IR	2012	12.136	19.276	0	1.392	6
	2013	15.996	16.583	0	18.686	1
	2014	11.893	14.234	0	1.614	7.4
	2015	12.439	13.354	0.183	1.444	14.3
	2016	7.112	14.039	0.129	0.043	5.202
	2017	7.405	20.309	0.115	0.512	23.738
	2018	8.886	18.953	0.180	0.057	64.631
		total L	L corresponding with discard info	% coverage of L	total D	rate
	2012	1104.28	818.24	0.74	27.02	0.032
	2013	1092.76	978.88	0.90	27.39	0.027
	2014	1041.88	934.01	0.90	22.40	0.023
	2015	830.44	769.80	0.93	27.22	0.034
	2016	830.66	720.15	0.87	30.56	0.041
	2017	776.30	697.70	0.90	59.44	0.079
	2018	850.08	766.00	0.88	132.63	0.148
	average 16-18			0.88	74.21	0.089

Table 36.7 - Sol.27.7fg - Indices of abundance (No/100km) for UK(E&W)-BTS-Q3

	0	1	2	3	4	5	6	7	8	9
1988	30	81	326	49	19	5	0	0	0	0
1989	144	222	331	176	20	15	7	4	2	2
1990	30	385	313	50	16	4	7	3	0	0
1991	32	241	517	67	17	15	4	0	2	2
1992	4	394	260	139	30	18	10	1	2	1
1993	3	169	320	43	19	1	2	2	1	1
1994	1	333	387	99	14	7	7	0	0	2
1995	27	124	222	52	11	6	12	1	1	1
1996	3	150	212	54	23	6	3	3	1	3
1997	32	433	180	18	11	12	4	3	5	0
1998	91	770	411	50	10	8	4	2	1	4
1999	24	2464	250	32	13	6	3	4	1	0
2000	13	916	1356	31	22	5	0	2	1	1
2001	22	379	600	259	19	8	5	2	0	2
2002	8	663	239	127	102	12	6	2	3	0
2003	12	392	530	46	25	47	8	3	3	0
2004	56	749	378	86	13	19	37	3	3	0
2005	37	343	225	32	13	6	4	14	1	2
2006	11	273	201	40	13	7	0	2	10	0
2007	91	358	108	43	13	7	6	3	3	11
2008	5	1039	105	13	15	6	8	3	3	4
2009	1	509	318	24	7	8	3	3	3	2
2010	18	85	471	121	17	2	4	8	3	2
2011	18	502	52	138	69	7	2	6	3	0
2012	13	542	231	8	53	24	1	1	1	3
2013	9	279	518	43	13	24	15	1	5	1
2014	34	244	257	76	13	5	23	8	1	1
2015	28	746	48	44	31	7	3	13	6	0
2016	26	573	359	12	27	13	7	3	5	8
2017	6	1046	174	67	13	16	17	4	3	11
2018	27	434	906	279	45	17	10	15	11	4
Mean	27.60	510.91	348.54	74.79	23.36	11.09	7.12	3.83	2.72	2.16

Table 36.8 - Sol.27.7fg- Indices of effort.

Year	England & Wales				Belgium		Ireland		
	Otter trawl[1]	Otter trawl[6]	Beam trawl[1]	Beam trawl[6]	Beam trawl[3]	Beam trawl[5]	Otter trawl[4]	Scottish seine[5]	Beam trawl[5]
1971	-	-	-	-	11.06	-	-	-	-
1972	45.72	-	-	-	8.44	-	-	-	-
1973	45.28	-	-	-	17.39	-	-	-	-
1974	38.94	-	-	-	18.83	-	-	-	-
1975	33.53	-	-	-	16.38	-	-	-	-
1976	25.61	-	-	-	28.07	-	-	-	-
1977	27.16	-	-	-	24.11	-	-	-	-
1978	27.08	-	2.50	-	18.09	-	-	-	-
1979	23.84	-	1.96	-	18.90	-	-	-	-
1980	26.43	-	4.31	-	29.02	-	-	-	-
1981	24.10	-	6.24	-	35.39	-	-	-	-
1982	19.20	-	9.95	-	28.77	-	-	-	-
1983	17.61	620	12.35	195	34.95	-	-	-	-
1984	23.16	1723	13.55	901	33.48	-	-	-	-
1985	25.24	1493	18.70	1101	40.49	-	-	-	-
1986	21.18	1125	20.72	973	52.46	-	-	-	-
1987	24.43	1211	38.76	1681	37.26	-	-	-	-
1988	20.09	838	25.62	1102	42.92	-	-	-	-
1989	17.61	966	20.26	861	53.58	-	-	-	-
1990	22.56	1229	30.77	1256	40.27	-	-	-	-
1991	18.57	1066	40.81	1667	18.05	-	-	-	-
1992	16.00	898	35.78	1420	25.47	-	-	-	-
1993	13.79	836	39.64	1669	31.27	-	-	-	-
1994	9.48	623	37.03	2219	38.35	-	-	-	-
1995	8.46	580	37.59	2303	47.81	-	63.33	6.43	20.69
1996	8.67	593	39.78	2391	47.63	53.27	59.97	9.73	26.70
1997	8.14	577	43.00	2661	51.98	57.36	65.00	16.07	28.16
1998	7.13	517	47.84	2846	52.11	57.79	72.25	14.88	35.33
1999	5.69	395	50.87	3058	55.03	55.11	51.48	8.01	41.04
2000	4.05	284	51.19	3133	56.05	51.34	60.56	9.86	36.91
2001	4.42	309	49.32	3172	52.06	54.90	69.37	16.33	39.50
2002	6.10	416	37.53	2652	43.24	49.60	77.20	20.88	31.49
2003	9.94	696	40.71	2669	42.81	62.73	86.78	20.07	49.39
2004	9.42	641	32.37	2503	-	78.73	97.12	18.42	57.77
2005	12.09	876	27.73	1968	-	64.50	124.67	14.64	51.67
2006	12.97	924	18.57	1330	-	49.61	118.04	14.78	63.21
2007	10.66	798	15.37	1407	-	45.91	135.36	15.81	56.59
2008	10.13	711	13.83	1202	-	28.72	125.41	11.65	38.66
2009	8.97	656	12.31	1105	-	30.65	137.11	8.18	39.11
2010	7.67	565	14.44	1162	-	32.46	140.79	9.68	40.97
2011	7.44	525	13.79	868	-	38.77	120.33	11.05	36.07
2012	7.79	543	12.77	1408	-	46.25	127.68	14.21	40.49
2013	4.27	280	0.78	1611	-	45.23	118.20	13.15	38.74
2014	-	156	-	959	-	31.30	127.34	12.46	37.88
2015	-	79	-	726	-	31.79	132.69	9.29	37.79
2016	-	0	-	915	-	32.34	148.17	10.44	39.67
2017	-	93	-	986	-	33.35	136.05	9.76	35.24
2018*	-	127	-	1071	-	31.48	108.22	9.69	37.44

[1]Division VIIf only - Fishing hours (x10^3) corrected for fishing power
[2]Days at sea VIIfg
[3]Fishing hours (x 10^3) corrected for fishing power using P = 0.000204 BHP^1.23
[4]Division VIIg only - Fishing hours (x10^3)
[5]Fishing hours (x10^3)
[6]Division VIIf only - Days fished corrected for fishing power
* provisional

Table 36.9 - Sol.27.7fg - LPUE

	UK	England & Wales						Belgium		Ireland		
	BT Survey[4]	Otter trawl[1]	Otter trawl[6]	Otter trawl[1]	Otter trawl[6]	Beam trawl[1]	Beam trawl[6]	Beam trawl[2]	Beam trawl[5]	Otter trawl[5]	Scottish sein[5]	Beam trawl[5]
Year	Division VIIfg	Division VIIf	Division VIIf	Division VIIg[3]	Division VIIg[3]	Division VIIf	Division VIIf	Division VIIfg	Division VIIfg	Division VIIg	Division VIIg	Division VIIg
1971	-	-	-	-	-	-	-	47.92	-	-	-	-
1972	-	2.42	-	2.11	-	-	-	37.06	-	-	-	-
1973	-	2.45	-	0.98	-	-	-	39.47	-	-	-	-
1974	-	2.10	-	1.83	-	-	-	37.81	-	-	-	-
1975	-	1.82	-	1.79	-	-	-	31.41	-	-	-	-
1976	-	2.02	-	1.30	-	-	-	30.50	-	-	-	-
1977	-	1.84	-	1.21	-	-	-	27.90	-	-	-	-
1978	-	1.82	-	1.17	-	13.99	-	23.35	-	-	-	-
1979	-	1.80	-	1.15	-	14.83	-	33.19	-	-	-	-
1980	-	1.86	-	1.55	-	18.99	-	29.73	-	-	-	-
1981	-	1.45	-	0.60	-	13.58	-	24.03	-	-	-	-
1982	-	1.73	-	0.56	-	11.79	-	25.93	-	-	-	-
1983	-	2.22	30.54	1.14	35.75	13.50	201.80	22.18	-	-	-	-
1984	-	1.53	19.53	1.70	28.04	13.59	204.65	20.78	-	-	-	-
1985	-	1.55	26.58	1.55	37.31	12.52	240.45	17.94	-	-	-	-
1986	-	1.38	25.55	0.99	21.27	10.94	247.74	17.83	-	-	-	-
1987	-	0.94	19.85	1.15	36.02	7.31	179.34	17.32	-	-	-	-
1988	79.52	0.62	11.13	0.27	8.88	4.39	110.35	15.29	-	-	-	-
1989	150.02	0.99	17.36	0.87	18.75	5.38	130.42	11.33	-	-	-	-
1990	93.61	0.76	13.41	0.67	18.08	5.98	148.47	15.64	-	-	-	-
1991	122.06	0.69	12.26	0.85	16.20	4.80	119.52	24.24	-	-	-	-
1992	121.41	1.00	17.90	1.25	20.99	4.14	105.84	18.57	-	-	-	-
1993	76.37	0.55	8.85	0.25	4.27	4.80	118.08	15.21	-	-	-	-
1994	109.74	0.90	13.00	0.27	3.50	4.26	70.00	13.94	-	-	-	-
1995	69.91	0.96	13.76	0.87	12.75	4.52	73.20	13.62	-	0.40	0.62	0.81
1996	71.71	0.66	9.69	0.52	6.95	3.94	65.05	11.27	11.45	0.73	0.05	0.88
1997	81.67	0.86	12.55	0.52	6.42	3.28	53.81	9.96	9.68	0.42	0.23	1.16
1998	137.11	0.60	8.24	0.40	4.85	2.67	44.86	10.12	9.64	0.48	0.11	1.11
1999	168.46	0.91	13.25	0.74	8.18	3.21	52.36	11.26	12.14	0.17	0.09	0.50
2000	228.46	0.49	7.01	1.85	23.26	3.36	53.85	11.90	13.77	0.19	0.05	0.26
2001	158.08	1.14	17.1	2.13	27.5	4.02	62.39	13.25	13.60	0.31	0.55	0.18
2002	121.89	0.78	11.61	3.60	47.01	5.64	79.47	18.71	17.80	0.43	0.29	0.14
2003	123.91	0.57	8.03	0.00	0.00	5.23	80.85	19.48	11.40	0.12	0.03	0.19
2004	152.03	0.60	8.84	0.19	2.70	5.75	76.09	-	9.17	0.19	0.02	0.20
2005	76.28	0.76	10.67	0.26	3.07	4.94	70.02	-	9.78	0.14	0.00	0.29
2006	68.96	1.16	16.40	0.60	6.23	5.97	81.57	-	10.63	0.11	0.05	0.26
2007	80.95	0.78	10.75	1.00	15.04	9.87	92.17	-	11.53	0.13	0.02	0.20
2008	115.96	0.82	11.94	0.86	10.67	9.46	94.85	-	14.35	0.12	0.02	0.29
2009	90.64	0.94	13.13	0.46	6.88	6.37	69.37	-	14.01	0.10	0.00	0.28
2010	109.55	1.01	13.59	0.63	8.63	5.92	79.90	-	16.68	0.13	0.01	0.20
2011	99.47	1.47	20.78	0.31	4.47	6.72	109.20	-	17.90	0.19	0.01	0.20
2012	101.45	1.67	24.10	0.47	5.17	6.47	80.16	-	17.01	0.15	0.01	0.48
2013	119.38	1.76	27.81	0.34	4.62	-	82.82	-	16.54	0.14	0.01	0.65
2014	86.75	-	6.19	-	11.56	-	107.25	-	21.30	0.12	-	0.34
2015	85.45	-	51.13	-	5.62	-	103.07	-	20.14	0.11	-	0.31
2016	113.55	-	0.00	-	0.00	-	113.16	-	16.25	0.10	0.01	0.20
2017	111.38	-	31.29	-	18.09	-	100.03	-	15.72	0.18	0.05	0.22
2018*	206.44		36.37	-	4.86	-	119.89	-	18.09	0.18	-	0.27

[1]Kg/hr corrected for GRT.
[2]Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23
[3]Division VIIg (East).
[4]Kg/100km
[5]Kg/hour
[6]Kg/day
* provisional

Table 36.10 - Sol.27.7fg - Tuning series

Indices in bold are used in the assessment

BE-CBT **Belgium Beam trawl (Effort = Corrected formula)**

1971	1996												
1	1	0	1										
2	14												
11.06	111	77	384	179	124	154	218	108	32	107	76	21	40
8.44	132	220	76	163	80	52	57	76	39	23	14	38	14
17.39	179	926	368	150	173	58	54	57	108	32	23	21	45
18.83	102	287	565	270	136	156	64	79	90	75	38	39	37
16.38	69	167	195	370	176	64	59	39	33	29	37	18	23
28.07	199	533	357	391	357	167	84	125	40	17	21	51	35
24.11	220	307	244	190	170	283	84	20	35	39	36	18	52
18.09	173	403	185	84	86	54	108	38	11	21	61	8	9
18.9	222	379	506	141	104	133	84	103	35	12	16	4	6
29.02	438	647	583	389	119	45	63	66	92	22	25	16	10
35.39	429	481	565	286	268	107	86	67	86	74	33	13	13
28.77	245	594	221	334	200	148	66	80	54	19	41	16	25
34.95	363	605	409	159	196	127	108	29	44	32	15	12	12
33.48	372	467	334	300	102	153	59	26	26	16	24	19	18
40.49	52	909	471	372	208	75	104	46	68	15	29	16	10
52.46	377	900	823	359	230	140	49	58	65	29	50	6	9
37.23	247	664	438	344	191	119	47	29	20	4	14	2	16
42.92	362	293	603	250	197	77	51	36	26	19	19	13	16
53.58	244	680	428	471	179	145	62	13	24	10	19	3	17
40.27	231	742	663	181	240	70	59	17	26	12	2	4	12
18.05	1028	380	225	131	29	26	9	7	13	8	4	1	2
25.47	327	1062	376	210	98	14	14	7	9	5	0	0.3	2
31.27	296	615	629	161	81	75	38	36	19	4	2	1	1
38.35	205	524	523	530	176	71	20	15	16	11	6	5	7
47.81	77	827	838	277	250	78	48	21	17	8	1	5	2
47.63	104	737	579	258	130	88	29	17	9	12	3	3	0

BE-CBT2 Belgium Beam trawl (Effort = Corrected formula)

1997	2005												
1	1	0	1										
2	14												
49.22	179	615	351	224	133	69	51	21	15	17	7	3	2
52.04	156	724	571	176	94	79	31	23	20	8	6	9	7
48.2	459	1196	579	176	61	33	10	13	5	3	1	3	0
56.08	1436	1118	414	118	19	15	13	6	2	9	3	1	1
52.33	591	1375	676	292	166	36	15	10	10	6	16	1	1
50.28	105	1230	1623	543	155	53	26	14	1	1	1	4	1
66.57	146	494	852	1167	289	146	46	18	11	2	7	0	1
86.7	365	1456	633	562	390	52	15	9	2	2	1	0	0
69.77	166	650	571	360	279	144	23	16	4	5	2	0	1

BE-CBT3 **Belgium Beam trawl**

	2006	2018														
	1	1	0	1												
	1	15														
1		0.042	0.996	1.783	0.836	0.596	0.161	0.118	0.084	0.031	0.013	0.006	0.003	0.001	0.001	0.000
1		0.025	0.430	1.040	0.843	0.494	0.281	0.151	0.117	0.101	0.009	0.010	0.001	0.007	0.005	0.000
1		0.040	0.317	0.551	0.667	0.762	0.327	0.193	0.077	0.103	0.084	0.025	0.001	0.000	0.000	0.000
1		0.000	0.793	0.536	0.452	0.344	0.289	0.190	0.088	0.039	0.052	0.073	0.019	0.006	0.000	0.017
1		0.009	0.415	1.754	0.963	0.401	0.277	0.167	0.132	0.055	0.046	0.015	0.012	0.023	0.000	0.006
1		0.011	0.160	1.298	1.767	0.465	0.303	0.222	0.145	0.064	0.106	0.025	0.030	0.011	0.000	0.018
1		0.000	0.196	0.257	1.149	1.513	0.405	0.212	0.135	0.088	0.055	0.065	0.022	0.032	0.039	0.025
1		0.000	0.551	1.059	0.352	0.866	0.667	0.215	0.049	0.054	0.022	0.014	0.015	0.010	0.017	0.022
1		0.008	0.207	0.913	0.974	0.279	0.506	0.503	0.124	0.091	0.042	0.033	0.035	0.024	0.024	0.061
1		0.000	0.136	1.341	1.323	0.538	0.167	0.286	0.148	0.108	0.044	0.049	0.017	0.021	0.014	0.015
1		0.040	0.991	0.693	0.963	1.041	0.326	0.053	0.172	0.114	0.006	0.012	0.008	0.007	0.003	0.015
1		0.000	0.505	2.010	0.830	0.564	0.621	0.197	0.046	0.079	0.071	0.011	0.002	0.009	0.010	0.027
1		0.000	0.801	1.458	2.030	0.436	0.512	0.325	0.085	0.043	0.053	0.072	0.016	0.001	0.001	0.023

Table 34.10 - Sol.27.7fg -Tuning series continued

Indices in bold are used in the assessment

UK(E&W)-CBT	**UK(E+W) 7.f Beam trawl**													
1991	**2012**													
1	**1**	**0**	**1**											
1	**14**													
1	0	51.6	**97.9**	**188.8**	**171**	**59.7**	**66.7**	**23.4**	20.3	16.3	13.3	4.5	3.6	3.7
1	0	17.7	**219.6**	**102.7**	**82.9**	**69.1**	**22.4**	**21.3**	9.8	13.4	5.3	2.6	1	1
1	1.9	5.8	**82.8**	**197.9**	**76.7**	**49.7**	**40.8**	**11**	23.6	8.5	4.9	4.2	2.7	3.9
1	0	23.2	**79.8**	**58.9**	**115.6**	**35.7**	**31.3**	**19.3**	11.4	15.3	7.9	4.6	4.8	3.8
1	0	15.9	**86.9**	**73**	**56**	**105**	**24.1**	**30.4**	22.5	8.1	8.1	4.1	4.8	2.7
1	0.2	22.2	**95.9**	**128.3**	**70.3**	**44.8**	**52.5**	**14.5**	13.1	12	3.7	9.2	4.7	2.2
1	0	9.7	**60.3**	**86.2**	**68.7**	**52.8**	**27.1**	**38.7**	11	11.2	4.6	4.6	3.2	1.7
1	0	12.6	**101.3**	**73.4**	**76.5**	**50.4**	**16.6**	**13.3**	19.7	6.5	5.6	3.8	1.9	1.3
1	0.4	31.2	**203.5**	**107.1**	**52.4**	**49.6**	**28**	**13.1**	5.6	10.3	3.7	1.9	0.8	0
1	0.1	72.2	**151.8**	**149.8**	**75.4**	**26.9**	**28**	**19.5**	9.1	4	7.8	2.5	1.7	2
1	0	37.3	**271.9**	**98.5**	**88.9**	**48.2**	**19.1**	**16.7**	10.6	8.6	3.4	7.2	1.3	2.3
1	0	11	**149.3**	**375.1**	**89.7**	**63.4**	**28.4**	**18.2**	13.6	8.6	5.5	3.6	3.5	0.9
1	0.1	17.8	**100.5**	**175.5**	**368.9**	**76.8**	**45**	**17.7**	5.6	6.8	2.5	3.8	0.6	1.8
1	0	18.9	**90.8**	**65.1**	**113.5**	**179.6**	**34.1**	**26.7**	14.5	6.5	3.1	4.9	0.8	0.5
1	0	27.4	**77.8**	**126**	**54.5**	**60.1**	**115.4**	**14.6**	13.5	3.6	4.8	2	1.7	0.9
1	0	15.7	**85.5**	**93.9**	**103.3**	**31.9**	**39.4**	**68.9**	13.2	7.7	3.8	2.2	1.6	0.7
1	0.9	17.9	**77.1**	**89.4**	**77.4**	**82.1**	**31.9**	**40.5**	76.3	8.1	7.5	3.9	1.6	3.2
1	0	12.1	**76**	**100.3**	**67.1**	**52**	**54.1**	**18.9**	31.6	42.3	10	4.9	2.4	3.1
1	0	23	**54**	**72**	**72**	**63**	**27**	**29**	12	12	29	4	3	1
1	0	2	**98**	**65**	**48**	**46**	**34**	**19**	18	5	5	13	1	1
1	0.4	7.1	**57.3**	**124.8**	**41**	**34.4**	**22.4**	**19.3**	12.1	12.4	3.8	7.1	16.4	0.9
1	0	2.8	**14.1**	**83.6**	**107.7**	**26.2**	**18.2**	**16.7**	8.9	7	6	1.2	3	3.2

UK(E&W)-BTS-Q3	**UK(E+W) 7.f Corystes (automated indices since 1995)**									
1988	**2018**									
1	**1**	**0.75**	**0.85**							
0	**9**									
74.120	22	**60**	**242**	**36**	**14**	**4**	0	0	0	0
91.909	132	**204**	**304**	**162**	**18**	**14**	6	4	2	2
69.858	21	**269**	**219**	**35**	**11**	**3**	5	2	0	0
123.410	40	**297**	**638**	**83**	**21**	**18**	5	0	3	2
125.078	5	**493**	**325**	**174**	**37**	**23**	12	1	2	1
127.672	6	**207**	**436**	**52**	**28**	**3**	2	2	1	1
120.816	1	**424**	**430**	**133**	**23**	**11**	9	0	0	3
114.886	31	**142**	**255**	**60**	**13**	**7**	14	1	1	1
118.592	3	**178**	**251**	**64**	**27**	**7**	3	4	1	3
114.886	37	**498**	**207**	**21**	**13**	**14**	5	3	6	0
114.886	104	**885**	**472**	**58**	**11**	**9**	5	2	1	5
118.592	29	**2922**	**297**	**38**	**16**	**7**	4	5	1	0
118.592	16	**1086**	**1608**	**37**	**26**	**6**	0	2	1	1
118.592	26	**449**	**711**	**307**	**23**	**9**	6	2	0	2
118.592	9	**786**	**283**	**151**	**121**	**14**	7	2	3	0
118.592	14	**465**	**628**	**55**	**30**	**56**	9	3	3	0
114.886	64	**860**	**434**	**99**	**15**	**22**	42	4	3	0
118.592	44	**407**	**267**	**38**	**16**	**7**	5	17	1	2
118.592	13	**324**	**238**	**47**	**16**	**8**	0	2	12	0
118.592	108	**424**	**128**	**51**	**16**	**8**	7	3	4	13
118.592	6	**1232**	**124**	**15**	**18**	**7**	9	4	3	5
118.592	1	**604**	**377**	**29**	**8**	**10**	4	3	3	2
118.592	21	**101**	**558**	**144**	**20**	**2**	5	9	4	2
118.592	21	**595**	**62**	**164**	**82**	**8**	2	7	3	0
118.592	16	**643**	**274**	**9**	**63**	**28**	1	1	1	3
118.592	11	**331**	**614**	**51**	**16**	**29**	18	1	6	1
118.592	40	**289**	**305**	**90**	**16**	**6**	27	9	1	1
118.592	33	**885**	**57**	**52**	**37**	**8**	4	16	7	0
118.592	31	**680**	**426**	**14**	**32**	**15**	8	4	6	9
118.592	7	**1240**	**206**	**80**	**15**	**19**	20	5	4	13
118.592	32	**515**	**1074**	**331**	**53**	**20**	11	18	13	5

Table 34.10 - Sol.27.7fg -Tuning series continued

Indices in bold are used in the assessment

IR - GFS : Irish Groundfish Survey (IBTS 4th Qtr) - 7.g Sole number at age (Interim indices for new Celtic Explorer series)

	2003	2014									
	1	1	0.79	0.92							
	1	10									
832		1.0	5.2	1.1	3.2	3.0	4.1	4.0	0.0	1.0	0.0
980		1.0	8.0	6.0	5.0	1.0	2.0	1.0	0.0	0.0	1.0
845		0.0	0.0	6.0	2.0	4.0	2.0	2.0	0.0	0.0	0.0
1046		0.0	0.0	4.0	4.0	6.0	4.0	1.0	0.0	0.0	0.0
1168		0.0	2.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
1139		2.0	9.0	7.0	3.0	2.0	0.0	2.0	0.0	1.0	0.0
1018		0.0	15.0	3.0	4.0	1.0	1.0	2.0	1.0	0.0	2.0
1381		0.0	12.0	24.7	9.1	8.2	1.0	3.0	3.9	0.0	2.1
1392		2.0	0.0	20.1	8.0	6.1	3.1	0.0	1.0	1.0	3.7
1470		0.0	7.0	3.0	3.0	3.0	1.0	0.0	0.0	0.0	0.0
1439		0.0	2.0	10.0	7.5	1.8	2.0	3.8	2.0	1.0	1.0
1487		0.1	3.4	7.7	8.0	6.1	3.7	0.5	0.1	0.1	0.1

UK (E+W) TRAWL 107F. (Processed as unsexed - from 2001WG)
(LPUE data reprocessed in 2014. Effort changed from hours to days)

	1991	2017									
	1	1	0	1							
	1	10									
1066		0.0	1.7	6.4	12.9	11.1	3.5	3.3	1.1	0.8	0.8
899		0.0	8.4	29.6	10.4	6.9	5.9	1.5	1.8	0.8	0.9
836		0.1	0.8	3.7	10.2	3.8	2.0	1.4	0.3	0.6	0.2
623		0.0	1.7	4.3	2.4	4.9	1.7	1.5	1.1	0.6	0.7
580		0.0	2.3	12.0	5.3	2.5	4.5	0.9	1.2	0.7	0.2
593		0.1	2.8	4.3	5.0	2.4	1.4	1.4	0.3	0.5	0.2
577		0.0	2.0	8.2	6.9	4.1	2.1	0.7	1.2	0.4	0.3
517		0.0	2.0	4.0	2.7	2.1	1.3	0.4	0.3	0.5	0.1
396		0.1	8.5	12.4	3.5	1.6	1.2	0.8	0.4	0.1	0.3
284		0.0	0.9	1.8	1.6	0.7	0.2	0.2	0.2	0.1	0.0
309		0.0	1.5	10.1	2.3	1.7	0.6	0.3	0.2	0.2	0.1
416		0.0	0.5	4.8	8.3	1.8	1.0	0.3	0.2	0.2	0.1
696		0.1	1.6	2.8	3.3	6.7	1.0	0.7	0.3	0.1	0.1
641		0.0	1.0	4.8	2.9	3.3	4.9	0.9	0.6	0.4	0.2
876		0.0	2.7	5.0	6.3	2.3	2.6	5.0	0.7	0.7	0.2
924		0.0	0.4	7.2	7.8	9.7	3.0	4.0	7.0	1.3	0.9
798		0.0	0.5	2.6	3.6	3.3	3.3	1.2	1.5	2.6	0.3
711		0.0	0.4	3.6	5.0	3.9	2.9	2.8	0.9	1.6	2.2
656		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
565		0.0	0.2	5.5	3.8	2.4	2.2	1.1	0.8	1.0	0.2
525		0.0	0.7	5.8	8.8	3.2	3.3	2.4	1.3	1.2	0.9
543		0.0	3.8	2.9	9.6	10.0	3.4	2.5	1.5	1.3	0.8
280		0.0	0.3	5.4	0.9	2.3	2.6	1.2	0.6	0.4	0.2
156		0.0	0.0	0.3	0.6	0.1	0.4	0.4	0.2	0.1	0.1
79		0.0	0.1	0.6	1.4	1.1	0.5	0.5	0.4	0.2	0.1
0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
93		0.0	0.3	2.6	1.8	0.8	1.3	0.5	0.2	0.4	0.3

Table 36.11. Sol.27.7fg – Diagnostics.

```
FLR XSA Diagnostics 2019-05-14 10:21:23

CPUE data from indices

Catch data for 48 years. 1971 to 2018. Ages 1 to 10.

           fleet first age last age first year last year alpha beta
1         BE-CBT         3        9       1971      1996     0    1
2        BE-CBT3         2        9       2006      2018     0    1
3    UK(E&W)-CBT         3        8       1991      2012     0    1
4 UK(E&W)-BTS-Q3         1        5       1988      2018  0.75 0.85


 Time series weights :
   Tapered time weighting not applied

Catchability analysis :
    Catchability independent of size for all ages
    Catchability independent of age for ages >   7

Terminal population estimation :
    Survivor estimates shrunk towards the mean F
    of the final   5 years or the  5 oldest ages.
    S.E. of the mean to which the estimates are shrunk =   1.5
    Minimum standard error for population
    estimates derived from each fleet =  0.3
   prior weighting not applied

Regression weights
     year
age   2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
    year
age   2009  2010  2011  2012  2013  2014  2015  2016  2017  2018
  1  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
  2  0.074 0.049 0.074 0.040 0.083 0.028 0.033 0.066 0.039 0.029
  3  0.152 0.202 0.226 0.173 0.357 0.148 0.247 0.206 0.171 0.153
  4  0.255 0.343 0.317 0.335 0.368 0.402 0.277 0.266 0.332 0.210
  5  0.275 0.304 0.277 0.467 0.442 0.374 0.331 0.316 0.199 0.286
  6  0.314 0.302 0.369 0.390 0.428 0.380 0.389 0.326 0.226 0.239
  7  0.309 0.260 0.346 0.469 0.399 0.446 0.298 0.393 0.256 0.162
  8  0.240 0.319 0.310 0.387 0.295 0.400 0.189 0.291 0.307 0.247
  9  0.270 0.214 0.264 0.321 0.292 0.508 0.390 0.213 0.196 0.407
  10 0.270 0.214 0.264 0.321 0.292 0.508 0.390 0.213 0.196 0.407


 XSA population number (Thousand)
      age
year       1     2    3    4    5    6    7   8   9  10
  2009  6758  8995 3461 1986 1514 1138  684 507 195 854
  2010  2023  6115 7561 2690 1392 1041  752 454 360 643
  2011  4735  1830 5266 5590 1727  930  696 525 299 899
  2012  6372  4284 1538 3802 3685 1184  582 446 348 939
  2013  4861  5766 3724 1170 2461 2090  725 329 274 687
  2014  3051  4398 4803 2357  733 1431 1232 440 222 573
  2015  9333  2760 3870 3748 1426  456  885 714 267 428
  2016  6969  8445 2417 2735 2570  927  280 595 535 512
  2017 13524  6306 7152 1780 1898 1695  606 171 402 655
  2018  5997 12237 5489 5456 1156 1408 1223 424 114 422


 Estimated population abundance at 1st Jan  2019
      age
year   1    2     3    4    5   6    7   8   9 10
  2019 0 5427 10752 4264 4000 786 1003 942 300 68
```

Fleet: BE-CBT

Log catchability residuals.

age	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	-0.512	0.161	0.374	-0.109	-0.350	0.398	0.129	0.048	0.056
4	0.269	-0.186	0.121	-0.041	-0.310	-0.019	0.000	0.053	0.384
5	0.303	0.151	0.151	0.125	0.001	0.247	-0.094	-0.450	0.105
6	0.103	0.268	-0.113	0.422	0.215	-0.210	0.049	-0.260	0.028
7	0.431	-0.030	-0.325	0.120	0.293	0.110	0.170	-0.410	0.584
8	0.276	0.171	-0.409	-0.014	-0.428	0.513	-0.026	-0.155	0.298
9	0.020	-0.107	-0.199	0.187	-0.075	0.123	-0.306	-0.213	0.062

age	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	0.024	0.190	0.085	-0.059	-0.228	-0.087	-0.021	-0.193	-0.571
4	0.246	-0.112	-0.169	-0.278	-0.375	-0.156	-0.113	-0.019	-0.212
5	0.159	-0.169	0.012	-0.268	-0.023	0.065	-0.084	-0.030	-0.076
6	-0.105	0.121	0.138	-0.254	-0.169	-0.008	0.015	0.302	-0.080
7	-0.888	0.117	0.331	0.082	0.152	-0.118	-0.010	0.608	-0.045
8	-0.176	-0.130	0.343	0.460	-0.102	0.162	-0.285	-0.156	0.558
9	0.022	0.115	0.487	-0.183	-0.285	-0.023	-0.039	0.226	0.082

age	1989	1990	1991	1992	1993	1994	1995	1996
3	-0.511	0.148	0.387	0.386	0.250	-0.245	0.050	0.198
4	-0.168	0.108	0.059	0.294	-0.068	0.200	0.367	0.125
5	-0.136	-0.066	-0.019	0.213	-0.215	0.142	-0.006	-0.037
6	0.047	0.171	-0.396	-0.023	-0.395	0.302	-0.115	-0.052
7	0.166	0.200	-0.466	-0.874	0.228	-0.115	0.090	-0.400
8	0.150	0.325	-0.300	-0.926	0.472	-0.656	0.021	-0.194
9	-0.215	-0.084	-0.140	-0.204	0.442	0.173	-0.010	-0.114

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	3	4	5	6	7	8	9
Mean_Logq	-5.0597	-4.8417	-4.8479	-4.8637	-4.941	-4.941	-4.941
S.E_Logq	0.2670	0.2670	0.2670	0.2670	0.267	0.267	0.267

Fleet: BE-CBT3

Log catchability residuals.

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2	1.051	0.488	-0.047	0.078	-0.196	0.070	-0.592	0.163	-0.573	-0.526	0.361	-0.035	-0.241
3	0.525	0.241	-0.204	-0.512	-0.084	-0.012	-0.425	0.192	-0.309	0.338	0.130	0.093	0.028
4	-0.010	-0.103	-0.123	-0.405	0.089	-0.047	-0.084	-0.072	0.260	0.045	0.036	0.349	0.066
5	-0.053	-0.102	0.232	-0.414	-0.161	-0.242	0.267	0.102	0.148	0.119	0.185	-0.181	0.100
6	-0.344	-0.268	0.005	-0.206	-0.166	0.067	0.127	0.076	0.156	0.192	0.125	0.119	0.118
7	-0.552	0.138	-0.106	-0.012	-0.260	0.144	0.335	0.097	0.438	0.135	-0.351	0.123	-0.127
8	-0.938	-0.153	-0.069	-0.514	0.039	-0.018	0.115	-0.636	0.048	-0.361	0.023	-0.054	-0.364
9	-0.041	-0.276	0.218	-0.364	-0.657	-0.299	-0.097	-0.369	0.468	0.402	-0.321	-0.410	0.347

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-9.3293	-8.1376	-7.811	-7.7952	-7.8722	-7.9801	-7.9801	-7.9801
S.E_Logq	0.3000	0.3000	0.300	0.3000	0.3000	0.3000	0.3000	0.3000

Fleet: UK(E&W)-CBT

Log catchability residuals.

age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	0.055	0.310	-0.151	-0.251	-0.123	0.179	-0.331	-0.128	0.229	-0.187	-0.468
4	0.502	0.092	-0.027	-0.513	-0.399	0.230	0.012	-0.164	-0.159	-0.127	-0.689
5	0.529	0.043	-0.092	-0.244	-0.266	-0.064	-0.045	0.137	-0.084	-0.246	-0.446
6	0.385	0.156	-0.245	-0.380	0.128	-0.063	0.137	0.007	0.052	-0.378	-0.317
7	0.364	-0.062	0.086	-0.209	-0.149	-0.047	0.028	-0.322	-0.140	-0.107	-0.355
8	0.522	-0.161	-0.306	0.027	0.490	0.026	0.248	0.010	0.087	0.000	-0.129

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	-0.193	-0.164	-0.394	-0.125	0.240	0.574	0.857	0.351	0.030	-0.093	-0.215
4	-0.105	-0.271	-0.527	-0.014	0.255	0.288	0.724	0.620	0.096	0.052	0.125
5	-0.270	0.061	-0.247	-0.266	0.328	0.365	0.233	0.571	0.103	-0.236	0.139
6	-0.237	0.044	0.026	-0.346	-0.113	0.537	0.309	0.529	0.139	0.026	-0.397
7	-0.061	-0.119	0.133	0.187	-0.011	0.419	0.559	0.095	0.048	-0.224	-0.111
8	0.491	0.109	0.260	-0.009	0.517	0.630	0.469	0.435	-0.002	-0.104	0.060

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	3	4	5	6	7	8
Mean_Logq	-6.8983	-6.2752	-5.9454	-5.7335	-5.6402	-5.6402
S.E_Logq	0.2947	0.2947	0.2947	0.2947	0.2947	0.2947

Fleet: UK(E&W)-BTS-Q3

Log catchability residuals.

age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-1.379	-0.180	-0.477	-0.229	0.198	-0.688	0.347	-0.654	-0.653	0.094
2	0.132	0.405	0.508	0.263	0.220	0.401	0.432	0.193	0.205	-0.142
3	0.387	1.151	0.196	0.565	0.632	0.012	0.851	0.218	0.537	-0.528
4	-0.152	0.529	-0.091	0.149	0.774	-0.215	0.341	-0.194	0.612	0.136
5	-0.137	0.406	-0.058	0.687	1.007	-1.033	-0.253	0.066	0.080	0.928

age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	0.530	0.856	0.469	0.204	0.302	0.038	0.567	-0.045	0.033	0.098
2	0.344	-0.228	0.647	0.402	0.018	0.365	0.359	-0.318	-0.173	-0.537
3	0.245	-0.427	-0.620	0.529	0.453	-0.071	0.261	-0.520	-0.415	-0.097
4	0.122	0.114	0.212	-0.089	0.540	-0.167	-0.292	-0.607	-0.454	-0.462
5	0.630	0.630	-0.163	-0.142	0.243	0.661	0.363	-0.269	-0.618	-0.486

age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	0.367	0.040	-0.542	0.381	0.161	-0.232	0.098	0.099	0.128	0.066	0.000
2	-0.816	-0.489	0.269	-0.702	-0.094	0.450	-0.022	-1.230	-0.310	-0.766	0.214
3	-1.169	-0.804	0.057	0.568	-1.146	-0.148	-0.002	-0.256	-1.130	-0.500	1.170
4	-0.238	-0.955	-0.272	0.386	0.523	0.357	-0.316	-0.041	0.119	-0.156	-0.111
5	-0.708	-0.240	-1.742	-0.593	0.054	0.473	0.054	-0.359	-0.330	0.115	0.732

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	1	2	3	4	5
Mean_Logq	-7.1506	-7.3196	-8.5522	-9.0505	-9.2560
S.E_Logq	0.5081	0.5081	0.5081	0.5081	0.5081

```
 Terminal year survivor and F summaries:

Age =  1 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2017

Fleet =  UK(E&W)-BTS-Q3
                   1
Survivors   5427.000
Raw weights    4.759


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "UK(E&W)-BTS-Q3" "5427"       "0.458"   "Inf"     "Inf"     "1" "1"         "0"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "5427"   ""       ""       ""        "0"




Age =  2 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2016

Fleet =  BE-CBT3
                   2
Survivors   8450.000
Raw weights    4.218


Fleet =  fshk
                   2
Survivors   6297.000
Raw weights    0.444


Fleet =  UK(E&W)-BTS-Q3
                    2        1
Survivors   13322.000 11480.00
Raw weights     4.436     4.62


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT3"        "8450"       "0.48"    "Inf"     "Inf"     "1" "0.307"     "0.037"
[2,] "fshk"           "6297"       "1.478"   "Inf"     "Inf"     "1" "0.032"     "0.05"
[3,] "UK(E&W)-BTS-Q3" "12348"      "0.327"   "0.074"   "0.226"   "2" "0.66"      "0.026"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "10752"  ""       ""       ""        "0.029"




Age =  3 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2015

Fleet =  BE-CBT3
                   3        2
Survivors   4385.000 4118.000
Raw weights    8.709    3.588


Fleet =  fshk
                   3
Survivors   2767.000
Raw weights    0.444
```

```
Fleet =  UK(E&W)-BTS-Q3
                    3        2       1
Survivors   13740.000 1981.000 4845.00
Raw weights     2.107    3.773    3.93


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT3"        "4305"       "0.263"   "0.028"   "0.106"   "2" "0.545"     "0.151"
[2,] "fshk"           "2767"       "1.39"    "Inf"     "Inf"     "1" "0.02"      "0.226"
[3,] "UK(E&W)-BTS-Q3" "4297"       "0.291"   "0.513"   "1.763"   "3" "0.435"     "0.151"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "4264"   ""       ""       ""        "0.153"




Age =  4 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2014

Fleet =  BE-CBT3
                   4       3        2
Survivors   4271.000 4389.00 5737.000
Raw weights    9.003    6.93    2.778


Fleet =  fshk
                   4
Survivors   2397.000
Raw weights    0.444


Fleet =  UK(E&W)-BTS-Q3
                   4        3        2        1
Survivors   3579.000 2426.000 2934.000 4417.000
Raw weights    5.069    1.677    2.921    3.043


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT3"        "4508"       "0.199"   "0.072"   "0.362"   "3" "0.587"     "0.189"
[2,] "fshk"           "2397"       "1.35"    "Inf"     "Inf"     "1" "0.014"     "0.33"
[3,] "UK(E&W)-BTS-Q3" "3416"       "0.237"   "0.112"   "0.473"   "4" "0.399"     "0.242"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "4000"   ""       ""       ""        "0.21"




Age =  5 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2013

Fleet =  BE-CBT3
                  5        4       3       2
Survivors   868.000 1113.000 895.000 464.000
Raw weights   8.348    5.991   4.451   1.845


Fleet =  fshk
                  5
Survivors   658.000
Raw weights   0.444
```

```
Fleet =  UK(E&W)-BTS-Q3
                   5       4       3      2      1
Survivors   1634.000 672.000 254.000 230.00 867.00
Raw weights    2.022   3.373   1.077   1.94   2.02


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT3"         "888"        "0.17"    "0.133"   "0.782"   "4" "0.655"     "0.257"
[2,] "fshk"            "658"        "1.3"     "Inf"     "Inf"     "1" "0.014"     "0.333"
[3,] "UK(E&W)-BTS-Q3" "621"        "0.225"   "0.343"   "1.524"   "5" "0.331"     "0.35"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "786"    ""       ""       ""        "0.286"




Age =  6 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2012

Fleet =  BE-CBT3
                   6       5        4        3       2
Survivors   1129.000 837.000 1041.000 1408.000 566.000
Raw weights    8.752   7.176    5.502    3.924   1.634


Fleet =  fshk
                  6
Survivors   644.000
Raw weights   0.444


Fleet =  UK(E&W)-BTS-Q3
                   5        4       3       2      1
Survivors   1126.000 1130.000 777.000 981.000 796.00
Raw weights    1.738    3.098   0.949   1.718   1.79


     Fleet             Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT3"         "1016"       "0.15"    "0.112"   "0.747"   "5" "0.735"     "0.236"
[2,] "fshk"            "644"        "1.331"   "Inf"     "Inf"     "1" "0.012"     "0.351"
[3,] "UK(E&W)-BTS-Q3" "990"        "0.224"   "0.078"   "0.348"   "5" "0.253"     "0.242"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "1003"   ""       ""       ""        "0.239"




Age =  7 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2011

Fleet =  BE-CBT3
                  7       6       5       4       3        2
Survivors   830.000 1061.00 1133.000 985.000 691.000 1108.000
Raw weights   9.451    7.54    5.495   4.165   3.279    1.293


Fleet =  fshk
                  7
Survivors   383.000
Raw weights   0.444
```

```
Fleet =  UK(E&W)-BTS-Q3
                  5       4       3        2        1
Survivors   677.000 903.000 939.000 1477.000 1106.000
Raw weights   1.331   2.345   0.793    1.359    1.416


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT3"        "945"        "0.139"   "0.072"   "0.518"   "6" "0.802"     "0.161"
[2,] "fshk"           "383"        "1.383"   "Inf"     "Inf"     "1" "0.011"     "0.359"
[3,] "UK(E&W)-BTS-Q3" "982"        "0.223"   "0.125"   "0.561"   "5" "0.186"     "0.156"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "942"    ""       ""       ""        "0.162"




Age =  8 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2010

Fleet =  BE-CBT3
                  8       7       6       5       4       3       2
Survivors   208.000 339.000 340.000 338.000 389.000 364.000 166.000
Raw weights   4.681   6.719   4.852   3.486   2.331   1.488   0.612


Fleet =  fshk
                  8
Survivors   243.000
Raw weights   0.444


Fleet =  UK(E&W)-BTS-Q3
                  5       4      3       2       1
Survivors   210.000 219.000 259.00 273.000 439.000
Raw weights   0.844   1.312   0.36   0.644   0.671


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT3"        "308"        "0.142"   "0.093"   "0.655"   "7" "0.85"      "0.241"
[2,] "fshk"           "243"        "1.326"   "Inf"     "Inf"     "1" "0.016"     "0.297"
[3,] "UK(E&W)-BTS-Q3" "258"        "0.23"    "0.131"   "0.57"    "5" "0.135"     "0.282"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "300"    ""       ""       ""        "0.247"




Age =  9 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2009

Fleet =  BE-CBT3
                 9      8      7      6      5      4     3      2
Survivors   97.000 65.000 48.000 83.000 79.000 64.000 45.00 73.000
Raw weights  4.371  2.934  3.673  2.488  1.712  1.185  0.91  0.362


Fleet =  fshk
                  9
Survivors   134.000
Raw weights   0.444
```

```
Fleet =  UK(E&W)-BTS-Q3
                 5      4     3     2      1
Survivors   72.000 98.000 22.00 34.00 40.000
Raw weights  0.415  0.667  0.22  0.38  0.396


Fleet =  UK(E&W)-CBT
                 3
Survivors   55.000
Raw weights  0.819


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT3"        "70"         "0.146"   "0.102"   "0.699"   "8" "0.841"     "0.4"
[2,] "fshk"           "134"        "1.224"   "Inf"     "Inf"     "1" "0.021"     "0.229"
[3,] "UK(E&W)-BTS-Q3" "55"         "0.225"   "0.262"   "1.164"   "5" "0.099"     "0.486"
[4,] "UK(E&W)-CBT"    "55"         "0.331"   "Inf"     "Inf"     "1" "0.039"     "0.486"

 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "68"     ""       ""       ""        "0.407"
```

Table 36.12 - Sol.27.7fg - Fishing mortality

Age/Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0846	0.0701	0.1077	0.0563	0.0431	0.1327	0.0736	0.0842	0.0729	0.2466
3	0.1478	0.2590	0.3273	0.1638	0.1261	0.4161	0.2488	0.2216	0.1881	0.2841
4	0.4004	0.2294	0.3159	0.2182	0.1637	0.3417	0.2729	0.2761	0.3247	0.4417
5	0.4118	0.3176	0.3238	0.2553	0.2223	0.4416	0.2460	0.1658	0.2437	0.4017
6	0.3314	0.3520	0.2446	0.3416	0.2717	0.2755	0.2814	0.1991	0.2231	0.3058
7	0.4256	0.2406	0.1846	0.2329	0.2704	0.3507	0.2924	0.1572	0.3604	0.1176
8	0.3660	0.2925	0.1687	0.2015	0.1321	0.5246	0.2404	0.2029	0.2697	0.2656
9	0.2815	0.2246	0.2078	0.2244	0.1869	0.3582	0.1780	0.1953	0.2141	0.3221
+gp	0.2815	0.2246	0.2078	0.2244	0.1869	0.3582	0.1780	0.1953	0.2141	0.3221
FBAR 4-8	0.3870	0.2864	0.2475	0.2499	0.2120	0.3868	0.2666	0.2002	0.2843	0.3065

Age/Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1480	0.0857	0.1682	0.1232	0.0503	0.1086	0.1263	0.1140	0.1339	0.0917
3	0.3824	0.2787	0.3739	0.3069	0.3837	0.4720	0.2819	0.2442	0.3501	0.3984
4	0.3511	0.2686	0.3739	0.3302	0.4472	0.5296	0.5280	0.4005	0.5040	0.6313
5	0.3281	0.3202	0.3759	0.4651	0.5181	0.5576	0.4778	0.5526	0.4856	0.6555
6	0.4353	0.3581	0.3740	0.3948	0.4439	0.6439	0.5594	0.6038	0.5766	0.6988
7	0.3999	0.4017	0.4827	0.5061	0.3448	0.5144	0.8494	0.4857	0.5889	0.6971
8	0.3109	0.4051	0.7080	0.3892	0.4606	0.5030	0.4868	0.8251	0.5910	0.7813
9	0.3995	0.4661	0.3744	0.3259	0.4514	0.6446	0.7071	0.6229	0.5727	0.7830
+gp	0.3995	0.4661	0.3744	0.3259	0.4514	0.6446	0.7071	0.6229	0.5727	0.7830
FBAR 4-8	0.3651	0.3508	0.4629	0.4171	0.4429	0.5497	0.5803	0.5735	0.5492	0.6928

Age/Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.2203	0.1283	0.0966	0.0800	0.0446	0.0647	0.0741	0.0429	0.1198	0.1489
3	0.3073	0.3819	0.3587	0.2880	0.4469	0.5206	0.4641	0.3905	0.5494	0.4189
4	0.4436	0.4636	0.4061	0.5249	0.7171	0.6699	0.5735	0.7566	0.6407	0.3879
5	0.5284	0.4836	0.4094	0.5681	0.5674	0.5954	0.6274	0.5521	0.6684	0.3376
6	0.4904	0.4982	0.3747	0.6477	0.6386	0.6187	0.7634	0.5313	0.4985	0.2530
7	0.4877	0.3319	0.6053	0.5151	0.6398	0.5003	0.7432	0.7817	0.4510	0.3279
8	0.5873	0.3047	0.5966	0.4640	0.8185	0.5542	0.6356	0.6718	0.4723	0.4130
9	0.7420	0.5968	0.8067	0.9195	1.0544	0.7744	1.0370	0.5191	0.6500	0.5253
+gp	0.7420	0.5968	0.8067	0.9195	1.0544	0.7744	1.0370	0.5191	0.6500	0.5253
FBAR 4-8	0.5075	0.4164	0.4784	0.5440	0.6763	0.5877	0.6686	0.6587	0.5462	0.3439

Age/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1086	0.0079	0.0230	0.1121	0.0593	0.1748	0.1127	0.0572	0.0736	0.0495
3	0.2192	0.3081	0.2688	0.4686	0.2911	0.3695	0.3103	0.1961	0.1519	0.2021
4	0.4044	0.3747	0.4207	0.4929	0.3675	0.3439	0.3232	0.3013	0.2554	0.3433
5	0.4046	0.5528	0.6390	0.5232	0.5161	0.3783	0.3580	0.3870	0.2747	0.3037
6	0.5864	0.3802	0.8058	0.4871	0.4531	0.2739	0.3382	0.3261	0.3142	0.3017
7	0.4201	0.4271	0.7132	0.4967	0.3868	0.2480	0.4089	0.3164	0.3090	0.2602
8	0.3527	0.6571	0.8040	0.3715	0.3334	0.2859	0.3638	0.3154	0.2404	0.3186
9	0.4156	0.5684	0.8035	0.8719	0.3957	0.4726	0.4753	0.4540	0.2704	0.2137
+gp	0.4156	0.5684	0.8035	0.8719	0.3957	0.4726	0.4753	0.4540	0.2704	0.2137
FBAR 4-8	0.4336	0.4784	0.6765	0.4743	0.4114	0.3060	0.3584	0.3292	0.2787	0.3055

Age/Year	2011	2012	2013	2014	2015	2016	2017	2018
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0739	0.0401	0.0828	0.0279	0.0329	0.0662	0.0388	0.029436
3	0.2258	0.1735	0.3574	0.1481	0.2471	0.2060	0.1706	0.152522
4	0.3167	0.3349	0.3682	0.4024	0.2772	0.2656	0.3318	0.21041
5	0.2773	0.4671	0.4423	0.3736	0.3307	0.3164	0.1985	0.285906
6	0.3690	0.3904	0.4284	0.3802	0.3894	0.3257	0.2259	0.238705
7	0.3463	0.4687	0.3990	0.4457	0.2980	0.3927	0.2557	0.16181
8	0.3097	0.3869	0.2948	0.4003	0.1891	0.2907	0.3073	0.247246
9	0.2639	0.3212	0.2920	0.5081	0.3899	0.2127	0.1957	0.407104
+gp	0.2639	0.3212	0.2920	0.5081	0.3899	0.2127	0.1957	0.407104
FBAR 4-8	0.3238	0.4096	0.3865	0.4004	0.2969	0.3182	0.2639	0.2288

Table 36.13 - Sol.27.7fg - Stock numbers at age (start of year, in thousands)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	9290	4143	3291	3280	2914	5142	4568	5424	3490	5083
2	5002	8406	3749	2977	2968	2637	4652	4133	4907	3157
3	2065	4159	7091	3045	2547	2573	2090	3911	3438	4128
4	4272	1612	2905	4625	2339	2031	1535	1474	2836	2577
5	1946	2590	1160	1916	3364	1797	1306	1057	1012	1854
6	1613	1167	1706	759	1343	2437	1046	924	811	718
7	1628	1048	742	1209	488	926	1674	714	685	587
8	2617	963	745	559	866	337	590	1131	552	432
9	1611	1642	650	570	413	687	180	420	835	381
+gp	5212	3809	3602	2822	2289	1609	2348	1027	921	1339
TOTAL	35258	29539	25640	21763	19533	20177	19989	20215	19486	20257

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	4836	4856	6724	4653	5581	3118	5667	4437	3670	8566
2	4599	4375	4394	6084	4210	5050	2821	5127	4015	3320
3	2232	3589	3634	3360	4867	3623	4099	2250	4139	3178
4	2811	1378	2457	2262	2237	3000	2045	2798	1595	2639
5	1499	1791	953	1530	1471	1294	1599	1091	1696	872
6	1123	977	1176	592	869	793	671	897	568	944
7	478	657	618	732	361	505	377	347	444	289
8	472	290	398	345	399	231	273	146	193	223
9	300	313	175	177	212	228	127	152	58	97
+gp	1208	915	1074	1031	693	722	369	604	245	248
TOTAL	19559	19142	21604	20767	20900	18564	18047	17849	16622	20376

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	4177	4464	4454	3427	3283	3984	5450	6259	14451	7909
2	7751	3780	4039	4030	3100	2970	3605	4932	5664	13076
3	2741	5627	3008	3318	3366	2683	2519	3029	4275	4546
4	1930	1824	3475	1902	2251	1948	1442	1433	1854	2233
5	1270	1121	1038	2095	1018	994	902	735	609	884
6	409	678	625	624	1074	522	496	436	383	282
7	425	227	373	389	295	513	255	209	232	211
8	130	236	147	184	210	141	282	110	87	134
9	92	65	157	73	105	84	73	135	51	49
+gp	323	207	187	253	174	205	171	225	96	131
TOTAL	19249	18228	17504	16294	14876	14045	15195	17502	27701	29454

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	4262	6766	5215	5861	4958	3651	4476	9941	6758	2023
2	7157	3857	6122	4718	5304	4486	3304	4050	8995	6115
3	10194	5809	3462	5414	3816	4523	3408	2671	3461	7561
4	2706	7408	3863	2394	3066	2581	2828	2261	1986	2690
5	1371	1634	4609	2295	1323	1921	1656	1852	1514	1392
6	571	828	851	2201	1231	715	1191	1047	1138	1041
7	198	287	512	344	1224	708	492	768	684	752
8	137	118	170	227	189	752	500	296	507	454
9	80	87	55	69	142	123	511	314	195	360
+gp	248	123	159	99	144	142	194	494	854	643
TOTAL	26924	26917	25016	23622	21397	19601	18559	23694	26091	23032

	2011	2012	2013	2014	2015	2016	2017	2018
1	4735	6372	4861	3051	9333	6969	13524	5997
2	1830	4284	5766	4398	2760	8445	6306	12237
3	5266	1538	3724	4803	3870	2417	7152	5489
4	5590	3802	1170	2357	3748	2735	1780	5456
5	1727	3685	2461	733	1426	2570	1898	1156
6	930	1184	2090	1431	456	927	1695	1408
7	696	582	725	1232	885	280	606	1223
8	525	446	329	440	714	595	171	424
9	299	348	274	222	267	535	402	114
+gp	899	939	687	573	428	512	655	422
TOTAL	22496	23180	22087	19240	23888	25984	34188	33927

Table 36.14 - Sol.27.7fg - Summary

	RECRUITS Age 1	SSB	BIOMASS	LANDINGS	FBAR 4-8	YIELD/SSB
1971	9290	7385	8809	1861	0.387	0.25
1972	4143	5820	7427	1278	0.286	0.22
1973	3291	4884	6175	1391	0.248	0.28
1974	3280	5128	6113	1105	0.250	0.22
1975	2914	4574	5403	919	0.212	0.2
1976	5142	3958	4964	1350	0.387	0.34
1977	4568	4322	5566	961	0.267	0.22
1978	5424	3433	4735	780	0.200	0.23
1979	3490	3560	4754	954	0.284	0.27
1980	5083	3714	4922	1314	0.306	0.35
1981	4836	3191	4356	1212	0.365	0.38
1982	4856	3301	4542	1128	0.351	0.34
1983	6724	3439	4905	1373	0.463	0.4
1984	4653	3695	5138	1266	0.417	0.34
1985	5581	3146	4611	1328	0.443	0.42
1986	3118	3200	4438	1600	0.550	0.5
1987	5667	2395	3595	1222	0.580	0.51
1988	4437	2556	3735	1146	0.574	0.45
1989	3670	2000	3121	992	0.549	0.5
1990	8566	2267	3732	1189	0.693	0.52
1991	4177	1955	3417	1107	0.507	0.57
1992	4464	2280	3685	981	0.416	0.43
1993	4454	2362	3721	928	0.478	0.39
1994	3427	2142	3154	1009	0.544	0.47
1995	3283	2048	2979	1157	0.676	0.57
1996	3984	1996	2969	995	0.588	0.5
1997	5450	1751	2893	927	0.669	0.53
1998	6259	1592	3013	875	0.659	0.55
1999	14451	1792	4184	1012	0.546	0.56
2000	7909	1926	3848	1091	0.344	0.57
2001	4262	3073	5313	1168	0.434	0.38
2002	6766	3938	5796	1345	0.478	0.34
2003	5215	3568	5408	1547	0.677	0.43
2004	5861	3119	4727	1398	0.474	0.45
2005	4958	2995	4678	1118	0.411	0.37
2006	3651	2536	3968	946	0.306	0.37
2007	4476	2627	3784	945	0.358	0.36
2008	9941	2393	4289	800	0.329	0.33
2009	6758	2758	5127	805	0.279	0.29
2010	2023	3046	4866	876	0.306	0.29
2011	4735	3329	4814	1029	0.324	0.31
2012	6372	3236	4613	1104	0.410	0.34
2013	4861	2797	4430	1093	0.387	0.39
2014	3051	2819	4102	1042	0.400	0.37
2015	9333	2769	4586	830	0.297	0.3
2016	6969	2867	5118	831	0.318	0.29
2017	13524	3063	5976	776	0.264	0.25
2018	5997	3557	6404	850	0.229	0.24
Arith. Mean	5528	3131	4644	1103	0.415	0.38
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 36.15 - Sol.27.7fg

Input for catch forecast and Fmsy analysis

Input: F in 2019: TAC constraint for 2019 (841 t)
F in 2020-2021: mean 16-18 scaled to 2018
Catch and stock weights: mean 16-18
N age 1 in 2019-2021: GM(71-16)

2019

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4975	0.1	0	0	0	0.105333	0	0.121333
2	5427	0.1	0.14	0	0	0.148333	0.02624	0.176667
3	10751	0.1	0.45	0	0	0.193667	0.10333	0.211667
4	4264	0.1	0.88	0	0	0.233667	0.15774	0.261
5	4000	0.1	0.98	0	0	0.282	0.15638	0.306333
6	786	0.1	1	0	0	0.331	0.15433	0.351
7	1003	0.1	1	0	0	0.383667	0.15821	0.418
8	942	0.1	1	0	0	0.453	0.16505	0.474333
9	300	0.1	1	0	0	0.48	0.15924	0.475667
+gp	322	0.1	1	0	0	0.536007	0.15924	0.55215
fbar 4-8							0.15834	

2020

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4975	0.1	0	0	0	0.105333	5.87E-17	0.121333
2	4502	0.1	0.14	0	0	0.148333	0.037916	0.176667
3	4783	0.1	0.45	0	0	0.193667	0.149316	0.211667
4	8773	0.1	0.88	0	0	0.233667	0.227949	0.261
5	3295	0.1	0.98	0	0	0.282	0.22598	0.306333
6	3096	0.1	1	0	0	0.331	0.223018	0.351
7	609	0.1	1	0	0	0.383667	0.228627	0.418
8	775	0.1	1	0	0	0.453	0.238504	0.474333
9	722	0.1	1	0	0	0.48	0.23012	0.475667
+gp	480	0.1	1	0	0	0.536007	0.23012	0.55215
fbar 4-8							0.228815	

2021

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4975	0.1	0	0	0	0.105333	5.87E-17	0.121333
2	4502	0.1	0.14	0	0	0.148333	0.037916	0.176667
3	3922	0.1	0.45	0	0	0.193667	0.149316	0.211667
4	3728	0.1	0.88	0	0	0.233667	0.227949	0.261
5	6320	0.1	0.98	0	0	0.282	0.22598	0.306333
6	2379	0.1	1	0	0	0.331	0.223018	0.351
7	2241	0.1	1	0	0	0.383667	0.228627	0.418
8	439	0.1	1	0	0	0.453	0.238504	0.474333
9	552	0.1	1	0	0	0.48	0.23012	0.475667
+gp	864	0.1	1	0	0	0.536007	0.23012	0.55215
fbar 4-8							0.228815	

Table 36.16 - Sol.27.7fg - Management option table

F in 2019: TAC constraint for 2019 (841 t)
F in 2020-2021: mean 16-18 scaled to 2018
Catch and stock weights: mean 16-18
N age 1 in 2019-2021: GM(71-16)

2019				
Biomass	SSB	FMult	FBar	Landings
6924	4420	0.692005	0.15834131	766

2020				2021
SSB	FMult	FBar	Landings	SSB
5439	0.0000	NA	0	6763
5439	0.1000	0.0229	137	6627
5439	0.2000	0.0458	272	6493
5439	0.3000	0.0686	404	6362
5439	0.4000	0.0915	533	6235
5439	0.5000	0.1144	659	6109
5439	0.6000	0.1373	783	5987
5439	0.7000	0.1602	904	5867
5439	0.8000	0.1831	1022	5750
5439	0.9000	0.2059	1138	5635
5439	1.0000	0.2288	1252	5523
5439	1.1000	0.2517	1363	5413
5439	1.2000	0.2746	1472	5305
5439	1.3000	0.2975	1579	5200
5439	1.4000	0.3203	1684	5097
5439	1.5000	0.3432	1786	4997
5439	1.6000	0.3661	1886	4898
5439	1.7000	0.3890	1984	4802
5439	1.8000	0.4119	2080	4707
5439	1.9000	0.4348	2174	4615
5439	2.0000	0.4576	2267	4524

Input units are thousands and kg - output in tonnes

2020			2021	2021-2020	2020-2019	
FMult	Landings	FBar	SSB	SSB change	TAC change	Basis
1.298	1577	0.297	5202	-4.4%	105.8%	msyapproach
1.298	1577	0.297	5202	-4.4%	105.8%	Fmsy
2.1808	2428	0.499	4366	-19.7%	216.9%	Fmsy_upper
0.7211	929	0.165	5842	7.4%	21.2%	Fmsy_lower
0.6568	766	0.13417	6003	10.4%	0.0%	TACstable
0.7637	881	0.15581	5890	8.3%	15.0%	TACplus15
0.5523	651	0.11295	6117	12.5%	-15.0%	TACminus15
1.8355	2114	0.42	4674	-14.1%	175.9%	Fpa
2.5261	2721	0.578	4080	-25.0%	255.1%	Flim
0.7651	894	0.15834	5877	8.1%	16.7%	FInt
5.6814	4644	1.31261	2228	-59.0%	506.1%	Btrigger
7.6075	5325	1.753	1592	-70.7%	595.0%	Blim

Table 36.17 - Sol.27.7fg - Detailed results

F in 2019: TAC constraint for 2019 (841 t)
F in 2020-2021: mean 16-18 scaled to 2018
Catch and stock weights: mean 16-18
N age 1 in 2019-2021: GM(71-16)

Year:	2019	F multiplier:	0.76511	Fbar:	0.15834		
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
1	0.00000	0	0	4975	524	0	0
2	0.02624	134	24	5427	805	760	113
3	0.10333	1005	213	10751	2082	4838	937
4	0.15774	593	155	4264	996	3752	877
5	0.15638	552	169	4000	1128	3920	1105
6	0.15433	107	38	786	260	786	260
7	0.15821	140	58	1003	385	1003	385
8	0.16505	137	65	942	427	942	427
9	0.15924	42	20	300	144	300	144
10	0.15924	45	25	322	173	322	173
Total	0.15834	2755	766	32770	6924	16623	4420

Year:	2020	F multiplier:	1	Fbar:	0.22882		
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
1	0.000	0	0	4975	524	0	0
2	0.038	159	28	4502	668	630	93
3	0.149	632	134	4783	926	2152	417
4	0.228	1705	445	8773	2050	7721	1804
5	0.226	635	195	3295	929	3229	911
6	0.223	590	207	3096	1025	3096	1025
7	0.229	119	50	609	234	609	234
8	0.239	157	74	775	351	775	351
9	0.230	142	67	722	347	722	347
10	0.230	94	52	480	257	480	257
Total	0.22882	4233	1252	32010	7311	19414	5439

Year:	2021	F multiplier:	1	Fbar:	0.22882		
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
1	0.000	0	0	4975	524	0	0
2	0.038	159	28	4502	668	630	93
3	0.149	518	110	3922	759	1765	342
4	0.228	724	189	3728	871	3280	766
5	0.226	1219	373	6320	1782	6194	1747
6	0.223	453	159	2379	787	2379	787
7	0.229	437	183	2241	860	2241	860
8	0.239	89	42	439	199	439	199
9	0.230	108	52	552	265	552	265
10	0.230	169	94	864	463	864	463
Total	0.22882	3876	1229	29922	7179	18344	5523

Input units are thousands and kg - output in tonnes

Figure 36.1 - Sol.27.7fg - Dotted lines give the length distributions of UK (England and Wales) landings; solid lines of Belgian landings

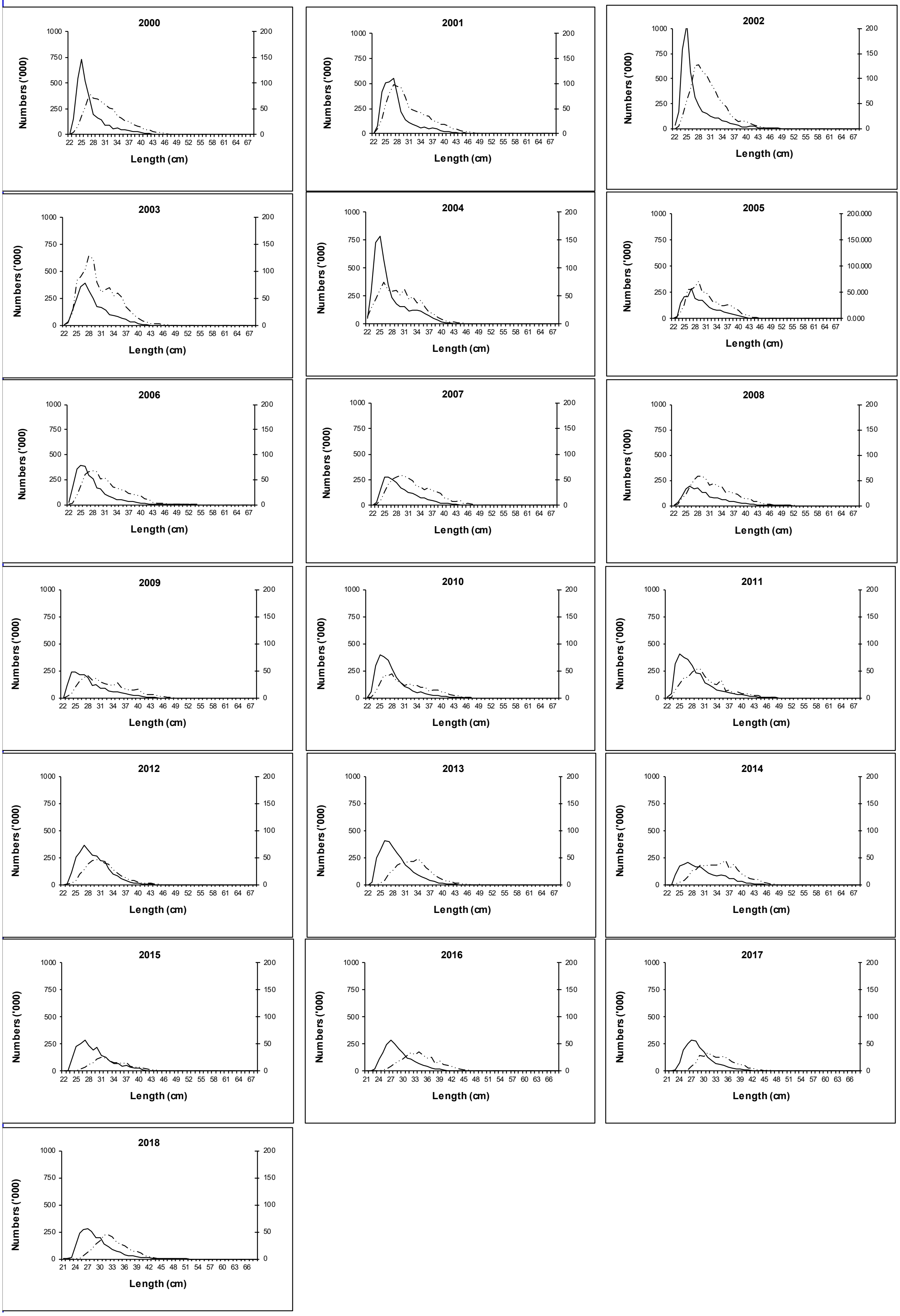


Figure 36.2 - Sol.27.7fg - Age composition of landings

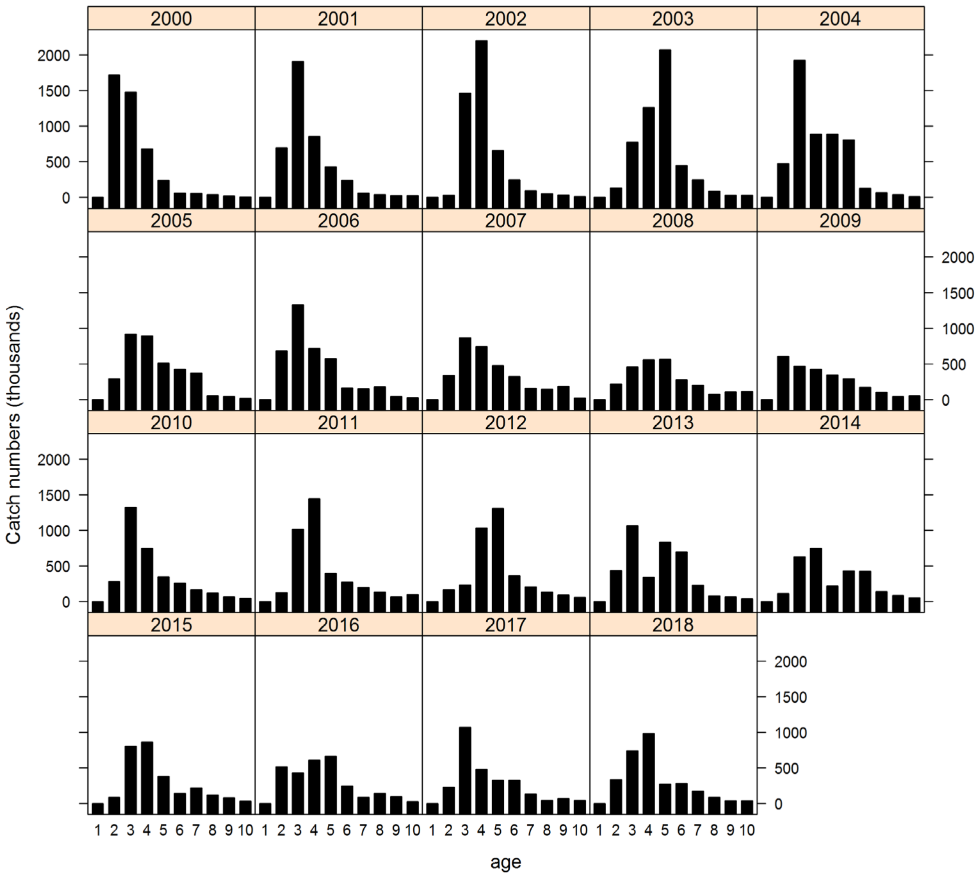


Figure 36.3 - Sol.27.7fg - Standardized catch proportion

Figure 36.4a - Sol.27.7fg - Belgian length distributions of discarded and retained fish from discard sampling studies

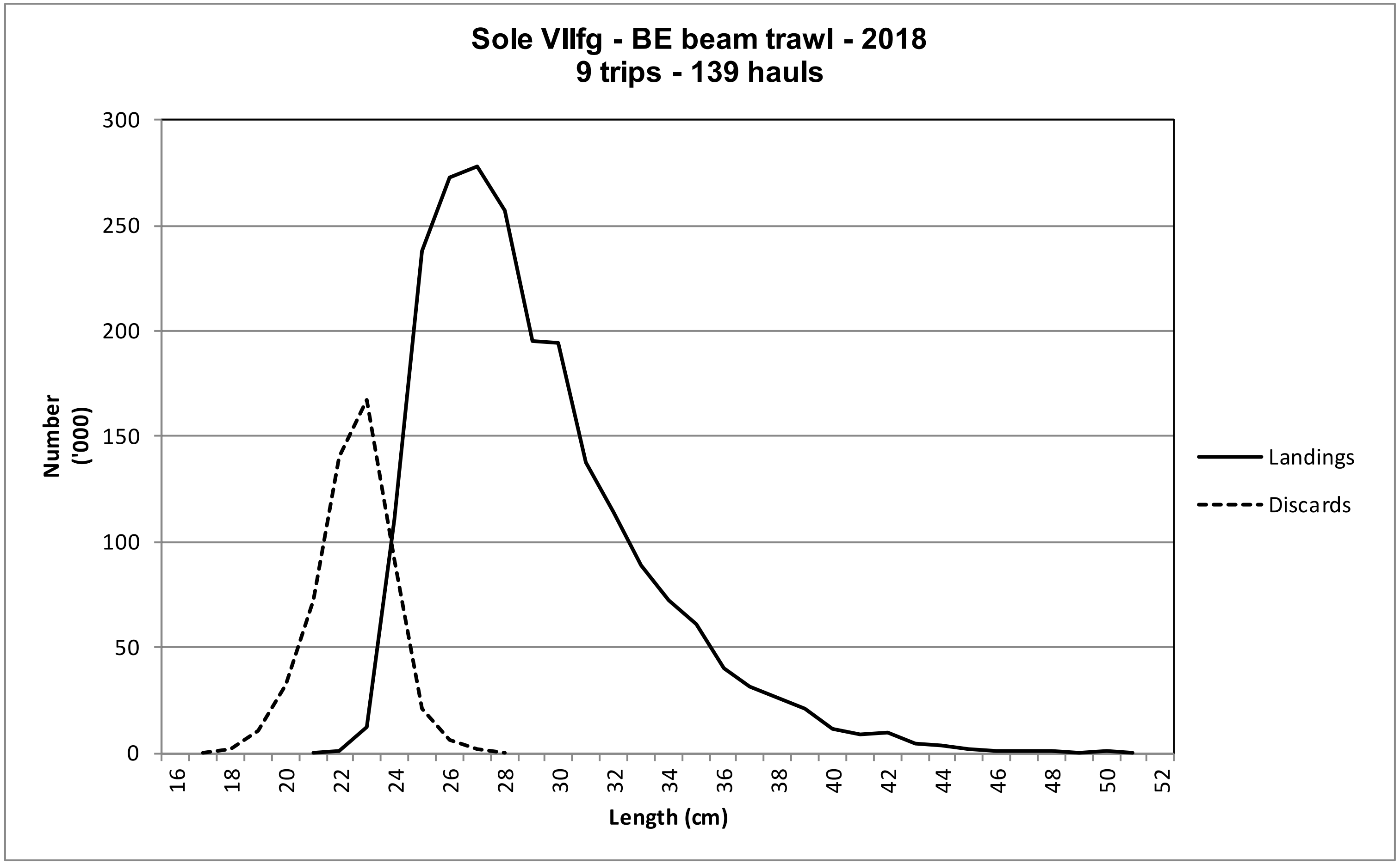


Figure 36.4b - Sol.27.7fg - UK (E+W) Length distributions of discarded and retained fish from discard sampling studies

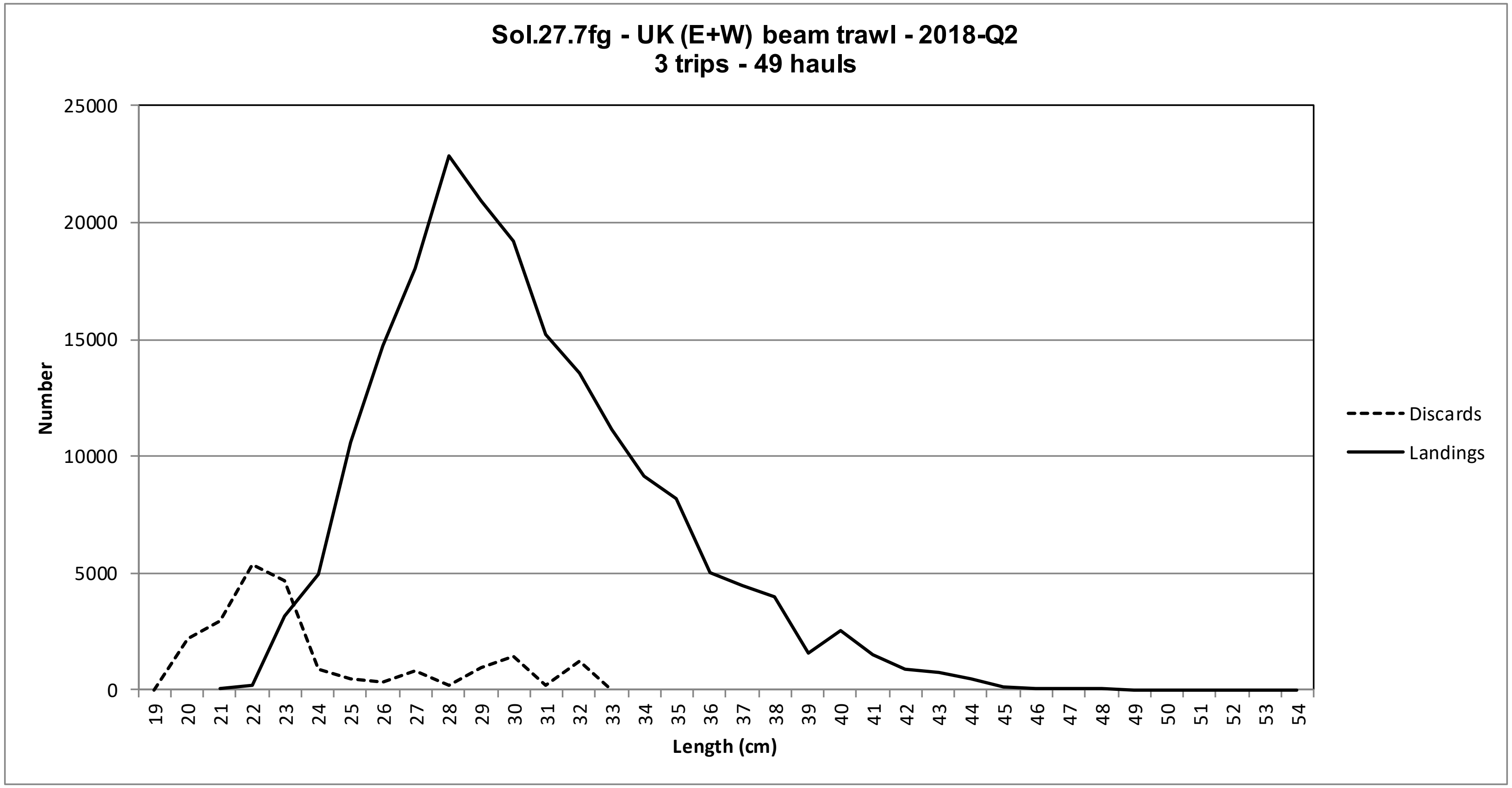
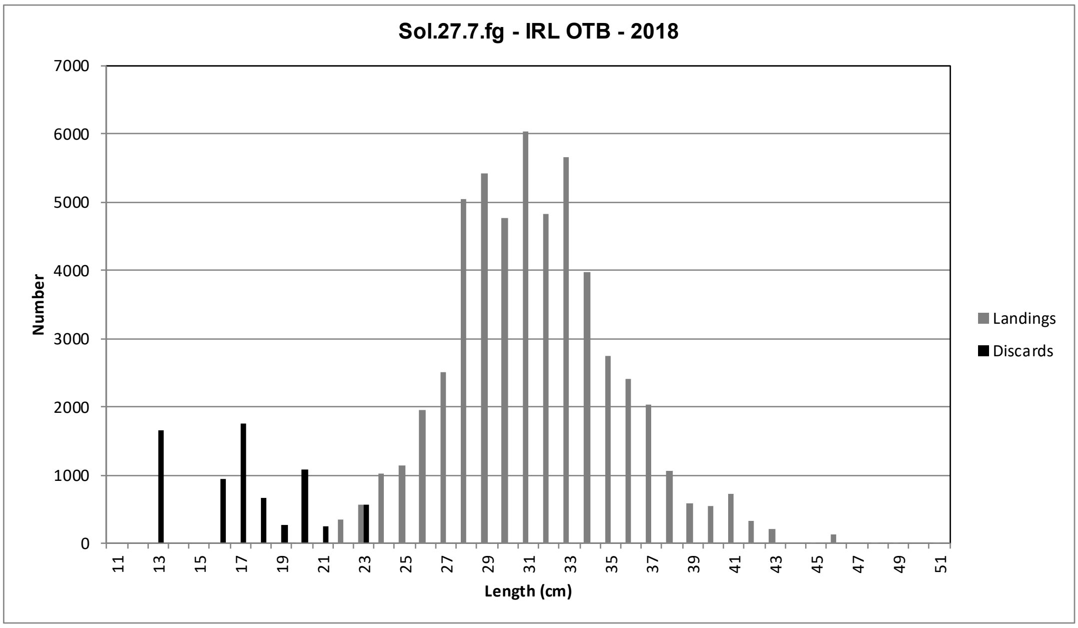


Figure 36.4c - Sol.27.7fg -
Ireland Length distributions of discarded and retained fish from discard sampling studies



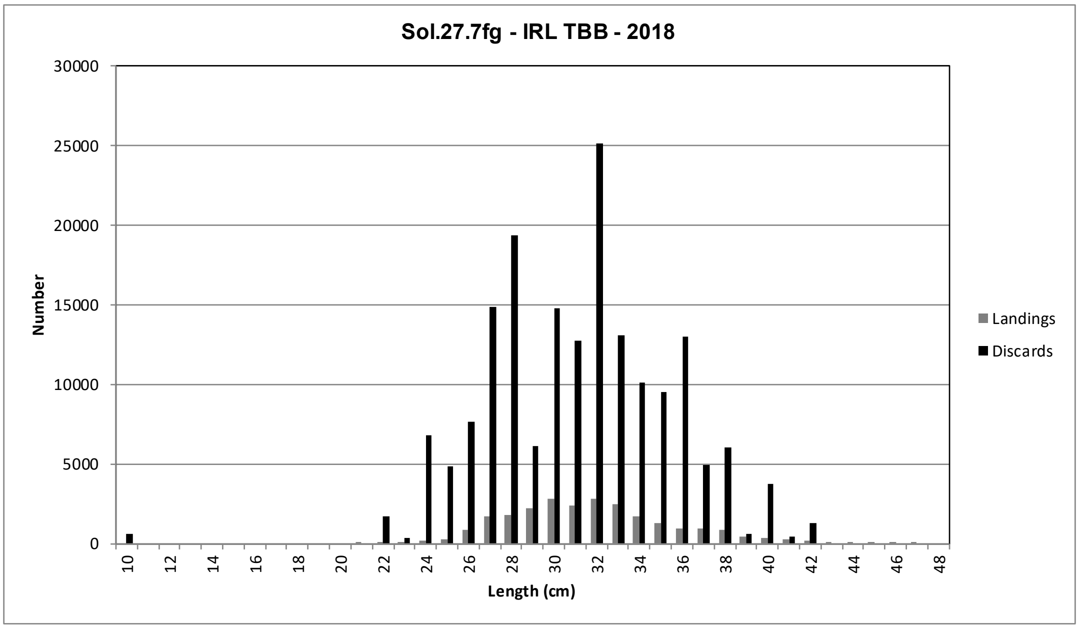
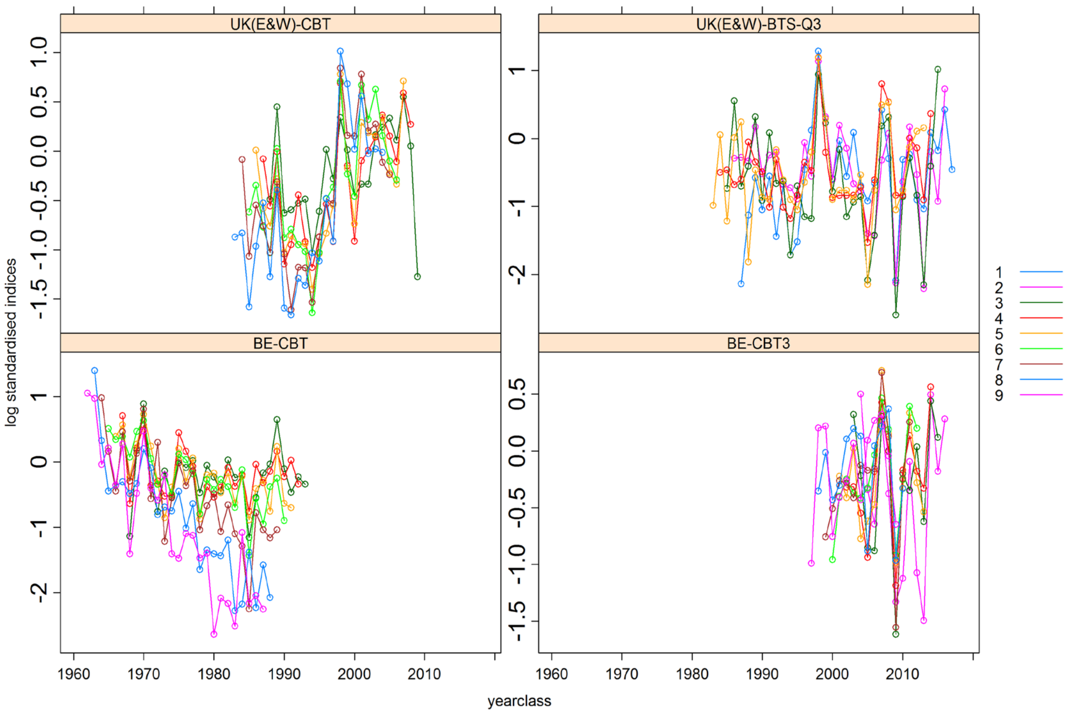


Figure 36.5a - Sol.27.7.fg - Mean-standardised indices



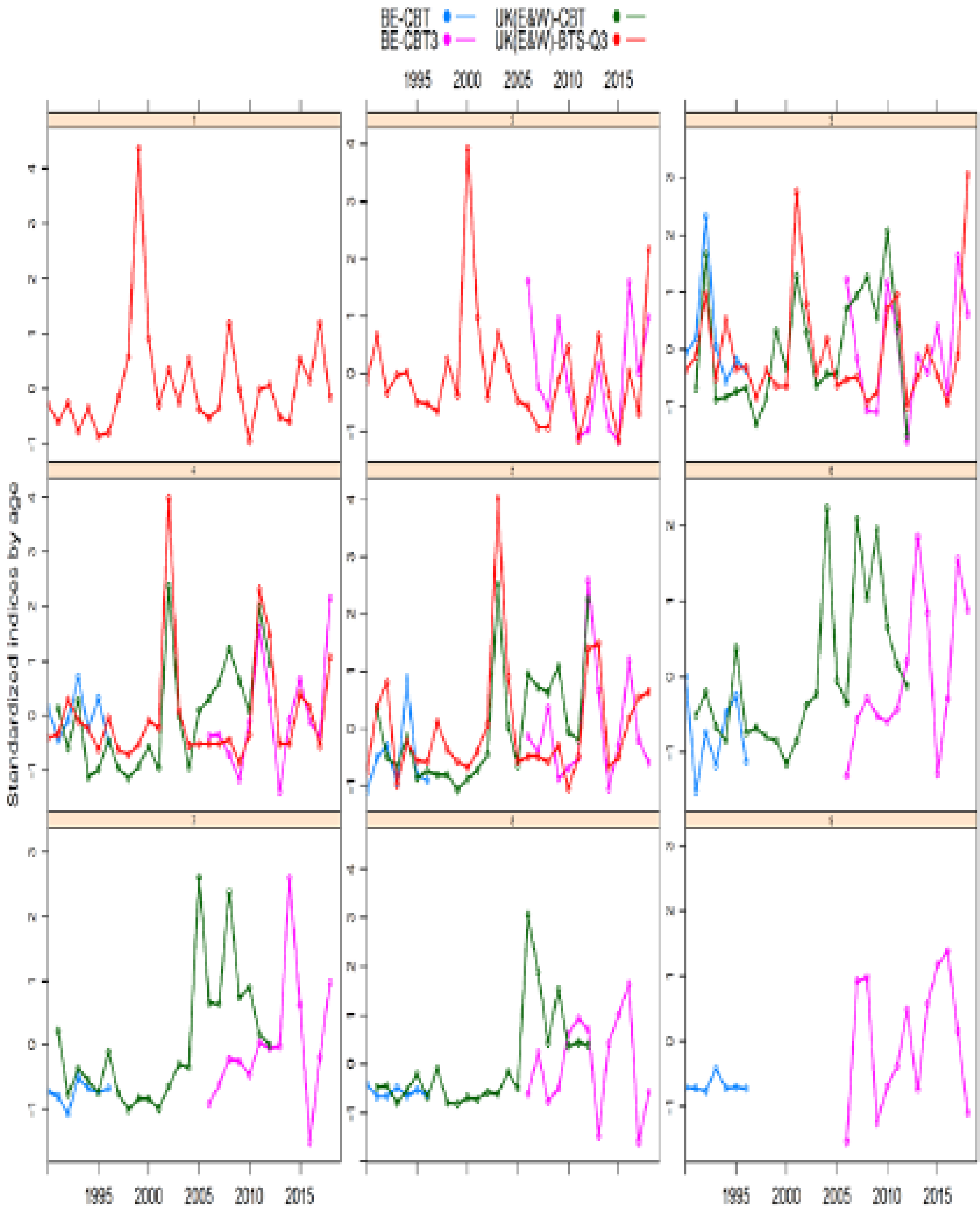


Figure 36.5b. Sol.27.7.fg - Mean-standardised indices.

Figure 36.6 - Sol.27.7fg - Consistency plot UK(E&W)-BTS-Q3 survey

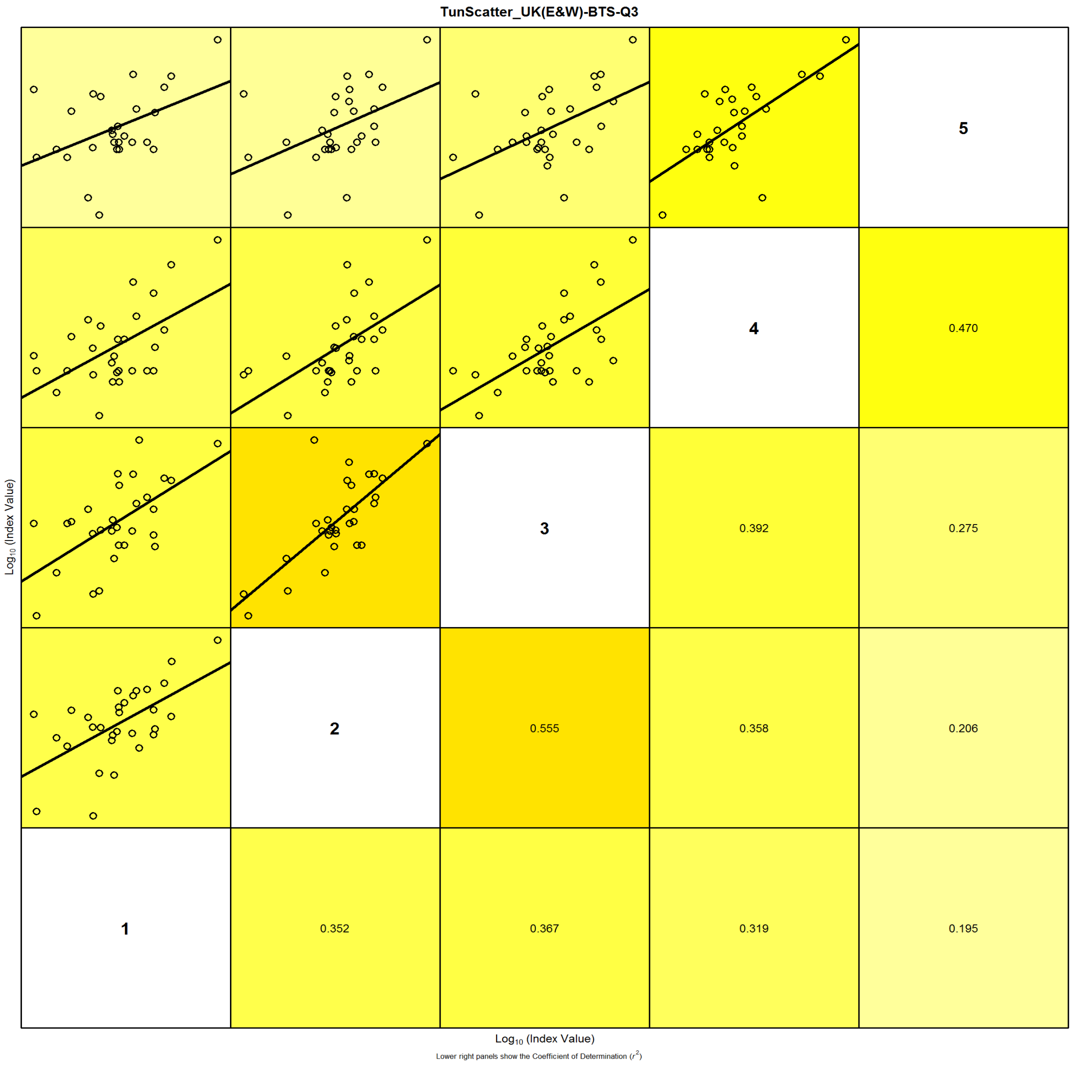
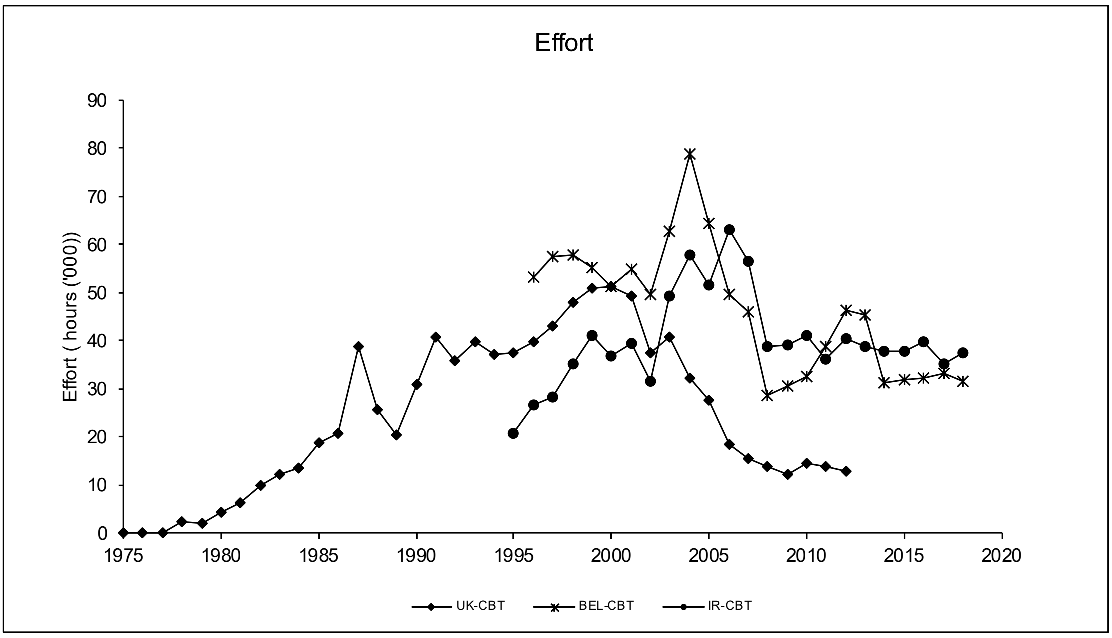


Figure 36.7 - Sol.27.7.fg - Effort (hours ('000) (BE-CBT and IR-CBT), hours ('000) GRT corrected (UK-CBT)) and LPUE (kg/hour (BE-CBT and IR-CBT), kg/hour GRT corrected (UK-



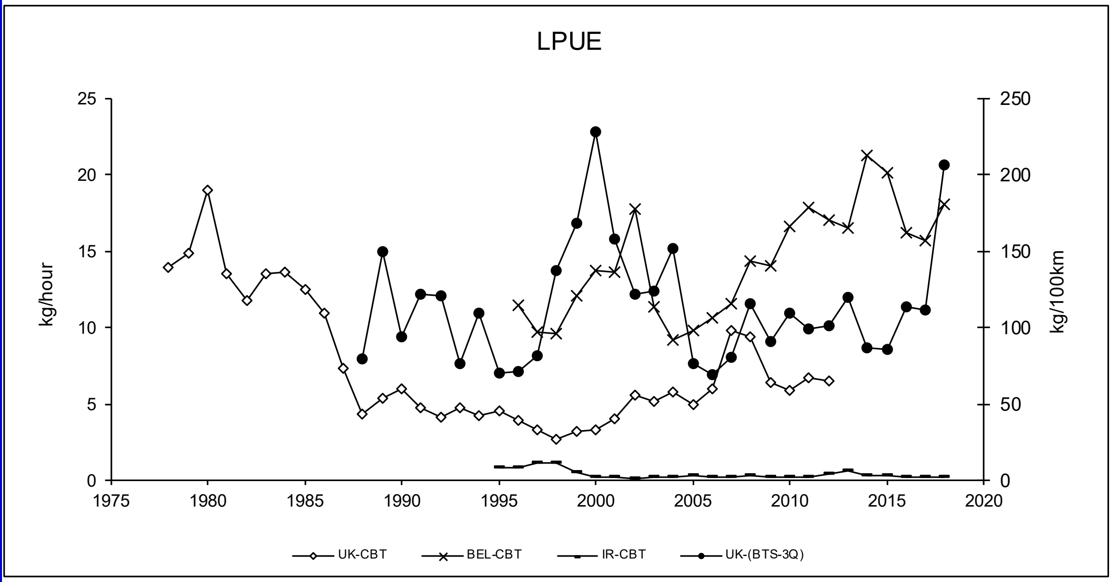


Figure 36.8 - Sol.27.7fg - Consistency plot UK(E&W) commercial beam trawl

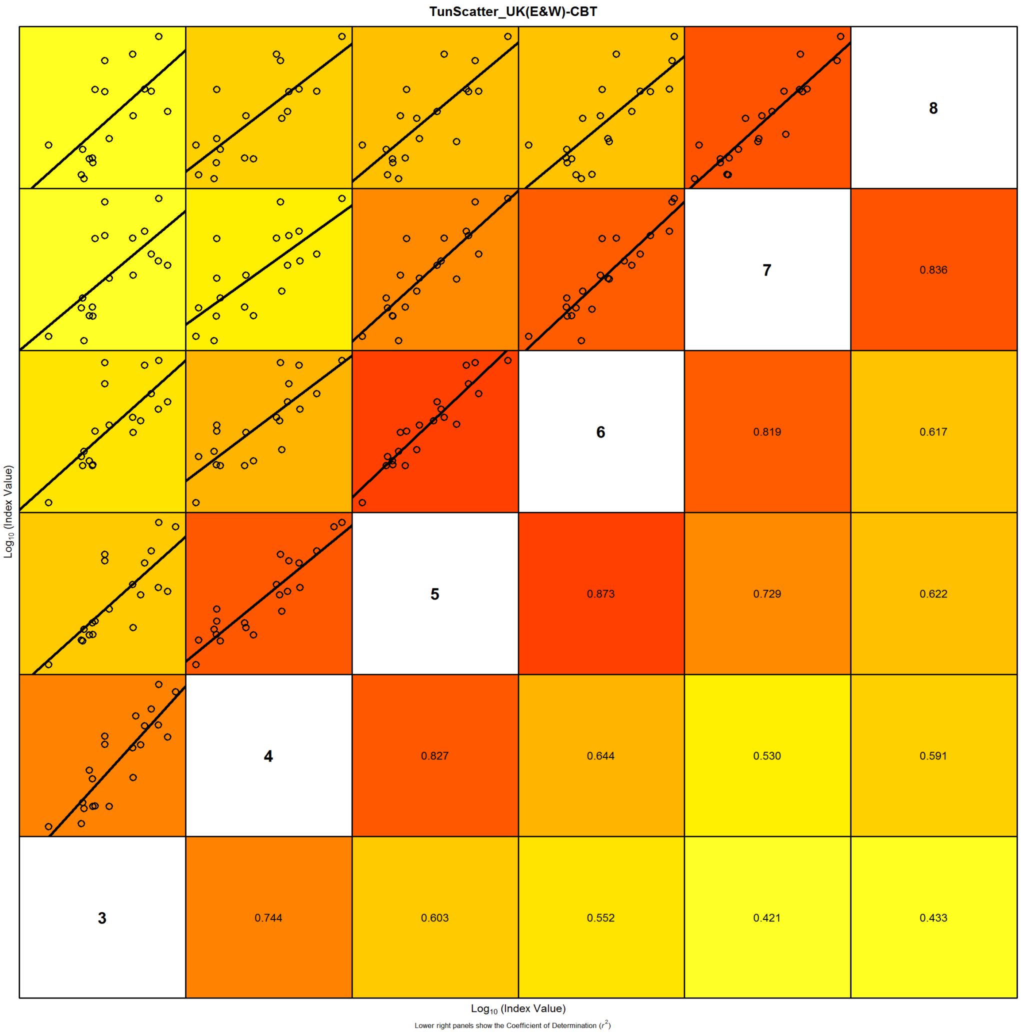


Figure 36.9a - Sol.27.7fg - Consistency plot commercial Belgian beam trawl (1971-1996)

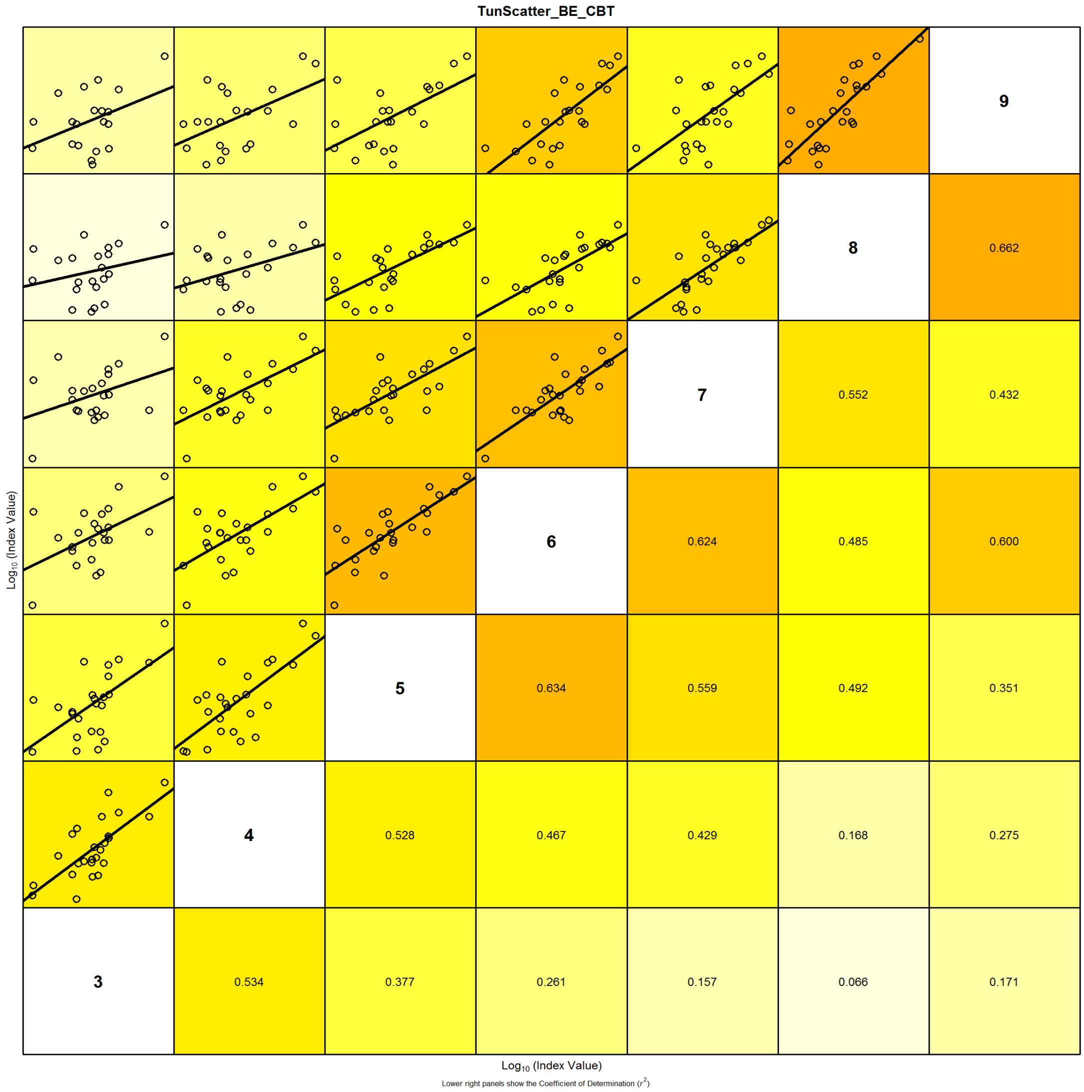


Figure 36.9b - Sol.27.7fg - Consistency plot commercial Belgian beam trawl (2006-2018)

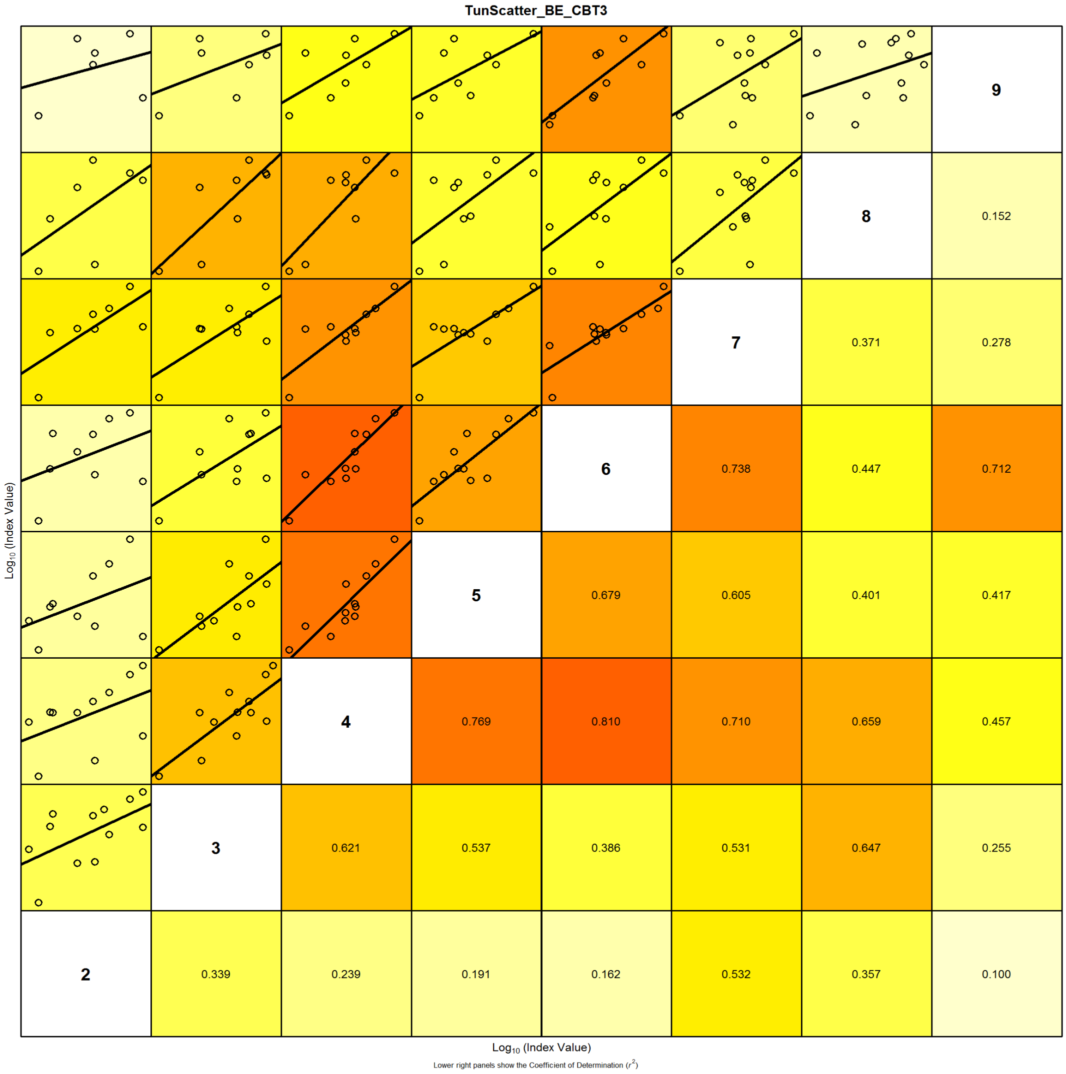


Figure 36.10 - Sol.27.7fg - Catchability residuals for the final XSA run

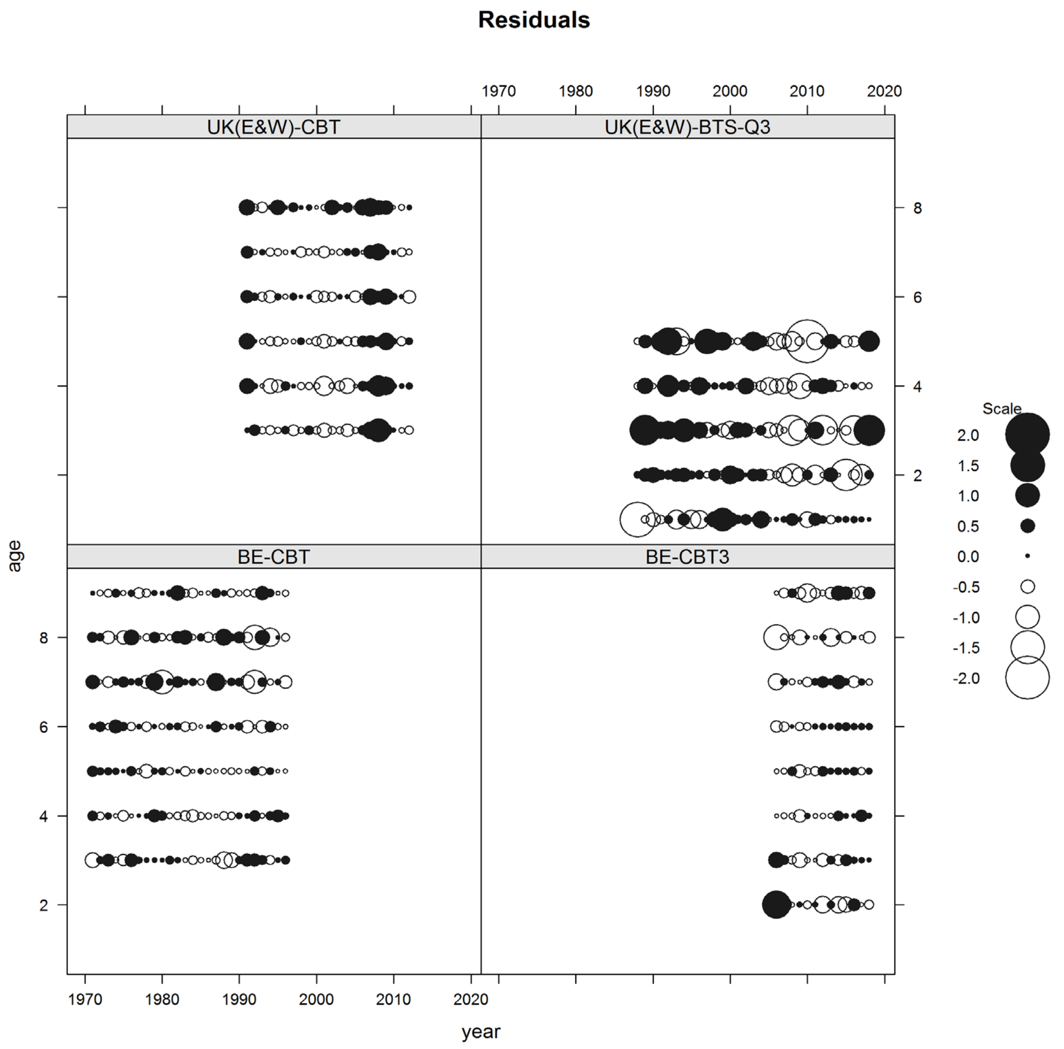


Figure 36.11 - Sol.27.7.fg - Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run

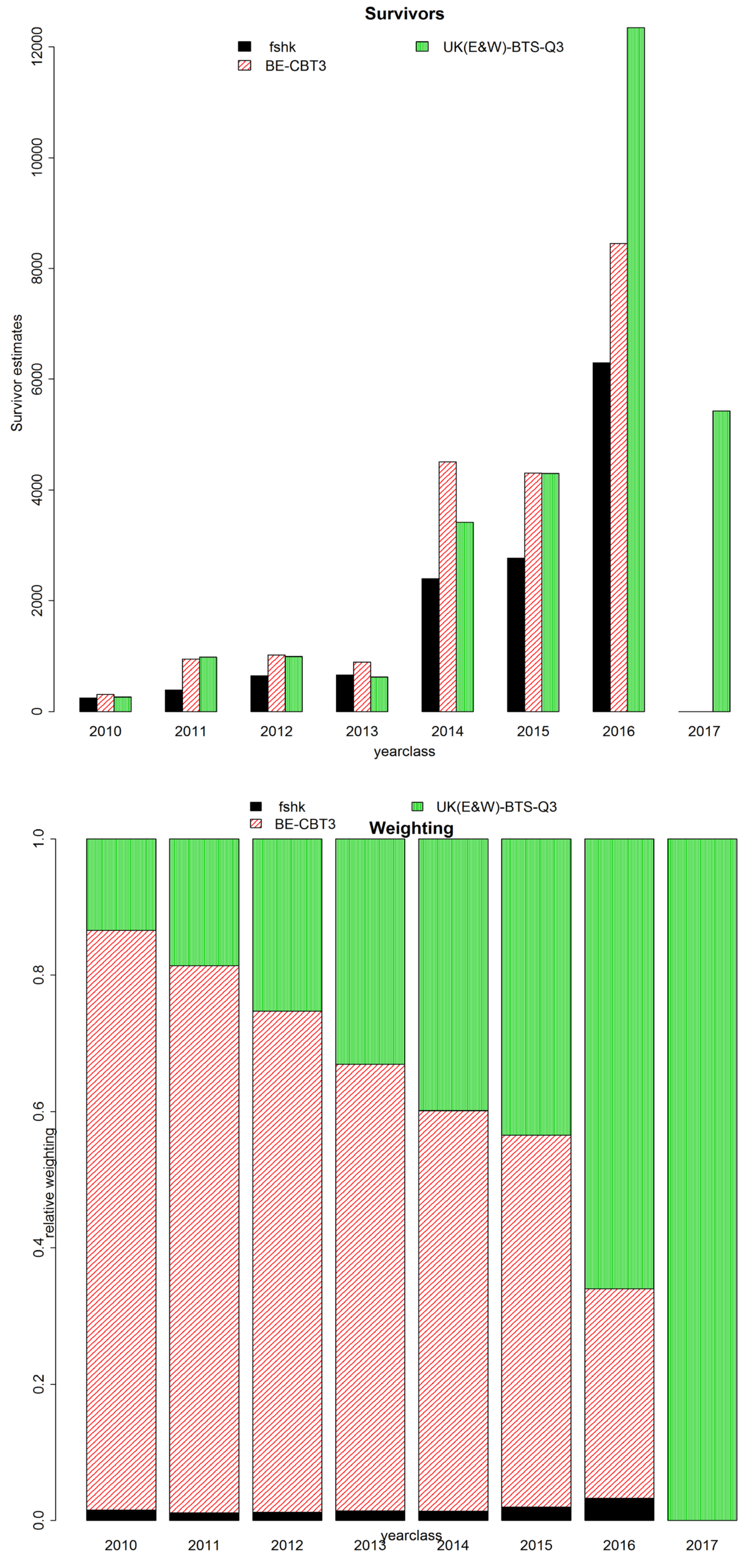


Figure 36.12 - Sol.27.7fg - Retrospective XSA analysis (shinkage SE=1.5)

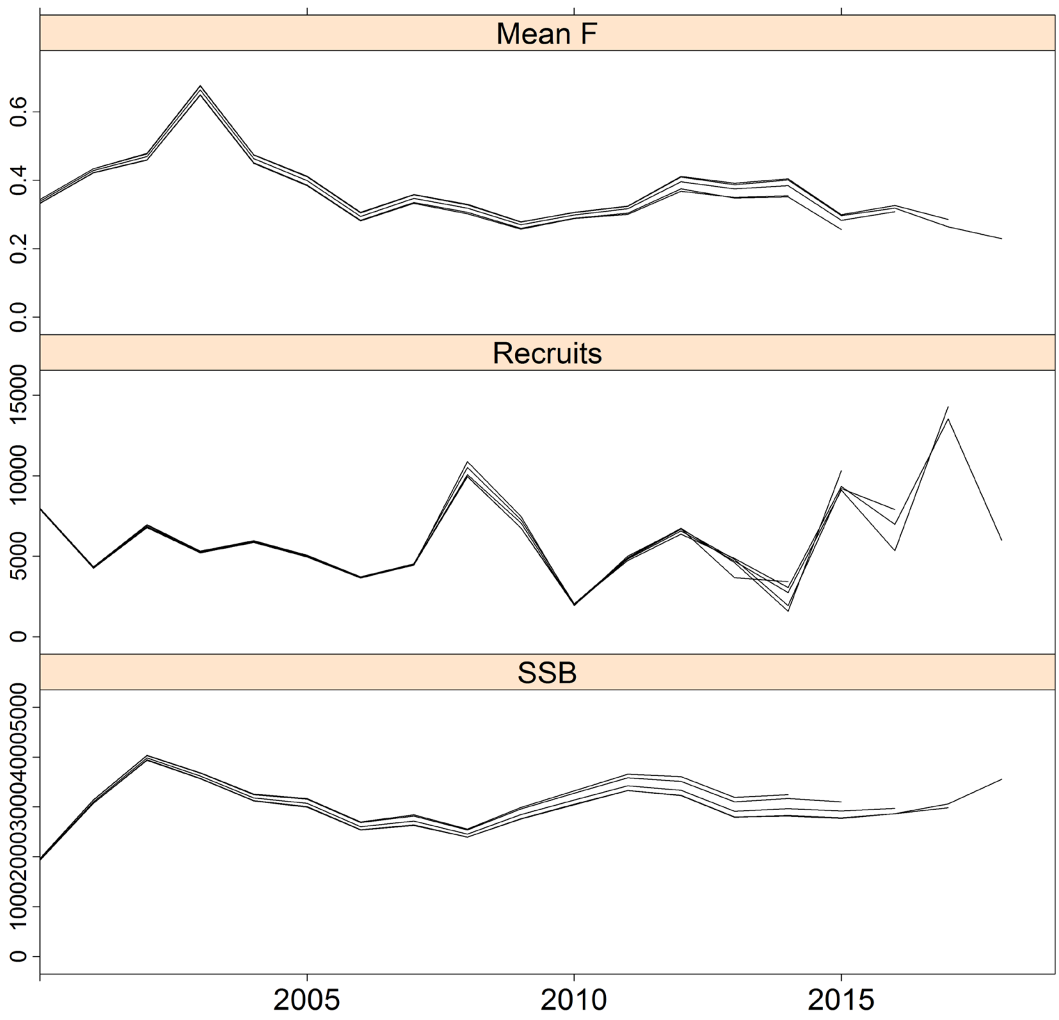


Figure 36.13 - Sol.27.7fg - Summary plots

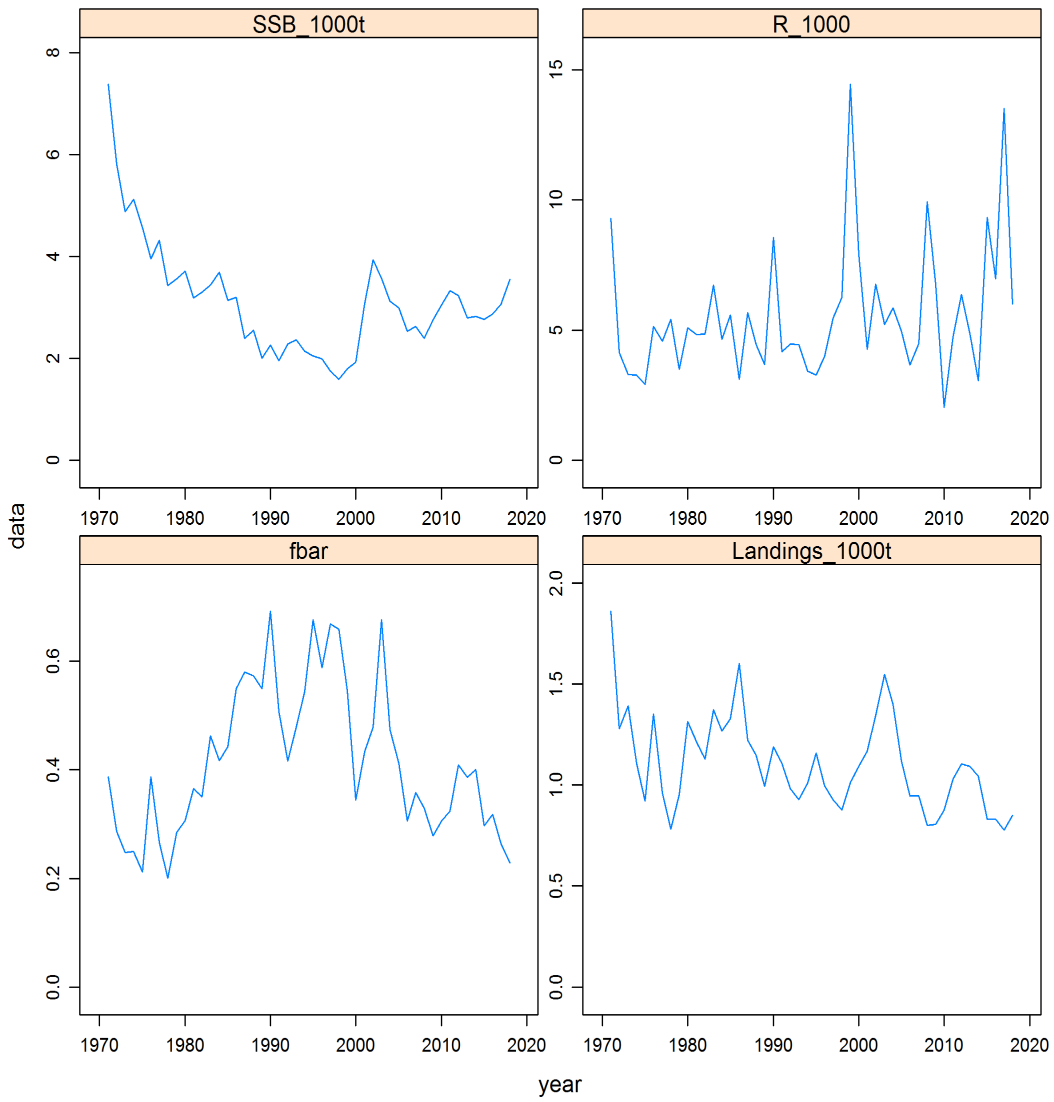


Figure 36.14 - Sol.27.7fg - Comparison with last year's assessment

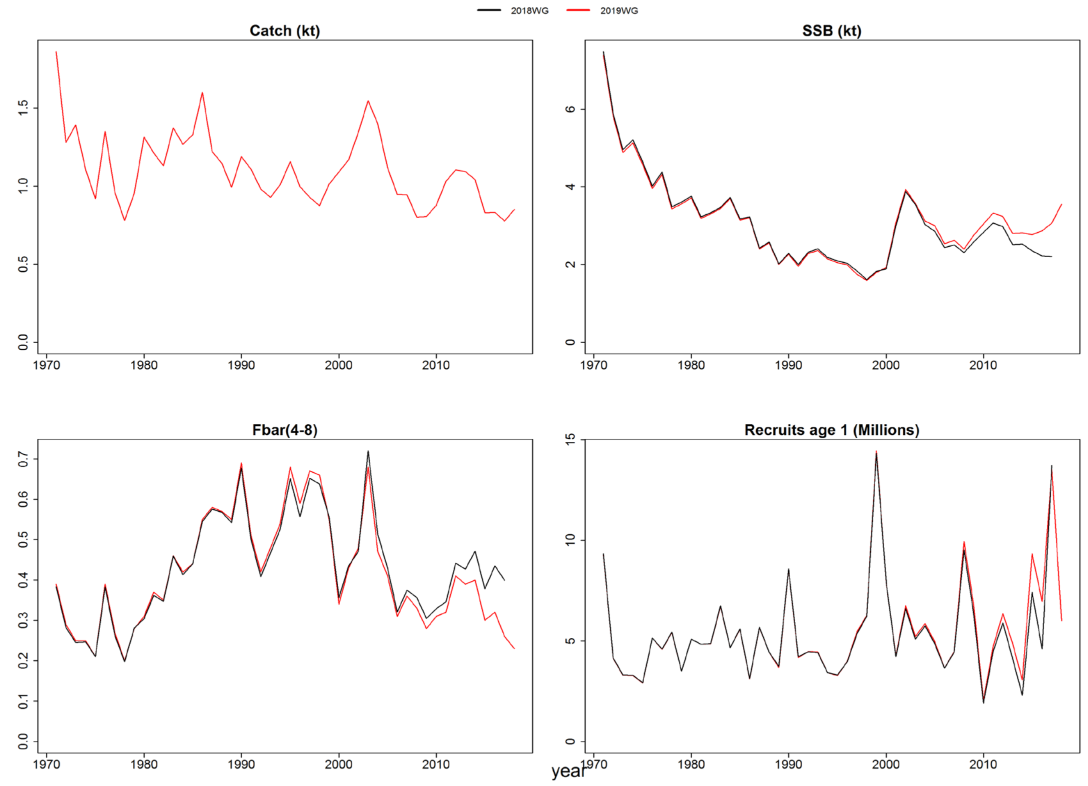


Figure 36.15 - Sol.27.7fg -
Year-class sources and contributions for the short-term forecast

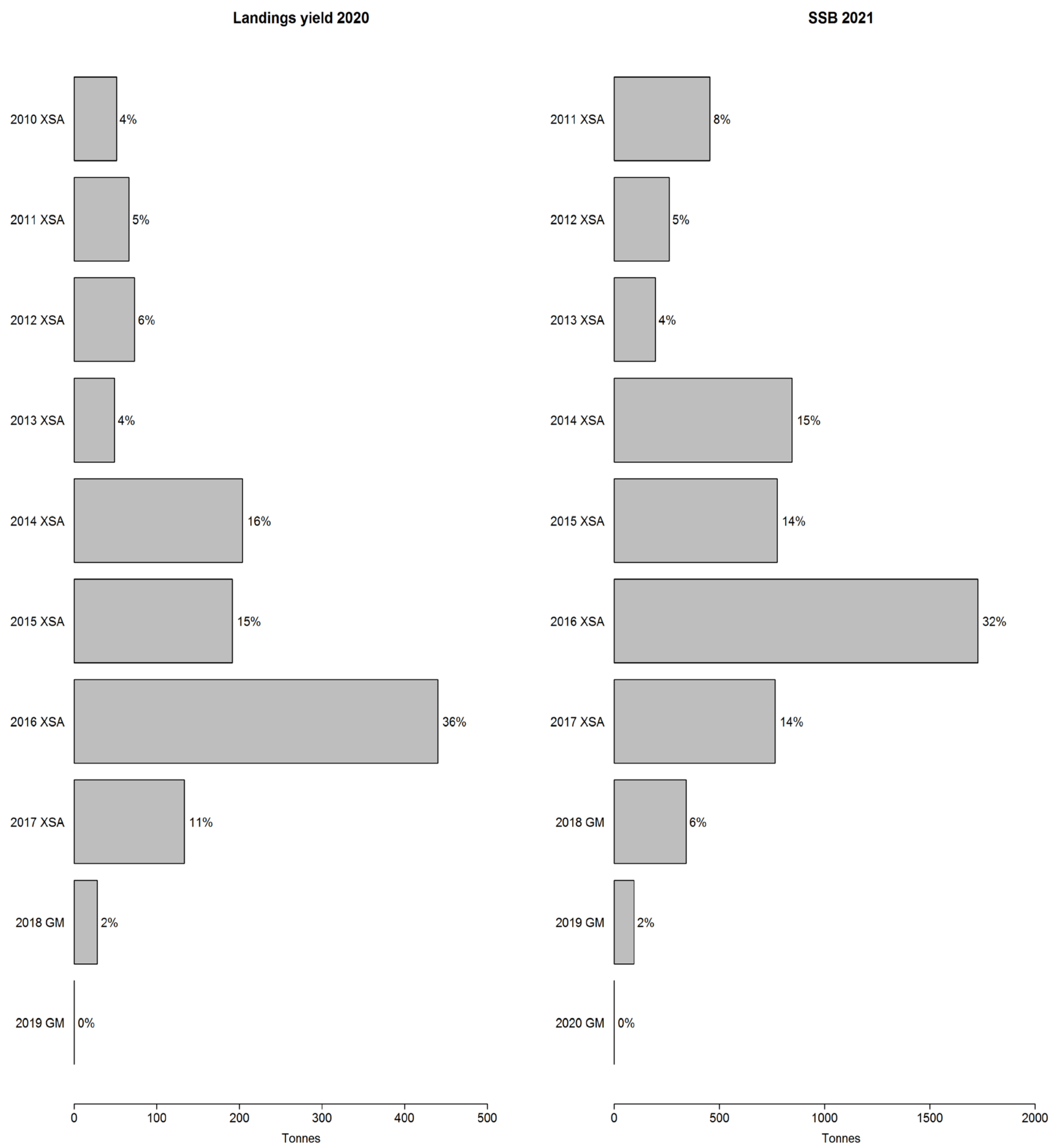


Figure 36.16 - Sol.27.7fg - Three year average exploitation pattern, standardised to Fbar (4-8)

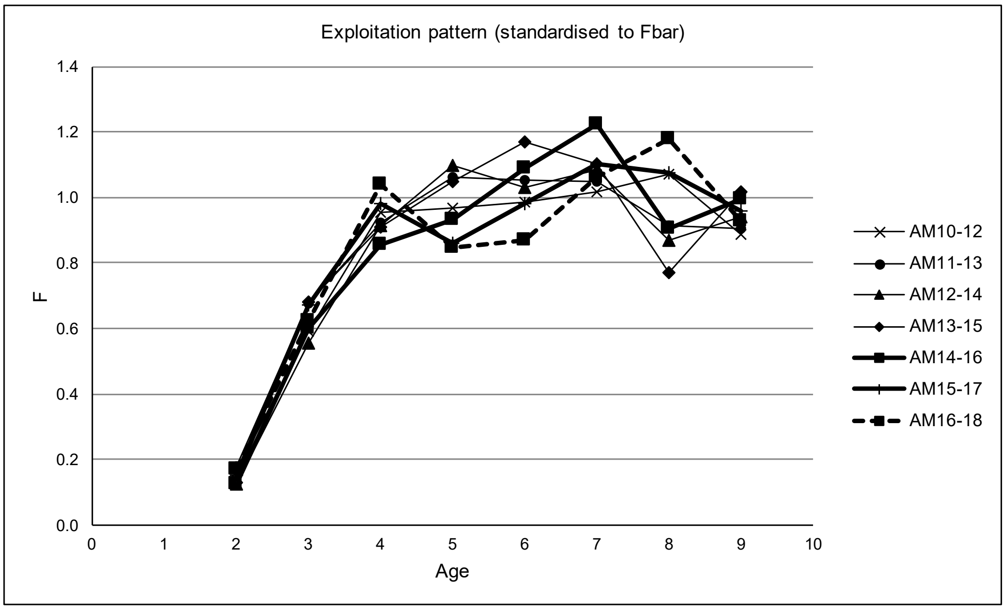
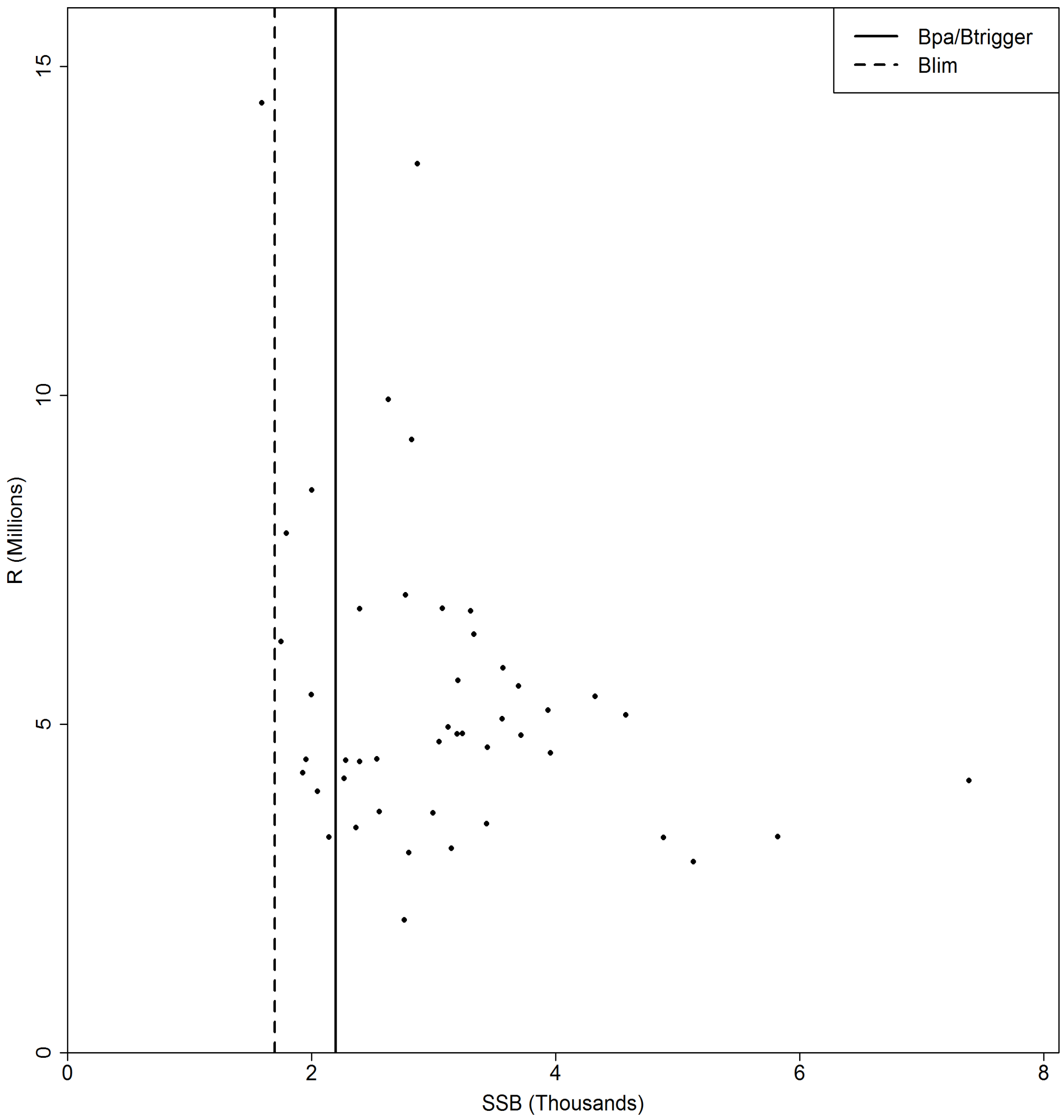


Figure 36.17 - Sol.27.7fg - Stock/recruitment plot



35 Sole (*Solea solea*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)

Type of assessment in 2019

An update XSA assessment was performed for the 7.jk component of the landings according to the stock annex. Only MSY reference points were explored as they are comparable with the XSA.

ICES advice applicable to 2019

ICES advises that when the precautionary approach is applied, catches in 2019 should be no more than 213 tonnes.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2019/2019/sol-7h-k.pdf

ICES advice applicable to 2018

Based on ICES approach to data-limited stocks, ICES advises that catches should be no more than 268 t in 2018. All catches are assumed to be landed.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2017/2017/sol.27.7h-k.pdf

35.1 General

Stock description and management units

Sole in 7.j are mainly caught by Irish vessels on sandy grounds off the southwest of Ireland. Catches in 7.k are negligible. 7.h is also considered part of the stock for assessment purposes, but there is no evidence to suggest that this is actually the same stock (Figure 33.1). Irish VMS and logbook data indicate that the 7.j landings occur close to shore and this species is a small (but valuable) component (up to 5%) of the landings in a mixed fishery.

The TAC is set for divisions 7.h,j and k. However, as historically no age-disaggregated data were available for 7.h, the assessment is performed for 7.jk only.

Management applicable to 2019 and 2018

TAC table 2019

Species:	Common sole *Solea solea*	**Zone:**	7h, 7j and 7k (SOL/7HJK.)
Belgium	32		
France	64		
Ireland	171		
The Netherlands	51		
United Kingdom	64		
Union	382		
TAC	382		Precautionary TAC Article 7(2) of this Regulation applies Article 13(1) of this Regulation applies

TAC table 2018

Species:	Common sole *Solea solea*	**Zone:**	7h, 7j and 7k (SOL/7HJK.)
Belgium	32		
France	64		
Ireland	171		
The Netherlands	51		
United Kingdom	64		
Union	382		
TAC	382		Precautionary TAC Article 7(2) of this Regulation applies Article 12(1) of this Regulation applies

Article 12(1) refers to the closure of the Porcupine Bank in May and July.

Landings obligation

In 2016 the landings obligation will apply to this stock for the first time. According to the regulation (EC, 2015) vessels where more than 5% of their landings using beam trawls were sole during the reference years (2013 and 2014) in ICES divisions 7.b, 7.c and 7.f–7k will be covered by the Landings Obligation. The landings obligation will also apply to all catches of sole with trammelnets or gillnets. These vessels will have to land all sole in 2016. However, a *de minimis* exemption will also apply allowing for up to a maximum of 3% of the annual catch to be discarded. Given the low discards observed in the fishery the landings obligation is unlikely to have a significant impact on this stock or the advice given.

35.2 Data

35.2.1 Landings and discards

The nominal landings are given in Table 33.1. Historic Belgian landings from 7.j are considered to have been area misreported and have been removed from the total landings. Because age data were only available for Irish landings (which were mainly from 7.jk) the remainder of Section 37 concerns 7.jk only.

Table 33.2 gives the landings in 7.jk. Generally, Ireland has taken around 90% of the landings.

Discarding of sole in 7.jk is not considered to be a problem. Only three of the 13 observer trips noted discards of sole (Figure 33.2).

35.2.2 Landings numbers-at-age

Landings numbers-at-age are given in Table 33.2 and Figure 33.3. Figure 33.4 shows a bubbleplot of the standardised landings proportions-at-age. The numbers-at-age matrix shows quite good cohort tracking, suggesting that ageing is accurate and that recruitment is variable. Figure 33.5 gives the stock weights (which are the same as the landings weights).

35.2.3 Biological

Natural mortality was assumed to be 0.1 for all ages and the proportion mature is assumed to be as follows:

Age 2	Age 3	Age 4	Age 5	Age 6+
0.14	0.45	0.88	0.98	1.00

35.2.4 Surveys and commercial tuning fleets

Historically, no survey index was available for this stock as the Irish IBTS Q4 ground fish Survey data were considered too noisy to be used. The development of the Irish Beam Trawl Ecosystem Survey (IBES) may now represent a suitable index. The first of these surveys took place in 2016 (ICES, 2016c) and was repeated in 2017 and 2018. The addition of this index would need to be considered at a benchmark. A commercial tuning index is available which uses Irish VMS data linked to logbook landings (see Gerritsen *et al*., 2011 for details on linking VMS and logbook data). The data were used to identify an area where sole are caught by OTB vessels (Figure 33.6). Next, the effort and landings of the OTB vessels inside the sole area were estimated. The VMS-based lpue showed similar trends to the lpue of Irish OTB vessels in the whole of 7.j, however by limiting the spatial extent, the index will be less sensitive to changes in the spatial distribution of the fleet. All vessels operating in this area are assumed to be capable of catching sole, however this is not the case, as offshore vessels catch little to no sole.

The age composition of the Irish OTB fleet in 7.j was used for the tuning fleet (Table 33.4). Figure 33.7 shows the log-standardised numbers-at-age in the tuning index by year and cohort. No year effects are obvious, and cohort tracking appears to be reasonably good, however, there is a clear decrease in the age 3 in 2018. Figure 33.8 shows the internal consistency regressions for the tuning fleet.

35.2.5 Data quality

Sampling appears to be sufficient to establish catch numbers-at-age. The tuning index is quite short and does, but should be long enough to inform the trends that are not already converged.

35.3 Historical stock assessment development

Target category: 3.2.0.

Model used: XSA.

Software used: Lowestoft vpa95.exe and FLR with R version 3.5.1 and packages FLXSA_2.6.2 , FLAssess_2.6.3, FLEDA_2.5.2, FLCore_2.6.13.

35.3.1 Exploratory assessment

Several exploratory assessments were carried out by means of a separable VPA and XSA. The initial VPA runs explored the year and age range to be used in the separable and the choices of reference age, final F and S. The XSA runs explored the choices of q-age, F-shrinkage and the minimum SE threshold. The results of these are available on the ICES SharePoint site of WGCSE under data for this stock.

35.3.2 Final assessment

The model was applied to catch numbers for ages 2–10+ for the years 1993–2018. The tuning fleet included ages 3–9 for the years 2006–2018.

Model Options:

Option	Setting
Ages catch dep stock size	None
Q plateau	7
Taper	No
F shrinkage SE	1.5
F shrinkage year range	5
F shrinkage age range	5
Fleet SE threshold	0.2
Prior weights	No

The diagnostics of the final XSA assessment are given in Table 33.5. Figure 33.9 shows the residuals. There are some year effects but the absolute values are small. Because the catch and the tuning fleet have nearly identical age compositions, the year effects result from the lpue estimate of the tuning fleet.

A Mohn's rho analysis was conducted based on the XSA stock assessment results, i.e. the last data year (2018) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 3–9)	recruitment
Mohn's rho value	-0.00759231890293091	0.0406781290651195	0.00784258485351308

The Mohn's rho values for this assessment are very low and well below the threshold of 20% imposed by ICES for 2019 assessments, i.e. the current assessment indicates a high consistency.

35.3.3 State of the stock

The summary table with a time-series of landings, recruitment, SSB and F is given in Table 33.6 and Figure 33.10. Recruitment is variable without a clear trend. The SSB has declined from nearly 800 tonnes to around 400 t in 2000–2009 but appears to have recovered to around 800 t in recent years F shows a slowly declining trend and currently appears to be quite low, with another revision down in 2018.

35.4 MSY evaluation

Previously for this stock WKProxy (ICES, 2016a) proposed an F_{MSY} reference point of F = 0.17, based on $F_{0.1}$ from a Thompson–Bell yield-per-recruit analysis of the landings numbers-at-age. This is a data-limited approach (which was in line with the ToRs of WKProxy); however, the resulting reference point is not directly comparable with the outputs from the XSA (only the landings data are used in the Thompson–Bell approach). In 2016 this working group (ICES, 2016d) recommended that it would be more appropriate to move the stock to Category 2 next year and to apply the WKMSYREF4 (ICES, 2016b) methodology for estimating reference points (ICES, 2012).

An exploratory MSY evaluation was completed by WGCSE in 2017 (ICES, 2017), which followed the WKMSYREF4 guidelines. These reference points were not revaluated in 2018, but were applied as estimated in 2017 (ICES, 2017). As there is no obvious stock–recruitment relationship, it is difficult to specify an appropriate SR model. The SR estimation was carried out on age >= 3 as that is the onset of recruitment using: *fit <- eqsr_fit_shift(stock, nsamp = 1000, models = c("Segreg"), rshift = 3).* From this B_{lim} was estimated to be 424.88 (*B_{lim} <- median(fit$sr.sto$b.b))* and a B_{pa} at 590.41 (*B_{pa} <- B_{pa}(B_{lim}, 0.2)*. The following settings were used to estimate the MSY reference points using the eqsim_run{msy} function in the MSY package in R (full code available on SharePoint):

```
stocksetup <- list(data = stock,
        bio.years = c(2007, 2016),
        bio.const = FALSE,
        sel.years = c(2007, 2016),
        sel.const = FALSE,
        Fscan = seq(0,0.44,by=0.005),
        Fcv = 0.212,
        Fphi = 0.423,
        Blim = Blim,
        Bpa = Bpa,
        verbose = TRUE,
        extreme.trim=c(0.05,0.95)
```

Where F_{cv} and F_{phi} were the same as those used by WKMSYREF4 for plaice in 7.e (ICES, 2016b), which was calculate during WKMSYREF3 (ICES, 2014). Figures 33.12 and 33.13 summarise the MSY evaluation. The analysis resulted in an estimate of F_{MSY} = 0.161 without a $B_{trigger}$ harvest control rule and F_{MSY} = 0.181 with a $B_{trigger}$ = B_{PA} HCR. These values are slightly higher than the F_{MSY} proxy of 0.25 proposed by WKProxy (ICES, 2016a).

35.4.1 MSY and Biological reference points

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	590	B_{pa}	ICES (2017)
	F_{MSY}	0.161	Median point estimates of EqSim with segmented regression S–R relationship	ICES (2017)
Precautionary approach	B_{lim}	425	Breakpoint segmented regression S–R relationship	ICES (2017)
	B_{pa}	590	$B_{lim} \times \exp(1.645 \times \sigma)$; σ = 0.20	ICES (2017)
	F_{lim}	0.222	F with 50% probability of SSB< B_{lim}	ICES (2017)
	F_{pa}	0.161	$F_{lim} \times \exp(-1.645 \times \sigma)$; σ = 0.20	ICES (2017)
Management plan	SSB_{mgt}			
	F_{mgt}			

35.5 Uncertainties and bias in the assessment and forecast

The assessment is carried out on the 7.jk part of the stock area only.

There is sufficient contrast in the landings-at-age matrix to inform the model. However, there may be some data issues between 1999 and 2003, which result in erratic F estimates.

The use of a commercial tuning fleet has the potential to introduce bias if the behaviour or efficiency of the fleet changes. E.g. changes to the gear, vessel power, towing speed, etc. can influence the catch rates. By limiting the index to an area where sole is known to be caught, some of the potential bias due to changes in spatial effort distribution will be avoided. The working group applied a spatial stratification to check that changes in effort distribution within the sole area did not affect the index and this did not appear to be the case. Because the stratified estimate is likely to be less precise, the final tuning index was based on the un-stratified estimate. More sophisticated modelling approaches to standardise the commercial index could be investigated for a future benchmark.

35.6 Recommendations for the next benchmark

This stock is scheduled to be benchmarked in 2020.

35.7 Management considerations

Fishing mortality has been slowly declining in the last ten years and SSB has been stable in recent years.

The TAC area includes Division 7h. However, the landings from divisions 7jk are taken in the north eastern part of Division 7j which is remote from the northern part of Division 7h, where most of the Division 7h landings are taken. It is likely that the sole from Division 7h are part of the divisions 7e or 7fg stocks. No further information on stock structure is likely to become available in the short term.

The catches are taken in a mixed fisheries and should be managed as such. Constraining the landings by TAC will not constrain the catches. Because sole are caught in spatially distinct areas, restricting effort in these areas will be more effective than limiting landings. The catches are taken in a mixed fisheries and should be managed as such. Constraining the landings by TAC will not constrain the catches. The TAC is currently not restrictive, but for some countries, the quota appears to have become restrictive.

35.8 References

Gerritsen HD and Lordan C. 2011. Integrating Vessel Monitoring Systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES J Mar Sci 68 (1): 245–252.

ICES. 2012. ICES implementation of advice for data limited stocks in 2012. Report in support of ICES advice. ICES CM 2012/ACOM:68.

ICES. 2014. Report of the Joint ICES-MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 164 pp.

ICES. 2016a. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

ICES. 2016b. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2016c. Final Report of the Working Group on Beam Trawl Surveys (WGBEAM), 12–15 April 2016, La Rochelle, France. ICES CM 2016/ SSGIEOM:20. 125 pp.

ICES. 2016d. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 4–13 May 2016, Copenhagen, Denmark. ICES CM 2016ACOM:13. 1312 pp.

Table 39.1. Sole in Divisions 7.h–k (Southwest Ireland). Nominal landings (t), 1993–2018, as officially reported to ICES. Belgian landings from 7.j are considered to have been area-misreported and are not included in the total. * Preliminary data.

	7 h					7 j				7 k			7 h Total	7 jk Total	7 hjk	7hjk
Row Labels	BEL	FRA	IRE	NL	UK	BEL	FRA	IRE	UK	FRA	IRE	UK	TOT	TOT	TOT	WG Est
1993		43			206		1	237	8				249	246	495	
1994		42	8		172			176	2				222	178	400	
1995		44	11		186		1	232	6	2			241	241	482	
1996		48	20	70	147		2	162	1		1		285	166	451	443
1997		56	16		111		2	187	1			1	183	191	374	564
1998		65	13	7	109		8	208	2	1			194	219	413	423
1999	5		8	1	96	96		199	1				110	200	310	381
2000		72	8	10	95	8	4	103		2			185	109	294	329
2001	6	86	11		111	7	11	113		2	1		214	127	341	325
2002	85	85	9		124	69	8	120		15	1		303	144	447	430
2003	122	113	23		78	48	20	82					336	102	438	245
2004	155	95	33		79	2	7	78					362	85	447	290
2005	90	86	28		112		7	69			1		316	77	393	326
2006	36	81	14	1	86	0	11	49	1	0	0	0	218	61	279	272
2007	31	69	4	0	91	0	9	73	0	0	1	0	195	83	278	277
2008	10	49	3	0	80	0	8	69	0	0	0	0	142	77	219	225

	7 h					7 j				7 k			7 h Total	7 jk Total	7 hjk	7hjk
Row Labels	BEL	FRA	IRE	NL	UK	BEL	FRA	IRE	UK	FRA	IRE	UK	TOT	TOT	TOT	WG Est
2009	11	70	0	0	58	0	9	60	0	0	0	0	139	69	208	208
2010	20	73	3	0	51	0	14	68	0	0	0	0	147	82	229	228
2011	10	70	1	0	54	0	23	63	0	1	0	0	135	87	222	237
2012	18	74	2	0	46	0	11	83	0	0	0	0	140	94	234	228
2013	4	69	1	0	47	0	7	84	0	0	0	0	121	91	212	211
2014	42	56	3	0	54	0	5	82	0	0	0	0	155	87	242	243
2015	40	70	3	0	53	0	4	74	0	0	0	0	166	78	244	248
2016	91	67	4	0	61	0	10	94	2	0	0	0	223	115	329	344
2017	70	75	4	0	38	4	6	81	1	1	1	0	188	92	280	295
2018*	92	84	8	0	33	5	7	53	<1	<1	<1	0	217	66	282	294

Table 33.2. Landings numbers-at-age for sole in 7.jk.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1993	32.8	217.9	224.5	76.8	55.7	56.7	31.5	20.6	11.6	11.0	5.5	4.7	4.7	8.2	0.9
1994	23.5	117.3	130.2	68.8	40.8	22.4	19.1	10.9	12.0	13.0	10.7	4.0	3.3	11.0	12.1
1995	0.0	279.2	80.8	174.0	117.1	50.9	14.9	15.3	4.1	22.0	7.7	8.5	2.1	2.2	2.1
1996	12.3	45.9	115.9	80.4	52.7	54.2	31.5	8.1	4.8	5.6	10.0	2.6	5.3	6.3	20.9
1997	39.0	160.9	83.5	109.7	42.6	41.5	37.7	15.7	1.4	0.0	3.9	3.0	3.2	2.2	11.4
1998	23.5	137.2	113.3	58.9	92.7	40.0	43.1	34.4	8.8	5.4	2.8	5.0	2.8	0.0	29.7
1999	51.2	179.3	217.7	187.0	67.0	76.9	30.1	27.6	19.1	1.8	10.5	1.3	0.0	1.2	18.1
2000	39.4	95.6	82.9	41.8	28.9	15.8	20.9	10.8	16.6	7.9	3.0	0.0	1.7	0.0	3.4
2001	64.6	114.6	52.6	49.1	37.7	22.4	21.8	14.3	9.2	3.6	2.0	5.2	3.0	1.7	3.3
2002	12.7	139.3	183.5	65.7	37.9	38.7	15.0	8.3	24.1	7.7	20.6	5.2	5.5	3.2	22.1
2003	2.0	53.6	92.6	128.0	76.2	44.9	18.4	3.9	5.4	8.9	13.7	0.0	2.7	0.9	5.4
2004	7.0	18.4	92.3	47.8	36.4	18.7	13.7	5.9	8.0	1.2	6.9	1.2	4.5	3.4	12.3
2005	9.4	34.0	47.2	64.7	17.1	38.3	20.7	9.4	3.8	4.2	0.0	3.8	4.4	3.2	6.7
2006	12.8	29.1	29.7	27.6	37.7	17.8	15.7	10.8	6.0	3.8	1.3	0.6	1.4	1.3	8.6
2007	1.1	44.0	35.7	30.1	44.4	42.3	20.5	15.9	10.1	4.3	4.2	1.2	3.3	1.1	3.3
2008	1.2	24.7	89.6	42.6	21.5	20.3	25.0	10.5	7.9	4.8	2.8	3.2	2.0	1.4	3.9
2009	0.3	14.8	38.4	76.5	31.4	16.9	16.6	15.9	6.3	6.1	5.5	1.0	0.8	0.0	3.2

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2010	5.0	48.5	49.5	54.0	47.3	13.7	8.8	9.1	8.8	6.2	6.7	2.9	3.1	0.2	4.8
2011	0.7	24.3	65.1	46.3	32.8	32.7	13.5	8.4	8.4	7.6	6.9	4.4	2.2	1.0	8.4
2012	0.7	11.4	48.1	70.8	33.6	31.0	26.4	9.8	9.1	6.8	8.2	5.5	3.3	2.6	7.0
2013	0.2	8.3	28.8	65.6	57.2	30.2	16.8	13.3	7.0	3.7	4.1	2.4	2.1	2.2	3.3
2014	1.5	21.5	28.5	38.1	64.1	53.7	21.7	12.1	8.7	4.0	2.9	2.6	1.6	2.1	2.9
2015	2.1	29.4	51.4	27.7	33.0	42.3	32.0	17.3	8.1	7.4	3.5	2.7	1.7	1.7	3.2
2016	5.2	20.4	59.2	67.4	37.2	30.3	29.5	23.1	11.3	9.4	5.3	2.7	2.3	1.3	5.1
2017	1.6	49.3	33.5	68.1	62.6	27.0	17.9	18.2	11.8	7.7	3.9	4.9	1.8	1.1	3.6
2018	0.0	0.8	18.5	49.9	32.0	29.2	20.9	11.4	8.9	11.0	7.5	6.2	3.2	2.2	3.7

Table 7.14.3. Weight-at-age for sole in 7.jk.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1993	0.154	0.221	0.275	0.342	0.412	0.455	0.511	0.496	0.628	0.567	0.762	0.499	0.505	0.777	1.095
1994	0.143	0.233	0.278	0.346	0.421	0.453	0.514	0.552	0.610	0.632	0.632	0.583	0.660	0.845	0.661
1995	0.141	0.194	0.322	0.362	0.338	0.370	0.493	0.452	0.722	0.579	0.401	0.297	0.836	0.350	0.607
1996	0.138	0.169	0.230	0.307	0.435	0.421	0.505	0.587	0.613	0.712	0.755	0.643	0.765	0.723	0.673
1997	0.133	0.200	0.281	0.334	0.409	0.526	0.618	0.592	0.679	0.679	0.691	0.848	0.889	0.695	0.974
1998	0.136	0.223	0.281	0.357	0.379	0.448	0.515	0.554	0.455	0.647	0.497	0.641	0.659	0.763	0.819
1999	0.152	0.192	0.308	0.345	0.400	0.426	0.461	0.575	0.578	0.657	0.449	0.896	0.592	0.832	0.760
2000	0.180	0.210	0.255	0.396	0.416	0.472	0.503	0.489	0.506	0.452	0.555	0.818	0.525	0.850	0.694
2001	0.164	0.228	0.295	0.337	0.394	0.481	0.548	0.530	0.587	0.795	0.542	0.740	0.967	0.867	0.438
2002	0.203	0.198	0.254	0.305	0.469	0.490	0.473	0.654	0.730	0.721	0.626	0.616	1.150	0.643	0.871
2003	0.168	0.191	0.296	0.323	0.329	0.378	0.371	0.575	0.499	0.548	0.477	0.557	0.446	0.779	0.640
2004	0.094	0.199	0.197	0.293	0.313	0.353	0.287	0.584	0.636	0.499	0.595	0.499	0.845	0.457	0.761
2005	0.131	0.168	0.198	0.249	0.383	0.313	0.340	0.446	0.525	0.468	0.604	0.489	0.393	0.437	0.841
2006	0.160	0.180	0.205	0.257	0.298	0.354	0.354	0.377	0.456	0.377	0.612	0.438	0.568	0.508	0.775
2007	0.154	0.208	0.268	0.282	0.329	0.341	0.378	0.395	0.449	0.376	0.418	0.554	0.494	0.594	0.527
2008	0.144	0.204	0.236	0.278	0.305	0.339	0.339	0.395	0.389	0.445	0.560	0.450	0.512	0.457	0.744
2009	0.123	0.196	0.234	0.265	0.268	0.318	0.386	0.420	0.393	0.417	0.368	0.476	0.828	0.480	0.527

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2010	0.177	0.197	0.247	0.304	0.331	0.364	0.371	0.400	0.440	0.427	0.512	0.423	0.541	0.503	0.505
2011	0.186	0.207	0.236	0.260	0.298	0.340	0.420	0.479	0.469	0.523	0.580	0.600	0.597	0.485	0.639
2012	0.191	0.216	0.254	0.294	0.320	0.362	0.404	0.423	0.459	0.483	0.461	0.517	0.584	0.681	0.552
2013	0.141	0.226	0.268	0.302	0.339	0.352	0.404	0.440	0.483	0.483	0.546	0.614	0.477	0.557	0.647
2014	0.130	0.209	0.246	0.282	0.314	0.348	0.354	0.398	0.485	0.479	0.451	0.493	0.438	0.653	0.820
2015	0.152	0.206	0.231	0.284	0.316	0.319	0.330	0.374	0.393	0.455	0.476	0.533	0.404	0.643	0.510
2016	0.203	0.254	0.280	0.302	0.336	0.359	0.403	0.383	0.443	0.418	0.452	0.491	0.491	0.528	0.591
2017	0.144	0.204	0.236	0.278	0.305	0.339	0.339	0.395	0.389	0.445	0.560	0.450	0.512	0.457	0.693
2018	0.000	0.189	0.237	0.296	0.332	0.360	0.376	0.416	0.489	0.475	0.472	0.486	0.541	0.615	0.705

Table 39.4. Tuning data. The ages (3–9) and years used in the assessment are in bold.

SOL7jk, WGCSE															
101															
IRL-VMS: nos per 1000 hours															
2006	2018														
1	1	0	1												
2	16														
1	172	390	398	369	506	239	210	145	81	52	18	9	19	17	115	#2006
1	14	591	480	405	597	569	276	214	136	58	56	17	44	14	44	#2007
1	19	412	1495	711	358	339	417	176	131	80	47	54	33	24	65	#2008
1	4	223	578	1150	472	254	249	238	95	92	83	15	12	0	49	#2009
1	64	624	638	695	609	177	113	117	113	79	86	38	39	3	61	#2010
1	10	343	919	654	463	462	191	118	119	107	97	62	32	14	119	#2011
1	9	145	612	901	427	394	335	125	115	86	105	70	42	33	89	#2012
1	4	155	536	1224	1067	563	313	248	131	70	77	45	39	42	62	#2013
1	25	361	477	640	1075	901	363	202	146	66	49	44	26	36	49	#2014
1	45	627	1094	591	703	901	681	369	173	158	75	57	36	37	68	#2015
1	104	407	1179	1343	740	604	588	461	224	188	107	54	46	25	101	#2016
1	22	712	*483*	*983*	904	389	259	262	170	112	57	70	26	15	51	#2017
1	0	15	356	961	617	563	403	220	171	212	144	119	61	42	71	#2018

Table 7.14.5. XSA diagnostics.

```
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CPUE data from indices

Catch data for 26 years 1993 to 2018. Ages 2 to 10.

                        fleet first age last age first year last year alpha
beta
1 IRL-VMS: nos per 1000 hours         3        9       2006      2018  <NA>
<NA>


 Time series weights :

    Tapered time weighting not applied

 Catchability analysis :

     Catchability independent of size for all ages

     Catchability independent of age for ages >   7

 Terminal population estimation :

     Survivor estimates shrunk towards the mean F
    of the final   5 years or the  5 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   1.5

    Minimum standard error for population
    estimates derived from each fleet =  0.2

    prior weighting not applied

Regression weights
     year
age   2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
    year
age   2009  2010  2011  2012  2013  2014  2015  2016  2017  2018
  2  0.000 0.008 0.002 0.002 0.000 0.003 0.004 0.015 0.086 0.000
  3  0.037 0.075 0.044 0.034 0.025 0.040 0.056 0.050 0.172 0.051
```

```
  4  0.132 0.148 0.123 0.103 0.101 0.099 0.113 0.138 0.097 0.081
  5  0.273 0.248 0.180 0.171 0.179 0.169 0.119 0.191 0.208 0.183
  6  0.310 0.241 0.209 0.172 0.183 0.238 0.194 0.207 0.243 0.128
  7  0.282 0.193 0.234 0.278 0.207 0.233 0.218 0.246 0.204 0.153
  8  0.293 0.207 0.263 0.268 0.213 0.202 0.190 0.208 0.201 0.215
  9  0.225 0.231 0.278 0.276 0.188 0.210 0.219 0.182 0.172 0.170
  10 0.225 0.231 0.278 0.276 0.188 0.210 0.219 0.182 0.172 0.170


 XSA population number (Thousand)
      age
year     2   3   4   5   6   7   8   9  10
  2009 778 434 326 337 124  72  69  83 119
  2010 663 704 378 259 232  82  49  46 166
  2011 398 595 591 295 183 165  61  36 168
  2012 398 359 515 472 223 134 118  43 185
  2013 642 359 314 420 360 170  92  82 152
  2014 625 581 317 257 318 271 125  67 137
  2015 492 564 505 260 196 227 195  92 151
  2016 367 443 483 408 209 146 165 146 235
  2017  21 327 381 380 305 154 104 121 231
  2018   0  17 249 313 279 217 113  77 287


 Estimated population abundance at 1st Jan  2019
      age
year   2 3  4   5   6   7   8  9 10
  2019 0 0 15 208 236 222 168 83 59


 Fleet:  IRL-VMS: nos per 1000 hours

 Log catchability residuals.

   year
age   2006  2007  2008   2009   2010   2011   2012   2013   2014   2015  2016
2017   2018
  3  0.483 0.239 0.244 -0.500  0.063 -0.382 -0.745 -0.683 -0.310  0.279 0.086
1.181  0.044
  4  0.163 0.128 0.619 -0.019 -0.060 -0.153 -0.432 -0.072 -0.199  0.173 0.305
-0.197 -0.259
  5 -0.398 0.056 0.411  0.270  0.018 -0.206 -0.361  0.067 -0.095 -0.210 0.194
0.135  0.120
  6 -0.330 0.328 0.172  0.288 -0.116 -0.167 -0.464 -0.023  0.136  0.172 0.167
0.179 -0.343
  7 -0.345 0.088 0.133  0.156 -0.375 -0.091 -0.024  0.064  0.078  0.251 0.302
-0.033 -0.205
```

```
  8 -0.215 0.147 0.151  0.193 -0.307  0.027 -0.063  0.094 -0.070  0.110 0.138
-0.047  0.138
  9 -0.009 0.169 0.071 -0.070 -0.198  0.077 -0.028 -0.034 -0.032  0.256 0.007
-0.204 -0.098


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

              3      4      5      6      7      8      9
Mean_Logq -0.0970 0.7042 1.1389 1.2470 1.2839 1.2839 1.2839
S.E_Logq   0.2749 0.2749 0.2749 0.2749 0.2749 0.2749 0.2749


 Terminal year survivor and F summaries:

 ,Age 3 Year class =2015

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.877        15  2015
fshk                            0.123        11  2015

 ,Age 4 Year class =2014

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.962       161  2014
fshk                            0.038       152  2014

 ,Age 5 Year class =2013

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.967       266  2013
fshk                            0.033       250  2013

 ,Age 6 Year class =2012

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.964       158  2012
fshk                            0.036       128  2012

 ,Age 7 Year class =2011

source
```

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.976	137	2011
fshk	0.024	112	2011

,Age 8 Year class =2010

source

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.978	95	2010
fshk	0.022	88	2010

,Age 9 Year class =2009

source

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.979	53	2009
fshk	0.021	66	2009

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CPUE data from indices

Catch data for 26 years 1993 to 2018. Ages 2 to 10.

fleet first age last age first year last year alpha
beta

Table 33.6. Summary table for sole 7.jk. Landings in tonnes (7.jk only). Recruitment (age 3) in thousands. SSB in tonnes.

year	landings	recruit	fbar	ssb
1993	246	920	0.357	699
1994	178	573	0.214	809
1995	241	943	0.383	686
1996	166	421	0.242	681
1997	191	663	0.298	681
1998	219	649	0.329	666
1999	200	575	0.707	549
2000	109	508	0.29	423
2001	127	749	0.225	462
2002	144	500	0.328	615
2003	102	561	0.377	433
2004	85	318	0.205	419
2005	77	247	0.184	358
2006	61	294	0.158	338
2007	83	562	0.216	371
2008	77	387	0.207	382
2009	69	434	0.188	375
2010	82	704	0.178	460
2011	87	595	0.139	511
2012	94	359	0.12	577
2013	91	359	0.122	584
2014	87	581	0.137	544
2015	78	564	0.121	541
2016	115	443	0.146	656
2017	114	327	0.18	550
2018	75	17	0.111	536
2019		553		460

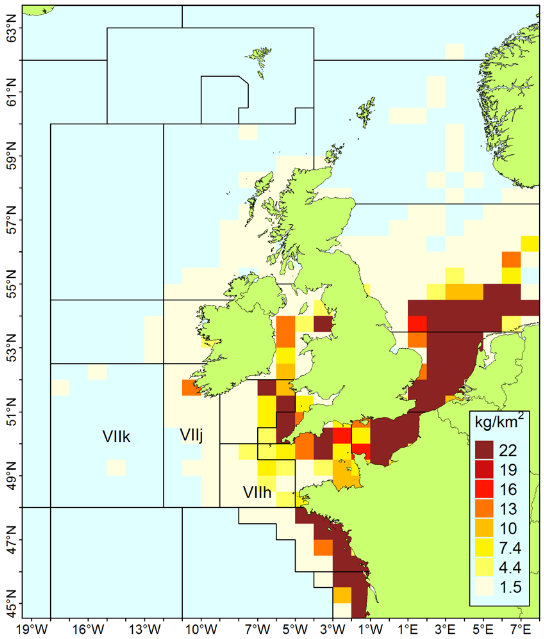


Figure 33.1. The spatial distribution of International landings of sole (2012 data, all gears combined; data from STECF).

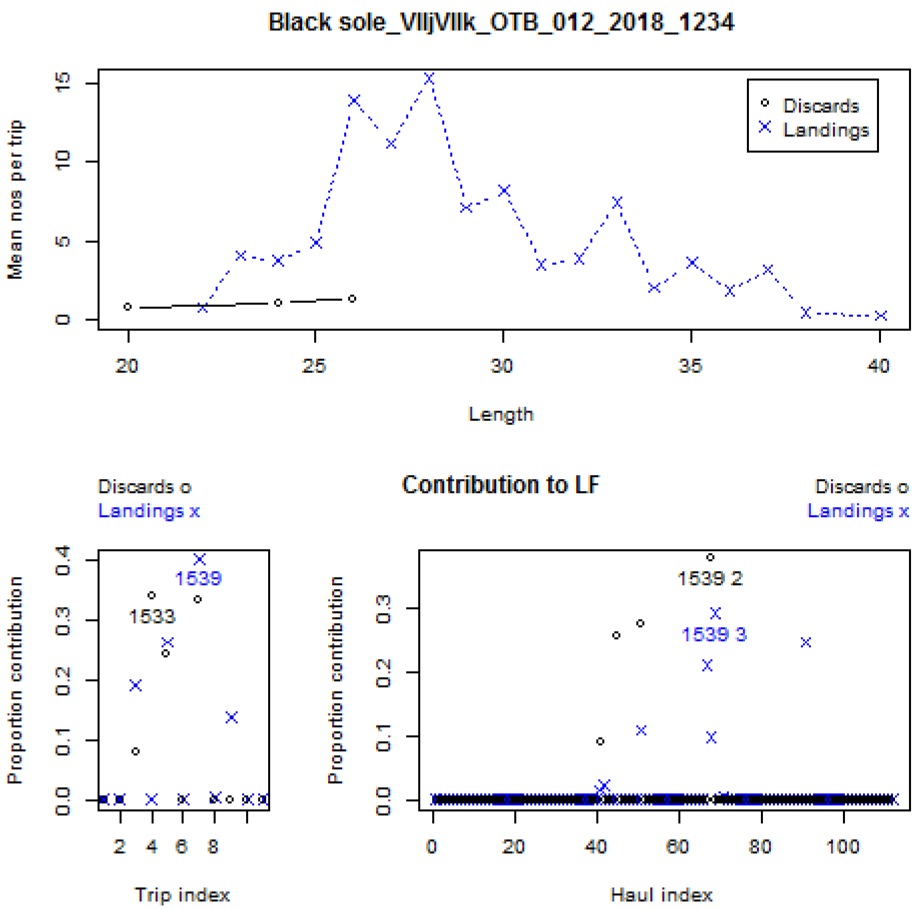


Figure 33.2. Irish OTB retained catches on observer trips in 7.jk during 2018. Numbers raised to fleet level using fishing effort (hours fished).

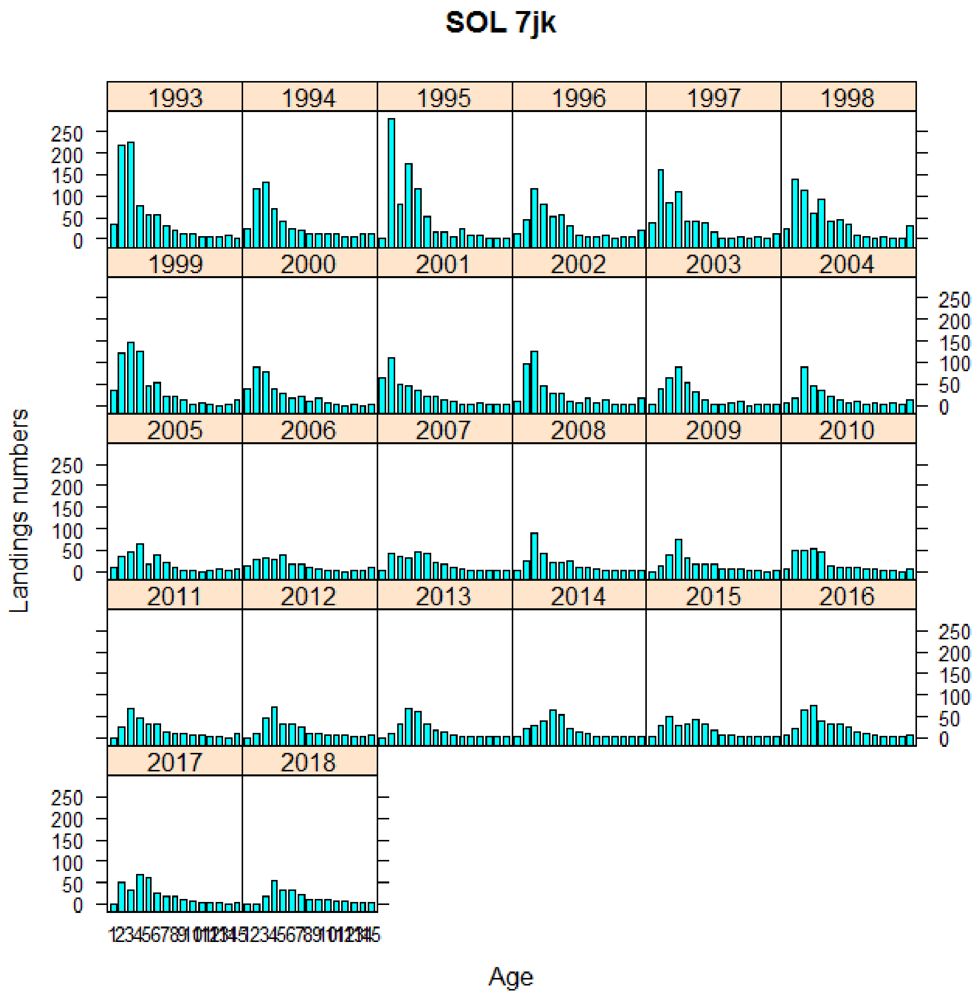


Figure 7.14.3. Age distribution of sole in 7.jk between 1993 and 2018. All gears and quarters combined.

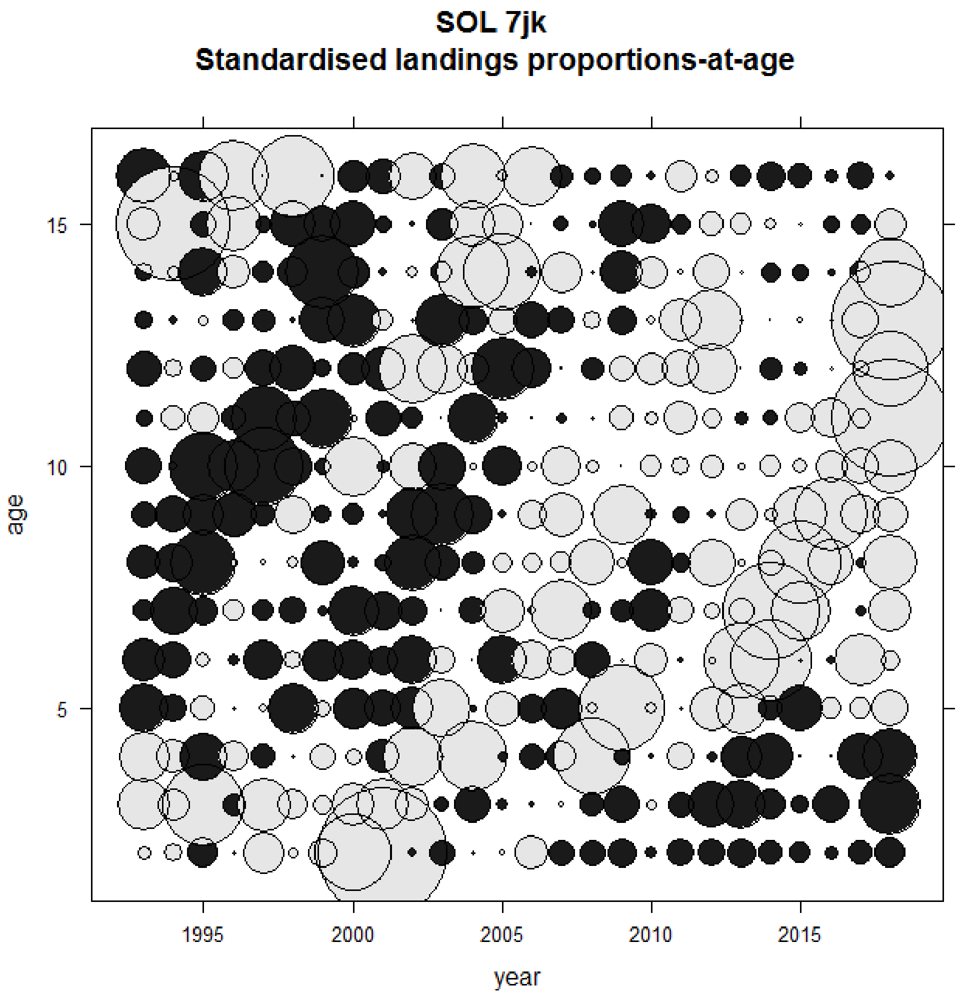


Figure 33.4. Standardised catch proportions-at-age for sole in 7.jk. Grey bubbles represent higher than average catch-at-age and black bubbles represent lower than average catch-at-age.

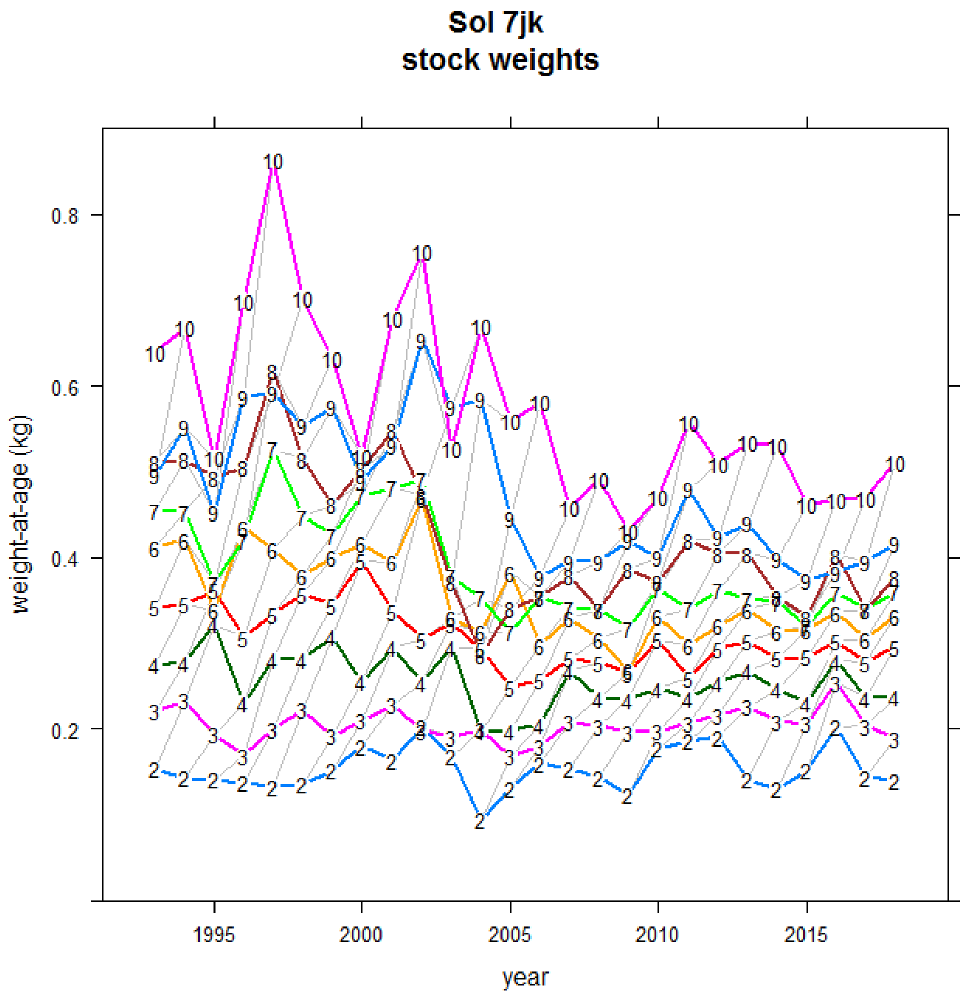


Figure 33.5. Catch weights/stock weights of sole 7.jk.

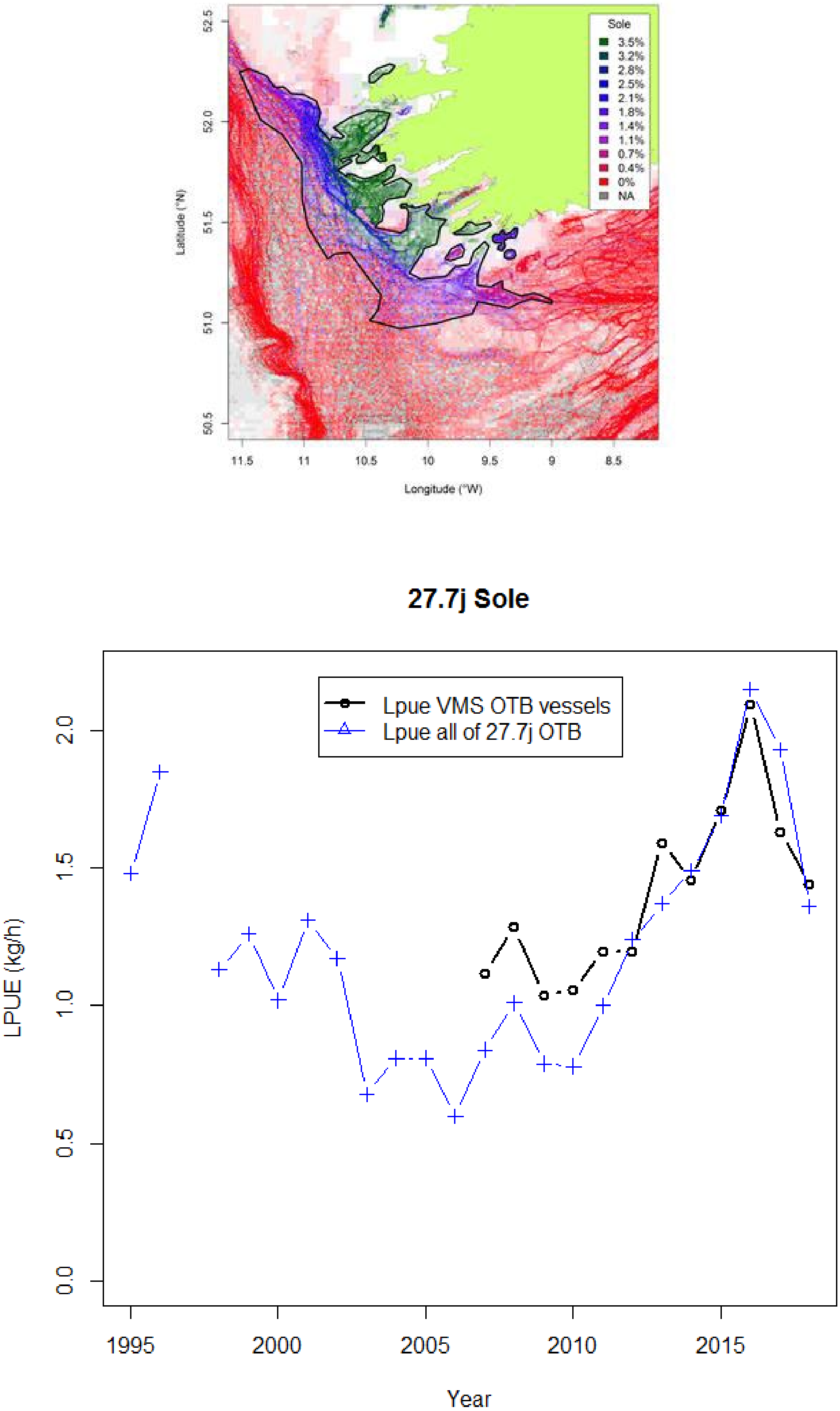
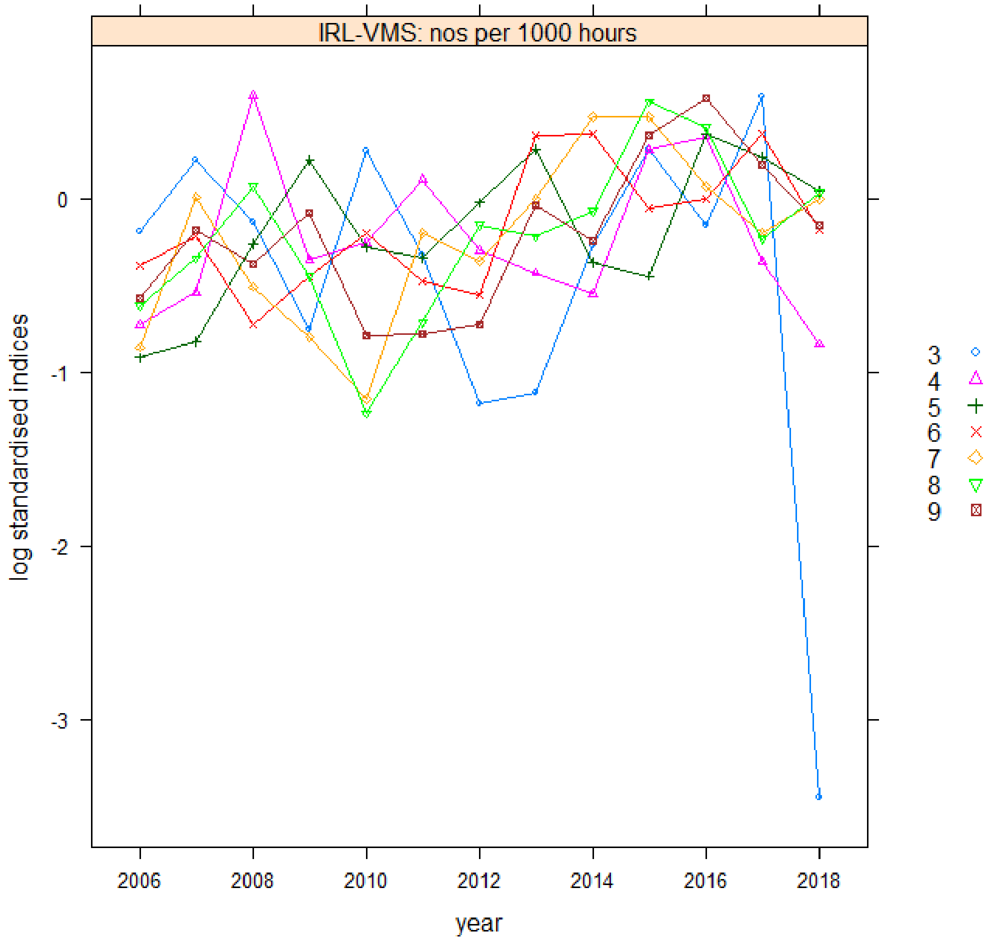


Figure 33.6. Top: the proportion of sole in landings of Irish vessels with VMS over the years 2006–2017. The black line indicates the polygon inside which sole are caught. Effort and landings from the VMS/logbooks data inside the polygon were used as a tuning index. Bottom: the VMS lpue index (black line) and the lpue of sole in the whole of 7.j (1995–2018).


IRL-VMS: nos per 1000 hours
log standardised indices
0
-1
-2
-3
2006
2008
2010
2012
2014
2016
2018
year
3
4
5
6
7
8
9

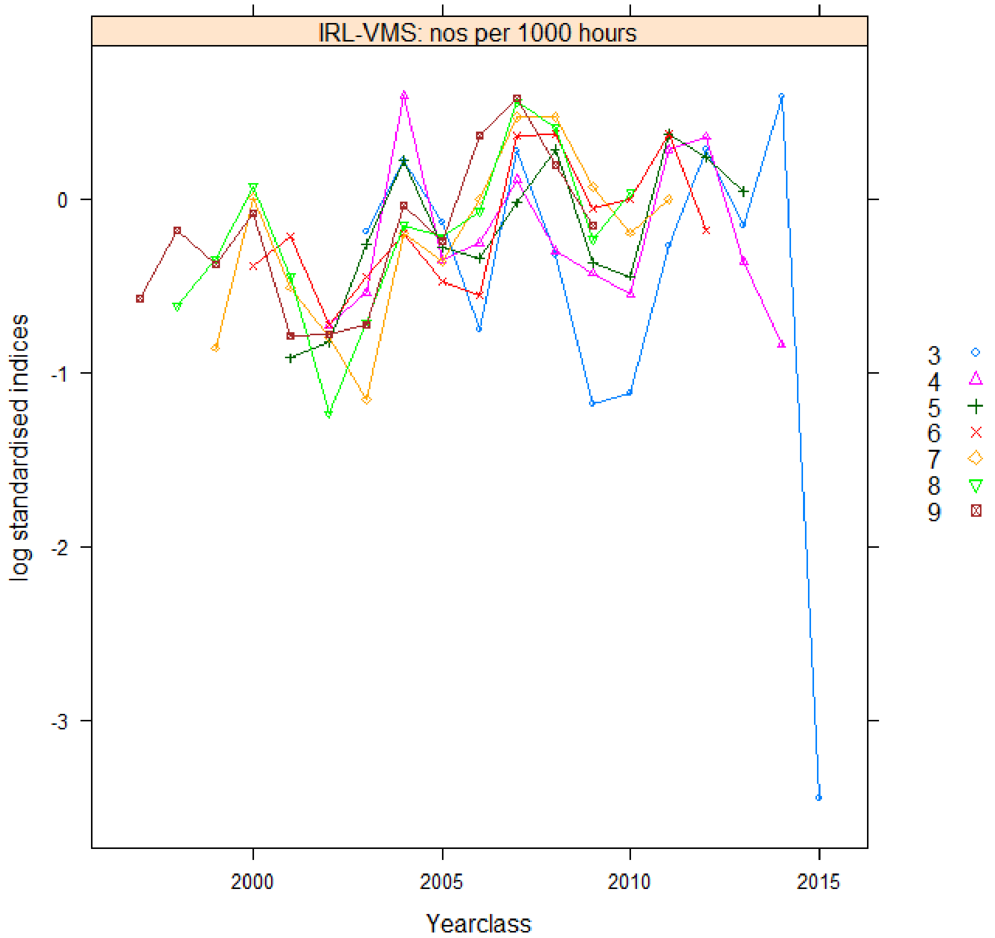


Figure 33.7. The log-standardised tuning index by year (top) and cohort (bottom). The cohorts are tracked quite well and no year effects are obvious.

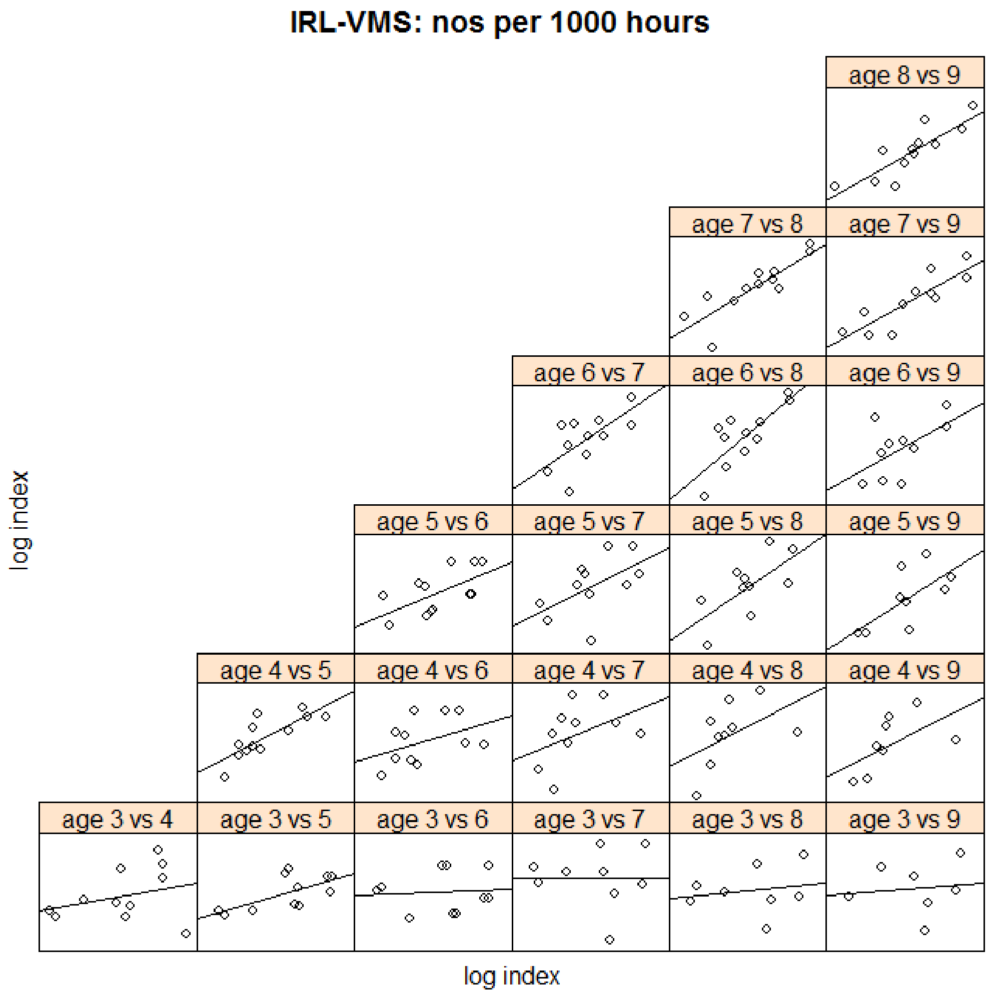


Figure 33.8. Internal consistency of the tuning fleet.

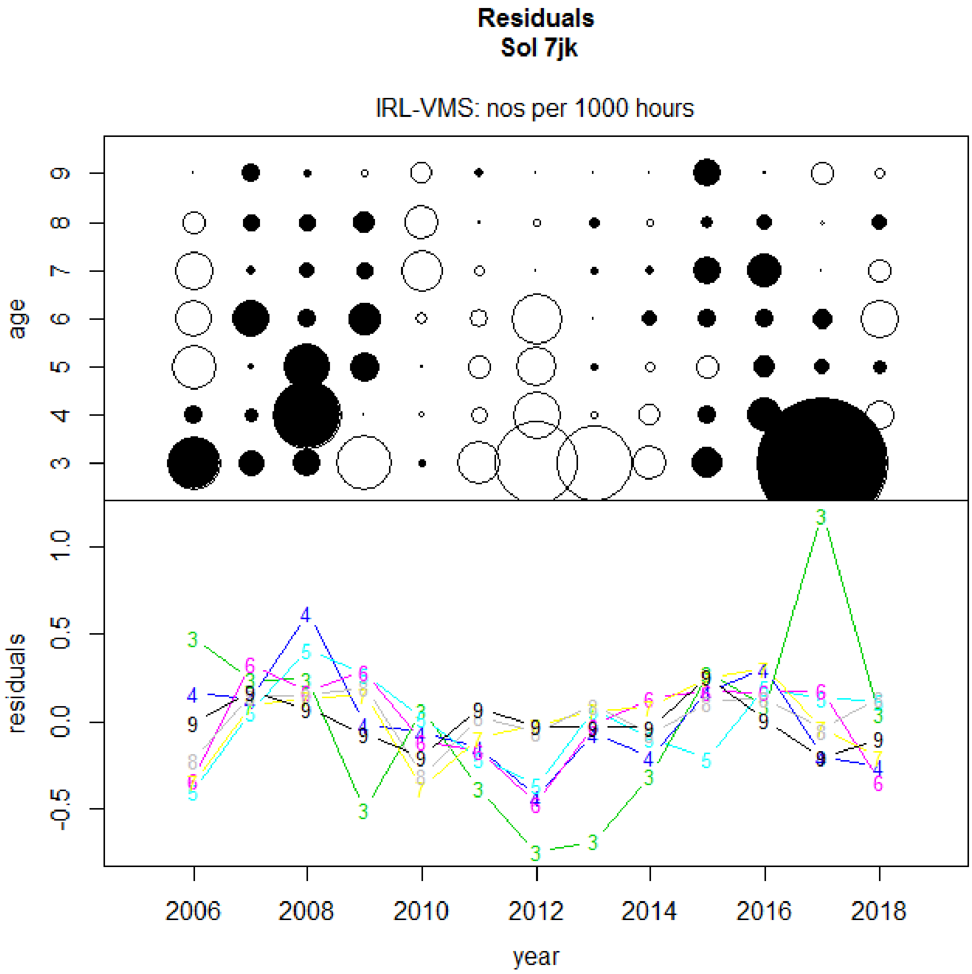


Figure 33.9. Residuals of the index fit.

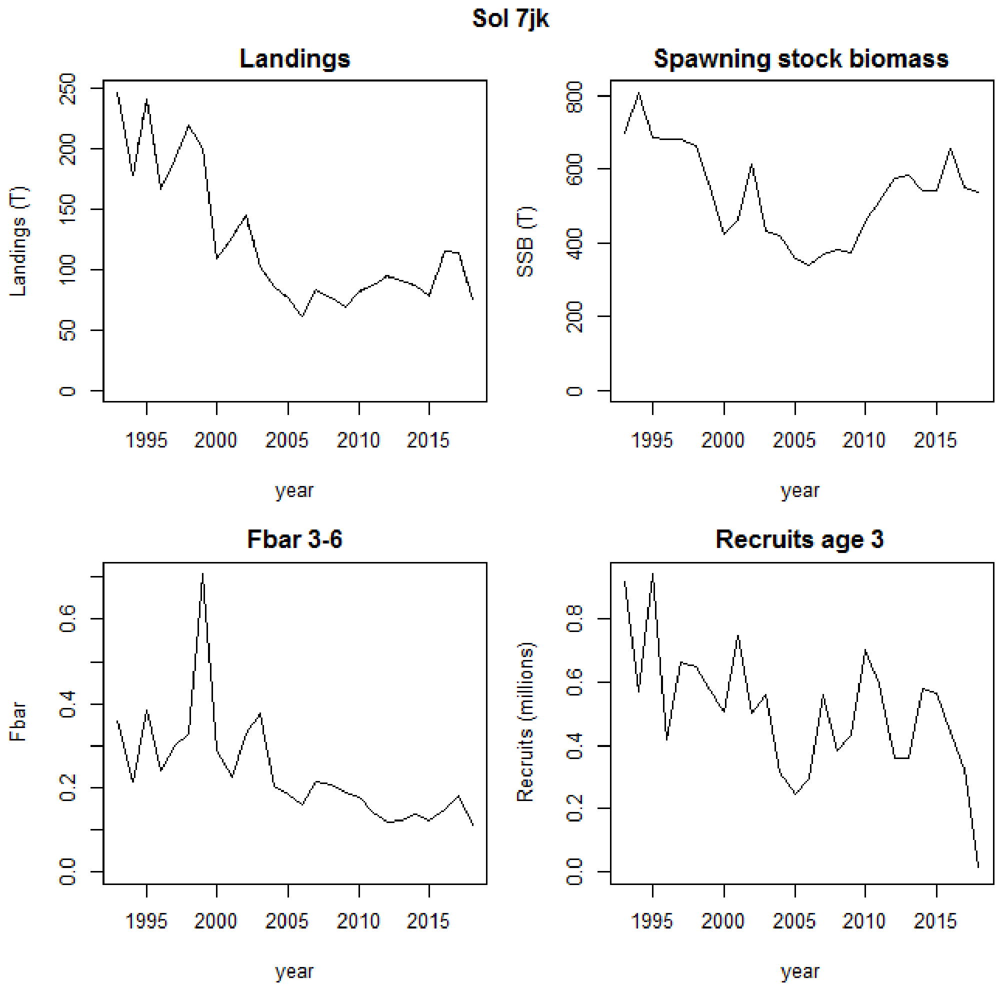


Figure 33.10. Stock summary plot.

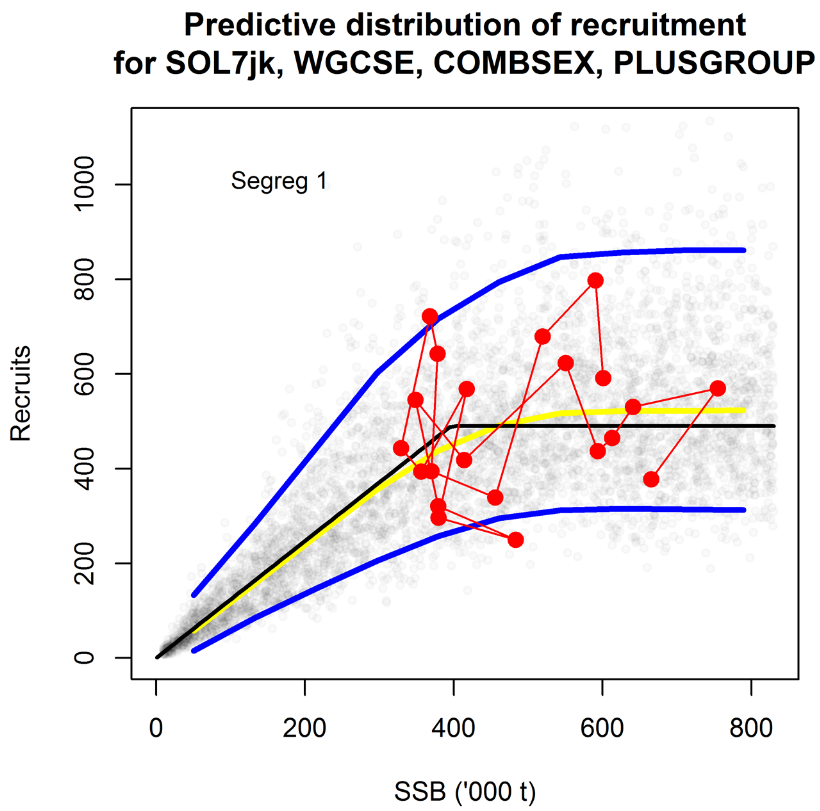


Figure 33.11. Sole 7jk stock–recruit plot. Because recruitment does not appear to be impaired at the lowest stock size, the inflection point of the segmented regression was chosen to be B_{loss}. Estimated as part of WGCSE 2017.

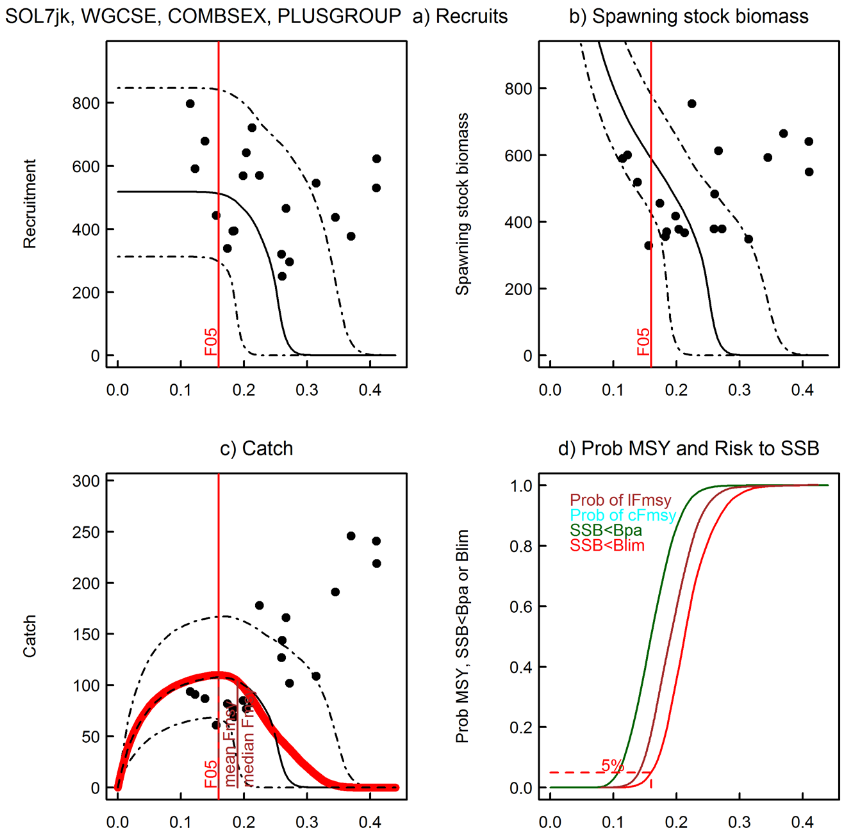


Figure 33.12. Sole 7.jk Summary of MSY evaluations (without $B_{trigger}$ harvest control rule), a) simulated and Marine 2018 observed recruitment, b) simulated and observed biomass, c) simulated and observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}.. Estimated as part of WGCSE 2017.

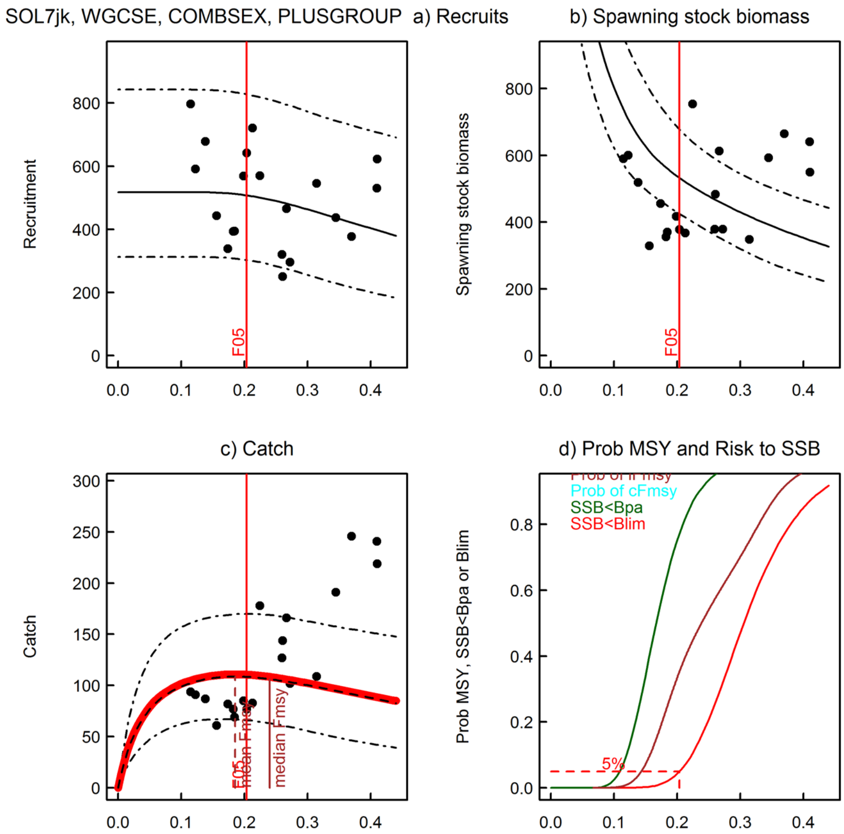


Figure 33.13. Sole 7.jk Summary of MSY evaluations (with $B_{trigger}$=B_{loss} harvest control rule), a) simulated and observed recruitment, b) simulated and observed biomass, c) simulated and observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}. Estimated as part of WGCSE 2017.

36 Whiting (*Merlangius merlangus*) in Division 6.a (West of Scotland)

Type of assessment in 2019

An update/SPALY Time-Series Analysis (TSA) was carried out with catch and survey data, following the procedure outlined in the Stock Annex. No changes were considered with regard to reference points in relation to those estimated in the previous year.

ICES advice applicable to 2019

ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2019 and 2020.
http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/whg.27.6a.pdf

ICES advice applicable to 2017 and 2018

ICES advises that when the MSY approach is applied, there should be zero catch in each of the years 2017 and 2018.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/whg-scow.pdf

36.1 General

Stock description

General information is presented in the Stock Annex.

Management applicable to 2018 and 2019

The TAC for whiting (in tonnes) is set for ICES subareas 6, 12 and 14 and EU and international waters of ICES Division 5b, for 2019 and 2018 is shown below.

TAC for 2019

Species:	Whiting *Merlangius merlangus*	**Zone:**	6; Union and international waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	3 (1)		
France	68 (1)		
Ireland	324 (1)		
United Kingdom	717 (1)		
Union	1 112 (1)		
TAC	1 112 (1)		Analytical TAC Article 8 of this Regulation applies

(1) Exclusively for by-catches of whiting in fisheries for other species. No directed fisheries for whiting are permitted under this quota.

(Council Regulation (EU) 2019/124).

TAC for 2018

Species:	Whiting *Merlangius merlangus*	Zone:	6; Union and international waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	1 (1)		
France	26 (1)		
Ireland	64 (1)		
United Kingdom	122 (1)		
Union	213 (1)		
TAC	213 (1)		Analytical TAC

(1) Exclusively for by-catches. No directed fisheries are permitted under this quota.

(Council Regulation (EU) 2018/120).

The minimum landing size for whiting in Division 6.a is 27 cm.

Fishery in 2018

A description of the fisheries in the West of Scotland is given in the Stock Annex.

Anecdotal information from the fishing industry suggests that the number of vessels targeting whiting continues to be very low. The year 2019 ends the transition period in the imposition of the landing obligation. The quota uptake for this stock in the preceding period varied from moderate to high. It is uncertain how the increased TAC will affect the catches of whiting.

Total landings (nominal landings, ICES statistics) in 2018 were 180 t, up by 6% from 2017 (Table 38.1). They were the second lowest in the time-series. The majority were landed by Scottish and Irish vessels, and smaller amounts by Danish, French and Dutch vessels. The UK landings in Division 6.a in 2018, constituted 83% of the pre-2019 quota for the UK, while Ireland exceeded its quota by 13%. Total landings in 2018 constituted 84% of the TAC for that year.

The total estimated international catch of ages 1 and older in 2018 was 681 t of which 492 t were discards (Table 38.2). An additional 109 t were discarded as the 0-group. Of the discards, 55% were discarded by the trawl fleet targeting crustaceans (*Nephrops*).

Mandatory introduction of larger square mesh panels for the *Nephrops* fleet in 2008 does not seem to have had much of an effect on the discards of whiting in Division 6.a in 2018. In terms of quantity, the discards in 2018 (ages 1 and older) were by 41% lower than those in 2017 and also below the average in the last decade. In terms of discard rate (discards as a proportion of catch), they were the tenth highest in the time-series.

The general perception from fishermen is that large number of whiting are being discarded by the *Nephrops* fleet and that the numbers of smaller whiting has exploded recently but mainly in inshore areas.

36.2 Data

Landings

Total landings, as officially reported to ICES in 1965–2018, are shown in Figure 38.1 and Table 38.2. In the past, there had been concerns that the quality of landings data was deteriorating, giving a possible reason for the different stock dynamics implied by the commercial fleet and the annual survey (ScoGFS-WIBTS-Q1) being in operation at that time (see Section 5.1.6.1.3 in the 2005 WG Report; ICES, 2005). As a result, the total landings data from 1995 to 2005 are not used in the assessment. Improved compliance measures and the introduction of UK and Irish legislation requiring registration of all fish buyers and sellers ensures that the reported total landings from 2006 onwards are more representative of actual landings.

Landings uploaded to InterCatch by métier and country are shown in Figure 38.2. Age distributions were estimated from market samples. Annual numbers-at-age in the landings are given in Table 38.3. Annual mean weights-at-age in the landings are given in Table 38.6 and shown in Figure 38.3. They decreased considerably last year in nearly all age groups. Overall, the mean weights-at-age in the landings have been variable in recent years due to the variability associated with low sample sizes. Efforts to increase sampling in these fisheries are being pursued.

Discards

This year, WG estimates of discards are based on data collected in the Irish and Scottish discard programme (raised by weighted average to the level of the total international discards). Discard age compositions from Scottish and Irish samples have been applied to unsampled fleets. Discards uploaded to InterCatch by métier and country are shown in Figure 38.2.

Annual numbers-at-age in the discards are given in Table 38.4. Annual mean weights-at-age in the discards are given in Table 38.7 and shown in Figure 38.3.

Biological

Annual numbers-at-age in the total catch are given in Table 38.5. Annual mean weights-at-age in the total catch are given in Table 38.8 and shown in Figure 38.3. As in previous assessments, the catch mean weights-at-age were also used as stock mean weights-at-age (see the Stock Annex).

Natural mortality (*M*) is assumed to vary and be dependent on fish weight (Lorenzen, 1996). *M* values are time-invariant and are calculated as:

$$M_a = 3.0\overline{W_a}^{-0.29}$$

where M_a is natural mortality-at-age *a*, $\overline{W_a}$ is the time averaged stock weight-at-age *a* (in g) and the numbers are the Lorenzen's parameters for fish in natural ecosystems.

Maturity-at-age was assumed to be knife-edge, with the value 0 at age 1 and full maturity-at-age 2+ according to the Stock Annex.

Surveys

Five research vessel survey series for whiting in 6.a were available to the WG.

- Scottish first-quarter west coast groundfish survey (ScoGFS-WIBTS-Q1): all ages 1 and older, years 1985–2010;
- Scottish fourth-quarter west coast groundfish survey (ScoGFS-WIBTS-Q4): all ages including age 0, years 1996–2009.

The Q1 Scottish Groundfish survey was running in the period 1981–2010, and this was performed using a repeat station format with the GOV survey trawl together with the west coast groundgear rig, 'C'. Similarly, the Q4 Scottish Groundfish survey was running in 1996–2009, once again using the GOV survey trawl with groundgear 'C' and the fixed station format. The Q4 survey was not carried out in 2010 due to an engine break down of the research vessel.

In 2011, the Q1 and Q4 Scottish Groundfish surveys were re-designed. The previous repeat station survey format consisting of the same series of survey trawl positions being sampled at approximately the same temporal period every year is considered a rather imprecise method for surveying both these subareas. Therefore, a move towards some sort of random stratified survey design was judged necessary (see further details of the modified survey design in the Stock Annex). The introduction of the new design initiated two time-series:

- Scottish first-quarter west coast groundfish survey (UK-SCOWCGFS-Q1): all ages 1 and older, years 2011–2019;
- Scottish fourth-quarter west coast groundfish survey (UK-SCOWCGFS-Q4): all ages including age 0, years 2011–2018.

The distribution of whiting at-age (cpue) in the Q1 and Q4 surveys in 2016–2019 is shown in Figure 38.4. The Q4 survey in 2013 (not shown in Figure 38.4) was not fully implemented due to adverse weather conditions; it covered only the northern half of Division 6.a and is therefore not used in the assessment. The Q1 survey in 2019 has recently been completed and processed. As a result, nine years of data are currently available in the time-series for the Q1 survey and seven years of data for the Q4 survey (as valid indices). These data were made available in this year's assessment.

The Irish groundfish survey:

- Irish fourth-quarter west coast groundfish survey (IGFS-WIBTS-Q4): all ages including age 0, years 2003–2018.

The distribution of whiting at-age (cpue) in the two Q4 surveys, UKSGFS-WIBTS-Q4 (only the southern part) and IGFS-WIBTS-Q4 in 2015–2018 is shown in Figure 38.5. The previous Irish survey (IreGFS), being in operation in 1993–2002 (see the Stock Annex), is not used in the assessment. The current Irish survey uses the RV Celtic Explorer and is part of the IBTS coordinated western waters surveys. The vessel uses a GOV trawl, and the design is a depth stratified survey with randomised stations. Effort is recorded in terms of minutes towed. This time-series was considered long enough to be used in the assessment of whiting in Division 6.a, giving useful additional indications of year-class strength.

Further descriptions of the above five surveys can be found in "Manual of the IBTS North Eastern Atlantic Surveys" (ICES, 2017) and in the last IBTSWG report (ICES, 2018).

During the Inter-Benchmark Protocol of West of Scotland Roundfish (IBPWSRound), it was decided to include the new Scottish survey time-series in the assessment (ICES, 2015). An attempt was made to use one index to represent the stock abundance combining the two Q4 surveys currently in operation, IGFS-WIBTS-Q4 and UK-SCOWCGFS-Q4. However, considerable differences were found between the two surveys with cpue being overall higher in the Irish survey. As a consequence of these differences, the IBPWSRound agreed to continue using the Irish Q4 survey as an independent time-series. The differences between the two Q4 surveys were explored in more detail by Working Group on Improving use of Survey Data for Assessment and Advice (WGISDAA) in 2018. The group's interim report will soon be available. However, the issue will further explored at WGISDAA in 2019. Ultimately, five survey time-series were used in the present assessment of the whiting stock (just as last year).

The five surveys indices are shown in Table 38.9 with the data used in the final assessment being highlighted in bold.

A comparison of scaled (standardised to z-scores) survey indices (from the five time-series) at-age show roughly similar trends, mainly for the Scottish surveys, for most ages (up to age 5, Figure 38.6). The two new Scottish surveys seem to show greater consistency (on a year basis) compared to the previous surveys.

Log mean-standardised survey indices by year class and by year in the Irish survey and new Scottish time-series are shown in Figure 38.7. Given the short length of the survey time-series, the year-class plots demonstrate, in most cases, the ability of the surveys to reliably track year classes and to identify the stronger/weaker than average year classes.

The log catch curves for the commercial catch and for the surveys are shown in Figure 38.8. The curves for both ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4 (the two surveys discontinued in 2010 in 2009, respectively) are relatively linear and not very noisy. They also show a fairly steep and consistent drop in abundance. Patterns are less clear with the Irish survey. Little can be said in this respect about the new survey time-series (UK-SCOWCGFS-Q1 and UK-SCOWCGFS-Q4) as they are relatively short.

Commercial cpue

Four commercial catch-effort time-series were previously available to the WG, but they have not been used for a number of years. They are only presented in the Stock Annex.

36.3 Historical stock development

The final assessment of whiting in 6.a was conducted using a TSA model. The method was first developed by Gudmundsson (1994), and it was modified by Rob Fryer for the purpose of assessing time-series containing several years with survey data but no reliable catch data (Fryer, 2002). Subsequent enhancements to the method are detailed in Needle and Fryer (2002). The TSA model allows for years with missing catch or survey data.

Alternative exploratory assessments conducted using SURBA (Needle, 2003) and a Bayesian approach (Cook, 2012) were presented at the WKROUND benchmark in 2012 (ICES, 2012), but were not further explored in this assessment.

Data screening and exploratory runs

Model used: TSA
Software used: NAG library (FORTRAN DLL) and functions in R.
Input data types and characteristics:

- Landings, ages 1–7+, years 1981–2018 (1995–2005 age structure only used),
- Discards, ages 1–7+, years 1981–2018 (1995–2005 age structure only used)
- ScoGFS-WIBTS-Q1, ages 1–6, years 1985–2010
- ScoGFS-WIBTS-Q4, ages 1–6, years 1996–2009
- IGFS-WIBTS-Q4, ages 1–4, years 2003–2006 and 2008–2018
- UK-SCOWCGFS-Q1: ages 1–6, years 2011–2019
- UK-SCOWCGFS-Q4: ages 1–6, years 2011–2012 and 2014–2018

The assessment of whiting in 6.a was conducted using a TSA model with updated survey data (five time-series). The details of the method are presented in the Stock Annex. No modification to the landings was made to account for area misreporting although total landings are excluded from the assessment for the years 1995–2005 as the reported landings data are considered to be unreliable during this period. (ICES, 2012). A "hockey-stick" model was employed to describe the stock–recruitment relationship. Some extra variability in landings and discards was allowed for some ages. Also, some points in the time-series that were identified as outliers were down-weighted to improve the fit. One point in the IGFS-WIBTS-Q4 time-series (for 2007) was treated as an outlier and was excluded from the analysis. Similarly, one point in UK-SCOWCGFS-Q4 (for 2013) was excluded as the survey was not complete in that year. Table 38.10 shows the TSA parameter settings for the assessment run.

The main diagnostics of the quality of the model fit was the value of the objective function (-2*log likelihood), residuals and a consideration of how well the model has replicated discard ratios in the input data.

The WG assessment in 2015 was not properly optimised. The introduction of the new survey time-series at IBPWSRound had a considerable effect (not anticipated at that time) on some of the model parameters. In the 2016 assessment, greater care was taken to ensure that the model parameters were accurately chosen, which consequently improved the model's performance. That alteration resulted in a downward revision of the stock biomass compared to the 2015 assessment. This year's assessment closely followed the optimisation setup used in the last three assessments.

At IBPWSRound, TSA runs with and without a survey catchability trend were compared (ICES, 2015). In the latter, the parameters for persistent and transitory trends in survey catchability were both set to 0. Given the overestimation of catch and uncertainty in the assessment with fixed survey catchability, this option was not further explored and the assessment including estimation of survey catchability trend was retained, which also applied from 2016 onwards.

Final assessment

The TSA run using the five surveys is presented as the final assessment run. Table 38.11 shows the TSA parameter estimates for the assessment.

Figure 38.9 shows the proportion discarded at-age from the final TSA run. Discards continue to account for a large proportion of the total catch, with no obvious tendency to decrease or to level off.

Table 38.12 gives the TSA population numbers-at-age and Table 38.13 gives the associated standard errors. Estimated F at-age is given in Table 38.14 and standard errors on the log of this mortality are given in Table 38.15. Full summary output is given in Table 38.16.

Standardised residuals for landings and discards are given in Figure 38.10, and those for the five surveys in Figure 38.11. None of these are large enough to invalidate the model fit and there are no obvious time-trends in recent years.

TSA also estimated a change in catchability (this is plotted as the percentage change compared to the catchability at the start of each of the five surveys, Figure 38.12). There was a large increase in catchability in the two previous Scottish surveys and in the Irish current survey (although in recent years, this trend seems to have been reversed for the Irish survey). No major change could be seen in the new Scottish surveys in this respect. In fact, the parameters for persistent trends in survey catchability in the Q4 survey was found to be 0 in this assessment (Table 38.11).

The TSA stock–recruit plot is presented in Figure 38.13 and shows a rather good relationship, partly because the stock was driven to very low levels of SSB in 2006–2010. Both SSB and recruitment have been at their highest levels in the two last decades. The summary plots for the final assessment are shown in Figure 38.14.

The final estimates for the stock are:

$F_{(2\text{-}4)}$ in 2018 = 0.032

SSB in 2019 = 18 961 t

Retrospectives for the final assessment run are shown in Figure 38.15. This figure also shows lines at ±2 se (approximate 95% confidence limits) around the run in the last year. Retrospective bias is small with respect to SSB. With respect to mean F and recruitment, the results are roughly within the confidence limits of this year's run. The confidence interval for mean F reflects uncertainty in estimation of mean F when that estimation is based to a large extent on survey data (1995–2005) or the age structure of discards data (2006 onwards).

Comparison with last year's assessment

The above estimates show relatively high consistency with regard to F with the last year's assessment. The SSB estimate for 2018 was revised down by 6 thousand tonnes in this assessment.

$F_{(2-4)}$ in 2017= 0.041 (the present assessment: in 2017, 0.043)

SSB in 2018= 23 143 t (the present assessment: in 2018, 17 175 t)

State of the stock

The spawning–stock biomass (SSB) has been increasing since 2010 but remains very low compared to the historical estimates and is below B_{lim}. Fishing mortality (F) has declined continuously since around 2000 and is now well below F_{MSY}. Recruitment is estimated to have been very low since 2002 but estimated to have increased in recent years.

36.4 Short-term projections

No short-term projection was conducted this year as the forecast for this stock is up-dated biennially starting from the year 2018. The next forecast is scheduled in 2020.

The last short-term projection (in 2018) followed the procedure outlined in the Stock Annex.

36.5 MSY explorations

The reference points for this stock were not updated in this assessment.

In 2016, MSY reference points and ranges were calculated for the stock using the same procedure as that agreed at WKMSYREF4 (ICES, 2016a). The details of the analysis and the results are presented in Working Document 7 (ICES, 2016b).

36.6 MSY and Biological reference points

The reference points estimated in 2016 are summarised in the table below:

Reference point	WKMSY-REF4 2016	WGCSE 2016	Rationale (WKSYREF4)
B_{lim}	28 500 t	31 900 t	SSB value at the change point in the segmented regression
B_{pa}	39 900 t	44 600 t	B_{lim} × 1.4
F_{lim}	0.25	0.27	Based on segmented regression simulation of recruitment
F_{pa}	0.18	0.19	F_{lim}/1.4
F_{MSY}	0.22	0.23	with $B_{trigger}$(=B_{pa})
	0.16	0.18	upper precautionary with $B_{trigger}$(=B_{pa})
F_{MSY} upper	0.34	0.32	with $B_{trigger}$(=B_{pa})
F_{MSY} lower	0.16	0.15	with $B_{trigger}$(=B_{pa})
MSY $B_{trigger}$	39 900 t	44 600 t	B_{pa}
Median SSB at	36 600		

36.7 Management plans

There are no specific management objectives or a management plan for this stock, but a plan is under development.

36.8 Uncertainties and bias in the assessment and forecast

The most significant problem with assessment of this stock is related to the commercial data. Incorrect reporting of landings (species and quantity) is known to have occurred in the past and directly affecting the perception of the stock. TSA is explicitly designed to allow omission of catch data (1995–2005 uses only age structure data from the catch), which is why it was used here to run the final assessment.

The survey data and commercial catch data contain different signals concerning the stock. A similar problem has been present in the North Sea whiting stock (as reported by ICES, 2010). Three potential sources of this discrepancy were identified for the North Sea stock, and they may apply to whiting in 6.a as well: bias in catch estimates, changes in survey catchability or changes in natural mortality due to predation or regime shift (ICES, 2010). Allowing the TSA assessment to interpret this difference as a persistent trend (increase) in survey catchability may lead to an underestimation of stock size, but the magnitude of underestimation is unknown.

After being explored extensively, new reliable reference points were eventually delivered by the 2016 WG for the stock and, if necessary, will be updated in future assessments.

Long-term information on the historical yield and catch composition indicates that the present stock size is low. The current assessment also indicates that the stock is at a low level. Total mortality has been declining over the past few years. The sum of the Scottish West Coast groundfish survey indices, (both in quarter one and quarter four) is also low, but shows a moderate increase from 2010 onwards.

36.9 Recommendation for next benchmark

A landings and discards disaggregated assessment appeared to be a reliable basis for determining the status of the whiting stock in Division 6.a.

The emergence of a trend in survey catchability needs to be addressed. The cause of this is very uncertain. Trends in catchability have been a feature of this assessment in the past and point to some issues with the model structure or assumptions. There have been significant changes in the commercial fishing practices in recent years that are not explicitly taken into account by this assessment model (e.g. emergency measures since 2010 and decline in the TR1 gadoid fishery prior to that). This will require detail explorations in the next benchmark.

The discrepancy in catch rate between the two Q4 surveys, IGFS-WIBTS-Q4 and UKSGFS-WIBTS-Q4 is subject to further exploration (by WGISDAA). This analysis may provide, especially with more years of data available, more insight into the difference in catchability in the two surveys with the ultimate goal of creating one common index.

With regard to the assessment method, changes to the variance structures used in the model should be allowed if they improve model diagnostics (e.g. likelihood ratio tests, prediction error and residual plots).

36.10 Management considerations

Recruitment during the 1990s appears to have been high while after the year 2000, it has been below average. A number of relatively strong (compared to the recent past) year classes have been recorded recently (fish recruited in 2015–2019).

Whiting are caught in mixed fisheries with cod and haddock in Division 6.a. Management of whiting will be strongly linked to that for cod for which there is an ongoing recovery plan (EC, 2008). There have also been several technical conservation measures introduced in the 6.a gadoid fishery in recent years including the mandatory increases in mesh size to 120 mm.

Whiting are caught and heavily discarded in small-meshed fisheries for *Nephrops*. When this stock falls under the landing obligation, it can (in the presence of high discards and low quota) become a "choke species" for the *Nephrops* fishery.

36.11 References

Cook, R. M. 2012. Assessment of West of Scotland cod (ICES Division VIa) using a Bayesian approach, Working paper to WKROUND 2012, February 2012: 1–31.

EC. 2008. Council Regulation (EC) No 1342/2008 of 18 December 2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks and repealing, Regulation (EC) No 423/2004, OJ L 348, 24.12.2008: 20–33.

Fryer, R. J. 2002. TSA: is it the way? Appendix D in report of Working Group on Methods on Fish Stock Assessment. ICES CM 2002/D:01.

Gudmundsson, G. 1994. Time-series analysis of catch-at-age observations. Applied Statistics 43: 117–126.

ICES. 2005. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS), 10–19 May 2005, Murmansk, Russia, ICES CM 2005/ACFM:13, pp. 644.

ICES. 2010. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 5–11 May 2010, ICES Headquarters, Copenhagen, ICES CM 2010/ACOM:13, pp. 1072.

ICES. 2012. Report of the Benchmark Workshop on Western Waters Roundfish (WKROUND), 22–29 February 2012, Aberdeen, UK. ICES CM 2012/ACOM:49, pp. 283.

ICES. 2015. Report of the Inter-Benchmark Protocol of West of Scotland Roundfish (IBPWSRound), February–April 2015, By correspondence. ICES CM 2015/ACOM:37. 72 pp.

ICES. 2016a. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 183 pp.

ICES. 2016b. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 4–13 May 2016, Copenhagen, Denmark. ICES CM 2016/ACOM:13. 1343 pp.

ICES. 2017. Manual of the IBTS North Eastern Atlantic Surveys. Series of ICES Survey Protocols SISP 15. 92 pp. http://doi.org/10.17895/ices.pub.3519.

ICES. 2018. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 19–23 March 2018, Oranmore, Ireland. ICES CM 2018/EOSG:01. 233 pp.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology, 49: 627–647.

Needle, C. L. 2003. Survey-based assessments with SURBA. Working Document to the ICES Working Group on Methods of Fish Stock Assessment, Copenhagen, 29 January–5 February 2003.

Needle, C. L. and Fryer, R. J. 2002. A modified TSA for cod in Division VIa: separate landings and discards. Working document to the ICES Advisory Committee on Fisheries Management, October 2002.

Table 38.1. Whiting in Division 6.a. Nominal landings (in tonnes) as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	1	-	+	-	+	+	+	-	1	1	+	-	-	-	-	+	-	-	-	-
Denmark	1	+	3	1	1	+	+	+	+	-	-	-	-	-	+	+	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
France	199	180	352	105	149	191	362	202	108	82	300	48	52	21	11	6	9	7	6	1
Germany	+	+	+	1	1	+	-	+	-	-	+	-	-	-	-	-	-	+	1	-
Ireland	1315	977	1200	1377	1192	1213	1448	1182	977	952	1121	793	764	577	568	356	172	196	56	69
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	1	-	1	2	+	-	2	-	-	-	-	-	-	-
UK (E, W and NI)	44	50	218	196	184	233	204	237	453	251	210	104	71	73	35	13	5	2	1	
UK (Scot.)	6109	4819	5135	4330	5224	4149	4263	5021	4638	3369	3046	2258	1654	1064	751	444	103	178	424	
UK (total)																				370
Total landings	7669	6026	6908	6010	6751	5786	6278	6642	6178	4657	4677	3203	2543	1735	1365	819	289	383	488	441

Table 38.1. Continued.

Country	2009	2010	2011	2012	2013	2014	2015	2016	2017*	2018*
Belgium	-	-	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	2
Faroe Islands	-	+	1	1	-	-	-	-	-	-
France	1	3	+	+	1	1	+	5	3	2
Germany	-	-	-	-	-	-	-	-	-	-
Ireland	125	99	149	96	97	97	88	77	53	72
Netherlands	-	-	-	-	-	-	11	52	19	2
Norway	2	-	-	-	-	-	-	-	-	+
Spain	-	-	-	-	-	-	-	-	-	-
UK (E, W and NI)										
UK (Scot.)										
UK (total)	354	247	80	204	116	83	122	98	94	101
Total landings	482	349	230	301	214	181	221	232	169	180

*** Preliminary.**

+ <0.5 t.

Table 38.2. Whiting in Division 6.a. Landings, discards and catch estimates 1978–2018, as used by the WG. Values are totals for fish over the ages 1 to 7+. Discard and catch values for the years 1978–2003 are revised compared to previous assessments because of a revised method for raising discards.

	Weight (tonnes)			Numbers (thousands)		
Year	Total	Human consumption	Discards	Total	Human consumption	Discards
1978	19346	14677	4669	85502	54369	31133
1979	20100	17081	3019	77484	61393	16091
1980	14598	12816	1782	54643	44562	10081
1981	14335	12203	2132	59247	46067	13180
1982	19356	13871	5485	84886	47883	37003
1983	22264	15970	6294	86244	49359	36885
1984	20475	16458	4017	89113	50218	38895
1985	17733	12893	4840	75192	43166	32026
1986	11123	8454	2669	49413	31273	18140
1987	23462	11544	11918	158176	41221	116955
1988	19484	11352	8132	109474	40681	68793
1989	13407	7531	5876	72364	26876	45488
1990	10173	5643	4530	51426	19201	32225
1991	11543	6660	4883	63767	25103	38664
1992	15253	6004	9249	93424	22266	71158
1993	11631	6872	4759	52365	23246	29119
1994	9356	5901	3455	44986	20060	24926
1995	11847	6076	5771	66432	18763	47669
1996	15096	7156	7940	81230	22329	58901
1997	11536	6285	5251	55724	19250	36474
1998	13847	4631	9216	88803	14387	74416
1999	8588	4613	3975	43219	15970	27249
2000	16295	3010	13285	176734	10118	166616
2001	6701	2438	4263	38114	8477	29637
2002	4560	1709	2851	28381	5765	22616
2003	2075	1356	719	10063	4124	5939

	Weight (tonnes)			Numbers (thousands)		
Year	Total	Human consumption	Discards	Total	Human consumption	Discards
2004	3437	811	2626	21749	2571	19178
2005	1239	341	898	6154	1051	5103
2006	1326	380	946	12988	1049	11939
2007	849	484	365	4879	1145	3734
2008	617	443	174	3085	1232	1853
2009	905	488	417	18038	1115	16923
2010	1193	307	886	18391	601	17790
2011	569	230	339	4877	583	4294
2012	1041	313	729	9679	702	8977
2013	1175	222	953	15444	522	14922
2014	770	184	586	11226	408	10818
2015	1060	227	833	9336	479	8857
2016	1029	233	796	7102	433	6669
2017	1386	176	1209	11572	386	11187
2018	681	188	492	4491	433	4058
Min	569	176	174	3085	386	1853
GM	5062	2243	2287	314598	6704	20101
AM	9304	5567	3737	50132	18996	31136
Max	23462	17081	13285	176734	61393	166616

Table 38.3. Whiting in Division 6.a. Landings-at-age (thousands).

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1965	6938	6085	43530	4803	388	103	22
1966	1685	10544	2229	28185	1861	186	52
1967	5169	26023	10619	697	14574	789	143
1968	7265	16484	9239	3656	324	5036	368
1969	873	25174	8644	2566	1206	118	2333
1970	730	6423	28065	3241	670	214	550
1971	2387	8617	4122	34784	1338	240	223
1972	16777	12028	4013	1363	14796	793	148
1973	14078	36142	5592	1461	357	4292	310
1974	9083	51036	10049	1166	180	52	849
1975	14917	16778	36318	2819	281	57	245
1976	8500	46421	15757	17423	1508	66	57
1977	16120	13376	25144	3127	4719	292	24
1978	17670	18175	6682	9400	941	1433	68
1979	6334	34221	13282	3407	3488	276	384
1980	11650	11378	14860	4155	1244	1085	190
1981	3593	24395	11297	4611	1518	452	201
1982	2991	5783	29094	6821	2043	803	348
1983	3418	7094	8040	22757	6070	1439	540
1984	7209	12765	8221	4387	14825	1953	858
1985	4139	19520	8574	3351	1997	4764	822
1986	2674	14824	9770	2653	532	291	529
1987	6430	13935	13988	5442	837	330	259
1988	1842	20587	9638	6168	1949	290	207
1989	2529	5887	11889	4767	1266	468	71
1990	3203	8028	2393	4009	1326	204	37
1991	3294	8826	10046	1208	1391	286	51

	Age						
Year	1	2	3	4	5	6	7+
1992	2695	9440	4473	4782	396	373	106
1993	1051	10179	6293	2673	2738	163	147
1994	909	4889	9158	3607	712	715	69
1995	215	4322	6516	5654	1397	376	282
1996	990	5410	7675	5052	2461	583	157
1997	877	3658	8514	4316	1441	338	106
1998	840	3504	4277	3698	1442	338	288
1999	1013	6131	4546	2040	1774	355	112
2000	484	2952	4211	1570	485	328	89
2001	461	3271	2630	1567	401	131	16
2002	62	1624	3018	799	227	23	13
2003	170	710	1111	1673	347	111	2
2004	54	724	543	521	622	78	29
2005	28	276	455	140	99	45	7
2006	82	139	369	260	61	113	24
2007	187	168	255	326	132	27	50
2008	6	265	394	336	152	55	24
2009	59	216	254	430	100	44	13
2010	53	94	153	119	126	24	31
2011	0	310	133	82	28	17	12
2012	9	25	375	210	57	15	11
2013	21	49	83	277	67	18	7
2014	12	30	131	102	99	23	11
2015	11	83	61	164	69	67	25
2016	1	73	166	75	74	16	28
2017	16	35	167	71	49	38	10
2018	0	71	88	199	60	8	7

Table 38.4. Whiting in Division 6.a. Discards-at-age (thousands). Previous discard estimates (ICES, WGCSE 2011) for the years 1978–2003 were replaced by those estimated by Millar and Fryer (2005).

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1965	17205	4968	11437	531	14	2	0
1966	4322	8946	515	3317	79	3	0
1967	12237	20791	2674	84	629	12	1
1968	16394	12612	2137	377	13	82	3
1969	1983	20494	2093	292	51	2	26
1970	1776	6704	7494	382	33	4	0
1971	5505	6719	969	3906	57	4	1
1972	39192	8930	850	152	610	14	1
1973	30521	26995	1225	147	14	77	2
1974	23101	40590	2362	123	7	1	7
1975	37295	13541	8485	310	12	1	0
1976	24891	35812	3360	1940	63	1	0
1977	48148	8675	5432	301	212	5	0
1978	17886	12512	501	194	0	40	0
1979	2581	12099	1113	264	34	0	0
1980	2725	4889	2003	366	86	12	0
1981	1128	10415	1397	201	27	12	0
1982	19511	3421	12683	1197	187	4	0
1983	21690	6748	2909	5372	158	8	0
1984	34330	2400	909	371	811	73	1
1985	17615	9858	3273	672	205	363	40
1986	6159	9823	1962	185	1	0	10
1987	97611	17427	1763	154	0	0	0
1988	28057	38019	2239	467	11	0	0
1989	31079	5598	8570	223	13	5	0
1990	20952	11176	71	23	3	0	0
1991	23211	7540	7355	266	236	56	0

Year	Age 1	2	3	4	5	6	7+
1992	50665	16729	2810	954	0	0	0
1993	14057	11139	2903	588	431	0	1
1994	12700	6859	3872	1152	189	150	4
1995	21974	21786	3416	484	7	1	1
1996	33621	18625	5086	1535	13	1	20
1997	22422	9632	3806	540	71	2	1
1998	53742	16058	3553	847	177	31	8
1999	7928	17097	1402	503	275	44	0
2000	158913	5254	2238	154	16	41	0
2001	5666	23084	715	172	0	0	0
2002	11055	8531	2428	415	175	9	3
2003	3770	1416	334	374	32	9	4
2004	14667	3557	536	305	107	4	2
2005	2923	1578	534	37	19	7	4
2006	9784	852	1000	256	36	11	2
2007	995	1077	308	64	4	3	0
2008	806	638	142	162	51	41	0
2009	6926	112	72	49	16	3	0
2010	16005	1427	245	42	61	6	1
2011	2697	1410	172	12	3	0	0
2012	7837	434	576	106	21	2	0
2013	13156	1338	159	252	12	3	2
2014	10618	44	71	35	36	10	3
2015	7550	866	284	119	20	17	0
2016	4640	1736	261	15	11	4	1
2017	9007	916	1005	68	189	2	0
2018	2673	846	316	196	22	5	0

Table 38.5. Whiting in Division 6.a. Total catch-at-age (thousands).

	Age						
Year	1	2	3	4	5	6	7+
1965	24143	11054	54967	5334	402	105	22
1966	6007	19490	2744	31502	1940	189	53
1967	17406	46814	13293	781	15204	801	144
1968	23659	29096	11376	4034	337	5118	372
1969	2856	45668	10737	2858	1257	120	2358
1970	2506	13128	35559	3623	703	218	550
1971	7891	15336	5090	38690	1395	245	224
1972	55969	20958	4863	1514	15406	807	149
1973	44599	63137	6817	1608	371	4369	313
1974	32185	91625	12412	1289	188	53	856
1975	52213	30319	44804	3129	293	58	245
1976	33392	82233	19117	19363	1571	67	57
1977	64268	22051	30576	3428	4931	297	24
1978	35556	30687	7183	9594	941	1473	68
1979	8915	46320	14395	3671	3522	276	384
1980	14375	16267	16863	4521	1330	1097	190
1981	4721	34810	12694	4812	1545	464	201
1982	22502	9204	41777	8018	2230	807	348
1983	25108	13842	10949	28129	6228	1447	540
1984	41539	15165	9130	4758	15636	2026	859
1985	21754	29378	11847	4023	2202	5127	862
1986	8833	24647	11732	2838	533	291	539
1987	104041	31362	15751	5596	837	330	259
1988	29899	58606	11877	6635	1960	290	207
1989	33608	11485	20459	4990	1279	473	71
1990	24155	19204	2464	4032	1329	204	37
1991	26505	16366	17401	1474	1627	342	51

Year	Age 1	2	3	4	5	6	7+
1992	53360	26169	7283	5736	396	373	106
1993	15108	21318	9196	3261	3169	163	148
1994	13609	11748	13030	4759	901	865	73
1995	22189	26108	9932	6138	1404	377	283
1996	34611	24035	12761	6587	2474	584	177
1997	23299	13290	12320	4856	1512	340	107
1998	54582	19562	7830	4545	1619	369	296
1999	8941	23228	5948	2543	2049	399	112
2000	159397	8206	6449	1724	501	369	89
2001	6127	26355	3345	1739	401	131	16
2002	11117	10155	5446	1214	402	32	16
2003	3940	2126	1445	2047	379	120	6
2004	14721	4281	1079	826	729	82	31
2005	2951	1854	989	177	118	52	11
2006	9866	991	1369	516	97	124	26
2007	1182	1245	563	390	136	29	50
2008	812	903	536	498	203	96	24
2009	6985	328	325	478	116	47	13
2010	16058	1521	399	161	187	30	32
2011	2697	1720	305	93	32	17	12
2012	7846	460	952	316	78	16	11
2013	13177	1388	243	529	79	21	8
2014	10630	75	202	137	136	33	14
2015	7561	949	345	283	88	84	25
2016	4641	1809	427	90	85	21	29
2017	9023	951	1172	139	238	39	10
2018	2674	917	404	395	82	13	7

Table 38.6. Whiting in Division 6.a. Landings weight-at-age (kg).

	Age						
Year	1	2	3	4	5	6	7+
1965	0.218	0.249	0.308	0.452	1.208	0.72	0.778
1966	0.238	0.243	0.325	0.374	0.61	0.72	0.828
1967	0.204	0.24	0.319	0.424	0.412	0.639	0.821
1968	0.206	0.263	0.366	0.444	0.554	0.538	0.735
1969	0.178	0.223	0.335	0.5	0.57	0.649	0.63
1970	0.205	0.203	0.274	0.382	0.519	0.619	0.683
1971	0.209	0.247	0.276	0.316	0.426	0.551	0.712
1972	0.211	0.258	0.345	0.368	0.426	0.494	0.638
1973	0.196	0.235	0.362	0.479	0.485	0.532	0.666
1974	0.193	0.215	0.317	0.444	0.591	0.641	0.584
1975	0.209	0.245	0.305	0.471	0.651	0.615	0.717
1976	0.201	0.242	0.309	0.361	0.497	0.687	0.856
1977	0.2	0.244	0.296	0.392	0.431	0.629	0.819
1978	0.199	0.235	0.286	0.389	0.516	0.549	0.612
1979	0.218	0.232	0.306	0.404	0.536	0.678	0.693
1980	0.172	0.242	0.33	0.42	0.492	0.595	0.817
1981	0.192	0.228	0.289	0.382	0.409	0.409	0.547
1982	0.184	0.22	0.276	0.352	0.505	0.513	0.526
1983	0.216	0.249	0.28	0.34	0.409	0.494	0.51
1984	0.216	0.259	0.313	0.371	0.412	0.458	0.458
1985	0.185	0.238	0.306	0.402	0.43	0.461	0.538
1986	0.174	0.236	0.294	0.365	0.468	0.482	0.499
1987	0.188	0.237	0.304	0.373	0.511	0.52	0.576
1988	0.176	0.215	0.301	0.4	0.483	0.567	0.6
1989	0.171	0.22	0.279	0.348	0.459	0.425	0.555
1990	0.225	0.251	0.324	0.359	0.417	0.582	0.543
1991	0.199	0.22	0.291	0.354	0.391	0.442	0.761

Year	Age 1	2	3	4	5	6	7+
1992	0.193	0.23	0.288	0.349	0.388	0.397	0.51
1993	0.186	0.242	0.314	0.361	0.412	0.452	0.474
1994	0.161	0.217	0.29	0.371	0.451	0.482	0.483
1995	0.19	0.225	0.296	0.381	0.469	0.473	0.528
1996	0.195	0.245	0.288	0.365	0.483	0.526	0.569
1997	0.198	0.245	0.297	0.384	0.522	0.629	0.661
1998	0.215	0.236	0.301	0.364	0.438	0.5	0.646
1999	0.181	0.225	0.28	0.365	0.44	0.524	0.594
2000	0.205	0.241	0.298	0.336	0.419	0.488	0.617
2001	0.173	0.234	0.303	0.37	0.395	0.376	0.595
2002	0.213	0.257	0.304	0.363	0.464	0.65	0.707
2003	0.228	0.264	0.309	0.362	0.374	0.436	0.717
2004	0.193	0.251	0.295	0.345	0.382	0.403	0.342
2005	0.189	0.261	0.313	0.378	0.44	0.482	0.356
2006	0.221	0.292	0.319	0.394	0.455	0.528	0.567
2007	0.215	0.280	0.349	0.418	0.498	0.598	0.660
2008	0.274	0.245	0.322	0.384	0.514	0.530	0.653
2009	0.328	0.347	0.437	0.479	0.470	0.519	0.595
2010	0.288	0.402	0.456	0.567	0.652	0.619	0.613
2011	0.210	0.327	0.405	0.523	0.613	0.570	0.393
2012	0.295	0.304	0.387	0.508	0.615	0.705	0.493
2013	0.191	0.277	0.354	0.442	0.541	0.631	0.729
2014	0.243	0.271	0.374	0.463	0.544	0.659	0.699
2015	0.290	0.356	0.444	0.467	0.513	0.601	0.624
2016	0.272	0.402	0.520	0.543	0.614	0.700	0.693
2017	0.341	0.353	0.418	0.544	0.500	0.507	0.677
2018	0.177	0.408	0.394	0.433	0.516	0.468	0.574

Table 38.7. Whiting in Division 6.a. Discards weight-at-age (kg).

	Age						
Year	1	2	3	4	5	6	7+
1965	0.122	0.177	0.213	0.249	0.287	0.303	0.287
1966	0.122	0.178	0.212	0.248	0.29	0.297	0.286
1967	0.122	0.178	0.213	0.248	0.29	0.295	0.289
1968	0.128	0.179	0.213	0.249	0.291	0.298	0.287
1969	0.121	0.178	0.214	0.249	0.29	0.295	0.285
1970	0.121	0.175	0.213	0.249	0.29	0.299	0.284
1971	0.12	0.177	0.211	0.248	0.29	0.299	0.284
1972	0.121	0.177	0.213	0.248	0.289	0.301	0.281
1973	0.123	0.176	0.215	0.252	0.288	0.301	0.285
1974	0.119	0.177	0.214	0.25	0.285	0.299	0.288
1975	0.119	0.176	0.213	0.25	0.286	0.301	0.278
1976	0.116	0.177	0.213	0.249	0.288	0.3	0.28
1977	0.118	0.177	0.214	0.249	0.289	0.299	0.282
1978	0.135	0.167	0.199	0.288	0.32	0.238	-
1979	0.173	0.188	0.208	0.215	0.281	-	-
1980	0.14	0.179	0.208	0.22	0.271	0.386	-
1981	0.108	0.16	0.195	0.298	0.286	0.295	-
1982	0.096	0.18	0.209	0.243	0.283	0.44	-
1983	0.141	0.186	0.228	0.237	0.267	0.267	-
1984	0.087	0.199	0.246	0.26	0.259	0.303	0.227
1985	0.102	0.191	0.237	0.286	0.326	0.312	0.316
1986	0.092	0.17	0.196	0.245	0.258	0.33	0.263
1987	0.085	0.182	0.233	0.249	0.225	-	-
1988	0.076	0.143	0.203	0.227	0.262	-	-
1989	0.099	0.177	0.205	0.209	0.294	0.305	-
1990	0.124	0.171	0.214	0.219	0.237	0.264	-
1991	0.085	0.169	0.205	0.223	0.226	0.281	-

Year	Age 1	2	3	4	5	6	7+
1992	0.109	0.173	0.219	0.227	-	-	-
1993	0.118	0.197	0.225	0.242	0.256	-	0.436
1994	0.087	0.157	0.22	0.283	0.297	0.253	0.299
1995	0.075	0.154	0.189	0.246	0.278	0.597	0.493
1996	0.095	0.18	0.203	0.229	0.302	0.421	0.26
1997	0.112	0.182	0.221	0.235	0.243	0.422	0.819
1998	0.098	0.179	0.225	0.254	0.282	0.264	0.245
1999	0.077	0.168	0.217	0.205	0.266	0.268	-
2000	0.075	0.164	0.203	0.233	0.282	0.25	-
2001	0.094	0.154	0.196	0.203	0.381	-	-
2002	0.073	0.162	0.212	0.245	0.24	0.295	0.276
2003	0.077	0.177	0.231	0.242	0.213	0.3	0.278
2004	0.086	0.186	0.236	0.246	0.304	0.349	0.314
2005	0.088	0.149	0.223	0.214	0.315	0.292	0.373
2006	0.046	0.197	0.235	0.295	0.322	0.518	0.362
2007	0.059	0.159	0.225	0.226	0.334	0.794	0.266
2008	0.075	0.211	0.286	0.301	0.397	0.222	0.304
2009	0.051	0.288	0.227	0.262	0.248	0.253	-
2010	0.038	0.124	0.269	0.375	0.376	0.401	0.964
2011	0.030	0.141	0.321	0.266	0.221	-	-
2012	0.057	0.151	0.292	0.355	0.349	0.414	0.907
2013	0.041	0.208	0.238	0.355	0.377	0.297	0.371
2014	0.049	0.168	0.279	0.364	0.442	0.441	0.791
2015	0.074	0.181	0.226	0.349	0.322	0.440	-
2016	0.073	0.216	0.282	0.292	0.310	0.261	0.384
2017	0.065	0.197	0.348	0.411	0.328	0.881	-
2018	0.066	0.178	0.267	0.337	0.404	1.107	-

Table 38.8. Whiting in Division 6.a. Total catch weight-at-age (kg).

	Age						
Year	1	2	3	4	5	6	7+
1965	0.150	0.217	0.288	0.432	1.176	0.712	0.778
1966	0.155	0.213	0.304	0.361	0.597	0.713	0.812
1967	0.146	0.212	0.298	0.405	0.407	0.634	0.817
1968	0.152	0.227	0.337	0.426	0.544	0.534	0.729
1969	0.138	0.203	0.311	0.474	0.559	0.643	0.626
1970	0.145	0.189	0.261	0.368	0.508	0.613	0.683
1971	0.147	0.216	0.264	0.309	0.420	0.545	0.710
1972	0.148	0.223	0.322	0.356	0.421	0.491	0.636
1973	0.146	0.210	0.336	0.458	0.478	0.528	0.661
1974	0.140	0.198	0.297	0.425	0.576	0.635	0.582
1975	0.145	0.214	0.288	0.449	0.636	0.610	0.717
1976	0.138	0.214	0.292	0.350	0.489	0.681	0.856
1977	0.139	0.218	0.281	0.379	0.425	0.623	0.819
1978	0.160	0.210	0.276	0.387	0.516	0.545	0.612
1979	0.202	0.222	0.295	0.378	0.530	0.678	0.693
1980	0.167	0.220	0.308	0.393	0.467	0.594	0.817
1981	0.173	0.196	0.271	0.379	0.402	0.408	0.547
1982	0.109	0.202	0.252	0.336	0.499	0.513	0.526
1983	0.155	0.215	0.270	0.324	0.405	0.479	0.510
1984	0.099	0.245	0.305	0.358	0.397	0.454	0.456
1985	0.107	0.216	0.288	0.383	0.427	0.448	0.537
1986	0.109	0.198	0.274	0.360	0.465	0.481	0.474
1987	0.097	0.210	0.297	0.369	0.510	0.520	0.576
1988	0.080	0.164	0.281	0.392	0.477	0.567	0.600
1989	0.108	0.204	0.255	0.337	0.446	0.422	0.555
1990	0.140	0.217	0.295	0.342	0.405	0.575	0.543
1991	0.096	0.207	0.265	0.338	0.376	0.424	0.761

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1992	0.114	0.195	0.265	0.329	0.388	0.397	0.510
1993	0.123	0.211	0.271	0.331	0.361	0.452	0.473
1994	0.089	0.170	0.258	0.344	0.419	0.448	0.473
1995	0.076	0.166	0.235	0.361	0.440	0.472	0.526
1996	0.098	0.198	0.257	0.336	0.482	0.526	0.537
1997	0.116	0.200	0.275	0.369	0.505	0.629	0.661
1998	0.101	0.197	0.274	0.341	0.420	0.469	0.573
1999	0.084	0.194	0.269	0.341	0.433	0.505	0.594
2000	0.076	0.199	0.277	0.329	0.415	0.477	0.617
2001	0.100	0.183	0.280	0.350	0.395	0.376	0.560
2002	0.074	0.194	0.270	0.346	0.385	0.541	0.728
2003	0.080	0.211	0.287	0.340	0.360	0.424	0.498
2004	0.086	0.197	0.266	0.308	0.371	0.400	0.340
2005	0.089	0.166	0.264	0.344	0.420	0.456	0.362
2006	0.047	0.210	0.258	0.345	0.406	0.527	0.551
2007	0.084	0.175	0.281	0.387	0.494	0.616	0.659
2008	0.076	0.221	0.312	0.357	0.484	0.397	0.649
2009	0.053	0.327	0.391	0.457	0.440	0.500	0.595
2010	0.038	0.141	0.341	0.517	0.562	0.573	0.622
2011	0.030	0.174	0.358	0.491	0.571	0.570	0.393
2012	0.058	0.160	0.329	0.456	0.543	0.673	0.497
2013	0.041	0.211	0.278	0.401	0.516	0.583	0.658
2014	0.050	0.210	0.341	0.438	0.517	0.593	0.720
2015	0.074	0.196	0.264	0.417	0.470	0.567	0.624
2016	0.073	0.224	0.374	0.500	0.573	0.612	0.680
2017	0.066	0.203	0.358	0.479	0.363	0.521	0.677
2018	0.066	0.195	0.294	0.385	0.486	0.729	0.574

Table 38.9. Whiting in Division 6.a. Survey data made available to the WG. Data used in the TSA run are highlighted in bold. For the Scottish surveys, numbers are standardised to catch-rate per ten hours. The Scottish surveys from 2011 have been conducted according to the new design and ground gear.

	ScoGFS-WIBTS-Q1 – Scottish Groundfish Survey – numbers-at-age/10 h							
Year	Effort	Age						
	(hours)	1	2	3	4	5	6	7
1985	10	**3140**	**1792**	**380**	**85**	**23**	**156**	18
1986	10	**1456**	**1525**	**403**	**68**	**10**	**9**	10
1987	10	**6938**	**1054**	**584**	**142**	**36**	**2**	1
1988	10	**567**	**3469**	**654**	**189**	**42**	**5**	1
1989	10	**910**	**505**	**586**	**237**	**48**	**3**	0
1990	10	**1818**	**571**	**122**	**216**	**61**	**4**	1
1991	10	**3203**	**276**	**299**	**22**	**39**	**9**	1
1992	10	**4777**	**1597**	**410**	**517**	**56**	**18**	0
1993	10	**5532**	**6829**	**644**	**91**	**30**	**11**	2
1994	10	**6614**	**2443**	**1487**	**174**	**56**	**15**	6
1995	10	**5598**	**2831**	**1160**	**370**	**70**	**17**	32
1996	10	**9385**	**2237**	**635**	**341**	**135**	**30**	4
1997	10	**5663**	**2444**	**1531**	**355**	**102**	**17**	4
1998	10	**9851**	**1352**	**294**	**195**	**50**	**14**	1
1999	10	**6125**	**4952**	**489**	**103**	**16**	**1**	0
2000	10	**12862**	**471**	**152**	**34**	**10**	**11**	0
2001	10	**4653**	**1955**	**242**	**41**	**8**	**1**	1
2002	10	**5542**	**1028**	**964**	**89**	**15**	**1**	1
2003	10	**6934**	**746**	**436**	**300**	**32**	**2**	4
2004	10	**5887**	**1566**	**189**	**131**	**44**	**9**	1
2005	10	**1308**	**723**	**183**	**35**	**8**	**11**	2
2006	10	**1441**	**466**	**282**	**77**	**0**	**3**	1
2007	10	**614**	**522**	**127**	**75**	**16**	**3**	2
2008	10	**593**	**127**	**77**	**26**	**8**	**3**	0
2009	10	**906**	**387**	**103**	**105**	**20**	**9**	7
2010	10	**3523**	**340**	**108**	**52**	**40**	**4**	3

Table 38.9. Continued.

	ScoGFS-WIBTS-Q4 – Scottish Groundfish Survey – numbers-at-age/10 h								
Year	Effort	Age							
	(hours)	0	1	2	3	4	5	6	7
1996	10	5154	**1908**	**1116**	**570**	**188**	**51**	**6**	1
1997	10	8001	**2869**	**951**	**323**	**160**	**46**	**12**	1
1998	10	1852	**2713**	**1125**	**150**	**100**	**20**	**1**	0
1999	10	8203	**2338**	**582**	**141**	**33**	**24**	**1**	1
2000	10	4434	**4056**	**789**	**160**	**9**	**7**	**1**	0
2001	10	9615	**1957**	**1420**	**155**	**40**	**12**	**2**	0
2002	10	14658	**1591**	**621**	**479**	**30**	**9**	**5**	0
2003	10	9932	**3446**	**567**	**338**	**83**	**27**	**4**	0
2004	10	5923	**1758**	**940**	**83**	**57**	**62**	**1**	0
2005	10	2297	**308**	**318**	**76**	**9**	**4**	**1**	1
2006	10	415	**296**	**140**	**101**	**35**	**8**	**3**	0
2007	10	1894	**434**	**326**	**99**	**83**	**48**	**1**	0
2008	10	2297	**208**	**78**	**110**	**28**	**24**	**4**	0
2009	10	4833	**236**	**178**	**50**	**58**	**12**	**6**	6

	IGFS-WIBTS-Q4 – Irish groundfish survey – numbers-at-age/10 h							
Year	Effort	Age						
	(hours)	0	1	2	3	4	5	6
2003	10	586	**6860**	**1541**	**273**	**154**	54	1
2004	10	3462	**1557**	**656**	**52**	**18**	8	1
2005	10	569	**1393**	**704**	**57**	**3**	3	0
2006	10	39	**419**	**366**	**85**	**11**	1	0
2007	10	70	**1018**	**1217**	**369**	**87**	129	62
2008	10	13	**2295**	**702**	**303**	**128**	65	19
2009	10	7361	**623**	**431**	**141**	**29**	9	18
2010	10	50	**4565**	**702**	**178**	**56**	30	7
2011	10	211	**2074**	**2817**	**318**	**135**	32	33
2012	10	129	**3226**	**499**	**970**	**276**	24	11
2013	10	11247	**494**	**1865**	**498**	**555**	65	6
2014	10	14934	**7930**	**1300**	**2618**	**300**	356	30
2015	10	1862	**15267**	**3237**	**794**	**400**	81	54
2016	10	6404	**5918**	**8840**	**1387**	**234**	290	92
2017	10	252	**1969**	**1414**	**1873**	**331**	39	45
2018	10	8451	**2357**	**2860**	**1853**	**712**	42	0

Table 38.9. Continued.

	UK-SCOWCGFS-Q1 – Scottish Groundfish Survey – numbers-at-age/10 h							
Year	**Effort**	**Age**						
	(hours)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2011	10	**222**	**1884**	**397**	**64**	**37**	**45**	12
2012	10	**3441**	**293**	**738**	**72**	**14**	**5**	7
2013	10	**552**	**1031**	**302**	**463**	**61**	**7**	3
2014	10	**5805**	**125**	**246**	**110**	**74**	**7**	1
2015	10	**2545**	**760**	**285**	**259**	**65**	**58**	8
2016	10	**3226**	**3485**	**576**	**148**	**84**	**42**	25
2017	10	**4970**	**1981**	**1707**	**203**	**49**	**32**	5
2018	10	**1960**	**1827**	**1069**	**1142**	**132**	**14**	2
2019	10	**3231**	**666**	**577**	**191**	**99**	**25**	0

	UK-SCOWCGFS-Q4 – Scottish Groundfish Survey – numbers-at-age/10 h								
Year	**Effort**	**Age**							
	(hours)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2011	10	3644	**119**	**2096**	**109**	**30**	**14**	**10**	1
2012	10	748	**964**	**426**	**658**	**110**	**19**	**2**	11
2013	10	1732	**125**	**309**	**110**	**159**	**27**	**2**	0
2014	10	11569	**1518**	**346**	**168**	**82**	**55**	**31**	0
2015	10	4263	**2794**	**727**	**115**	**91**	**20**	**27**	1
2016	10	5262	**2415**	**2300**	**259**	**83**	**115**	**29**	13
2017	10	3306	**2943**	**4139**	**1167**	**177**	**2**	**12**	2
2018	10	6442	**503**	**552**	**284**	**220**	**33**	**1**	5

Table 38.10. Whiting in Division 6.a. TSA parameter settings for the assessment run.

Parameter	Setting	Justification
Age of full selection	$a_m = 4$	Based on inspection of previous XSA and TSA runs.
Multipliers on variance matrices of measurements	$B_{\text{landings}}(a) = 2$ for ages 1, 7+ $B_{\text{discards}}(a) = 2$ for age 5 $B_{\text{ScoGFS-WIBTS-Q4}}(a) = 2$ for age 6	Allows extra measurement variability for poorly-sampled ages.
Multipliers on variances for fishing mortality estimates	$H(1) = 2$	Allows for more variable fishing mortalities for age 1 fish.
Down-weighting of particular datapoints	Discards: cvmult = 3 for age 1 in 1981, age 3 in 1991, age 1 in 2000, age 1 in 2013, age 5 in 2017 Surveys: *ScoGFS-WIBTS-Q1* cvmult = 3 for age 5 in 1992, age 2 in 1993, age 1 in 2000 and age 2 in 2000 cvmult = 5 for age 4 in 1992 *ScoGFS-WIBTS-Q4* cvmult = 3 for age 4 in 2007 and for age 5 in 2007	Large values indicated by exploratory prediction error plots.
Discards	Discards are allowed to evolve over time constrained by a trend. Ages 1 to 5 are modelled independently.	
Recruitments	Modelled by a hockey-stick model, with numbers-at-age 1 assumed to be independent and normally distributed. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.	

Table 38.11. Whiting in Division 6.a. TSA parameter estimates for final assessment presented this year.

Parameter	Notation	Description	2017 WG	2018 WG	2019 WG
Initial fishing mortality	*F* (1, 1981)	Fishing mortality-at-age *a* in year *y*	0.09	0.0937	0.0945
	F (2, 1981)		0.11	0.1054	0.1071
	F (4, 1981)		0.32	0.3129	0.3207
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.01	0.0319	0.0000
	σ_U	Persistent changes in selection (age effect in F)	0.09	0.0879	0.0884
	σ_V	Transitory changes in the year effect in fishing mortality	0.00	0.0008	0.0000
	σ_Y	Persistent changes in the year effect in fishing mortality	0.28	0.2654	0.2652
Measurement CVs	$CV_{landings}$	CV of landings-at-age data	0.16	0.1626	0.1688
	$CV_{discards}$	CV of discards-at-age data	0.53	0.5276	0.5275
Recruitment		Hockey-stick parameter Recruitment value at change point	29.4	28.9494	29.6289
		Hockey-stick parameter SSB at change point	2.90	2.932	3.3912
	CV_{rec}	Coefficient of variation of recruitment data	0.33	0.3407	0.3331
Discards	$\sigma_{logit\ p}$	Transitory trends in discarding	0.26	0.2621	0.2827
	$\sigma_{persistent}$	Persistent trends in discarding	0.22	0.2389	0.2275
Survey selectivities (ScoGFS-WIBTS-Q1)	$\Phi(1)$	Survey selectivity-at-age *a*	1.01	0.9447	1.0934
	$\Phi(2)$		1.05	0.9838	1.1093
	$\Phi(3)$		0.89	0.8326	0.9403
	$\Phi(4)$		0.75	0.6929	0.7852
	$\Phi(5)$		0.60	0.554	0.6455
	$\Phi(6)$		0.53	0.4955	0.5628
	σ_{survey}	Standard error of survey data	0.45	0.4667	0.4549
	σ_η		0.10	0.1046	0.1056
Survey catchability standard deviations	σ_Ω	Transitory changes in survey catchability	0.22	0.2443	0.1916

Parameter	Notation	Description	2017 WG	2018 WG	2019 WG
	σ_{β}	Persistent changes in survey catchability	0.11	0.113	0.1084
Survey selectivities (ScoGFS-WIBTS-Q4)	$\Phi(1)$	Survey selectivity-at-age *a*	3.15	3.4002	3.5733
	$\Phi(2)$		3.00	3.2019	3.2021
	$\Phi(3)$		2.33	2.4699	2.4844
	$\Phi(4)$		1.99	2.1113	2.1317
	$\Phi(5)$		2.67	2.8075	2.8519
	$\Phi(6)$		0.48	0.4558	0.4902
	σ_{survey}	Standard error of survey data	0.20	0.1987	0.2146
	σ_{η}		0.19	0.2015	0.1993
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	0.00	0	0
	σ_{β}	Persistent changes in survey catchability	0.14	0.1413	0.1417
Survey selectivities (IGFS-WIBTS-Q4)	$\Phi(1)$		12.47	13.6417	13.3725
	$\Phi(2)$		11.60	12.7080	11.9858
	$\Phi(3)$		14.72	15.7623	15.1872
	$\Phi(4)$		10.26	11.3506	11.5093
	σ_{survey}	Standard error of survey data	0.27	0.2445	0.2769
	σ_{η}		0.47	0.4742	0.4365
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	0.08	0.1222	0.1578
	σ_{β}	Persistent changes in survey catchability	0.18	0.2016	0.1607
Survey selectivities (UK-SCOWCGFS-Q1)	$\Phi(1)$		5.42	4.9149	6.0373
	$\Phi(2)$		6.40	5.8231	6.9723
	$\Phi(3)$		7.67	7.2411	8.0850
	$\Phi(4)$		6.32	6.6973	7.8329
	$\Phi(5)$		5.53	4.6753	5.4372
	$\Phi(6)$		6.30	4.8854	5.7624
	σ_{survey}	Standard error of survey data	0.36	0.3801	0.3763

Parameter	Notation	Description	2017 WG	2018 WG	2019 WG
	σ_η		0.16	0.2546	0.2062
Survey catchability standard deviations	σ_Ω	Transitory changes in survey catchability	0.01	0	0126
	σ_β	Persistent changes in survey catchability	0.06	0	0.1881
Survey selectivities (UK-SCOWCGFS-Q4)	$\Phi(1)$		6.02	4.8981	4.7286
	$\Phi(2)$		10.36	13.8002	13.2288
	$\Phi(3)$		6.12	6.3429	5.7722
	$\Phi(4)$		7.89	6.7193	5.7311
	$\Phi(5)$		6.89	5.6839	4.4555
	$\Phi(6)$		8.09	6.3067	4.8454
	σ_{survey}	Standard error of survey data	0.26	0.3987	0.3842
	σ_η		0.01	0.0202	0.1695
Survey catchability standard deviations	σ_Ω	Transitory changes in survey catchability	0.13	0	0.1982
	σ_β	Persistent changes in survey catchability	0.01	0	0
Misreporting		Transitory changes in misreporting	0.00	0	0
		Persistent changes in misreporting	0.16	0.1777	0.1915

Table 38.12. Whiting in Division 6.a. TSA population numbers-at-age (thousands).

	Age						
Year	1	2	3	4	5	6	7+
1981	199423	470520	85528	22260	7075	2086	898
1982	165088	79380	218328	38485	9370	3059	1319
1983	197237	64095	35504	94594	15898	3988	1901
1984	325817	72150	24449	12346	31664	5399	2066
1985	310357	115409	24475	7282	3400	9323	2221
1986	291281	111599	37798	6003	1395	665	2546
1987	404905	110032	40829	12246	1492	352	828
1988	106310	143393	37376	12469	3282	337	241
1989	328200	34671	42998	10880	2557	618	41
1990	174358	120500	10835	11927	2636	476	65
1991	244996	63962	47051	3966	3581	796	115
1992	334144	91151	24074	17100	1339	1201	309
1993	262160	125125	34998	8976	5848	477	557
1994	274566	99114	48451	12757	2772	1866	335
1995	291943	105481	40474	18271	4104	914	740
1996	179537	112355	41028	14844	5235	1165	466
1997	163752	62677	41693	13599	3758	1293	401
1998	214790	54125	20662	13027	3216	887	404
1999	152810	66904	15536	5815	3016	708	284
2000	235620	43362	17598	3743	1091	588	194
2001	102705	68736	12529	4884	715	217	159
2002	40754	29785	20959	3726	977	138	76
2003	63845	9610	10253	7156	1034	281	63
2004	40215	16392	2788	3423	1706	259	88
2005	23483	10127	4842	823	855	402	86
2006	28198	7306	3884	1774	261	260	161
2007	15449	9126	2889	1521	593	89	147

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2008	16893	4747	3818	1224	549	225	91
2009	25105	5271	1824	1584	409	186	111
2010	59545	8460	2159	745	592	155	115
2011	19074	19951	3774	971	304	253	116
2012	38435	7121	9321	1862	466	147	183
2013	19782	14125	3427	4609	921	236	172
2014	45389	7587	6869	1757	2376	489	222
2015	105619	17416	3775	3557	938	1300	399
2016	66931	42094	8617	1959	1910	518	958
2017	79508	27279	21193	4535	1077	1077	856
2018	60000	32697	13833	11325	2528	617	1134
2019*	140154	25191	16700	7476	6395	1467	1044
2020*	175106	58676	12854	9014	4216	3704	1489
GM(81–18)	100335	37366	14907	5700	1839	598	300

*** Estimates for 2019 and 2020 are TSA projections.**

Table 38.13. Whiting in Division 6.a. Standard errors on TSA population numbers-at-age (thousands).

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	20088	34082	7457	1976	730	260	225
1982	17707	8104	16460	3675	931	355	171
1983	19493	7062	3947	8010	1733	468	227
1984	26806	7297	3208	1690	3302	795	296
1985	24040	9584	3087	1181	635	1438	451
1986	21630	8976	4060	1112	438	273	805
1987	34057	8438	3988	1641	447	192	452
1988	11437	12534	3262	1447	611	176	226
1989	22212	3972	4514	1249	553	249	131
1990	18899	8401	1314	1706	494	239	141
1991	23526	7103	3369	514	711	227	152
1992	29277	8870	2711	1330	202	295	140
1993	24459	11152	3527	1074	567	82	155
1994	27139	9737	4850	1591	456	281	93
1995	25465	11272	4595	2404	736	217	176
1996	20640	10435	4974	1996	945	315	165
1997	23369	7912	4117	1856	617	323	161
1998	33450	9064	3223	1598	613	227	162
1999	27455	12028	3405	1066	492	197	115
2000	38631	9291	3747	954	234	126	72
2001	15914	12718	2612	916	171	47	42
2002	8708	5336	3997	755	212	45	25
2003	11261	2600	1650	1368	198	61	20
2004	7129	3636	641	538	338	59	25
2005	3420	2067	856	178	114	94	25
2006	2578	787	452	199	31	26	32
2007	1852	802	268	168	67	12	21

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2008	1685	634	346	128	83	35	16
2009	2107	591	267	166	63	42	24
2010	5375	769	267	130	85	33	32
2011	1703	2019	357	136	67	47	33
2012	4454	675	1001	189	75	38	43
2013	2168	1795	337	543	107	42	42
2014	6285	896	914	185	310	63	45
2015	10118	2623	458	503	105	182	59
2016	9868	4295	1352	252	286	62	135
2017	19510	4188	2230	742	145	168	110
2018	23195	8332	2171	1240	426	86	155
2019*	47647	9859	4299	1200	719	252	136
2020*	69044	20190	5052	2350	689	429	219
GM(81–18)	11783	4484	1825	759	295	125	89

*** Estimates for 2019 and 2020 are TSA projections.**

Table 38.14. Whiting in Division 6.a. TSA estimates for mortality-at-age.

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	0.1029	0.1242	0.2178	0.3301	0.3301	0.3301	0.3301
1982	0.1152	0.1538	0.2590	0.3476	0.3475	0.3475	0.3475
1983	0.1775	0.2661	0.4310	0.5562	0.5562	0.5563	0.5562
1984	0.2193	0.3761	0.5461	0.6891	0.6889	0.6893	0.6888
1985	0.2324	0.4417	0.6223	0.7929	0.7929	0.7930	0.7931
1986	0.1815	0.3631	0.4920	0.5964	0.5962	0.5964	0.5963
1987	0.2230	0.4442	0.5932	0.7116	0.7114	0.7115	0.7114
1988	0.2560	0.5176	0.6456	0.8705	0.8707	0.8708	0.8708
1989	0.2273	0.4475	0.5950	0.7675	0.7675	0.7675	0.7675
1990	0.1728	0.3108	0.4285	0.5675	0.5675	0.5676	0.5676
1991	0.1761	0.3340	0.4379	0.5712	0.5712	0.5712	0.5712
1992	0.1688	0.3209	0.4310	0.5578	0.5577	0.5577	0.5577
1993	0.1706	0.3118	0.4371	0.6404	0.6404	0.6403	0.6404
1994	0.1556	0.2693	0.3926	0.5868	0.5873	0.5872	0.5871
1995	0.1799	0.3035	0.4256	0.6599	0.6599	0.6598	0.6602
1996	0.2412	0.3815	0.5255	0.8079	0.8077	0.8080	0.8078
1997	0.2843	0.4474	0.5939	0.8548	0.8554	0.8547	0.8551
1998	0.3331	0.5188	0.6663	0.9289	0.9291	0.9288	0.9288
1999	0.4048	0.6297	0.7833	1.1296	1.1297	1.1298	1.1298
2000	0.4010	0.5796	0.7259	1.1352	1.1352	1.1352	1.1352
2001	0.3796	0.5119	0.6260	1.0311	1.0311	1.0309	1.0311
2002	0.3026	0.3837	0.4613	0.7435	0.7436	0.7434	0.7434
2003	0.3456	0.3992	0.4660	0.8207	0.8211	0.8206	0.8211
2004	0.4022	0.4173	0.5115	0.8277	0.8272	0.8280	0.8274
2005	0.3765	0.3495	0.4461	0.6643	0.6646	0.6658	0.6644
2006	0.3620	0.2862	0.3713	0.5733	0.5729	0.5726	0.5731
2007	0.3307	0.2279	0.2806	0.4668	0.4669	0.4660	0.4663

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2008	0.3836	0.2649	0.3043	0.5300	0.5297	0.5295	0.5305
2009	0.3661	0.2316	0.2775	0.4342	0.4336	0.4338	0.4336
2010	0.2921	0.1700	0.2094	0.3173	0.3171	0.3173	0.3175
2011	0.1961	0.1090	0.1329	0.1894	0.1894	0.1894	0.1893
2012	0.1803	0.0918	0.1200	0.1658	0.1658	0.1658	0.1658
2013	0.1449	0.0706	0.0928	0.1205	0.1205	0.1205	0.1205
2014	0.1168	0.0556	0.0762	0.0906	0.0906	0.0905	0.0906
2015	0.1055	0.0527	0.0760	0.0836	0.0836	0.0836	0.0836
2016	0.0824	0.0407	0.0604	0.0613	0.0613	0.0613	0.0613
2017	0.0676	0.0329	0.0475	0.0471	0.0471	0.0471	0.0471
2018	0.0519	0.0262	0.0364	0.0347	0.0347	0.0347	0.0347
2019*	0.0540	0.0272	0.0379	0.0362	0.0362	0.0362	0.0362
2020*	0.0560	0.0283	0.0394	0.0376	0.0376	0.0376	0.0376
GM(81–18)	0.2081	0.2292	0.3071	0.4243	0.4242	0.4242	0.4243

*** Estimates for 2019 and 2020 are TSA projections.**

Table 38.15. Whiting in Division 6.a. Standard errors of TSA estimates for log mortality-at-age.

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	0.0132	0.0141	0.0240	0.0333	0.0333	0.0333	0.0333
1982	0.0171	0.0190	0.0300	0.0365	0.0365	0.0365	0.0365
1983	0.0290	0.0332	0.0499	0.0536	0.0535	0.0535	0.0535
1984	0.0377	0.0473	0.0631	0.0636	0.0639	0.0635	0.0639
1985	0.0410	0.0526	0.0694	0.0715	0.0715	0.0715	0.0713
1986	0.0335	0.0443	0.0564	0.0571	0.0572	0.0571	0.0571
1987	0.0417	0.0527	0.0649	0.0663	0.0664	0.0664	0.0664
1988	0.0477	0.0643	0.0703	0.0801	0.0799	0.0798	0.0798
1989	0.0431	0.0606	0.0662	0.0729	0.0728	0.0729	0.0729
1990	0.0333	0.0441	0.0521	0.0569	0.0568	0.0568	0.0568
1991	0.0339	0.0475	0.0525	0.0588	0.0589	0.0590	0.0589
1992	0.0329	0.0469	0.0535	0.0610	0.0610	0.0611	0.0610
1993	0.0343	0.0482	0.0567	0.0741	0.0739	0.0742	0.0739
1994	0.0318	0.0438	0.0531	0.0702	0.0693	0.0696	0.0697
1995	0.0380	0.0518	0.0615	0.0847	0.0846	0.0847	0.0844
1996	0.0521	0.0682	0.0789	0.1067	0.1069	0.1067	0.1068
1997	0.0613	0.0804	0.0871	0.1122	0.1119	0.1124	0.1120
1998	0.0699	0.0889	0.0912	0.1091	0.1087	0.1092	0.1092
1999	0.0837	0.1017	0.1024	0.1197	0.1199	0.1197	0.1196
2000	0.0838	0.0937	0.0949	0.1240	0.1241	0.1240	0.1241
2001	0.0795	0.0845	0.0864	0.1195	0.1195	0.1192	0.1195
2002	0.0653	0.0679	0.0672	0.0933	0.0932	0.0933	0.0934
2003	0.0757	0.0741	0.0705	0.1005	0.1003	0.1006	0.1003
2004	0.0932	0.0831	0.0870	0.1156	0.1161	0.1154	0.1155
2005	0.0918	0.0753	0.0834	0.1113	0.1112	0.1106	0.1107
2006	0.0744	0.0503	0.0492	0.0637	0.0629	0.0629	0.0634
2007	0.0677	0.0409	0.0396	0.0575	0.0570	0.0583	0.0576

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2008	0.0791	0.0487	0.0431	0.0611	0.0611	0.0609	0.0606
2009	0.0768	0.0433	0.0407	0.0525	0.0533	0.0528	0.0532
2010	0.0619	0.0326	0.0313	0.0409	0.0408	0.0412	0.0416
2011	0.0429	0.0217	0.0210	0.0248	0.0248	0.0248	0.0248
2012	0.0413	0.0191	0.0198	0.0222	0.0222	0.0221	0.0222
2013	0.0347	0.0152	0.0162	0.0164	0.0165	0.0164	0.0165
2014	0.0284	0.0124	0.0138	0.0122	0.0122	0.0122	0.0122
2015	0.0266	0.0123	0.0145	0.0114	0.0114	0.0114	0.0114
2016	0.0218	0.0100	0.0126	0.0086	0.0086	0.0086	0.0086
2017	0.0190	0.0087	0.0107	0.0068	0.0068	0.0068	0.0068
2018	0.0157	0.0075	0.0091	0.0053	0.0053	0.0053	0.0053
2019*	0.0219	0.0108	0.0141	0.0116	0.0116	0.0116	0.0116
2020*	0.0282	0.0140	0.0189	0.0168	0.0168	0.0168	0.0168
GM(81–18)	0.0432	0.0388	0.0438	0.0498	0.0498	0.0498	0.0498

*** Estimates for 2019 and 2020 are TSA projections.**

Table 38.16. Whiting in Division 6a. TSA summary table. "Obs." denotes sum-of-products of numbers and mean weights-at-age, not reported caught, landed and discarded weight.

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes))			Mean F(2–4)		SSB (tonnes)		TSB (tonnes)		Recruitment (000s at age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1981	12194	11441	1281	2132	4554	948	14325	15994	1465	0.224	0.020	134180	7515	168467	8465	199423	20088
1982	13880	13052	1425	5485	4362	921	19366	17415	1637	0.253	0.023	91841	4952	109621	5444	165088	17707
1983	15962	16708	1550	6294	5285	935	22257	21994	2014	0.418	0.035	63123	3555	92947	4908	197237	19493
1984	16459	14390	1305	4017	5084	951	20476	19474	1870	0.537	0.044	46147	2889	81788	4428	325817	26806
1985	12879	11380	1113	4840	7183	1245	17719	18563	1810	0.619	0.048	42257	2699	78815	4152	310357	24040
1986	8458	7875	847	2669	5362	915	11127	13237	1325	0.484	0.040	38271	2467	72299	3751	291281	21630
1987	11542	9953	996	11918	8082	1377	23460	18035	1789	0.583	0.045	40750	2422	77744	4175	404905	34057
1988	11349	10568	1013	8132	5496	1068	19481	16063	1522	0.678	0.052	41444	2550	50179	2945	106310	11437
1989	7523	6629	705	5876	6122	1058	13399	12750	1412	0.603	0.049	22737	1695	57007	3091	328200	22212
1990	5642	5235	561	4530	4944	910	10172	10180	1123	0.436	0.039	33795	2077	57751	3593	174358	18899
1991	6658	5750	558	4883	4022	740	11541	9773	1029	0.448	0.040	27593	1873	51889	3282	244996	23526
1992	6005	5696	539	9249	6124	1064	15253	11820	1292	0.437	0.042	30711	2162	68550	4423	334144	29277
1993	6872	6735	645	4759	7036	1175	11631	13771	1418	0.463	0.048	43157	3099	75332	5199	262160	24459
1994	5901	5951	572	3455	5177	812	9356	11128	1070	0.416	0.045	37684	3110	62929	4984	274566	27139
1995	6078	6758	1060	5771	5782	1040	11849	12540	1836	0.463	0.055	37485	3655	59706	5076	291943	25465
1996	7158	7611	1326	7940	7364	1421	15098	14975	2442	0.572	0.072	40626	3808	58196	5308	179537	20640

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes))			Mean F(2–4)		SSB (tonnes)		TSB (tonnes)		Recruitment (000s at age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1997	6290	7635	1197	5251	6599	1319	11542	14234	2230	0.632	0.080	31884	3215	50755	5358	163752	23369
1998	4627	5531	919	9216	7289	1568	13843	12820	2235	0.705	0.081	22259	2994	43695	5808	214790	33450
1999	4613	4755	942	3975	6261	1466	8588	11016	2191	0.848	0.088	20081	3341	33648	5333	152810	27455
2000	3011	3414	790	13285	6481	1577	16296	9895	2176	0.814	0.085	15043	2883	32807	5351	235620	38631
2001	2439	2971	648	4263	5096	1214	6702	8067	1713	0.723	0.079	16962	2919	27227	4223	102705	15914
2002	1767	2351	551	2851	1960	530	4618	4311	998	0.529	0.063	12473	2082	15480	2578	40754	8708
2003	1355	1902	439	719	1776	501	2074	3679	869	0.562	0.068	7916	1363	13248	2154	63845	11261
2004	811	1125	275	2159	1649	508	2970	2774	738	0.585	0.082	5791	1050	9266	1551	40215	7129
2005	341	701	174	629	875	255	970	1576	402	0.487	0.080	3814	569	5903	771	23483	3420
2006	380	542	54	946	644	114	1327	1186	143	0.410	0.041	3481	243	4819	307	28198	2578
2007	427	441	39	317	451	81	745	892	101	0.325	0.035	3445	210	4737	297	15449	1852
2008	445	436	40	314	554	100	759	990	120	0.366	0.039	3093	238	4385	311	16893	1685
2009	488	419	40	419	516	91	908	935	113	0.314	0.035	3497	306	4836	369	25105	2107
2010	307	309	32	893	565	103	1200	874	117	0.232	0.027	2809	249	5121	384	59545	5375
2011	230	252	27	339	322	58	569	573	71	0.144	0.018	5673	484	6245	509	19074	1703
2012	313	279	31	727	473	86	1039	752	98	0.126	0.016	5499	479	7700	638	38435	4454
2013	222	237	25	951	289	51	1173	526	63	0.095	0.013	6497	624	7313	677	19782	2168

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes))			Mean F(2–4)		SSB (tonnes)		TSB (tonnes)		Recruitment (000s at age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
2014	184	210	21	583	300	60	767	511	70	0.074	0.010	6378	632	8612	846	45389	6285
2015	227	210	21	835	702	147	1063	912	155	0.071	0.010	7328	838	15178	1422	105619	10118
2016	233	232	24	797	591	115	1030	823	127	0.054	0.008	15680	1571	20569	2065	66931	9868
2017	176	209	23	1207	565	116	1383	774	125	0.043	0.007	16824	1813	22031	2738	79508	19510
2018	189	206	23	492	342	86	681	548	96	0.032	0.006	17175	2547	21136	3549	60000	23195
2019*	NA	275	83	NA	553	219	NA	829	283	0.034	0.011	18961	3643	28516	5807	140154	47647
2020*	NA	327	136	NA	759	376	NA	1085	491	0.035	0.015	25931	5960	37869	8812	175106	69044
Min	176	206	21	314	289	51	569	511	63	0.032	0.006	2809	210	4385	297	15449	1685
GM	1929	2038	252	2237	2122	423	4547	4310	585	0.321	0.035	16528	1514	25878	2206	100335	11783
AM	4833	4739	575	3766	3586	703	8599	8326	1053	0.416	0.044	26458	2136	41788	3170	150216	16503
Max	16459	16708	1550	13285	8082	1577	23460	21994	2442	0.848	0.088	134180	7515	168467	8465	404905	38631

*** Estimates for 2019 and 2020 are TSA projections.**

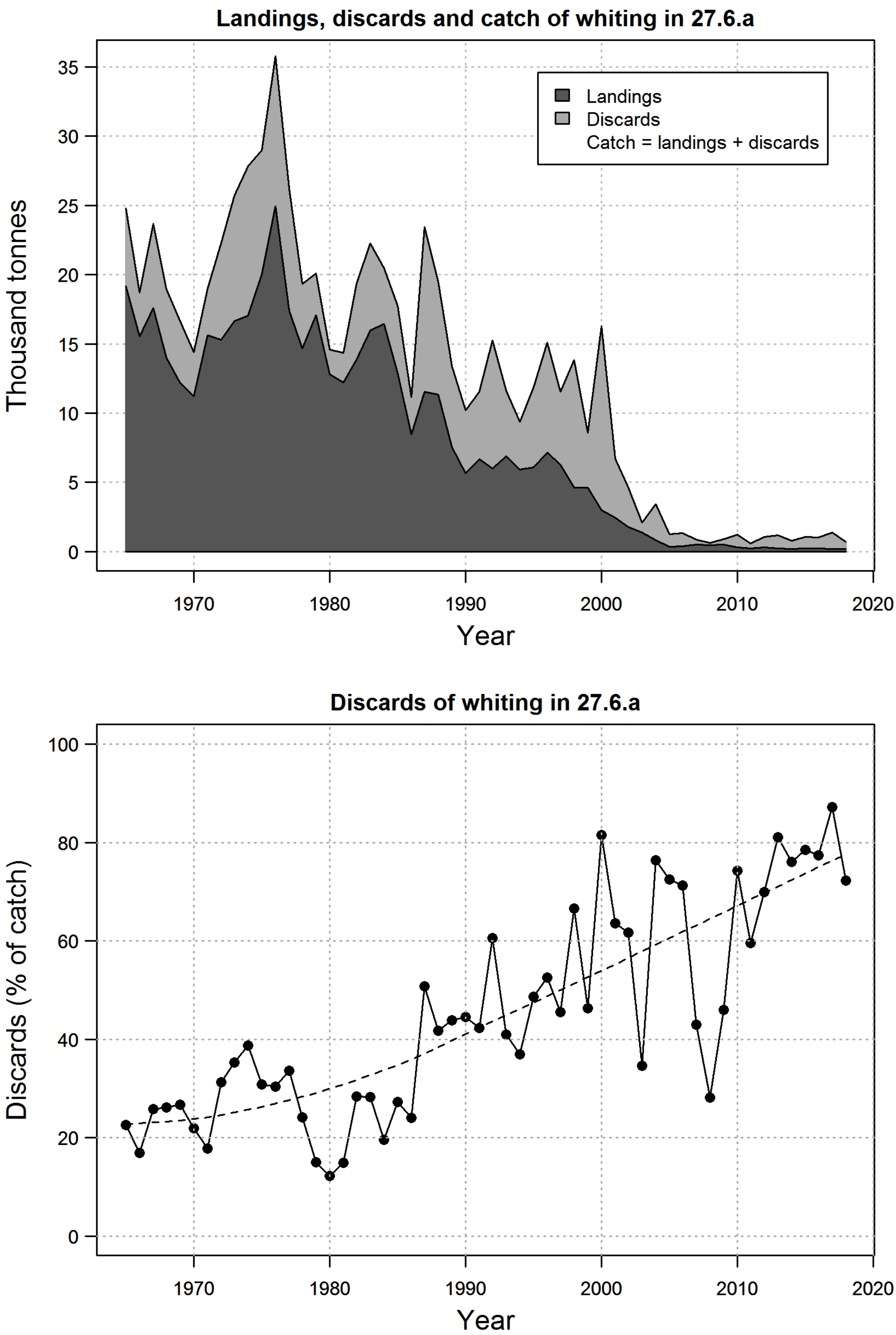


Figure 38.1. Whiting in Division 6.a. Landings, discards and catch (in tonnes, whiting at-age 1 and older) as officially reported to ICES (upper panel) and discards (as % of catch, lower panel).

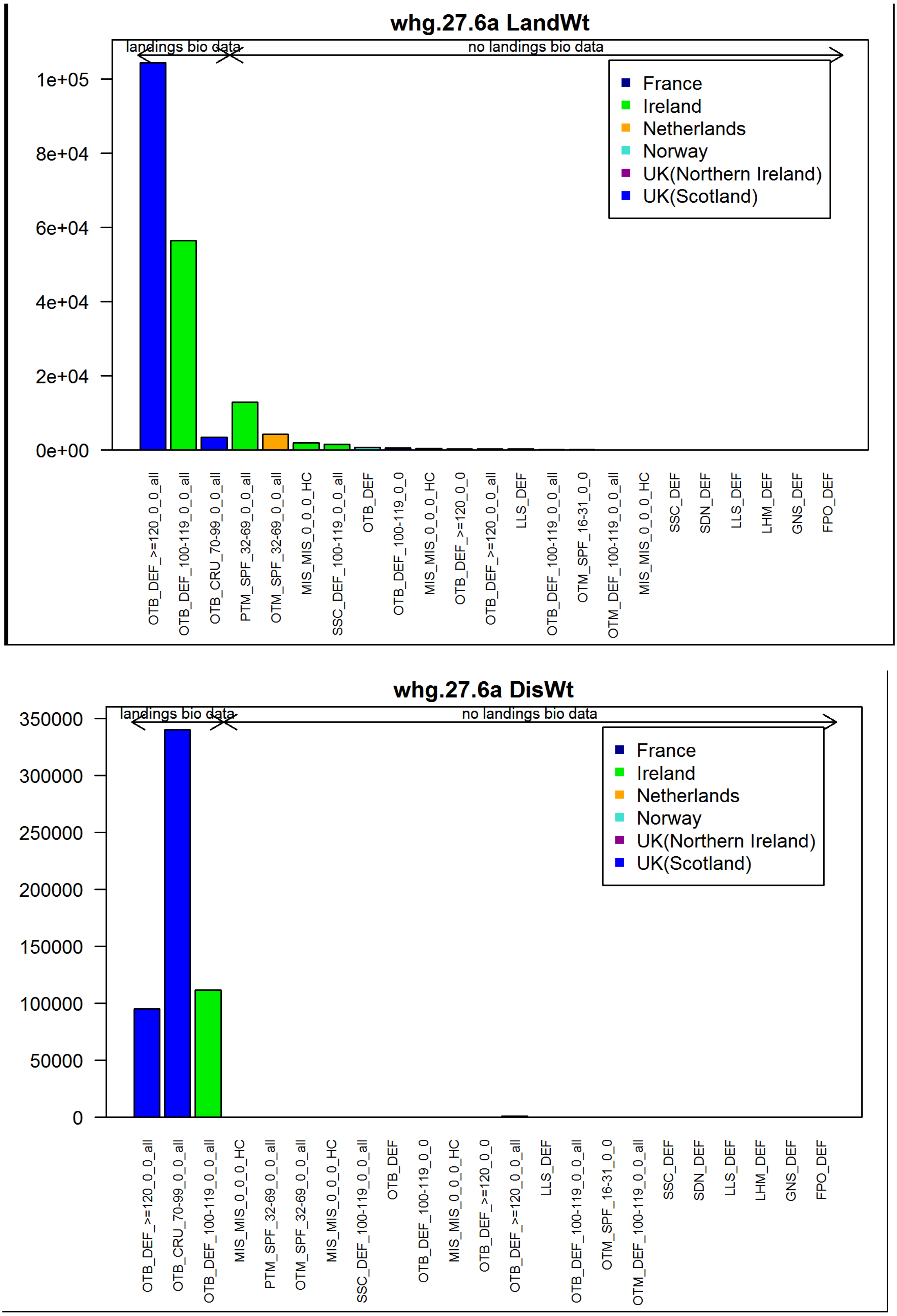


Figure 38.2. Whiting in Division 6.a. Landings (upper panel) and discards (all ages, lower panel) by métier (kg) in 2019 as entered into InterCatch.

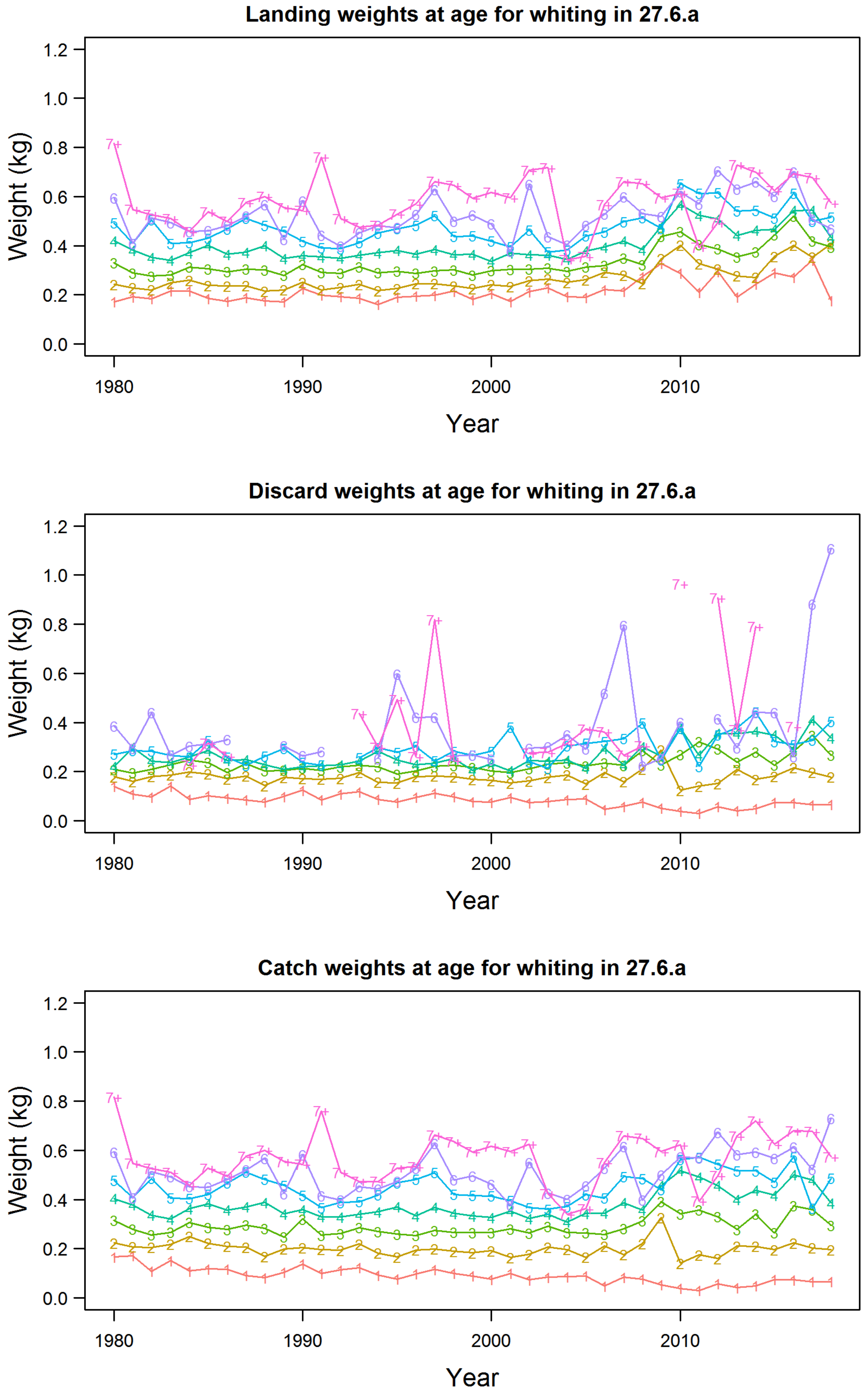


Figure 38.3. Whiting in Division 6.a. Mean weight-at-age in the landings (upper panel), discards (middle panel) and catch (lower panel).

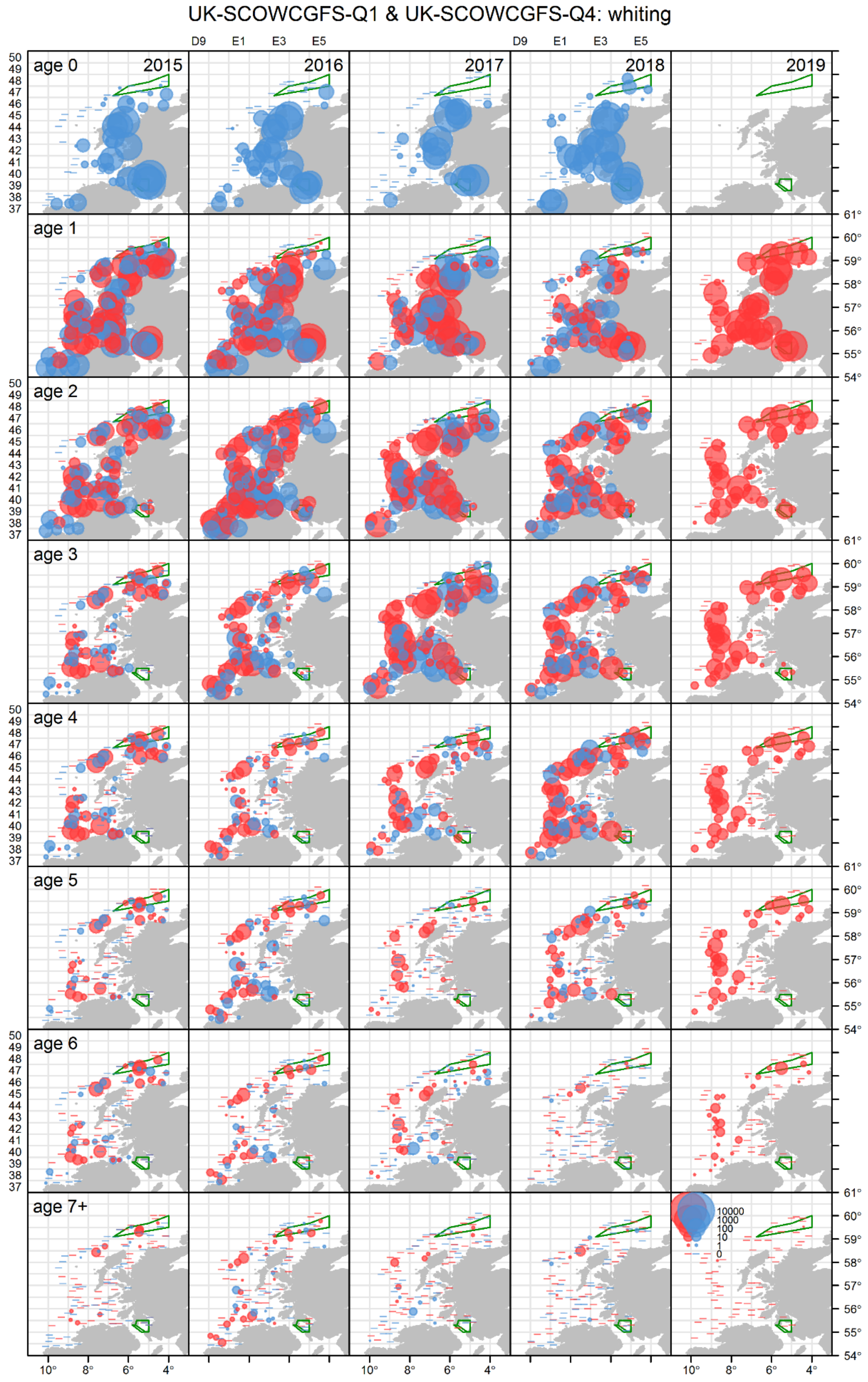


Figure 38.4. Whiting in Division 6.a. Cpue from the Scottish first quarter west coast groundfish survey (UK-SCOWCGFS-Q1, in red) and the Scottish fourth quarter groundfish survey (UK-SCOWCGFS-Q4, in blue) in 2016–2019. Numbers are standardised to 30 minutes towing. Two closed areas (the Windsock in the north and the Clyde in the south) are shown as green polygons.

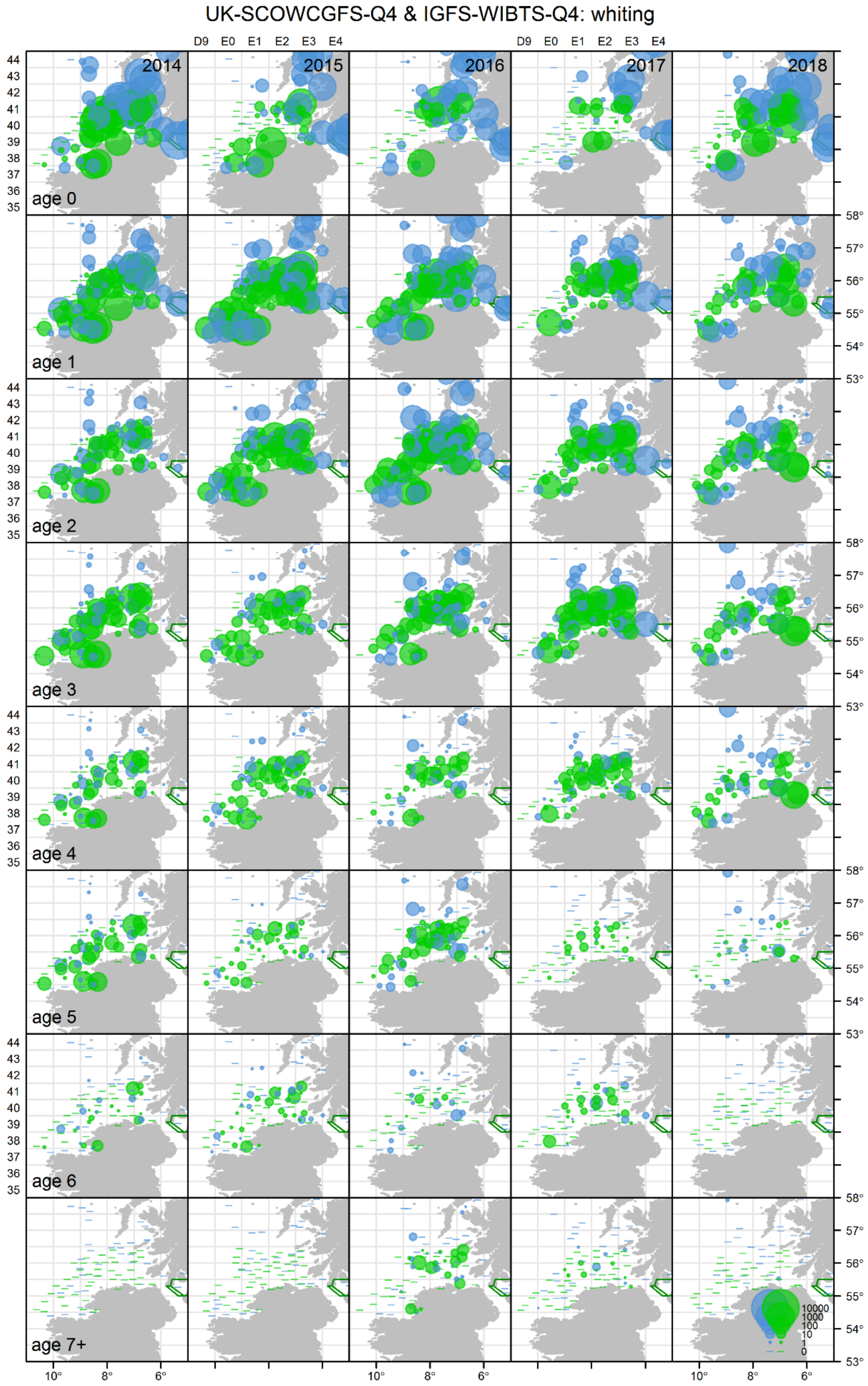


Figure 38.5. Whiting in Division 6.a. Cpue from the Scottish fourth quarter west coast groundfish survey (UK-SCOWCGFS-Q4, only the southern part of the survey area, in blue) and the Irish fourth quarter groundfish survey (IGFS-WIBTS-Q4, in green) in 2015–2018. Numbers are standardised to 30 minutes towing. The Clyde closed area is shown as a green polygon.

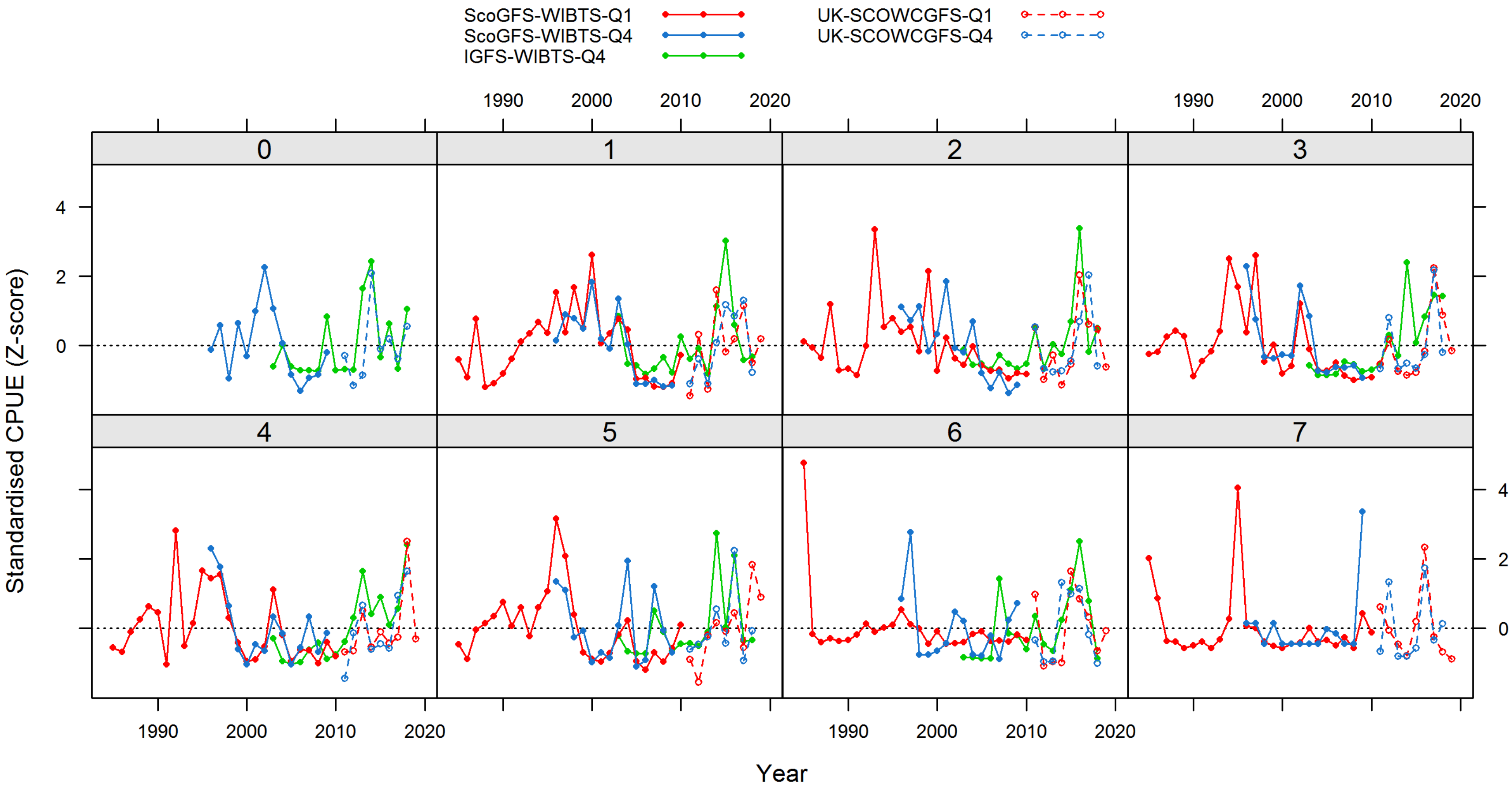


Figure 38.6. Whiting in Division 6.a. Scaled survey indices (Z-scores) from ScoGFS-WIBTS-Q1, ScoGFS-WIBTS-Q4, IGFS-WIBTS-Q4, UK-SCOWCGFS-Q1 and UK-SCOWCGFS-Q4. The abundance index for IGFS-WIBTS-Q4 is shown only for ages 0–6.

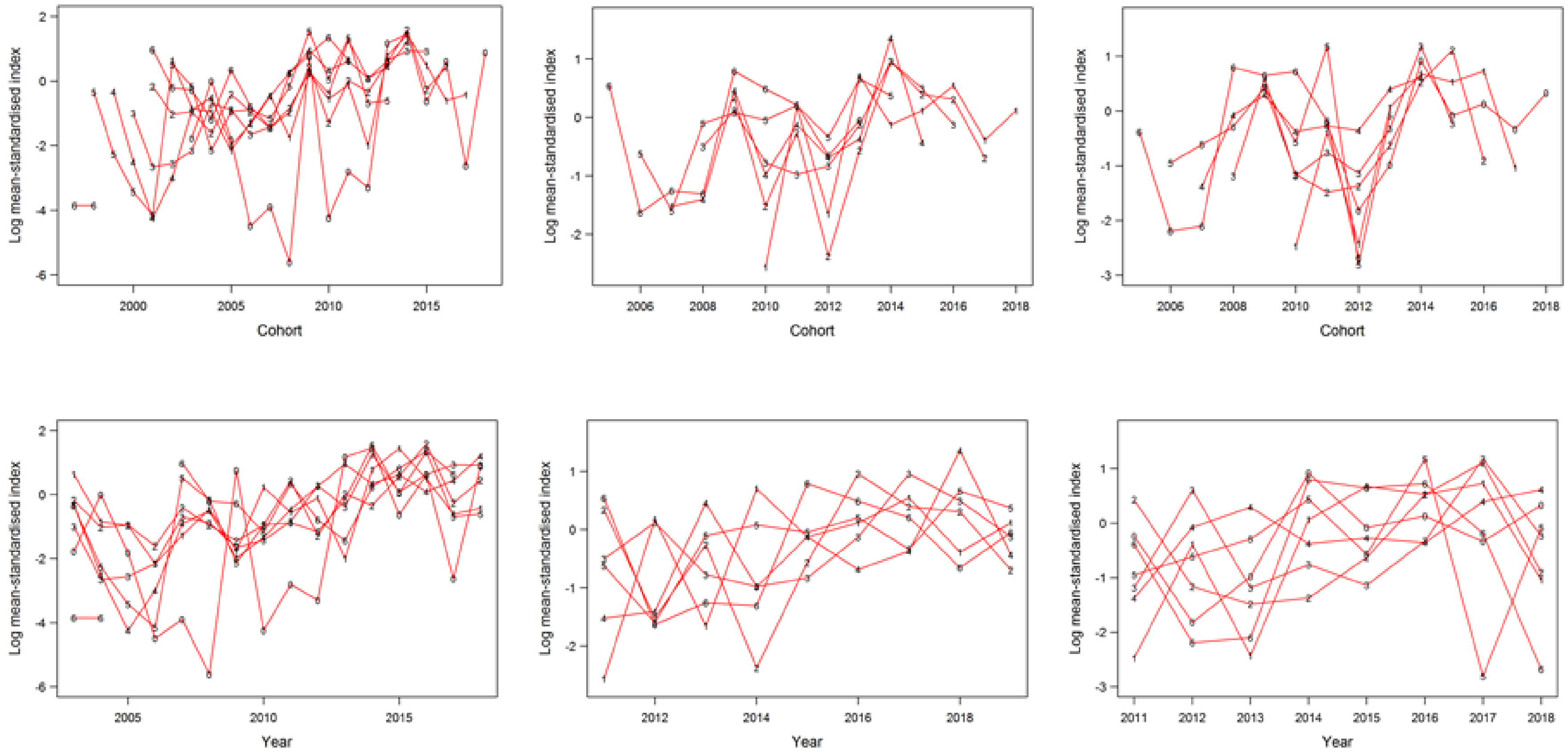


Figure 38.7. Whiting in Division 6.a. Log mean standardised survey index for each age by cohort (upper panels) and year (lower panels) in IGFS-WIBTS-Q4, UK-SCOWCGFS-Q1 and UK-SCOWCGFS-Q4, respectively.

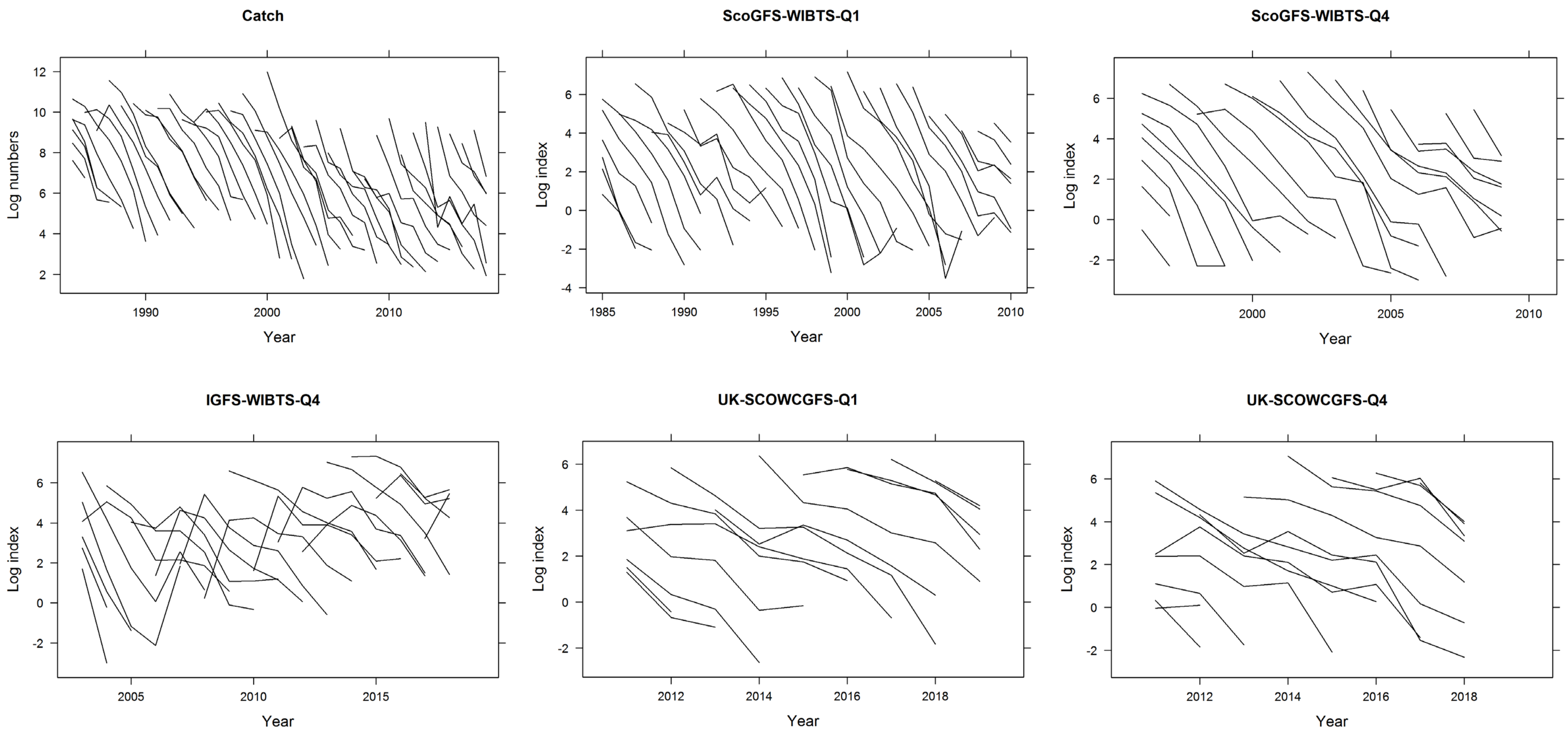


Figure 38.8. Whiting in Division 6.a. Log catch curves from the catch (ages 1–7+) and from the five survey series (ages as specified in Table 38.9).

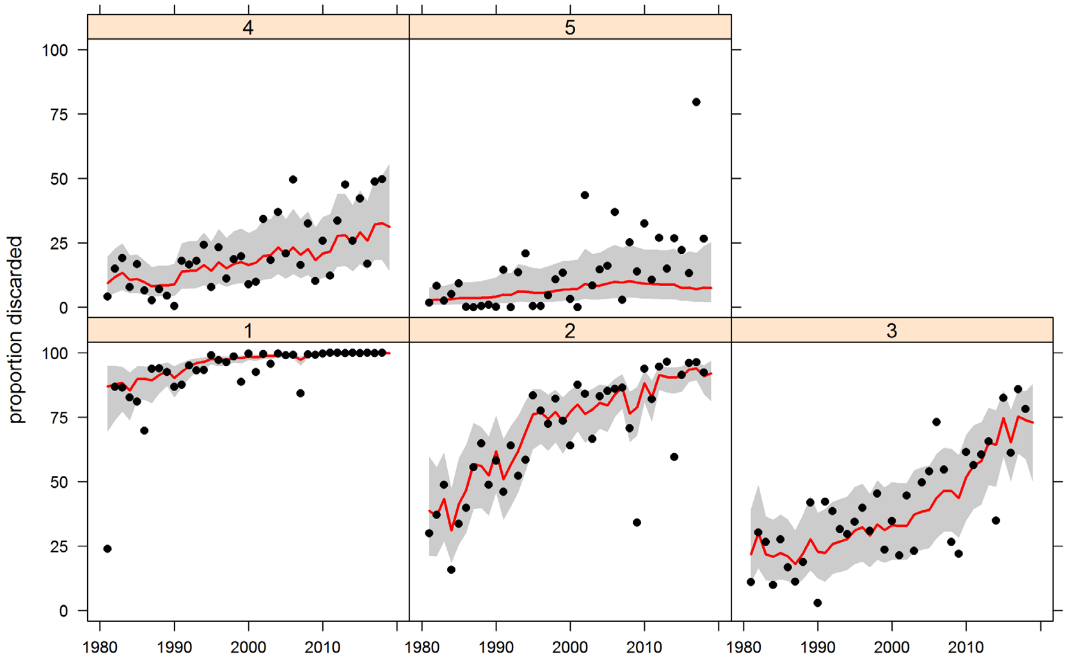


Figure 38.9. Whiting in Division 6.a. Proportion discarded at-age from the final TSA run.

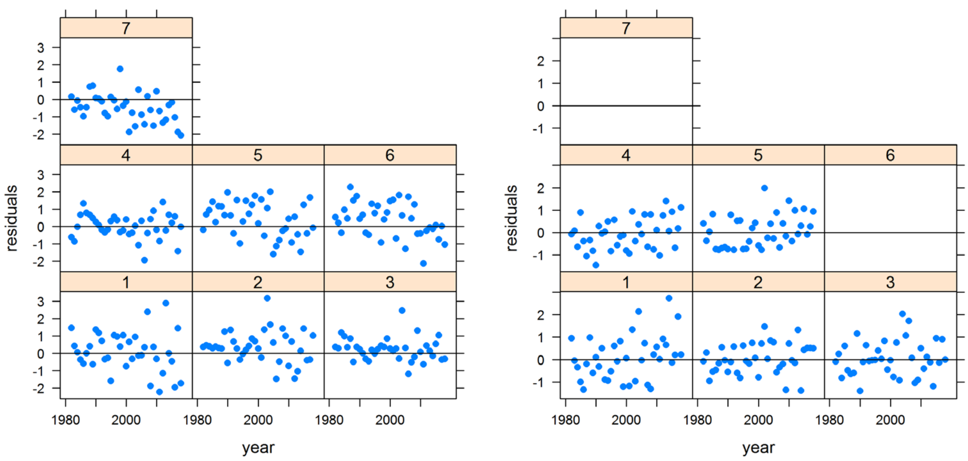


Figure 38.10. Whiting in Division 6.a. Standardised residuals for landings (left panel) and discards (right panel) from the final TSA run.

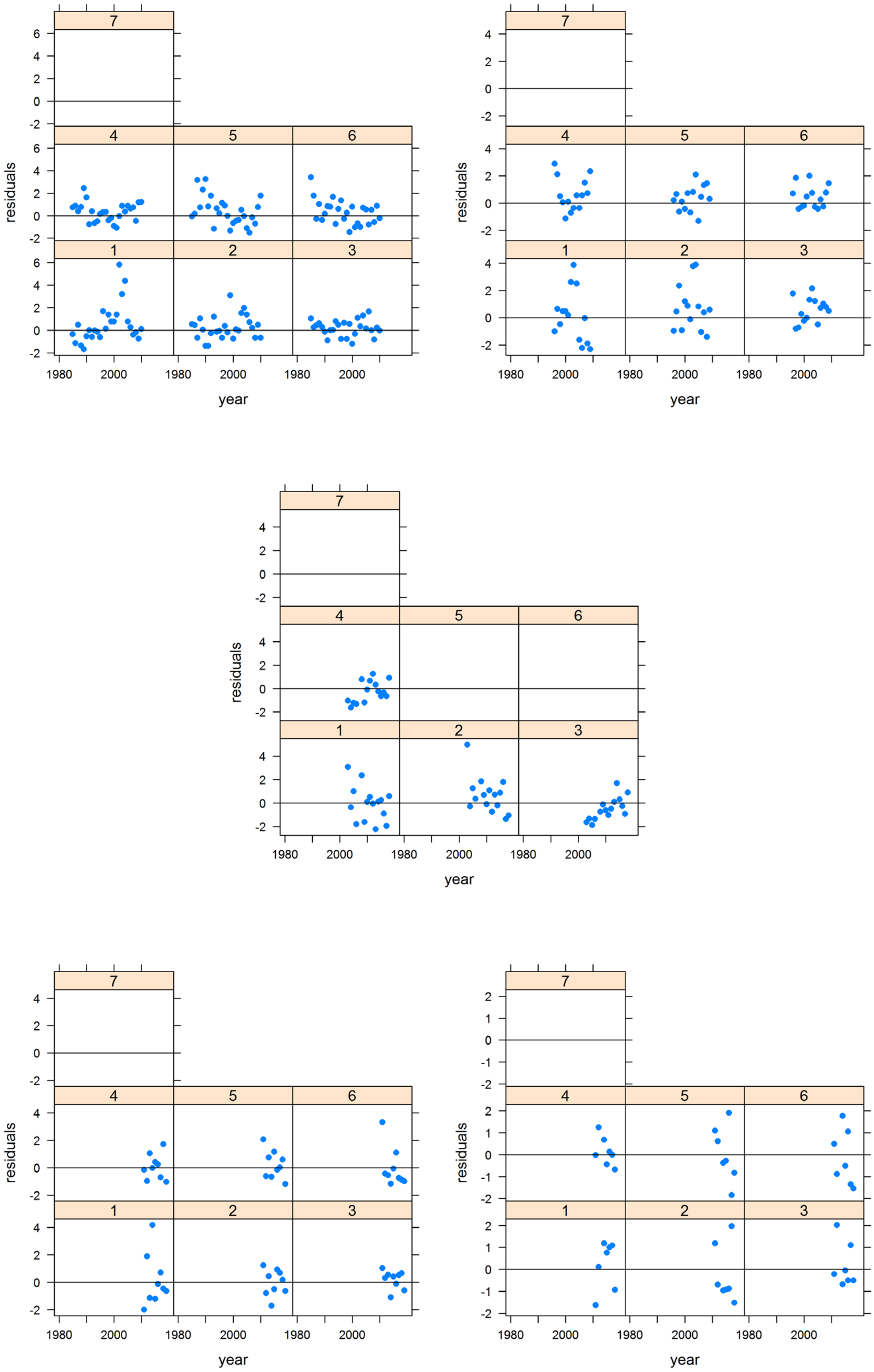


Figure 38.11. Whiting in Division 6.a. Standardised survey residuals from TSA in ScoGFS-WIBTS-Q1 (top left panel), ScoGFS-WIBTS-Q4 (top left panel), IGFS-WIBTS-Q4 (middle panel), UK-SCOWCGFS-Q1 (bottom left panel) and UK-SCOWCGFS-Q4 (bottom right panel), from the final TSA run.

Figure 38.12. Whiting in Division 6.a. Percentage change in catchability from the final TSA run. Transient changes (points) and the persistent change (solid line) with uncertainty bounds.

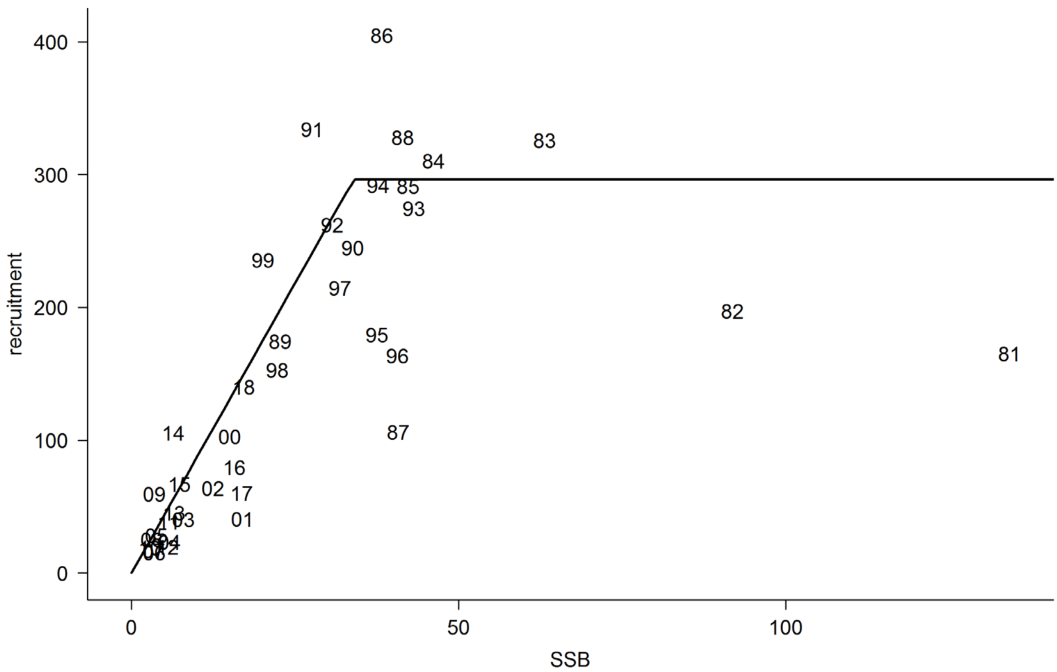


Figure 38.13. Whiting in Division 6.a. Stock–recruitment relationship (recruitment in millions, SSB in thousand tonnes) from the final TSA run, with points labelled as year classes, and fitted with a segmented-regression model ("hockey-stick", solid line).

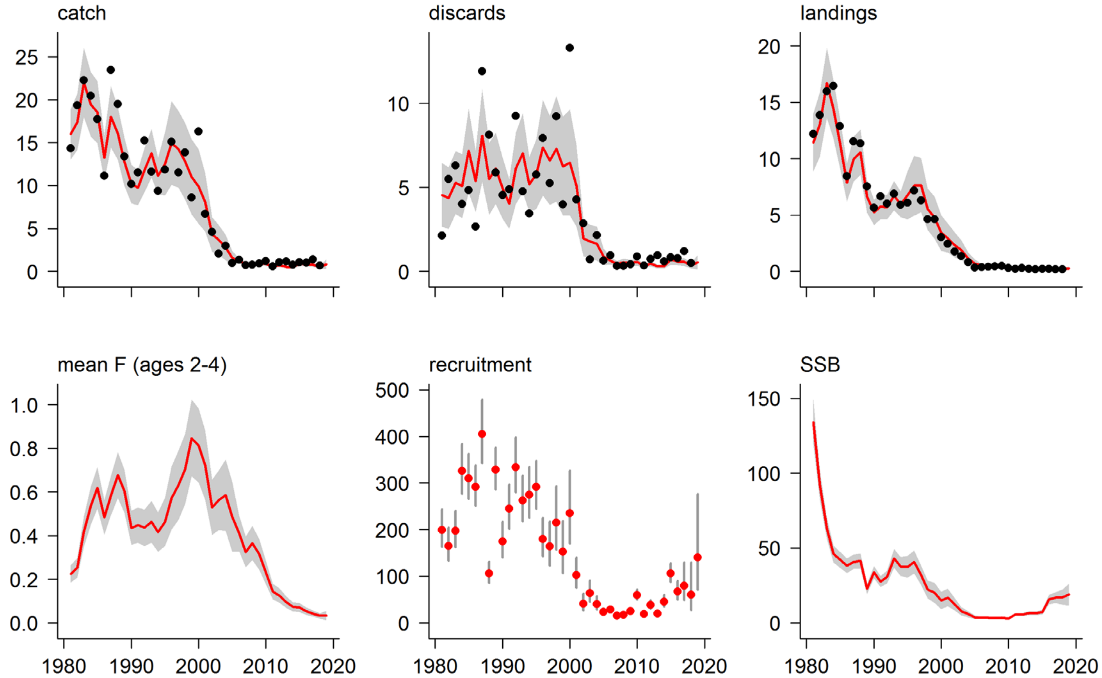


Figure 38.14. Whiting in Division 6.a. TSA stock summaries from the final TSA run. Catch, landings, discards and SSB in tonnes, recruitment in thousands. Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, landings and discards.

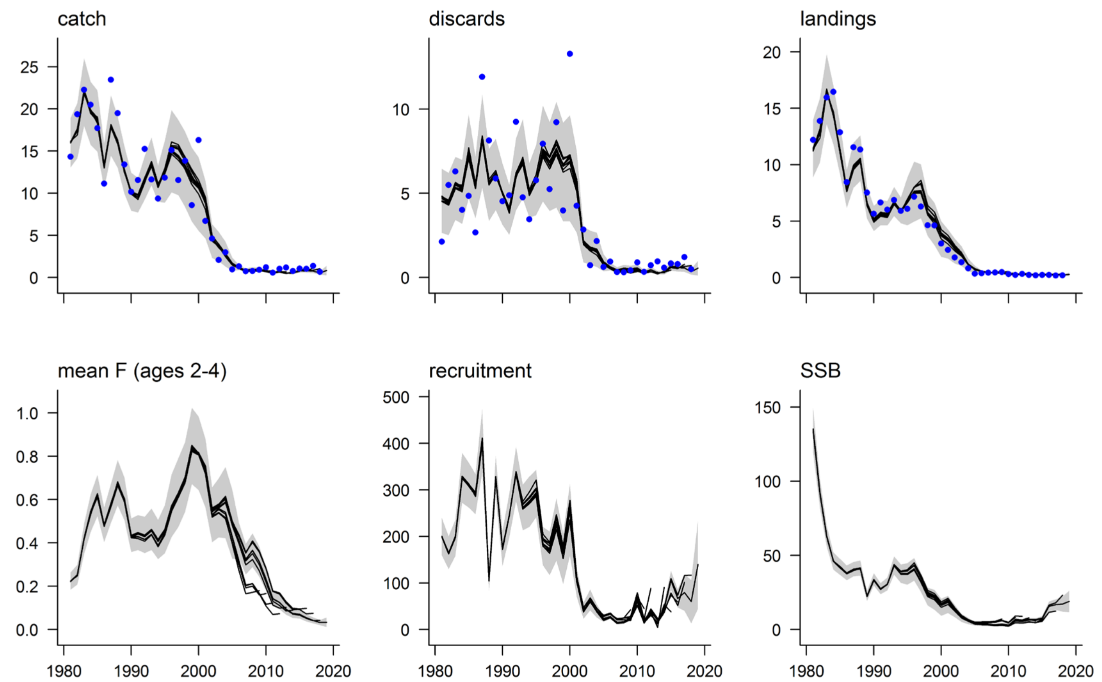


Figure 38.15. Whiting in Division 6.a. Retrospective plots of TSA run (the retro analysis for 2009–2018). Catch, landings, discards and SSB in tonnes, recruitment in thousands. Blue points show observed values, black lines show estimates in the respective years, grey bands show confidence intervals for the last estimate.

37 Whiting (*Merlangius merlangus*) in Division 6.b (Rockall)

Type of assessment in 2019

No assessment was performed in 2018.

ICES advice applicable to 2019

In 2018, ICES provided multiyear advice:

ICES advises that when the precautionary approach is applied, wanted catches should be no more than 9 tonnes in each of the years 2019, 2020, and 2021. ICES cannot quantify the corresponding total catches.
http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/whg.27.6b.pdf

ICES advice applicable to 2016–2018

In 2015, ICES provided multiyear advice:
ICES advises that when the precautionary approach is applied, catches should be no more than 11 tonnes in each of the years 2016, 2017, and 2018.
http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/whg-rock.pdf

37.1 General

Stock description

There is an absence of information on whiting stock structure in this region and whiting caught at Rockall may potentially be part of the adjacent 6.a stock.

Management applicable to 2018 and 2019

The TAC for whiting (in tonnes) is set for ICES subareas 6, 12, and 14, and EU and international waters of ICES Division 5b, for 2019 and 2018 is shown below.

TAC for 2019

Species:	Whiting *Merlangius merlangus*	**Zone:**	6; Union and international waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	3 ([1])		
France	68 ([1])		
Ireland	324 ([1])		
United Kingdom	717 ([1])		
Union	1 112 ([1])		
TAC	1 112 ([1])		Analytical TAC Article 8 of this Regulation applies

([1]) Exclusively for by-catches of whiting in fisheries for other species. No directed fisheries for whiting are permitted under this quota.

(Council Regulation (EU) 2019/124).

TAC for 2018

Species:	Whiting *Merlangius merlangus*	Zone:	6; Union and international waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	1 ([1])		
France	26 ([1])		
Ireland	64 ([1])		
United Kingdom	122 ([1])		
Union	213 ([1])		
TAC	213 ([1])		Analytical TAC

([1]) Exclusively for by-catches. No directed fisheries are permitted under this quota.

(Council Regulation (EU) 2018/120).

Fishery in 2018

No specific information is available for 2018. Whiting at Rockall are taken as a bycatch in fisheries for other species such as haddock and anglerfish.

37.2 Data

Landings data for whiting in 6.b are shown by nation in Table 39.1 and Figure 39.1. Total officially reported landings were 43 t in 2018, of which 34 t were reported by the UK, 9 t by Ireland, and <0.5 t by Norway. In the past, official landings have shown very high interannual variation and it is not known whether these are a true reflection of removals.

Landings and discards have been uploaded to InterCatch for 2018 (Figure 39.2).

In addition, some landings and discards age compositions were also uploaded to InterCatch. About 78% of the total landings (44 t) are from the Scottish TR1 fleet which, based on two sampled trips has a 12% discard rate. The data available in InterCatch are shown below.

Country	Landings (t)	Discards (t)	Total (t)
Ireland	9.0	1.2	10.2
UK (Scotland)	34.0	4.6	38.6
Norway	0.5	0.1	0.6
Grand total	5.9	43.6	49.4

Survey catch rates of whiting at Rockall are extremely low (Table 39.2, Figure 39.3) and are therefore unlikely to provide a reliable index of abundance.

Catches of whiting (both survey and commercial) are too low to support the collection of the necessary information for an assessment of stock status.

37.3 Target category

In 2012, advice was provided using the DL approach for category 6.2.0; stocks with negligible landings stocks and stocks caught in minor amounts as bycatch with no indication of F in relation to reference points and no marked positive trends in stock indicators. WKLIFE has previously suggested a target category of 4 for this stock. Given the comments in Section 39.2 regarding the potential unreliability of landings data and lack of sampled data, WGCSE considers that whiting in 6.b is likely to remain a category 6 stock.

37.4 Management considerations

Rockall whiting is managed under a TAC for the combined Divisions 6.a and 6.b, and therefore cannot be effective in limiting catches in Rockall.

Table 39.1. Whiting in Division 6.b. Nominal landings (in tonnes) as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	32	10	4	23	3	1	-	-	10	-	2	3	3	104
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
UK (E, W & NI)	16	6	1	5	10	2	5	26	49	20	-	-	-	-	-	-	-	-
UK (Scotland)	18	482	459	283	86	68	53	36	65	23	44	58	4	7	11	1	1	1
UK (all)																		
Total	34	488	460	288	128	80	62	85	117	44	44	58	14	7	13	4	4	105

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*	2018*
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-
France	+	-	-	-	-	-	-	-	-	-	-	-
Ireland	16	23	4	2	3	-	+	6	6	9	7	9
Norway	-	-	-	-	-	-	-	-	-	1	-	+
Spain	-	-	-	-	-	-	-	-	-	-	-	-
UK (E, W & NI)	-	-	-	-	-	-	-	-				
UK (Scotland)	1	8	12	16	6	1	3	23				
UK (all)									46	22	32	34
Total	17	31	16	18	9	1	3	29	52	33	40	43

*** Preliminary.**

+ < 0.5 t.

Table 39.2. Whiting in Division 6.b. Survey data made available to the WG: Scottish Q3 groundfish survey (UK-SCOROC-Q3). Catch rates are given as number per ten hours.

	UK-SCOROC-Q3 – Scottish Groundfish Survey – numbers at age/10 h								
Year	**Effort**	**Age**							
	(hours)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2011	10	0	0	0	0	0	0	0	0
2012	10	33.279	0	0.358	0	0	0	0	0
2013	10	6.687	1.924	0	0	0	0	0	0
2014	10	17.425	3.426	0.838	0.307	0	0	0	0
2015	10	8.853	0.559	0.559	0.55	0	0	0	0
2016	10	250.012	0.782	0	0.223	0.447	0	0	0
2017	10	23.147	10.84	0	0	0	0	0	0
2018	10	0.531	0.754	0.894	0	0	0.307	0	0

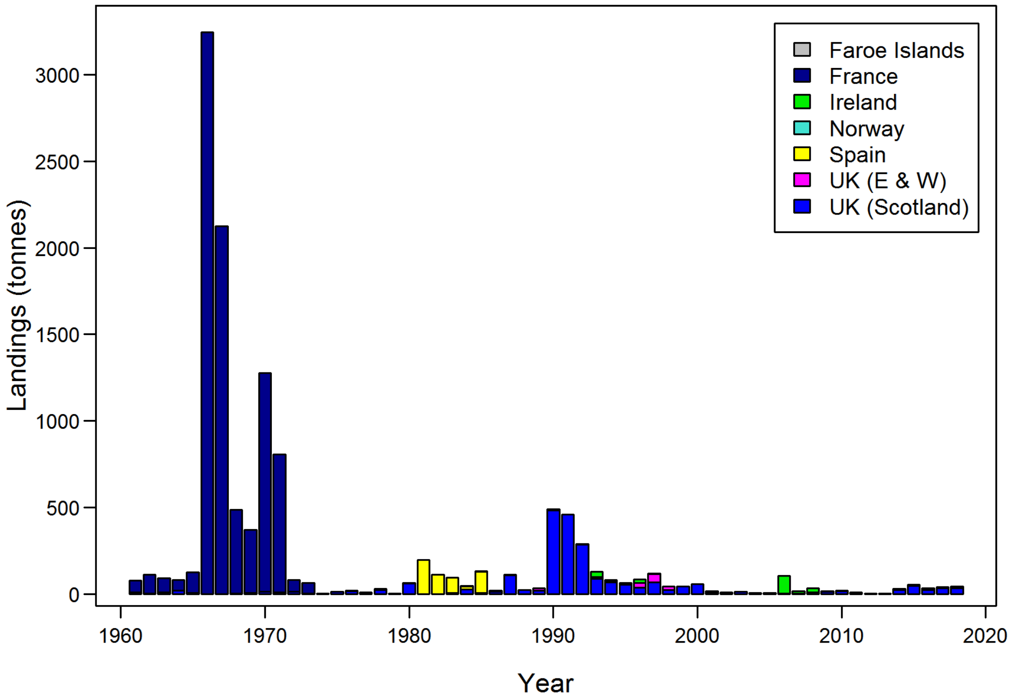


Figure 39.1. Whiting in Division 6.b. Official landings by nation.

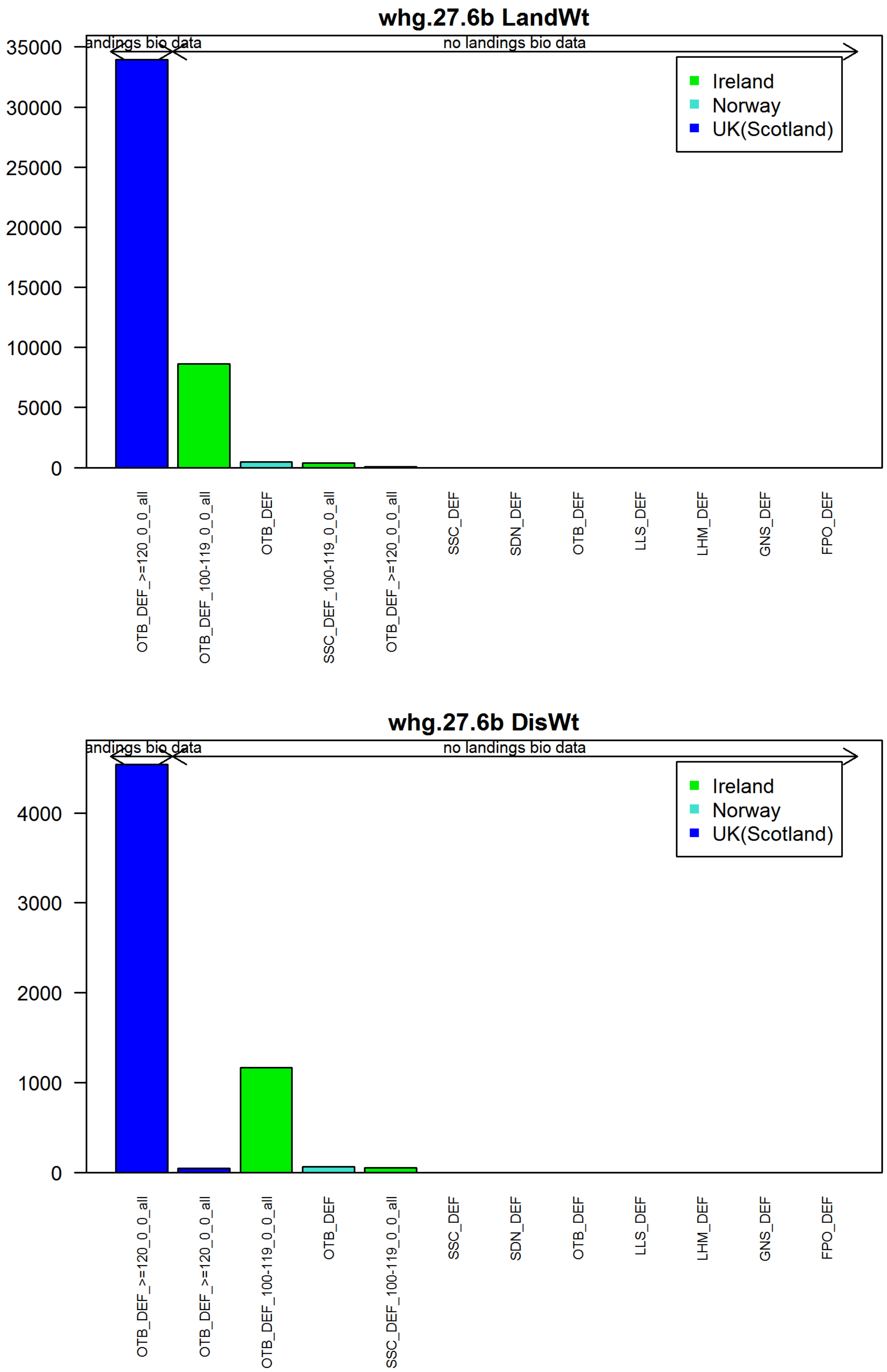


Figure 39.2. Whiting in Division 6.b. Landings (upper panel) and discards (lower panel), all ages, by métier (kg) in 2018 as entered into InterCatch.

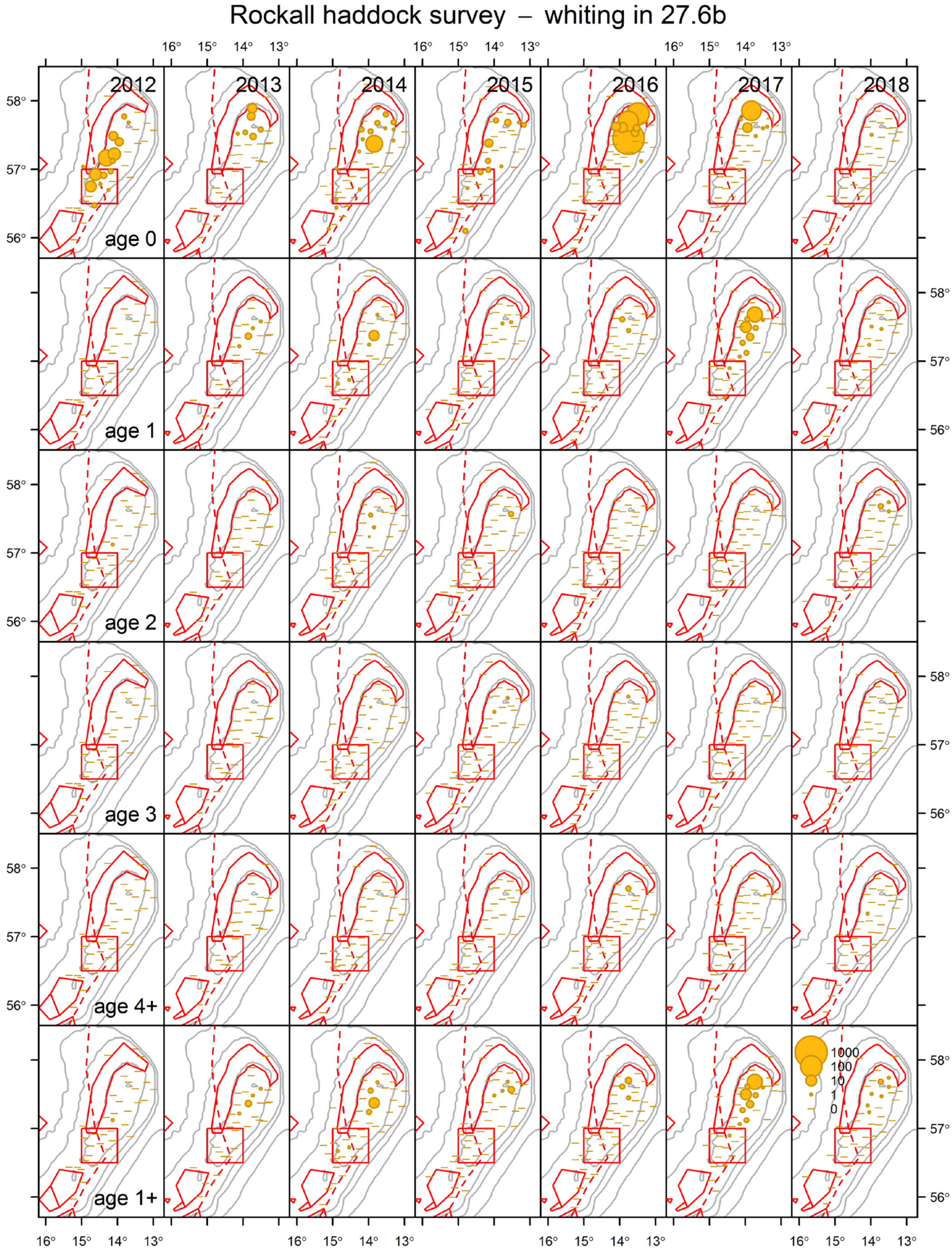


Figure 39.3. Whiting in Division 6.b. Whiting distribution by age on the Rockall Bank in 2012–2018 as observed in the Rockall Haddock survey. The densities (numbers of fish per 30 min) are represented by circles. The red polygons show the protected areas. The red rectangle in the centre shows the Haddock Box. The dashed line shows the NEAFC Regulatory Area.

38 Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea)

2019 Assessment and advice

This stock was benchmarked in 2017 and the outcome was to upgrade the assessment from category 3 (trends based) to category 1 (analytical assessment and forecast). Data exploration was carried out in WKIrish2 (ICES, 2017). A full analytical assessment procedure was developed during WKIrish3 (ICES, 2017) using ASAP. Reference points were also estimated during WKIrish3. WGCSE 2019 updated the assessment with 2018 data. The advice for this stock is biennial and is produced for 2019; however, it was also updated in October 2018 following a special request to ICES to update the advice based on the most recent discard estimates.

Furthermore, in response to an EC request for advice on the removal of TACs for certain stocks ICES advises that removing the EU TAC for Whiting in ICES Division 7.a may generate a high risk of the stock being unsustainably exploited. However, ICES notes that the TAC is not currently controlling exploitation.

Type of assessment

SPALY update of ASAP assessment.

ICES advice applicable to 2019 and 2020

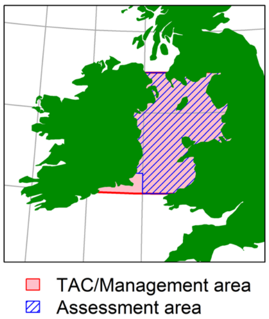
ICES advises that when the MSY approach is applied, there should zero catches in each of the years 2018 and 2019.

http://ices.dk/sites/pub/Publication%20Reports/Advice/2018/Special_requests/uk.2018.29.pdf

38.1 General

Stock description and management units

The stock and the management unit are both ICES Division 7.a (Irish Sea). Whiting landings taken or reported in ICES rectangles 33E2 and 33E3 have been reassigned to the 7.b,c,e–k whiting stock since 2003.



Management applicable to 2017 and 2018

The minimum conservation reference size of whiting is 27 cm. The 2018 TAC for whiting 7.a was 80 t. Overall, official landings in 2018 were below the TAC but some countries landings were close to their quotas. This stock is now subject to the landings obligation by way of the Commission Delegated Regulation (EU) 2018/2034. In 2019, the TAC was increased to 727 t.

2018	2018 Quota	2018 Officially reported Landings
Belgium	0	1
France	3	<0.5
Ireland	46	44
The Netherlands	0	-
United Kingdom	31	19

Note for Ireland, 18 t were reallocated from rectangles 33E2 & 33E3.

TAC 2018

Species: Whiting *Merlangius merlangus*		Zone: VIIa (WHG/07A.)
Belgium	0	
France	3	
Ireland	46	
The Netherlands	0	
United Kingdom	31	
Union	80	
TAC	80	Analytical TAC

TAC 2019

Species: Whiting *Merlangius merlangus*		Zone: 7a (WHG/07A.)
Belgium	2 (1)	
France	25 (1)	
Ireland	419 (1)	
The Netherlands	0 (1)	
United Kingdom	281 (1)	
Union	727 (1)	
TAC	727 (1)	Analytical TAC Article 8 of this Regulation applies

Fishery in 2018

The characteristics of the fishery are described in the stock annex.

The fishery in 2018 was prosecuted by the same fleets and gears as in recent years. In addition to this, 65% of the Irish landings were submitted were from the PTM_SPF métier for 2018. These were from trips targeting herring where whiting was a bycatch.

Table 40.1 gives the official nominal landings of 7.a whiting as reported by each country to ICES. Working Group estimates of the landings and discards for the main fleets are given in Table 40.2. In recent years, the values provided to the WG are very similar to officially reported landings.

The majority of the catch was discarded in the *Nephrops* fishery (853 t) by UK-NI and IRE (Table 40.2).

The closure of the western Irish Sea to whitefish fishing from mid-February to the end of April, designed to protect cod, was continued in 2018 but is unlikely to have affected whiting catches, which are mainly bycatch in the derogated *Nephrops* fishery. *Nephrops* vessels can obtain a derogation to fish in certain sections of the closed area, providing they fit separator panels to their nets to allow escape of cod and other fish. The TR2 fleet in 7.a are obliged to use one of four types of cod selective measures, namely a 'Swedish' grid; the inclined separator panel, SELTRA trawl or 300 square mesh panel.

A summary of the 2018 catches by main gear types is presented below.

Catch (2018)	Landings			Discards	
	fin-fish trawls	*Nephrops* directed otter trawl	Other gears	*Nephrops* directed otter trawls	Other gears
899 t	38%	14.3%	48%	98%	2%
		46 t		853 t	

38.2 Information from the Industry

There was no information on the whiting stock from the industry.

38.3 Data

Data were provided by all countries according to the data call.

For WGCSE (2019) all data have been updated. To allow an age-based assessment, catch numbers-at-age, catch weights-at-age, stock weights-at-age have all be constructed since 2003 (WGCSE, 2017). These updates are documented in the Stock Annex.

Fishery landings

Working Group estimates of catch available since 1980 are illustrated in Figure 40.1 and indicate the declining trend since the start of the time-series.

The introduction of UK and Irish legislation requiring registration of fish buyers and sellers may mean that the reported landings from 2006 onwards are more representative of actual landings.

Working group estimates of landings are corrected for misreporting in the past. There is information that officially reported landings of whiting, especially around the mid-1990s, have been inaccurate due to misreporting. Landings data have previously been partially corrected for by using sample-based estimates of landings at a number of Irish Sea ports. Due to the low level of landings recently, this has not been carried out since 2003. As for 7.a cod and haddock, the whiting landings taken or reported in ICES rectangles 33E2 and 33E3 have been reassigned to the 7.e–k whiting stock since 2003 (Table 40.3).

Fishery discards

Discard estimates are available from Ireland and Northern Ireland, with minor discards from the UK E&W. Data were submitted for the OTB_DEF_100-119_0_0_all métier from Ireland due to increased sampling in this métier in 2018. Raising methods used are described in the stock annex for 7.a whiting.

Landings-at-age data

Sampling and raising methods previously used are described in the stock annex for 7.a whiting. Methods for estimating quantities and composition of landings are described in the stock annex.

Landings numbers-at-age are given in Table 40.4. For the 2003 data onwards, the catch and mean weight-at-age are estimated using combined UK (NI) and Irish quarterly length–weight relationships and age–length keys. These data are raised to the international catch data provided to ICES. Typically, quarterly landings are provided by the UK (Scotland), Belgium and France and annual landings are provided by UK (IOM). The quality of the landings-at-age data has been declining in recent years due to reduced sample numbers commensurate with the decline in landings.

Discards numbers-at-age data

Discard number-at-age are given in Table 40.5. Discarding of whiting is high within the Irish Sea. Discard Numbers-at-age were combined for Ireland and Northern Ireland for ages 0 to 6+ and then raised to the international discards. From 2003, the discard time-series from Ireland is based on the *Nephrops* fleet only. Therefore, the discard weight in tonnes has been revised. Discards from NI were not available from 2003–2005 and so discard numbers-at-age are based on Irish sampling data only. There has been a high number of age 1 and 2 discarded at the start of the time-series with almost all age 1 and 2 discarded later in time-series (Figure 40.3).

The length–frequency of discards of national sampled fleets in 2018 is given in Figure 40.2. More detailed information is available in the stock annex.

Biological data

The derivation of these parameters and variables is described in the stock annex. The Lorenzen method was used to estimate M. This was derived during WKIrish2 and investigated during WKIrish3. Maturity-at-age is knife-edge at-age 2. Stock weights were also revised at the benchmark meeting. Stock weights-at-age were derived from the catch weights and then smoothed using a three-year moving average. Figure 40.4 shows the stock weights used. There are strong trends in mean weights-at-age over the time-series with a minimum around 2000s for most ages. There was a small increase in the mid-2000s but overall mean weights are significantly lower than at the start of the series.

Survey data used in assessment

Table 40.6 describes the survey data made available to the Working Group.

In 2016, the entire time-series of the UK (E&W)-BTS-Q3 survey data was revised so that only the selected prime stations are used.

Survey series for whiting provided to the Working Group are further described in the stock annex for 7.a whiting (Section B.3). Five survey series were available. The inclusion of the different available surveys was tested in a series of preliminary model runs at WKIrish3. Figure 40.5 shows the log-standardized indices of tuning fleets by cohort. There are very little cohort signals in any of the indices. The beam trawl survey shows an increasing trend in the early part of the time-series not seen in the other surveys. The three surveys included in the final assessment were NIGFSQ1, NIGFSQ2 and the NIMIK net survey.

38.4 Historical stock development

Model used: ASAP

Software used: ASAP V3.0.17 NOAA Fisheries toolbox (http://nft.nefsc.noaa.gov)

FLR with R version 3.1.2 with packages FLCore 2.5.20150309, FLAssess _2.5.20130716, FLXSA 2.5.20140808 and FLEDA 2.5 (http://flr-project.org)

Data screening

The general approach to data screening and analysis was followed in addition to the data exploration tools available in the FLR package FLEDA. The results of the data screening are fully documented using R markdown and are available in the folder 'Data\Whg 7.a \Assessment. on SharePoint. Table 40.7 shows the ASAP input data.

Final update assessment

The final assessment was run using the same settings as described in WKIrish3. These final settings are described in the Stock Annex.

The observed and predicted catches are shown in Figure 40.7. Fit to the overall catch is reasonably good. There is some deviation in the early to mid-1990s. This is most likely due to the introduction of the survey data into the assessment model.

The observed and predicted index cpue values are shown in Figure 40.8. There is poor fit to the Northern Irish groundfish survey indices in the first half of the series but it improves in recent years.

Figure 40.6 shows the selectivity-at-age in the catch. Full selectivity is assumed for age 3 and the model is allowed to estimate ages 1 and 2. Table 40.8 shows the model estimates.

Figure 40.9 shows the retrospective analysis. The predicted catch shows no obvious retrospective pattern, neither does the recruitment estimate. There is some deviation in the early part of the time-series when the surveys were first introduced. However, recent estimates of SSB and F are consistent with no apparent bias.

A Mohn's rho analysis was conducted based on the ASAP stock assessment results, i.e. the last data year (2018) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 1–3)	recruitment
Mohn's rho value	0.129	-0.190	0.29

The Mohn's rho values for this assessment are below the threshold of 20% imposed by ICES for 2019 assessments.

The state of the stock

Table 40.9 shows the estimated fishing mortality-at-age and Table 40.10 shows the stock numbers-at-age. The stock summary is given in Table 40.11 and Figure 40.10.

The present stock size is extremely low. SSB has declined since the start of the time-series and has been well below B_{lim} since the mid-1990s. Recruitment has been low since the early 1990s. Large variations in fishing mortality estimates have been observed in recent years. F has been well above F_{lim} since the early 1990s.

38.5 Short-term predictions

Short-term projections were performed using FLR libraries. Recruitment for 2019–2021was estimated at 118 853 (GM 2000 onwards; thousands). Three-year averages were used for F (unscaled) and weights-at-age.

Input data for the short-term forecast are given in Table 40.12. The single-option output is given in Tables 40.13 and 40.14 gives the management options.

Estimates of the relative contribution of recent year classes to the 2020 landings and 2021 SSB are shown in Figure 40.11. The 2015–2017 year class estimates from ASAP accounts for 79% of the projected landings in 2020. The 2019 GM assumption contributes considerably to the estimated SSB in 2021 as does the 2018 ASAP assessment.

38.6 Medium-term projection

There is no analytical assessment for this stock.

38.7 MSY evaluations and Biological Reference Points

ICES carried out and evaluation of MSY and PA reference points for this stock at WKIrish3. The results are summarized below:

	Type	Value	Technical basis
MSY	MSY Btrigger	16 300 t	Bpa
Approach	F_{MSY}	0.22	Median point estimates of EqSim with combined SR
	$F_{MSY\ lower}$	0.158	Median point estimates of EqSim with combined SR
	$F_{MSY\ upper}$	0.294	Median point estimates of EqSim with combined SR
	Blim	10 000 t	Below 10,000 t recruitment is impaired
Precautionary	Bpa	16 300 t	Blim combined with the assessment error
Approach	Flim	0.37	F with 50% probability of SSB less than Blim
	Fpa	0.22	Flim combined with the assessment error

38.8 Management plans

No management plan has been agreed or proposed.

38.9 Uncertainties and bias in assessment and forecast

This stock was benchmarked in January 2017. The result of the benchmark was that the stock was elevated from a category 3 stock (trend-based assessment) to a category 1 stock (analytical assessment). The assessment includes information from the commercial fishery, including both landings and discards, and takes into account selectivity changes that have occurred in 1995. Three survey series are used within the assessment. Natural mortality parameters were updated to reflect current stock dynamics. The highly fluctuating estimates of fishing mortality in recent years (2002–present) are likely to be the result of variability in the sampling data and discard estimates. Despite this inherent uncertainty, it is clear from the assessment and additional information from surveys that the stock remains extremely low.

Stock status classification relative to MSY proxies is given below.

	Fishing pressure					Stock size				
		2016	2017	2018			2017	2018	2019	
Maximum sustainable yield	F_{MSY}	✗	✗	✗	Above	MSY $B_{trigger}$	✗	✗	✗	Below trigger
Precautionary approach	F_{pa},F_{lim}	✗	✗	✗	Harvested unsustainably	B_{pa},B_{lim}	✗	✗	✗	Reduced reproductive capacity
Management plan	F_{MGT}	–	–	–	Not applicable	B_{MGT}	–	–	–	Not applicable

38.10 Recommendations for next benchmark assessment

This stock was benchmarked in 2017 as part of the WKIRISH process. A number of recommendations for future work were made and these are listed below. Given the current stock status there is no urgency to schedule another benchmark for this stock in the short term.

Time-varying M

The stock shows very strong changes in weights-at-age over time (they can change by a factor of up to 2). This is likely to affect the natural mortality. Further information to support this would be very useful for future benchmarks.

Dome-shaped selectivity surveys

There are very little data to inform the question whether survey catchability is flat-topped or dome-shaped. At the moment, the highly truncated age structure means that this makes little difference in the model outputs. However if the stock recovers and more older fish appear then this will need to be revisited.

FSP survey

The FSP survey potentially has useful information on the older fish (even though the survey is discontinued). Including the survey in the final assessment run resulted in many of the retrospective runs to fail to converge. It appears therefore that it causes the model to be unstable and was omitted from the final run. For future benchmarks, it may be useful to investigate why this survey makes the model unstable.

38.11 Management considerations

Discarding in the *Nephrops* fishery is the main management issue. Despite the implementation of several technical measures, which experimentally reduce whiting catches, as part of the cod long-term management plan the discards estimates still remain c.700 t. Given the continued high discards and low TAC, this stock could become a major 'choke species' for the 7.a *Nephrops* fishery in the context of the landing obligation.

Effort limitations are in force within the Irish Sea as a result of the cod long-term management plan. These effort limitations have not significant reduced mortality on whiting.

Whiting has a low market value, which is likely to contribute to discarding rates.

Technical measures applied to this stock include a minimum conservation reference size (≥27 cm), whiting now mature well below this MCRS.

38.12 References

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp.

ICES. 2016. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen, Denmark. ICES CM 2015/ACOM:61. 159 pp.

ICES. 2017 :Report of the Benchmark Workshop on the Irish Sea Ecosystem (WKIrish3), 30 January–3 February 2017, Galway, Ireland, ICES CM 2017/BSG:01.

ICES. 2017. Report of the Second Workshop on the Impact of Ecosystem and Environmental Drivers on Irish Sea Fisheries Management (WKIrish2), 26–29 September 2016, Belfast, Northern Ireland, ICES CM 2016/BSG:02.

Table 40.1. Official Landings (t) of whiting in Division 7.a, 1988–2018, as reported to ICES.

Year	Belgium	France	Ireland	Netherlands	UK(NI, Engl. & Wales)	Spain	UK (Isle of Man)	UK (Scotland)	UK	Total human consumption
1988	90	1,063	4,394		5,823		15	107		11,492
1989	92	533	3,871		6,652		26	154		11,328
1990	142	528	2,000		5,202		75	236		8,183
1991	53	611	2,200		4,250		74	223		7,411
1992	78	509	2,100		4,089		44	274		7,094
1993	50	255	1,440		3,859		55	318		5,977
1994	80	163	1,418		3,724		44	208		5,637
1995	92	169	1,840		3,125		41	198		5,465
1996	80	78	1,773	17	3,557		28	48		5,581
1997	47	86	1,119	14	3,152		24	30		4,472
1998	52	81	1,260	7	1,900		33	22		3,355
1999	46	150	509	6	1,229		5	44		1,989
2000	30	59	353	1	670		2	15		1,130
2001	27	25	482		506		1	25		1,066
2002	22	33	347		284		1	27		714
2003	13	29	265		130	85	1	31		554
2004	11	8	96		82		1	6		204
2005	10	13	94		47			<0.5		164
2006	4	4	55		22			<0.5		85
2007	3	3	187		3		1	<0.5		197
2008	2	2	68		11		1			84
2009	2		78		20					100
2010	5	3	97		16		<0.5			121
2011	4	3	95		16		<0.5			118
2012	5	1	58		10			1	11	86
2013	2	<0.5	44				<0.1	2	20	68
2014	2	<0.5	60		11		<0.1			73
2,015	1	<0.5	49		8					59
2,016	1	<0.5	44		5		<0.1			50
2,017	2	<0.5	32		17		<0.1			50
2018*	1		44		19		<0.5			63

*** Preliminary.**

Table 40.2. ICES estimates of discards, landings and catch of whiting in Division 7.a, 1988–2018.

Year	Discards by Country/Fleet					Discards	Landings	Catch
	Nephrops fishery [b]	IR-OTB fleet[ce]	NI *Nephrops* fishery[d]	Belgium	UK (E&W) fleet			
1988	1,611					1,611	10,245	11,856
1989	2,103					2,103	11,305	13,408
1990	2,444					2,444	8,212	10,656
1991	2,598					2,598	7,348	9,946
1992	4,203					4,203	8,588	12,791
1993	2,707					2,707	6,523	9,230
1994	1,173					1,173	6,763	7,936
1995	2,151					2,151	4,893	7,044
1996	3,631					3,631	4,335	7,966
1997	1,928					1,928	2,277	4,205
1998	1,304					1,304	2,229	3,533
1999	1,092					1,092	1,670	2,762
2000	2,118					2,118	762	2,880
2001	1,012					1,012	733	1,745
2002	740					740	747	1,487
2003		480				480	517	996
2004		905				905	133	1,038
2005		272				272	125	397
2006		1,580	193			1,773	64	1,837
2007		725	787			1,512	35	1,547
2008		693	476			1,169	37	1,206
2009		688	633			1,321	39	1,360
2010		240	914			1,154	30	1,184
2011		330	616			946	31	977
2012		257	1,065	17	1	1,339	60	1,399
2013		95	833	17	3	948	33	981
2014		263	1,645	15	28	1,951	23	1,974
2015		438	1,074	9	1	1,521	28	1,549
2016		173	589		3	765	15	780
2017		122	544		1	667	36	703
2018*		98	754		<0.5	853	46	899

b Based on UK(N.Ireland) and Ireland data.

c Based on data from Ireland.

d Based on data from Northern Ireland.

*** Preliminary (and rounded).**

e Raised using Days

Table 40.3. Whiting landings taken or reported in ICES rectangles 33E2, 33E3 and 33E4 have been reassigned to the 7.e–k whiting stock since 2003.

Year	Official landings	ICES landings	ICES Discards	ICES catch	Landings taken or reported in rectangles 33E2 and 33E3
1988	11,492	10,245	1,611	11,856	
1989	11,328	11,305	2,103	13,408	
1990	8,183	8,212	2,444	10,656	
1991	7,411	7,348	2,598	9,946	
1992	7,094	8,588	4,203	12,791	
1993	5,977	6,523	2,707	9,230	
1994	5,637	6,763	1,173	7,936	
1995	5,465	4,893	2,151	7,044	
1996	5,581	4,335	3,631	7,966	
1997	4,472	2,277	1,928	4,205	
1998	3,355	2,229	1,304	3,533	
1999	1,989	1,670	1,092	2,762	
2000	1,130	762	2,118	2,880	
2001	1,066	733	1,012	1,745	
2002	714	747	740	1,487	
2003	554	517	480	996	159
2004	204	133	905	1,038	51
2005	164	125	272	397	33
2006	85	64	1,773	1,837	22
2007	197	35	1,512	1,547	161
2008	84	37	1,169	1,206	44
2009	100	39	1,321	1,360	63
2010	121	30	1,154	1,184	91
2011	118	31	946	977	75
2012	86	60	1,339	1,399	43
2013	68	33	948	981	33
2014	73	23	1,951	1,974	50
2015	59	28	1,521	1,549	34
2016	50	15	765	780	40
2017	50	36	667	703	20
2018	63	46	853	899	18

Table 40.4. Whiting7.a. Landings numbers-at-age.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1980	0	14520	21811	6468	2548	350	0
1981	0	11203	29011	16004	2596	821	0
1982	41	5427	18098	19340	6108	813	0
1983	0	4886	9943	9100	4530	1165	321
1984	0	18254	12683	5257	2571	1045	402
1985	0	15540	35324	8687	996	0	675
1986	0	6306	16839	10809	1877	285	0
1987	0	10149	21563	6968	1943	242	0
1988	0	6983	25768	6989	1513	396	0
1989	0	11645	14029	13011	3645	490	0
1990	0	9502	17604	4734	1477	318	0
1991	102	7426	18406	5829	993	0	311
1992	0	8380	21907	7959	1374	462	0
1993	38	2742	21468	7327	932	0	135
1994	0	3245	6983	18509	1801	208	0
1995	0	1124	10095	3020	4444	233	0
1996	129	1652	6162	7432	1263	1082	135
1997	0	610	4239	2567	1795	87	79
1998	0	329	3287	4727	888	261	95
1999	1	341	2806	2607	741	160	119
2000	0	319	1364	1002	299	115	15
2001	0	111	1189	1006	171	53	20
2002	0	67	748	1480	376	48	41
2003	0	89	1051	606	199	0	0
2004	0	0	17	117	150	17	0
2005	0	0	101	216	95	21	3
2006	0	34	41	88	39	9	1
2007	0	24	41	32	10	3	0
2008	0	38	66	25	5	1	0
2009	0	65	44	22	4	1	0
2010	0	18	83	11	3	0	0
2011	0	1	17	59	15	3	0
2012	0	4	29	80	60	9	1
2013	8	81	36	20	5	1	1
2014	0	2	25	24	11	1	1
2015	0	2	25	24	11	1	1
2016	0	0	6	21	10	3	0
2017	0	0	9	50	43	5	1
2018	0	1	14	70	38	19	2

Table 40.5. Whiting7.a. Discards numbers-at-age.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1980	12786	32318	6888	65	26	0	0
1981	9865	24935	9162	162	26	0	0
1982	4047	8489	560	19	0	0	0
1983	23847	7328	2036	9	0	0	0
1984	26394	33900	1568	11	0	0	0
1985	12380	26461	1859	9	0	0	0
1986	28364	21111	1464	33	0	0	0
1987	16594	40598	1875	0	0	0	0
1988	6922	17958	1940	0	0	0	0
1989	17247	20701	2476	26	0	0	0
1990	4216	31810	3353	72	0	0	0
1991	20349	29334	3823	146	1	0	0
1992	1497	61451	10404	97	0	0	0
1993	12639	13979	17707	426	5	0	0
1994	3731	12063	1812	1702	29	0	0
1995	7118	17613	7015	492	234	0	0
1996	12732	39647	8168	1976	81	0	0
1997	8163	25497	5352	689	141	0	0
1998	6096	27131	2293	550	44	0	0
1999	20851	7677	2117	228	34	2	2
2000	7321	38922	4395	564	55	1	10
2001	16940	12631	3150	102	10	0	0
2002	8538	13412	1588	231	33	0	1
2003	12389	4595	201	0	0	0	0
2004	19699	14938	345	59	0	0	0
2005	643	5797	346	16	3	0	0
2006	15764	20590	613	21	0	0	0
2007	17436	24319	747	50	0	0	0
2008	10645	19994	676	16	0	0	0
2009	6622	27448	1176	0	0	0	0
2010	3946	15102	2810	64	1	0	0
2011	25982	8197	658	314	0	0	0
2012	6637	31020	790	37	1	3	0
2013	8493	11945	613	4	0	0	0
2014	13467	27553	2425	259	10	0	0
2015	3883	23595	2603	223	1	0	0
2016	4509	5780	4804	294	15	0	0
2017	3559	5870	4385	240	14	0	0
2018	6523	7386	2557	614	92	10	0

Table 40.6. Whiting in 7.a. Survey data available to WGCSE 2019.

NIGFS-WIBTS-Q1: Northern Ireland March Groundfish Survey

1992	2018						
1	1	0.21	0.25				
1	6						
1	665.6	710.3	81.2	11.7	4.3	0.8	1993
1	1804.6	262.1	299.2	44.7	11.9	8.1	1994
1	1688.9	635.7	174.2	88.4	22.0	6.3	1995
1	1468.4	334.0	213.0	35.1	37.2	5.4	1996
1	1406.1	1536.4	156.0	52.8	4.5	13.7	1997
1	1485.0	754.4	415.4	29.7	7.4	1.8	1998
1	1369.4	373.2	111.2	41.5	3.7	1.0	1999
1	2302.4	410.9	181.8	26.6	3.7	0.0	2000
1	1065.7	696.5	124.6	13.7	5.9	2.7	2001
1	2307.7	686.7	175.3	52.9	11.2	1.4	2002
1	1495.1	905.2	130.2	10.9	1.6	0.1	2003
1	1609.8	231.7	61.4	2.7	1.3	0.2	2004
1	689.3	124.0	28.5	12.3	2.8	0.1	2005
1	959.8	235.6	30.3	6.0	0.1	0.1	2006
1	905.0	158.6	14.9	2.7	0.2	0.0	2007
1	756.7	347.0	45.0	2.8	0.3	0.4	2008
1	1062.3	281.1	36.3	1.8	0.2	0.1	2009
1	739.4	545.8	51.6	4.7	6.4	0.0	2010
1	586.4	156.5	36.0	3.9	0.6	0.0	2011
1	972.2	354.4	42.3	5.9	1.2	0.0	2012
1	629.6	649.3	66.7	3.5	0.5	0.0	2013
1	922.1	367.6	67.0	4.3	0.2	0.1	2014
1	2797.3	469.3	18.8	2.3	0.0	0.0	2015
1	1409.1	924.8		38.7	1.5	0.1	2016
1	888.1	831.8	142.2	11.2	0.7	0.1	2017
1	431.4	296.8	119.4	17.9	2.3	0.0	2018

Table 40.6. Continued. Whiting in 7.a. Survey data available to WGCSE 2019.

NIGFS-WIBTS-Q4: Northern Ireland October Groundfish Survey

1993	2018							
1	1	0.83	0.88					
0	6							
1	714.0	1040.5	475.9	67.5	8.2	3.1	0.3	1993
1	1113.1	1320.0	208.6	150.7	33.9	2.3	0.5	1994
1	3124.4	477.3	166.5	30.6	35.6	5.4	1.2	1995
1	2306.2	591.2	134.4	52.4	10.5	7.0	1.3	1996
1	2626.5	676.6	497.6	61.0	18.2	4.6	4.5	1997
1	2863.5	466.8	153.8	72.8	6.2	2.2	0.1	1998
1	2478.4	1079.7	192.0	51.7	43.3	3.7	1.8	1999
1	2374.3	1084.7	126.0	20.0	16.9	6.0	2.7	2000
1	6356.4	658.3	270.8	28.9	4.9	2.3	0.0	2001
1	2692.4	1322.5	268.3	41.6	4.5	1.2	0.0	2002
1	4431.0	1572.3	921.1	74.8	16.8	1.5	0.0	2003
1	4457.1	699.6	268.3	113.8	4.4	1.9	0.0	2004
1	2377.2	487.8	183.3	15.8	1.5	0.4	0.0	2005
1	2849.2	144.8	46.8	7.9	1.8	0.0	0.0	2006
1	2163.1	957.6	149.1	16.7	4.8	4.3	0.2	2007
1	4884.6	1312.6	114.3	3.8	0.2	0.0	0.0	2008
1	2246.5	510.8	71.7	7.5	1.6	0.0	0.2	2009
1	2274.4	312.1	259.6	8.2	0.7	0.2	0.0	2010
1	3534.1	348.4	139.7	26.3	3.5	0.9	0.0	2011
1	1330.9	402.5	134.7	19.5	6.2	0.1	0.0	2012
1	7135.8	354.7	155.9	31.1	1.5	0.5	0.9	2013
1	4504.0	507.7	135.5	8.8	0.7	0.0	0.0	2014
1	2802.4	891.0	115.2	6.3	0.7	0.0	0.0	2015
1	2718.7	859.3	203.5	31.7	3.5	0.4	0	2016
1	3011.1	714.1	368.4	78.4	4.2	0.0	0.1	2017
1	4424.7	897.5	367.6	23.4	8.3	0.2	0.04	2018

Table 40.6. Continued. Whiting in 7.a. Survey data available to WGCSE 2019.

UK (E&W)-BTS-Q3: Corystes Irish Sea Beam-Trawl Survey - Prime stations only –

Effort and numbers-at-age (per km towed)

1988	2018		
1	1	0.75	0.79
0	1		
1	96	26	1988
1	93	21	1989
1	99	33	1990
1	216	25	1991
1	405	206	1992
1	253	95	1993
1	205	125	1994
1	1949	87	1995
1	169	194	1996
1	409	254	1997
1	893	199	1998
1	550	137	1999
1	320	122	2000
1	585	195	2001
1	280	96	2002
1	456	229	2003
1	917	330	2004
1	849	294	2005
1	1010	228	2006
1	339	89	2007
1	780	72	2008
1	389	371	2009
1	324	33	2010
1	1002	341	2011
1	442	426	2012
1	1535	228	2013
1	261	113	2014
1	211	112	2015
1	666	213	2016
1	489	230	2017
1	662	380	2018

Table 40.6. Continued. Whiting in 7.a. Survey data available to WGCSE 2019.

NIMIK : Northern Ireland MIK Net Survey

1994	2018		
1	1	0.46	0.50
0	0		
1	778	1994	
1	225	1995	
1	397	1996	
1	205	1997	
1	59	1998	
1	91	1999	
1	40	2000	
1	167	2001	
1	19	2002	
1	148	2003	
1	101	2004	
1	135	2005	
1	118	2006	
1	82	2007	
1	99	2008	
1	173	2009	
1	78	2010	
1	122.2	2011	
1	123.9	2012	
1	197.6	2013	
1	54.9	2014	
1	59.5	2015	
1	6.7	2016	
1	175.5	2017	
1	90.7	2018	

Eastern Irish Sea FSP: Isadale 2005–2013: Numbers of fish per hour towed

2005	2013						
1	1	0.2	0.2				
1	6.0						
1	0.2	11.1	21.1	5.3	1.0	0.0	0.7
1	8.7	46.7	15.2	1.9	0.5	0.0	0.0
1	4.2	10.8	5.6	1.0	0.3	0.0	0.0
1	3.7	10.3	8.6	2.0	0.4	0.3	0.0
1	27.3	84.9	48.7	3.6	0.3	0.0	0.0
1	4.5	57.9	43.5	5.0	0.2	0.1	0.0
1	2.2	8.4	31.9	5.1	1.0	0.0	0.0
1	5.2	80.9	29.8	22.1	1.2	0.1	0.0
1	4.2	47.4	26.4	3.1	1.7	0.0	0.0

Table 40.7. Whiting7.a. ASAP input data.

```
# ASAP VERSION 3.0
#
# Number of Years
39
# First Year
1980
# Number of Ages
7
# Number of Fleets
1
# Number of Selectivity Blocks
2
# Number of Available Indices
5
# Natural Mortality
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
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 1.0780  0.8030  0.7180  0.6080  0.5540  0.5180  0.5180
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Fecundity option

0

Fraction of Year Prior to Spawning

0.0000

Maturity

0.0000 0.0000 1.0000 1.0000 1.0000 1.0000 1.0000

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Number of Weights-at-age Matrices

2

Weight Matrix 1

0.0000 0.1100 0.2350 0.3630 0.5290 0.6300 0.7720

0.0400 0.1180 0.2400 0.3640 0.5290 0.6300 0.8880

0.0310 0.1350 0.2650 0.3650 0.5330 0.6300 0.7360

0.0330 0.1460 0.2560 0.3970 0.4910 0.6050 0.6550

0.0320 0.1250 0.2440 0.4030 0.5500 0.7000 0.7450

0.0210 0.1070 0.2450 0.3330 0.4780 0.5670 0.6420

0.0250 0.1000 0.2170 0.3420 0.5120 0.7090 0.9400

0.0240 0.1010 0.2170 0.3630 0.5350 0.7200 0.9330

0.0210	0.0880	0.2010	0.3300	0.5470	0.7630	1.0050
0.0260	0.1110	0.1930	0.2690	0.4330	0.6800	1.0790
0.0360	0.0940	0.2040	0.3100	0.4360	0.6760	0.8000
0.0310	0.0770	0.1940	0.2630	0.3520	0.4530	0.6920
0.0140	0.0630	0.1700	0.2720	0.3610	0.5130	1.0070
0.0290	0.0670	0.1420	0.2280	0.3310	0.4540	0.8920
0.0300	0.0740	0.1830	0.2210	0.3010	0.3780	0.4960
0.0310	0.0630	0.1790	0.2570	0.3260	0.5510	1.3200
0.0270	0.0570	0.1590	0.2300	0.2840	0.3640	0.7150
0.0260	0.0440	0.1530	0.2220	0.2870	0.3960	0.6790
0.0170	0.0350	0.1560	0.2280	0.2680	0.3500	0.4210
0.0280	0.0440	0.1610	0.2460	0.3240	0.3510	0.3250
0.0240	0.0380	0.1270	0.2180	0.2910	0.3470	0.3100
0.0170	0.0360	0.1320	0.3010	0.3380	0.5380	0.3370
0.0160	0.0330	0.1240	0.2530	0.3390	0.4490	0.4250
0.0200	0.0480	0.2320	0.2950	0.2590	0.0000	0.0000
0.0170	0.0340	0.1310	0.3240	0.5090	0.4660	0.0000
0.0170	0.0370	0.1480	0.2630	0.3630	0.3600	0.3200
0.0170	0.0690	0.1520	0.2680	0.3610	0.3600	0.3200
0.0230	0.0420	0.1220	0.2950	0.4340	0.6240	1.2600
0.0220	0.0440	0.1180	0.2620	0.3740	0.8340	1.3540
0.0230	0.0390	0.0940	0.3400	0.3230	0.5430	0.0000
0.0200	0.0480	0.1250	0.2560	0.4010	0.3750	0.0000
0.0180	0.0440	0.1040	0.1960	0.4050	0.4620	0.7990
0.0230	0.0350	0.1090	0.2750	0.3980	0.4100	0.3050
0.0300	0.0520	0.1120	0.2400	0.3460	0.2800	0.3800
0.0300	0.0420	0.1330	0.2260	0.4250	0.6590	1.0120
0.0220	0.0440	0.1270	0.2910	0.4480	0.2980	0.4820
0.0220	0.0350	0.0850	0.1950	0.3410	0.4660	0.8820
0.0280	0.0320	0.0750	0.1980	0.3620	0.4320	0.5000
0.0210	0.0450	0.1040	0.1610	0.2400	0.3190	0.4080

Weight Matrix 2

0.0000	0.0733	0.1733	0.2992	0.4460	0.5795	0.7203
0.0000	0.0785	0.1797	0.3003	0.4468	0.5795	0.7143
0.0000	0.0840	0.1873	0.3110	0.4408	0.5760	0.6948
0.0000	0.0850	0.1940	0.3210	0.4500	0.5813	0.6668
0.0000	0.0790	0.1918	0.3163	0.4473	0.5743	0.6628

0.0000	0.0697	0.1807	0.3038	0.4455	0.5825	0.6998
0.0000	0.0643	0.1685	0.2907	0.4338	0.5893	0.7485
0.0000	0.0598	0.1572	0.2857	0.4387	0.6195	0.8123
0.0000	0.0617	0.1500	0.2662	0.4250	0.6262	0.8682
0.0000	0.0607	0.1497	0.2533	0.3963	0.6057	0.8412
0.0000	0.0608	0.1473	0.2400	0.3550	0.5375	0.7817
0.0000	0.0545	0.1417	0.2393	0.3318	0.4772	0.7180
0.0000	0.0480	0.1233	0.2218	0.3148	0.4282	0.7055
0.0000	0.0463	0.1170	0.2045	0.2927	0.3982	0.6358
0.0000	0.0462	0.1180	0.2002	0.2798	0.3960	0.6755
0.0000	0.0473	0.1208	0.2020	0.2695	0.3752	0.6523
0.0000	0.0420	0.1142	0.2050	0.2675	0.3703	0.6678
0.0000	0.0367	0.1053	0.1952	0.2580	0.3345	0.5210
0.0000	0.0322	0.1010	0.1940	0.2598	0.3227	0.4225
0.0000	0.0313	0.0945	0.1937	0.2632	0.3212	0.3588
0.0000	0.0312	0.0895	0.2015	0.2742	0.3532	0.3367
0.0000	0.0293	0.0835	0.1987	0.2888	0.3812	0.3847
0.0000	0.0290	0.0992	0.2054	0.2847	0.4021	0.4114
0.0000	0.0281	0.1007	0.2267	0.3261	0.3847	0.4357
0.0000	0.0288	0.1045	0.2282	0.3338	0.3984	0.4062
0.0000	0.0323	0.0918	0.2277	0.3525	0.3862	0.3827
0.0000	0.0331	0.0939	0.2097	0.3355	0.4296	0.5145
0.0000	0.0352	0.0901	0.2082	0.3326	0.4961	0.7133
0.0000	0.0311	0.0815	0.2152	0.3261	0.5283	0.9183
0.0000	0.0331	0.0770	0.1989	0.3325	0.4804	0.9181
0.0000	0.0326	0.0756	0.1883	0.3311	0.4127	0.7840
0.0000	0.0313	0.0780	0.1750	0.3326	0.3957	0.5933
0.0000	0.0320	0.0753	0.1748	0.3127	0.3924	0.4550
0.0000	0.0334	0.0808	0.1777	0.3134	0.4162	0.4746
0.0000	0.0369	0.0836	0.1851	0.3267	0.4009	0.5369
0.0000	0.0339	0.0805	0.1806	0.3283	0.4403	0.6021
0.0000	0.0308	0.0680	0.1713	0.3104	0.4016	0.5479
0.0000	0.0306	0.0625	0.1401	0.2712	0.3946	0.5050
0.0000	0.0317	0.0615	0.1297	0.2489	0.3634	0.4623

Weight-at-age Pointers

1

1

1

1

2

2

Selectivity Blocks

FLEET-1

1

1

1

1

1

1

1

1

1

1

1

1

1

1

1

2

2

2

2

2

2

2

2

2

2

2

2

2

2

2

2

```
2
2
2
2
2
2
2
2
# Selectivity Types
2  2
# Selectivity Block Spec
# Block 1
 0.0000    1    0.0000   0.2500
 0.5000    1    0.0000   0.2500
 0.9000    1    0.0000   0.2500
 1.0000   -1    0.0000   0.2500
 1.0000   -1    0.0000   0.2500
 1.0000   -1    0.0000   0.2500
 1.0000   -1    0.0000   0.2500
 3.0000    1    0.0000   1.0000
 0.5000    1    0.0000   1.0000
 0.0000    0    0.0000   0.0000
 0.0000    0    0.0000   0.0000
 0.0000    0    0.0000   0.0000
 0.0000    0    0.0000   0.0000
# Block 2
 0.2000    1    0.0000   0.5000
 1.0000   -1    0.0000   0.0000
 1.0000   -1    0.0000   0.0000
 1.0000   -1    0.0000   0.0000
 1.0000   -1    0.0000   0.0000
 1.0000   -1    0.0000   0.0000
 1.0000   -1    0.0000   0.0000
 2.0000    1    0.0000   1.0000
 0.5000    1    0.0000   1.0000
 0.0000    0    0.0000   0.0000
 0.0000    0    0.0000   0.0000
```

0.0000 0 0.0000 0.0000

0.0000 0 0.0000 0.0000

Fleet Selectivity Start Age

1

Fleet Selectivity End Age

7

Age Range Average F

2 4

Average F Report Option

1

Use Likelihood Constants

1

Release Mortality

1.0000

Catch at Age FLEET-1

12786.000	46838.000	28699.000	6533.000	2574.000	350.000	621.000	16737.000
9865.000	36138.000	38173.000	16166.000	2622.000	821.000	339.000	21331.000
4088.000	13916.000	18658.000	19359.000	6108.000	813.000	400.000	17969.000
23847.000	12214.000	11979.000	9109.000	4530.000	1165.000	321.000	12405.000
26394.000	52154.000	14250.000	5268.000	2571.000	1045.000	402.000	14999.000
12380.000	42001.000	37183.000	8696.000	996.000	675.000	372.000	18169.000
28364.000	27417.000	18303.000	10842.000	1877.000	285.000	270.000	12129.000
16594.000	50747.000	23438.000	6968.000	1943.000	242.000	111.000	14270.000
6922.000	24941.000	27708.000	6989.000	1513.000	396.000	197.000	11856.000
17247.000	32346.000	16505.000	13037.000	3645.000	490.000	177.000	13408.000
4216.000	41312.000	20957.000	4806.000	1477.000	318.000	128.000	10656.000
20451.000	36760.000	22229.000	5975.000	994.000	311.000	84.000	9946.000
1497.000	69831.000	32311.000	8056.000	1374.000	462.000	93.000	12791.000
12677.000	16721.000	39175.000	7753.000	937.000	135.000	27.000	9230.000
3731.000	15308.000	8795.000	20211.000	1830.000	208.000	50.000	7936.000
7118.000	18737.000	17110.000	3512.000	4678.000	233.000	21.000	7044.000
12861.000	41299.000	14330.000	9408.000	1344.000	1082.000	135.000	7966.000
8163.000	26107.000	9591.000	3256.000	1936.000	87.000	79.000	4205.000
6096.000	27460.000	5580.000	5277.000	932.000	261.000	95.000	3533.000
20852.000	8018.000	4923.000	2835.000	776.000	161.000	121.000	2762.000
7321.000	39242.000	5758.000	1566.000	354.000	115.000	25.000	2880.000
16940.000	12742.000	4338.000	1108.000	181.000	53.000	20.000	1745.000

8538.000	13480.000	2336.000	1710.000	408.000	48.000	42.000	1487.000
12389.000	4685.000	1252.000	606.000	199.000	0.000	0.000	996.000
19699.000	14938.000	362.000	176.000	150.000	17.000	0.000	1038.000
643.000	5797.000	448.000	232.000	98.000	21.000	3.000	397.000
15764.000	20624.000	654.000	109.000	39.000	9.000	1.000	1837.000
17436.000	24343.000	787.000	82.000	10.000	3.000	0.000	1547.000
10645.000	20032.000	742.000	41.000	5.000	1.000	0.000	1206.000
6622.000	27513.000	1220.000	22.000	4.000	1.000	0.000	1360.000
3946.000	15120.000	2894.000	75.000	4.000	0.000	0.000	1184.000
25982.000	8198.000	675.000	373.000	15.000	3.000	0.000	977.000
6637.000	31023.000	819.000	116.000	61.000	12.000	1.000	1399.000
8501.000	12026.000	649.000	24.000	5.000	1.000	1.000	981.000
13467.000	27555.000	2450.000	284.000	21.000	1.000	1.000	1974.000
3883.000	23595.000	2613.000	267.000	15.000	1.000	1.000	1549.000
4509.000	5780.000	4809.000	315.000	25.000	3.000	0.000	780.000
3559.000	5871.000	4394.000	290.000	57.000	5.000	1.000	704.000
6523.000	7386.000	2571.000	684.000	129.000	29.000	2.000	899.000

Discards at Age FLEET-1

0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Release Proportion at Age FLEET-1

0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Survey Specifications

Survey Units

2 2 2 2 2

Survey Age ProportionUnits

2 2 2 2 2

Survey Weight-at-age Matrix

1 1 1 1 1

Survey Month

3 10 5 9 5

Survey Choice

-1 -1 -1 -1 -1

Survey Selectivity Type

1 1 1 1 2

Survey Start Age

```
2  1  1  1  2
# Survey End Age
7  7  1  2  7
# Estimate Survey Proportion at Age ?
1  1  0  0  0
# Use Survey ?
1  1  1  0  0
# Index Selectivity
# INDEX-1
  0.000000   -1    0.000000    0.000000
  0.500000    1    0.000000    0.500000
  1.000000   -1    0.000000    0.000000
  1.000000   -1    0.000000    0.000000
  1.000000   -1    0.000000    0.000000
  1.000000   -1    0.000000    0.000000
  1.000000   -1    0.000000    0.000000
  2.000000    1    0.000000    1.000000
  0.500000    1    0.000000    1.000000
  0.000000    0    0.000000    0.000000
  0.000000    0    0.000000    0.000000
  0.000000    0    0.000000    0.000000
  0.000000    0    0.000000    0.000000
# INDEX-2
  0.200000    1    0.000000    0.500000
  0.500000    1    0.000000    0.500000
  1.000000   -1    0.000000    0.000000
  1.000000   -1    0.000000    0.000000
  1.000000   -1    0.000000    0.000000
  1.000000   -1    0.000000    0.000000
  1.000000   -1    0.000000    0.000000
  2.000000    1    0.000000    1.000000
  0.500000    1    0.000000    1.000000
  0.000000    0    0.000000    0.000000
  0.000000    0    0.000000    0.000000
  0.000000    0    0.000000    0.000000
  0.000000    0    0.000000    0.000000
# INDEX-3
```

1.000000	-1	0.000000	0.000000
0.000000	-1	0.000000	0.000000
0.000000	-1	0.000000	0.000000
0.000000	-1	0.000000	0.000000
0.000000	-1	0.000000	0.000000
0.000000	-1	0.000000	0.000000
0.000000	-1	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000

INDEX-4

1.000000	-1	0.000000	1.000000
1.000000	-1	0.000000	0.000000
1.000000	-1	0.000000	0.000000
1.000000	-1	0.000000	0.000000
1.000000	-1	0.000000	0.000000
1.000000	-1	0.000000	0.000000
1.000000	-1	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000

INDEX-5

0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
0.000000	0	0.000000	0.000000
4.000000	1	0.000000	1.000000
0.500000	1	0.000000	1.000000

```
 0.000000   0   0.000000   0.000000
 0.000000   0   0.000000   0.000000
 0.000000   0   0.000000   0.000000
 0.000000   0   0.000000   0.000000
# Index Data
# INDEX-1
1980   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1981   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1982   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1983   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1984   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1985   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1986   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1987   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1988   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1989   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1990   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1991   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1992   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
1993  1474.000000   0.300000   0.000000   0.452000   0.482000   0.055000   0.008000   0.003000   0.001000   50.000000
1994  2431.000000   0.300000   0.000000   0.742000   0.108000   0.123000   0.018000   0.005000   0.003000   50.000000
1995  2615.000000   0.300000   0.000000   0.646000   0.243000   0.067000   0.034000   0.008000   0.002000   50.000000
1996  2093.000000   0.300000   0.000000   0.702000   0.160000   0.102000   0.017000   0.018000   0.003000   50.000000
1997  3169.000000   0.300000   0.000000   0.444000   0.485000   0.049000   0.017000   0.001000   0.004000   50.000000
1998  2694.000000   0.300000   0.000000   0.551000   0.280000   0.154000   0.011000   0.003000   0.001000   50.000000
1999  1900.000000   0.300000   0.000000   0.721000   0.196000   0.059000   0.022000   0.002000   0.001000   50.000000
2000  2925.000000   0.300000   0.000000   0.787000   0.140000   0.062000   0.009000   0.001000   0.000000   50.000000
2001  1909.000000   0.300000   0.000000   0.558000   0.365000   0.065000   0.007000   0.003000   0.001000   50.000000
2002  3235.000000   0.300000   0.000000   0.713000   0.212000   0.054000   0.016000   0.003000   0.000000   50.000000
2003  2543.000000   0.300000   0.000000   0.588000   0.356000   0.051000   0.004000   0.001000   0.000000   50.000000
2004  1907.000000   0.300000   0.000000   0.844000   0.121000   0.032000   0.001000   0.001000   0.000000   50.000000
2005  857.000000   0.300000   0.000000   0.804000   0.145000   0.033000   0.014000   0.003000   0.000000   50.000000
2006  1232.000000   0.300000   0.000000   0.779000   0.191000   0.025000   0.005000   0.000000   0.000000   50.000000
2007  1081.000000   0.300000   0.000000   0.837000   0.147000   0.014000   0.002000   0.000000   0.000000   50.000000
2008  1152.000000   0.300000   0.000000   0.657000   0.301000   0.039000   0.002000   0.000000   0.000000   50.000000
2009  1382.000000   0.300000   0.000000   0.769000   0.203000   0.026000   0.001000   0.000000   0.000000   50.000000
2010  1348.000000   0.300000   0.000000   0.549000   0.405000   0.038000   0.003000   0.005000   0.000000   50.000000
```

2011 783.000000 0.300000 0.000000 0.749000 0.200000 0.046000 0.005000 0.001000 0.000000 50.000000

2012 1376.000000 0.300000 0.000000 0.707000 0.258000 0.031000 0.004000 0.001000 0.000000 50.000000

2013 1350.000000 0.300000 0.000000 0.466000 0.481000 0.049000 0.003000 0.000000 0.000000 50.000000

2014 1361.000000 0.300000 0.000000 0.677000 0.270000 0.049000 0.003000 0.000000 0.000000 50.000000

2015 3288.000000 0.300000 0.000000 0.851000 0.143000 0.006000 0.001000 0.000000 0.000000 50.000000

2016 2374.000000 0.300000 0.000000 0.594000 0.390000 0.000001 0.016000 0.001000 0.000000 50.000000

2017 1874.000000 0.300000 0.000000 0.474000 0.444000 0.076000 0.006000 0.001000 0.000000 50.000000

2018 868.000000 0.300000 0.000000 0.497000 0.342000 0.138000 0.021000 0.003000 0.000000 0.021000

INDEX-2

1980 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1981 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1982 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1983 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1984 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1985 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1986 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1987 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1988 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1989 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1990 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1991 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1992 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1993 2309.000000 0.300000 0.309000 0.451000 0.206000 0.029000 0.004000 0.001000 0.000000 50.000000

1994 2829.000000 0.300000 0.393000 0.467000 0.074000 0.053000 0.012000 0.001000 0.000000 50.000000

1995 3841.000000 0.300000 0.813000 0.124000 0.043000 0.008000 0.009000 0.001000 0.000000 50.000000

1996 3103.000000 0.300000 0.743000 0.191000 0.043000 0.017000 0.003000 0.002000 0.000000 50.000000

1997 3889.000000 0.300000 0.675000 0.174000 0.128000 0.016000 0.005000 0.001000 0.001000 50.000000

1998 3566.000000 0.300000 0.803000 0.131000 0.043000 0.020000 0.002000 0.001000 0.000000 50.000000

1999 3851.000000 0.300000 0.644000 0.280000 0.050000 0.013000 0.011000 0.001000 0.000000 50.000000

2000 3631.000000 0.300000 0.654000 0.299000 0.035000 0.006000 0.005000 0.002000 0.001000 50.000000

2001 7322.000000 0.300000 0.868000 0.090000 0.037000 0.004000 0.001000 0.000000 0.000000 50.000000

2002 4331.000000 0.300000 0.622000 0.305000 0.062000 0.010000 0.001000 0.000000 0.000000 50.000000

2003 7017.000000 0.300000 0.631000 0.224000 0.131000 0.011000 0.002000 0.000000 0.000000 50.000000

2004 5545.000000 0.300000 0.804000 0.126000 0.048000 0.021000 0.001000 0.000000 0.000000 50.000000

2005 3066.000000 0.300000 0.775000 0.159000 0.060000 0.005000 0.000000 0.000000 0.000000 50.000000

2006 3050.000000 0.300000 0.934000 0.047000 0.015000 0.003000 0.001000 0.000000 0.000000 50.000000

2007 3296.000000 0.300000 0.656000 0.291000 0.045000 0.005000 0.001000 0.001000 0.000000 50.000000

2008	6315.000000	0.300000	0.773000	0.208000	0.018000	0.001000	0.000000	0.000000	0.000000	50.000000
2009	2838.000000	0.300000	0.791000	0.180000	0.025000	0.003000	0.001000	0.000000	0.000000	50.000000
2010	2855.000000	0.300000	0.797000	0.109000	0.091000	0.003000	0.000000	0.000000	0.000000	50.000000
2011	4053.000000	0.300000	0.872000	0.086000	0.034000	0.006000	0.001000	0.000000	0.000000	50.000000
2012	1894.000000	0.300000	0.703000	0.213000	0.071000	0.010000	0.003000	0.000000	0.000000	50.000000
2013	7680.000000	0.300000	0.929000	0.046000	0.020000	0.004000	0.000000	0.000000	0.000000	50.000000
2014	5157.000000	0.300000	0.873000	0.098000	0.026000	0.002000	0.000000	0.000000	0.000000	50.000000
2015	3816.000000	0.300000	0.734000	0.234000	0.030000	0.002000	0.000000	0.000000	0.000000	50.000000
2016	3817.000000	0.300000	0.712000	0.225000	0.053000	0.008000	0.000000	0.000000	0.000000	50.000000
2017	4176.000000	0.300000	0.721000	0.171000	0.088000	0.019000	0.000000	0.000000	0.000000	50.000000
2018	5713.000000	0.300000	0.774000	0.157000	0.000000	0.064000	0.000000	0.000000	0.000000	50.000000

INDEX-3

1980	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1981	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1982	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1983	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1984	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1985	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1986	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1987	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1988	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1989	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1990	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1991	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1992	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1993	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1994	778.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1995	225.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1996	397.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1997	205.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1998	59.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1999	91.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2000	40.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2001	167.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2002	19.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2003	148.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2004	101.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

2005 135.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2006 118.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2007 82.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2008 99.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2009 173.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2010 78.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2011 122.200000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2012 123.900000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2013 197.600000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2014 54.900000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2015 59.500000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2016 6.700000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2017 175.400000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2018 90.740000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

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1980 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

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1987 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1988 96.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1989 93.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1990 99.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1991 216.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1992 405.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1993 253.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1994 205.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1995 1949.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1996 169.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1997 409.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1998 893.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

1999 550.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2000 320.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2001 585.000000 0.500000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

2002	280.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2003	456.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2004	917.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2005	849.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2006	1010.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2007	339.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2008	780.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2009	389.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2010	324.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2011	1002.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2012	442.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2013	1535.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2014	261.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2015	211.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2016	666.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2017	489.000000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2018	661.750000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

INDEX-5

1980	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1981	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1982	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1983	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1984	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1985	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1986	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1987	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1988	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1989	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1990	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1991	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1992	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1993	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1994	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1995	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1996	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1997	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1998	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

1999	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2002	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2003	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2004	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2005	38.660000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2006	72.953000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2007	21.870000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2008	25.230000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2009	164.820000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2010	111.120000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2011	48.600000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2012	139.250000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2013	82.850000	0.500000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2014	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2015	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2016	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2017	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2018	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Phase Flags

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Lambda Index

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Lambda Catch

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Lambda Discard

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Catch CV

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Discard CV
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Discard Sample Size

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FMult Lambda

0.000000

FMult cv

0.900000

F dev Lambda

0.000000

F dev cv

0.900000

#N 1st Year Lambda

0.000000

#N 1st Year cv

0.9000

#Recruit Lambda

0.100000

Lambda

0.000000 0.000000 0.000000 0.000000 0.000000

```
# cv
  0.900000    0.900000    0.900000    0.900000    0.900000
# Lambda
  0.000000    0.000000    0.000000    0.000000    0.000000
# cv
  0.900000    0.900000    0.900000    0.900000    0.900000
# Lambda Steepness
  0.000000
# cv Steepness
  0.900000
# Lambda Unexploited Srock
  0.000000
# cv
  0.900000
# Stock at Age in 1st Year Option
1
# Initial Guess Stock at Age in 1st Year
1000000.000000  500000.000000  250000.000000  125000.000000  60000.000000  30000.000000  10000.000000
# Initial Guess
  1.000000
# Initial Guess
1.000000e-003  1.000000e-003  1.000000e-003  1.000000e-003  1.000000e-003
# Stock Recruitment Option
0
# Initial Guess
1.000000e+003
# Initial Guess
1.000000e+000
# Initial Guess
    2.5000
# Ignore Guesses
0
# Projection
0
#
1
#
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2019 -1 3 -99.0000 1.0000

#MCMC

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FINIS

Table 40.8. Whiting 7.a. Selectivity of the catches and indices.

Age	Catch	NI-Q1	NI-Q4	NI-MIK
0	0.120	0.000	0.664	1.000
1	0.836	0.560	0.749	0.000
2	0.995	1.000	1.000	0.000
3	1.000	1.000	1.000	0.000
4	1.000	1.000	1.000	0.000
5	1.000	1.000	1.000	0.000
6	1.000	1.000	1.000	0.000

Table 40.9. Whiting7.a Fishing mortality- (F) -at age.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1980	0.027	0.177	0.438	0.521	0.532	0.533	0.533
1981	0.032	0.208	0.516	0.613	0.626	0.627	0.627
1982	0.035	0.23	0.57	0.678	0.692	0.693	0.694
1983	0.036	0.233	0.579	0.689	0.703	0.705	0.705
1984	0.044	0.286	0.71	0.844	0.861	0.863	0.863
1985	0.053	0.347	0.862	1.025	1.046	1.048	1.048
1986	0.041	0.27	0.671	0.798	0.815	0.816	0.817
1987	0.044	0.287	0.712	0.847	0.864	0.866	0.866
1988	0.037	0.243	0.603	0.717	0.732	0.734	0.734
1989	0.052	0.341	0.846	1.006	1.027	1.03	1.03
1990	0.044	0.289	0.718	0.854	0.872	0.874	0.874
1991	0.044	0.29	0.72	0.857	0.874	0.876	0.877
1992	0.072	0.47	1.167	1.388	1.417	1.42	1.42
1993	0.057	0.373	0.926	1.102	1.124	1.127	1.127
1994	0.059	0.385	0.957	1.137	1.161	1.164	1.164
1995	0.103	0.718	0.855	0.859	0.859	0.859	0.859
1996	0.113	0.79	0.94	0.945	0.945	0.945	0.945
1997	0.098	0.684	0.813	0.817	0.817	0.817	0.817
1998	0.137	0.954	1.135	1.141	1.141	1.141	1.141
1999	0.108	0.757	0.9	0.905	0.905	0.905	0.905
2000	0.142	0.991	1.179	1.185	1.185	1.185	1.185
2001	0.115	0.801	0.953	0.958	0.958	0.958	0.958
2002	0.157	1.096	1.303	1.31	1.31	1.31	1.31
2003	0.077	0.541	0.644	0.647	0.647	0.647	0.647
2004	0.215	1.504	1.789	1.798	1.798	1.798	1.798
2005	0.056	0.394	0.469	0.472	0.472	0.472	0.472
2006	0.192	1.344	1.598	1.607	1.607	1.607	1.607
2007	0.152	1.059	1.26	1.266	1.266	1.266	1.266
2008	0.122	0.855	1.018	1.023	1.023	1.023	1.023
2009	0.139	0.972	1.157	1.163	1.163	1.163	1.163
2010	0.143	1.002	1.192	1.198	1.199	1.199	1.199
2011	0.109	0.759	0.902	0.907	0.907	0.907	0.907
2012	0.143	0.999	1.189	1.195	1.195	1.195	1.195
2013	0.082	0.576	0.686	0.689	0.689	0.689	0.689
2014	0.189	1.32	1.57	1.578	1.579	1.579	1.579
2015	0.122	0.854	1.016	1.021	1.021	1.021	1.021
2016	0.071	0.494	0.588	0.591	0.591	0.591	0.591
2017	0.061	0.426	0.507	0.509	0.509	0.509	0.509
2018	0.059	0.411	0.489	0.492	0.492	0.492	0.492

Table 40.10. Whiting7.a Stock Numbers-at-age (start of year) ('1000).

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1980	635229	389102	123970	20821	7385	1015	1811
1981	322377	210420	146103	39006	6731	2493	987
1982	284961	106282	76586	42548	11502	2069	1107
1983	880745	93635	37846	21124	11761	3309	946
1984	630711	289238	33220	10343	5776	3346	1253
1985	513642	205477	97366	7969	2422	1403	1156
1986	870632	165785	65062	20063	1557	489	534
1987	474781	284311	56680	16221	4918	396	269
1988	488017	154654	95613	13564	3787	1191	167
1989	601264	160029	54338	25509	3604	1046	388
1990	522554	194247	50982	11368	5076	741	305
1991	684435	170152	65163	12125	2635	1220	260
1992	230234	222831	57027	15463	2803	631	367
1993	214824	72931	62381	8655	2101	390	144
1994	183733	69063	22498	12048	1566	392	103
1995	340766	58958	21047	4216	2103	282	92
1996	203244	104625	12876	4367	972	512	94
1997	170729	61766	21270	2453	924	217	140
1998	167298	52681	13969	4600	590	235	94
1999	208166	49661	9088	2189	800	108	63
2000	109119	63565	10440	1802	482	186	41
2001	191982	32222	10573	1566	300	85	41
2002	79962	58251	6479	1988	327	66	29
2003	120096	23261	8725	858	292	51	15
2004	95546	37820	6065	2235	245	88	21
2005	105851	26218	3767	494	202	23	11
2006	155056	34042	7918	1149	168	72	13
2007	103942	43533	3979	781	126	19	10
2008	148998	30397	6765	551	120	20	5
2009	92765	44859	5789	1193	108	25	5
2010	92709	27465	7599	888	203	19	6
2011	151604	27332	4516	1125	146	35	4
2012	79507	46281	5735	893	247	34	10
2013	159742	23450	7635	852	147	43	8
2014	198580	50053	5903	1876	233	42	15
2015	122731	55942	5990	599	211	28	7
2016	71365	36959	10671	1058	117	44	7
2017	108234	22626	10102	2891	319	37	17
2018	174768	34652	6621	2968	946	110	19
2019	118853	56071	10289	1980	988	332	47

Table 40.11. Whiting7.a Stock Summary: weights in tonnes: CatchPred is predicted catch from ASAP. Recruitment at age zero ('1000), F_{bar} ages (1–3).

Year	Lan	Dis	Cat	CatPred	Tsb	Ssb	SsbCv	Recr	RecrCv	Fbar	FbarCv
1980	13422	3314	16737	16686.66	61420.92	32899.73	0.325139	635228.6	0.32582	0.378692	0.324908
1981	18267	3064	21331	21129.95	59643.69	43125.71	0.245329	322376.8	0.423325	0.44553	0.293808
1982	17167	801	17969	17944.82	43535.43	34607.72	0.267068	284961.4	0.444025	0.492468	0.329788
1983	10577	1829	12405	12364.61	29928.45	21969.51	0.344828	880744.9	0.252695	0.50039	0.388297
1984	11619	3380	14999	14737.24	37828.55	14978.71	0.411684	630711	0.313234	0.613033	0.354924
1985	15525	2644	18169	17963.08	37041.66	22719.89	0.29332	513641.5	0.343469	0.744383	0.325236
1986	10063	2066	12129	12082.71	28818.99	18159.02	0.321438	870631.9	0.261661	0.579761	0.350248
1987	10411	3859	14270	14066.37	33168.22	16166.41	0.336946	474780.8	0.346118	0.615143	0.3249
1988	10245	1611	11856	11796.21	29995.06	20452.89	0.278758	488017.2	0.322468	0.521227	0.327535
1989	11305	2103	13408	13403.95	26698.08	16984.32	0.306306	601264.4	0.266655	0.731254	0.323376
1990	8212	2444	10656	10636.01	24487.3	12677.07	0.327726	522554.5	0.249696	0.620477	0.308166
1991	7348	2598	9946	9916.834	23051.68	13778.43	0.261503	684435.3	0.167116	0.622459	0.255149
1992	8588	4203	12791	12550.01	22568.53	11872.65	0.20842	230234.3	0.151858	1.008557	0.186355
1993	6523	2707	9230	6899.206	13307.06	9930.362	0.151344	214824.4	0.130265	0.800337	0.169928
1994	6763	1173	7936	5062.492	8920.66	5729.961	0.161059	183732.7	0.136829	0.826415	0.1764
1995	4893	2151	7044	4563.806	6915.524	4126.811	0.163397	340766.3	0.118301	0.810776	0.171416
1996	4335	3631	7966	4401.417	7272.473	2878.211	0.185191	203244.2	0.128363	0.891615	0.149134
1997	2277	1928	4205	3013.874	5369.606	3102.811	0.150431	170729.1	0.138898	0.771362	0.166861
1998	2229	1304	3533	2898.949	4268.241	2571.897	0.158677	167298.4	0.130187	1.076882	0.167957
1999	1670	1092	2762	2262.029	3105.083	1550.688	0.195674	208166.1	0.127571	0.853836	0.178442
2000	762	2118	2880	2366.311	3492.466	1509.236	0.188354	109119	0.139041	1.118118	0.154152
2001	733	1012	1745	1635.71	2273.041	1328.933	0.171596	191982.3	0.130194	0.904033	0.184241
2002	747	740	1487	1891.912	2871.969	1182.682	0.192723	79961.99	0.136065	1.236361	0.160342
2003	517	480	996	1276.436	1848.185	1194.555	0.170942	120095.8	0.148765	0.61084	0.237885
2004	133	905	1038	2078.563	2357.977	1268.768	0.19478	95545.88	0.124788	1.696695	0.173514
2005	125	272	397	499.4508	1389.403	542.5556	0.262056	105850.6	0.138365	0.444997	0.279148
2006	64	1773	1837	2592.853	2205.217	1078.421	0.21537	155056.1	0.125793	1.516174	0.183468
2007	35	1512	1547	1531.212	2112.059	579.6879	0.270007	103942.5	0.130861	1.194777	0.170542

Year	Lan	Dis	Cat	CatPred	Tsb	Ssb	SsbCv	Recr	RecrCv	Fbar	FbarCv
2008	37	1169	1206	1285.84	1669.595	724.2601	0.207149	148998	0.124539	0.965297	0.193505
2009	39	1321	1360	1499.778	2220.505	735.6692	0.212079	92764.96	0.133154	1.097418	0.176569
2010	30	1154	1184	1446.459	1716.639	821.2836	0.19131	92709.21	0.128164	1.131069	0.190696
2011	31	946	977	985.5709	1469.646	614.1699	0.229025	151604	0.125392	0.855986	0.198344
2012	60	1339	1399	1433.651	2163.881	682.8956	0.212126	79506.58	0.135284	1.127338	0.173719
2013	33	948	981	1035.359	1619.363	836.1217	0.197555	159742	0.140032	0.650456	0.222075
2014	23	1951	1974	2637.666	2788.931	941.9842	0.209781	198580.4	0.11835	1.489569	0.179951
2015	28	1521	1549	1727.956	2572.353	675.9363	0.252716	122731	0.12349	0.96351	0.188623
2016	15	765	780	816.4469	2103.228	964.8841	0.191329	71364.91	0.154039	0.557581	0.224075
2017	36	668	704	728.7112	1838.558	1146.201	0.192279	108234.5	0.172921	0.480626	0.263552
2018	46	853	899	921.0501	2175.082	1076.617	0.235776	174768	0.236359	0.464076	0.292646
2019*	NA	NA	NA	NA	NA	1375.539	NA	118853	NA	0.500761	NA

Table 40.12. Whiting7.a. Input values for short-term forecast. Note that Sel and CWt refer to the landings and DSel and DCWt refer to the discards. Numbers in thousands; Weights in kg.

2019										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	118853	1.078	0	0	0	0	0	0	0.063	0.024
1	56071	0.803	0	0	0	0.031	0.05	0.129	0.394	0.037
2	10289	0.718	1	0	0	0.064	0.236	0.259	0.292	0.088
3	1980	0.608	1	0	0	0.147	0.398	0.311	0.132	0.179
4	988	0.554	1	0	0	0.277	0.489	0.4	0.041	0.293
5	332	0.518	1	0	0	0.387	0.522	0.438	0.009	0.233
6	47	0.518	1	0	0	0.505	0.524	0.615	0.007	0
2020										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	118853	1.078	0	0	0	0	0	0	0.063	0.024
1	37954	0.803	0	0	0	0.031	0.05	0.129	0.394	0.037
2	16117	0.718	1	0	0	0.064	0.236	0.259	0.292	0.088
3	2960	0.608	1	0	0	0.147	0.398	0.311	0.132	0.179
4	634	0.554	1	0	0	0.277	0.489	0.4	0.041	0.293
5	334	0.518	1	0	0	0.387	0.522	0.438	0.009	0.233
6	133	0.518	1	0	0	0.505	0.524	0.615	0.007	0
2021										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	118853	1.078	0	0	0	0	0	0	0.063	0.024
1	37954	0.803	0	0	0	0.031	0.05	0.129	0.394	0.037
2	10910	0.718	1	0	0	0.064	0.236	0.259	0.292	0.088
3	4636	0.608	1	0	0	0.147	0.398	0.311	0.132	0.179
4	948	0.554	1	0	0	0.277	0.489	0.4	0.041	0.293
5	214	0.518	1	0	0	0.387	0.522	0.438	0.009	0.233
6	164	0.518	1	0	0	0.505	0.524	0.615	0.007	0

Table 40.13. Whiting7.a. Single-option output of the short-term forecast. (F = mean F 2016–2018). Numbers in thousands, weights in tonnes.

2019										
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.063	4500	107	118853	0	0	0
1	0.05	1	0	0.394	14220	531	56071	1740	0	0
2	0.236	9	2	0.292	3097	273	10289	659	10289	659
3	0.398	71	22	0.132	556	100	1980	291	1980	291
4	0.489	153	61	0.041	167	49	988	274	988	274
5	0.522	97	42	0.009	13	3	332	128	332	128
6	0.524	16	10	0.007	0	0	47	24	47	24
Total	0.228	347	137	0.273	22553	1063	188560	3116	13636	1376
2020										
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.063	4500	107	118853	0	0	0
1	0.05	0	0	0.394	9625	359	37954	1178	0	0
2	0.236	14	4	0.292	4851	427	16117	1031	16117	1031
3	0.398	107	33	0.132	831	149	2960	435	2960	435
4	0.489	98	39	0.041	107	31	634	176	634	176
5	0.522	97	43	0.009	13	3	334	129	334	129
6	0.524	44	27	0.007	0	0	133	67	133	67
Total	0.228	360	146	0.273	19927	1076	176985	3016	20178	1838
2021										
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.063	4500	107	118853	0	0	0
1	0.05	0	0	0.394	9625	359	37954	1178	0	0
2	0.236	9	2	0.292	3283	289	10910	698	10910	698
3	0.398	167	52	0.132	1302	233	4636	682	4636	682
4	0.489	147	59	0.041	160	47	948	262	948	262
5	0.522	62	27	0.009	8	2	214	83	214	83
6	0.524	54	33	0.007	0	0	164	83	164	83
Total	0.228	439	173	0.273	18878	1037	173679	2986	16872	1808

Table 40.14. Whiting7.a. Management options table. Weights in tonnes.

Fmult	Catch20	Land20	Dis20	Basis	FCatch20	FLand20	FDis20	SSB21	dSSB	dTac
0	0	0	0		0	NA	NA	2971	61.56%	-100%
0.1	146	18	128		0.05008	0.00206	0.04801	2827	53.73%	-97.52%
0.2	286	35	251		0.10015	0.00412	0.09603	2690	46.28%	-95.19%
0.3	420	51	369		0.15023	0.00619	0.14404	2559	39.15%	-92.99%
0.4	549	67	482		0.2003	0.00825	0.19206	2435	32.41%	-90.78%
0.5	672	81	591		0.25038	0.01031	0.24007	2317	25.99%	-88.86%
0.6	791	95	696		0.30046	0.01237	0.28809	2205	19.90%	-86.93%
0.7	905	109	796		0.35053	0.01443	0.3361	2098	14.08%	-85.01%
0.8	1015	122	893		0.40061	0.0165	0.38411	1996	8.54%	-83.22%
0.9	1120	134	986		0.45068	0.01856	0.43213	1900	3.32%	-81.57%
1	1222	146	1076		0.50076	0.02062	0.48014	1808	-1.69%	-79.92%
1.1	1319	157	1162		0.55084	0.02268	0.52816	1720	-6.47%	-78.40%
1.2	1413	167	1246		0.60091	0.02474	0.57617	1637	-10.98%	-77.03%
1.3	1503	177	1326		0.65099	0.0268	0.62418	1558	-15.28%	-75.65%
1.4	1590	187	1403		0.70107	0.02887	0.6722	1483	-19.36%	-74.28%
1.5	1674	196	1477		0.75114	0.03093	0.72021	1411	-23.27%	-73%
1.6	1754	205	1549		0.80122	0.03299	0.76823	1343	-26.97%	-71.80%
1.7	1832	214	1618		0.85129	0.03505	0.81624	1278	-30.51%	-70.56%
1.8	1907	222	1685		0.90137	0.03711	0.86426	1216	-33.88%	-69.46%
1.9	1979	229	1750		0.95145	0.03918	0.91227	1158	-37.03%	-68.50%
2	2048	237	1812		1.00152	0.04124	0.96028	1102	-40.08%	-67.40%
2.1	2115	244	1872		1.0516	0.0433	1.0083	1049	-42.96%	-66%
2.2	2180	250	1930		1.10167	0.04536	1.05631	998	-45.73%	-65.61%
2.3	2243	257	1986		1.15175	0.04742	1.10433	950	-48.34%	-64.65%
2.4	2303	263	2040		1.20183	0.04949	1.15234	904	-50.84%	-63.82%
2.5	2361	269	2093		1.2519	0.05155	1.20036	861	-53.18%	-63.00%

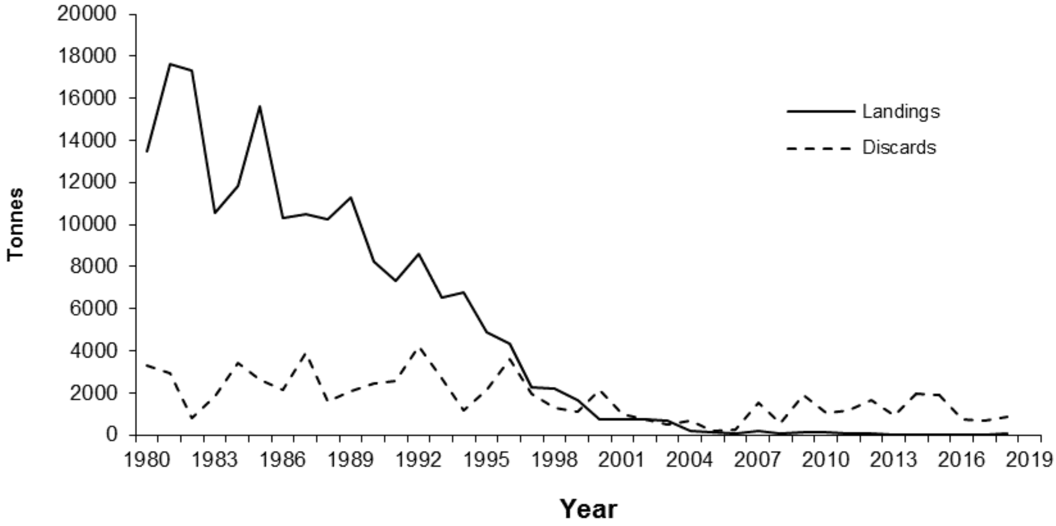


Figure 40.1. Whiting 7.a. Working group estimates of International landings and discards between 1980–2018.

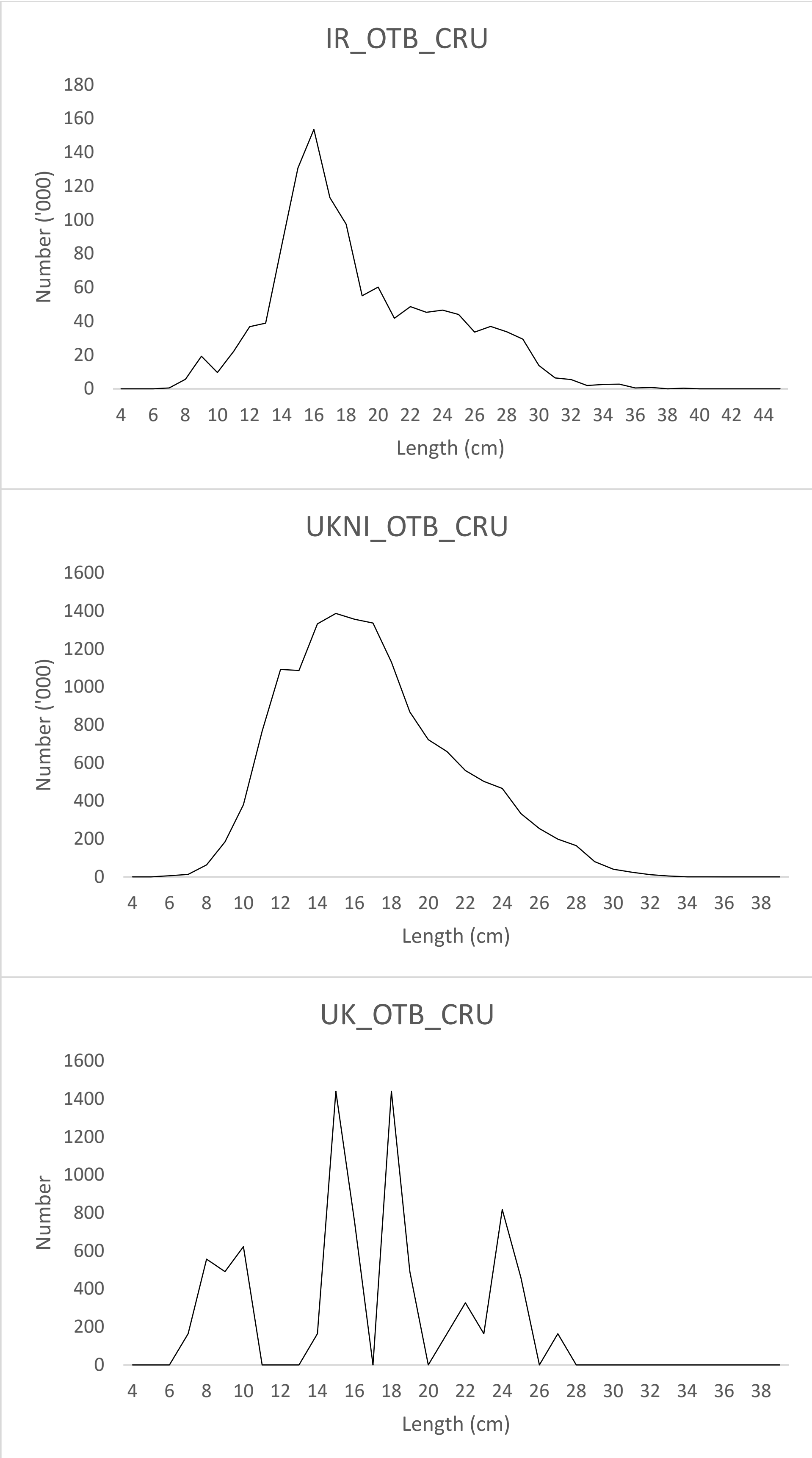


Figure 40.2. 7.a Whiting discard length–frequency by national fleets in 2018 for the OTB_CRU métier. Note due to low levels of retained catch, and hence low sampling, these data are not presented.

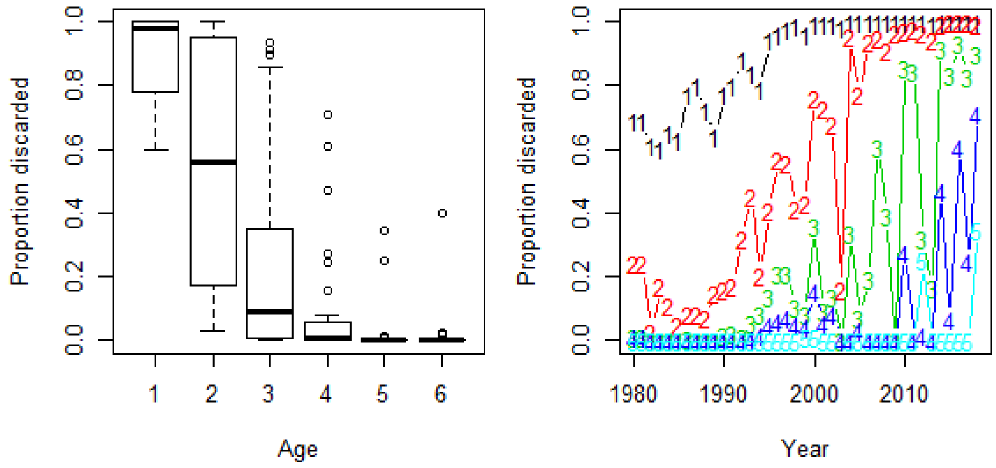


Figure 40.3. Whiting 7.a Proportion of discards by age (left) and year (right).

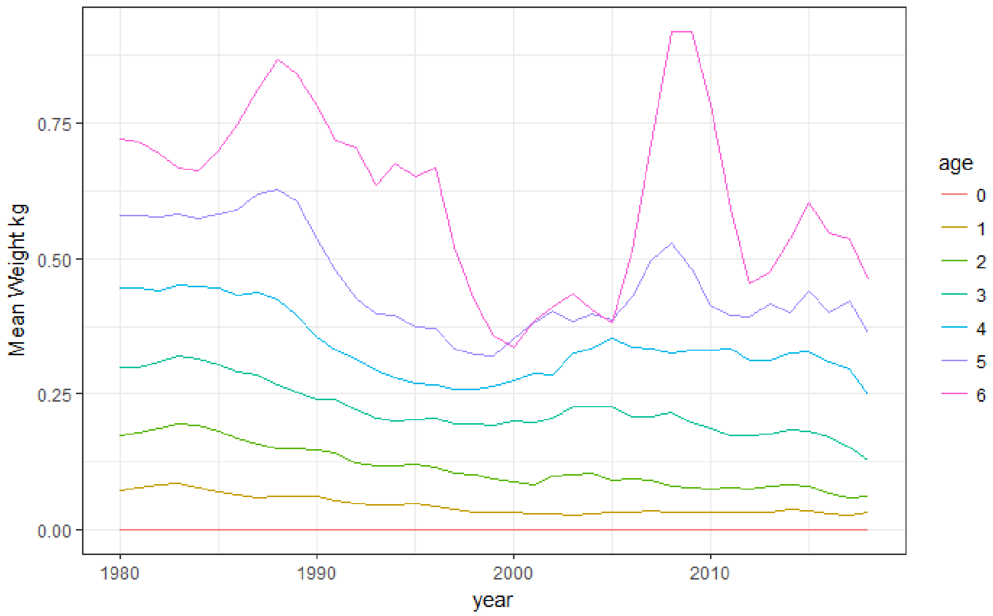


Figure 40.4. Whiting 7.a Smoothed Stock Weights (Three year running average).

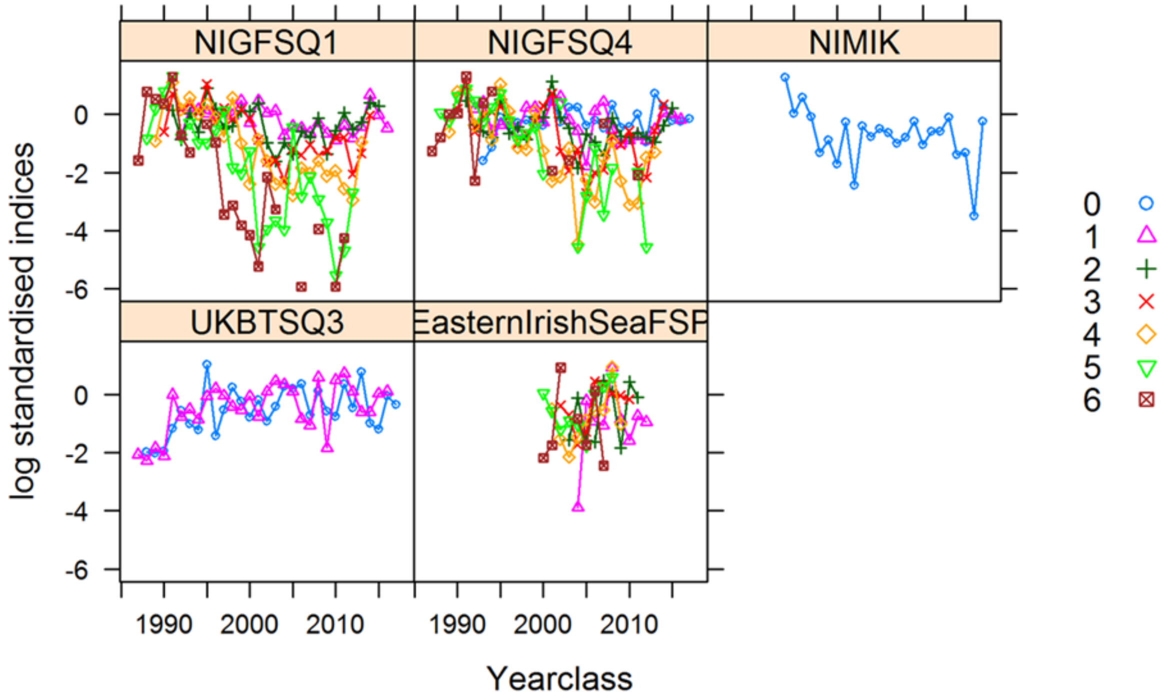


Figure 40.5. Whiting 7.a. Log Standardized indices of tuning fleets by cohort.

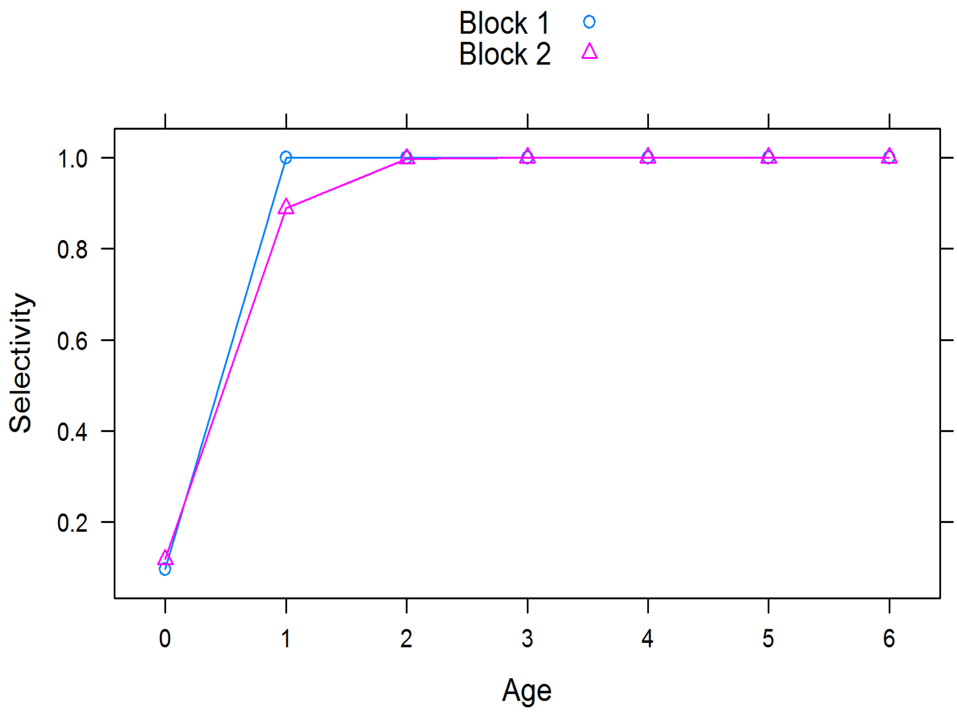


Figure 40.6. Whiting 7.a. Selectivity-at-age in the Catch.

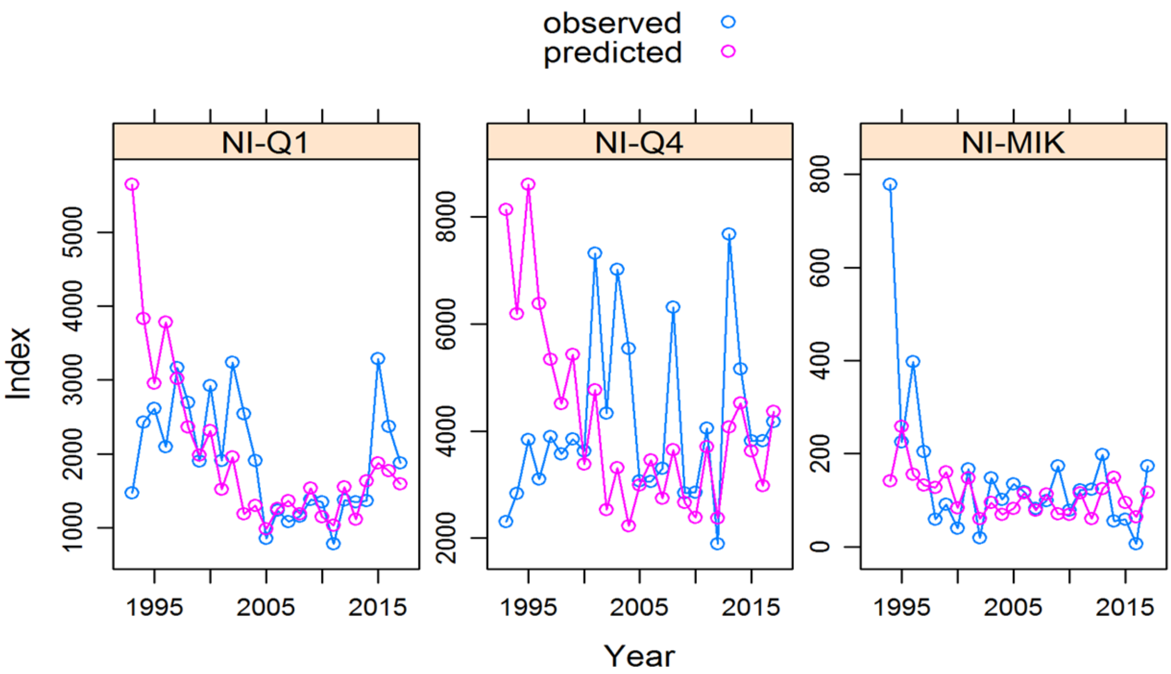


Figure 40.7. Whiting 7.a. Observed and Predicted Catches.

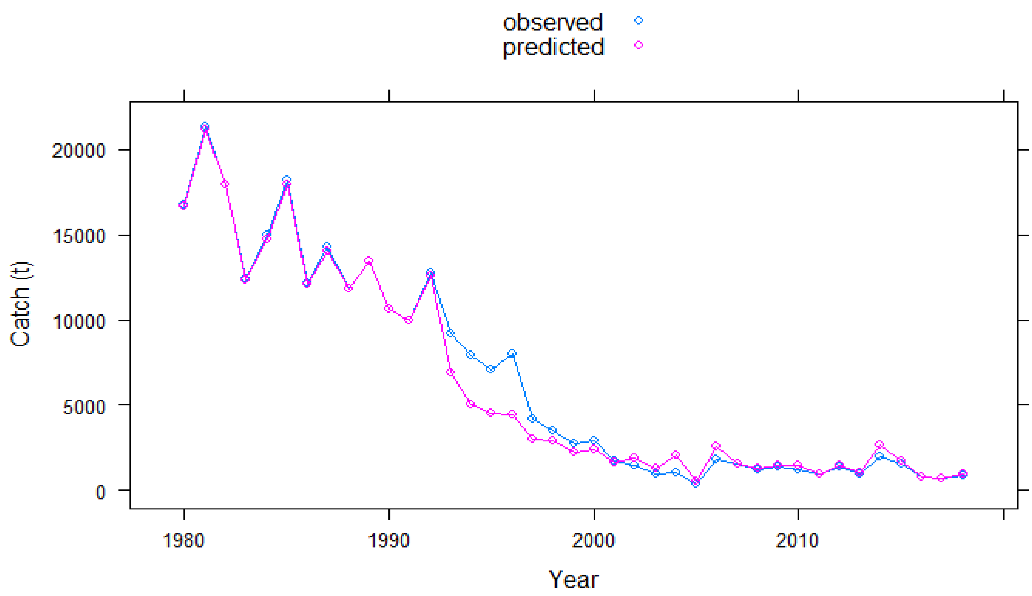


Figure 40.8. Whiting 7.a. Observed and Predicted index cpue.

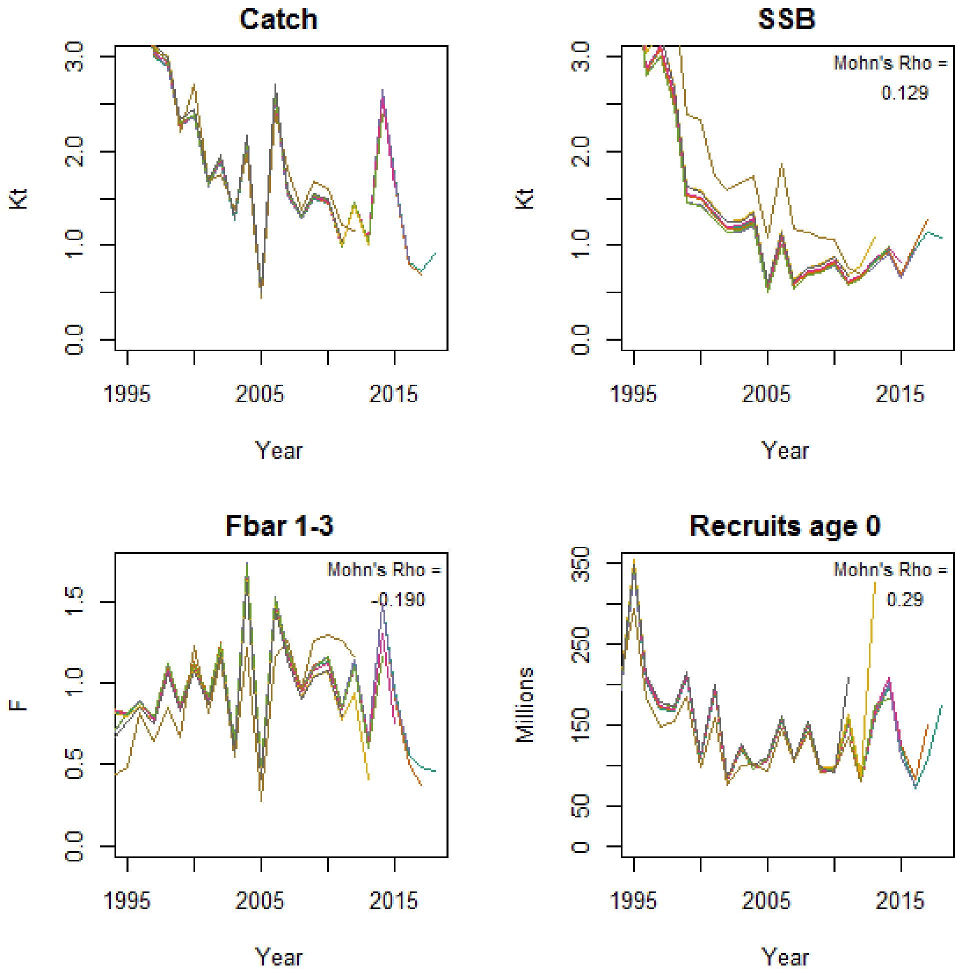


Figure 40.9. Whiting 7.a. Retrospective analysis of the final ASAP run with Mohn's Rho calculation.

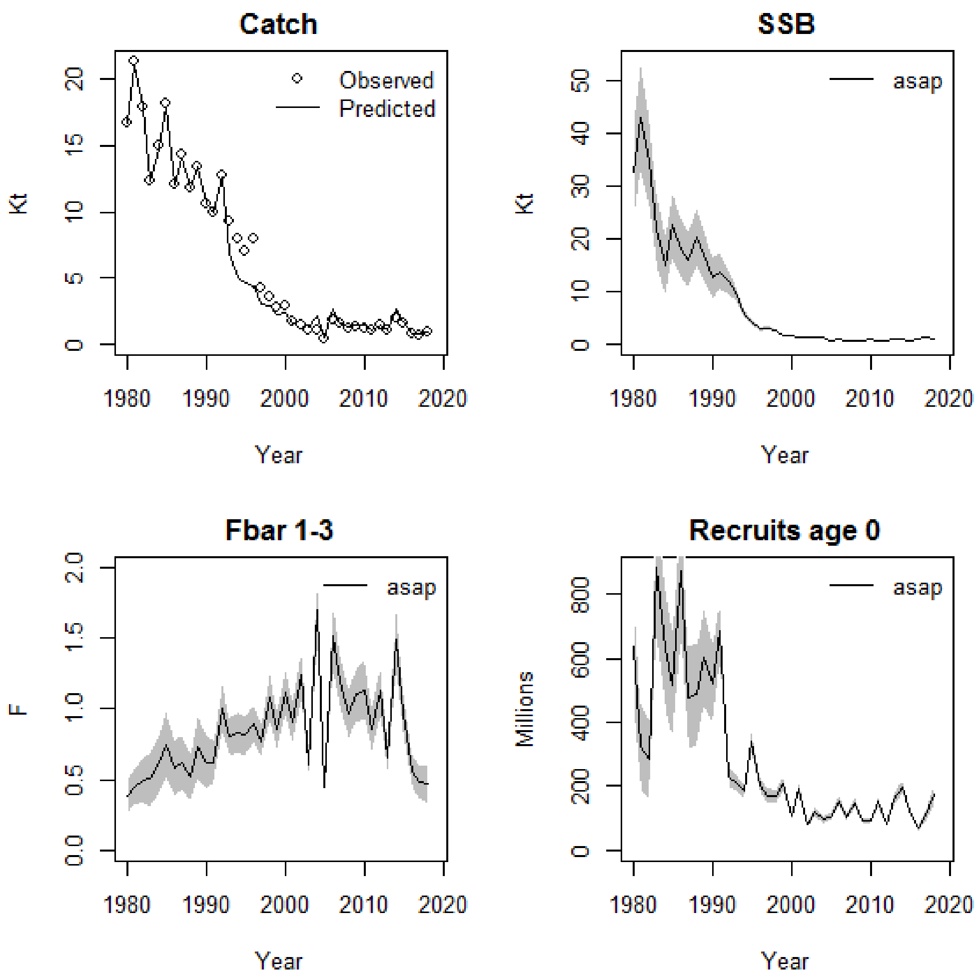


Figure 40.10. Whiting 7.a. Stock Summary Plot. The thick black line represents the ASAP assessment standard deviations from ASAP are shaded grey. The forecast/ assumed values are given by open circles. The thick black line in the catch plot represents the predicted catch from ASAP.

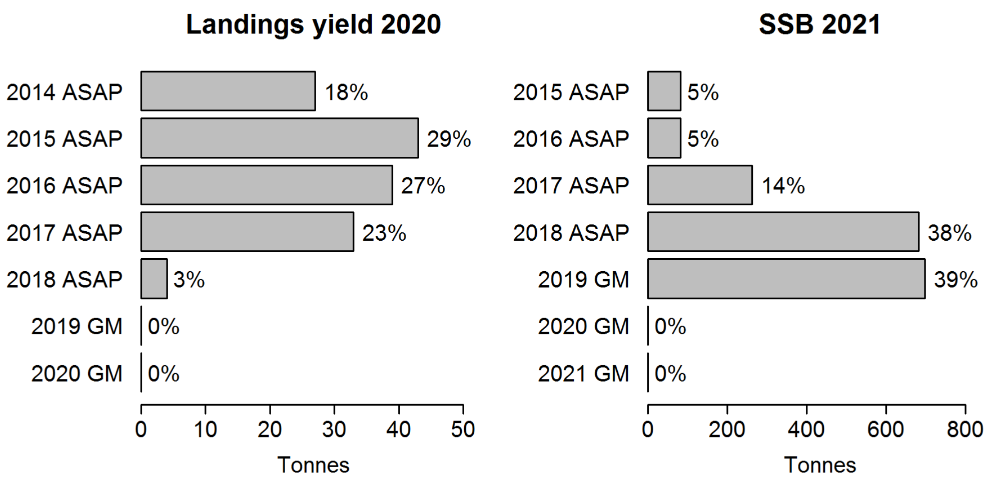


Figure 40.11. Whiting 7.a. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

39 Whiting (*Merlangius merlangus*) in divisions 7.b–c and 7.e–k (southern Celtic Seas and eastern English Channel)

Type of assessment in 2019

Full analytical assessment (XSA) and short-term forecast tuned with a single combined survey index according to the stock annex. Since WGCSE 2015, national discard data have been available through InterCatch for countries with significant landings for this stock. Biological reference points proposed by WKMSYREF4 (ICES, 2016a) are included also.

ICES advice applicable to 2019

ICES advises that when the MSY approach is applied, catches in 2019 should be no more than 15 841 tonnes.
Management should be implemented at the stock level.

http://ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/whg.27.7b-ce-k.pdf

ICES advice applicable to 2018

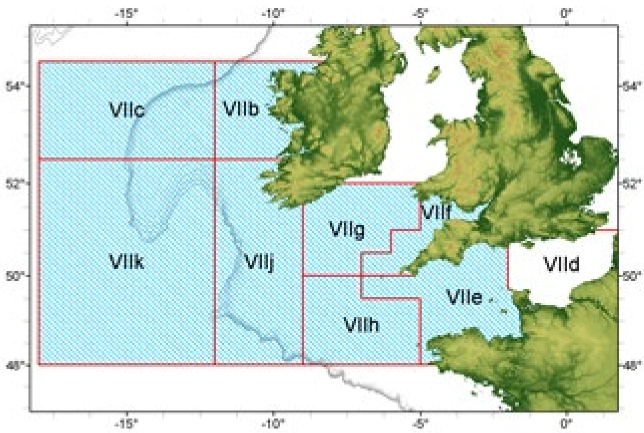
ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 19 429 tonnes.

http://ices.dk/sites/pub/Publication%20Reports/Advice/2017/2017/whg.27.7b-ce-k.pdf

39.1 General

Stock description and management units

The TAC for whiting is set for divisions 7.b, 7.c, 7.d, 7.e, 7.f, 7.g, 7.h, 7.j and 7.k. The assessment area does not correspond to the TAC area. Since the 2014 Benchmark (WKCELT), Whiting in 7.b,c are now assessed as part of 7.bc, e–k, while whiting in 7.d remain part of the WGNSSK assessment of the North Sea stock. Any management measures implemented for this stock should be consistent with the assessment area.



Red Boxes-TAC/Management Areas Blue Shading-Assessment Area.

The TAC for whiting 7.bc, e–k decreased from 22 213 t (2018) to 19 184 (2019). ICES official landings for whiting 7.bc, e–k in 2019 are 9019 t and estimated catch of 10 268 t. Thus, the current TAC for whiting catches in the 7.bk stock area is not restrictive in the 7.bc, e–k assessment area.

TAC in 2018/120

Species:	Whiting *Merlangius merlangus*	Zone:	7b, 7c, 7d, 7e, 7f, 7g, 7h, 7j and 7k (WHG/7X7A-C)
Belgium	217		
France	13 328		
Ireland	6 176		
The Netherlands	108		
United Kingdom	2 384		
Union	22 213		
TAC	22 213		Analytical TAC Article 7(2) of this Regulation applies Article 12(1) of this Regulation applies

TAC in 2019/124

Species:	Whiting *Merlangius merlangus*	Zone:	7b, 7c, 7d, 7e, 7f, 7g, 7h, 7j and 7k (WHG/7X7A-C)
Belgium	187		
France	11 510		
Ireland	5 334		
The Netherlands	94		
United Kingdom	2 059		
Union	19 184		
TAC	19 184		Analytical TAC Article 7(2) of this Regulation applies Article 13(1) of this Regulation applies

Landings obligation

Since 2017, the landings obligation (LO) has applied to this stock in accordance with Delegated Regulation (EC, 2016) superseded by (EU) 2018/2034[1]. This implies that all catches of whiting in the Celtic Sea and Western Channel by those vessels must be landed. However, a 6% *de minimus* applies to bottom trawls using a mesh size of ≥80 mm, as well as pelagic trawls and beam trawls using 80–119 mm mesh. There are also three specific technical measures in operation for vessels using bottom trawls or seines in the Celtic Sea Protection Zone.

A significant proportion of unwanted catch is above the Minimum Conservation Reference Size (MCRS = 27 cm) in whiting, although discards are assessed by ICES to have reduced in 2018 to 15% from 32–26% for the previous three years. Whiting is also the least limiting stock for most fleets in a mixed fishery context for the Celtic Sea, where cod is generally considered the likely choke species. In this context it is difficult to accurately predict the impact of the LO on Celtic Sea whiting.

[1] https://www.agriculture.gov.ie/media/migration/seafood/fisheriesmanagementnotices/2019/CommissionDelRegEU2034NWW241218.pdf

39.2 The fishery in 2018

ICES officially reported landings for divisions 7.b, c, e–k and landings as used by the Working Group are given in Table 1.

Catch for 7.b, c, e–k in addition to landings for 7.d (excluding discards) is also presented as a guide figure for comparison to the 7.b–k TAC.

The 7.bc, e–k whiting stock is primarily targeted by otter trawlers and to a lesser extent Scottish seines and beam trawls. An overview of landings by fleet is given in Table 2 and more generally effort trends in fleets catching whiting in the Celtic Sea is provided by STECF (STECF, 2018).

The spatial distributions of landings by Irish fleets 1995–2016 are given in Figure 1. Irish catches are primarily from within 7.g particularly within 32E2 and 31E3. Landings also emanate, to a lesser extent from 7.j. In previous years, French landings have exhibited similar spatial and temporal focus around 31E3. The majority of UK landings are from otter trawlers in 7.e, and concentrated within rectangles 29E5 and 29E6.

39.3 Data

Landings

National landings and numbers-at-age data were aggregated in InterCatch for the Area 7.bc, e–k following methodology described in the stock annex.

The allocation schemes below were used:

Discard raising scheme

STRATA	UNSAMPLED		SAMPLED
1	GNS_UK	->	GNS_UK
2	GNS_FRA	->	GNS_FRA
3	TBB_BEL&UK	->	TBB_UK
4	OTT_DEF_70_99_FRA	->	OTT_DEF_70_99_FRA
5	OTT_100_119_FRA	->	OTT_100_119_FRA
6	GTR_DEF_FRA	->	GTR_DEF_FRA[1]
7	GTR_DEF_UK	->	GTR_DEF_UK
8	SSC_AllCountries_7e	->	SSC_IRL_7g
9	OTM_PTM_7ej	->	OTB_DEF_AllCountries_7egh
10	MIS_UK	->	MIS_UK
11	MIS_IRL	->	GNS_IRL
12	MIS_FRA	->	GNS_FRA
13	LLS_UK	->	GNS_UK
14	OTB_DEF_70_99_IRL_FRA	->	OTB_DEF_70_99_FRA_UK
15	OTB_DEF_>=100_AllCountriesAreas	->	OTB_DEF_
16	OTB_CRU_16_100_AllCountriesAreas	->	OTB_DEF_70_100_ FRA_UK
17	OTB_CRU_>=100_IRL_UK	->	OTB_DEF_100_FRA_IRL

Sample allocation scheme

Strata	Unsampled		Sampled
1	GNS_UK	->	GNS_UK
2	GNS_FRA	->	GNS_FRA
3	TBB_BEL&UK	->	TBB_UK
4	OTT_DEF_70_99_FRA	->	OTT_DEF_70_99_FRA
5	OTT_100_119_FRA	->	OTT_100_119_FRA
6	GTR_DEF_FRA	->	GTR_DEF_FRA[1]
7	GTR_DEF_UK	->	GTR_DEF_UK
8	SSC_AllCountries_7e	->	SSC_IRL_7g
9	OTM_PTM_7ej	->	OTB_DEF_AllCountries_7egh
10	MIS_UK	->	MIS_UK
11	MIS_IRL	->	GNS_IRL
12	MIS_FRA	->	GNS_FRA
13	LLS_UK	->	GNS_UK
14	OTB_DEF_70_99_IRL_FRA	->	OTB_DEF_70_99_FRA_UK
15	OTB_DEF_>=100_AllCountriesAreas	->	OTB_DEF_
16	OTB_CRU_16_100_AllCountriesAreas	->	OTB_DEF_70_100_ FRA_UK
17	OTB_CRU_>=100_IRL_UK	->	OTB_DEF_

NB: Everything has been raised by CATON.

Age sampling allocation scheme

The length compositions available in InterCatch for 2018 from the main gears are presented in Table 3 and Figure 2. The landings and discard length distributions are similar for the all otter trawl fleets (OTB), but TBB tend to have discarded slightly larger fish. It is important to note that discards for the French OTB fleet are significantly reduced in 2018 relative to previous years.

The international catch and landings numbers-at-age are given in Table 4 and Figure 3. It is possible to track the very strong 1999 and 2013 year classes, but the strong 2009 recruitment is only apparent at some older ages. The age distribution had remained similar over time with the exception of periods where strong year classes pass through older ages. In 2018 however, there appears to be a significant shortfall in 1+ age classes in both the survey sampling (Figure 7) and commercial data from France in particular (Figure 2).

Age group-0 was included in the assessment data to allow inclusion of -group indices in the XSA, although landings at this age are not recorded in most years. Mean weights-at-age in the catch and stock (Tables 5 and 6) were derived as per methodology described in the stock annex. The stock weights are shown in Figure 4. There is some variability of stock weights particularly at older ages. Mean weight-at-age appears to have declined during the period of recent high fishing effort and landings between 2005–2008.

Discards

A time-series of discard data for Ireland and France was made available at WKCELT 2014 and is now included in the assessment. Procedures for raising discards to international landings are described above and in the stock annex. However, as more accurate national data become available through InterCatch, these have been included in the assessment as an improvement over simply raising Irish and French OTB discards to the international landings to produce a catch time-series.

A summary of discarding rates-at-age for 2018 as available in InterCatch is presented in Table 7. Discarded whiting length distributions from 2017 for the main fleets is presented in Figure 2. The available data suggest that discarding occurs well above the 27 cm minimum conservation reference size (MCRS) with fish occasionally being discarded above 40 cm in some fleets. Annual proportions-at-age of discard numbers in the catch, and also catch numbers in the predicted stock from the XSA assessment are given in Figure 3. Data show a recent upward trend in discarding of all ages in the catch and stock.

Figure 5 presents the proportion of 1–3 year olds in the discards vs stock, discard vs catch and catch vs stock respectively. The data suggest that the ratio of 1:2 year old fish in the discards vs catch have remained relatively constant to each other. However, the proportion of three-year old fish being taken in the catch and discards has increased in 2018 relative to two-year old fish in the stock meaning either F for that age group probably has not gone up, but the estimates of that cohort in the stock has proportionately come down.

Biological

Mean stock and catch weights-at-age data were calculated following the methodology described in the stock annex. Natural mortality is based on Lorenzen's model and thus a power function of catch weights-at-age. Maturity is knife-edge at-age 2.

The proportions of F and M before spawning were both set to zero to reflect the SSB calculation date of January 1st.

Surveys

The combined Q4 IBTS survey index for the Irish (IGFS) and French (EVHOE) time-series for ages 0–5 is given in Table 8. Further details for combining the survey series is given in the stock annex.

The internal consistency of the survey tuning fleet was examined using pairwise scatterplots of log numbers-at-age (Figure 6), bearing in mind that the correlations may be impacted by changes in fishing mortality. Other than 0 vs 1-grp fish, the index is reasonably consistent for older ages (ages 1–5).

Cohort and year effects were examined with mean log standardized plots of indices by cohort Figure 6 and year (Figure 7). The index is quite noisy and shows a strong year affect for 2018 where all ages above 0-group appear to have dropped significantly.

Examination of the raw length frequency data going into the survey index (see below) from both the IGFS (left panel) and EVHOE (right panel) surveys highlight virtually a complete absence of length data for 2018 above about 20 cm which approximates to an 0-group fish cut-off point.

Sum of RaisedNoPerHour	Cruise								
LngtCm	IGFS2010	IGFS2011	IGFS2012	IGFS2013	IGFS2014	IGFS2015	IGFS2016	IGFS2017	IGFS2018
0	0	0	0	0	0	0	0	0	0
7		2		13			51	66	
8		40		124	42	82	417	150	29
9	2	385	68	760	41	394	3,735	1,140	628
10	131	1,374	824	2,215	432	1,402	6,982	3,406	3,436
11	380	1,428	1,689	6,934	979	2,725	8,446	5,740	8,264
12	1,293	2,702	3,037	12,307	2,013	3,552	8,665	5,570	8,154
13	1,661	4,852	3,809	26,725	2,343	3,330	9,346	5,227	7,009
14	2,544	7,754	3,588	36,764	3,498	4,741	7,512	4,968	6,439
15	2,458	9,041	4,521	35,411	3,371	4,933	4,808	4,620	4,547
16	2,657	12,156	4,585	28,460	3,806	4,931	3,260	4,570	4,592
17	3,089	12,237	4,967	17,804	3,679	6,214	2,239	3,549	3,465
18	3,199	9,243	4,903	11,901	2,470	5,779	1,156	2,622	2,638
19	2,370	7,235	4,517	5,583	1,730	4,889	636	2,147	1,880
20	1,926	3,235	3,209	2,114	752	2,953	350	1,609	1,546
21	1,719	1,948	2,412	890	1,861	1,698	543	1,080	890
22	3,650	1,692	2,053	698	3,878	921	1,026	1,441	543
23	5,513	2,811	2,432	1,062	7,176	1,596	2,709	1,912	686
24	8,140	3,226	3,532	1,875	10,089	2,125	3,760	3,205	804
25	8,876	5,358	3,250	2,355	13,026	3,025	5,055	2,588	832
26	8,693	5,258	4,200	3,156	13,777	4,675	4,478	3,532	767
27	8,918	7,603	3,699	4,050	10,573	4,289	4,550	2,793	670
28	8,811	9,588	4,583	3,529	8,132	4,695	4,494	2,170	842
29	6,429	8,965	5,762	2,926	6,457	3,676	3,743	1,558	675
30	5,994	8,391	6,284	3,056	4,175	3,298	3,323	934	395
31	3,179	6,679	6,155	2,830	3,156	3,297	2,878	472	332
32	3,083	5,219	4,759	2,163	2,817	2,321	2,318	358	246
33	1,894	3,859	3,985	1,707	2,496	1,571	1,489	289	257
34	1,370	2,328	2,583	1,355	2,204	1,409	1,599	297	195
35	1,179	1,657	2,043	1,188	1,364	923	1,299	151	167
36	1,028	1,259	1,518	693	1,071	674	797	155	111
37	519	1,150	982	495	755	477	696	126	188
38	399	671	781	393	582	352	499	98	100
39	342	523	430	221	603	217	364	75	59
40	189	255	470	194	594	167	308	53	68
41	274	223	307	198	317	136	208	69	41
42	129	152	246	155	342	128	179	48	49
43	79	142	239	84	158	66	150	30	55
44	50	106	195	112	116	51	138	23	35
45	40	116	134	73	83	40	97	21	12
46	46	69	123	44	54	30	58	20	10
47	71	30	123	30	62	21	52	28	10
48	28	26	84	51	41	22	62	8	10
49	20	20	89	32	32	22	36	16	14
50	16	14	33	35	28	10	33	12	7
51	6	22	24	22	37	10	29	6	6
52	12	6	33	22	13	13	18	6	10
53	14	10	20	8	42	12	10	8	3
54	8	14	18	14	6	4	8	2	8
55		2	36	10	9	8	10	6	12
56	4	8	12	6	9	8	9	2	6
57	2	4	4	10	6	4	6	5	2
58	4	8	6		8	4		2	
59		2	6	2	6	2	7	2	4
60							2		2
61				6	4		2		2
62			2	2	5				2
64		2							
65			2						
80						81			
Grand Total	102,439	151,097	103,363	222,866	121,320	88,003	104,649	68,982	61,754

Sum of RaisedNoPerHour	Cruise							
LngtCm	EVHOE10	EVHOE11	EVHOE12	EVHOE13	EVHOE14	EVHOE15	EVHOE16	EVHOE18
-9	0	0	0	0	0	0	0	0
6		2						
7	4	2						
8		2		9			54	26
9	8			58		8	492	55
10	60	2	18	87		113	2007	228
11	79	6	80	195	8	271	2499	775
12	217	16	191	146	51	696	1905	497
13	416	34	200	171	148	972	1852	385
14	435	74	303	289	145	1044	2645	199
15	470	129	361	291	222	689	1177	195
16	523	238	278	537	242	1003	1366	129
17	634	475	389	581	223	1357	1165	75
18	750	395	347	674	224	1198	476	125
19	470	363	342	662	135	941	203	171
20	293	307	186	660	146	630	255	186
21	182	230	130	460	136	226	284	95
22	120	240	173	101	303	110	420	37
23	252	922	94	250	568	333	610	29
24	257	1452	132	567	774	626	794	73
25	322	1404	202	1012	1061	733	958	105
26	365	2600	211	733	1290	857	1063	110
27	407	3555	216	1201	1096	1207	916	130
28	682	3573	286	874	954	1093	860	124
29	690	3159	293	832	764	1322	1152	122
30	837	2740	436	1085	524	1118	927	67
31	494	1885	436	1236	262	1216	779	105
32	523	1571	341	955	311	980	714	83
33	438	1240	303	791	232	1007	446	68
34	273	813	307	821	140	727	586	64
35	157	379	153	847	186	319	401	88
36	88	367	186	607	92	270	403	72
37	190	281	103	481	119	218	305	37
38	85	27	82	459	121	173	179	2
39	85	72	80	316	87	189	184	10
40	75	74	73	287	70	86	79	13
41	36	91	56	218	25	70	123	9
42	14	91	15	114	32	96	66	13
43	10	41	22	107	36	44	72	3
44	36	111	28	18	22	34	44	4
45	12	4	7	87	24	32	38	
46	4	6	7	4	22	30	18	
47	10	4	16		20	33	14	5
48	10			4	20	9	12	
49	4		4	6	14	22	18	
50	2	7	3		16	53	14	
51	2	2		2	8	6	10	1
52	2			2	8	7	10	
53	4				6	2	16	
54	2		3			2	12	
55					6		6	
56	4				2	5	9	
57	4				2	2	5	
58					2		2	
59					2	2	8	
60							6	
61						2	8	
65						2		
246						2		
Grand Total	11039	28883	7091	18835	10900	22186	18666	4515

This is also the case for French commercial OTB data (Figure 2) and these older age classes appear only to be represented in significant numbers in the Irish commercial data, particularly west of Ireland.

Commercial lpue

Commercial lpue, from 2000 to 2013, were evaluated at WKCELT 2014 and have been omitted from the assessment due to catchability trends.

39.4 Historical stock development

An XSA assessment was carried out for this stock applying the same settings as last year, using a truncated time-series 1999–2018 of combined landings and discards data. The settings previously used were applied again this year and are detailed within the stock annex.

Data screening and Final update assessment

The general methodology is outlined in Section 2. Exploratory analysis was carried out using FLR under R version 3.1.1. The packages FLCore 2.5, and FLXSA 2.5 and FLEDA 2.5 were used.

Catch date range:	Years	1999–2017
	Ages	-7+
Fbar Age Range:		2–5
Assessment Method:		XSA
Survey Tuning-series:		
IGFS-EVHOE	Yrs	2003–2015
	Ages	-5
Time taper:		No
Q plateau age:		5
F shrinkage S.E:		1.
	Num yrs	5
	Num ages	3
Fleet S.E:		.5

The full XSA diagnostics are given in Table 9. Overall the estimates are reasonably consistent for ages 1+ given that whiting are prone to year effects in survey catches.

The log-catchability residuals from the XSA fit are plotted for the tuning-series in Figure 8. The residual patterns for the survey index shows some significant recent trends. There are strong positive residuals for 0-group and 1-group fish in 2017 changing to negative residuals for 1 and two-year old fish in 2018.

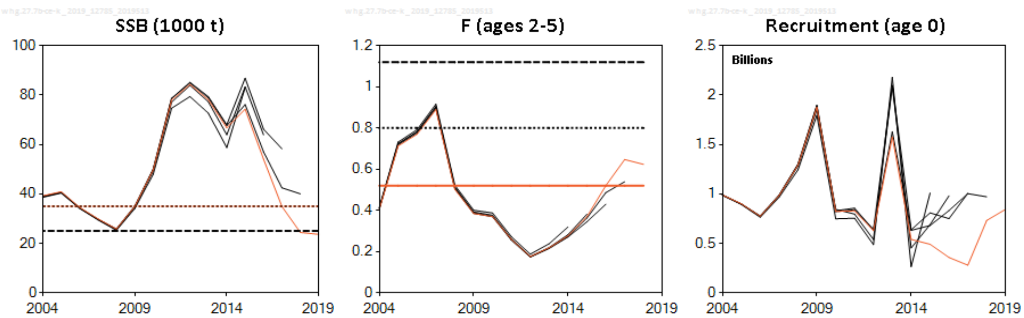
The retrospective pattern is shown in Figure 9. A retrospective bias in F appeared to be developing in this assessment with F being revised down. As with 2017, this year the WG scaled F to F_{2018} to address this retrospective trend.

In the three most recent years however, there has been a general upward revision in F and downward revision in SSB. In this year's assessment, a significant revision in recent recruitment due to low 1–3 year fish in the catch and survey data are likely to have driven the strong downward revision in SSB.

Estimates of fishing mortality and stock numbers from the final XSA are given in Table 10 and Table 11. These are summarized in Figure 10. The assessment this year reveals a further increase in fishing mortality for older fish and recruitment in 2013 is estimated to be the third highest in the time-series (Figure 11).

Comparison with previous assessments

The current assessment shows a strong retrospective revision in terms of recruitment in particular from the 2017 assessment. SSB is also assessed to now be below B_{lim} for the first time in the time-series.



Mohn's Rho was calculated using the recent five years of data, up to and including 2018, to estimate the bias. The estimates gave an F_{bar} value of 0.009 and SSB of 0.061.

39.5 State of the stock

Trends in landings, F(2–5), SSB, and recruitment are presented in Table 12. For the current time-series SSB displays a peak biomass in 2012 following the strong recruitment of the 2009 year class and again in 2015 following the 2013 recruitment.

Fishing mortality (F_{bar}) has increased since 2012 and is now assessed to be above F_{msy}. SSB is now estimated to be below B_{lim}, below the precautionary limits for this stock.

The 2013 cohort, estimated to be the third highest in the time-series, now seems to have passed through the fishery without being evident in 2018 in substantial numbers resulting in both recruitment and SSB being revised down in the assessment and F_{bar} revised upwards.

39.6 Short-term projections

The short-term projection settings were as described in the stock annex with the following exceptions. The GM period was 1999–2017 (full time-series minus the last year).

Table 13 gives the management option table. Given the status of SSB the ICES Advice Rule was applied such that F_{MSY} (0.52) becomes F_{MSY}*SSB2020/MSY $B_{trigger\ (0.35)}$. Fishing at F_{MSY} = 0.35 in 2020 implies catches of 6481 t and landings of 3885 t.

The input values for the catch forecast (using FLR 2.5) are given in Table 14. The F-at-age values used were calculated as the mean of the XSA values from 2016–2018, scaled to the most recent year. Historically F has been used unscaled, but as mentioned in the Annex, it was suggested in the benchmark that other options might be considered depending on consistent patterns in the retrospective analysis. Catch and stock weights-at-age were also the mean of the period 2016–2018. Stock numbers-at-age in 2018 for ages and older were obtained from the XSA. SSB values are calculated for 1 January.

The estimated contributions of recent recruited year classes to the landings and SSB predictions are given in Figure 12. Yield is still heavily reliant on the XSA estimate 2018 year class, which is estimated at 35%. The assumptions of $GM_{1999\text{-}2017}$ recruitment for 2019 are predicted to contribute ca. 57% to the SSB in 2021.

39.7 MSY evaluations and Biological reference points

ICES carried out an evaluation of MSY and PA reference points for this stock at WKMSYREF4 (ICES, 2016a). The results are summarised below:

Reference points

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	35 000 t	B_{pa}	ICES, 2016b
	F_{MSY}	.524	Segmented regression with B_{lim} as the breakpoint Range = .32–.67	ICES, 2016b
Precautionary approach	B_{lim}	25 000 t	B_{loss}, the lowest observed spawning–stock biomass.	2016a
	B_{pa}	35 000 t	B_{lim} X 1.4	ICES, 2016a
	F_{lim}	1.120	Based on segmented regression simulation of recruitment with B_{lim} as the breakpoint	2016a
	F_{pa}	.800	F_{lim}/1.4	2016a
Management plan	SSB_{MGT}	Undefined		
	F_{MGT}	Undefined		

39.8 Management plans

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including whiting in ICES divisions 7.b-ce-k.

39.9 Uncertainties and bias in assessment and forecast

Sampling

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches. There has been SOP differences in some recent years particularly that have led to a disparity between the reported catch in tons (landings and discards) going into the assessment and the comparable ∑(CNAA x MWAA) coming out of the assessment. While the overall SOP checks have invariably been ≤3%, any difference in the catches going into the assessment vs those coming out will cause concern. Rather than correct the national data provided therefore a SOP correction is now done within FLR once the initial data QC is complete to ensure corrections are minor and not masking a potential error/bias. Data submitted to InterCatch for 2018 for French discards was unusually low however, with the proportion of discards in the French OTB fleet catch dropping from 26% in 2017 to 7% in 2018. There is some evidence of very low numbers of 1–4 year olds in the survey tuning index also however.

Ageing

Cohort tracking in the landings-at-age matrix appears fairly consistent up to age 6. Tracking deteriorates at older ages.

Discards

Discarding is a major feature of most fisheries catching whiting in the Celtic Sea. Sampling coverage of discarding has improved over time particularly since 2004. Attempts to reconstruct a time-series for the main Irish and French fleets failed to extend further back than 1999. No discard data were available for France prior to 2004 and had to be constructed as proportion-at-age for the recent years where data were available. Sampling levels for either country also did not allow for quarterly age-based reconstruction of the discards so a length-based ogive from Ireland had to be used to reconstruct the data for both countries. Discard estimates for the UK were not available at the benchmark, but are available now through InterCatch and have been included in the assessment.

Selectivity

Square-mesh panels were introduced in the second half of 2012 to reduce catches and discards of smaller whiting and haddock. The current assessment does not show an obvious reduction in F-at-age since the introduction of this TCM (see Figures 5 and 10).

Surveys

The surveys for whiting are prone to year effects. However, cohort tracking for the 1+ fish is generally quite consistent for the combined tuning index. As mentioned there is a strong year affect in 2018 for 1+ fish which seems somewhat reflected in the commercial OTB data for France at least.

Misreporting

The level of misreporting of this stock is not known and underreporting has previously been considered unlikely to have been a significant source of unaccounted mortality of whiting in the assessment because the TAC has been in excess of recent landings.

39.10 Recommendation for next benchmark

This stock is part of a benchmark process, due to complete in Q1 2020.

39.11 Management considerations

Catches and SSB in 7.b, c, e–k whiting fluctuate considerably depending on year-class strength. The 2008 and 2009 year classes were above average with 2013 being third highest in the time-series. These contributed to catches and SSB in the short term but the upturn in catches and SSB was short-lived as recruitment is episodic, and F is now above F_{MSY} and SSB below $B_{trigger}$.

Discarding in this stock for different fleets is substantial and highly variable depending on gear and year-class strength. High levels of discarding for a species like whiting reduce the longer term yields one might expect so efforts to improve selection and reduce discards in the mixed fishery should be encouraged. ICES notes the introduction of square mesh panels in all trawl fisheries operating in ICES divisions 7.fg. It is important that these measures are fully implemented and their effectiveness in reducing discards and the impact on commercial catches is monitored and evaluated. Further gear modifications to increase the likelihood of small whiting passing through the gear, such as introduction of larger minimum mesh sizes, separator panels, or grids may be needed.

Ireland has the only directed fishery for whiting, which is part of mixed fishery throughout the Celtic Sea, as well as bycatch within *Nephrops* fisheries. Discard rates are high as a consequence of the low market value of the species, particularly at smaller sizes. High-grading above the MCRS to some extent is also prevalent in most fisheries.

From the 1 February to the 31 March, fishing activity has been prohibited within ICES rectangles: 30E4, 31E4, 32E3 (excluding within six nautical miles from the baseline) annually since 2005 to protect the cod stock.

There have been major changes in fleet dynamics over the period of the assessment. Effort in the French gadoid fleet has been declining since 1999, but the effort has fluctuated in recent years due to the way the effort series is derived. Irish otter-trawl effort in 7.b–k has been declined slightly over the time-series.

The full impact of the Landings Obligation is complex and unknown as yet and will depend on whether there is a measurable impact on discarding behaviour or whether variable practices continue and simply data becomes more reliable (for a summary of issues see http://www.discardless.eu/media/results/Celtic_Sea_Year2.pdf).

39.12 References

EC. 2015. Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters.

EC. 2016. Commission Delegated Regulation (EU) 2016/2375 of 12 October 2016 establishing a discard plan for certain demersal fisheries in north-western waters.

ICES. 2016a. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2016b. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES Subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

Table 1. Whiting in Divisions 7.bc,e–k. Nominal Landings (t) as reported to ICES, and total landings as used by the Working Group.

Official ICES Landings								Used by WG		7.bc,e–k Catch +		
Year	BEL	FRA	IRL	UK_EW	Others	Total	Unallocated	WG Total	Dicards	Catch	7.d Landings	TAC
1998	479	11748	5549	1755	179	19710	-	-	-	-		
1999b	448	16418	6013	1354	27	7842	-12336	20178	5420	25598	31401	
2000	194	9184	5358	1255	39	16030	385	15645	4400	20045	26117	
2001	171	7317	5365	948	31	13832	640	13192	9877	23070	29684	
2002	149	7546	5718	847	35	14295	655	13640	7336	20977	26338	
2003	129	5989	4516	763	21	11418	321	11097	3559	14656	21661	
2004	180	4870	4350	587	132	10119	-70	10189	6481	16670	21953	
2005	218	5886	5774	482	136	12496	285	12211	6700	18911	23812	
2006	128	4710	4570	413	129	9951	291	9660	12031	21691	25440	
2007	127	3574	4864	576	86	9226	139	9087	8456	17543	20934	19900
2008	121	3072	2406	620	35	6255	395	5860	2880	8740	11933	19900
2009	87	2814	2798	827	25	6551	38	6513	4101	10614	17183	16950
2010	102	3463	4330	798	85	8779	191	8588	3008	11596	17729	14407
2011	100	4312	4752	740	174	10077	593	9484	1954	11438	16902	16658
2012	170	3710	5841	764	141	10627	438	10188	2449	12637	16234	19053
2013	226	4006	6888	907	92	12119	188	11931	2512	14443	18700	24500
2014	222	4928	6874	1062	35	13121	158	12847	3977	16824	19954	19162
2015	152	5634	6437	828	97	13149	-26	13174	6101	19275	19954	17742
2016	186	6294	7700	892	39	15110	-69	15179	7278	22457	26187	22778
2017	102	5256	6296	607	32	12293	600	11693	4505	17098	17780	27500
2018	103	3666	4628	590	33	9019	246	8773	1495	10268	12625	22213

[a]Provisional data. [b]French Official landings not available, not updated.

Table 2. Whiting in Divisions 7.bc–ek. Landings (t) by fleet.

Fleet	BEL	FRA	IRL	UK	Others	Total	%
OTB	15	3404	3242	448	7	7115	78%
SSC	8	0	1283	2	25	1317	15%
TBB	81	0	68	51	0	199	2%
Other	0	282	58	87	6	433	5%
	103	3686	4650	588	37	9065	100%

Table 3. Whiting in Divisions 7.b,c,e–k. Length distributions for Landings (LAN) and Discards (DIS) for 2017 by country and main fleet (Numbers in '000s) available in InterCatch.

	BEL	FRA				IRL				UK			
	TBB	OTB	OTB	OTT	OTT	OTB	OTB	TBB	TBB	OTB	OTB	TBB	TBB
Lngt_cm	LAN	LAN	DIS	LAN	DIS	LAN	DIS	LAN	DIS	LAN	DIS	LAN	DIS
10			6				14				3		7
11			1				42				3		
12			3		1		91				6		3
13			11		2		160				4		
14			12		2		169				10		3
15			20		2		179				11		
16			20		3		204				14		3
17			25		2		149				8		
18			48		4		219				3		7
19			57		3		96				5		3
20			48		3		101				13		11
21			26		2		104		2		4		24
22			33		3		157				8		40
23			29		2		123		2		5		58
24		0	48	0	3		89		5		11		68
25		0	51		3		90		3	4	13		59
26		18	40		3		125		6	3	32		48
27	1	31	101	0	6		158		15	8	69	0	39

	BEL	FRA				IRL				UK			
	TBB	OTB	OTB	OTT	OTT	OTB	OTB	TBB	TBB	OTB	OTB	TBB	TBB
28	3	84	66	1	6	3	218		13	24	100	0	68
29	4	184	103	2	7	3	286		14	43	101	1	64
30	10	284	73	3	8	11	375		10	58	109	1	46
31	16	394	50	5	7	108	304		8	81	116	2	32
32	19	545	44	7	5	124	221		16	118	83	4	52
33	21	538	41	8	3	189	90	0	12	107	49	6	48
34	24	458	53	7	3	201	49	1	11	108	30	6	41
35	24	508	4	8	1	275	16	2	7	86	12	9	35
36	16	456	16	8	1	319	31	4	7	82	8	7	21
37	13	320	1	7	0	366	14	5	4	54	5	8	11
38	10	376	1	7		313	12	7	2	52	5	5	12
39	9	301	6	7		304	10	7	1	60	2	7	2
40	7	295	10	6	0	279	6	8	0	42	2	5	18
41	5	260		7	0	361		10	1	34	1	5	10
42	3	237		6		251		9		30		5	3
43	2	207		5		234		6		25		2	2
44	1	164		4		173		6		20	1	2	
45	1	212		5		233		6		22		4	1
46	1	161		5		268		6	1	14		3	
47	1	78		4		174		4	0	9		3	
48	1	112		4		201		3		6		2	
49		82		2		130		2		6		2	
50		112		3		118		2		7		1	
51		52		2		86		1		4		1	1
52		88		2		91		2		4		1	
53		26		1		68		2		4		1	
54		25		1		57				2		1	
55		22		1		48				2		1	

	BEL	FRA				IRL				UK			
	TBB	OTB	OTB	OTT	OTT	OTB	OTB	TBB	TBB	OTB	OTB	TBB	TBB
56		7		1		23				2			
57		10		0		25				1			
58		8		0		10		2		0			
59		2		0		11				1			
60		2		0		7							
61		2		0		1							
62				0		1							
63		1		0		1							
64				0									
65		1				1							
68						0							
71				0									
73													
75													
80													
90													

Table 4. Whiting in Divisions 7.bc,e–k. The strong 1999 year class is distinct in both the catch and landings data, with evidence of the strong 2009 and 2013 year classes appearing at older ages. Catch numbers-at-age ('000).

1999	**2018**						
0	7						
1							
5370.0	20744.1	25957.7	14662.4	8744.8	8987.8	6670.2	1498.7
8176.3	26561.7	26303.7	12529.9	6122.5	2605.9	2100.9	2424.3
8795.0	26105.8	51390.6	13715.2	5317.1	2049.0	763.1	627.3
4568.6	13387.4	34319.6	24356.6	5968.2	1057.6	291.6	111.0
3687.0	12213.5	11836.5	10634.3	12778.4	1640.7	227.8	58.1
2473.8	27330.2	15052.2	6542.4	7241.9	6212.0	573.2	81.2
1421.1	10663.5	32482.0	12581.9	5079.9	4819.8	3717.7	155.1
5114.1	29760.2	44102.5	10995.4	4217.2	1750.4	1181.6	579.4
1017.0	14791.8	36137.0	12258.9	5296.7	1407.4	345.4	325.7
1650.1	8270.8	13274.5	6373.7	3290.8	858.5	214.8	68.4
538.1	8045.5	20840.4	7931.2	2653.7	770.3	192.4	201.5
348.0	4004.6	12591.3	10429.8	4761.1	1201.0	260.9	101.4
737.0	4691.4	8226.7	8280.5	5464.3	1738.5	355.4	84.5
156.0	5399.4	6661.7	10006.3	5577.9	1725.5	505.5	116.1
739.0	1076.3	6880.1	7160.1	10810.1	4379.2	938.2	216.5
158.7	13119.4	5727.8	7237.2	6301.1	7941.1	2032.8	352.8
262.3	4167.2	25419.9	8601.1	7555.1	2619.8	4343.9	805.3
1223.7	9891.3	11827.4	29870.3	5397.2	3145.3	1160.7	1933.0
1055.7	6577.3	13369.2	7914.1	11829.3	2550.3	1437.8	315.5
223.8	2215.4	6562.5	6880.8	3238.0	3646.3	824.0	496.7

Table 5. Whiting in Divisions 7.bc,e–k. Catch weights-at-age (kg).

1999	2018						
0	7						
1							
0.0271	0.1331	0.2216	0.3412	0.4274	0.4402	0.4963	0.6230
0.0314	0.0690	0.2204	0.3955	0.5053	0.5630	0.5804	0.5868
0.0315	0.1116	0.1853	0.3778	0.5293	0.6335	0.7600	0.7775
0.0272	0.0965	0.1966	0.3506	0.5315	0.7069	0.8249	1.0133
0.0290	0.0945	0.2114	0.3604	0.4521	0.6291	0.8306	1.0873
0.0401	0.1554	0.2266	0.3612	0.4321	0.4910	0.5366	0.7846
0.0198	0.1047	0.1950	0.3608	0.5010	0.5038	0.4869	0.6744
0.0333	0.1235	0.2103	0.3855	0.5377	0.5878	0.5443	0.6750
0.0419	0.1214	0.2014	0.3644	0.4975	0.6423	0.6088	0.6382
0.0283	0.1093	0.2141	0.3859	0.5241	0.6264	0.7795	0.8298
0.0257	0.1168	0.2064	0.3950	0.5492	0.6530	0.6894	0.9506
0.0344	0.1190	0.2278	0.4205	0.5601	0.6793	0.8151	0.8356
0.0243	0.1261	0.2393	0.4435	0.6130	0.8109	0.9538	1.2106
0.0387	0.0956	0.2248	0.4607	0.6493	0.8084	0.9671	1.0881
0.0533	0.1303	0.2086	0.3576	0.6002	0.7042	0.9147	0.8644
0.0380	0.1420	0.2543	0.3968	0.5536	0.6621	0.7588	1.0072
0.0180	0.1017	0.2199	0.3754	0.5726	0.7777	0.6711	0.9295
0.0517	0.1489	0.2170	0.3584	0.5772	0.6847	0.7457	0.7836
0.0531	0.1540	0.2508	0.3895	0.4996	0.5695	0.7391	0.8509
0.0456	0.1463	0.2424	0.3917	0.5885	0.7063	0.8278	0.9755

Table 6. Whiting in Divisions 7.bc,e–k. Q1 Stock weights-at-age (kg) from Rivard corrected annual mean catch weights.

	Age							
		1	2	3	4	5	6	7+
1999	.0169	.1035	.1659	.2803	.3724	.3834	.4674	.623
2000	.0166	.0432	.1713	.296	.4152	.4906	.5055	.5868
2001	.018	.0592	.1131	.2885	.4575	.5658	.6541	.7775
2002	.0146	.0551	.1482	.2548	.4481	.6117	.7229	1.0133
2003	.0125	.0507	.1428	.2662	.3981	.5782	.7662	1.0873
2004	.0248	.0671	.1463	.2763	.3946	.4712	.581	.7846
2005	.0079	.0648	.1741	.2859	.4254	.4666	.4889	.6744
2006	.0174	.0495	.1484	.2742	.4404	.5427	.5237	.675
2007	.0259	.0636	.1577	.2769	.4379	.5877	.5982	.6382
2008	.0139	.0677	.1612	.2788	.437	.5582	.7076	.8298
2009	.012	.0575	.1502	.2908	.4604	.585	.6571	.9506
2010	.018	.0553	.1631	.2946	.4703	.6108	.7296	.8356
2011	.0122	.0659	.1688	.3179	.5077	.6739	.8049	1.2106
2012	.0211	.0482	.1683	.332	.5366	.7039	.8856	1.0881
2013	.0326	.0711	.1412	.2835	.5259	.6762	.8599	.8644
2014	.0232	.087	.182	.2877	.4449	.6304	.7309	1.0072
2015	.0063	.0622	.1767	.309	.4767	.6562	.6666	.9295
2016	.03	.0518	.1485	.2807	.4655	.6262	.7615	.7836
2017	.0316	.0893	.1932	.2907	.4232	.5734	.7114	.8509
2018	.0236	.0882	.1932	.3134	.4788	.594	.6866	.9755

Table 7. Whiting in Divisions 7.e–k. Summary of landings and discard data in 2017 provided to the Working Group.

weight in tonnes										
Discards	**Country**		**1**	**2**	**3**	**4**	**5**	**6**	**7+**	**Grand Total**
	Belgium	0.7	58.4	91.1	92.8	33.9	13.6	0.1	0.0	290.5
	France	7.7	73.0	99.6	73.1	18.4	7.0	0.3	0.0	279.2
	Ireland	0.0	31.4	218.5	229.2	75.2	4.0	0.0	0.0	558.3
	UK (England)	1.8	68.5	152.8	104.1	24.7	13.3	0.1	0.0	365.2
	Other	0.0	0.2	0.7	0.5	0.1	0.0	0.0	0.0	1.6
	Total	10.2	231.4	562.7	499.7	152.4	37.9	0.5	0.1	1494.8
Landings	Belgium	0.0	0.7	9.0	27.9	24.5	34.6	5.7	2.4	104.8
	France	0.0	63.9	507.1	926.6	547.1	737.3	262.9	349.0	3393.9
	Ireland	0.0	14.0	392.8	1022.6	1070.4	1631.9	395.7	122.4	4649.9
	UK (England)	0.0	13.6	114.5	209.1	104.3	123.4	14.5	8.1	587.5
	Other	0.0	0.4	4.5	9.6	7.0	10.2	2.9	2.5	37.2
	Total	0.0	92.7	1028.0	2195.9	1753.2	2537.4	681.7	484.5	8773.3
Number in 000's										
Discards	Country		1	2	3	4	5	6	7	Grand Total
	Belgium	17.2	412.3	454.7	327.5	87.8	30.7	0.1	0.0	1330.4
	France	147.9	447.6	442.4	257.0	51.2	16.6	0.4	0.1	1363.1

weight in tonnes										
Discards	**Country**		**1**	**2**	**3**	**4**	**5**	**6**	**7+**	**Grand Total**
	Ireland	0.0	511.8	1985.1	1273.5	273.3	11.0	0.0	0.0	4054.7
	UK (England)	58.3	504.5	732.4	375.0	72.8	30.3	0.1	0.0	1773.4
	Other	0.4	1.7	3.6	2.0	0.3	0.1	0.0	0.0	8.1
	Total	223.8	1877.9	3618.2	2235.0	485.4	88.7	0.6	0.1	8529.8
Landings	Belgium	0.0	2.4	23.7	52.9	36.3	45.8	6.6	2.2	170.0
	France	0.0	233.9	1464.4	2025.3	933.4	1196.1	323.7	351.6	6528.2
	Ireland	0.0	48.7	1047.5	2006.0	1575.2	2119.6	473.0	133.3	7403.3
	UK (England)	0.0	51.0	396.6	542.3	196.9	181.4	16.5	7.2	1392.0
	Other	0.0	1.6	12.0	19.3	10.8	14.7	3.5	2.3	64.3
	Total	0.0	337.5	2944.3	4645.8	2752.6	3557.6	823.4	496.6	15557.8

Table 8. Whiting in Divisions 7.bc,e–k. Combined survey abundance indices of age groups –5 (NB: values for 2017 comprised of extended Irish survey to compensate from missing French survey).

IGFSEVHOE No/Hr						
	Age					
		1	2	3	4	5
2003	207.826	201.071	73.602	26.557	13.911	.658
2004	698.971	186.364	79.658	19.396	7.531	5.387
2005	195.372	89.18	21.949	7.791	3.758	5.495
2006	459.365	144.858	70.157	14.538	6.327	1.488
2007	895.572	126.044	31.128	8.434	1.512	.689
2008	536.87	199.458	62.553	11.364	3.787	1.175
2009	755.508	267.503	52.211	12.282	2.666	1.082
2010	108.815	282.721	120.372	26.99	4.408	1.341
2011	432.351	205.258	208.778	71.683	14.117	3.000
2012	261.964	147.137	88.25	77.797	10.675	2.054
2013	1229.544	90.559	64.323	20.139	27.93	8.694
2014	112.842	314.208	38.057	19.858	9.104	12.72
2015	273.468	97.528	144.185	11.552	6.13	7.197
2016	280.238	117.811	72.835	38.436	7.998	4.413
2017	384.251	164.095	39.646	17.007	3.201	1.556
2018	335.329	30.691	7.530	3.642	2.031	0.946

Table 9. Whiting in Divisions 7.bc,e–k. XSA Diagnostics.

Run 1

FLR XSA Diagnostics 2019-05-15 09:41:01

CPUE data from indices

Catch data for 20 years 1999 to 2018. Ages 0 to 7.

	fleet	first age	last age	first year	last year	alpha	beta
1	IGFSExtendedNo/Hr	0	5	2003	2018	<NA>	<NA>

Time-series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for all ages

Catchability independent of age for ages > 5

Terminal population estimation :

Survivor estimates shrunk towards the mean F

of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1

Minimum standard error for population

estimates derived from each fleet = 0.5

prior weighting not applied

Regression weights

year

age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

year

age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.033	0.011	0.030	0.035	0.009	0.044	0.041	0.111	0.101	0.042
2	0.282	0.118	0.050	0.097	0.100	0.107	0.207	0.291	0.411	0.255
3	0.333	0.342	0.159	0.118	0.216	0.219	0.361	0.652	0.515	0.627

4	0.478	0.475	0.416	0.204	0.243	0.413	0.523	0.569	0.868	0.577
5	0.446	0.544	0.410	0.283	0.313	0.366	0.388	0.569	0.794	1.035
6	0.333	0.330	0.380	0.245	0.304	0.291	0.442	0.371	0.728	0.865
7	0.333	0.330	0.380	0.245	0.304	0.291	0.442	0.371	0.728	0.865

XSA population number (Thousand)

	age							
year	0	1	2	3	4	5	6	7
2009	1877546	381410	117428	35922	8664	2615	821	846
2010	823287	554308	156164	46245	15611	3496	1122	429
2011	827878	243059	231957	72427	19926	6315	1360	318
2012	628396	244415	99802	115148	37481	8555	2810	637
2013	1577179	185521	99915	47288	62048	19883	4322	982
2014	539974	465631	77805	47189	23105	31644	9742	1665
2015	490588	159417	188503	36480	22985	9948	14710	2673
2016	356770	144836	64748	80041	15427	8859	4523	7401
2017	278325	105329	54855	25256	25284	5683	3363	717
2018	731014	82170	40293	18977	9155	6907	1721	1004

Estimated population abundance at 1st Jan 2019

	age							
year	0	1	2	3	4	5	6	7
2019	0	215819	33330	16293	6152	3344	1644	496

Fleet: IGFSExtendedNo/Hr

Log catchability residuals.

	year															
age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0	-0.764	0.431	-0.748	0.256	0.686	-0.099	-0.131	-1.244	0.130	-0.096	0.530	-0.786	0.195	0.538	1.102	0.000

```
 1  0.422  0.098 -0.740 -0.050 -0.110  0.061  0.072 -0.265 0.255 -0.080 -0.311  0.043 -0.058 0.285  0.927 -0.550
 2  0.535  0.471 -0.826  0.361 -0.199  0.120 -0.321  0.093 0.191  0.212 -0.102 -0.371  0.159 0.615  0.273 -1.210
 3 -0.048  0.394 -0.369  0.216 -0.139  0.147 -0.344  0.197 0.573  0.158 -0.222 -0.232 -0.398 0.261  0.484 -0.678
 4 -0.136 -0.195  0.155  0.904 -0.363  0.475 -0.129 -0.217 0.653 -0.434  0.056  0.064 -0.234 0.468 -0.693 -0.373
 5 -0.682 -0.254  0.553  0.447 -0.072  0.393  0.027  0.033 0.135 -0.653 -0.028 -0.068  0.538 0.315 -0.096 -0.588

 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

              0       1       2       3       4       5
Mean_Logq -6.6702 -6.5897 -6.6200 -6.9415 -7.2004 -7.1118
S.E_Logq   0.4467  0.4467  0.4467  0.4467  0.4467  0.4467

 Terminal year survivor and F summaries:

 ,Age 0 Year class =2018

source
              scaledWts survivors yrcls
IGFSExtendedNo/Hr        1    215819  2018

 ,Age 1 Year class =2017

source
              scaledWts survivors yrcls
IGFSExtendedNo/Hr    0.793     19222  2017
fshk                 0.207     22044  2017

 ,Age 2 Year class =2016

source
```

```
              scaledWts survivors yrcls
IGFSExtendedNo/Hr     0.749      4859  2016
fshk                  0.251     18389  2016

 ,Age 3 Year class =2015
source
              scaledWts survivors yrcls
IGFSExtendedNo/Hr     0.681      3123  2015
fshk                  0.319     10851  2015

 ,Age 4 Year class =2014

source
              scaledWts survivors yrcls
IGFSExtendedNo/Hr     0.692      2302  2014
fshk                  0.308      3701  2014

 ,Age 5 Year class =2013

source
              scaledWts survivors yrcls
IGFSExtendedNo/Hr     0.587       913  2013
fshk                  0.413      4662  2013

 ,Age 6 Year class =2012

source
    scaledWts survivors yrcls
fshk         1       597  2012
```

Table 10. Whiting in Divisions 7.b, c, e–k. Fishing mortality (F)-at-age. F_{bar} range is 2–5.

	1	2	3	4	5	6	7+	F_{bar}2–5
2009	0.033	0.282	0.333	0.478	0.446	0.333	0.333	0.385
2010	0.011	0.118	0.342	0.475	0.544	0.330	0.330	0.370
2011	0.030	0.050	0.159	0.416	0.410	0.380	0.380	0.259
2012	0.035	0.097	0.118	0.204	0.283	0.245	0.245	0.176
2013	0.009	0.100	0.216	0.243	0.313	0.304	0.304	0.218
2014	0.044	0.107	0.219	0.413	0.366	0.291	0.291	0.276
2015	0.041	0.207	0.361	0.523	0.388	0.442	0.442	0.370
2016	0.111	0.291	0.652	0.569	0.569	0.371	0.371	0.520
2017	0.101	0.411	0.515	0.868	0.794	0.728	0.728	0.647
2018	0.042	0.255	0.627	0.577	1.035	0.865	0.865	0.624

Table 11. Whiting in Divisions 7.b, c, e–k. Stock number-at-age (‘000).

year	0	1	2	3	4	5	6	7
2009	1877546	381410	117428	35922	8664	2615	821	846
2010	823287	554308	156164	46245	15611	3496	1122	429
2011	827878	243059	231957	72427	19926	6315	1360	318
2012	628396	244415	99802	115148	37481	8555	2810	637
2013	1577179	185521	99915	47288	62048	19883	4322	982
2014	539974	465631	77805	47189	23105	31644	9742	1665
2015	490588	159417	188503	36480	22985	9948	14710	2673
2016	356770	144836	64748	80041	15427	8859	4523	7401
2017	278325	105329	54855	25256	25284	5683	3363	717
2018	731014	82170	40293	18977	9155	6907	1721	1004

Table 12. Whiting in Divisions 7.b, c, e–k. Summary table.

	RECRUITS	TOTALBIO	TOTSPBIO	CATCH	YIELD/SSB	F_{BAR} 2–5
1999	2305731	120232	50358	25600	0.508	0.719
2000	1365080	94515	42448	20044	0.472	0.702
2001	626150	85886	50757	23073	0.455	0.778
2002	719054	78311	57627	20976	0.364	0.577
2003	972995	68259	45333	14657	0.323	0.423
2004	990224	83083	39250	16669	0.425	0.405
2005	899817	66943	40891	18907	0.462	0.713
2006	774876	61182	34549	21691	0.628	0.770
2007	983016	69901	29891	17542	0.587	0.890
2008	1291906	63432	25827	8739	0.338	0.502
2009	1877546	79408	34946	10673	0.305	0.385
2010	823287	95221	49749	11522	0.232	0.370
2011	827878	104148	78031	11452	0.147	0.259
2012	628396	109381	84341	12261	0.145	0.176
2013	1577179	142762	78155	14914	0.191	0.218
2014	539974	119800	66763	16824	0.252	0.276
2015	490588	87363	74356	19275	0.259	0.370
2016	356770	71833	54055	22457	0.415	0.520
2017	278325	53102	34901	16198	0.464	0.647
2018	731014	48878	24379	10268	0.421	0.624
Geomean	844529					
Mean	952990	85182	49830	16687	0.370	0.516
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 13. Whiting in Divisions 7.b, c, e–k. Management options table.

Fmult	Catch18	Land18	Dis18	FCatch18	FLand18	FDis18	SSB19
					NA	NA	58900
0	0	0	0	0	NA	NA	39236
0.1	1261	770	491	0.06236	0.04394	0.01841	38151
0.2	2471	1503	968	0.12472	0.08789	0.03683	37114
0.3	3634	2201	1433	0.18707	0.13183	0.05524	36123
0.4	4753	2867	1886	0.24943	0.17577	0.07366	35175
0.5	5828	3502	2326	0.31179	0.21972	0.09207	34268
0.6	6864	4108	2756	0.37415	0.26366	0.11049	33399
0.7	7861	4686	3174	0.4365	0.3076	0.1289	32567
0.8	8821	5239	3583	0.49886	0.35155	0.14731	31770
0.9	9748	5767	3981	0.56122	0.39549	0.16573	31005
1	10641	6271	4370	0.62358	0.43943	0.18414	30270
1.1	11503	6755	4749	0.68593	0.48338	0.20256	29566
1.2	12336	7217	5119	0.74829	0.52732	0.22097	28889
1.3	13141	7660	5481	0.81065	0.57126	0.23939	28238
1.4	13919	8085	5835	0.87301	0.61521	0.2578	27612
1.5	14672	8492	6180	0.93536	0.65915	0.27621	27010
1.6	15400	8882	6518	0.99772	0.70309	0.29463	26431
1.7	16105	9257	6848	1.06008	0.74704	0.31304	25873
1.8	16789	9617	7172	1.12244	0.79098	0.33146	25335
1.9	17451	9963	7488	1.18479	0.83492	0.34987	24817
Additional Catch Options							
Basis20	Catch20	Land20	Dis	FCatch20	FLand20	FDis20	SSB21
FMSY	6481	3885	2597	0.35085	0.24724	0.10361	33720
FMSY Lower	4157	2513	1644	0.22	0.15	0.06	35680
FMSY Upper	8104	4826	3277	0.45	0.32	0.13	32365
F = 0	0	0	0	0	NA	NA	39236

Fmult	Catch18	Land18	Dis18	FCatch18	FLand18	FDis18	SSB19
F = Fpa	13006	7586	5420	0.8	0.56376	0.23624	28347
F = Flim	16762	9603	7159	1.12	0.78926	0.33074	25356
Blim	17216	9841	7376	1.16249	0.8192	0.34328	25000
Bpa	4960	2990	1970	0.26127	0.18412	0.07715	35000
Btrigger	4960	2990	1970	0.26127	0.18412	0.07715	35000
F = F2019	10641	6271	4370	0.62358	0.43943	0.18414	30270
Min FMSY	6017	3613	2404	0.323	0.22762	0.09538	34109
Max FMSY	11286	6633	4653	0.67	0.47215	0.19785	29743
Stable SSB	19001	10760	8240	1.33858	0.9433	0.39529	23615
-15% TAC	30999	16306	14692	3.06844	2.16232	0.90611	14941
Stable TAC	38530	19184	19346	5.00105	3.52423	1.47682	10173
+ 15% TAC	47392	22062	25331	9.07506	6.39518	2.67988	5290

Input units are thousands and kg output in tonnes.

Table 14. Whiting in divisions 7.b, c, e–k. Input values for the catch forecast.

Whiting in the Celtic Sea (7.b,c, e–k), WGCSE 2018, COMBSEX

F_{bar} age range: 2–5

nyears +1

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
1	215817	0.86	0	0	0	0.076	0.007	0.272	0.077	0.132
2	33330	0.65	1	0	0	0.178	0.086	0.348	0.233	0.179
3	16293	0.5	1	0	0	0.295	0.433	0.483	0.165	0.233
4	6151	0.43	1	0	0	0.456	0.617	0.61	0.055	0.317
5	3344	0.4	1	0	0	0.598	0.769	0.713	0.03	0.36
6	1644	0.38	1	0	0	0.72	0.629	0.797	0.026	0.576
7	791	0.36	1	0	0	0.87	0.638	0.902	0.017	0.555

nyears +2

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
1	249330	0.86	0	0	0	0.076	0.007	0.272	0.077	0.132
2	83591	0.65	1	0	0	0.178	0.086	0.348	0.233	0.179
3	12463	0.5	1	0	0	0.295	0.433	0.483	0.165	0.233
4	5292	0.43	1	0	0	0.456	0.617	0.61	0.055	0.317
5	1985	0.4	1	0	0	0.598	0.769	0.713	0.03	0.36
6	972	0.38	1	0	0	0.72	0.629	0.797	0.026	0.576
7	846	0.36	1	0	0	0.87	0.638	0.902	0.017	0.555

nyears +3

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
1	249330	0.86	0	0	0	0.076	0.007	0.272	0.077	0.132
2	96572	0.65	1	0	0	0.178	0.086	0.348	0.233	0.179
3	31258	0.5	1	0	0	0.295	0.433	0.483	0.165	0.233
4	4048	0.43	1	0	0	0.456	0.617	0.61	0.055	0.317
5	1708	0.4	1	0	0	0.598	0.769	0.713	0.03	0.36
6	577	0.38	1	0	0	0.72	0.629	0.797	0.026	0.576
7	633	0.36	1	0	0	0.87	0.638	0.902	0.017	0.555

Input units are thousands and kg output in tonnes.

Table 15. Whiting in Divisions 7.e–k. The detailed output for the *status quo* F forecast by age group.

NYears+1

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
							971263	21594		
1	0.008	1609	437	0.081	10728	1421	215817	16496	0	0
2	0.09	2499	870	0.244	4579	818	33330	5943	33330	5943
3	0.452	3610	1744	0.172	2500	582	16293	4805	16293	4805
4	0.644	2080	1268	0.057	502	159	6151	2804	6151	2804
5	0.803	1356	967	0.032	247	89	3344	1999	3344	1999
6	0.657	639	509	0.027	53	31	1644	1184	1644	1184
7	0.666	295	266	0.018	40	22	791	688	791	688
Total	0.497	12088	6061	0.126	18649	3122	1121899	57566	61553	17423

NYears+2

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
							971263	21594		
1	0.008	1859	505	0.081	12394	1641	249330	19057	0	0
2	0.09	6269	2182	0.244	11484	2051	83591	14904	83591	14904
3	0.452	2761	1334	0.172	1912	445	12463	3676	12463	3676
4	0.644	1790	1091	0.057	432	137	5292	2412	5292	2412
5	0.803	805	574	0.032	147	53	1985	1187	1985	1187
6	0.657	378	301	0.027	32	18	972	700	972	700
7	0.666	316	285	0.018	43	24	846	736	846	736
Total	0.497	14178	6272	0.126	26444	4369	1199008	66319	105149	23615

NYears+3

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
							971263	21594		
1	0.008	1859	505	0.081	12394	1641	249330	19057	0	0
2	0.09	7242	2520	0.244	13267	2369	96572	17219	96572	17219
3	0.452	6925	3346	0.172	4796	1117	31258	9219	31258	9219
4	0.644	1369	835	0.057	331	105	4048	1845	4048	1845
5	0.803	692	494	0.032	126	45	1708	1021	1708	1021
6	0.657	224	179	0.027	19	11	577	416	577	416
7	0.666	236	213	0.018	32	18	633	551	633	551
Total	0.497	18547	8092	0.126	30965	5306	1228655	72975	134796	30271

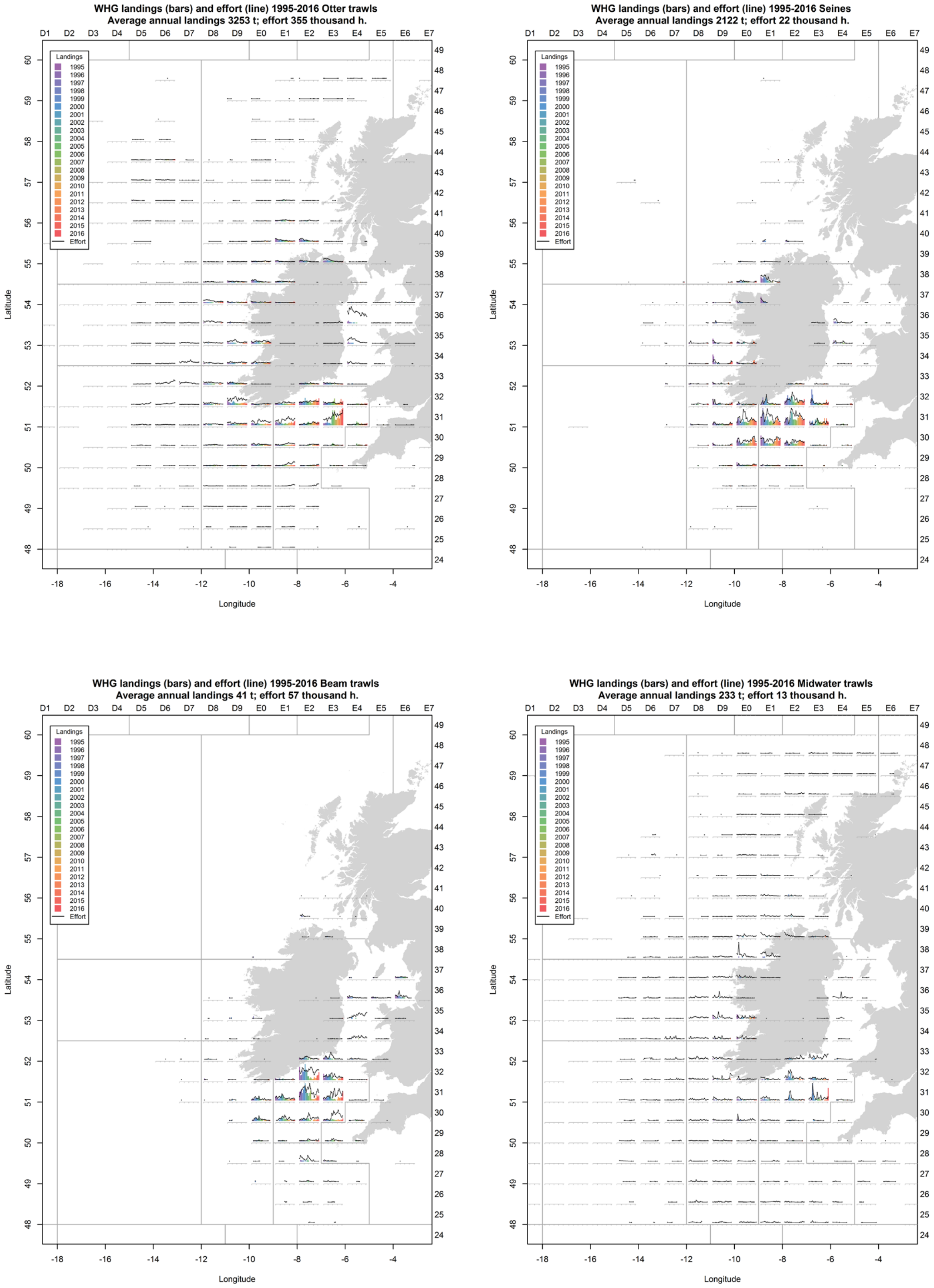
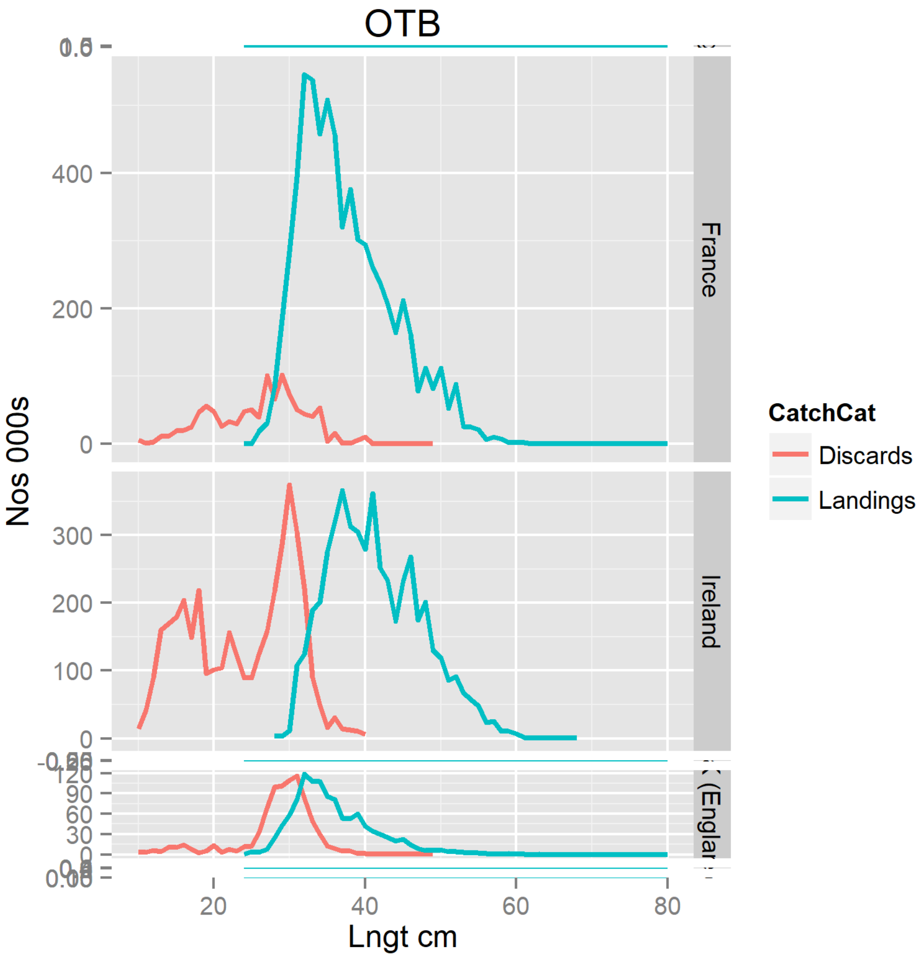
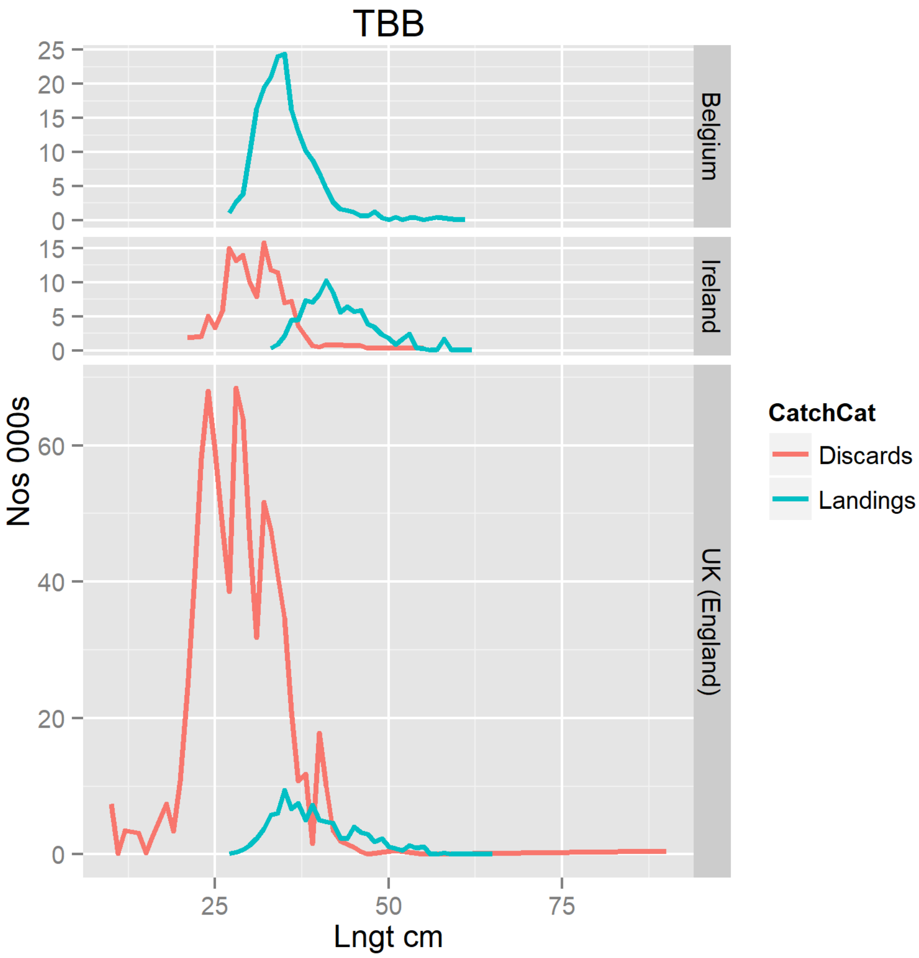


Figure 1. Irish landings for the main gear types in 1995–2016, along with annual average.


OTB
Nos 000s
Lngt cm
France
Ireland
K (Englar
CatchCat
Discards
Landings
0
200
400
100
300
30
60
90
120
20
40
60
80


TBB
Belgium
Ireland
UK (England)
Nos 000s
Lngt cm
25
20
15
10
5
0
60
40
20
50
75
CatchCat
Discards
Landings

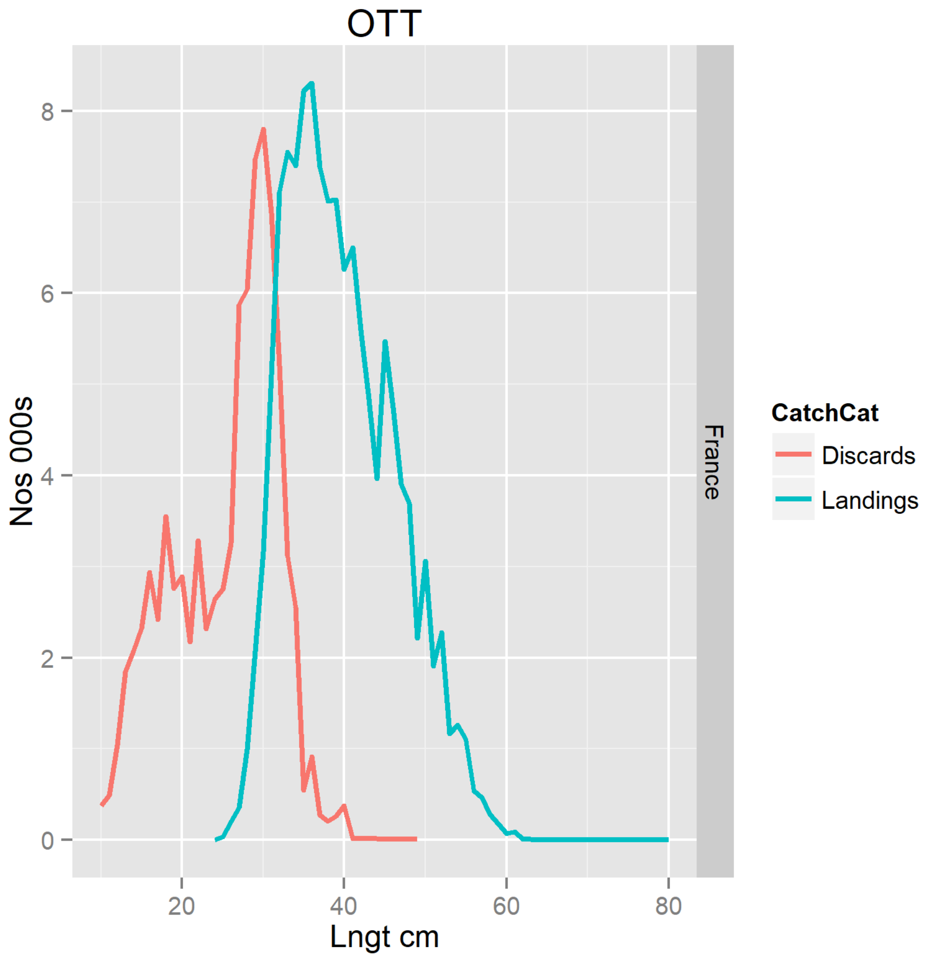


Figure 2. Whiting in 7.b, c, e–k (Celtic Sea). 2018 length compositions (raised numbers 000's) of French, UK and Irish Landings (LAN) and Discards (DIS) available in InterCatch for the main fleets.

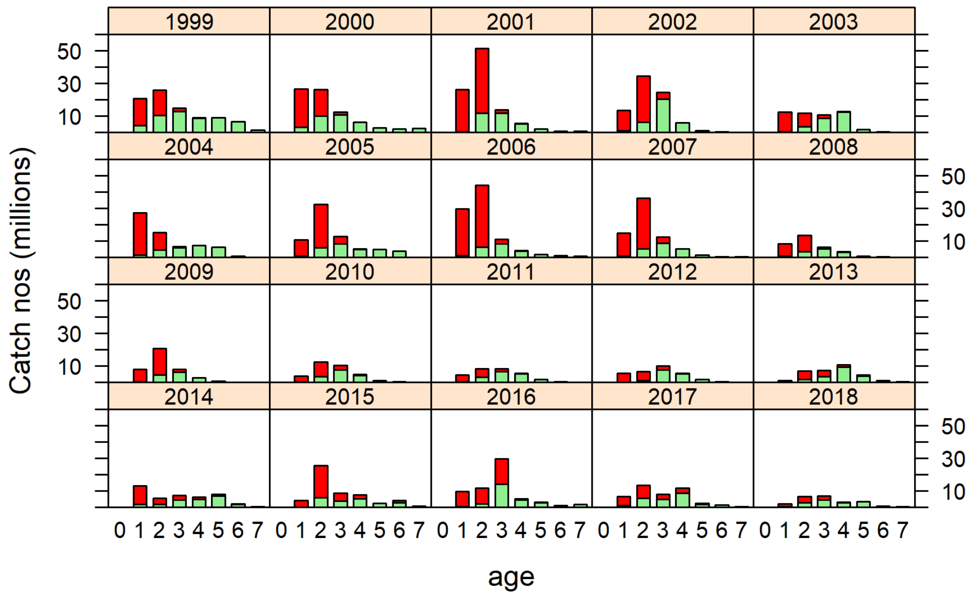


Figure 3. Whiting in 7.b, c, e–k (Celtic Sea), annual Landings (green) and Discards (red) by age composition.

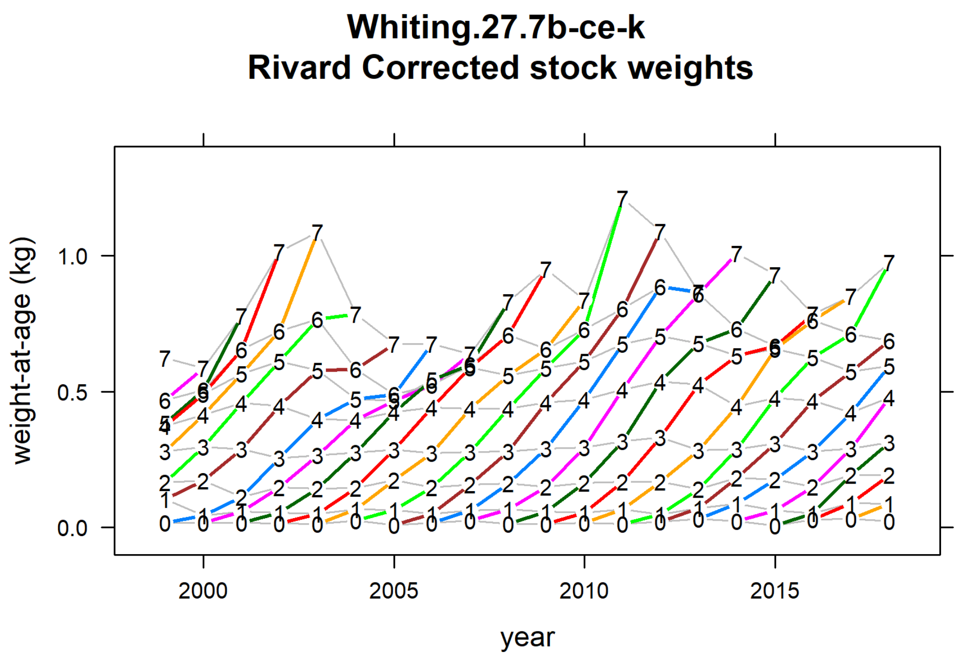


Figure 4. Whiting in 7.b, c, e–k (Celtic Sea). Rivard corrected stock weights-at-age.

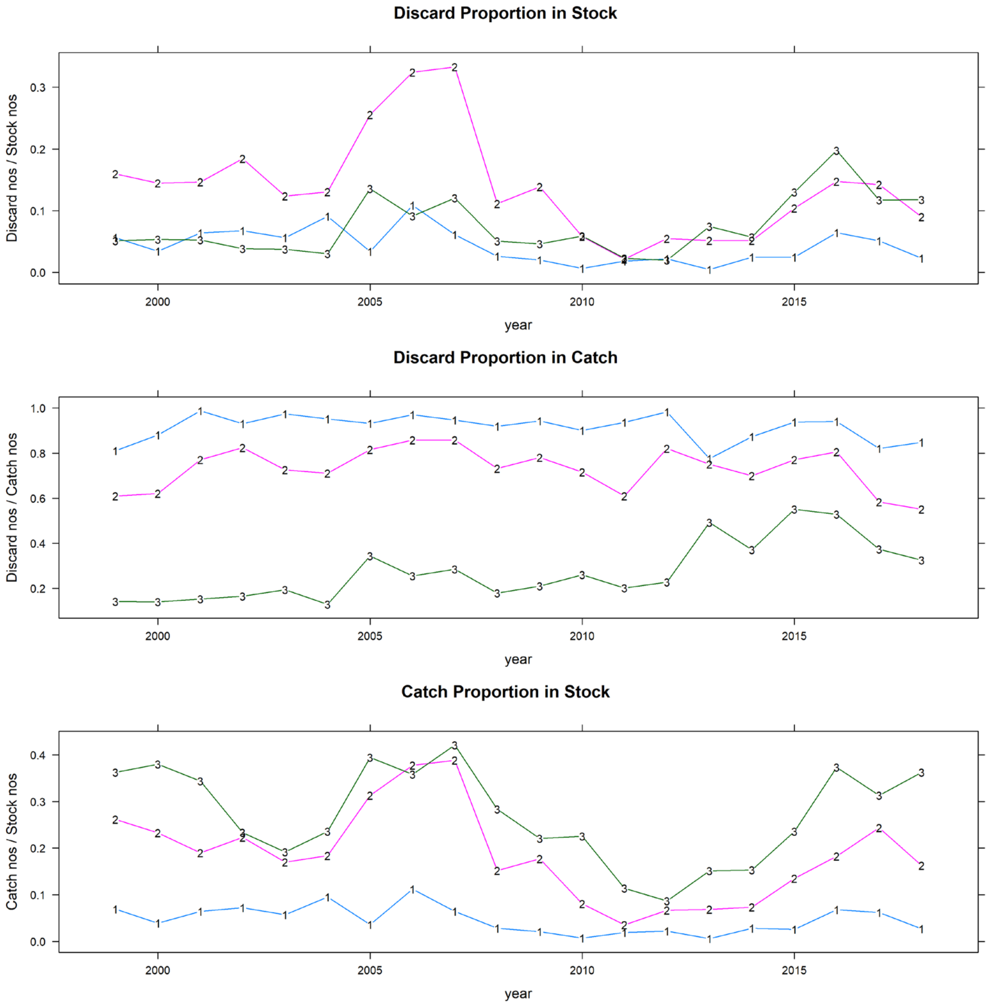


Figure 5. 2018 Annual proportions-at-age of Discard nos in the Stock (above); Discard nos in the Catch (middle) and Catch nos in the Stock (below) from the assessment.

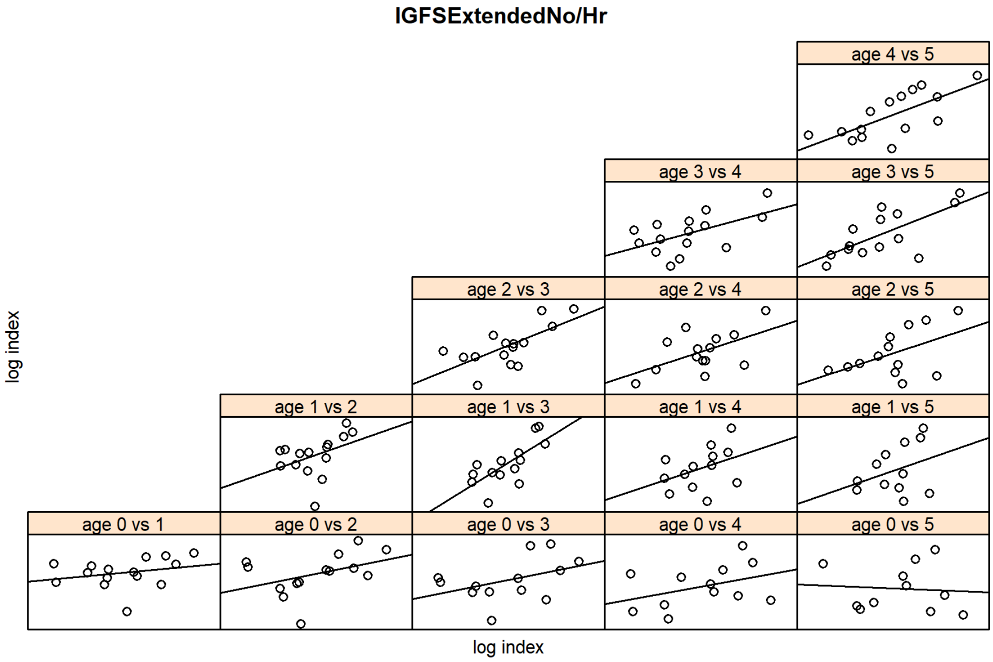
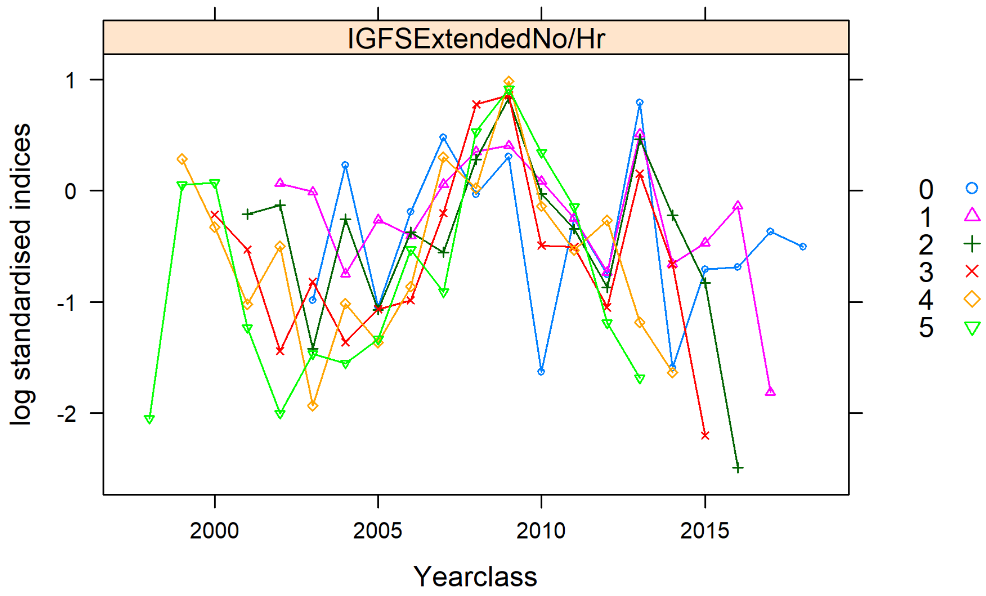


Figure 6. Whiting in 7.b, c, e–k (Celtic Sea). Pairwise scatterplots for the log numbers-at-age for the IGFS-EVHOE combined survey index.



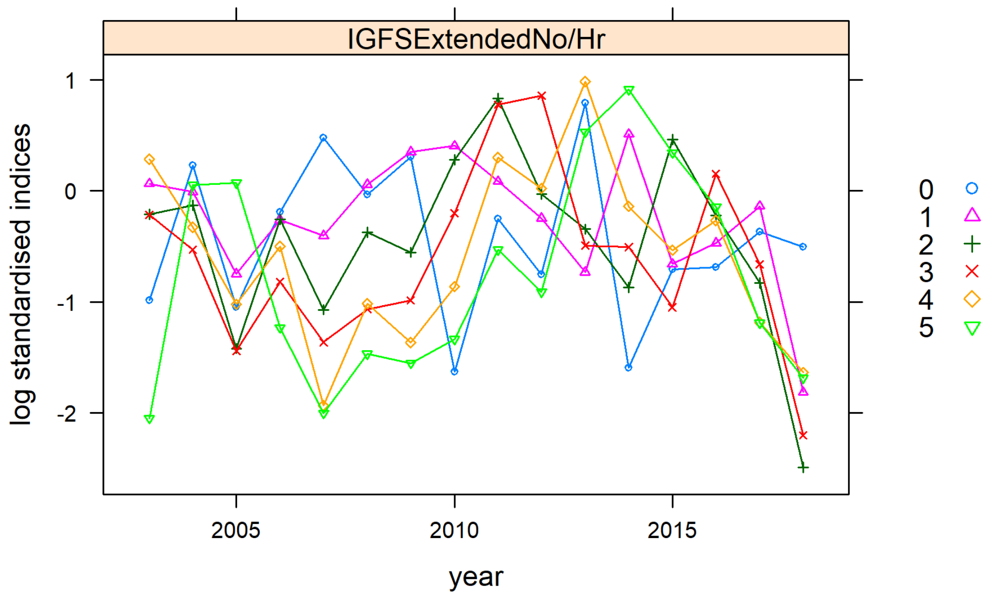


Figure 7. Whiting in 7.e–k (Celtic Sea). Mean log standardized plots of indices by year class (top panel) and by year (lower panel).

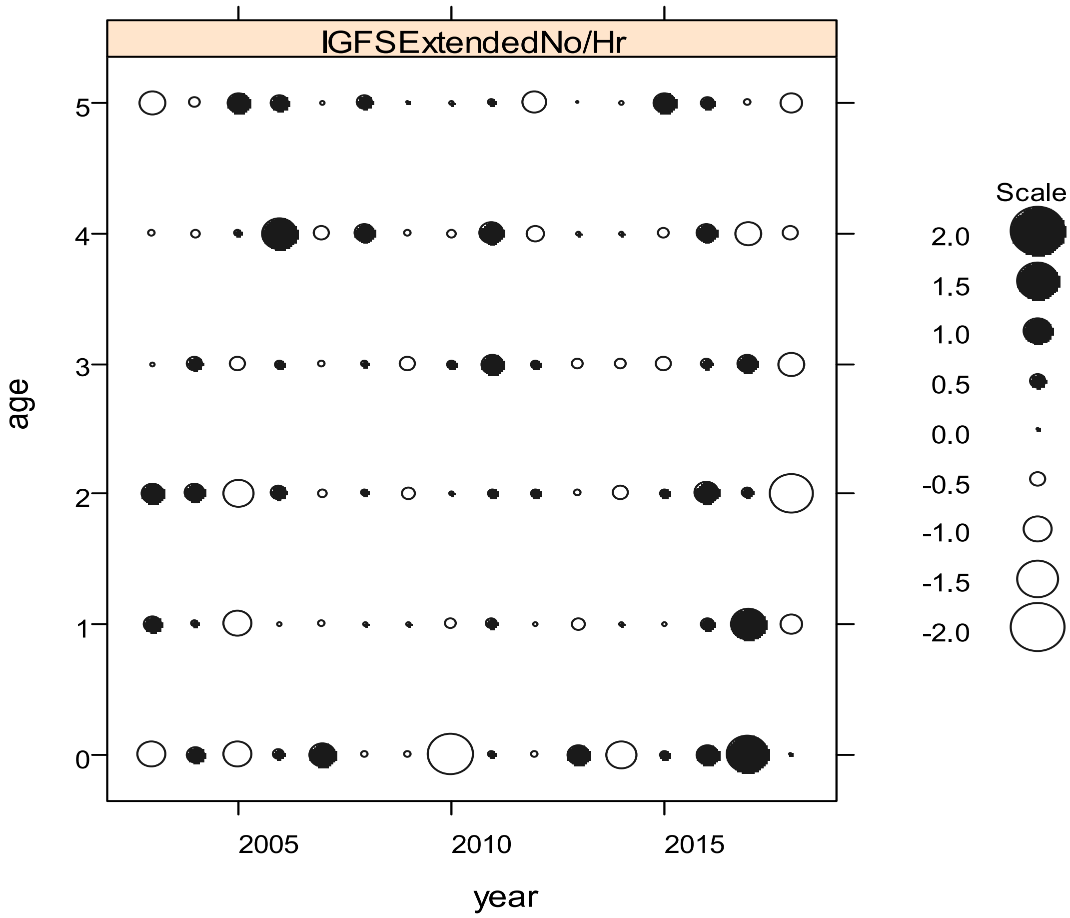


Figure 8. Whiting in 7.b, c, e–k (Celtic Sea). Log fleet catchability residuals bubble plots.

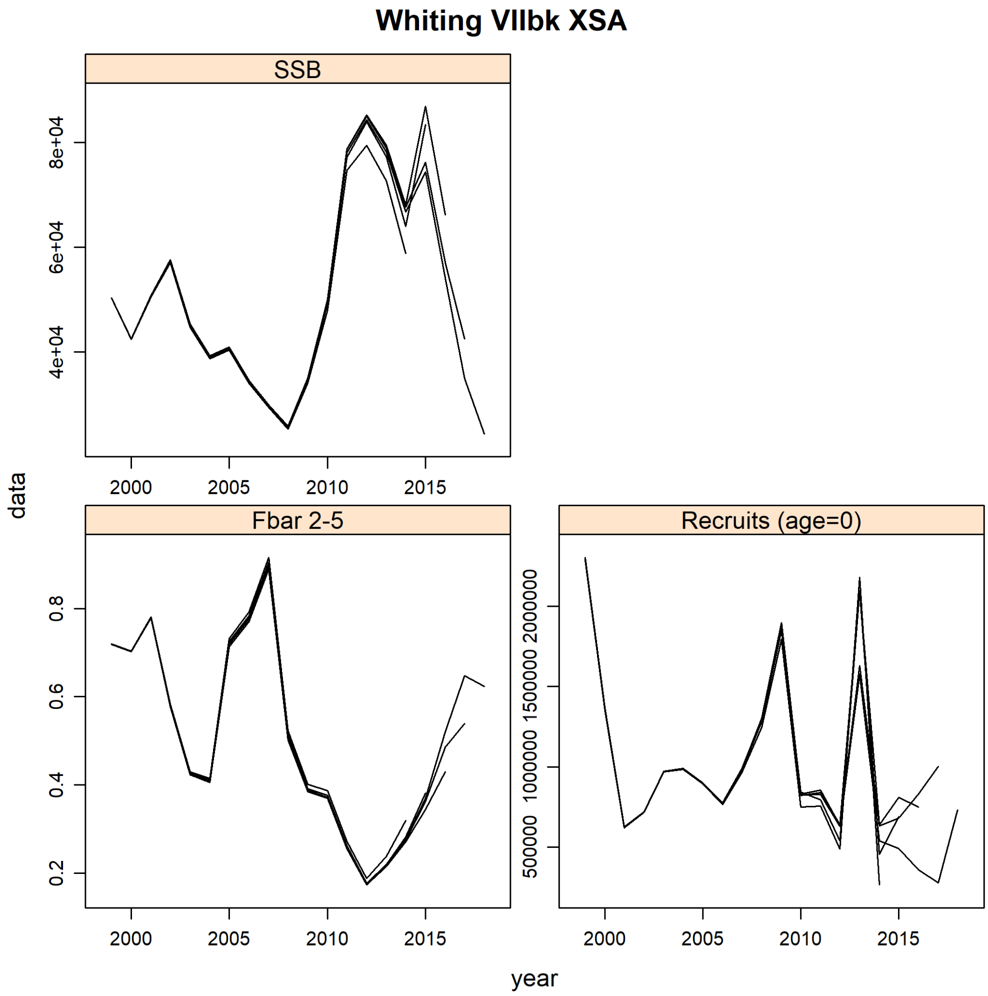


Figure 9. Whiting in 7.b, c, e–k (Celtic Sea). Retrospective analysis.

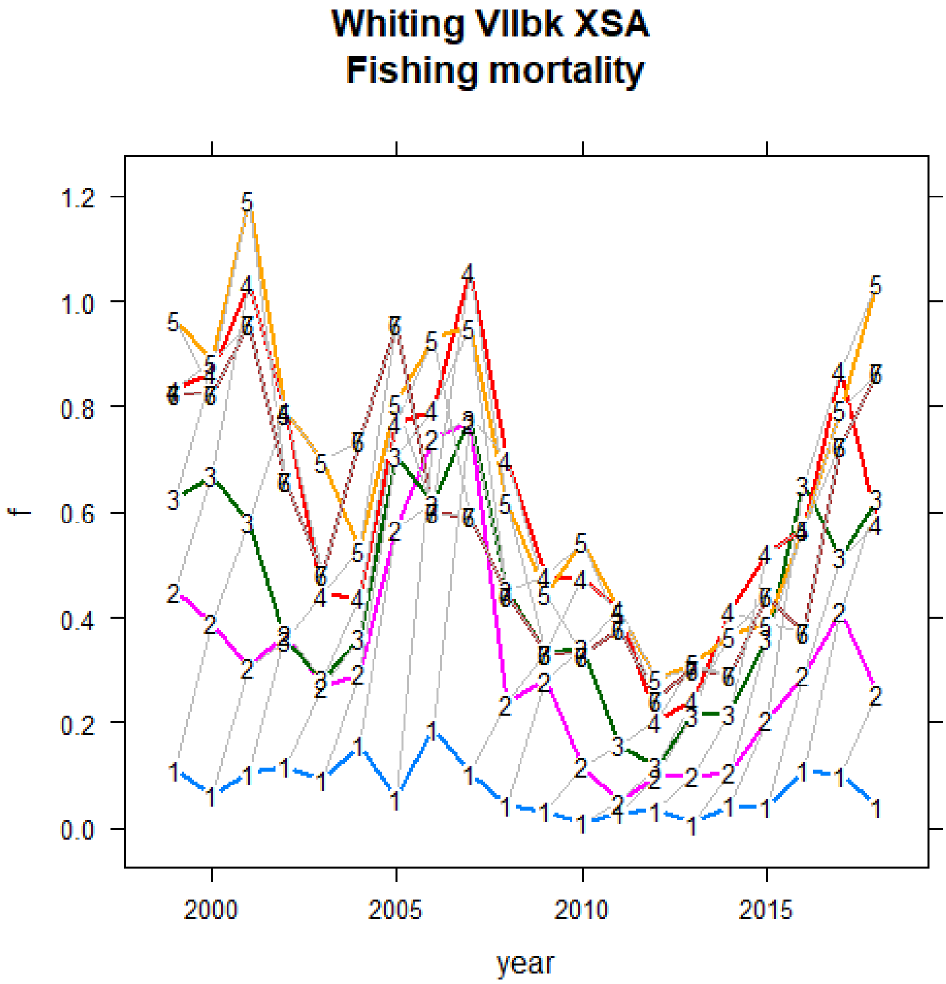


Figure 10. Whiting in 7.b, c, e–k (Celtic Sea). Fishing mortality-at-age.

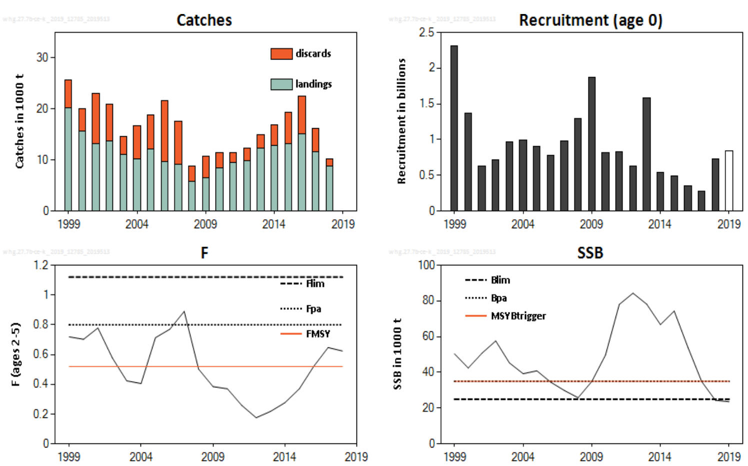


Figure 11. Whiting in 7.b, c, e–k (Celtic Sea). Stock summary.

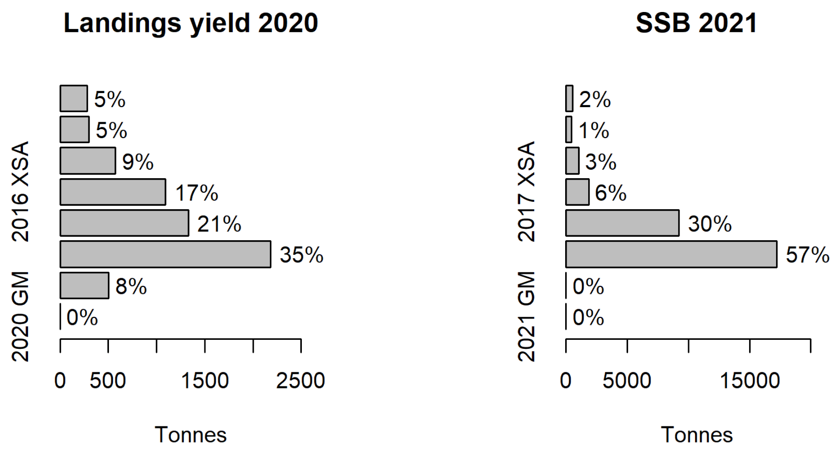


Figure 12. Whiting in Divisions 7.b, c, e–k. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Annex 1: List of participants

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Annex 2: Stock Annexes

The table below provides an overview of the WGCSE Stock Annexes. Stock Annexes for other stocks are available on the ICES website Library under the Publication Type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion*, *species*, and *acronym* of the relevant ICES expert group.

Stock ID	Stock name	Last updated	Link
anf.27.3a46	Anglerfish (*Lophius budegassa*, *Lophius piscatorius*) in subareas 4 and 6, and in Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat)	October 2019	Anglerfish 3.a46
bss.27.4bc7d–h	Seabass (*Dicentrarchus labrax*) in divisions 4.b–c, 7.a, and 7.d–h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel, and Celtic Sea)	March 2018	Sea bass 47
cod.27.7e–k	Cod (*Gadus morhua*) in divisions 7.e–k (eastern English Channel and southern Celtic Seas)	March 2016	Cod 7.e–k
cod.27.7a	Cod (*Gadus morhua*) in Division 7.a (Irish Sea)	March 2017	Cod 7.a
cod.27.6b	Cod (*Gadus morhua*) in Division 6.b (Rockall)	May 2013	Cod 6.b
cod.27.6a	Cod (*Gadus morhua*) in Division 6.a (West of Scotland)	March 2019	Cod 6.a
gug-celt	Grey gurnard in Subarea 6 and Divisions 7.a–c and e–k	March 2014	Grey gurnard
had.27.7b–k	Haddock (*Melanogrammus aeglefinus*) in divisions 7.b–k (southern Celtic Seas and English Channel)	May 2017	Haddock 7.b–k
had.27.7a	Haddock (*Melanogrammus aeglefinus*) in Division 7.a (Irish Sea)	May 2019	Haddock 7.a
had.27.6b	Haddock (*Melanogrammus aeglefinus*) in Division 6.b (Rockall)	September 2019	Haddock 6.b
had.27.46a20	Haddock (*Melanogrammus aeglefinus*) in Subarea 4, Division 6.a and Subdivision 20 (North Sea, West of Scotland, Skagerrak)	May 2009	Haddock 6.a
lez.27.4a6a	Megrim (*Lepidorhombus* ssp.) in divisions 4.a and 6.a (northern North Sea, West of Scotland)	May 2016	Megrim 4a6a

Stock ID	Stock name	Last updated	Link
nep.fu.11	Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 11 (West of Scotland, North Minch)	May 2016	*Nephrops* FU11
nep.fu.12	Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 12 (West of Scotland, South Minch)	May 2016	*Nephrops* FU12
nep.fu.13	Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 13 (West of Scotland, the Firth of Clyde and Sound of Jura)	May 2017	*Nephrops* FU13
nep.fu.14	Norway lobster (*Nephrops norvegicus*) in Division 7.a, Functional Unit 14 (Irish Sea, East)	September 2018	*Nephrops* FU14
nep.fu.15	Norway lobster (*Nephrops norvegicus*) in Division 7.a, Functional Unit 15 (Irish Sea, West)	May 2018	*Nephrops* FU15
nep.fu.16	Norway lobster (*Nephrops norvegicus*) in divisions 7.b–c and 7.j–k, Functional Unit 16 (west and southwest of Ireland, Porcupine Bank)	March 2013	*Nephrops* FU16
nep.fu.17	Norway lobster (*Nephrops norvegicus*) in Division 7.b, Functional Unit 17 (west of Ireland, Aran grounds)	May 2016	*Nephrops* FU17
nep.fu.19	Norway lobster (*Nephrops norvegicus*) in divisions 7.a, 7.g, and 7.j, Functional Unit 19 (Irish Sea, Celtic Sea, eastern part of south-west of Ireland)	October 2019	*Nephrops* FU19
nep.fu.2021	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h, functional units 20 and 21 (Celtic Sea)	October 2019	*Nephrops* FU2021
nep.fu.22	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.f, Functional Unit 22 (Celtic Sea, Bristol Channel)	May 2018	*Nephrops* FU22
nep.fu.2324	Norway lobster (*Nephrops norvegicus*) in divisions 8.a and 8.b, functional units 23–24 (northern and central Bay of Biscay)		Not available
ple.27.7bc	Plaice (*Pleuronectes platessa*) in divisions 7.b–c (West of Ireland)	April 2013	Plaice 7.bc
ple.27.7h–k	Plaice (*Pleuronectes platessa*) in divisions 7h–k (Celtic Sea South, southwest of Ireland)	May 2014	Plaice 7.h–k
ple.27.7fg	Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)	May 2018	Plaice 7.fg
ple.27.7e	Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel)	April 2016	Plaice 7.e
ple.27.7a	Plaice (*Pleuronectes platessa*) in Division 7.a (Irish Sea)	May 2019	Plaice 7.a
sol.27.7bc	Sole (*Solea solea*) in divisions 7.b and 7.c (West of Ireland)	April 2013	Sole 7.bc

Stock ID	Stock name	Last updated	Link
sol.27.7h–k	Sole (*Solea solea*) in divisions 7.h–k (Celtic Sea South, Southwest of Ireland)	May 2014	Sole 7.h–k
sol.27.7fg	Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)	May 2019	Sole 7.fg
sol.27.7e	Sole (*Solea solea*) in Division 7.e (western English Channel)	May 2017	Sole 7.e
sol.27.7a	Sole (*Solea solea*) in Division 7.a (Irish Sea)	May 2019	Sole 7.a
whg.27.7b–ce–k	Whiting (*Merlangius merlangus*) in divisions 7.b –c and 7.e–k (southern Celtic Seas and eastern English Channel)	June 2019	Whiting 7.bc,e–k
whg.27.7a	Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea)	May 2017	Whiting 7.a
whg.27.6b	Whiting (*Merlangius merlangus*) in Division 6.b (Rockall)	May 2013	Whiting 6.b
whg.27.6a	Whiting (*Merlangius merlangus*) in Division 6.a (West of Scotland)	May 2017	Whiting 6.a

Annex 3: Working documents

The following working documents were presented to WGCSE in 2019. They are found in full below in the following pages:

WD1: Review of changes in the reference points of bss.27.4bc7ad–h. Arni Magnusson, ICES.

WD2: Update of reference points 2019 for seabass in ICES divisions 4.b,c and 7.a, d–h. Lisa Readdy, Cefas.

WD3: Maturity-at-age estimates for Irish Demersal Stocks in 6.a, 7.a and 7.bgj between 2004–2018. Sara-Jane Moore and Hans Gerritsen, Marine Institute, Galway.

WD4: Pollack life-history parameters for MYAS project. Hans Gerritsen and Katie Thomas, Marine Institute, Galway.

WD5: Revision of the LPUE abundance index for the seabass in areas 4.b,c and 7.a, d–h. Mathieu Woillez[1], Mickael Drogou[1] and Alain Laurec[2]. [1]Ifremer. [2]ENSAR Department Halieutique.

WD6: *Nephrops* in the North Minch (FU11): results of the 2019 UWTV Survey and catch options for 2020. Katie Boyle, Lynda Blackadder and Helen Dobby, Marine Scotland Science.

WD7: *Nephrops* in the South Minch (FU12): results of the 2019 UWTV survey and catch options for 2020. Katie Boyle, Lynda Blackadder and Helen Dobby, Marine Scotland Science.

WD8: *Nephrops* in the Clyde (FU13): results of the 2019 UWTV survey and catch options for 2020. Katie Boyle, Lynda Blackadder and Helen Dobby, Marine Scotland Science.

WD9: Western Irish Sea *Nephrops* Grounds (FU15) 2019 UWTV Survey Report and catch options for 2020. Mathieu Lundy[1], Peter McCorriston[1], Ian McCausland[1], Keith Erskine[1], Katie Lilley[1], Gary Heaney[1],Jim McArdle[1], Aaron Buick[1], Jessica Graham[1], Charlotte Reeve[3] and Jennifer Doyle[2]. [1]Fisheries and Aquatic Ecosystems Branch, Agri-Food & Biosciences Institute. [2]Fisheries Ecosystems Advisory Services, Marine Institute. [3]Centre for Environment, Fisheries and Aquaculture Science, Lowestoft.

WD10: 01 2019 FU2021 SISP datacheck. Mikel Aristegui-Ezquibela and Jennifer Doyle, Marine Institute.

WD11: UWTV camera calibration test, Marine Institute. Mikel Aristegui-Ezquibela, Marine Institute.

WD12: SIAMISS Estimates of Anglerfish Biomass in subareas 4 and 6 for 2019. Elisa Barreto[1], Liz Clarke[1], Gerald McAllister[1], James Dooley[1], Ruadhan Gillespie-Mules[1], Eoghan Kelly[2], Hans Gerritsen[2]. [1]Marine Scotland Science and Marine Institute, Ireland.

Review of changes in the reference points of bss.27.4bc7ad-h

Arni Magnusson

24 June 2019

Background

Seabass in Divisions 4.b-c, 7.a, and 7.d-h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel, and Celtic Sea) is a category 1.2 stock, assessed by WGCSE using the SS3 model.

The basis of this review is the WGCSE WD 03 *Update of reference points 2019 for seabass in ICES Divisions 4.b,c and 7.a, d-h*, the WGCSE draft report, model files on the Sharepoint data folder, and the draft advice sheet. For the purposes of the review, a TAF repository was created (2019_bss.27.4bc7ad-h_review) using the SS3 model output file Report.sso found in the Sharepoint data folder.

Changes were made to the input data in this year's assessment, Landings per Unit of Effort (LPUE) and recreational catches. This causes changes in the estimated stock size and fishing mortalities.

The main reason to revise the reference points is that B_{loss} in the assessment has changed and all other reference points hinge on B_{loss} for this stock. In last year's assessment B_{loss} was SSB_{2016} = 9618 t, but in this year's assessment B_{loss} is SSB_{2018} = 10313 t, an increase of 7%. The effect on reference point values is described below.

Changes in the assessment

Two changes were made to the input data:

1 LPUE indices are now calculated based on 0.99 kg delta-GLM threshold instead of 0.05 kg.

2 Recreational catches were adjusted after the LPUE change, to fulfill the assumption that recreational F was constant in 1985-2014.

Changes in the reference points

Reference point	2018	2019	Change
MSY $B_{trigger} = B_{pa}$	13465	14439	+7%
F_{MSY}	0.203	0.1713	-16%
$B_{lim} = B_{loss}$	9618	10313	+7%
F_{lim}	0.295	0.254	-14%
F_{pa}	0.211	0.1815	-14%

B_{lim} is set to B_{loss}, and B_{pa} is calculated as $1.4 \times B_{lim}$.

F_{MSY} and F_{lim} are estimated with EqSim, and F_{pa} is calculated as $F_{lim}/1.4$.

Comments

- The changes in the assessment stem from a consensus in the WG that it was incorrect to use 0.05 kg as a delta-GLM threshold for calculating the LPUE indices. The WG decided to fix this error in the analysis for the 2019 assessment.

- The changes in the reference points seem to be justified and correctly calculated.

- In the EqSim analysis, F_{MSY} and F_{lim} are reduced to maintain the stock above a somewhat higher B_{lim} than was used in last year's advice.

- The WD, report, and draft advice sheet have reference point tables showing $F_{MSY} = 0.1713$, $F_{lim} = 0.254$, Fpa = 0.1815. In the WD text, they are also specified with higher precision, but in the advice sheet these reference points should perhaps be rounded to $F_{MSY} = 0.171$, $F_{lim} = 0.25$, Fpa = 0.182.

- In the WD, there is a minor typo where B_{lim} is specified as 10303 t in the text, but in all other places it is 10313 t.

Update of reference points 2019 for seabass in ICES Divisions 4.b,c and 7.a, d-h.

Lisa Readdy

Cefas

Introduction

In 2019 a corrected set of input data was provided for the Landings per Unit of Effort series, When including the new series the vector of recreational catch also required an update in order to maintain the assumption of constant fishing mortality for the timeseries 1985 to 2014. This impacted on the output estimation of biomass, total mortality and recruitment changing the perception of the stock. Due to these updates in input data, reference points were recalculated to reflect the change in the perception of the stock. This document sets out the process in defining reference points for the Northern stock of bass, bss.27.4.b,c & 7.a,d-h. The approach taken was to run the analysis with the 2019 update assessment using the stock synthesis framework 3.24u (Methot & Wetzel, 2013. The final proposed reference points are provided in table 3.

Materials and Methods

Data

The output files from the recent 2019 accepted assessment using stock synthesis was used to calculate reference points (Table 1). These files were produced during the assessment working group for the Celtic Seas Ecoregion.

Methods

The same software, EqSim, as used in 2018 (ICES, 2018) was used to calculate the update reference points (Table 1) following the standard ICES guidance for category 1 and 2 stocks (ICES, 2017). An R scripts was used to transform the stock synthesis output into the format required for the EqSim software. The same R script as that used during WKBass 2018 was updated and used to produce the reference points

Settings

Natural mortality (M) of 0.24 as accepted at the 2018 benchmark and used in the accepted assessment was used in the calculation of reference points.

The range of ages used F_{bar} is the same as that used in the accepted assessment and forecast, this includes the range of ages 4 to 15 years.

With the recent implementation of management measures, increase in minimum conservation reference size, for this stock the number of years used in the reference point calculation was set at 4 years. This is an increase on that used during WKBass which was only 2 years.

Other biological input data remains as a 10 year timeseries 2009 to 2018.

Although the three stock recruitment relationships were considered, the segmented regression stock-recruitment relationship was selected using the same rational as that described in the recent benchmarks (ICES, 2016 and ICES, 2018) for bass. While the stock recruitment relationship used in the assessment is Beverton and Holt, the steepness parameter is fixed at 0.999 as accepted at the benchmark. This setting gives a relationship with no clear signal between stock size and recruitment.

Recruitment for this stock is influenced by environmental conditions such as water temperature and any stock-recruitment relationship is difficult to detect under these conditions.

Results

Stock recruitment relationship and calculation of biomass Precautionary Approach (PA) reference points.

The weighted stock recruitment fits are presented in Figure 1. When the three stock recruitment (S-R) relationships where used, Ricker S-R was weighted the highest with it being selected 76% of the time. Most of the difference between each of the S-R relationships are below the level of SSB where there is no available data, SSB below 10, 000 tonnes. This difference is also true for the weighted Beverton-Holt and Segmented regression, with the segmented regression being selected 75% of the time. Because most of the difference occurs where data are not available this supports the decision made to just use the segmented regression Figure 2.

Given the S-R relationship and following the ICES guidance this stock could be considered and a potential type 1 or type 5 stock.

- *Type 1: Spasmodic stocks – stocks with occasional large year classes.*
- *Type 5: Stocks showing no evidence of impaired recruitment or with no clear relation between stock and recruitment (no apparent S-R signal).*

Given the outcome of the assessment and available evidence the stock remains as a type 5 which was also agreed at WKBass therefore B_{lim} is set to B_{loss} and the Segmented regression was recalculated with the breakpoint at B_{lim} (figure 3).

With B_{lim} set to B_{loss} (10 303 tonnes), Bpa could then be calculated at follows.

- B_{pa} = Blim*1.4
- *B_{pa} = Blim x exp(1.645 x σ) where σ is the uncertainty estimated from the model.*

As the assessment underestimates the uncertainty, not all uncertainty is accounted for in the model, and the uncertainty is less than the default the first option was used giving a final value of 14 439 tonnes.

Calculation of fishing motality PA reference points, F_{pa} and F_{lim}.

F_{lim} and F_{pa} was estimated using the EqSim software was used with the settings for Fcv, Fphi and MSY Btrigger set to zero (i.e. no assessment/advice error and no MSY $B_{trigger}$ used). The S-R used was that selected from the previous exercise, a segmented regression with the breakpoint equal to B_{lim}.

F_{lim} is estimated as the fishing mortality that, at equilibrium from a long-term stochastic projection, leads to a 50% probability of having SSB above B_{lim}. F_{lim} was estimated to be **0.2541203**, and F_{pa} is estimated to be **0.1815145** based on the following equation [$F_{pa} = F_{lim} \times 1.4^{-1}$]. The Alternative calculation, $F_{pa} = F_{lim} \times \exp \times -1.645 \times \sigma$, was not used as not all uncertainty is taken into account and the value is less than the default setting for σ.

Calculation of MSY reference points, F_{MSY}, F_{lower}, F_{upper} and MSY $B_{trigger}$.

Initially, F_{MSY} is calculated as the fishing mortality that maximises median long-term yield in stochastic simulations under constant F exploitation (i.e. without MSY $B_{trigger}$). Using the same simulation method with the inclusion of assessment/advice error default values: Fcv=0.212, Fphi=0.423 from WKMSYREF3 (ICES, 2015) and shown in table 1. F_{MSY} = 0.196997 and is thus above F_{pa} = 0.1815145, see figure 4 and 5. In such a case, F_{MSY} is reduced to F_{pa} (i.e. F_{MSY} cannot exceed F_{pa}).

ICES defines MSY $B_{trigger}$ as the 5th percentile of the distribution of SSB when fishing at F_{MSY}. However if the stock has not been fished at F_{MSY}, as in this case, table 2, then MSY $B_{trigger}$ is set to B_{pa}.

For this final run, assessment/advice error were included using the same default values and MSY $B_{trigger}$ was Set to 14 439 tonnes. As shown in figure 6, EqSim output $F_{p.05}$ (fishing mortality that gives 5% probability of SSB below B_{lim}) equals 0.1712511. As F_{MSY} estimated in the first run is above $F_{p.05}$, then F_{MSY} is further reduced to $F_{p.05}$, 0.1712511. F_{lower} was adjusted accordingly to take account of F_{MSY} rescaling to $F_{p.05}$. F_{upper} was set to the same value as $F_{p.05}$ as F_{MSY} was estimated as greater than $F_{p.05}$.

Tables

Table 1. Settings and inputs for the calculation of reference points.

DATA AND PARAMETERS	SETTING	COMMENTS
SSB-recruitment data	Full data series (years classes 1985-2018)	
Exclusion of extreme values (option extreme.trim)	No	
Trimming of R values	No	
Mean weights and proportion mature; natural mortality	These parameters are constant in SS·, the same values used.	
Exploitation pattern	2015-2018	
Assessment error in the advisory year. CV of F	0.212	Default value calculated from 5 stocks in WKMSYREF3 (ICES, 2015)
Autocorrelation in assessment error in the advisory year	0.423	Default value calculated from 5 stocks in WKMSYREF3 (ICES, 2015)

Table 2. F_{bar} for last 10 years above F_{MSY}

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
F_{bar}	0.201	0.233	0.217	0.236	0.271	0.218	0.197	0.121	0.099	0.078

Table 3: Summary table of proposed updated reference points using the WGCSE 2019 accepted assessment.

Stock	Seabass in ICES Divisions 4.b,c and 7.a, d-h.		
PA Reference points	Value 2019	Rational	
B_{lim}	10 313	Lowest observed SSB (Type 5 S-R relationship)	
B_{pa}	14 439	$B_{lim} \times 1.4$	
F_{lim}	0.254	In equilibrium gives a 50% probability of SSB>B_{lim}	
F_{pa}	0.1815	$F_{pa} = F_{lim} / 1.4$	
MSY Reference point			
F_{MSY}	0.1713 (0.197)	Reduce as F_{MSY}>F_{PA}>$F_{P.05}$	With WKMSYREF4 default values for assessment/advice error
$F_{MSY\ lower}$	0.142	Reduce as F_{MSY}>F_{PA}>$F_{P.05}$	
$F_{MSY\ upper}$	0.1713	Reduce as F_{MSY}>F_{PA}>$F_{P.05}$	
MSY $B_{trigger}$	14 439		

Figures

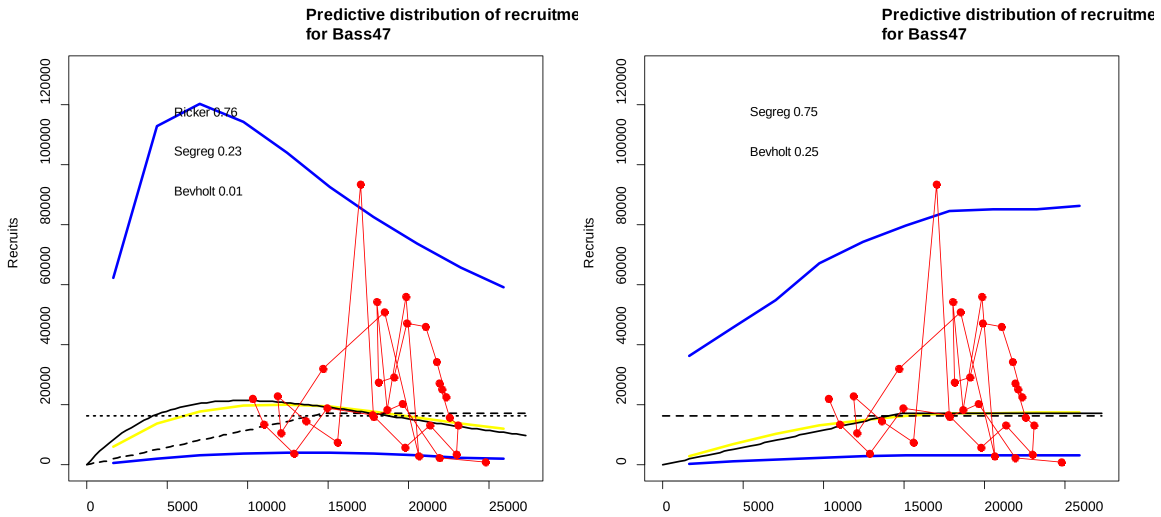

Figure 1. Stock recruitment model fit. The x-axis corresponds to SSB (tonnes). Left: Weighted S-R for Ricker, Beverton-Holt and Segmented regression. Right: Weighted S-R for Beverton-Holt and Segmented regression.

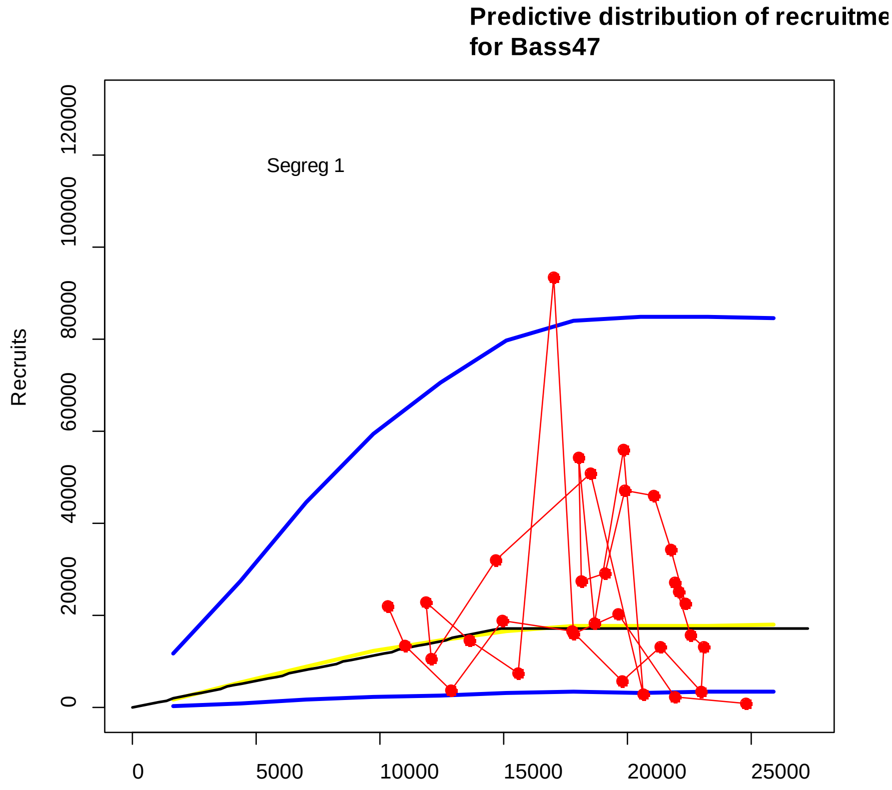

Figure 2. Stock recruitment model fit. Segmented regression, the x-axis corresponds to SSB (tonnes).

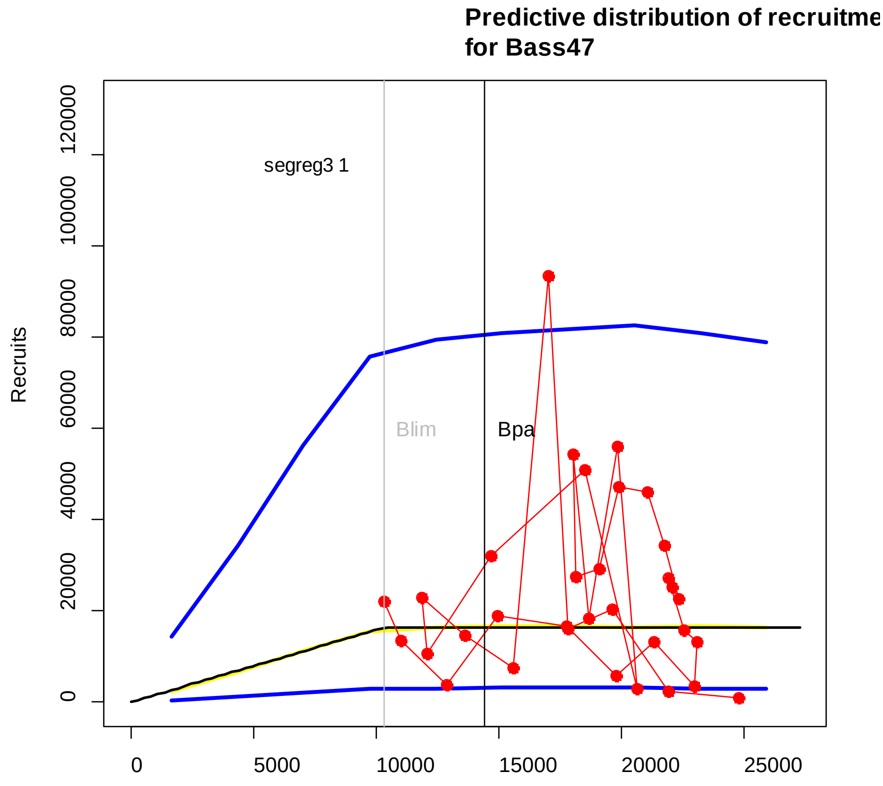

Figure 3. Stock recruitment model fit. Segmented regression fixing breakpoint at B_{lim}=B_{loss}, the x-axis corresponds to SSB (tonnes).

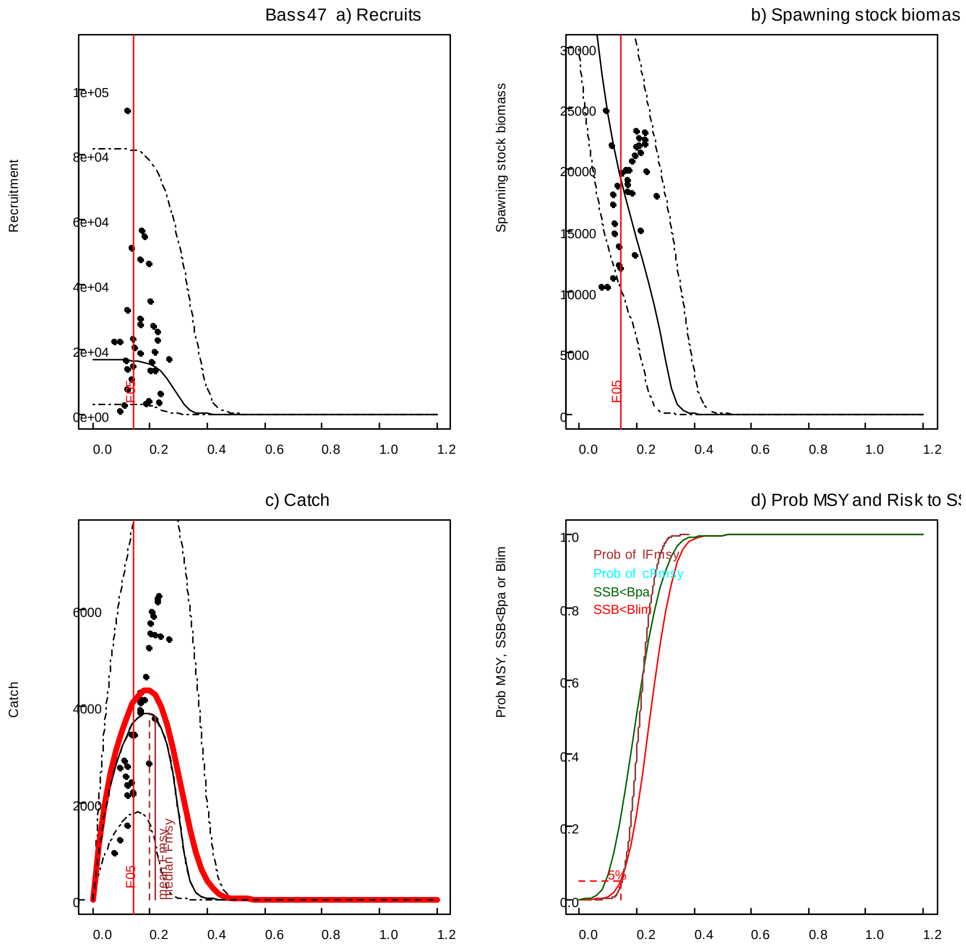

Figure 4. EqSim summary plot without MSY $B_{trigger}$. Panels a to c: historic values (dots) median (solid black) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. Panel c also shows mean landings (red solid line). Panel d shows the probability of SSB<B_{lim} (red), SSB<B_{pa} (green) and the cumulative distribution of FMSY based on yield as landings (brown).

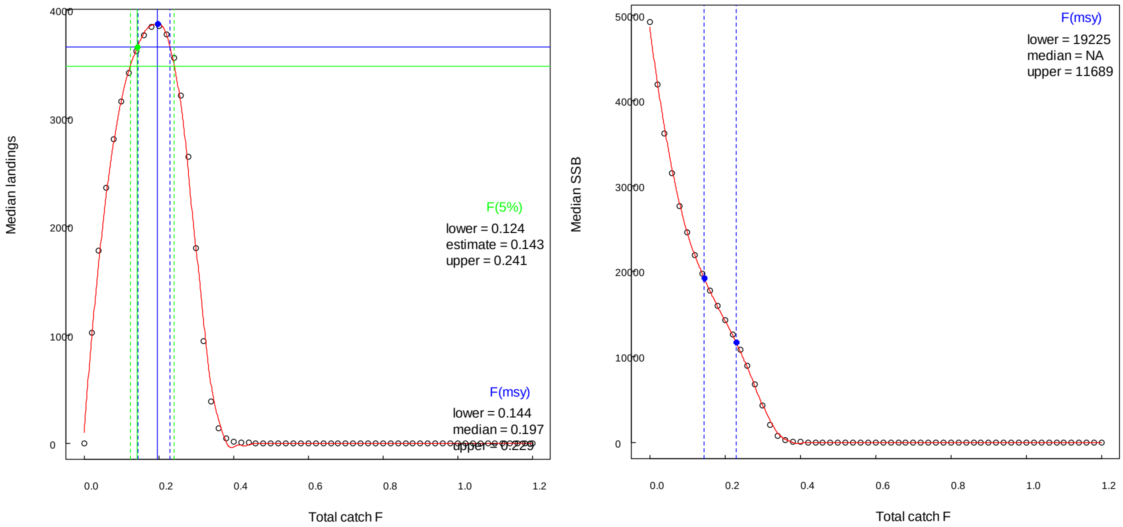

Figure 5. Left) Eqsim median landings yield curve with estimated reference points without MSY $B_{trigger}$. Blue lines: F_{MSY} estimate (solid) and range at 95% of maximum yield (dotted). Green lines: F (5%) estimate (solid) and range at 95% of yield implied by F (5%) (Dot-ted). Right) EqSim median SSB curve with estimated reference points without MSY $B_{trigger}$. Blue dots: lower and upper SSB corresponding to lower and upper F_{MSY}.

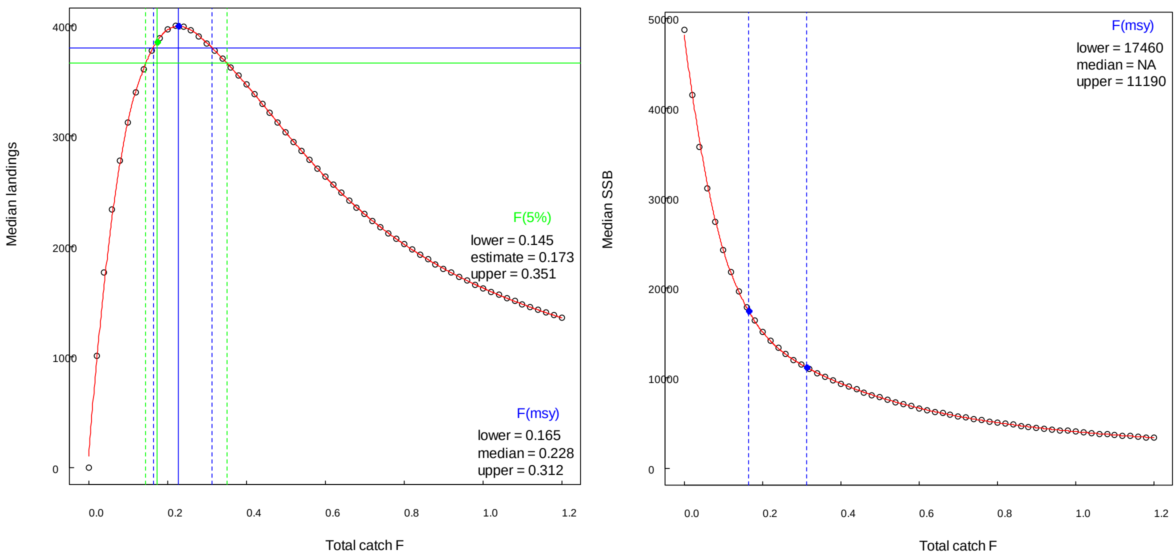

Figure 6. Eqsim median landings yield curve with estimated reference points with Btrigger. Blue lines: F_{MSY} estimate (solid) and range at 95% of maximum yield (dotted). Green lines: F (5%) estimate (solid) and range at 95% of yield implied by F (5%) (Dotted).

References

ICES. 2015. Report of the joint ICES-MYFISH workshop to consider the basis for FMSY ranges for all stocks (WKMSYREF3), 17-21 November 2014, Charlottenlund, Denmark.. ICES CM 2014/ACOM:64. 156 pp.

ICES. 2016. Report of the Second Inter-Benchmark Protocol for Sea Bass in the Irish Sea, Celtic Sea, English Channel, and Southern North Sea (IBP–Bass2). By correspondence. ICES CM 2016/ ACOM:31. 191 pp.

ICES. 2017. ICES fisheries management reference points for category 1 and 2 stocks. ICES Advice 2017, Book 12, Section 12.4.3.1.

ICES. 2018. Report of the Benchmark Workshop on Seabass (WKBASS), 20–24 February 2017 and 21–23 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM:44. 259 pp.

Methot, R. D., and Wetzel, C. R. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research, 142: 86-99.

Working document X

ICES Working Group for the Celtic Seas Ecoregion
8–17 May 2019
Ghent, Belgium

ICES Working Group for the Assessment of the Bay of Biscay and the Iberic waters Ecoregion
2–9 May 2019
Lisbon, Portugal

Maturity-at-age estimates for Irish Demersal Stocks in 6.a, 7.a and 7.bgj between 2004-2018

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Introduction
This document provides maturity-at-age estimates for stocks assessed by the WGCSE and WGBIE. All data are obtained on surveys and commercial sampling carried out by the Marine Institute.

Methods
Data was used from the Marine Institute Q1 Biological sampling programme (2010-2018), At-Sea Observer programme (2010-2018), Irish Anglerfish and megrim survey (2016-2018), the Irish beam trawl Ecosystem survey (2016-2018) and the MI Biological sampling survey (2004-2009). Proportions mature-at-age were estimated by constructing a matrix containing the sample numbers by age, sex and maturity state (mature/immature) at each length class. Unsexed individuals (usually small fish with undeveloped gonads) were assigned in equal numbers to both sexes. This Age-Sex-Maturity-Length Key (ASMLK) was applied to the length-frequency data to estimate the proportions mature-at-age for either sex and both sexes combined. Any gaps in the ASMLK were filled in using a multinomial model (Gerritsen et al., 2006).

Results
Figure 1 shows that for most stocks there are no clear trends in the L50 over time. Estimates for cod in area 7 (cod 7) varied from around 40cm to 60cm, however the sample sizes for this stock were generally very low at the start of the time-series; in recent years the estimates are were quite variable (around 40cm). Sole in 7 also exhibited variable estimates in recent years. Plaice in area 7 (ple 7) had an outlying estimate for 2013 but this was estimated with low precision. Because overall there was no clear evidence of trends in maturity over time for any stock, data from all years (2004-2018) were combined. Table 1. Shows the estimated

proportions mature-at-age. For the cod stocks, the proportion of mature 2-year-olds is somewhat higher than that the proportions used by the working group. For other ages the estimates are very similar. For haddock in 7.b-k the Irish estimates are slightly lower for 2-year-olds and in agreement for the other ages. For haddock in 7.a the Irish estimates are similar to those used by WGCSE, 2018 for all ages. For haddock in 6.a the Irish estimates for age 2 were higher than the proportions used by the WGNSSK working group. For megrim, the Irish estimates were very close for females of ages 2 to 4, for ages 5 to 8 the Irish estimates were somewhat lower than those used by the WGBIE working group. Estimated proportions mature for plaice and sole were also slightly lower than those used by the working group. For whiting in 7.b-k, the Irish maturity estimates are broadly in agreement with the ogives used by the working group, for the other whiting stocks the Irish estimates are considerably higher for the 0-group and similar for older fish.

Discussion

Some (relatively minor) differences were found between the ogives used by the working groups and the current findings. Because Irish sampling generally does not cover the full extent of the stocks, it is difficult to determine whether the Irish estimates are unbiased. It is possible that the lack of full spatial coverage can explain some of the differences.

References

Gerritsen, H.D., Armstrong, M.J., Allen, M., McCurdy, W.J. and Peel, J.A.D., 2003. Variability in maturity and growth in a heavily exploited stock: whiting (Merlangius merlangus L.) in the Irish Sea. J. Sea Res., 49(1): 69-82.

Gerritsen, H.D., McGrath, D. and Lordan, C., 2006. A simple method for comparing age-length keys reveals significant regional differences within a single stock of haddock (Melanogrammus aeglefinus). ICES J. Mar. Sci., 63(3): 1096-1100.

ICES, 2018. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 9-18 May, 2018, ICES CM 2018/ACOM:13

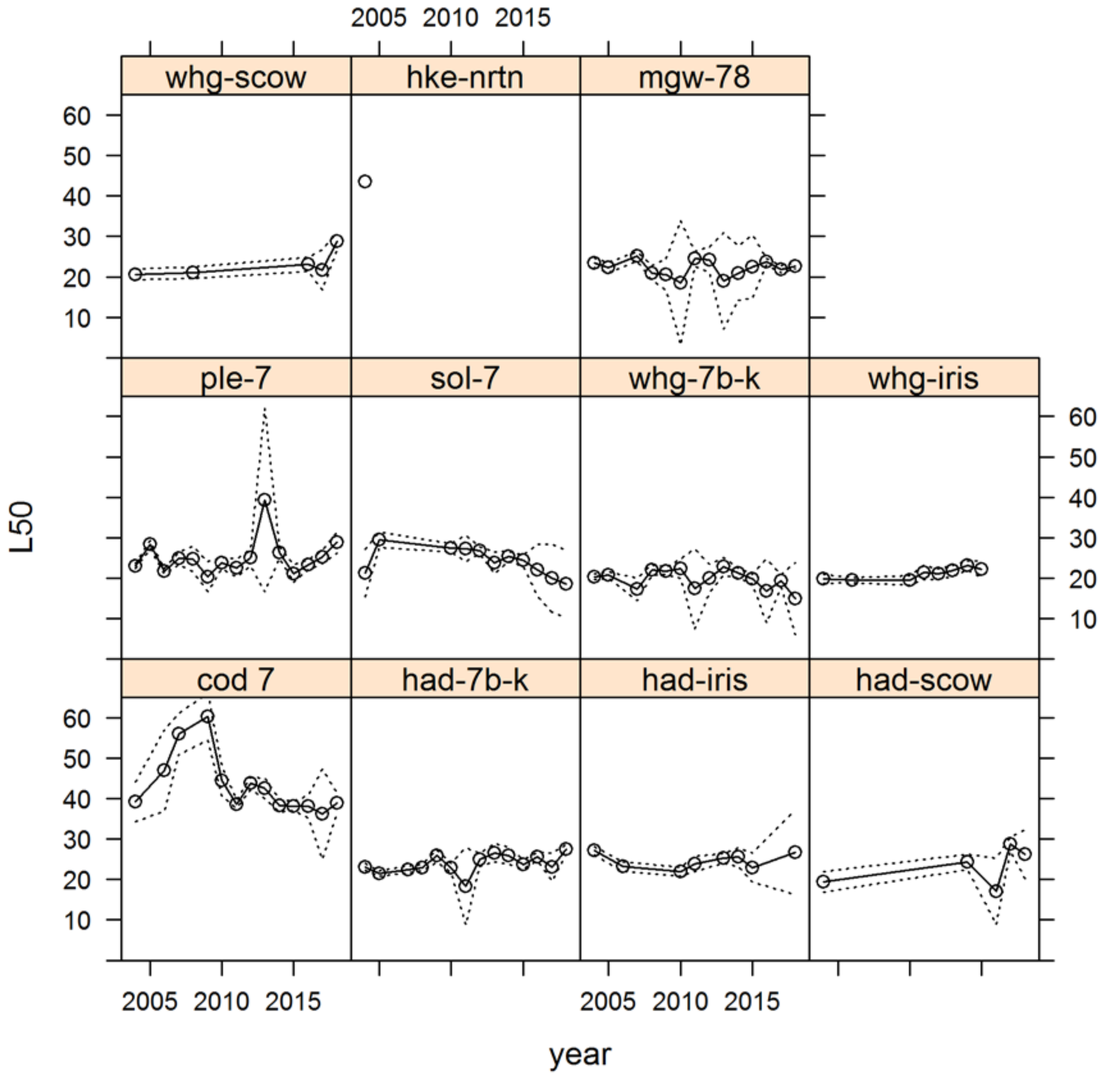


Figure 1. Length at 50% maturity (L50; cm) for females by stock and year.

Table 1. Estimated proportions mature (sample numbers in brackets) by stock, sex and age. Maturity ogives used by the WG are also given.

Stock	Sex/WG	1	2	3	4	5	6	7	8	9	10+
cod 7	**F**	0.02 (760)	0.60 (942)	0.95 (120)	1.00 (20)	1.00 (3)	1.00 (3)	1.00 (2)			
	M	0.01 (922)	0.75 (1494)	0.98 (133)	1.00 (14)	1.00 (2)					
cod 7.a	**WGCSE**	0	0.64	1	1	1	1	1	1	1	1
cod 7.e-k	**WGCSE**	0	0.39	0.87	0.93	1	1	1	1	1	1
had 7.b-k	**F**	0.01 (384)	0.89 (888)	0.98 (714)	0.98 (247)	1.00 (107)	1.00 (58)	1.00 (47)	1.00 (21)	1.00 (10)	1.00 (3)
	M	0.27 (493)	0.79 (726)	0.89 (482)	0.89 (172)	1.00 (81)	1.00 (30)	0.96 (19)	1.00 (15)	1.00 (4)	1.00 (1)
	WGCSE	0	1	1	1	1	1	1	1	1	1
had 7.a	**F**	0.02 (154)	0.78 (198)	0.96 (129)	1.00 (5)	1.00 (5)					
	M	0.14 (112)	0.72 (183)	0.87 (125)	1.00 (3)	1.00 (1)					
	WGCSE	0	0.72	0.99	1	1	1	1	1	1	1
had 6.a	**F**	0.05 (17)	0.91 (192)	0.82 (204)	0.83 (168)	0.94 (31)	0.96 (64)	0.98 (49)	1.00 (35)	0.91 (24)	1.00 (5)
	M	0.05 (35)	0.75 (150)	0.67 (132)	0.72 (80)	0.94 (12)	0.71 (18)	0.65 (12)	0.34 (11)	0.43 (7)	
	WGNSSK	0	0	1	1	1	1	1	1	1	1
mgw 78	**F**	0.10 (14)	0.25 (534)	0.67 (1096)	0.87 (840)	0.88 (539)	0.88 (372)	0.84 (192)	0.85 (141)	0.92 (125)	1.00 (1)
	M	0.66 (15)	0.35 (580)	0.54 (699)	0.69 (387)	0.71 (234)	0.75 (176)	0.85 (139)	0.90 (74)	0.94 (31)	
	WGHMM	0.04	0.21	0.6	0.9	0.98	1	1	1	1	1
ple 7	**F**	0.00 (13)	0.14 (222)	0.45 (720)	0.65 (547)	0.78 (406)	0.94 (164)	0.92 (98)	0.86 (50)	0.93 (18)	0.98 (28)
	M	0.00 (14)	0.31 (249)	0.57 (518)	0.72 (380)	0.81 (208)	0.87 (108)	0.87 (52)	0.91 (39)	0.83 (14)	1.00 (9)
ple 7.a	**WGCSE**	0	0.24	0.57	0.74	0.93	1	1	1	1	1
ple 7.fg	**WGCSE**	0	0.26	0.52	0.86	1	1	1	1	1	1
sol 7	**F**	0.00 (2)	0.17 (40)	0.47 (402)	0.65 (698)	0.87 (473)	0.93 (274)	0.96 (174)	0.98 (100)	0.95 (82)	0.96 (139)
	M		0.22 (22)	0.45 (81)	0.51 (127)	0.59 (96)	0.71 (132)	0.70 (118)	0.76 (113)	0.69 (73)	0.78 (164)
sol 7.fg	**WGCSE**	0	0.14	0.45	0.88	0.98	1	1	1	1	1
whg 7.b-k	**F**	0.29 (564)	0.96 (661)	0.98 (392)	0.99 (172)	1.00 (56)	1.00 (10)	1.00 (2)	1.00 (1)		
	M	0.49 (618)	0.82 (516)	0.95 (347)	0.85 (159)	0.80 (54)	1.00 (16)	1.00 (2)	1.00 (1)		
	WGCSE	0	1	1	1	1	1	1	1	1	1
whg 7.a	**F**	0.11 (295)	0.92 (281)	0.99 (144)	1.00 (22)	1.00 (4)					
	M	0.23 (239)	0.77 (148)	0.74 (48)	1.00 (9)	1.00 (5)					
	WGCSE	0	1	1	1	1	1	1	1	1	1
whg 6.a	**F**	0.44 (63)	0.90 (166)	0.93 (167)	0.92 (109)	0.96 (43)	1.00 (13)	1.00 (4)	1.00 (2)		0.00 (1)
	M	0.54 (77)	0.68 (136)	0.48 (119)	0.66 (54)	0.79 (13)	0.64 (12)	0.72 (6)	1.00 (1)		
	WGCSE	0	1	1	1	1	1	1	1	1	1

Pollack life-history parameters for MYAS project

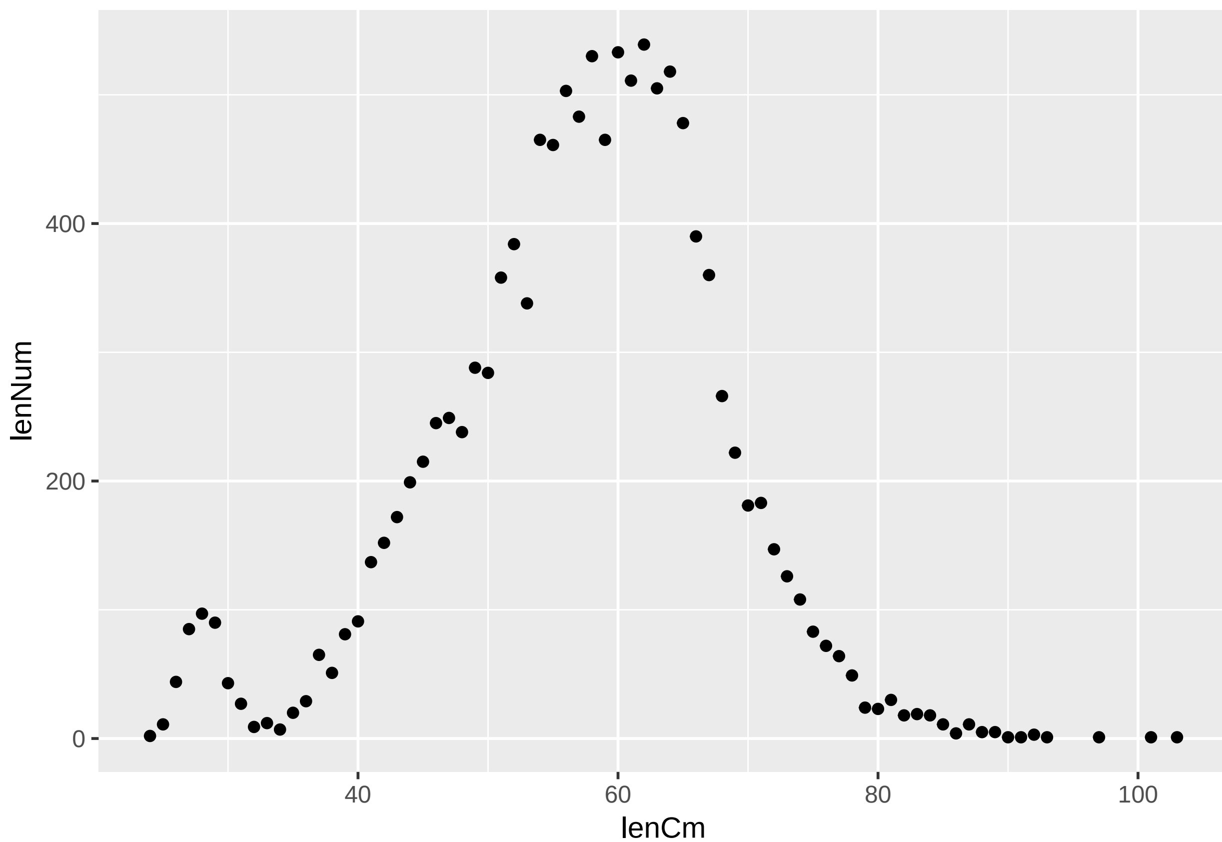
Hans Gerritsen, Katie Thomas

26 November 2018

MYDAS

The MYDAS project https://github.com/laurieKell/mydas requires realistic life-history parameters for each of the case-study stocks. By default these are obtained from http://www.fishbase.org but the quality of these parameters are difficult to judge. In regard to Pollack the Marine Institute, Ireland (MI) has a reasonable amount of data available from surveys, observer trips and port sampling. Age data are available for the landings data for 2016 and 2017 and also for a number of surveys.

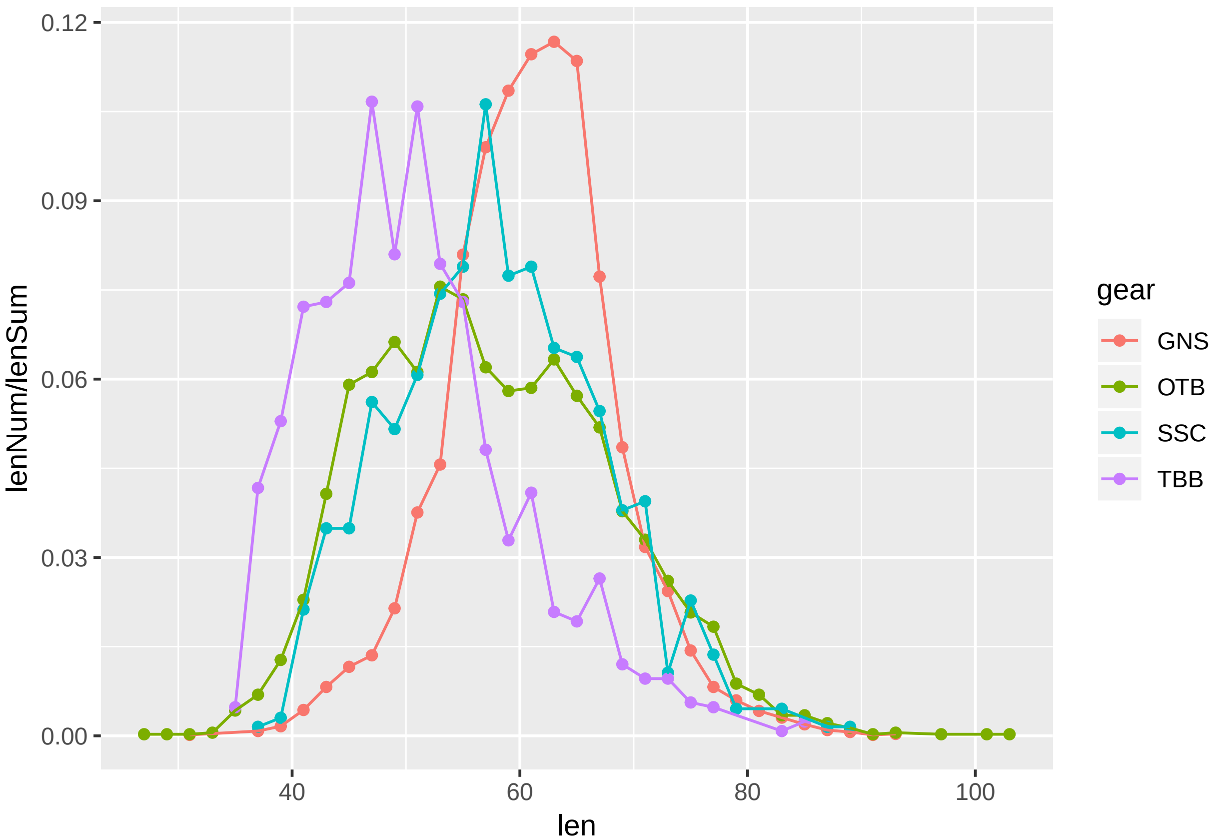
Length frequency of the landings



The largest observed fish is 103 cm. That can inform us about Linf. If the growth curve flattens off in the older fish, we would expect the largest fish to be a couple of standard deviations above Linf, therefore, Linf would be assumed to be above 80cm.

Note: There is a proportion of fish below 30cm. (This is due to the fish originating from a single sample and could well be species mis-identification)

Length-frequency by gear



Most of the landings are from gillnets, other gears seem to catch relatively more fish below 50cm suggesting the gillnets may have a higher L50 for gear selectivity (perhaps they operate in areas where smaller fish are not available). There is no obvious difference in the selectivity of the larger fish (with gillnets we expect a dome-shaped selection). Perhaps otter trawls and seines catch a few more fish >70cm relative to gillnets.

Note: There is also the issue of availability; younger fish simply do not seem to be available to the commercial fishery (probably due to remaining inshore during the juvinile stages). Beam trawls seem to catch the smallest pollack.

Biological data

Age data is available fish from the landings in 2016-17 from the IAMS (anglerfish) surveys 2016-17, also from IBES (beam trawl) 2016-17 and from IGFS (IBTS) 2016-17. Some individual weights and maturity data are available from other IGFS surveys.

```
## # A tibble: 16 x 7
## # Groups:   dataType [?]
##    dataType dataSource total  aged   sex   mat    wt
##    <fct>    <fct>      <int> <int> <int> <int> <int>
##  1 Landings Lan2015        4     0     4     4     4
##  2 Landings Lan2016      438   436     0    NA   438
##  3 Landings Lan2017      646   645     0    NA   646
##  4 Landings Lan2018      623     0     0    NA   621
##  5 Survey   IAMS2016      36    36    36    36    36
##  6 Survey   IAMS2017      39    39    39    39    39
```

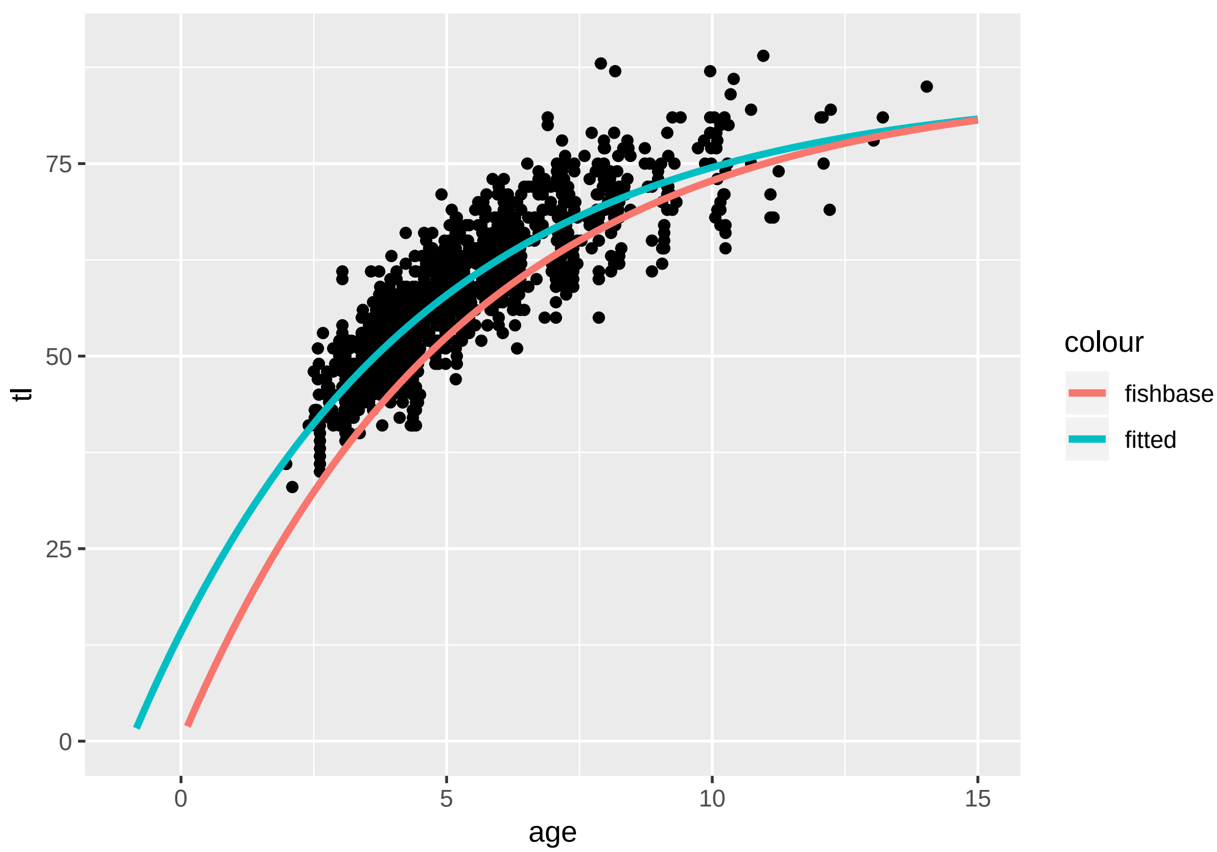
```
##   7 Survey   IBES2016       1     1     1     1     1
##   8 Survey   IBES2017       3     2     3     3     3
##   9 Survey   IGFS2010      38     0    38    38    38
## 10 Survey   IGFS2011      38     0    38    38    38
## 11 Survey   IGFS2012      23     0    23    23    23
## 12 Survey   IGFS2013      82     0    82    82    82
## 13 Survey   IGFS2014      42     0    41    42    42
## 14 Survey   IGFS2015       9     0     9     9     9
## 15 Survey   IGFS2016      24    24    24    24    24
## 16 Survey   IGFS2017      18    18    18    18    18
```

Growth

Fitting a VBGF to the raw age data gives the parameters below. **Note:** that there may be some bias due to length-stratified sampling.

```
##       Linf          K         t0
## 84.6191408  0.1941284 -0.9428006
```

These parameters are very **similar** to those given by fishbase (Linf=85.6,k=0.19,t0=0) except for t0. The fishbase parameters do not fit very well, **due to** the difference in t0.

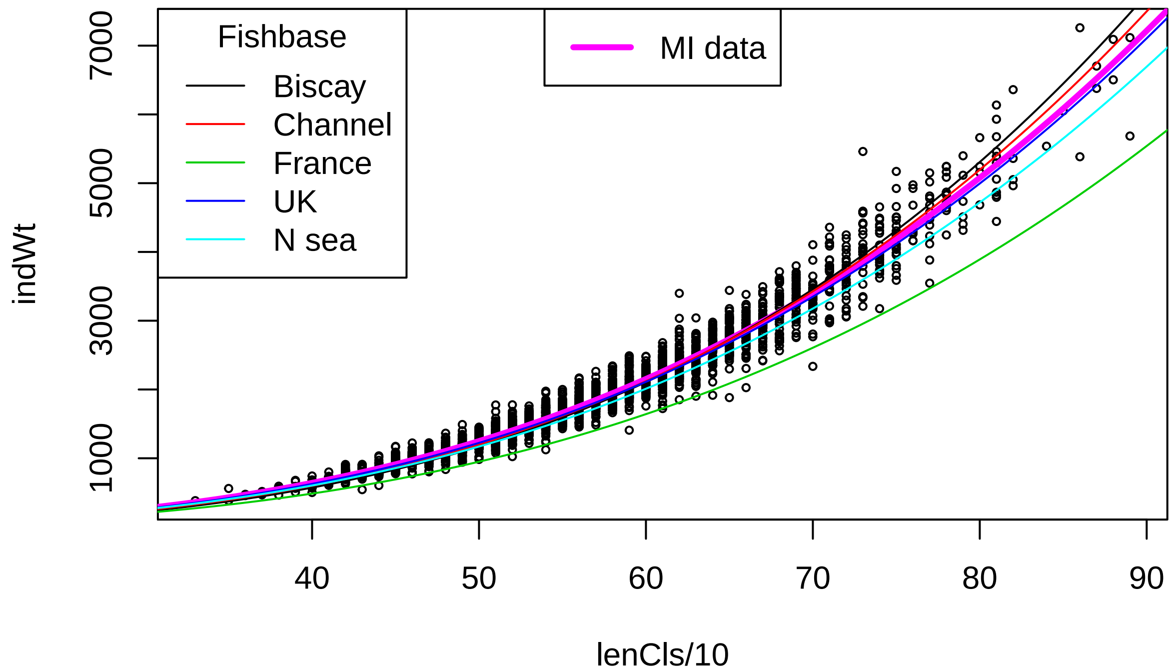


Conclusion: do not use the fishbase parameters but those based on MI data: Linf = 84.6; k = 0.19; t = -0.94

Length-weight

```
##
## Call:
## lm(formula = log(indWt) ~ log(lenCls/10))
##
## Coefficients:
##    (Intercept)  log(lenCls/10)
##         -4.541           2.984
```

Compare MI data to fishbase

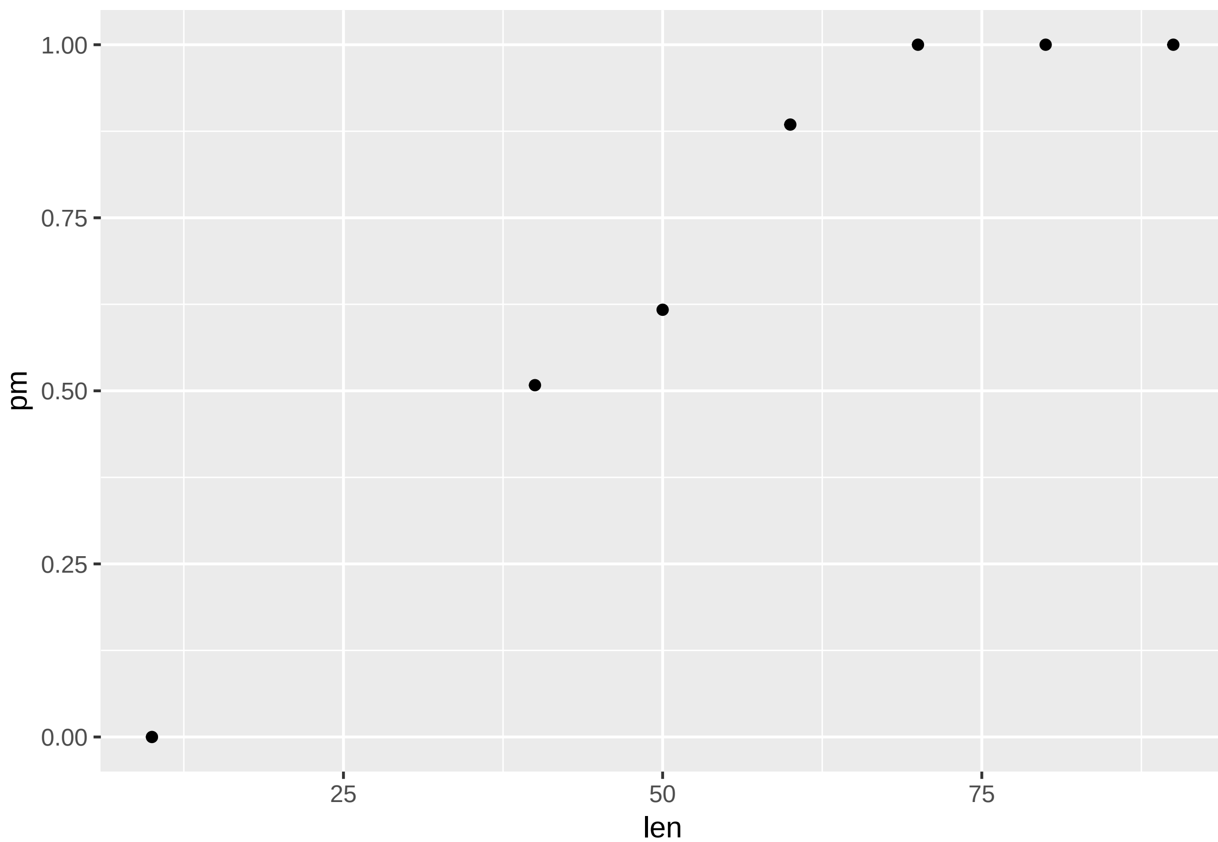


The France fishbase data appears incorrect and is perhaps due to weights being gutted weight as opposed to total weight. The MI data seems reliable.

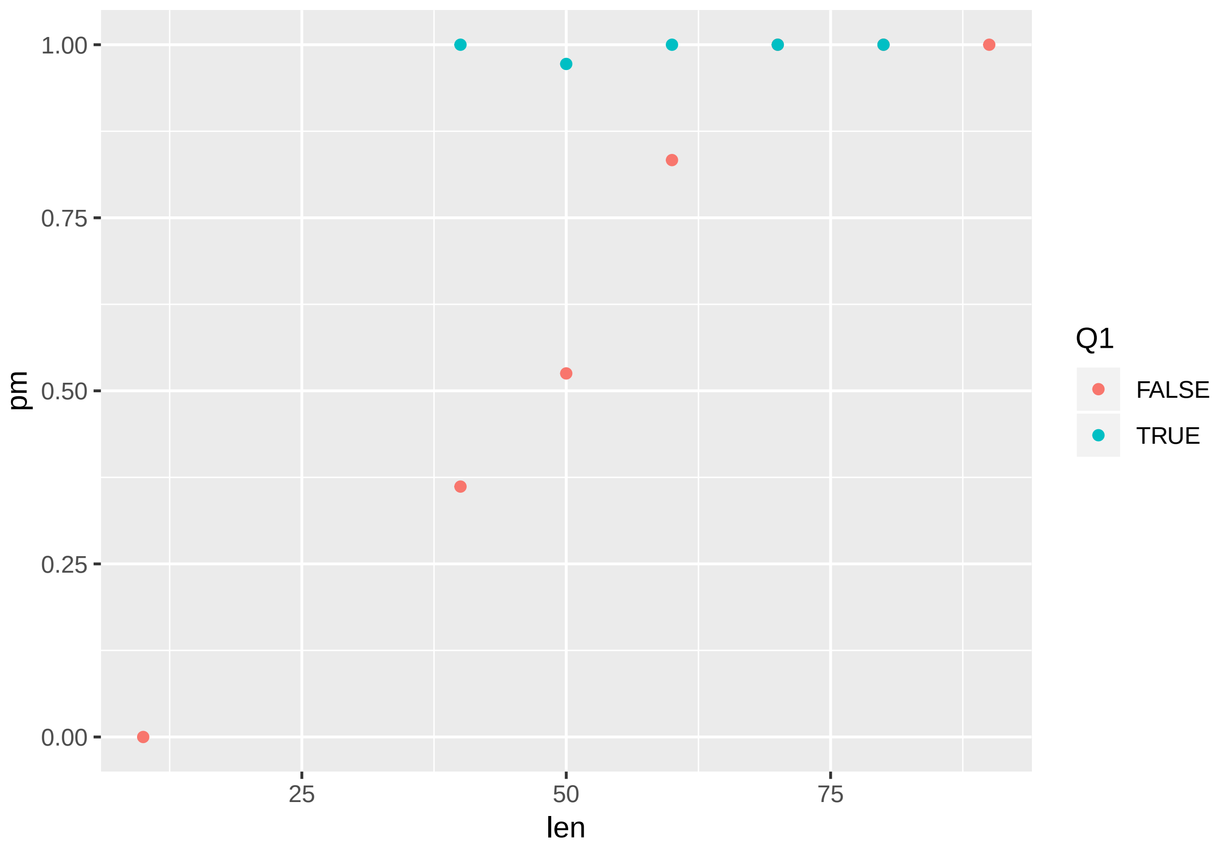
Conclusion: the suggested final length-weight parameters are: a = 0.0107; b = 2.98

Maturity

There seems to be an increasing number of mature fish up to 60cm when all data is included



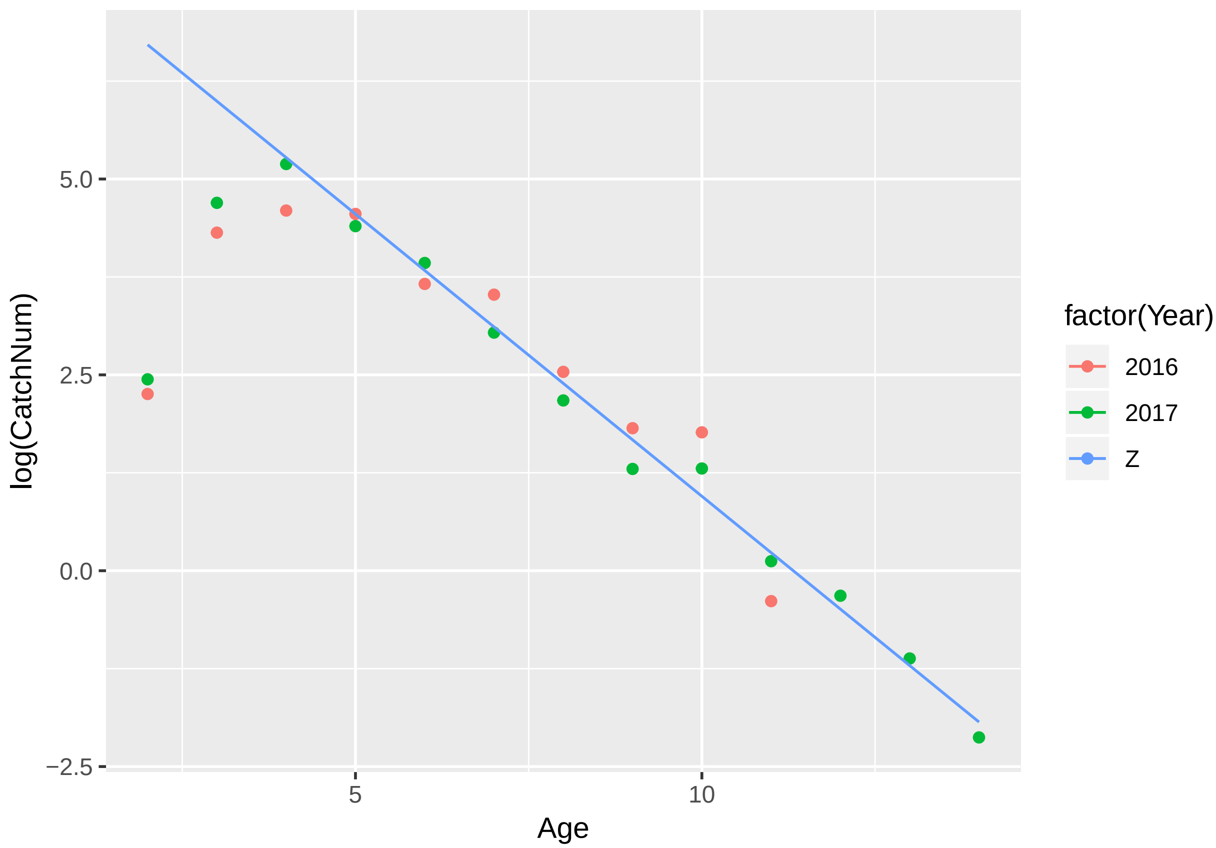
It appears that all the immature fish are from the Q4 surveys. At that time of year it is difficult to distinguish between virgin and recovered fish. The data from the beggining of the year (spawning time) suggests nearly 100% mature fish in the catches



Conclusion: all fish caught in the spring surveys are mature; immature fish may not be available to the surveys. The assumed age of first maturity is 3.

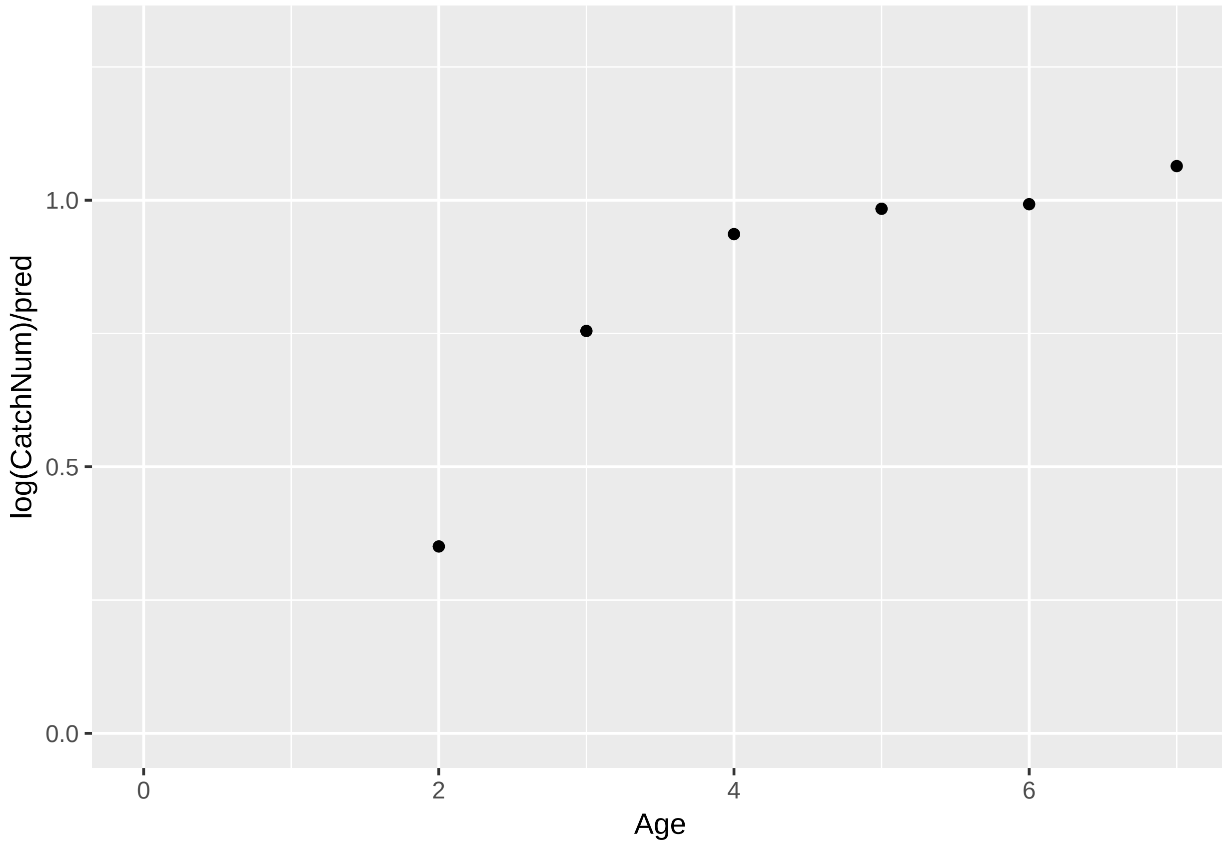
Total mortality and selectivity

If we apply the age length key data to the length frequency data we can get the numbers-at-age in the landings. We can then use this to see assess mortality from one age to the next. This is a rough measure of the total mortality (Z). If you substract the natural mortality from this, you get a ballpark figure of F.



The slope in the plot above is fitted over the average landings numbers at ages 5 to 9 over the two years. The slope is -0.72 which suggests that F may be around 0.52, which is high; quite possibly above Fmsy

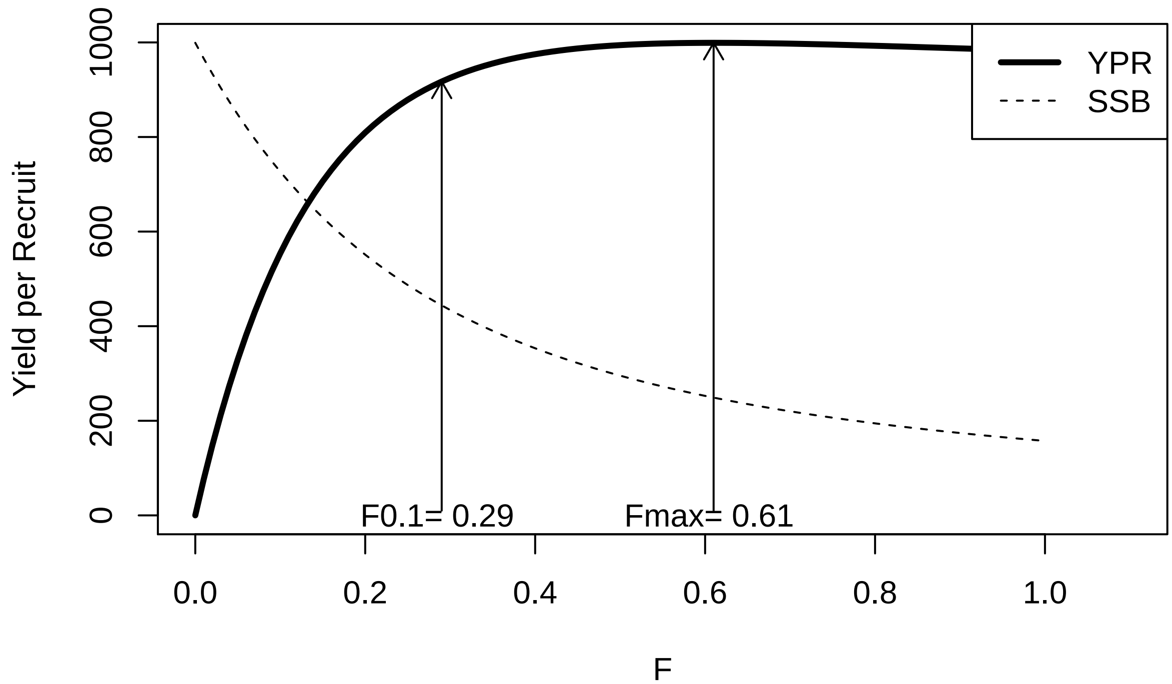
A bonus in estimating Z is that we extrapolate Z over the younger ages to see how many you would expect if selectivity and Z were the same for all ages:



Conclusion: it looks like the age at 50% selectivity is somewhere between 2 and 3.

Thompson-Bell yield-per recruit

We can estimate yield per recruit using the approach by Thompson and Bell (1934). For now assuming M=0.2, knife-edge maturity at age 3 and selectivity as reported above.



F01 can be used as a proxy for Fmsy. The F=Z-0.2 estimate of 0.52 is well above that. However F0.1 is quite conservative and F is below Fmax. The YPR is very flat-topped.

Summary

Growth parameters: Linf = 84.6; k = 0.19; t = -0.94

Length-weight parameters: a = 0.0107; b = 2.98

Maturity: knife edge at age 3 (?)

Selectivity: A50 between ages 2 and 3

Z: 0.72

F01: 0.29

Working Document on the revision of the LPUE abundance index for the seabass in areas 4b,c and 7a,d-h

Mathieu Woillez, Mickael Drogou and Alain Laurec

13/06/2019

Correction of an error in the computation

A bug was found in the computation of the French LPUE abundance index for seabass in areas 4b,c and 7a,d-h. For reminder, the LPUE abundance index is the product of 1) an index modelling the proportion of days at sea where positive catch were recorded and 2) an index modelling the average catch for those positive days. Both indices relied on a threshold that defined what a positive value is. The threshold accepted at the benchmark was 0.99 kg as mentioned in the report and the many annexes on the LPUE index (ICES, 2018).

However, in WKBASS2017/2018 and in WGCSE 2018, 0.05 kg was used as a threshold to define the first index, while 0.99 kg was used to define the second one. This was a mistake. This inconsistency between both indices that must be ultimately combined was thus corrected for WGCSE 2019. 0.99 kg is now used for both indices.

Figure 1 compares both series used for the assessments in WGCSE 2018 and 2019. The main differences occurs before 2009. The explanation comes from the fact that false positive values occurred in the log-book dataset over this period.

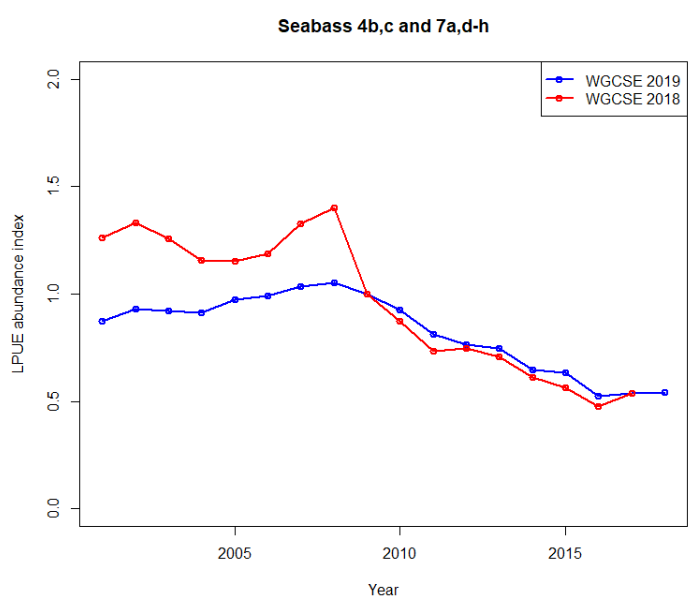


Figure 1: LPUE abundance indices used for WGCSE 2018 and 2019.

Heterogeneity in the very low catch values of seabass over time

Figure 2 corresponds to the overall histogram (all years from 2001 up to 2018) of the seabass catch values. Rounding is observed with spike appearing at 1 kg, 2kg, 3 kg… Decimal values also exist and are frequent for values below 1 kg. Those very low catch values reported in the log books may not be indicating of real catches of seabass, but rather of false positive values, i.e. zeroes. Indeed, 0.01 kg or 0.02 kg catches can be considered as a nonsense, as the minimum landing size of 36 cm corresponds to a seabass of 0.5 kg. A very low catch value may come from the division of low seabass catch for a given trip by the number of days of the trip.

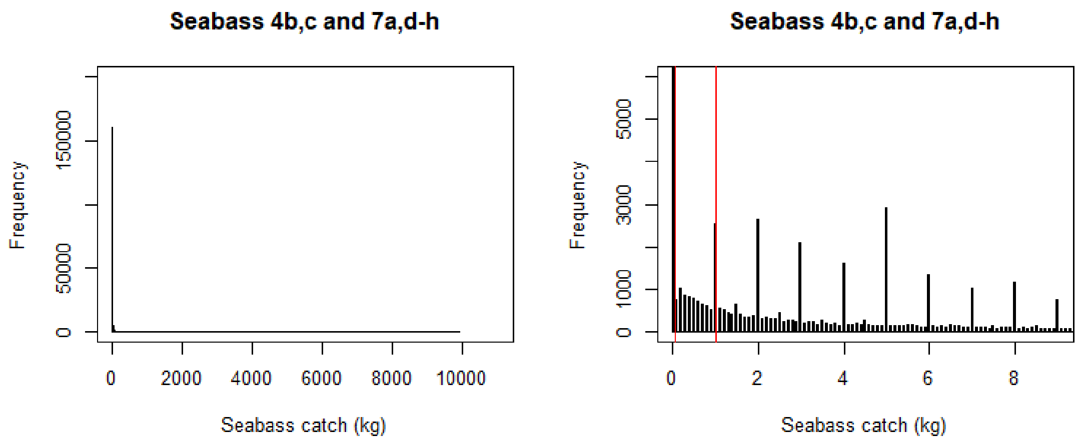


Figure 2: left) Overall histogram of the seabass catch values in areas 4b,c and 7a,d-h. Right) Zoom over the range [0; 9 kg] of the overall histogram of the seabass catch values from the left.

There is indeed some heterogeneity in the logbook dataset with a shift occurring between 2008 and 2009 (Table 1). It is feared that many of the very low catches (many are declared at 0.1 kg) are false positives. Before 2009, proportions of those false positive values are between 3% and 9%. After 2009, proportions of false positive values are pretty close to 0%. In order to homogenize the whole, a threshold defining what a positive catch is, was required. A threshold of 0.99 kg was considered correctly and reported in every previous working document, accepted by the review group, but mistake happens.

Table 1: Yearly proportions of positive (> 0.99 kg), epsilon (> 0.05 kg and <= 0.99 kg) and zero (<=0.05 kg) seabass catch values in areas 4b,c and 7a,d-h.

Variables	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
false positives	0.09	0.07	0.08	0.08	0.08	0.05	0.03	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
true positives	0.43	0.46	0.43	0.4	0.44	0.38	0.37	0.39	0.42	0.28	0.27	0.26	0.29	0.25	0.26	0.25	0.24	0.24	0.24
zeroes	0.48	0.47	0.49	0.47	0.48	0.58	0.60	0.59	0.54	0.72	0.73	0.74	0.71	0.75	0.74	0.74	0.76	0.76	0.76

Sensitivity analysis on the threshold defining what a positive values is

A sensitivity analysis on the threshold value was conducted. No threshold for the definition of positive days or catches is perfect, so that various values from 0.05 to 9.99 were tested. Figure 3 shows that the results are quite robust after 2009 in areas 4b,c and 7a,d-h. The main differences appear before 2009, where the log-book dataset is polluted by many very low values (Table 1).

The threshold value was thus kept equal to the threshold accepted during the benchmark, i.e. at 0.99 kg, and used for the WGCSE 2019 assessment.

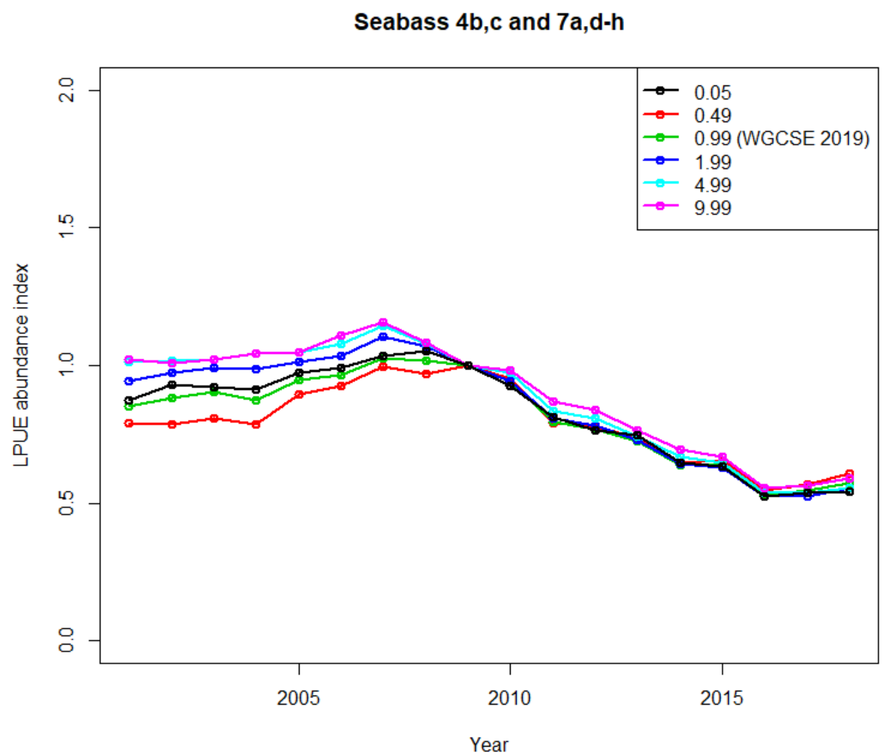


Figure 3: Sensitivity analysis on the threshold defining what a positive value is when computing the LPUE abundance index for WGCSE 2019.

Assessment model fit to the new LPUE time series and consequences

Fit of the assessment models to the LPUE time series are illustrated in the Figure 4. The fit is better with the new LPUE abundance index. The new expected LPUE index is always within the observed uncertainty range and closer to the average observed estimates in the assessment done during WGCSE 2019. This was not the case in the assessment done during WGCSE 2018. In addition, the linear relationship between the expected LPUE index and the observed LPUE index is improved in the assessment done during WGCSE 2019.

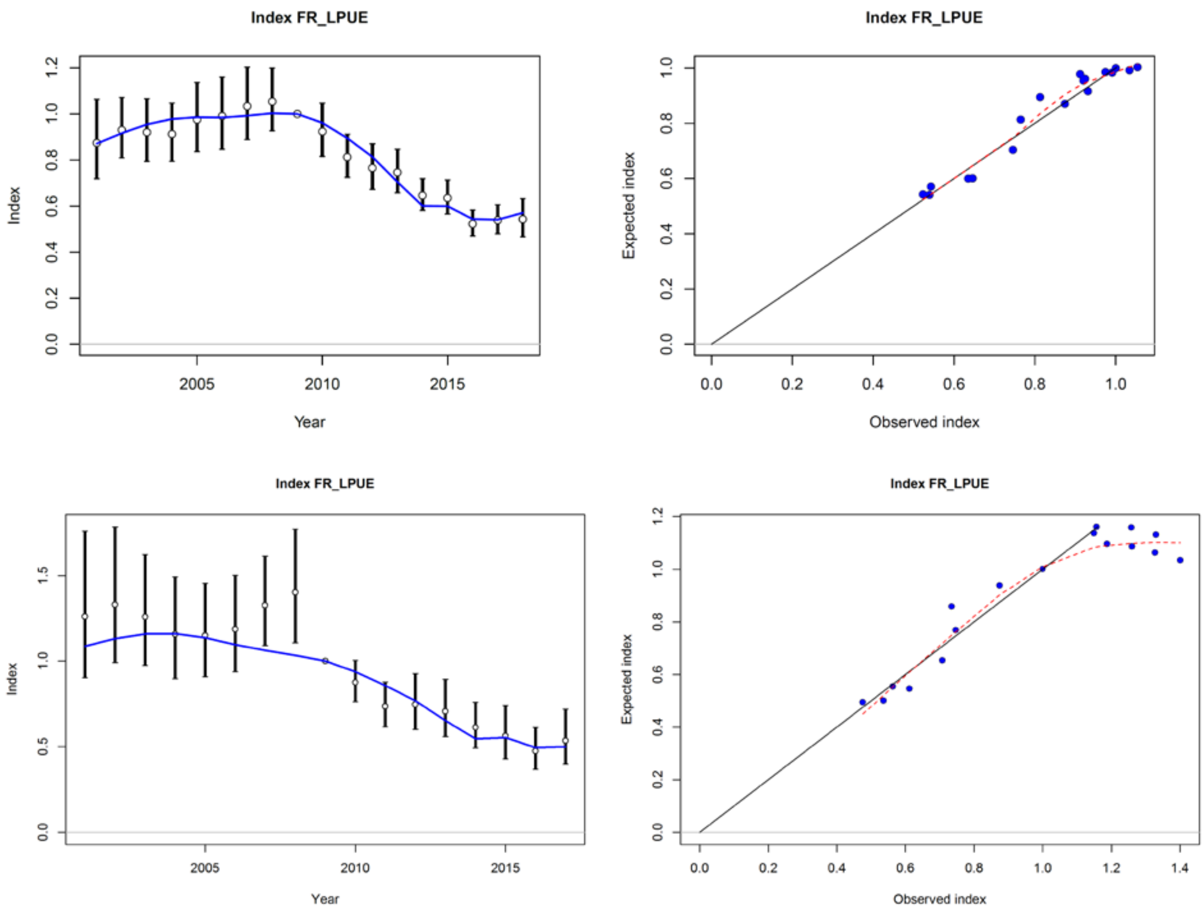


Figure 4: Top) Assessment model fit to the LPUE abundance index used in the WGCSE 2019. Bottom) Assessment model fit to the LPUE abundance index used in the WGCSE 2018.

So the revised series should be considered valid for the current assessment done during WGCSE 2019.

Reference

ICES. 2018. Report of the Benchmark Workshop on Seabass (WKBASS), 20–24 February 2017 and 21–23 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM:44. 259 pp.

Working Document for WGCSE, October ICES advice

Nephrops in the North Minch (FU 11): results of the 2019 UWTV Survey and catch options for 2020

Katie Boyle, Lynda Blackadder & Helen Dobby
September 2019
Marine Scotland Science
Aberdeen

Introduction

Since the early 1990s Marine Scotland Science (MSS) has carried out annual underwater television surveys (UWTV) targeting *Nephrops norvegicus* which have been used to estimate *Nephrops* abundance based on burrow counts. UWTV surveys for the estimation of *Nephrops* abundance reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*. UWTV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows.

UWTV surveys provide an absolute estimate of stock abundance in numbers which are used to estimate harvest ratios, defined as the ratio of total catch to total abundance. The landed proportion of the catch converted to biomass has been used by ICES to provide TAC advice.

UWTV surveys in the North Minch FU 11 have been conducted since 1994 (no surveys in 1995 and 1997). The survey takes place annually in May/June and also covers other Functional Units to the West of Scotland (FU 12 and FU 13) and in the North Sea (FU 7 and 34) and in 2019 FU10. The main objectives for the 2019 UWTV survey are listed below:

1) Obtain estimates of the abundance and distribution of *Nephrops* burrow complexes in each FU

2) Use the video footage to record the occurrence of other benthic fauna as well as evidence of commercial trawl activity.

3) Collect a sediment sample at each station.

4) To collect samples of *Nephrops* for comparison of reproductive condition and morphometrics in each of the different survey areas (functional units). One trawl station per sediment stratum in each of the main survey areas.

This report focuses on the work up of the 2019 North Minch FU 11 UWTV survey. The abundance estimates are then used to provide catch options for the ICES *Nephrops* advice for 2020.

Methods

The methods used in the survey are similar to those employed for other UWTV surveys of *Nephrops* stocks around Scotland and are documented by WKNEPHTV (ICES, 2007) and SGNEPS (ICES, 2010; ICES, 2012). A sledge is towed for a known distance and the number of burrows counted in a known field of view. Assuming a burrow occupancy of 1:1, the density of *Nephrops* is calculated and raised to the total habitat area.

Marine Scotland Science access to Vessel Monitoring System data (VMS) makes it possible to link geographical information on the positioning of vessels to landings data resulting in more detailed information on the spatial distribution of fishing effort in the *Nephrops* trawl fishery. For FU 11 the ground area calculation was based on the alpha convex-hull method to define and characterize the overall shape of a set of VMS points and is described in ICES (2010). The VMS area was updated in 2013 at the WKNEPH2013 (ICES, 2013a) and estimated to be 2908 km^2.

The survey design follows a random approach subject to certain geographic limits which ensure adequate coverage of the FU. At each sampling location the sledge is deployed and towed for 10 minutes. The distance covered by the sledge and the distance from the seabed are recorded to allow for the calculation of the viewed area. The video footage is recorded onto a DVD and analysed later by at least two counters providing independent estimates. Following the recommendation by SGNEPS (ICES, 2009), 7 minutes of footage are counted. All counters were re-familiarised using training material and reference footage for the North Minch before recounting at sea.

The Linn's concordance correlation coefficient (CCC) was used to compare the counts of the first two reviewers (obtained independently of each other). This statistical test measures correspondence between paired counts and has advantages over standard correlation analysis or *t* tests in that it measures agreement between two variables. For each run, a value of at least 0.5 correlation is expected for the first two counters and if this is not achieved the run is reviewed by more counters.

A number of factors are considered to influence the ability of the surveys to map directly to absolute abundance. In order to use the survey abundance estimate as an absolute estimate, it is necessary to apply a relative to absolute correction factor for these potential biases. The correction factors are FU specific and are given in the following table. They are based on simulation models, preliminary experimentation and expert opinion (ICES, 2009).

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative absolute factor	conversion
FU 11:North Minch	Since 2009	1.38	0.85	1.1	1	1.33	

All abundance estimates presented in this document are in absolute numbers (i.e. corrected for bias). Catch options for 2020 in FU 11 are provided using the 2019 abundance estimate.

Results

A total of 47 valid survey stations were completed in the North Minch in 2019 out of 52. Two stations were aborted because of rocks and three stations were deemed to be off strata. Figure 1 shows the distribution of stations in the 2019 TV survey with the size of the symbols reflecting the *Nephrops* burrow density.

Table 1 gives the estimates of mean and variance for density and abundance for the most recent TV survey conducted in FU 11. From 2010 onwards, a single strata based on VMS was applied to calculate the overall abundance. The CV for the most recent TV survey is 10.5 % and is below the 20 % limit precision level recommended by SGNEPS.

Table 2 and Figure 2 show the time-series of the estimated abundance for the UWTV surveys, with 95 % confidence intervals on annual estimates. The abundance in 2019 (1232 million) shows an increase of 3.7 % compared to the value estimated for 2018 although the confidence intervals are larger.

Table 3 shows the assessment summary and table 4 the catch options inputs for 2020 with the most recent abundance estimate for FU 11. The forecast makes use of inputs derived from commercial data up to and including 2018. The inputs are the mean weight in landings and discards (1999–2018), the average discard rate (2016–2018) and the estimate of discard survival.

Discussion

The UWTV survey is presented as the best available information on the North Minch *Nephrops* stock. The survey provides a fishery-independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey and therefore it only provides information on abundance in numbers over the area of the survey.

The UWTV survey estimates of abundance for *Nephrops* in the North Minch suggest that historically the population increased until 2003. Over the next ten years it showed significant fluctuations. Since 2013, the abundance has been stable at around the average of the time series and was 1232 million in 2019.

The survey abundance shows fluctuations throughout the time series. While is not always possible to link these variations to fishing effort changes, other factors may contribute to this pattern such as variable recruitment being detected by the survey or variable natural mortality in this FU.

From 2016 the EU landing obligation was applied to all catches of Norway lobster fisheries in ICES Subarea 6, with several exemptions. There is a high survivability exemption applied to all Norway lobster creel fisheries and also for catches of Norway lobster made with demersal trawls using a cod end between 80mm – 110mm and within 12 miles of shore in ICES divisions 6a.
Observations from 2016-2018 fishery indicate that some discarding above the minimum conservation reference size (MCRS) continues and has not changed markedly. Consequently, ICES is providing advice for 2020 assuming average discard rates as observed over the three years, which is considered to be a more realistic assumption. ICES are also presenting advice assuming a zero discards scenario.

Two catch scenarios are presented in Table 5 and Table 6. Table 5 assumes that selection parameters do not change. Table 6 assumes zero discarding. Under the landings obligation there are likely to be some changes in selectivity. However anecdotal information would indicate that the catch scenario assuming recent discard rates is most likely the best assumption. .

References

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14 Ref: LRC, PGCCDBS.

ICES. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9-11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22. 95 pp.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Ancona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2015. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE). ICES CM 2015/ACOM: 12

ICES. 2018. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 9-18 May 2018. ICES CM 2018/ACOM:13. 1340 pp.

ICES. 2019. Working Group for the Celtic Seas Ecoregion (WGCSE). ICES Scientific Reports. 1:29. 1078 pp. http://doi.org/10/17895/ices.pub.7982.

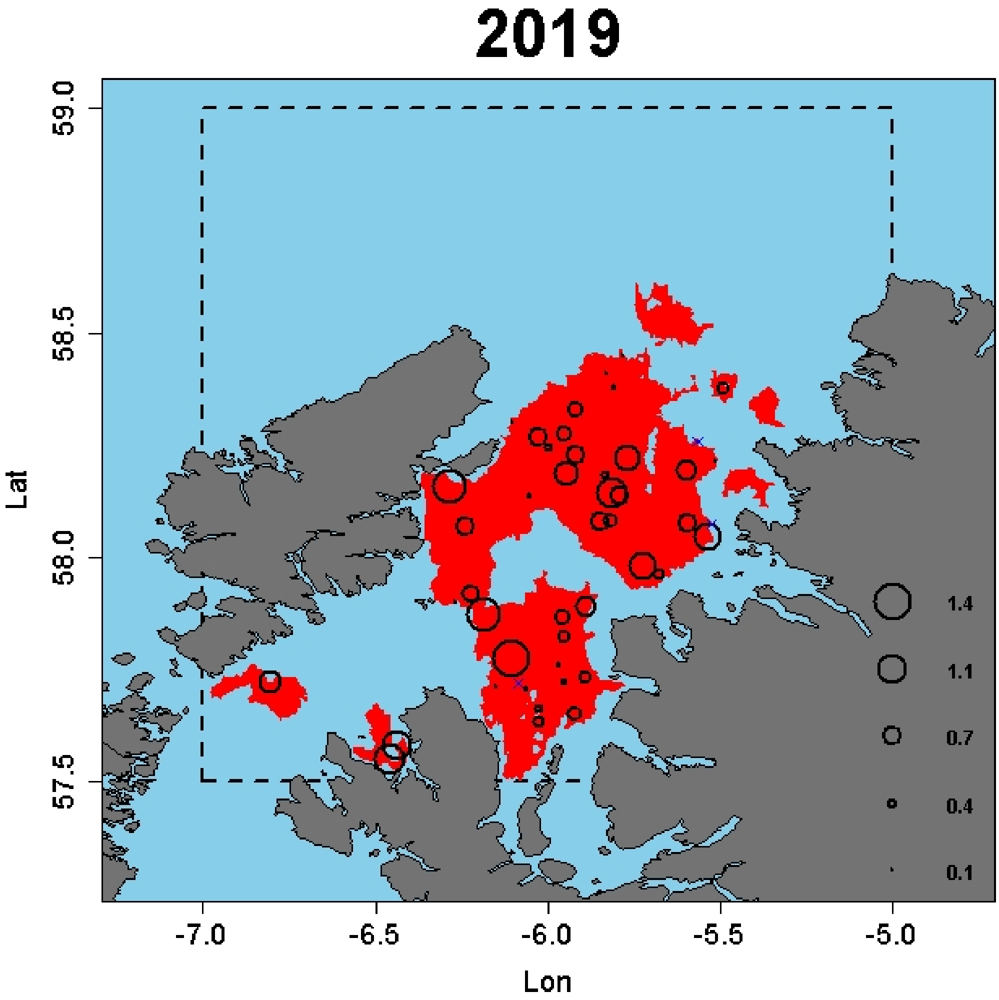


Figure 1. ***Nephrops*, North Minch (FU11), TV survey station distribution and relative density (burrows/m²), 2019.**

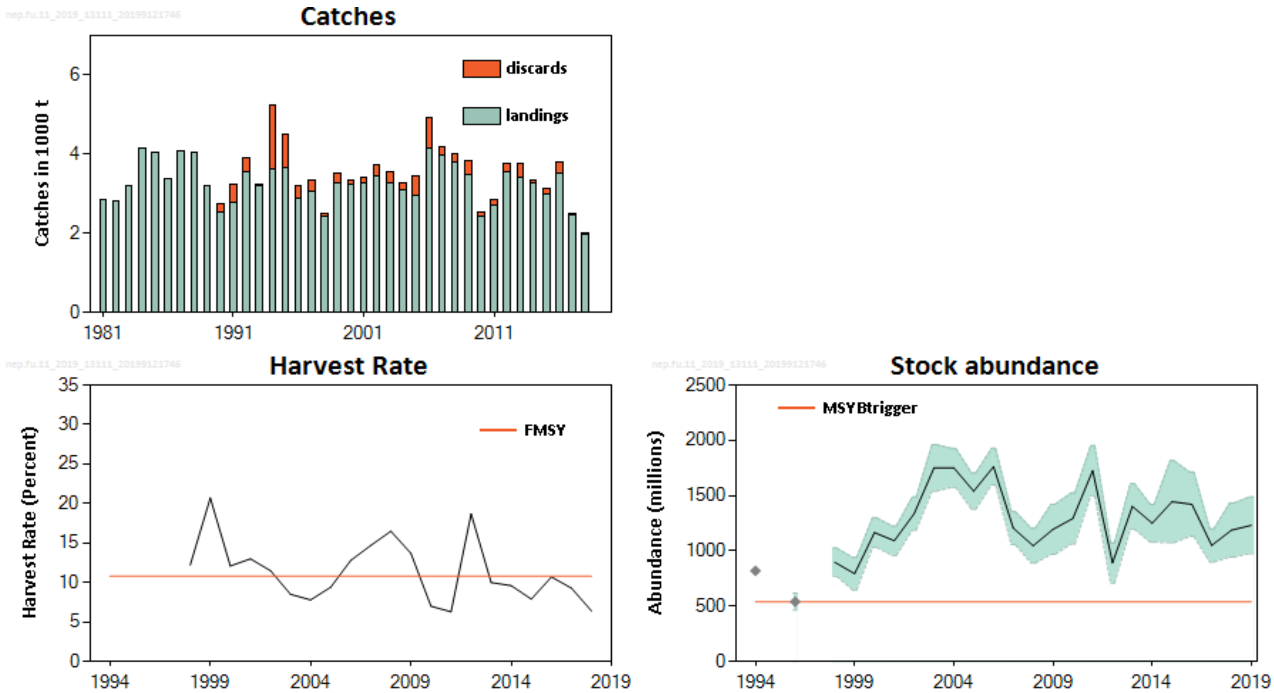


Figure 2. ***Nephrops*, North Minch (FU11). Assessment summary.**

Table 1. ***Nephrops*, North Minch (FU 11): Results of the 2019 TV survey.**

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance	Survey Precision Level (RSE)
2019 TV survey								
VMS	2908	47	0.423	0.092	1231.6	16438	1	
Total	2908	47			1231.6	16438	1	0.10

Table 2. ***Nephrops*****, North Minch (FU 11): Results of the UWTV surveys (absolute values).**

Year	Number of valid stations	Mean density	Abundance (Sediment)	95% confidence interval (sediment)	Abundance (VMS)	Approx. 95% confidence interval (VMS)
		burrows/m²	millions	millions	millions	millions
1994	41	0.29	500	74	820	
1995	No survey					
1996	38	0.19	330	47	541	
1997	No survey					
1998	38	0.31	547	77	898	
1999	36	0.27	484	89	794	
2000	39	0.4	711	82	1166	
2001	56	0.38	666	81	1092	
2002	37	0.46	815	91	1337	
2003	41	0.6	1068	129	1751	
2004	38	0.6	1068	107	1751	
2005	41	0.53	939	100	1540	
2006	30	0.61	1074	101	1762	
2007	36	0.41	735	92	1206	
2008	41	0.36	638	95	1047	
2009	26	0.41	729	138	1195	
2010	37	0.44	-	-	1293	231
2011	41	0.59	-	-	1726	226
2012	41	0.31	-	-	891	181
2013	41	0.48	-	-	1403	206
2014	44	0.43			1251	171
2015	41	0.5			1445	370
2016	39	0.49			1422	290
2017	42	0.36			1050	149
2018	44	0.41			1188	244
2019	47	0.42			1232	256

Table 3. ***Nephrops*****, North Minch (FU 11): Assessment summary.**

year	abundance	harvest.ratio	Landings numbers	Discard numbers	Removals numbers	landings	discard	Dead discard	Discard rate	mean.wt landings	mean.wt discards	dead.discard.rate
	millions	%	millions	millions	millions	tonnes	tonnes	tonnes	%	grammes	grammes	%
1994	820	31.5	154	139	258	3614	1637	1228	47.4	23.45	11.8	40.3
1995	NA	NA	164	80	225	3655	856	642	32.8	22.24	10.65	26.8
1996	541	23.5	108	26	127	2872	323	242	19.4	26.68	12.49	15.3
1997	NA	NA	140	26	159	3046	286	215	15.4	21.71	11.18	12
1998	898	12.2	103	8	110	2441	67	51	7.5	23.65	8.04	5.7
1999	794	20.7	144	28	165	3257	273	205	16.4	22.7	9.69	12.8
2000	1166	12.1	134	10	142	3247	100	75	6.9	24.19	10.08	5.2
2001	1092	13	129	17	141	3259	160	120	11.7	25.33	9.32	9.1
2002	1337	11.5	133	28	154	3440	277	208	17.6	25.93	9.78	13.8
2003	1751	8.5	126	30	148	3269	299	224	19.2	26.03	10	15.2
2004	1751	7.8	122	18	136	3082	202	151	13	25.16	11.02	10.1
2005	1540	9.4	107	50	144	2949	507	380	32	27.65	10.09	26.1
2006	1762	12.8	170	74	225	4166	757	568	30.3	24.52	10.27	24.6
2007	1206	14.7	168	12	177	3978	214	160	6.5	23.61	18.1	5
2008	1047	16.5	159	19	173	3799	194	145	10.5	23.9	10.36	8.1
2009	1195	13.7	138	35	164	3496	327	245	20.3	25.42	9.34	16
2010	1293	7	82	12	91	2413	128	96	12.4	29.39	10.98	9.6
2011	1726	6.3	96	16	108	2697	154	116	14.2	27.56	9.66	11
2012	891	18.7	151	21	167	3542	213	160	12.6	23.43	10.33	9.3
2013	1403	10	122	24	140	3413	364	273	16.4	27.52	15.18	12.8
2014	1251	9.6	115	8	121	3257	77	57	6.3	27.96	9.99	4.8
2015	1445	7.9	103	15	114	3002	143	107	12.6	28.74	9.66	9.8
2016	1422	10.7	136	22	152	3529.4	266	200	14	25.76	12.05	10.9
2017	1050	9.3	93	5	97	2448	64	48	5.2	25.89	12.51	4
2018	1188	6.4	72	5	76	1961	59	44	6.7	27.39	11.46	5.1
2019	1232	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 4. ***Nephrops*, North Minch (FU 11): Basis for advice for 2020.**

Variable	Value	Notes
Stock abundance	1232 million	Abundance in TV assessment UWTV 2019
Mean weight in wanted catch	25.9	Average 1999–2018
Mean weight in unwanted catch	10.99	Average 1999–2018
Unwanted catch proportion	8.6%	Average (proportion by number) 2016–2018
Unwanted catch survival rate	25%	Proportion by number
Dead unwanted catch rate	6.6%	Average 2016–2018 (proportion by number)

Table 5. Catch scenarios table for 2020 for FU 11 North Minch. Discarding assumed to continue at recent average. All weights in tonnes.

Basis	Total catch	Dead removals	Wanted catch	Dead unwanted catch	Surviving unwanted catch	Harvest rate*	% advice change **
	WC+DUC +SUC	WC+DUC	WC	DUC	SUC	for WC+DUC	
ICES advice basis							
MSY approach	3347	3315	3219	96	32	10.8	2.4%
Other options							
$F_{MSY\ lower}$	2604	2579	2504	75	25	8.4	-20%
$F_{MSY\ upper}$***	3347	3315	3219	96	32	10.8	2.4%
F_{2018}	1984	1965	1908	57	19	6.4	-39%

* Calculated for dead removals.
** Advice value 2020 relative to advice value 2019.
*** $F_{MSY\ upper} = F_{MSY}$ for this stock

Table 6. Catch scenarios table for 2020 for FU 11 North Minch. Assuming zero discards. All weights in tonnes.

Basis	Total catch	Wanted catch	Unwanted catch	Harvest rate*	% advice change **
	WC+UC	WC	UC	for WC+UC	
ICES advice basis					
MSY approach	3276	3150	126	10.8	0.18%
Other options					
$F_{MSY\ lower}$	2548	2450	98	8.4	-22%
$F_{MSY\ upper}$***	3276	3150	126	10.8	0.18%
F_{2018}	1942	1867	75	6.4	-41%

* Calculated for dead removals.
** Advice value 2020 relative to advice value 2019.
*** $F_{MSY\ upper} = F_{MSY}$ for this stock

Working Document for WGCSE, October ICES advice

Nephrops in the South Minch (FU12): results of the 2019 UWTV survey and catch options for 2020

Katie Boyle, Lynda Blackadder & Helen Dobby
September 2019
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Introduction

Since the early 1990s Marine Scotland Science has carried out annual underwater television surveys (UWTV) targeting *Nephrops norvegicus* which have been used to estimate *Nephrops* abundance based on burrow counts. UWTV surveys for the estimation of *Nephrops* abundance reduce the problems associated with traditional trawl surveys that arise from variability in the burrow emergence of *Nephrops*. UWTV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows.

UWTV surveys provide an absolute estimate of stock abundance in numbers which is used to estimate the harvest ratio (a measure of exploitation rate), defined as the ratio of total catch to total abundance. Based on a harvest ratio equivalent to fishing at F_{MSY} the landed proportion of the catch can be converted to biomass and is used by ICES to provide TAC advice.

UWTV surveys in the South Minch (FU 12) have been conducted since 1995. The survey takes place annually in May/June and also covers other Functional Units (FU) to the West of Scotland (FU 11 and FU 13) and in the North Sea (FU 7 and 34) and in 2019 FU10. The main objectives for the 2019 UWTV survey are listed below:

1) Obtain estimates of the abundance and distribution of *Nephrops* burrow complexes.

2) Use the video footage to record the occurrence of other benthic fauna as well as evidence of commercial trawl activity.

3) Collect a sediment sample at each station.

4) Collect samples of *Nephrops* for comparison of reproductive condition and morphometrics in each of the different survey areas (functional units). (One trawl station per sediment stratum in each of the main survey areas).

This report describes the work up of the 2019 South Minch (FU 12) UWTV survey. The abundance estimates are then used to provide catch options for ICES *Nephrops* advice for 2020.

Methods

The methods used in the survey are similar to those employed for other UWTV surveys of *Nephrops* stocks around Scotland and are documented by WKNEPHTV (ICES, 2007) and SGNEPS (ICES, 2010; ICES, 2012). A sledge is towed for a known distance and the number of burrows counted in a known field of view. Assuming a burrow occupancy of 1:1, the density of *Nephrops* is calculated and raised to the total habitat area.

A random stratified sampling design is used. Stratification is on the basis of British Geological Survey (BGS) sediment strata – mud, sandy mud and muddy sand. The *Nephrops* sediment area in the South Minch is estimated to be 5072 km^2.

At each sampling location the sledge is deployed and towed for 10 minutes. The distance covered by the sledge and the distance from the seabed is recorded to allow for the calculation of the viewed area. The video footage is recorded onto a DVD and analysed later by at least two counters providing independent estimates. Following the recommendation by SGNEPS (ICES, 2009), 7 minutes of footage are counted. All counters were re-familiarised using training material and reference footage for the South Minch before recounting at sea.

The Linn's concordance correlation coefficient (CCC) was used to compare the counts (made independently) of the two reviewers. This statistical test measures correspondence between paired counts and has advantages over standard correlation analysis or *t* tests in that it measures agreement between two variables. For each run, a value of at least 0.5 correlation is expected for the first two counters and if this is not achieved the run is reviewed by more counters.

A number of factors are considered to influence the ability of the surveys to map directly to absolute abundance. In order to use the survey abundance estimate as an absolute value it is necessary to apply a relative to absolute correction factor to account for these potential biases. The correction factors are FU specific and for FU12 are given in the following table. They are based on a combination of the results of simulation models, preliminary experimentation and expert opinion (ICES, 2009).

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative absolute factor	conversion
FU 12: South Minch	Since 2009	1.37	0.85	1.1	1	1.32	

All abundance estimates presented in this document are in absolute numbers (i.e. corrected for bias). Catch options for 2020 in FU 12 are provided using the 2019 abundance estimate.

Results

A total of 40 valid TV stations were completed in 2019, with one station excluded because of rocks. The number of stations in FU 12 UWTV survey has remained relatively stable throughout the time series. Figure 1 shows the distribution of stations in the 2019 TV survey with the size of the symbols reflecting the *Nephrops* burrow density. Higher densities were recorded in the inshore area of the ground, between the southwest of the Isle of Skye and the Ardnamurchan peninsula. Densities are generally lower in the western parts of the area towards the Outer Hebrides.

Table 1 gives the estimates of mean and variance for density and abundance (total and by strata) for the most recent UWTV survey conducted in FU 12. The CV for the most recent TV survey is 12 % and is below the 20 % limit precision level recommended by SGNEPS.

Table 2 and Figure 2 show the time-series of the estimated abundance for the UWTV surveys, with 95 % confidence intervals on annual estimates. The abundance in 2019 is 2362 million, which is an increase (21%) compared to the 2018 estimate.

Table 3 shows the assessment summary and table 4 the catch options inputs for 2020 with the most recent abundance estimate for FU 12. The forecast makes use inputs derived from commercial data up to and including 2018. The inputs are the mean weight in landings and discards (1999–2018), the average discard rate (2016–2018) and the estimate of discard survival.

Discussion

The UWTV survey is presented as the best available information on the South Minch *Nephrops* stock. The surveys provide a fishery-independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey and therefore it only provides information on abundance in numbers over the area of the survey.

The UWTV survey estimates of abundance for *Nephrops* in the South Minch show that the population has fluctuated without obvious trend over the period of the survey. The abundance decreased significantly in 2012 to the historical minimum but increased and was relatively stable at an above average level between 2014 and 2016. The abundance in 2019 (2362 million) shows a 21 % increase compared to the 2018 estimate.

The survey abundance has shown high fluctuations throughout the time series. While is not always possible to link this variations to fishing effort changes, other factors may contribute to this pattern such as variable recruitment being detected by the survey or variable natural mortality in this FU.

From 2016 the EU landing obligation was applied to all catches of Norway lobster fisheries in ICES Subarea 6, with several exemptions. There is a high survivability exemption applied to all Norway lobster creel fisheries and also for catches of

Norway lobster made with demersal trawls using a cod end between 80mm – 110mm and within 12 miles of shore in ICES divisions 6a.
Observations from 2016-2018 fishery indicate that some discarding above the minimum conservation reference size (MCRS) continues and has not changed markedly. Consequently, ICES is providing advice for 2020 assuming average discard rates as observed over the three years, which is considered to be a more realistic assumption. ICES are also presenting advice assuming a zero discards scenario.

Two catch scenarios are presented in Table 5 and Table 6. Table 5 assumes that selection parameters do not change. Table 6 assumes zero discarding. Under the landings obligation there are likely to be some changes in selectivity. However anecdotal information would indicate that the catch scenario assuming recent discard rates is most likely the best assumption.

References

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14 Ref: LRC, PGCCDBS.

ICES. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9-11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22. 95 pp.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2015. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE). ICES CM 2015/ACOM: 12

ICES. 2018. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE). 9-18 May 2018. ICES CM 2018/ACOM:13. 1340 pp.

ICES. 2019. Working Group for the Celtic Seas Ecoregion (WGCSE). ICES Scientific Reports. 1:29. 1078 pp. http://doi.org/10/17895/ices.pub.7982.

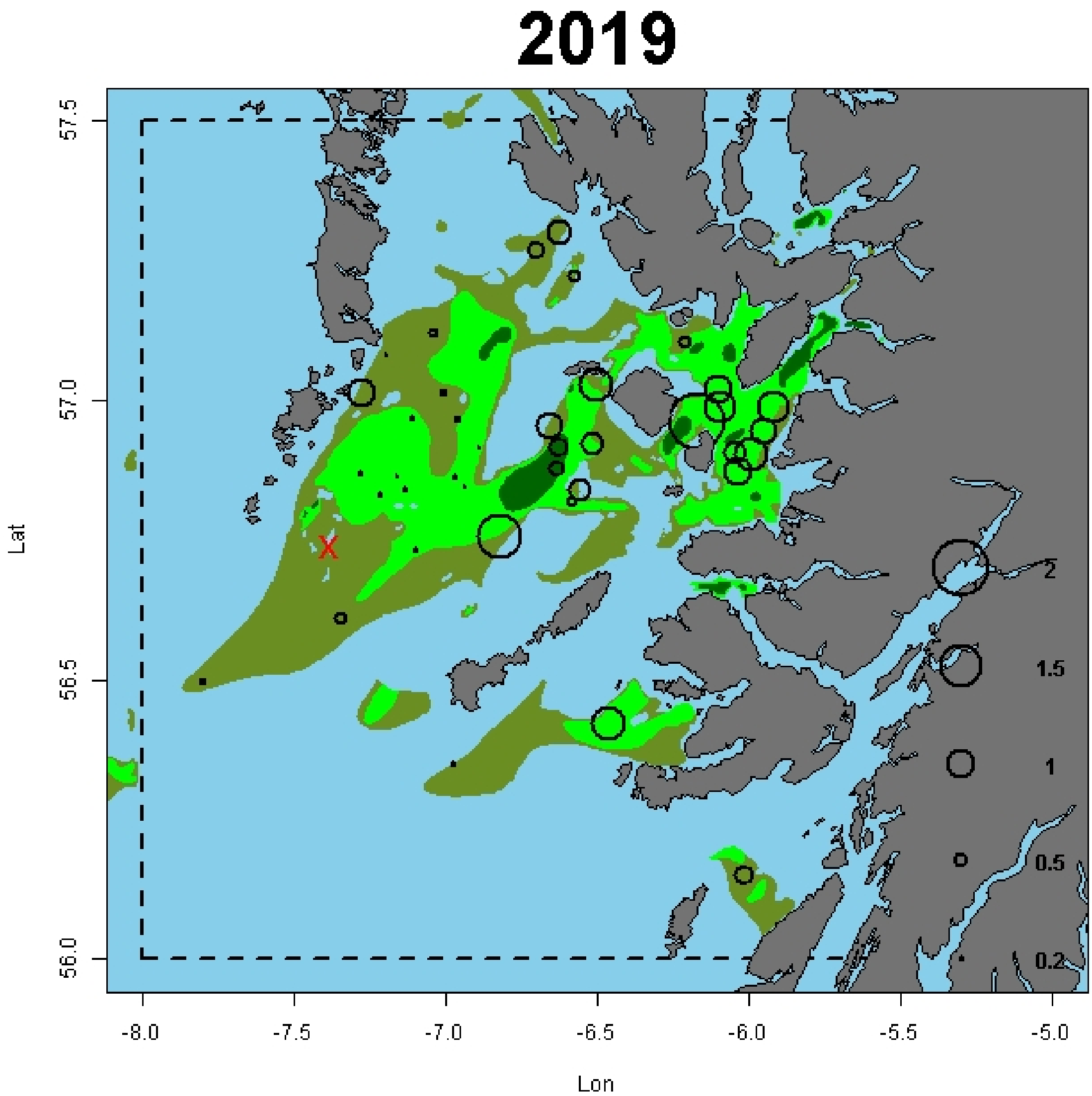

Figure 1. ***Nephrops*****, South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2019. Crosses represent zero observations.**

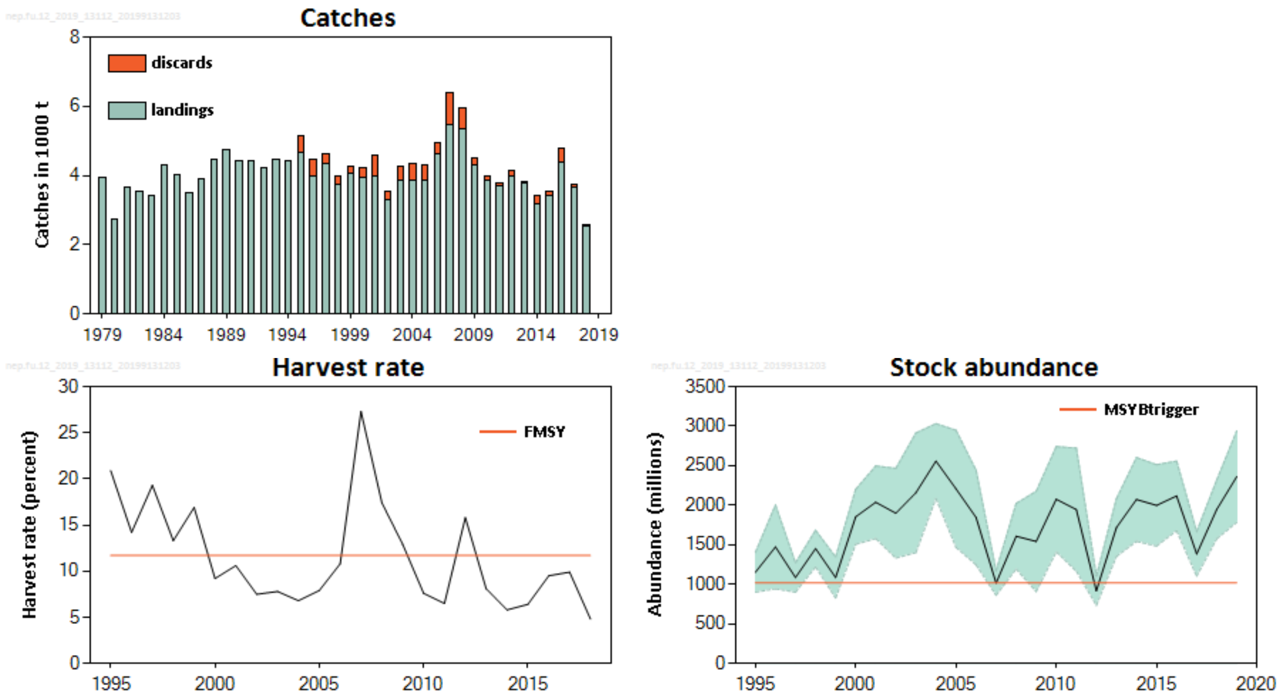

Figure 2. South Minch (FU12). Assessment summary.

Table 1. ***Nephrops*** **South Minch (FU12): Results by stratum of the 2018 TV survey. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance	Survey Precision Level (RSE)
2019 TV Survey								
M	303	2	0.466	0.001	141.2	65	0.001	
MS	2028	18	0.428	0.099	867.9	22546	0.27	
SM	2741	20	0.494	0.162	1352.7	61024	0.73	
Total	5072	40			2361.7	83635	1	0.12

Table 2. ***Nephrops*, South Minch (FU 12): Results of the UWTV surveys (absolute values).**

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	33	0.23	1152	251
1996	21	0.29	1473	530
1997	36	0.21	1086	185
1998	38	0.29	1452	232
1999	37	0.21	1086	260
2000	41	0.36	1854	348
2001	47	0.4	2037	459
2002	31	0.37	1899	567
2003	25	0.42	2157	756
2004	38	0.51	2558	473
2005	33	0.43	2208	740
2006	36	0.36	1845	598
2007	39	0.2	1016	155
2008	33	0.32	1608	415
2009	25	0.3	1542	634
2010	34	0.41	2076	665
2011	36	0.38	1945	778
2012	38	0.18	919	185
2013	38	0.34	1718	365
2014	36	0.41	2073	530
2015	35	0.39	1998	514
2016	37	0.42	2118	440
2017	41	0.27	1384	282
2018	39	0.38	1946	371
2019	40	0.466	2362	578

Table 3. ***Nephrops*****, South Minch (FU 12): Assessment summary.**

year	abundance	harvest.ratio	Landings numbers	Discard numbers	Removals numbers	landings	discard	Dead discard	Discard rate	mean.wt landings	mean.wt discards	dead.discard.rate
	millions	%	millions	millions	millions	tonnes	tonnes	tonnes	%	grammes	grammes	%
1995	1152	20.9	213	37	241	4682	455	341	14.8	21.96	12.28	11.5
1996	1473	14.2	173	48	209	3995	457	343	21.6	23.1	9.61	17.1
1997	1086	19.3	186	31	209	4344	271	203	14.3	23.37	8.7	11.2
1998	1452	13.3	168	32	192	3730	233	175	16.1	22.18	7.23	12.6
1999	1086	16.9	161	29	183	4052	206	154	15.4	25.14	7	12
2000	1854	9.2	145	33	170	3953	284	213	18.7	27.3	8.5	14.7
2001	2037	10.6	168	65	216	3991	591	444	27.9	23.79	9.11	22.5
2002	1899	7.5	123	26	143	3305	247	185	17.6	26.83	9.37	13.8
2003	2157	7.8	139	38	168	3879	381	286	21.3	27.86	10.1	16.9
2004	2558	6.8	141	44	175	3869	454	341	23.8	27.37	10.26	19
2005	2208	7.9	137	49	174	3848	452	339	26.5	28.11	9.17	21.2
2006	1845	10.8	177	30	199	4633	324	243	14.3	26.24	10.97	11.1
2007	1016	27.3	228	66	278	5471	903	677	22.4	23.95	13.73	17.8
2008	1608	17.4	224	74	279	5356	605	454	24.7	23.91	8.23	19.8
2009	1542	12.9	179	26	199	4285	216	162	12.5	23.87	8.44	9.6
2010	2076	7.6	149	12	158	3846	133	100	7.7	25.86	10.76	5.9
2011	1945	6.5	118	11	126	3702	92	69	8.2	31.1	8.78	6.3

2012	919	15.8	133	16	145	3989	145	109	10.8	29.17	9.05	8.3
2013	1718	8.1	136	4	140	3776	50	37	3.1	27.48	11.31	2.4
2014	2073	5.8	105	19	120	3179	233	175	15.6	29.91	12.04	12.1
2015	1998	6.4	120	10	128	3400	121	91	7.7	28.15	12.04	5.9
2016	2118	9.5	177	31	201	4402	365	274	14.9	24.76	11.74	11.6
2017	1384	9.9	127	13	137	3652	105	79	9.1	27.76	8.29	7
2018	1946	4.8	91	4	94	2536	54	41	4.5	27.27	12.74	3.4
2019	2362											

Table 4. *Nephrops*, South Minch (FU 12): Basis for advice for 2020.

Variable	Value	Notes
Stock abundance (2020)	2362 million	Abundance in TV assessment UWTV 2019
Mean weight in wanted catch	26.79 g	Average 1999–2018
Mean weight in unwanted catch	10.08 g	Average 1999–2018
Unwanted catch proportion	9.5%	Average 2016–2018 (proportion by number).
Unwanted catch survival rate	25%	Proportion by number.
Dead unwanted catch rate*	7.3%	Average 2016–2018 (proportion by number).

Table 5. Catch scenarios table for 2019 for FU 12 South Minch. Discarding assumed to continue at recent average. All weights in tonnes.

Basis	Total catch	Dead removals	Wanted catch	Dead unwanted catch	Surviving unwanted catch	Harvest rate*	% advice change **
	WC+DUC +SUC	WC+DUC	WC	DUC	SUC	for WC+DUC	
ICES advice basis							
MSY approach	7134	7066	6863	203	68	11.7	22%
Other options							
$F_{MSY\ lower}$	5671	5617	5455	162	54	9.3	-3%
$F_{MSY\ upper}$***	7134	7066	6863	203	68	11.7	22%
F_{2018}	2927	2899	2816	83	28	4.8	-50%

* Calculated for dead removals.
** Advice value 2020 relative to advice value 2019.
*** $F_{MSY\ upper} = F_{MSY}$ for this stock

All harvest rates are calculated in numbers and refer to the dead removals.

Table 6. Catch scenarios table for 2020 for FU 12 South Minch. Assuming zero discards. All weights in tonnes.

Basis	Total catch	Wanted catch	Unwanted catch	Harvest rate*	% advice change **
	WC+UC	WC	UC	for WC+UC	
ICES advice basis					
MSY approach	6965	6700	265	11.7	19.2%
Other options					
$F_{MSY\ lower}$	5536	5326	210	9.3	-22%
$F_{MSY\ upper}$***	6965	6700	265	11.7	-5.30%
F_{2018}	2858	2749	109	4.8	-51%

* Calculated for dead removals.
** Advice value 2020 relative to advice value 2019.
*** $F_{MSY\ upper} = F_{MSY}$ for this stock

Working Document for WGCSE, October ICES advice

Nephrops in the Clyde (FU13): results of the 2019 UWTV survey and catch options for 2020

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Introduction

Since the early 1990s Marine Scotland Science has carried out annual underwater television surveys (UWTV) targeting *Nephrops norvegicus* which have been used to estimate *Nephrops* abundance based on burrow counts. UWTV surveys for the estimation of *Nephrops* abundance reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*. UWTV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows.

UWTV surveys provide an absolute estimate of stock abundance in numbers which is used to estimate harvest ratio (a measure of exploitation rate), defined as the ratio of total catch in numbers by the total abundance. Based on a harvest ratio equivalent to fishing at F_{MSY}, the landed proportion of the catch can be converted to biomass and is used by ICES to provide TAC advice.

UWTV surveys in the Clyde FU 13 (Firth of Clyde and Sound of Jura) have been conducted for both sub areas since 1995 although the Sound of Jura has been surveyed more infrequently. The survey takes place annually in May/June and also covers other Functional Units (FU) to the west of Scotland (FU 11 and FU 12) and in the North Sea (FU 7 and 34) and in 2019 FU10. The main objectives for the 2019 UWTV survey are listed below:

1) Obtain estimates of the abundance and distribution of *Nephrops* burrow complexes.

2) Use the video footage to record the occurrence of other benthic fauna as well as evidence of commercial trawl activity.

3) Collect a sediment sample at each station.

4) Collect samples of *Nephrops* for comparison of reproductive condition and morphometrics in each of the different survey areas (functional units). (One trawl station per sediment stratum in each of the main survey areas).

This report documents the work up of the 2019 FU 13 UWTV survey which includes two subareas: the Firth of Clyde and the Sound of Jura. The abundance estimates of the two sub areas are worked up separately and used in separate catch options tables for the ICES *Nephrops* advice for 2020.

Methods

The methods used in the survey are similar to those employed for other UWTV surveys of *Nephrops* stocks around Scotland and are documented by WKNEPHTV (ICES, 2007) and SGNEPS (ICES, 2010; ICES, 2012). A sledge is towed for a known distance and the number of burrows counted in a known field of view. Assuming a 1:1 burrow occupancy, the density of *Nephrops* is calculated and raised to the total habitat area.

A random stratified sampling design is used for both subareas. Stratification is on the basis of British Geological Survey (BGS) sediment strata – mud, sandy mud and muddy sand. The *Nephrops* sediment area in FU 13 is estimated to be 2081 km^2 for the Firth of Clyde and 382 km^2 for the Sound of Jura.

At each sampling location the sledge is deployed and towed for 10 minutes. The distance covered by the sledge and the distance from the seabed are recorded to allow for the calculation of the viewed area. The video footage is recorded onto a DVD and analysed later by at least two counters providing independent estimates. Following the recommendation by SGNEPS (ICES, 2009), 7 minutes of footage are counted. All counters were re-familiarised using training material and reference footage for the Clyde and Sound of Jura before recounting at sea.

The Linn's concordance correlation coefficient (CCC) was used to compare the counts (made independently) of the two reviewers. This statistical test measures correspondence between paired counts and has advantages over standard correlation analysis or *t* tests in that it measures agreement between two variables. For each run, a value of at least 0.5 correlation is expected for the first two counters and if this is not achieved the run is reviewed by more counters

A number of factors are considered to influence the ability of the surveys to map directly to absolute abundance. In order to use the survey abundance estimate as an absolute estimate, it is necessary to apply a relative to absolute correction factor for these potential biases. The correction factors are FU specific and are given in the following table. They are based on simulation models, preliminary experimentation and expert opinion (ICES, 2009).

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative absolute factor	conversion
FU 13: Clyde	Since 2009	1.19	0.75	1.25	1	1.19	

All abundance estimates presented in this document are in absolute numbers (i.e. corrected for bias). Catch options for 2020 in FU 13 are provided using the 2019 abundance estimate.

Results

The total number of valid TV stations completed was 38 for the Firth of Clyde and 12 for the Sound of Jura (similar numbers to previous years). Figure 1 shows the distribution of stations for the 2019 UWTV surveys in FU 13, with the size of the symbols reflecting the *Nephrops* burrow density.

Tables 1 and 2 give the estimates of mean and variance for density and abundance (total and by strata) for the Firth of Clyde and Sound of Jura respectively. The CVs for the most recent TV survey in the Firth of Clyde and Sound of Jura are within the 20 % limit precision level proposed by SGNEPS at 9 % and 10 % respectively.

Tables 3 and 4 and Figure 2 show the time-series of the estimated abundances for both subareas, with 95 % confidence intervals on annual estimates. The abundance in 2019 in the Firth of Clyde has decreased by around 5 % since 2018 and is now 2083 million. For the Sound of Jura, the abundance estimate is 318 million which is an increase of 15 % since 2018.

Table 5 shows the assessment summary and table 6 the catch options inputs for 2020 with the most recent abundance estimates for each of the subareas in FU 13. The historical harvest rates were calculated using catches and abundance for the whole FU combined. This combined harvest rate is considered to be more representative for the Firth of Clyde than the Sound of Jura.

The forecast makes use inputs derived from commercial data up to and including 2018. The inputs are the mean weight in landings and discards (1999–2018), the average discard rate (2016–2018) and the estimate of discard survival.

Discussion

The UWTV survey is presented as the best available information on the FU 13 *Nephrops* stocks. The surveys provide a fishery-independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey and therefore it only provides information on abundance over the area of the survey.

The UWTV survey estimates of abundance for *Nephrops* in the Firth of Clyde suggest that the population increased until the mid 2000s suggesting a sustained period of increased recruitment. Over the past 10 years, the abundance has fluctuated around the long term average value. The 2019 abundance estimate for the Firth of Clyde is 2083 million.

Historically in the Sound of Jura, the abundance has fluctuated without trend. However, since 2013 it showed a continual increase to one of the highest values in the time series in 2016, before falling in 2017 and 2018 with an increase in 2019 to 318million.

Since 2015, the assessment has provided an estimate of the two subareas combined, rather than separately. This is because it is not possible to reliably disaggregate the landings (and catch) data for the two sub-areas. In contrast, catch options are provided for each subarea separately.

From 2016 the EU landing obligation was applied to all catches of Norway lobster fisheries in ICES Subarea 6, with several exemptions. There is a high survivability exemption applied to all Norway lobster creel fisheries and also for catches of Norway lobster made with demersal trawls using a cod end between 80mm – 110mm and within 12 miles of shore in ICES divisions 6a.
Observations from 2016-2018 fishery indicate that some discarding above the minimum conservation reference size (MCRS) continues and has not changed markedly. Consequently, ICES is providing advice for 2020 assuming average discard rates as observed over the three years, which is considered to be a more realistic assumption. ICES are also presenting advice assuming a zero discards scenario.

Two catch scenarios are presented in Table 5 and Table 6. Table 5 assumes that selection parameters do not change. Table 6 assumes zero discarding. Under the landings obligation there are likely to be some changes in selectivity. However anecdotal information would indicate that the catch scenario assuming recent discard rates is most likely the best assumption.

References

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14 Ref: LRC, PGCCDBS.

ICES. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9-11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22. 95 pp.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2015. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE). ICES CM 2015/ACOM: 12

ICES. 2018. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE). 9-18 May 2018. ICES CM 2018/ACOM:13. 1340 pp.

ICES. 2019. Working Group for the Celtic Seas Ecoregion (WGCSE). ICES Scientific Reports. 1:29. 1078 pp. http://doi.org/10/17895/ices.pub.7982.

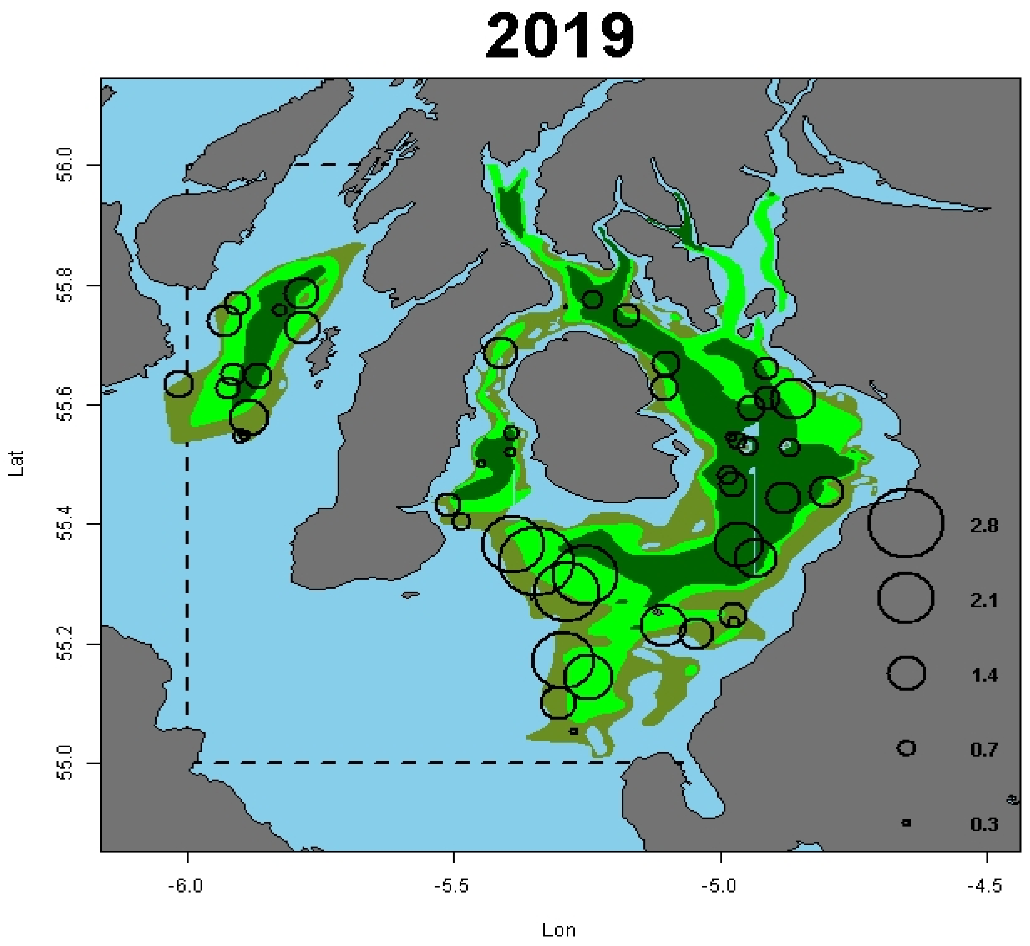

Figure 1. ***Nephrops*, Clyde (FU13), TV survey station distribution and relative density (burrows/m²) for Firth of Clyde and Sound of Jura subareas, 2019. Sound of Jura located in the west side. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*.**

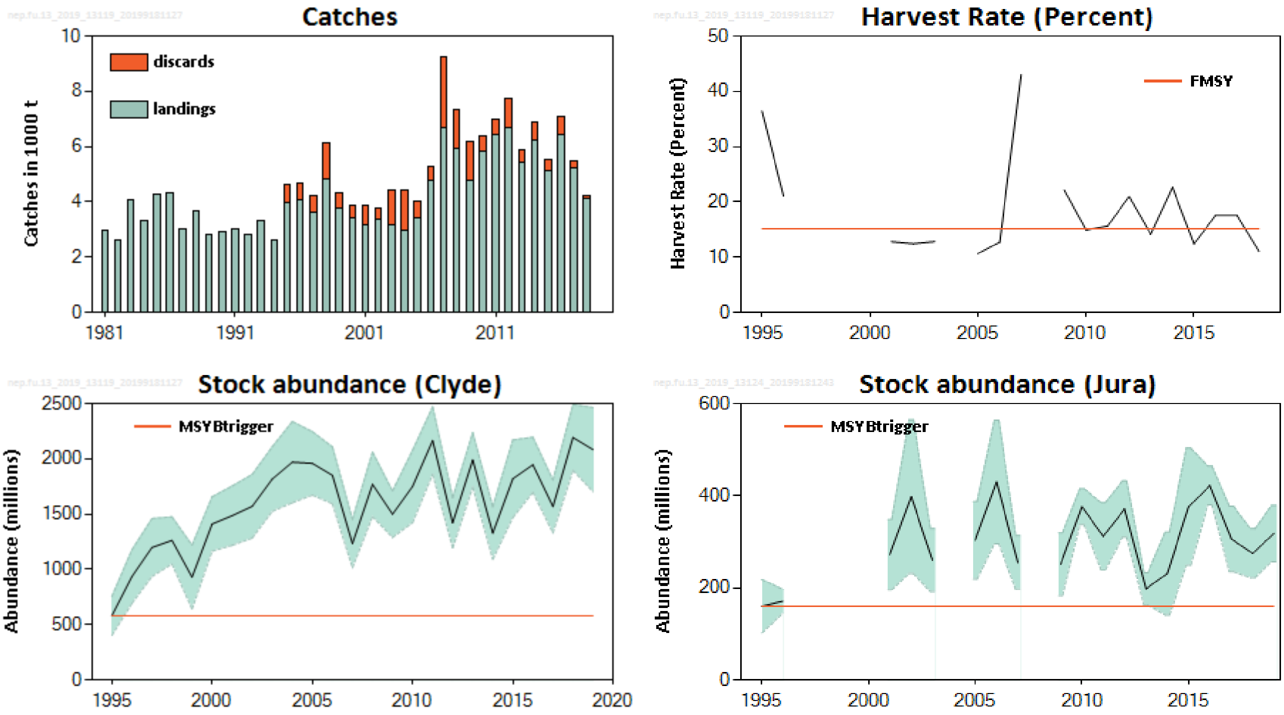

Figure 2. Clyde (FU13): Long term trends in catch (tonnes), harvest rate & UWTV survey abundance (by sub-area separately).

Table 1. ***Nephrops*****, Clyde (FU 13): Firth of Clyde subarea. Results by sediment stratum for 2019 TV survey. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance	Survey Precision Level (RSE)
2019 TV survey								
M	717	14	0.841	0.096	602.8	3517	0.097	
MS	665	13	0.832	0.367	552.4	12467	0.344	
SM	699	11	1.329	0.458	928.1	20296	0.559	
Total	2081	38			2083.3	36279	1.00	0.09

Table 2. ***Nephrops*****, Clyde (FU 13): Sound of Jura subarea. Results by sediment stratum for 2018 TV survey.** ***Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).***

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance	Survey Precision Level (RSE)
2018 TV survey								
M	90	2	0.689	0.088	62	357	0.389	
MS	142	6	0.874	0.129	124.1	434	0.472	
SM	150	4	0.878	0.023	131.8	128	0.139	
Total	382	12			317.9	919	1	0.101

Table 3. ***Nephrops*****, Clyde (FU 13): Firth of Clyde subarea. Results of the UWTV surveys (absolute values).**

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	29	0.28	579	176
1996	38	0.45	935	242
1997	31	0.57	1198	262
1998	38	0.61	1262	213
1999	39	0.45	930	289
2000	40	0.68	1411	246
2001	39	0.71	1486	268
2002	36	0.76	1571	288
2003	37	0.87	1817	292
2004	32	0.95	1970	367
2005	44	0.94	1959	287
2006	43	0.88	1851	257
2007	40	0.6	1233	218
2008	38	0.85	1769	291
2009	39	0.72	1499	210
2010	37	0.84	1750	327
2011	40	1.04	2165	305
2012	37	0.68	1421	227
2013	34	0.96	1990	246
2014	35	0.64	1328	237
2015	37	0.88	1820	351
2016	37	0.94	1946	249
2017	38	0.75	1568	239
2018	40	1.06	2193	297
2019	38	1.002	2083	381

Table 4. ***Nephrops*, Clyde (FU 13): Sound of Jura subarea. Results of the UWTV surveys (absolute values).**

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	7	0.42	160	58
1996	10	0.45	171	26
1997	no surveys			
1998				
1999				
2000				
2001	13	0.71	272	76
2002	9	1.04	398	167
2003	12	0.68	260	68
2004	no survey			
2005	11	0.79	303	84
2006	10	1.13	430	134
2007	10	0.67	255	58
2008	no survey			
2009	12	0.66	251	68
2010	12	0.98	376	38
2011	12	0.82	312	73
2012	12	0.98	371	61
2013	9	0.52	198	35
2014	9	0.61	231	90
2015	12	0.98	376	127
2016	12	1.10	422	42
2017	12	0.80	306	71
2018	12	0.72	275	53
2019	12	0.832	318	61

Table 5. *Nephrops*, Clyde (FU13) (Firth of Clyde and Sound of Jura subareas); Assessment summary

Year	Firth of Clyde UWTV abundan	Firth of Clyde 95 % CI	Sound of Jura UWTV abundan	Sound of Jura 95 % CI	Harvest rate	Landings numbers	Total discards numbers *	Removal s numbers	Landings	Total discards *	Discard rate	Mean weight in landings	Mean weight in discards	Dead discard .rate
	millions		millions		%	millions	millions	millions	tonnes	tonnes	%	grammes	grammes	%
1995	579	176	160	58	36.4	207	82	269	3987	619	28.4	19.24	7.54	22.9
1996	935	242	171	26	21.1	187	61	233	4057	635	24.7	21.68	10.35	19.7
1997	1198	262	NA	NA	NA	150	70	202	3621	598	32	24.21	8.5	26.1
1998	1262	213	NA	NA	NA	269	187	409	4841	1292	41	17.98	6.92	34.2
1999	930	289	NA	NA	NA	216	93	286	3752	566	30.2	17.39	6.05	24.5
2000	1411	246	NA	NA	NA	171	48	207	3417	470	22	19.96	9.75	17.4
2001	1486	268	272	76	12.8	164	82	225	3182	677	33.5	19.46	8.23	27.4
2002	1571	288	398	167	12.4	207	50	245	3384	406	19.5	16.35	8.12	15.4
2003	1817	292	260	68	12.8	166	134	266	3173	1247	44.7	19.13	9.31	37.7
2004	1970	367	NA	NA	NA	158	168	284	2973	1435	51.5	18.8	8.54	44.3
2005	1959	287	303	84	10.7	189	69	241	3395	611	26.8	17.96	8.81	21.6
2006	1851	257	430	134	12.7	248	55	290	4780	515	18.2	19.27	9.31	14.3
2007	1233	218	255	58	43	350	387	640	6660	2566	52.5	19.05	6.64	45.3
2008	1769	291	NA	NA	NA	357	207	512	5923	1433	36.6	16.59	6.94	30.3
2009	1499	210	251	68	22.2	261	169	388	4779	1390	39.3	18.31	8.23	32.7
2010	1750	327	376	38	14.9	276	55	317	5843	536	16.7	21.21	9.68	13.1
2011	2165	305	312	73	15.7	333	74	388	6432	568	18.2	19.34	7.65	14.3
2012	1421	227	371	61	21	306	93	376	6687	1066	23.4	21.83	11.42	18.6
2013	1990	246	198	35	14.1	262	62	309	5435	454	19	20.72	7.37	15

2014	1328	237	231	90	22.6	295	78	353	6207	696	20.9	20.79	8.92	16.6
2015	1820	351	376	127	12.4	232	54	273	5147	401	18.9	22.21	7.43	14.8
2016	1946	249	422	42	17.6	364	69	416	6447	636	15.9	17.7	9.21	12.4
2017	1568	239	306	71	17.6	305	31	329	5222	265	9.2	17.0	8.55	7.4
2018	2193	297	275	53	11.1	268	7	273	4141	68	2.5	16.14	9.79	1.9
2019	2083	381	318	61	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 6. . *Nephrops*, Clyde (FU 13): Basis for advice for 2020.

Firth of Clyde

Variable	Value	Notes
Stock abundance (2020)	2083 million	Abundance in TV assessment UWTV 2019
Mean weight in wanted catch	16.95 g	Average 2016–2018 (combined for Firth of Clyde and Sound of Jura)
Mean weight in unwanted catch	9.18 g	Average 2016–2018 (combined for Firth of Clyde and Sound of Jura)
Unwanted catch proportion	9.2 %	Average proportion by number 2016–2018 (combined for Firth of Clyde and Sound of Jura)
Unwanted catch survival rate	25%	Proportion by number.
Dead unwanted catch rate*	7.1 %	Average 2016–2018 (proportion by number).

Sound of Jura

Variable	Value	Notes
Stock abundance (2020)	318 million	Abundance in TV assessment UWTV 2019
Mean weight in wanted catch	16.95 g	Average 2016–2018 (combined for Firth of Clyde and Sound of Jura)
Mean weight in unwanted catch	9.18 g	Average 2016–2018 (combined for Firth of Clyde and Sound of Jura)
Unwanted catch proportion	9.2 %	Average proportion by number 2016–2018 (combined for Firth of Clyde and Sound of Jura)
Unwanted catch survival rate	25%	Proportion by number.
Dead unwanted catch rate*	7.1 %	Average 2016–2018 (proportion by number).

Table 7. Catch options tables for 2019 for Firth of Clyde subarea. All weights in tonnes.

Catch scenarios for 2020 assuming discarding continues at the recent average rate.

Basis	Total catch	Dead removals	Wanted catch	Dead unwanted catch	Surviving unwanted catch	Harvest rate*	% advice change **
	WC+DUC +SUC	WC+DUC	WC	DUC	SUC	for WC+DUC	
ICES advice basis							
MSY approach	5227	5159	4955	204	68	15.1	-12.70%
Other options							
$F_{MSY\ lower}$	3428	3383	3249	134	45	9.9	- 43%
$F_{MSY\ upper}$***	5227	5159	4955	204	68	15.1	-12.70%
F_{2018}	3842	3792	3642	150	50	11.1	-36%

* Calculated for dead removals and applied to total catch.
**Advice value 2019 relative to advice value 2018.
*** $F_{MSY\ upper} = F_{MSY}$ for this stock

Catch scenarios for 2020 assuming zero discards.

Basis	Total catch	Wanted catch	Unwanted catch	Harvest rate*	% advice change **
	WC+UC	WC	UC	for WC+UC	
ICES advice basis					
MSY approach	5107	4841	266	15.1	-14.70%
Other options					
$F_{MSY\ lower}$	3348	3174	174	9.9	-44%
$F_{MSY\ upper}$***	5107	4841	266	15.1	-14.70%
F_{2018}	3754	3559	195	11.1	-37%

* Calculated for dead removals.
** Advice value 2020 relative to advice value 2019.
*** $F_{MSY\ upper} = F_{MSY}$ for this stock

Table 8. Catch options tables for 2020 for Sound of Jura subarea. All weights in tonnes.

Catch scenarios for 2020 assuming discarding continues at the recent average rate.

Basis	Total catch	Dead removals	Wanted catch	Dead unwanted catch	Surviving unwanted catch	Harvest rate*	% advice change **
	WC+DUC +SUC	WC+DUC	WC	DUC	SUC	for WC+DUC	
ICES advice basis							
MSY approach	634	626	601	25	8	12	6.00%
Other options							
$F_{MSY\ lower}$	496	490	471	19	6	9.4	-17.10%
$F_{MSY\ upper}$***	634	626	601	25	8	12	6.00%
F_{2018}	587	579	556	23	8	11.1	-1.84%

* Calculated for dead removals and applied to total catch.
**Advice value 2019 relative to advice value 2018.
*** $F_{MSY\ upper} = F_{MSY}$ for this stock

Catch scenarios for 2020 assuming zero discards.

Basis	Total catch	Wanted catch	Unwanted catch	Harvest rate*	% advice change **
	WC+UC	WC	UC	for WC+UC	
ICES advice basis					
MSY approach	619	587	32	12.0	3.50%
Other options					
$F_{MSY\ lower}$	485	460	25	9.4	-18.90%
$F_{MSY\ upper}$***	619	587	32	12.0	3.50%
F_{2018}	573	543	30	11.1	- 4.2%

* Calculated for dead removals.
** Advice value 2020 relative to advice value 2019.
*** $F_{MSY\ upper} = F_{MSY}$ for this stock

Western Irish Sea *Nephrops* Grounds (FU15) 2019 UWTV Survey Report and catch options for 2020

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Abstract

This report provides the main results and findings of the 17th annual underwater television survey on the 'Irish sea west *Nephrops* grounds' ICES assessment area, Functional Unit 15. The survey was multi-disciplinary in nature collecting UWTV and other ecosystem data. The 2019 design consisted of a randomised isometric grid of 100 stations at 4.5 nautical mile intervals out over the full known extent the stock. The resulting krigged burrow abundance estimate was 4.4 billion burrows. This was a similar result of that obtained in 2015, but a 10% lower than the abundance in 2018. In contrast to 2017 the spatial distribution of burrows shows a high density band on the central western area of the survey ground. The abundance remains within previously observed ranges and is above MSY $B_{trigger}$. The CV (or relative standard error) of 3% is in line with previous estimates and well below the upper limit of 20% recommended by SGNEPS 2012. Total catches and landings options at various different fishing mortalities were calculated and fishing at F_{msy} in 2020 implies a total catch option at F_{msy} (=F_{max}) of 10,377 tonnes estimated to result in landings of no more than 8,546 tonnes. Sea-pens were observed at 21% of stations with high densities observed in the south-west of the ground. Trawl marks were noted at 15% of the UWTV stations.

Key words: *Nephrops norvegicus,* stock assessment, geostatistics, underwater television (UWTV), benthos.

Introduction

The Norway lobster, *Nephrops norvegicus*, is exploited throughout its geographic range, from Icelandic waters to the Mediterranean and the Moroccan coast. The western Irish Sea stock (FU15) is amongst the most productive of all the *Nephrops* stocks currently fished yielding landings of 5,000-10,000 tonnes annually from a relatively small geographic area (ICES, 2012a). *Nephrops* spend significant time in burrows, with emergence behaviour influenced by several factors: time of year, light intensity, tidal strength, etc. Underwater towed video surveys and assessment methodologies have been developed to provide a fishery independent estimate of stock size, exploitation status and catch advice (ICES, 2009a & 2012a).

This is the 17th survey in a time series of UWTV surveys in the western Irish Sea carried out jointly by the Agri-Food and Biosciences Institute (AFBI), Northern Ireland, and the Marine Institute, Ireland. The 2019 survey was multi-disciplinary in nature; the specific objectives are listed below:

1. To complete randomised fixed isometric survey grid of 100 UWTV with 4.5 nautical mile (nm) spacing stations on the western Irish Sea *Nephrops* ground (FU15).
2. To obtain 2019 quality assured estimates of *Nephrops* burrow distribution and abundance on the western Irish Sea *Nephrops* ground (FU15). These will be compared with those collected previously.
3. To collect ancillary information from the UWTV footage at each station such as the occurrence of sea-pens, other macro-benthos and fish species and trawl marks on the seabed.
4. Technology, staff and protocol transfer between AFBI, the Marine Institute and Cefas.

This report details the final UWTV results of the 2019 survey and also documents other data collected during the survey.

SGNEPS (ICES, 2012b) recommended that a CV (or relative standard error) of < 20% is an acceptable precision level for UWTV surveys. SGNEPS also recommended that investigations into the precision of surveys be carried out and where possible survey effort should be extended to grounds not already covered with UWTV surveys (including FU16, FU19 and FU20-21).

Material and methods

From 2003 to 2019 a randomized fixed square grid for the western Irish Sea (FU15) Nephrops ground has been used. An adaptive approach is taken whereby stations are continued past the known perimeter of the ground until the burrow densities are zero or very close to zero. The initial ground perimeter has been established using a combination of integrated logbook-VMS data (using the methods described in Gerritsen and Lordan, 2011), British Geological Survey (BGS) and other sediment maps, and previously collected UWTV data. The same ground boundaries have been used throughout the time-series. The grid spacing from 2003 to 2011 was 3.5 nautical miles (nM). Following a review (Doyle *et al.*, 2013) the grid design was changed from a 3.5 nM to 4.5 nM in 2012. In 2013, the grid spacing was increased further to a 5.0 nM isometric grid, whereas a 4.5 nM isometric grid was used again in 2014 - 2018 to ensure all edge of ground areas were represented adequately.

The survey took place on RV *Corystes* between 6th August and 16th August 2019. The survey covered the western Irish Sea (FU15) grid and the eastern Irish Sea (FU14). The results for FU14 will be presented in a separate report, led by Cefas. Survey timing for FU15 was generally standardised to August each year and was also timed to take full advantage of the neap tides when underwater visibility is normally better.

The protocols used were those presented and reviewed by WKNEPHTV 2007 (ICES, 2007) and are summarised as follows: at each station the UWTV sledge was deployed and once stable on the seabed a 10 minute tow was recorded onto DVD. Vessel position (dGPS) were recorded every 1 second. The navigational data were quality controlled using an "R" script developed by the Marine Institute (ICES, 2009b). In 2019 due to technical issues with the USBL, ship GPS navigational data were used to calculate distance over ground for 100% of stations, this was as carried out in 2018.

In line with SGNEPS recommendations all scientists were trained/re-familiarised using training material and validated using reference footage prior to recounting at sea (ICES, 2009b). Once this process had been undertaken, all recounts were conducted by two trained "burrow identifying" scientists independent of each other on board the research vessel during the survey. During this review process the visibility, ground type and speed of the sledge during one-minute intervals were subjectively classified using a classification key. In addition the numbers of *Nephrops* burrows complexes (multiple burrows in close proximity which appear to be part of a single complex which are only counted once), *Nephrops* activity in and out of burrows were counted and recorded by each scientist for each one-minute interval. Following the SISP (Series of ICES Survey Protocols) agreed by WGNEPS 2016 (ICES, 2016), eight minutes of recounts should be carried out for each station although only the first minute is then excluded from analysis with only seven minutes used for analysis. The first minute is thus treated as a 're-familiarisation' minute.

Notes were also recorded each minute on the occurrence of trawl marks, fish species and other species. Semi-quantitative abundance of seapen species were also recorded according to OSPAR Special Request (ICES 2011). A key was devised to categorise the densities of sea pens based on SACFOR abundance scale (Table 2) after ICES (2011). Finally, if there was any time during the one-minute where counting was not possible (due to sediment clouds or other reasons), the duration was also recorded so that the time window could be removed from the distance over ground calculations. The "R" quality control tool allowed for individual station data to be analysed in terms of data quality for navigation, overall tow factors such as speed and visual clarity and consistency in counts (examples are given in Figures 1 and 2). Consistency and bias between individual counters were examined no obvious bias between counters was observed.

The recount data were subjected to Lin's concordance correlation coefficient (CCC) for each station, and where the statistic fell below a threshold of 0.5, a third independent trained counter completed an additional set of recounts. These recounts were checked again using Lin's CCC and if the statistic remained below the threshold of 0.5, a fourth consensus count was carried out by the three counters who had previously counted the footage. This application of Lin's CCC to recount data during the survey is the fourth year where this has been used to bring quality control in line with other laboratories' protocols, such as those of Marine Scotland, Marine Institute and Cefas. The "R" scripts were developed by AFBI based on those used by Cefas. Lin's CCC was only applied to stations where average count per minute exceeded 1.5 burrow systems. In total, 35 of the stations failed to meet the 0.5 Lin's CCC threshold based on their first two counts by independent counters. Following third counts over 96% stations successfully met these threshold, however 4 stations did not pass after having 3 counts by independent staff and a consensus count was carried out for each of these stations.

Arithmetic means of the burrow density and *Nephrops* recounts were standardised by dividing by the survey area observed. The ship's navigation data were used to calculate distance over ground of the sledge. The field of view of the camera at the bottom of the screen was estimated at 68 cm using lasers with the sledge flat on the seabed (i.e. no sinking).

The "R" Geostats was used to complete the interpolation and analysis of data, and to calculate the CV. This was completed as in previous years using core "R" code used by the Marine Institute and first trialled on FU15 in 2016, using the adjusted burrow densities. A historical comparison of SURFER based estimates and R-geostats estimates showed consistent trend agreement. The Coefficient of Variance is provided using R-Geostats for the 2019 dataset.

Results

The station positions are shown in Figure 3. A violin plot of the observed burrow densities from 2003 to 2019 on the western Irish Sea is presented in Figure 4. Over the time series available the density estimates observed are very similar with average density of around 1 burrow/m^2. Figure 5 and Figure 6 show the variability in density between minutes and operators (counters) for each station, respectively. These quality control and consistency plots show that the burrow estimates were fairly consistent between minutes and counters. Variability is higher between minutes than counters. Higher density stations showed the greatest variability between counters. Stations in the west and south-west of the ground tend to show higher minute by minute variability than those in the centre and to the north of the ground. Recent trawling activity and the co-occurrence of other burrowing species (e.g. *Goneplax rhomboides* and *Calocaris macandreae*) sometimes impacts on the between minute variability.

The geo-statistical structural analysis is shown in the form of variograms in Figure 9. The blanked and krigged contour plot and posted point density data are shown in Figures 8 - 10. The krigged contours correspond well to the observed data. These densities surfaces show a relatively dynamic situation. Some parts of the ground have consistently higher or lower densities, such as to the south-west of the ground, near the northern-most extent of the ground, with a further 'hot spot' to the east of the ground (southwest of the Isle of Man). In most areas densities drop to zero or near zero as the ground boundary is approached, with the exception in 2016 - 2018 (and to a lesser extent in 2014) across the widest part of the ground at the western and easten (immediately SW of Isle of Man) boundaries. There tends to be a lower density towards the centre of the ground. The 2019 spatial pattern is most similar to that in 2007, but with slighty lower densities observed towards the southern west of the ground. The high density areas observed in the FU15 in the past had almost disappeared in recent years, however 2016 and 2017 has exhibited some stations with an average burrow density of greater than 2 systems/m^2; but in 2019 there were no densities this high observed, with the densities similar to those observed in 2015 (see Figure 5).

The summary statistics from this geo-statistical analysis are given in Table 3 and plotted in Figure 11. The 2019 final adjusted abundance estimate of 4.4 billion burrows is very close to that estimated in 2015, but represent some of the lowest total abundances on record. The overall burrow abundance trend is fairly stable although the abundance did decline between 2005 and 2008, and some decline was also seen between 2012 and 2015 but increased in 2016, and again in 2017, before falling in 2018. The CV for 2018 was 3% indicating a very precise survey in line with CVs observed previously.

Seapen distribution across the western Irish Sea *Nephrops* grounds is mapped in Figure 12. Trawl marks were noted at 26% of the stations surveyed, which is a decrease of 10% to that observed in the previous survey year.

Discussion

The western Irish Sea (FU 15) stock has accounted for >40% of the total landings reported to WGCSE for ICES Sub-area VII (ICES, 2018) making it an important FU in the TAC management area. The burrow densities typically observed in FU15 are amongst the highest observed of all *Nephrops* stocks but the mean sizes of individuals in the catches are relatively small. It appears that growth is suppressed due to competition and/or recruitment effects (Johnson et. al, 2012). There has been an increase in the mean landed weight of individual *Neprhops,* although a complex interaction of environmental and fishery factors could cause this. Despite the smaller size of individuals, the fishery is particularly important to the Northern Irish and Irish *Nephrops* métiers. In the last decade it has become by far the most economically important fishery in the Irish Sea. The Western Irish Sea *Nephrops* stock is relatively well studied with size information on catches extending back to the 1970s, a trawl survey series since 1994 and larval production surveys in a few years.

Since the benchmark assessment by ICES in 2009 this UWTV survey has become the main input for assessment and calculation of catch options for this stock. The survey information up to 2012 was used as the main basis for the ICES assessment of status and exploitation rate up to 2012. ICES concluded that this stock abundance is stable and is above MSY $B_{trigger}$ (ICES, 2013). The 2019 abundance estimate remains well above the MSY $B_{trigger}$ (biomass trigger) proposed by ICES of 3.0 billion burrows which was derived from a longer time series of trawl survey data. All other stock status indicators suggest that the stock remains at a stable healthy condition (ICES, 2013). Table 4 is an updated management option table giving total catch and landings options at various levels of fishing mortality for 2020. Using the 2019 estimate of abundance would imply a total catch option at F_{MSY} (=F_{max}) of no more 10,377 tonnes which would result in landings of more than 8,546 tonnes, if the fisher behaviour (discarding) as observed in 2016 – 2018 was maintained.

SGNEPS 2012 recommended a review of survey sampling intensity (ICES, 2012b). Following a review (Doyle et al., 2013) the grid design was changed from a 3.5 nautical mile square grid prior to 2012 to 5.0 nautical mile isometric grid in 2013. In 2014 the grid spacing was reduced to 4.5 nautical mile isometric grid as in 2012, and has remained at this spacing in the following years. The precision for all surveys at 4.5 nM spacing appears stable and high, with a CV of 3% which is in line with previous estimates well below the SGNEPS 2012 recommendation of 20%.

Burrow identification in the western Irish Sea is, at times, difficult due to the high underlying burrow densities and sometimes poor visibility. The burrows of *Calocaris macandreae* (a mud burrowing shrimp species) are abundant particularly in the softer muds in the middle of the western Irish Sea grounds, and the burrows of the crab *Goneplax rhomboides* in the west and south-west in particular cause some difficulty with *Nephrops* burrow discrimination. However, such allocation errors are minimised due to the training procedures employed during the survey. These include refresher training on classical *Nephrops* burrow signatures and consistency verification with reference count analyses (ICES, 2008 & 2009b). The counting performance of the 2018 counters was generally very high with Lin's CCC scores >0.5 for all stations.

An important objective of this UWTV survey is to collect various ancillary information. The occurrence of trawl marks on the footage is notable for two reasons. Firstly, it makes identification of *Nephrops* burrows more difficult as the trawl marks can remove some signature features making accurate burrow identification more difficult. Secondly, only occupied *Nephrops* burrows will persist in heavily trawled grounds and it is assumed that each burrow is occupied by one individual *Nephrops* (ICES, 2009a). The CTD data collected is currently being analysed as part of a larger project. The multi-disciplinary nature of the survey means that the information collected is highly relevant for a number of research and advisory applications.

The impact of trawling activity on the seabed communities' structure and functioning has been raised a potential ecosystem concern (OSPAR, 2010). Seapens in particular have been identified as a potential indicator species for benthic habitat health status. OSPAR have sought advice from ICES on the utility of UWTV surveys for collecting data on seapen status and distributions (ICES, 2011). The occurrence of seapens has been noted on this survey since the outset. This is the sixth year that a systematic quantification and of seapens was undertaken. There is evidence of co-occurrence of trawl marks and seapens, particularly in the south of the ground.

The main objectives of the survey were successfully met for the 17th successive year. The UWTV coverage and footage quality were generally good on the western Irish Sea grounds due to survey timing. Due to fishing activity over some stations these sites had to be re-visited as first attempts were marred by poor visibility. There were some technical difficulties with camera equipment.

Acknowledgments

We would like to express our thanks and gratitude to the Captain and crew of RV *Corystes* for their good will and professionalism during the survey. Finally, thanks to the AFBI, Marine Institute, and CEFAS staff onboard for their hard work and enthusiasm in making this survey a success.

References

Doyle, J., Lordan, C., Fitzgerald, R., Strong, J. and Service, M. 2012. Western Irish Sea Nephrops Grounds (FU15) 2012 UWTV Survey Report. Marine Institute and Agri-Food and Biosciences Institute. http://hdl.handle.net/10793/891

Doyle J., Lordan C., Ligas A., Brown V., Leocadio A., McCausland I., McCorriston P., Service M., Stewart P., and Schön P.-J. 2013. Western Irish Sea *Nephrops* Grounds (FU15) 2013 UWTV Survey Report and catch options for 2014. Marine Institute and AFBI UWTV Survey report.

Gerritsen, H., and Lordan, C. 2011. Integrating vessel monitoring systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES Journal of Marine Science: Journal du Conseil 68: 245–252. doi: http://dx.doi.org/10.1093/icesjms/fsq137.

Petitgas P. and Lafont, T, 1997. EVA (Estimation VAriance). A geostatistical software on IBM-PC for structure characterization and variance computation. Version 2.

ICES 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14 Ref: LRC, PGCCDBS.

ICES 2008. Report of the Workshop and training course on Nephrops burrow identification (WKNEPHBID). ICES CM: 2008/LRC: 3 Ref: LRC, ACOM.

ICES 2009a. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM: 2009/ACOM:33

ICES 2009b. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15. Ref: TGISUR.

ICES 2011. Report of the ICES Advisory Committee 2011. ICES Advice.2011. Book 1: Introduction, Overviews and Special Requests. Protocols for assessing the status of sea-pen and burrowing megafauna communities, section 1.5.5.3.

ICES 2012a. Report of the Working Group for Celtic Seas Ecoregion (WGCSE). ICES CM: 2012/ ACOM:12.

ICES 2012b. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2012/SSGESST: 19. Ref: SCICOM, ACOM

ICES 2012c. ACOM advice June 2012, *Nephrops* in Subarea VII, ICES Advice 2012, Book 5, pp 234-283.

ICES 2013. Report of the Working Group for Celtic Seas Ecoregion (WGCSE). ICES CM: 2013/ ACOM:12.

ICES 2016. Interim Report of the Working Group on Nephrops Surveys (WGNEPS). ICES CM 2016/SSGIEOM:32.

Johnson, M.P., Lordan, C., Power. A.M. 2012. Habitat and Ecology of *Nephrops norvegicus*. Advances in marine biology 64, 27-63

OSPAR, 2010. Background Document for Seapen and Burrowing megafauna communities. OSPAR Commission 2010, London. Publication number: 481/2010

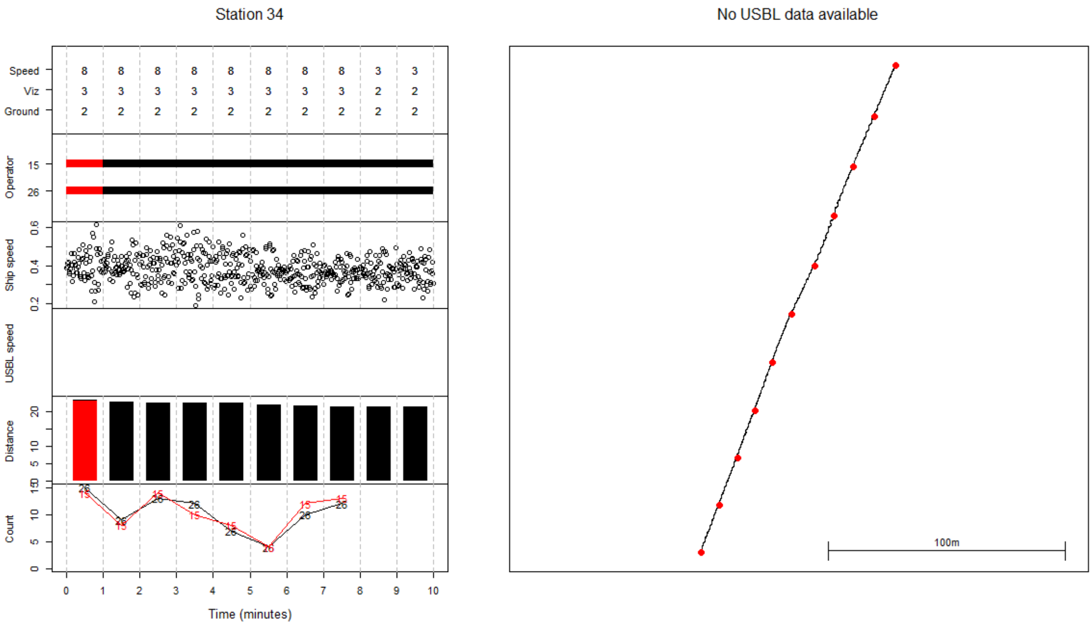


Figure 1: FU15 western Irish Sea grounds: R - tool quality control plot for station 34 of the 2018 survey.

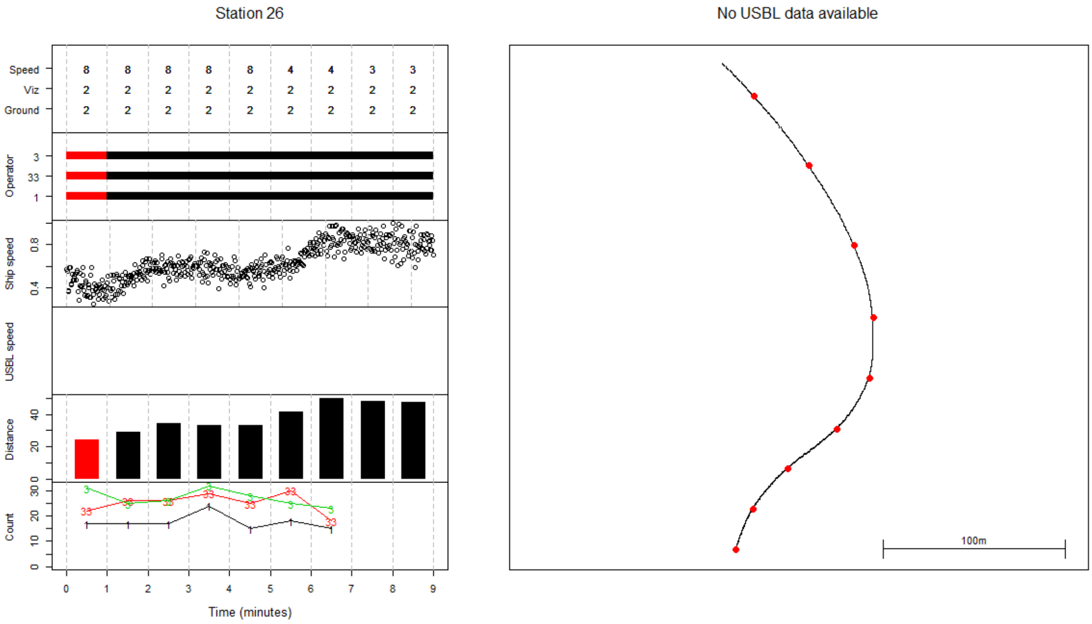


Figure 2: FU15 western Irish Sea grounds: R - tool quality control plot for station 26 of the 2019 survey.

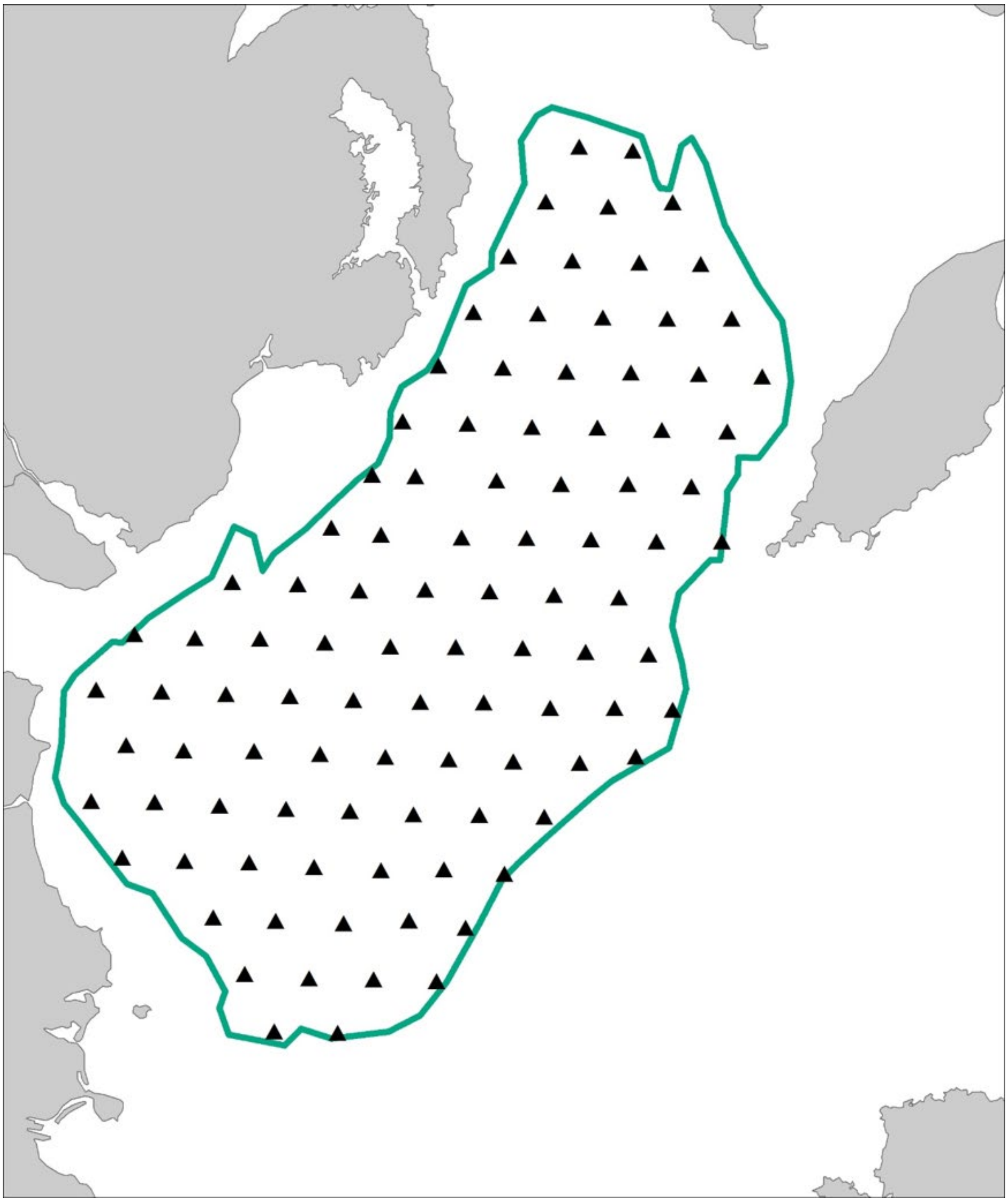


Figure 3: FU15 western Irish Sea grounds: Stations completed on the 2019 UWTV Survey.

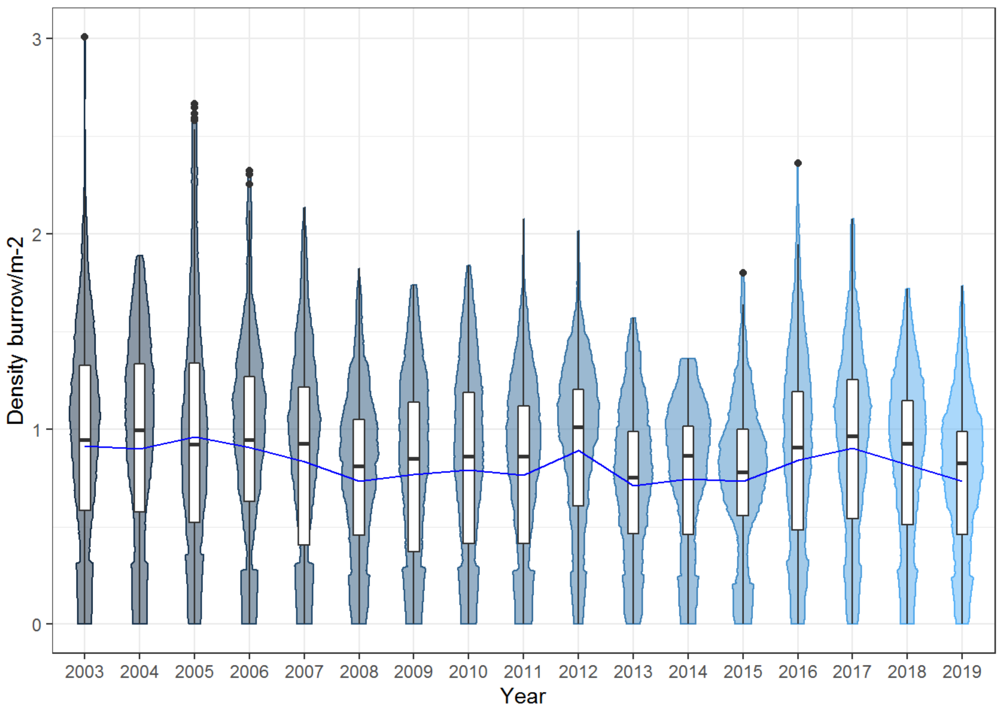


Figure 4: FU15 western Irish Sea grounds: Violin plot of burrow density distributions by year from 2003-2018.

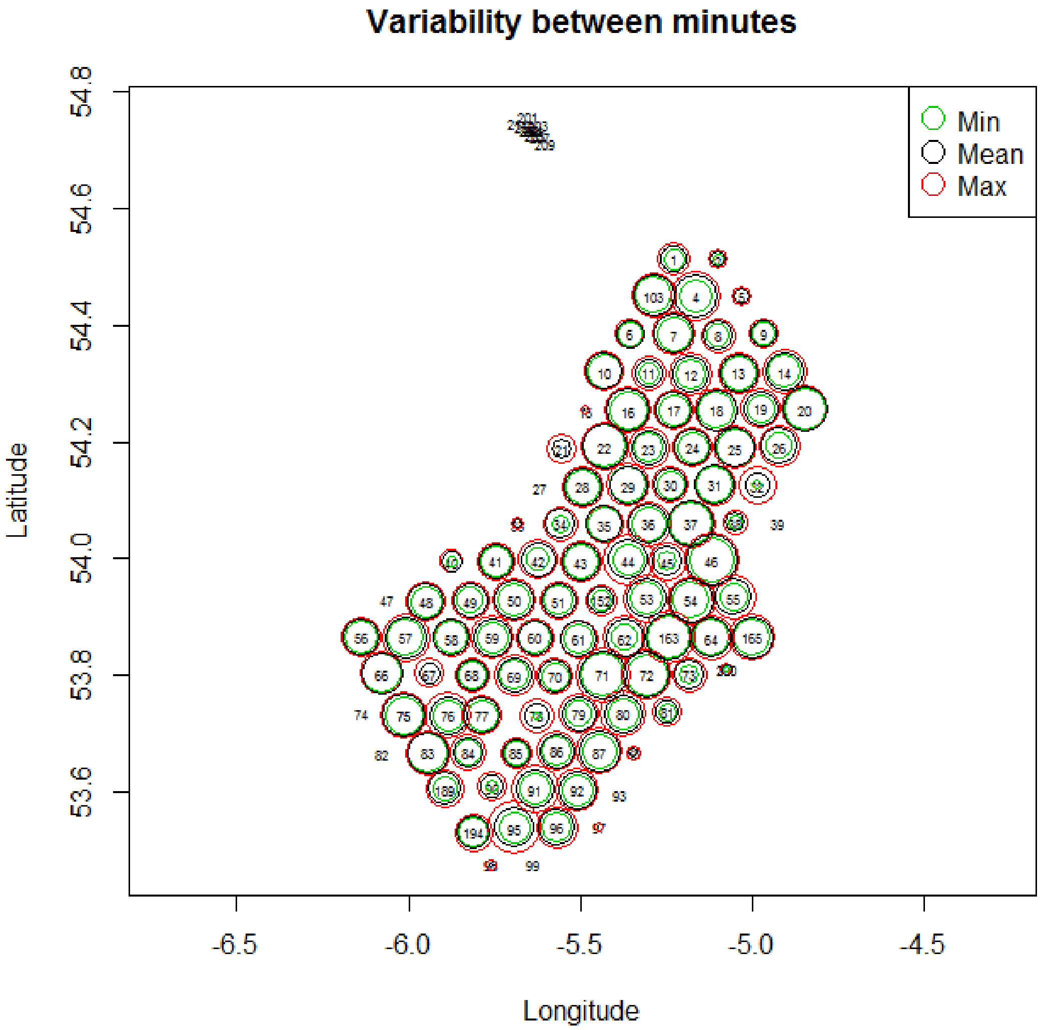


Figure 5: FU15 western Irish Sea grounds: Plot of the variability in density between minutes for each station in 2018.

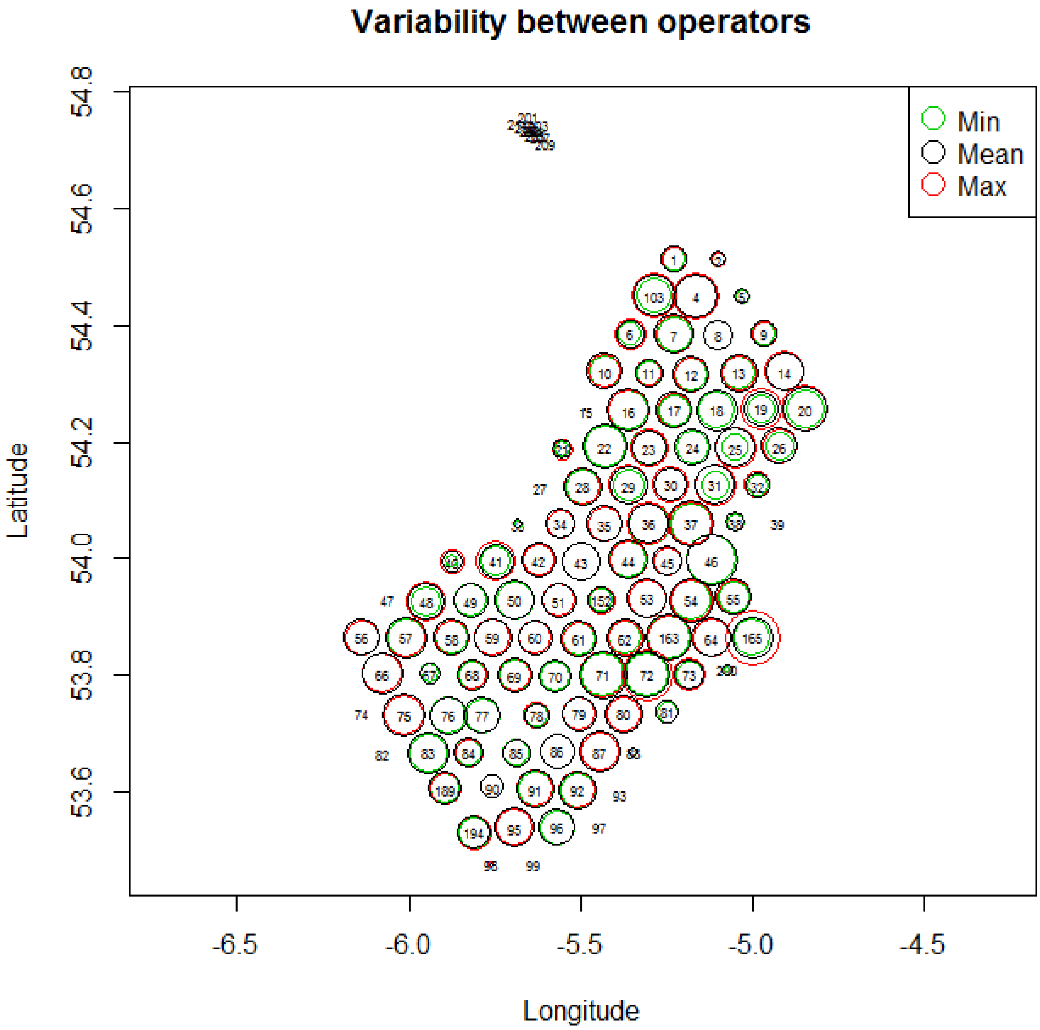


Figure 6: FU15 western Irish Sea grounds: Plot of the variability in density between operators (counters) for each station in 2018.

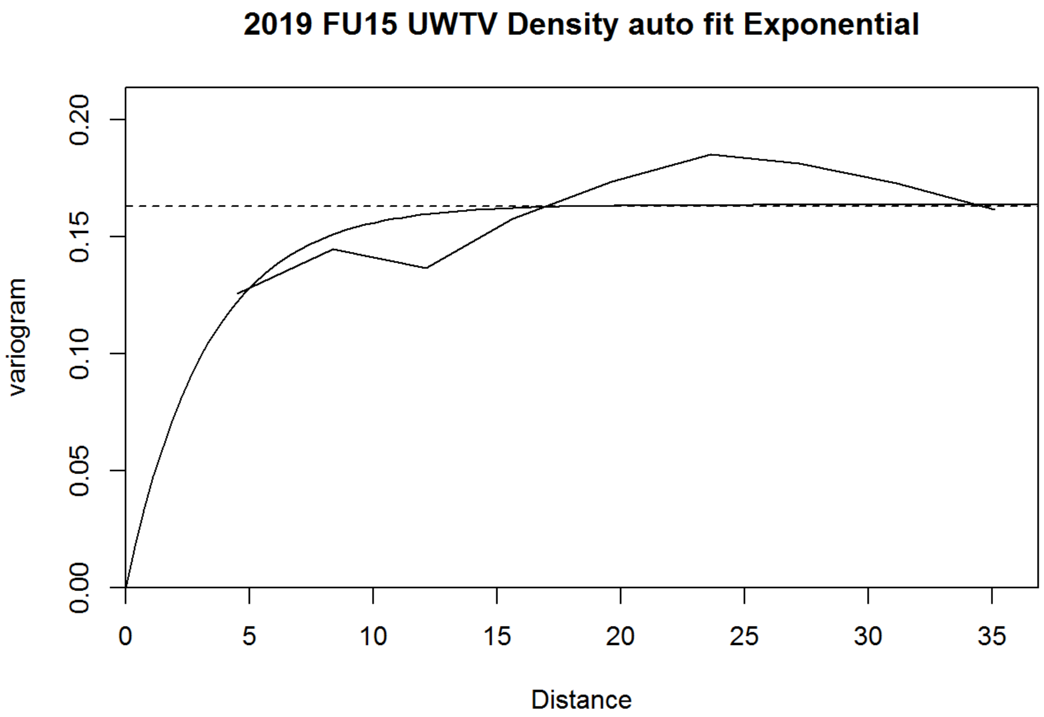


Figure 7: FU15 western Irish Sea grounds: Variograms for 2019.

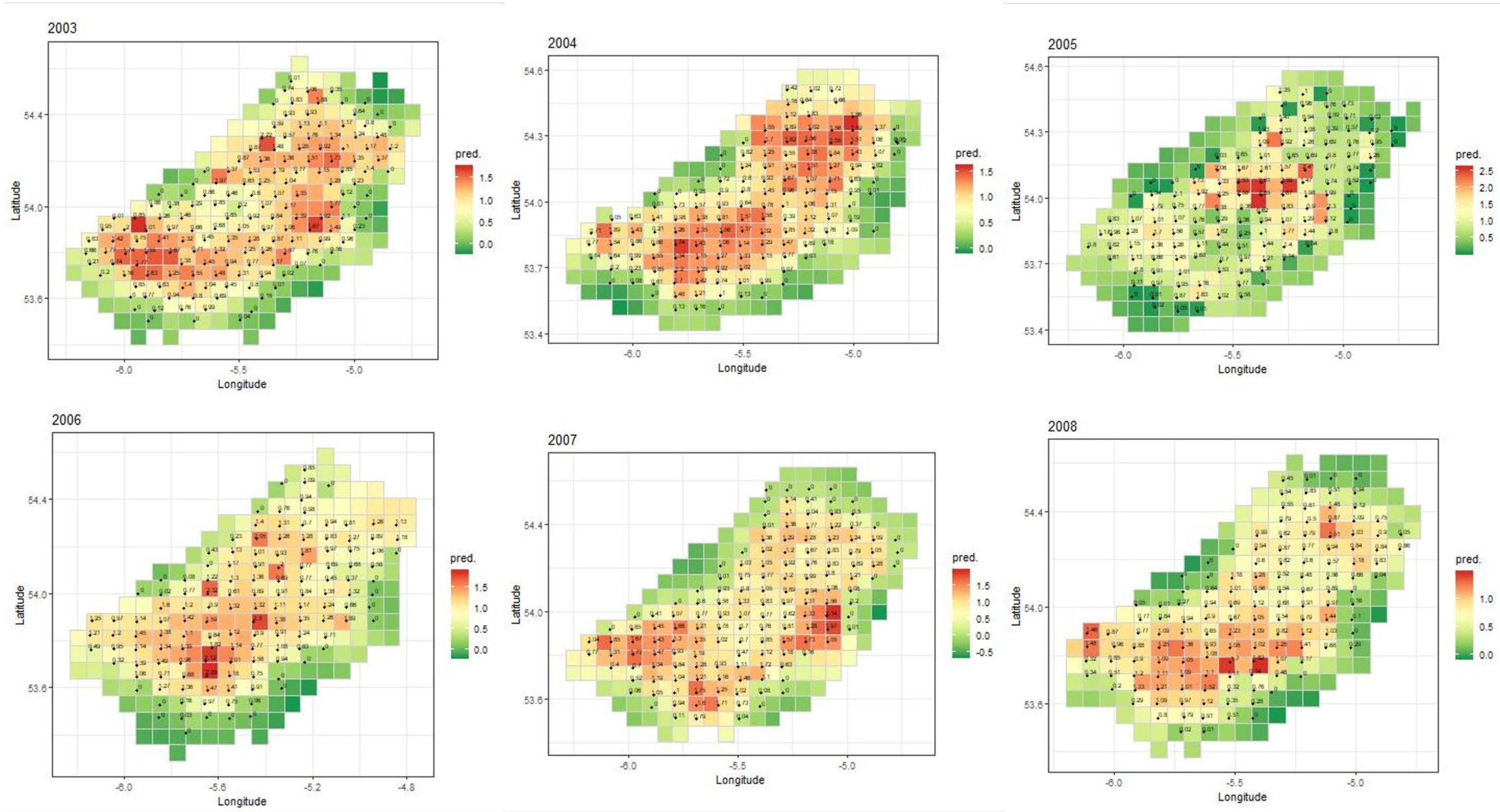


Figure 8: FU15 western Irish Sea grounds: Contour plots of the krigged density estimates by year from 2003 -2008.

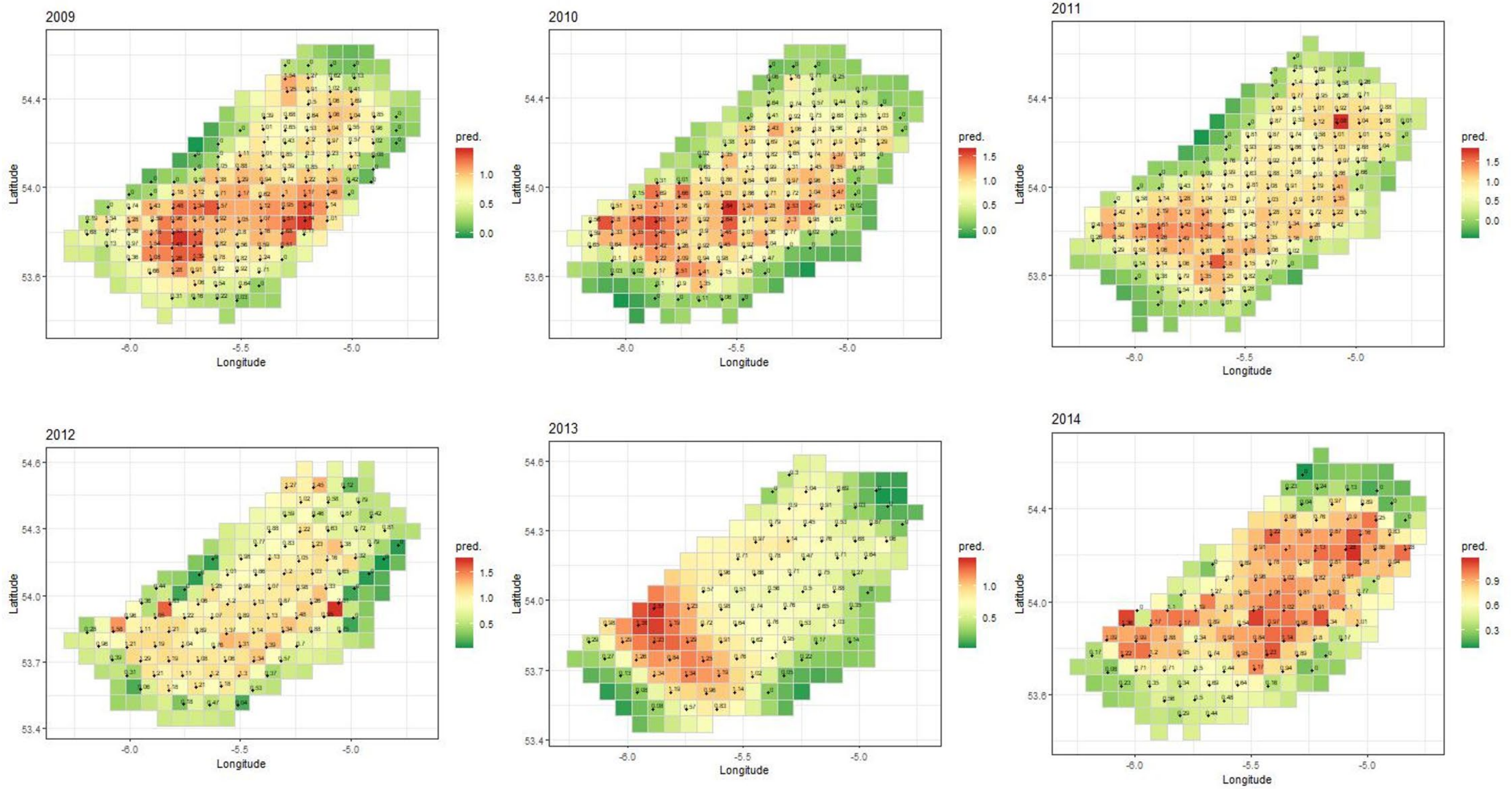


Figure 9: FU15 western Irish Sea grounds: Contour plots of the krigged density estimates by year from 2009 -2014.

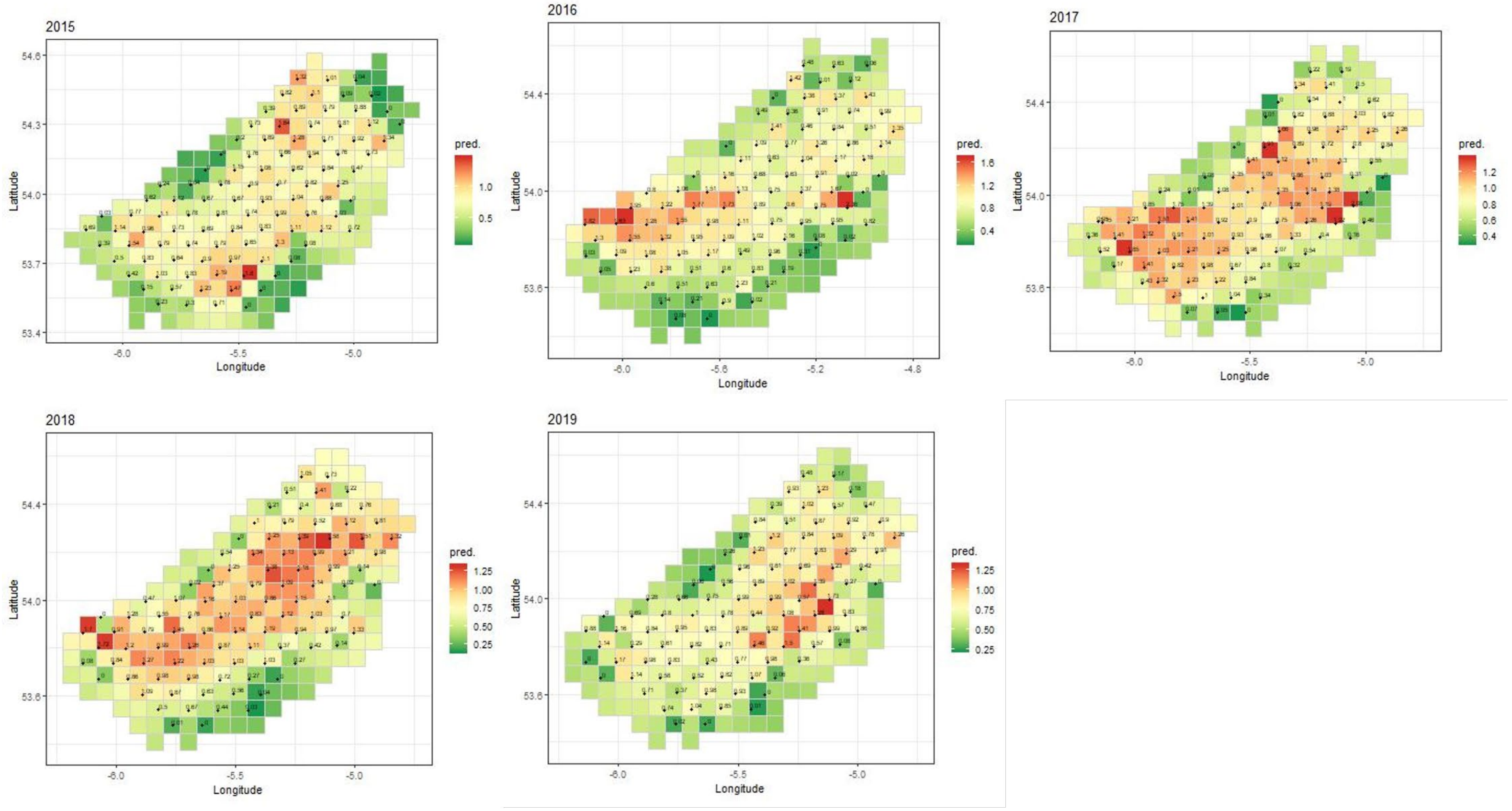


Figure 10: FU15 western Irish Sea grounds: Contour plots of the krigged density estimates by year from 2015 -2018.

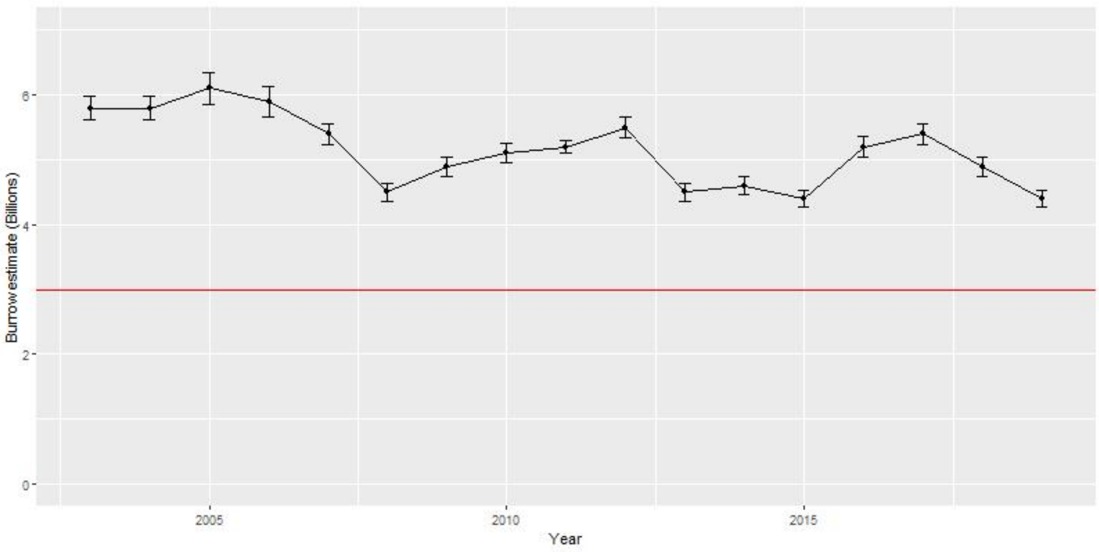


Figure 11: FU15 western Irish Sea grounds: Time series of geo-statistical adjusted abundance estimates (in billions of burrows) from 2003 -2019. Error bars correspond to the 95% confidence intervals calculated in EVA. Blue horizontal line is $B_{trigger}$ of 3.0 billion burrows.

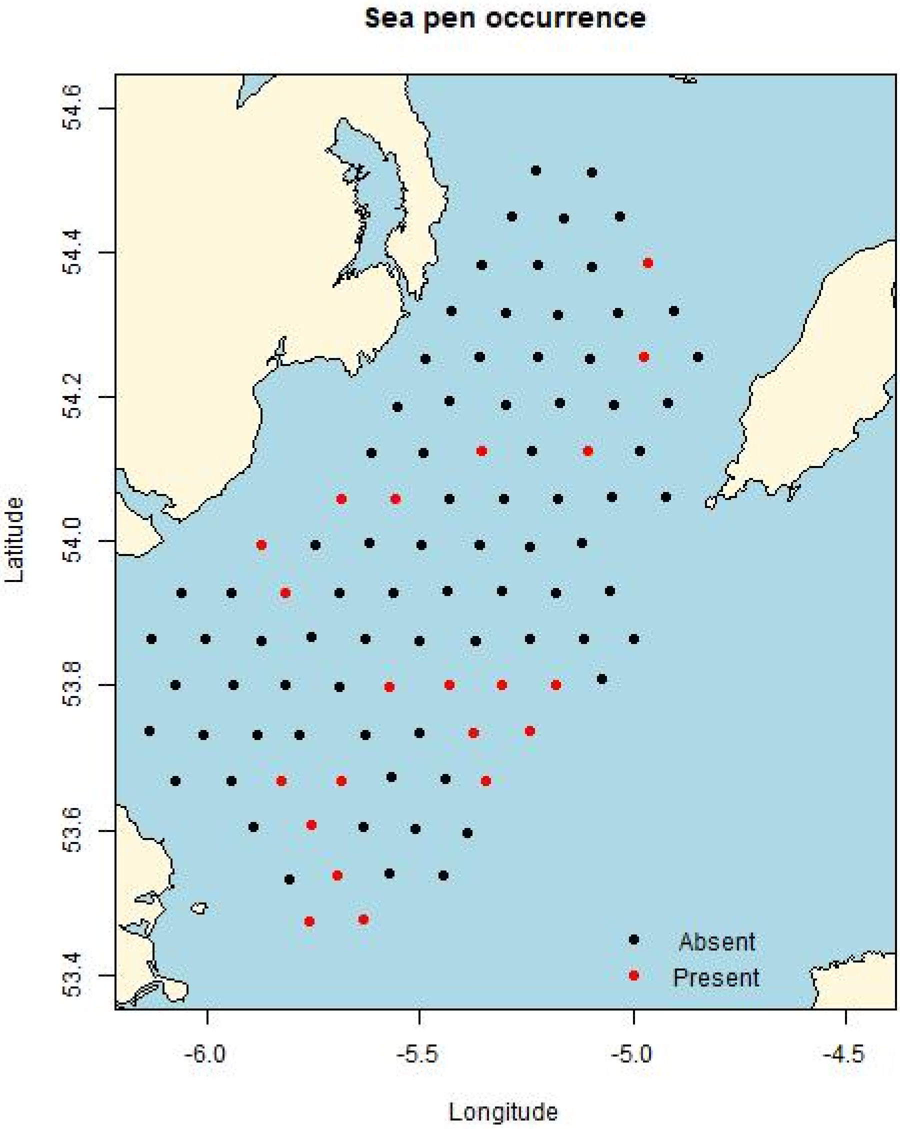


Figure 13: FU15 western Irish Sea grounds: Stations where sea pens were present in was identified during 2019.

Table 1: Key for classification of Seapen abundance as used on Irish UWTV surveys.

	Number/Min
Common	20-200
Frequent	2-19
Ocasional	<2

Species

Virgularia mirabilis

Pennatula phosphorea

Funiculina quadrangularis

Sea Pens								
V. mirabilis			*P. phosphorea*			*F. quadrangularis*		
C	F	O	C	F	O	C	F	O

Table 2: Cumulative bias factors for each *Nephrops* stock surveyed by UWTV method.

	Edge effect	Burrow detection	Burrow identification	Burrow occupancy	FU	*Cumulative Bias*
3&4 Skagerrak and Kattegat (IIIa)	1.3	0.75	1.05	1	FU3	1.1
6:Farn Deeps	1.3	0.85	1.05	1	FU6	1.2
7:Fladen	1.45	0.9	1	1	FU7	1.35
8:Firth of Forth	1.23	0.9	1.05	1	FU8	1.18
9:Moray Firth	1.31	0.9	1	1	FU9	1.21
10: Noup	1.31	0.9	1	1	FU10	1.21
11:North Minch	1.38	0.85	1.1	1	FU11	1.33
12:South Minch	1.37	0.85	1.1	1	FU12	1.32
13:Clyde	1.19	0.75	1.25	1	FU13	1.19
14: Irish Sea East	1.3	0.85	1.05	1	FU14	1.2
15:Irish Sea West	1.24	0.75	1.15	1	FU15	1.14
16: Porcupine	1.26	0.95	1.05	1	FU16	1.26
17:Aran	1.35	0.9	1.05	1	FU17	1.3
19:South Coast	1.25	0.9	1.15	1	FU19	1.3
20&21 Labadie	1.25	0.9	1.15	1	FU20	1.3
22:Smalls	1.35	0.9	1.05	1	FU22	1.3
34: Devil's Hole	1.3	0.85	1.05	1	FU34	1.2

Table 3: FU15 western Irish Sea grounds: Overview of geo-statistical results from 2003-2019.

FU 15	Year	Number of stations	Mean Density adjusted (burrows./m²)	Domain Area (km²)	R-GeoStats Estimate	CV on Burrow estimate
Western Irish Sea	2003	160	0.99	5295	5.8	3%
	2004	147	1.00	5310	5.8	3%
	2005	141	1.02	5281	6.1	4%
	2006	138	0.97	5194	5.9	4%
	2007	148	0.93	5285	5.4	3%
	2008	141	0.77	5287	4.5	3%
	2009	142	0.83	5267	4.9	3%
	2010	149	0.90	5307	5.1	3%
	2011	156	0.88	5289	5.2	2%
	*2012	99	0.91	5291	5.5	3%
	*2013	80	0.78	5278	4.5	3%
	*2014	99	0.83	5272	4.6	3%
	*2015	100	0.79	5279	4.4	3%
	*2016	100	0.84	5260	5.2	3%
	*2017	101	0.90	5304	5.4	3%
	*2018	100	0.85	5791	4.9	3%
	*2019	100	0.73	5792	4.4	3%

Table 4: FU15 western Irish Sea grounds: Short-term forecast management option table giving catch options for 2018 using the 2017 UWTV survey estimate.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F_{MSY}	10, 377	8,546	1,648	0,183	18.2
F_{2018}	5,701	4,696	905	0,101	10.0
F_{MSY} lower	7070	5,823	1,122	0,125	12.4
F_{MSY} upper precautionary	10, 377	8,546	1,648	0,183	18.2

Weights in tonnes.
* Total catches are the landings plus dead and surviving discards.
** Total discard rate is assumed to be 28.5% of the catches (in number); discard survival is assumed to be 10%.

01_2019_FU2021_SISP_datacheck

MAE/JD

2019-09-23

This markdown document compares the original sea count data for 2019 FU2021 and 20% SISP check stations counted after the survey.

- This review was undertaken as a result of plenary discussions at WGNEPS 2018 in May and WGNEPS 2018 SISP review, where it was recommended by the WG to review 20% of stations when there is a substantial difference in abundance from the previous year.
- The 20% review stations were distributed randomly among the 4 person review team.
- All reviews were undertaken in the lab after there was some initial training and familiaristion.

I am using R version 3.6.1 (2019-07-05). First we load the required packages.

```r
library(RODBC)
library(sqldf)
library(epiR)
library(reshape2)
library(mapplots)
library(shapefiles)
library(gridExtra)
library(grid)
library(lme4)
library(tidyverse)
library(vioplot)
library(data.table)
library(maptools)
library(maps)
library(mapproj)
library(captioner)
library(knitr)
```

Now to check the versions of the different packages:

Package	Version
RODBC	1.3-15
sqldf	0.4-11
epiR	1.0-2
reshape2	1.4.3
mapplots	1.5.1
shapefiles	0.7
gridExtra	2.3
grid	3.6.1
lme4	1.1-21
tidyverse	1.2.1
vioplot	0.3.2
data.table	1.12.2
maptools	0.9-5
maps	3.3.0

Package	Version
mapproj	1.2.6
captioner	2.2.3
knitr	1.23

Set Up Tables and Figures

Sample random stations

A random selection of stations from 2019 FU2021 footage where this selection does not include any true zero stations, that is, non nephrops habitat such as gravels, shelly sand etc. In total, we will review 19 stations from 2019 FU2021 footage.

Station 240 and 259 were chcosen as training stations - where all 4 reviewers counted these and discussed each burrow.

```
setwd("N:/Surveys/UWTV SURVEYS FU2022 CELTIC SEA/2019 Labadie/SISP_qc_check")


real.stn <- c(173,176,181,183,194,198,204,209,210,216,223,225,232,240,253,256,258,259,1850)
knitr::kable(cbind(Year=rep("2019", 19), Station=real.stn))
```

Year	Station
2019	173
2019	176
2019	181
2019	183
2019	194
2019	198
2019	204
2019	209
2019	210
2019	216
2019	223
2019	225
2019	232
2019	240
2019	253
2019	256
2019	258
2019	259
2019	1850

Map showing the 2019 stations and the 20% SISP check stations.

```
## Read the data and subset the year of interest
dat <- fread("N:/Surveys/UWTV SURVEYS FU2022 CELTIC SEA/2019 Labadie/Kriging/fu2021_tv_final_2019.csv",
dat<- subset(dat, Year==2019)


FG <- readShapePoly('//Galwayfs03/Nephrops/Surveys/ArcGis/ShapefilesR/NephropsGrounds_All',proj4string=
```

```
## Warning: readShapePoly is deprecated; use rgdal::readOGR or sf::st_read
```

```
EU <- readShapePoly('//Galwayfs03/Nephrops/Surveys/ArcGis/ShapefilesR/Europe',proj4string=CRS('+proj=lo
```

```
## Warning: readShapePoly is deprecated; use rgdal::readOGR or sf::st_read
```

```
m <- ggplot() +
      geom_polygon(data=EU, aes(x=long, y=lat, group=group), fill = "#006837") +
      geom_polygon(data=FG, aes(x=long, y=lat, group=group),fill = "Light Grey")


latlimits <- c(49.6, 51.2)
longlimits <- c(-7, -9.2)


dat <- dat %>% rename(lon=MidDeglong) %>% rename(lat=MidDegLat)
# new dataframe
dat2 <- dat

dat2<-data.frame(dat2)
str(dat2)
```

```
## 'data.frame':    95 obs. of  8 variables:
##  $ FU     : int  2021 2021 2021 2021 2021 2021 2021 2021 2021 2021 ...
##  $ Survey : chr  "CV19022" "CV19022" "CV19022" "CV19022" ...
##  $ Year   : int  2019 2019 2019 2019 2019 2019 2019 2019 2019 2019 ...
##  $ Station: int  170 171 172 173 174 175 176 177 178 179 ...
##  $ Count  : num  0 0 16.7 5.5 0 ...
##  $ lon    : num  -8.13 -7.98 -8.36 -8.21 -8.05 ...
##  $ lat    : num  49.7 49.7 49.8 49.8 49.8 ...
##  $ Ground : chr  "Labadie" "Labadie" "Labadie" "Labadie" ...
```

```
class(dat2)
```

```
## [1] "data.frame"
```

```
dat3 <- subset(dat2, Station %in% real.stn)

m  +
#geom_point(data=dat2 , aes(x=lon, y=lat), shape =3, colour = "blue") +
```

```r
  geom_point(data=dat3, aes(x=lon, y=lat), shape=1, size=8, colour="red") +
  geom_text(data = dat2, aes(x=lon, y=lat, label = (Station)), size = 4) +
theme_bw() +
coord_cartesian(xlim = longlimits, ylim = latlimits) +
labs(y="Latitude",x="Longitude")
```

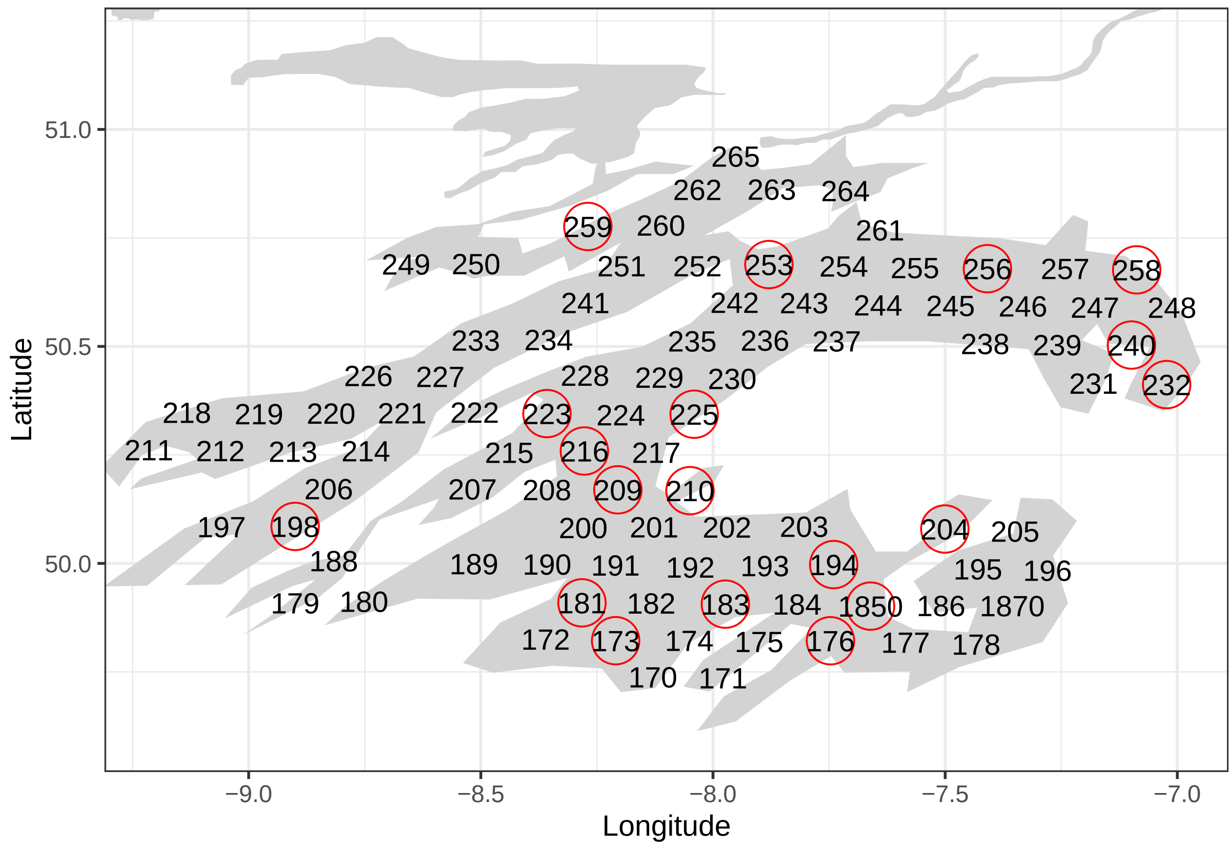


Figure 1: Map showing 2019 stations and historical review stations denoted by red circle

Read in the validation data

```
setwd("N:/Surveys/UWTV SURVEYS FU2022 CELTIC SEA/2019 Labadie/SISP_qc_check")
#ensure delete additional minutes in local survey database
#run queries 1-5 to generate Recounts-Clean or pop them in here to code

channel <- odbcConnectAccess("N:/Surveys/UWTV SURVEYS FU2022 CELTIC SEA/2019 Labadie/SISP_qc_check/LABAI

dataframe<-sqlFetch(channel, "Recounts")


recounts.clean <- dataframe[-which (dataframe$StartTime - dataframe$StopTime > 30),]

stns <- read.csv("SISP_Labadie_2019_stations_assigned_to_counters.csv")
stns <- stns[1:19,c("stn","first","second")]
stns19 <- stns

rec <- recounts.clean[which(recounts.clean$Video_Line_Name %in% unique(stns19$stn)),]
Recounts <- subset(rec, VideoOperatorID %in% c(18,19,20,21))

Ops<-sqlFetch(channel, "Video_Operator")
```

Check number of recount stations

```
length(unique(Recounts$Video_Line_Name))
```

```
## [1] 19
```

```
Recounts <- Recounts[order(Recounts$Video_Line_Name, Recounts$SurveyID,Recounts$VideoOperatorID,Recounts

selst <- Recounts %>% group_by(Video_Line_Name) %>%
  summarise(hatn =sum(BurrowCount)/length(BurrowCount))  %>%
  filter(hatn> 1.5)
selst <- as.list(selst[1])

SummedBurrow<-aggregate(BurrowCount~Video_Line_Name, sum, data = Recounts)
ZeroBurrow<-subset(SummedBurrow, BurrowCount > 0)
RecountsP<-subset(Recounts, Video_Line_Name %in% selst$Video_Line_Name)
length(unique(Recounts$Video_Line_Name))
```

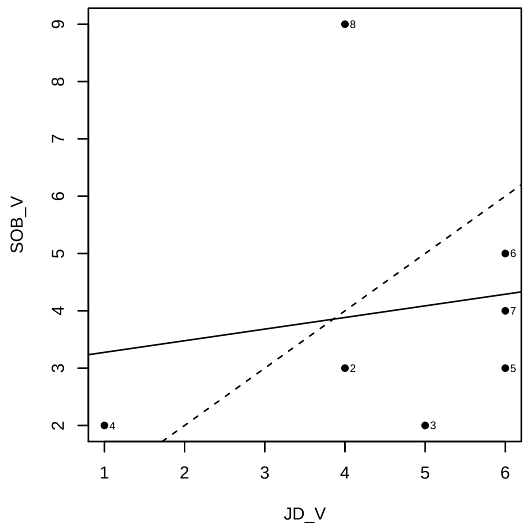
```
## [1] 19
```

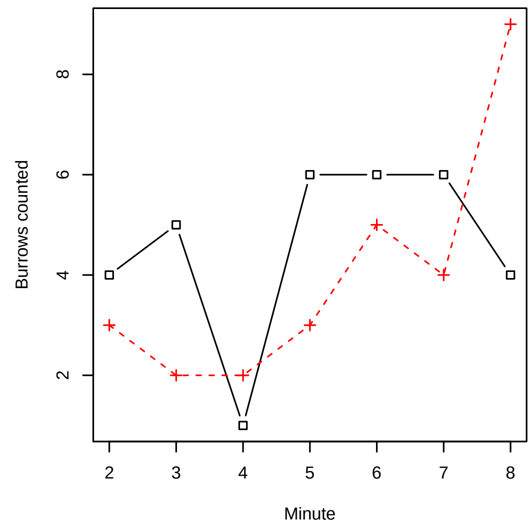
Quality control using Lin's CCC test.

As standard on UWTV surveys run the counts to check counter performance using a threshold of 0.5 for FU2021.

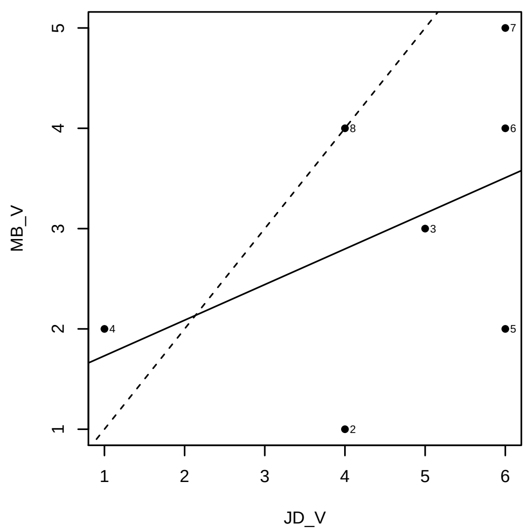
```
Lins<- 0.5
Oid <- sort(unique(RecountsP$Video_Line_Name))
par(mfrow=c(3,2))
for (o in c(1:length(Oid)))
{
  temp<-RecountsP[RecountsP$Video_Line_Name==Oid[o],]
  temp <- temp[order(temp$Minute),]

  Rs <- unique(temp$VideoOperatorID)
  l <- length(Rs)
  if(l>1)
  {
    for( i in c(1:(l-1)))
    {
      for(j in c((i+1):l))
      {
        temp2 <- temp[temp$VideoOperatorID %in% c(Rs[i],Rs[j]),]
        temp2<-dcast(temp2,Minute~VideoOperatorID, value.var = "BurrowCount", sum)
        c1<-as.numeric(names(temp2[2]))
        c2<-as.numeric(names(temp2[3]))
        c1<-Ops$Initials[match(c1,Ops$VideoOperatorID)]
        c2<-Ops$Initials[match(c2,Ops$VideoOperatorID)]

        tmp.ccc <- epi.ccc(temp2[,2], temp2[,3], ci = "z-transform",conf.level = 0.95)
        z <- lm(temp2[,3] ~ temp2[,2])
        par(pty = "s")
        plot(temp2[,2],temp2[,3], xlab = c1,ylab = c2, pch = 16,
             main = paste("Video Line =", unique(temp$Video_Line_Name),
                          "; Lin's CCC =",round(tmp.ccc$rho.c[1],2), sep = " "))
        abline(a = 0, b = 1, lty = 2)
        abline(z, lty = 1)
        text(temp2[,2]+.1,(temp2[,3]),temp2[,1], cex = 0.6)

        plot(temp2$Minute, temp2[,2], type="b", col=1, pch=0, lty=1,xlab="Minute",
             ylab = "Burrows counted", xlim=range(temp2$Minute), ylim=range(temp2[,2:3]))
        points(temp2$Minute, temp2[,3],  col=2, pch=3)
        lines(temp2$Minute, temp2[,3],  col=2, lty=2)

        LinsVL<-as.data.frame(c(unique(temp$Video_Line_Name),Rs[i],Rs[j],round(tmp.ccc$rho.c[1],2)))
        names(LinsVL)<-c("VideoLine", "Counter1","Counter2","LinsCCC")
        Lins<-as.data.frame(rbind(LinsVL,Lins))
      }}}}
```

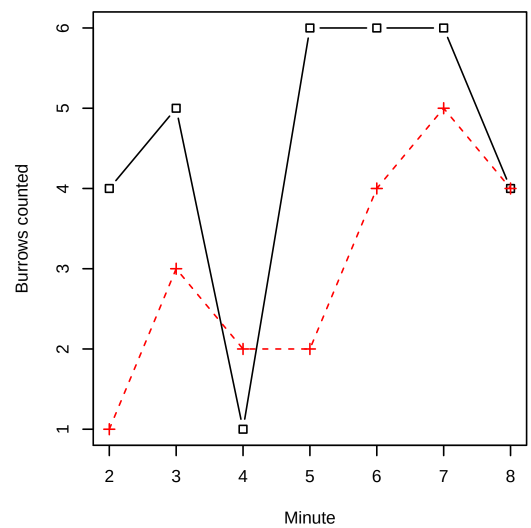
Video Line = 176 ; Lin's CCC = 0.14



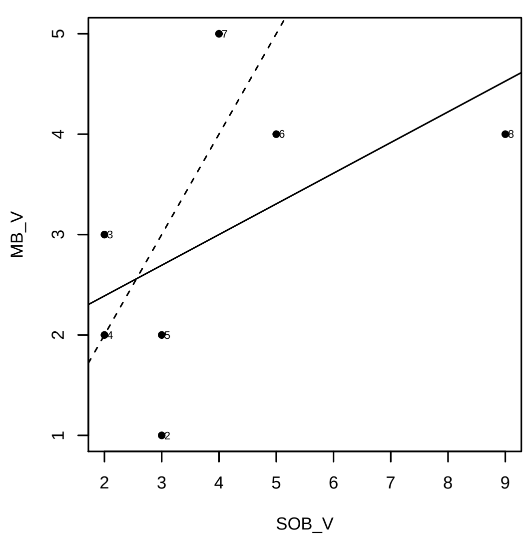


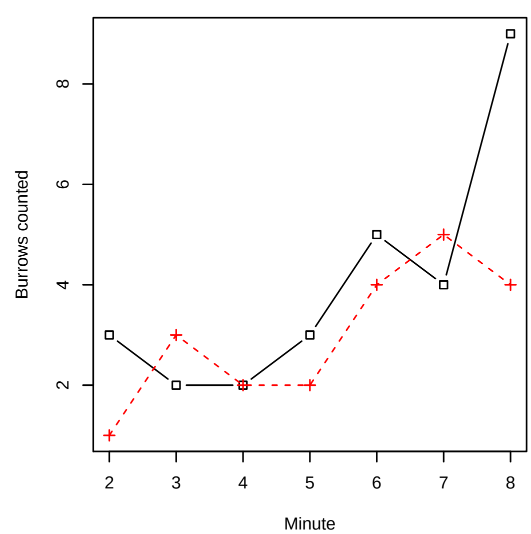
Video Line = 176 ; Lin's CCC = 0.29



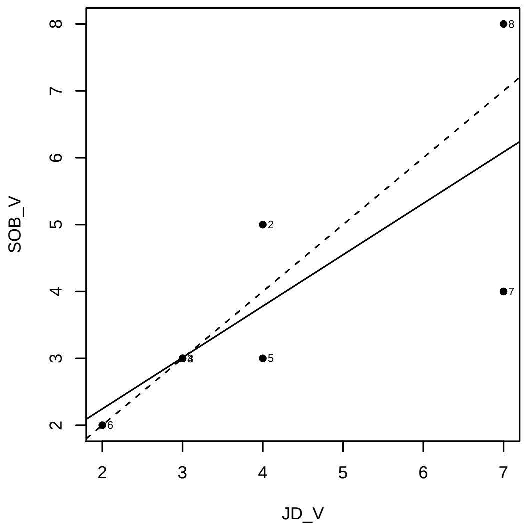


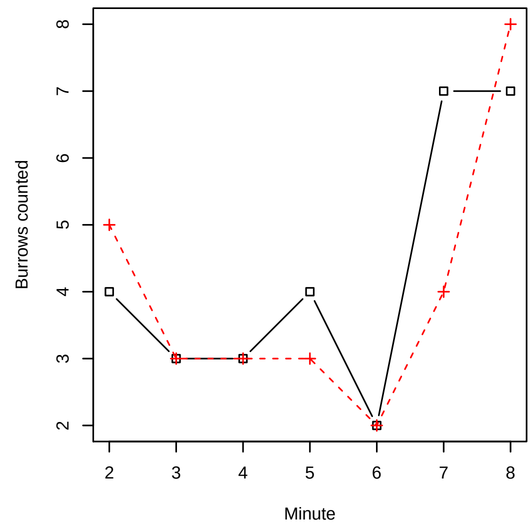
Video Line = 176 ; Lin's CCC = 0.4



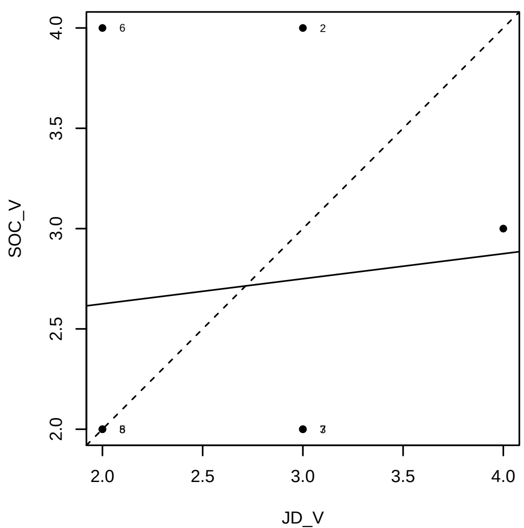


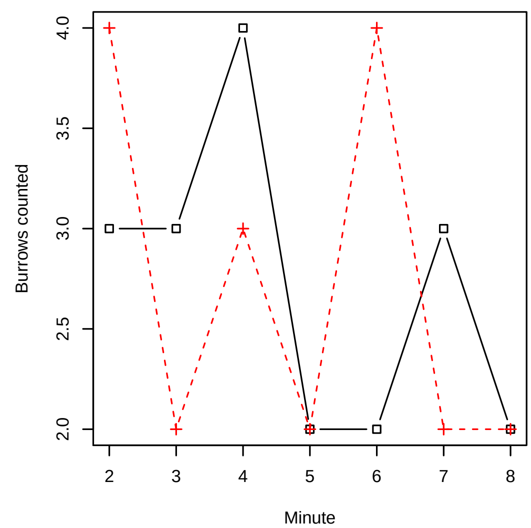
Video Line = 181 ; Lin's CCC = 0.75



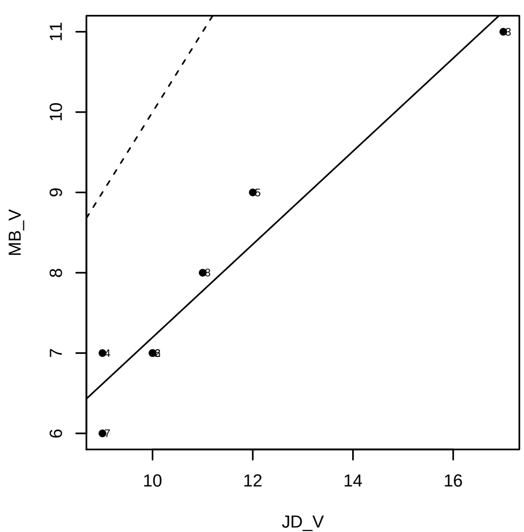


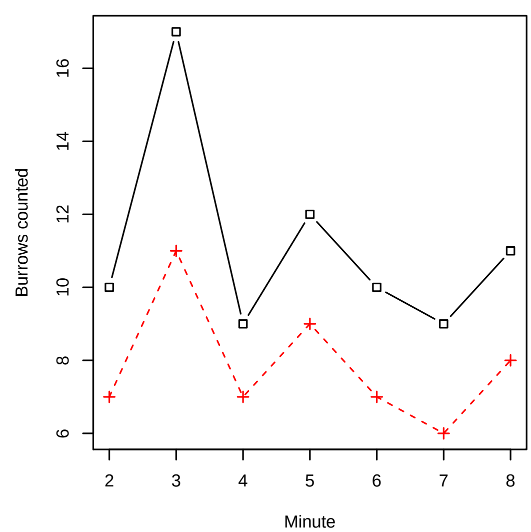
Video Line = 183 ; Lin's CCC = 0.1



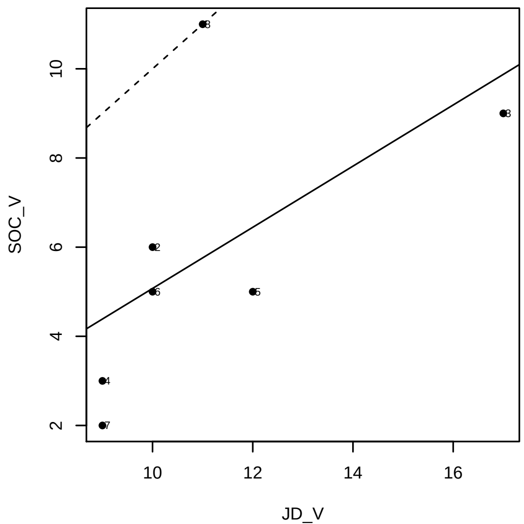


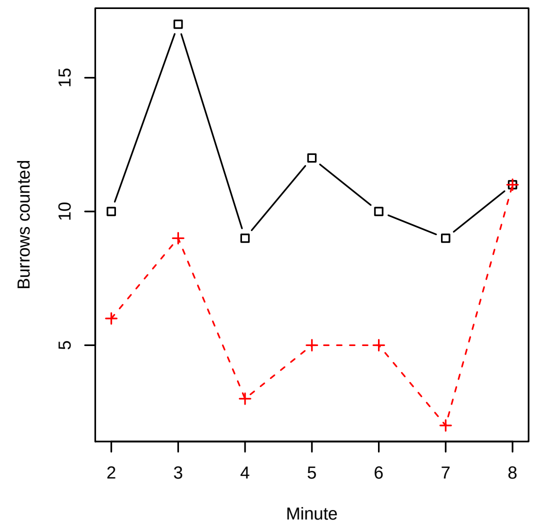
Video Line = 194 ; Lin's CCC = 0.39



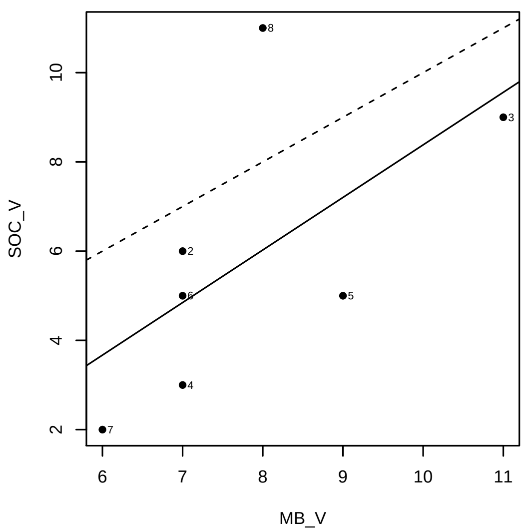


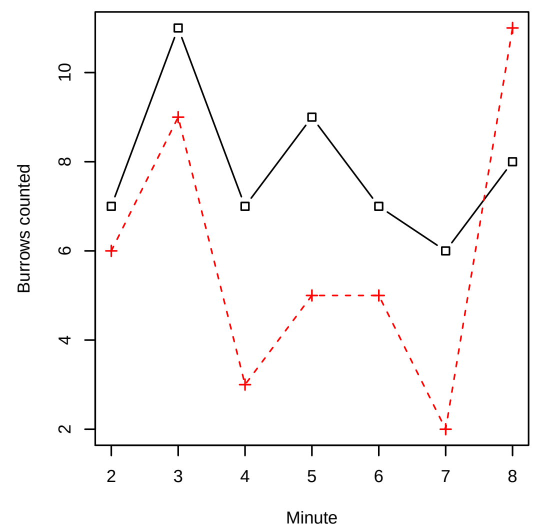
Video Line = 194 ; Lin's CCC = 0.21



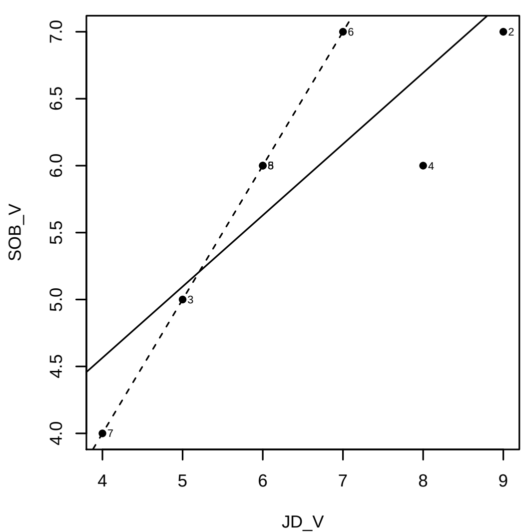


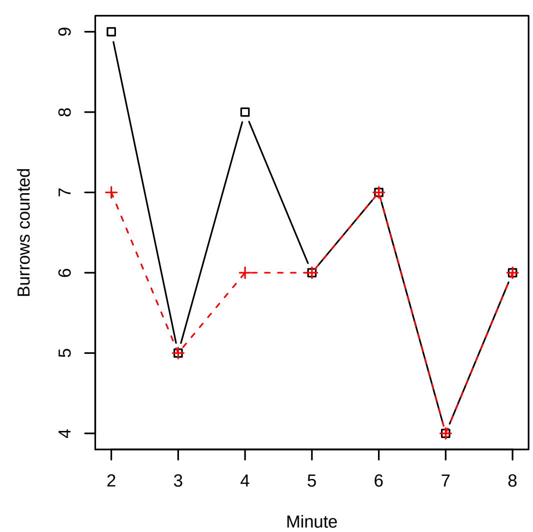
Video Line = 194 ; Lin's CCC = 0.38

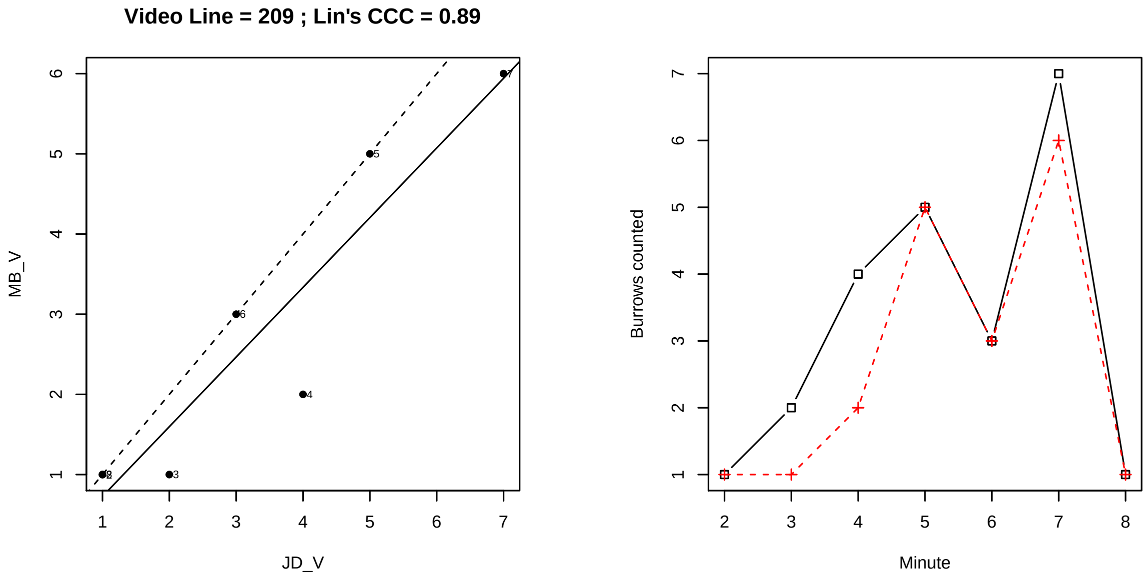


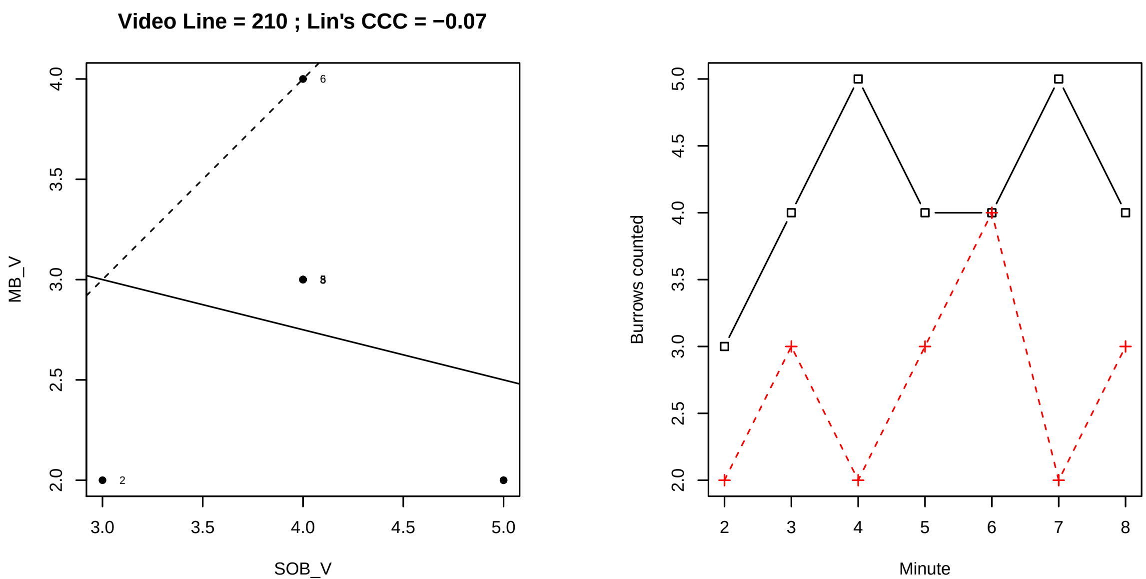


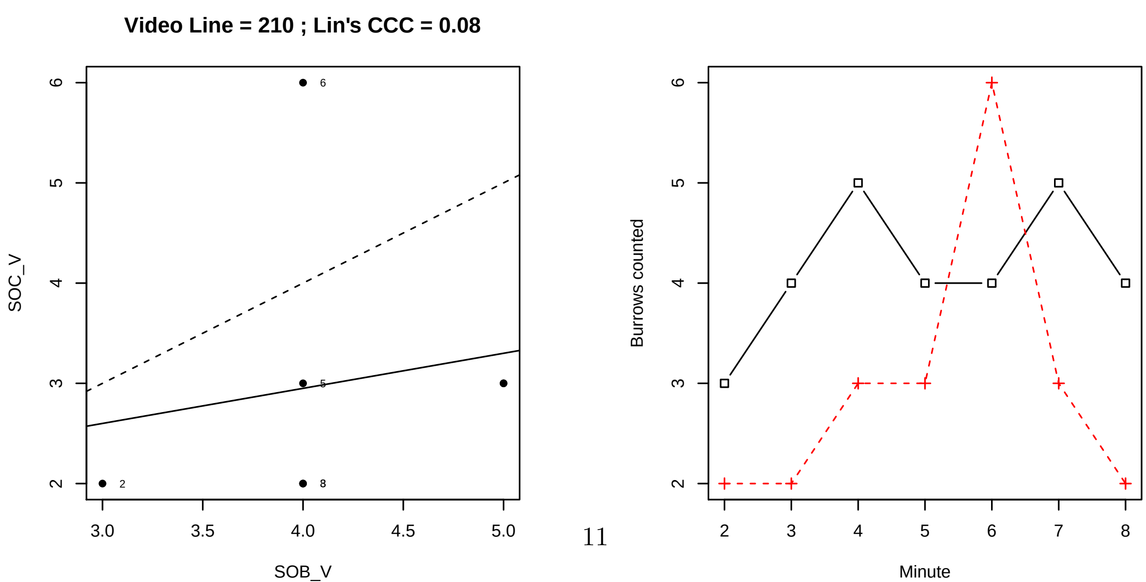
Video Line = 204 ; Lin's CCC = 0.7

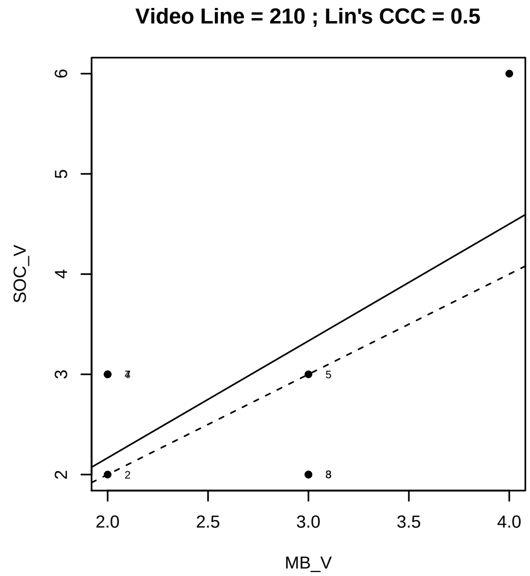


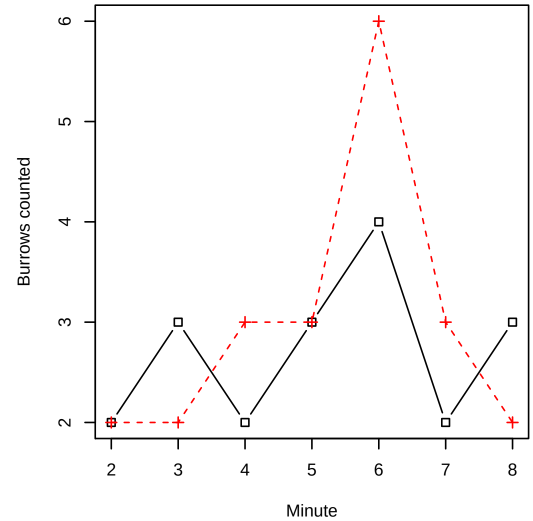


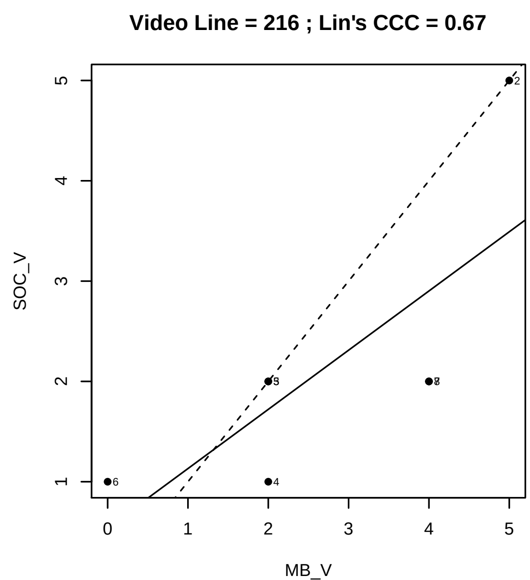

Video Line = 209 ; Lin's CCC = 0.89
MB_V
JD_V
Burrows counted
Minute

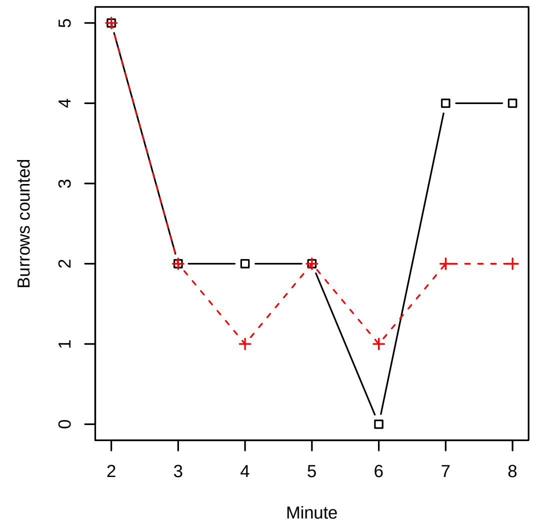

Video Line = 210 ; Lin's CCC = −0.07
MB_V
SOB_V
Burrows counted
Minute

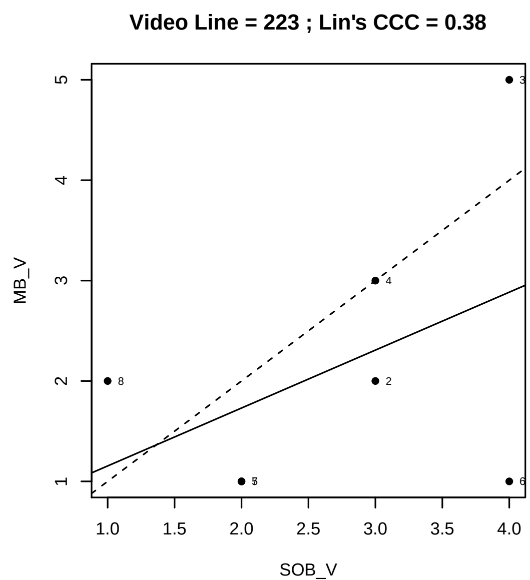

Video Line = 210 ; Lin's CCC = 0.08
SOC_V
SOB_V
Burrows counted
Minute

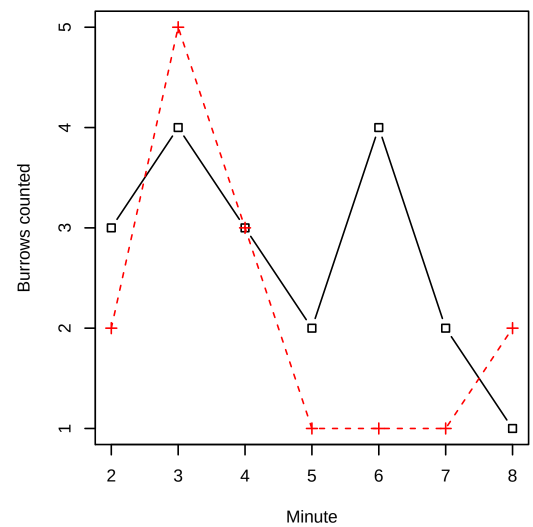

Video Line = 210 ; Lin's CCC = 0.5
SOC_V
MB_V
2.0 2.5 3.0 3.5 4.0
2 3 4 5 6


Burrows counted
Minute
2 3 4 5 6 7 8
2 3 4 5 6

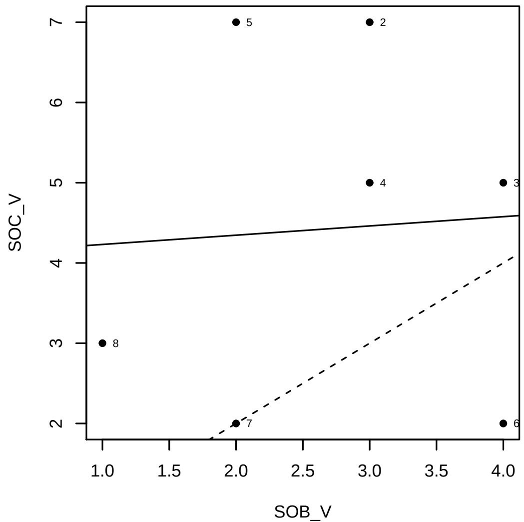

Video Line = 216 ; Lin's CCC = 0.67
SOC_V
MB_V
0 1 2 3 4 5
1 2 3 4 5

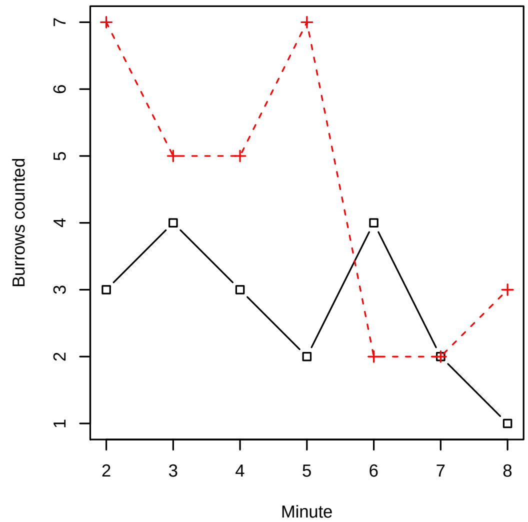

Burrows counted
Minute
2 3 4 5 6 7 8
0 1 2 3 4 5


Video Line = 223 ; Lin's CCC = 0.38
MB_V
SOB_V
1.0 1.5 2.0 2.5 3.0 3.5 4.0
1 2 3 4 5

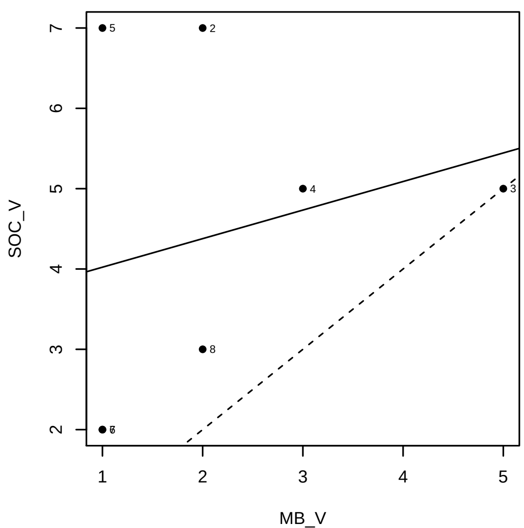

Burrows counted
Minute
2 3 4 5 6 7 8
1 2 3 4 5

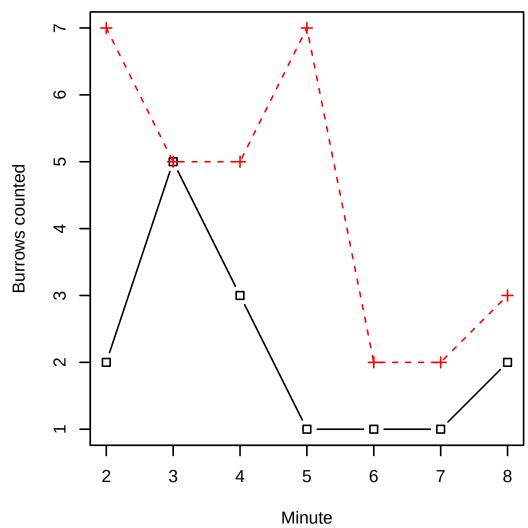
Video Line = 223 ; Lin's CCC = 0.03



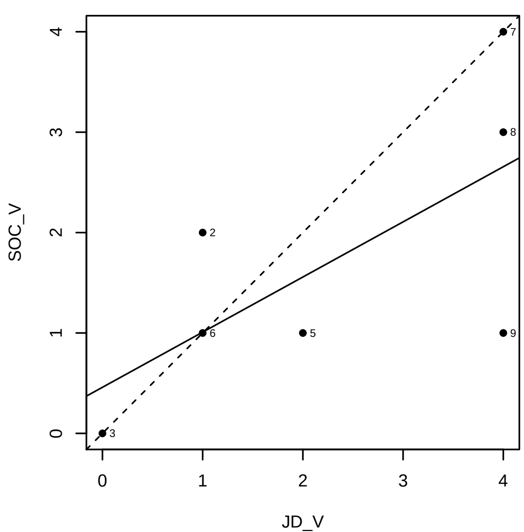


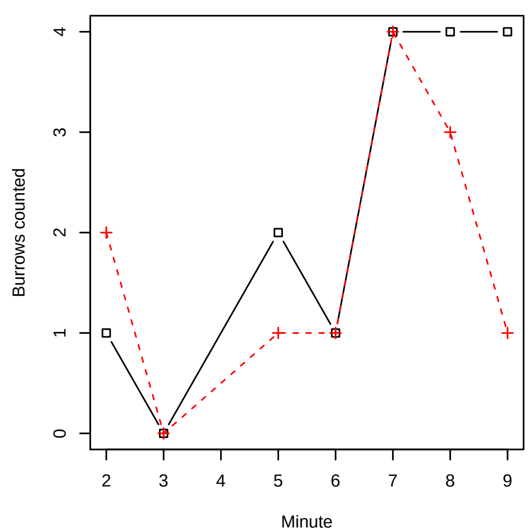
Video Line = 223 ; Lin's CCC = 0.12



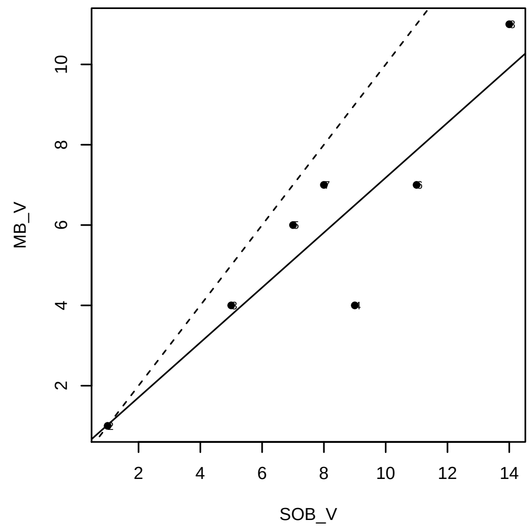


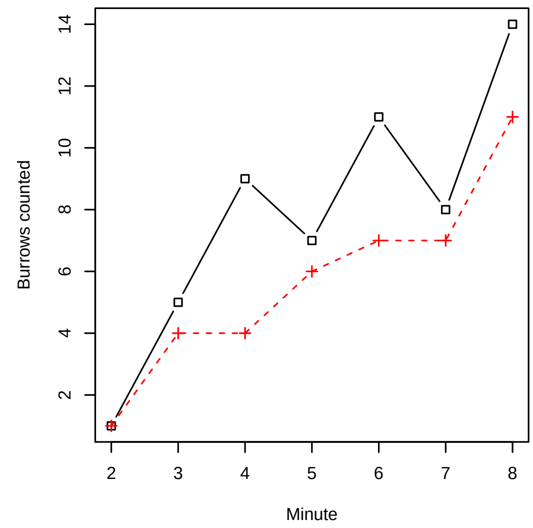
Video Line = 225 ; Lin's CCC = 0.61



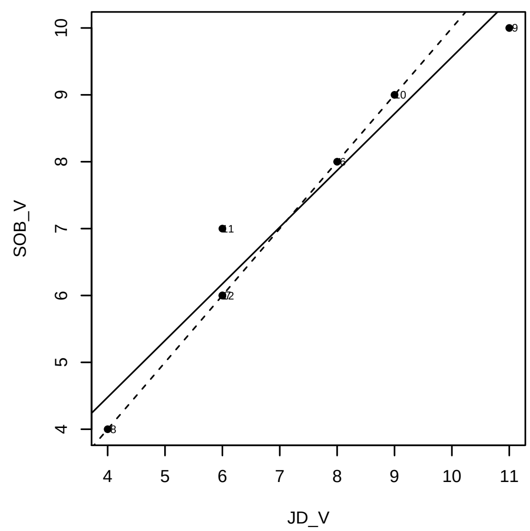


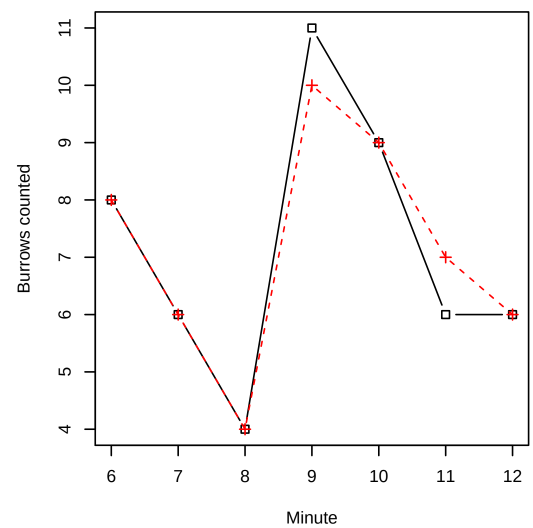
Video Line = 232 ; Lin's CCC = 0.73



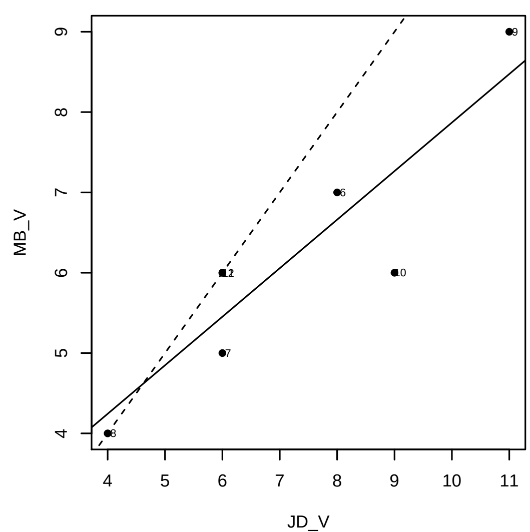


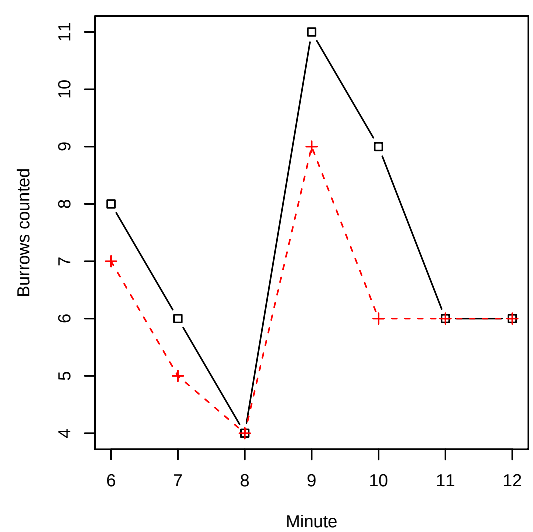
Video Line = 240 ; Lin's CCC = 0.97



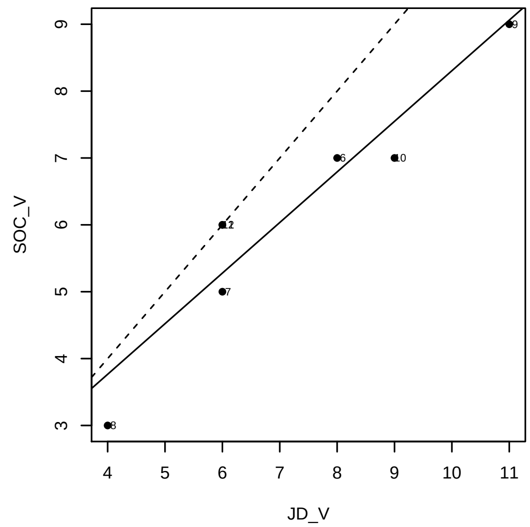


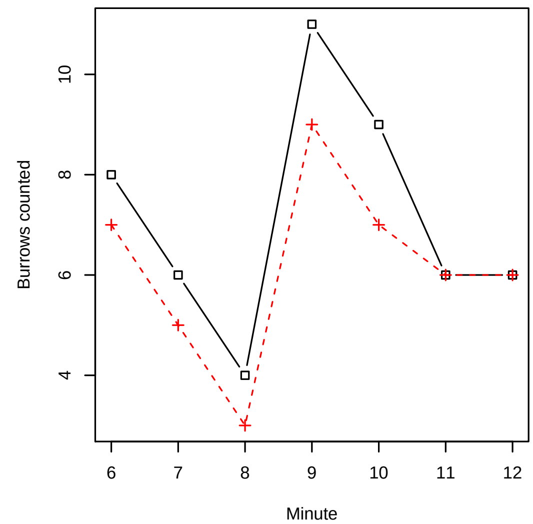
Video Line = 240 ; Lin's CCC = 0.73



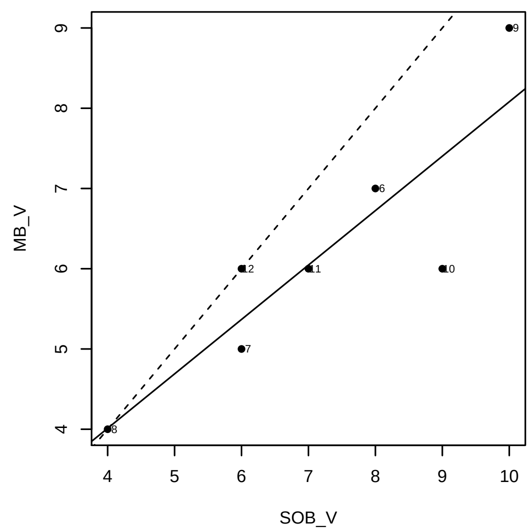


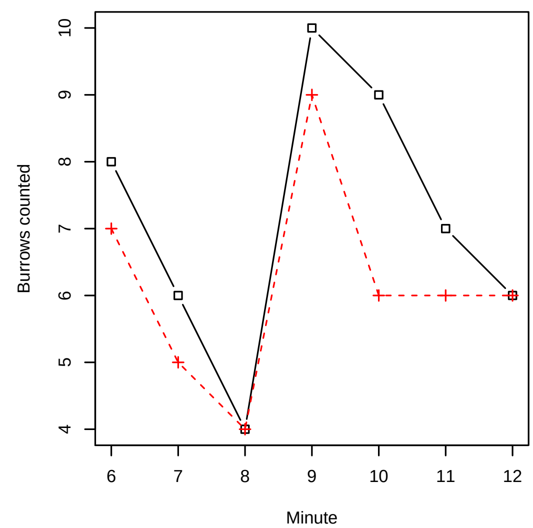
Video Line = 240 ; Lin's CCC = 0.82



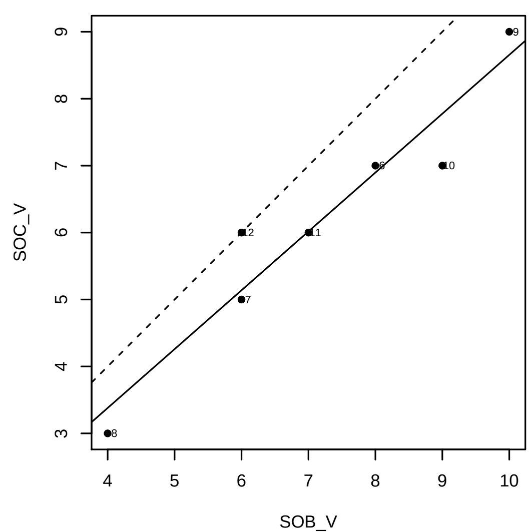


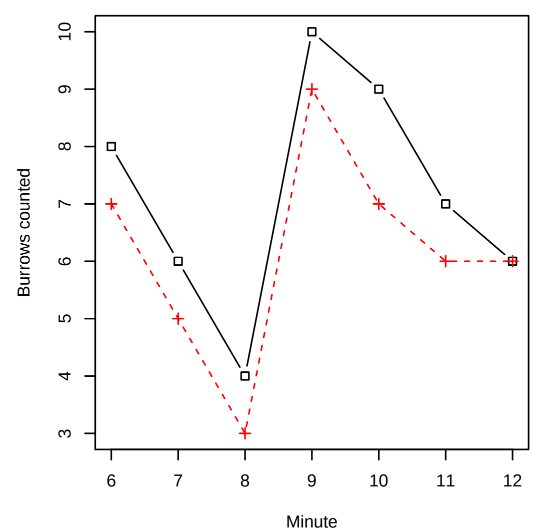
Video Line = 240 ; Lin's CCC = 0.72



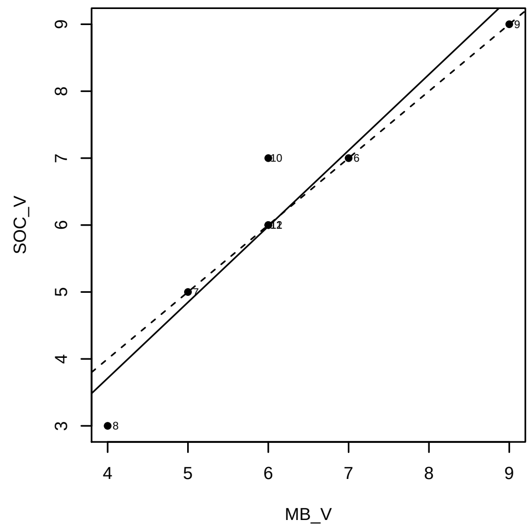


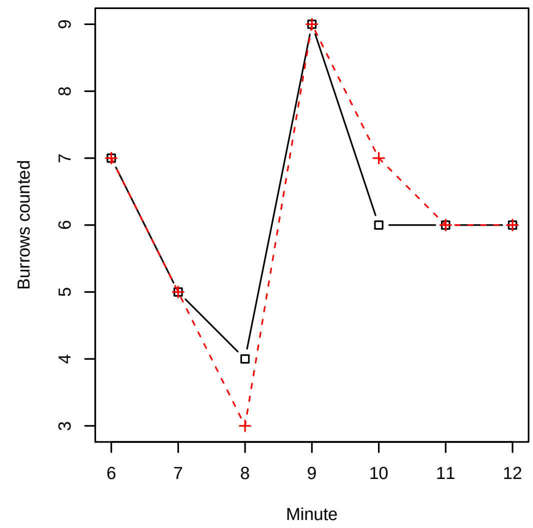
Video Line = 240 ; Lin's CCC = 0.83



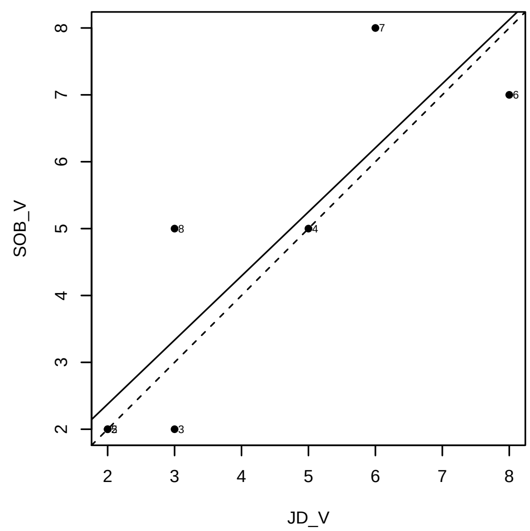


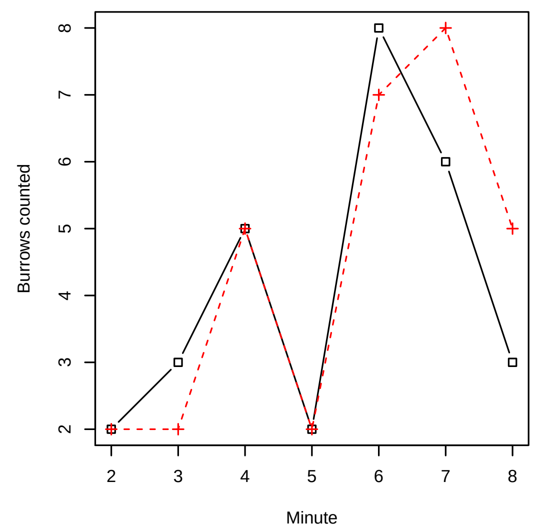
Video Line = 240 ; Lin's CCC = 0.94



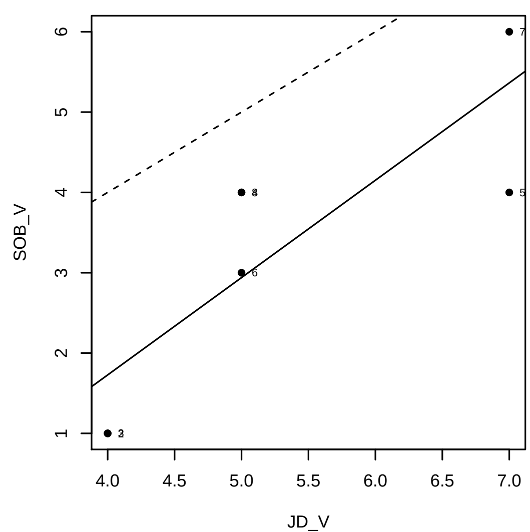


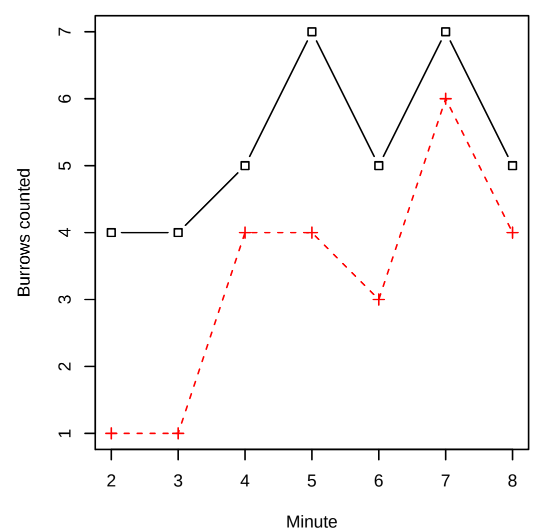
Video Line = 253 ; Lin's CCC = 0.86

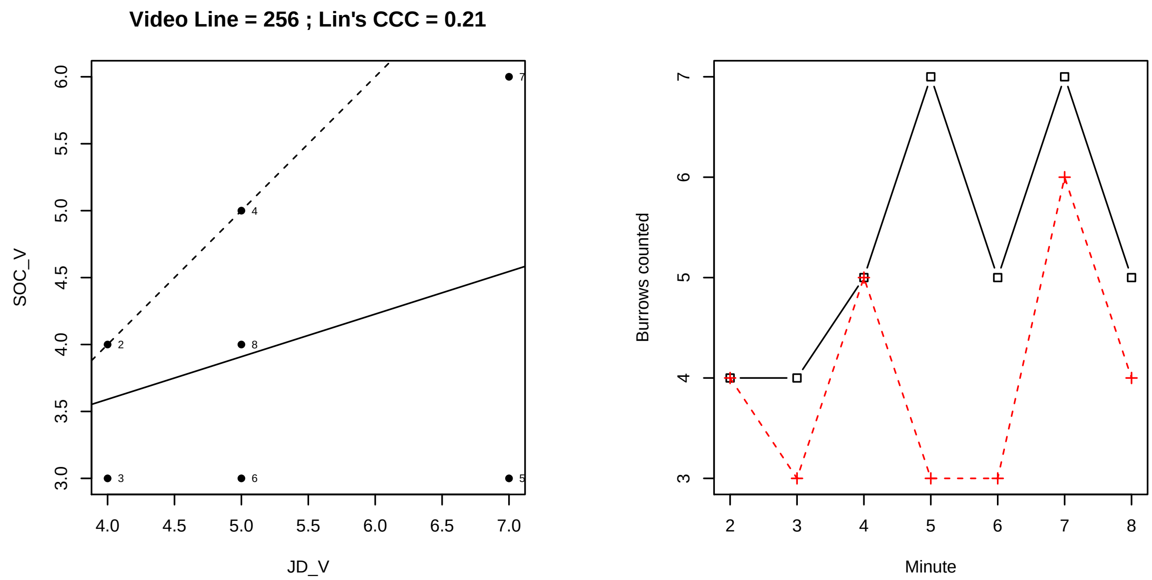


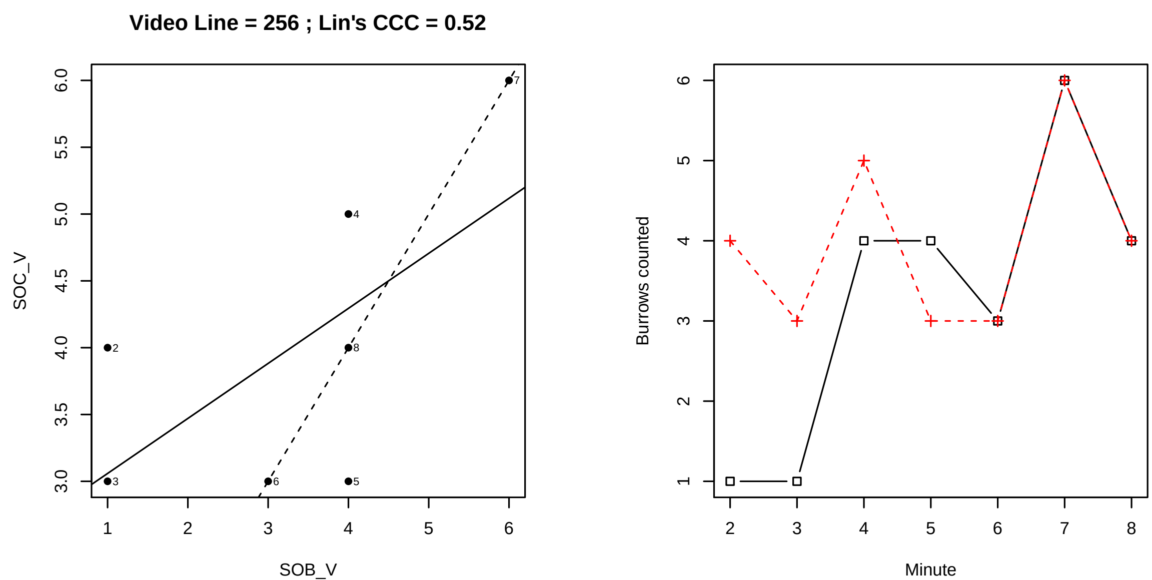


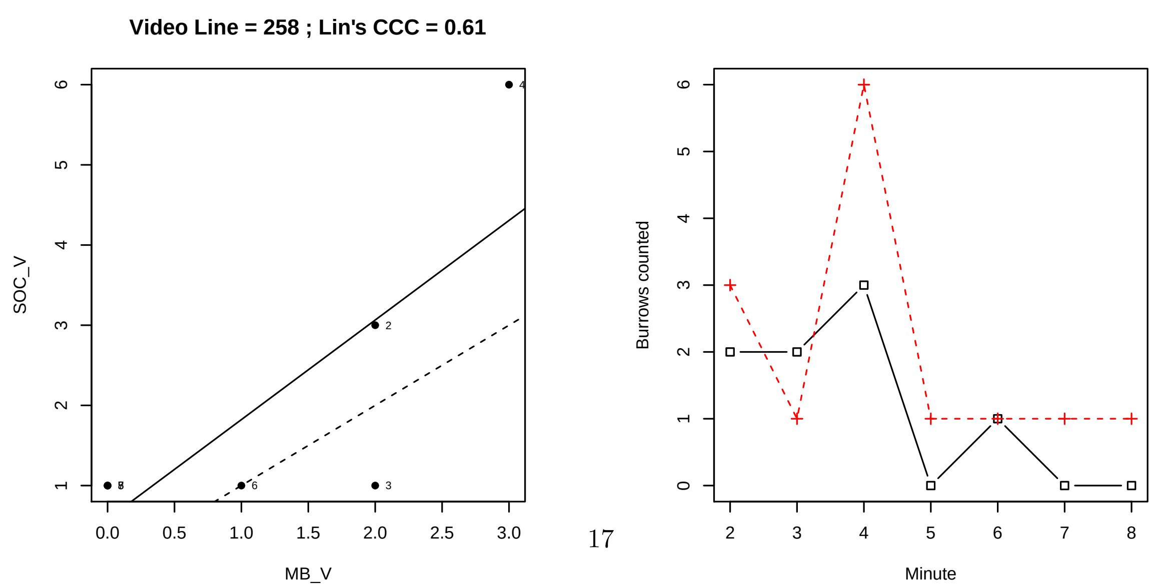
Video Line = 256 ; Lin's CCC = 0.4



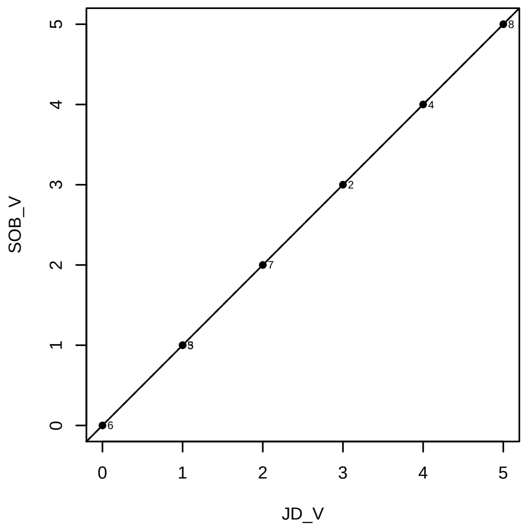


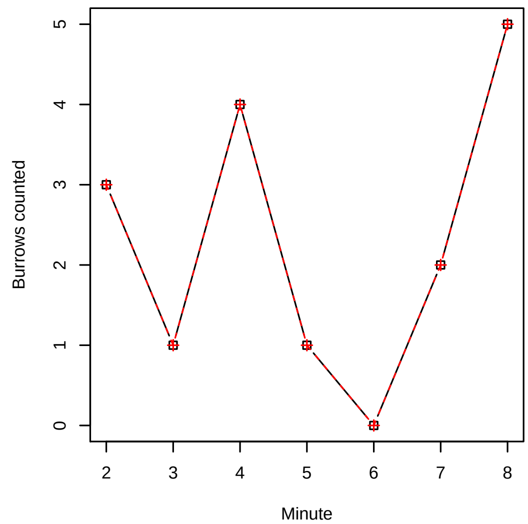

Video Line = 256 ; Lin's CCC = 0.21
SOC_V
JD_V
4.0 4.5 5.0 5.5 6.0 6.5 7.0
3.0 3.5 4.0 4.5 5.0 5.5 6.0
Burrows counted
Minute
2 3 4 5 6 7 8
3 4 5 6 7


Video Line = 256 ; Lin's CCC = 0.52
SOC_V
SOB_V
1 2 3 4 5 6
3.0 3.5 4.0 4.5 5.0 5.5 6.0
Burrows counted
Minute
2 3 4 5 6 7 8
1 2 3 4 5 6

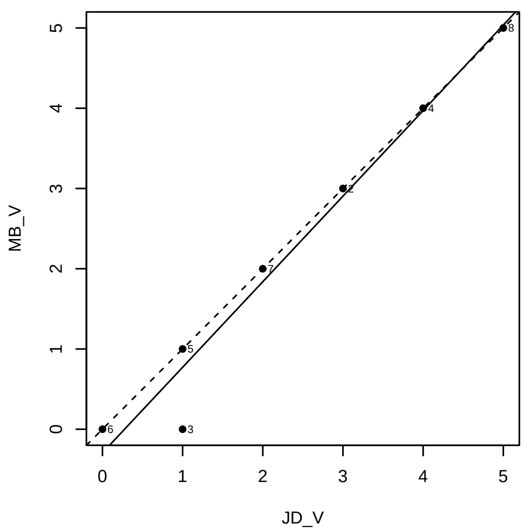

Video Line = 258 ; Lin's CCC = 0.61
SOC_V
MB_V
0.0 0.5 1.0 1.5 2.0 2.5 3.0
1 2 3 4 5 6
Burrows counted
Minute
2 3 4 5 6 7 8
0 1 2 3 4 5 6

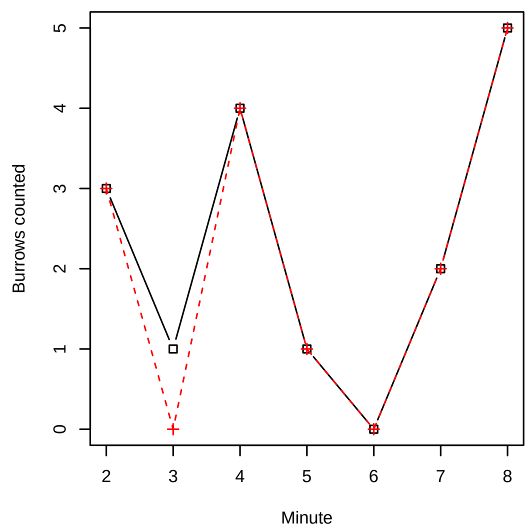
Video Line = 259 ; Lin's CCC = 1



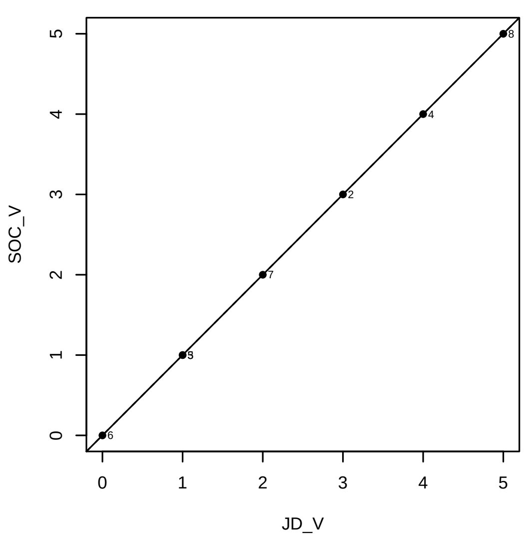


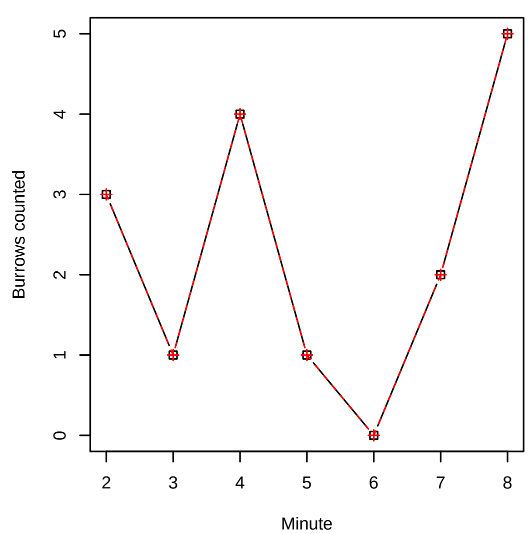
Video Line = 259 ; Lin's CCC = 0.98

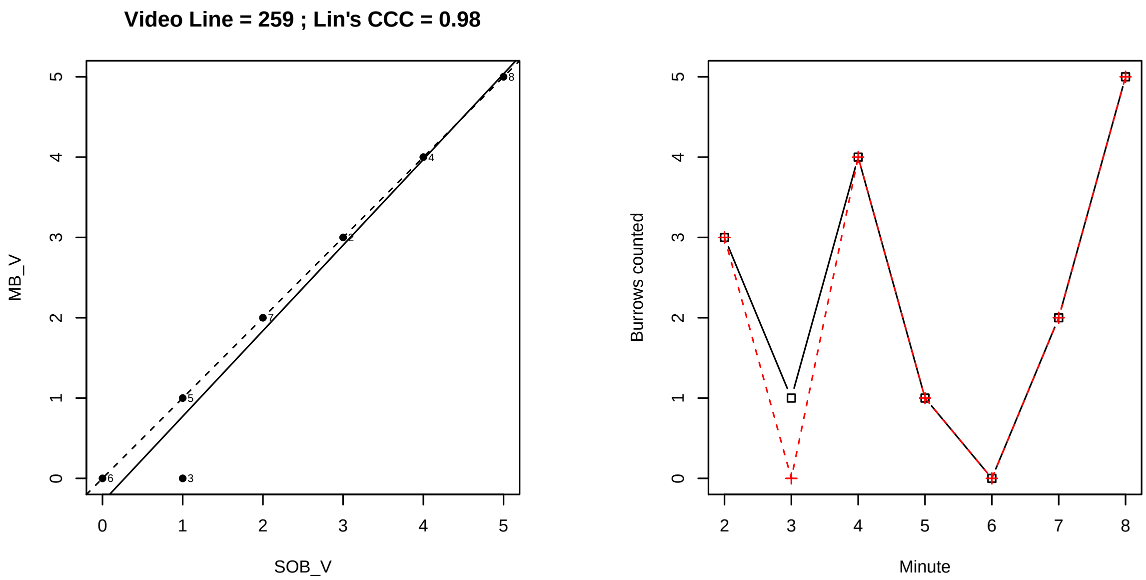


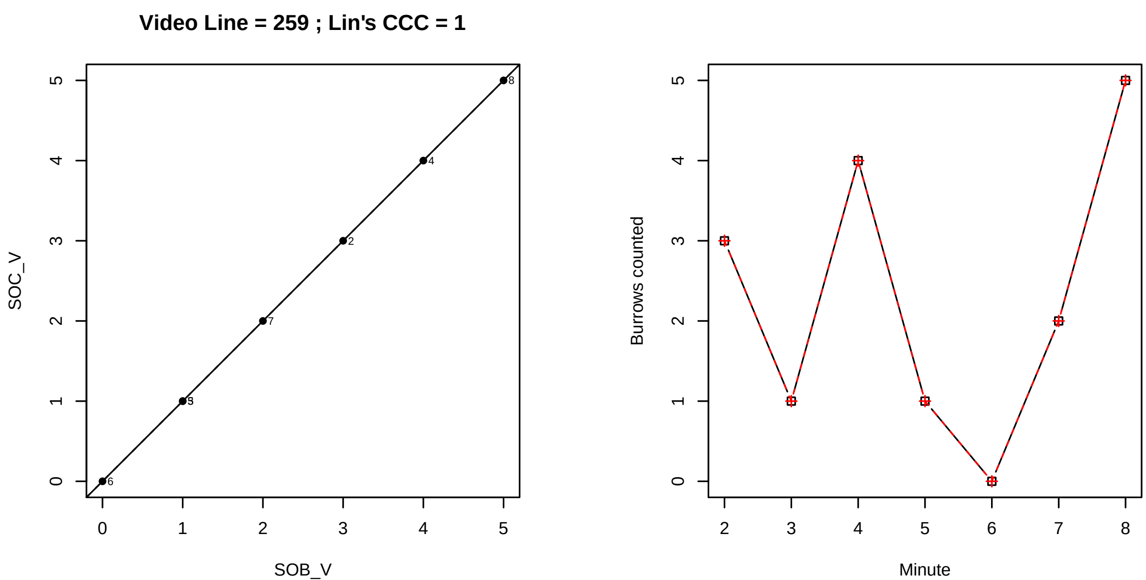


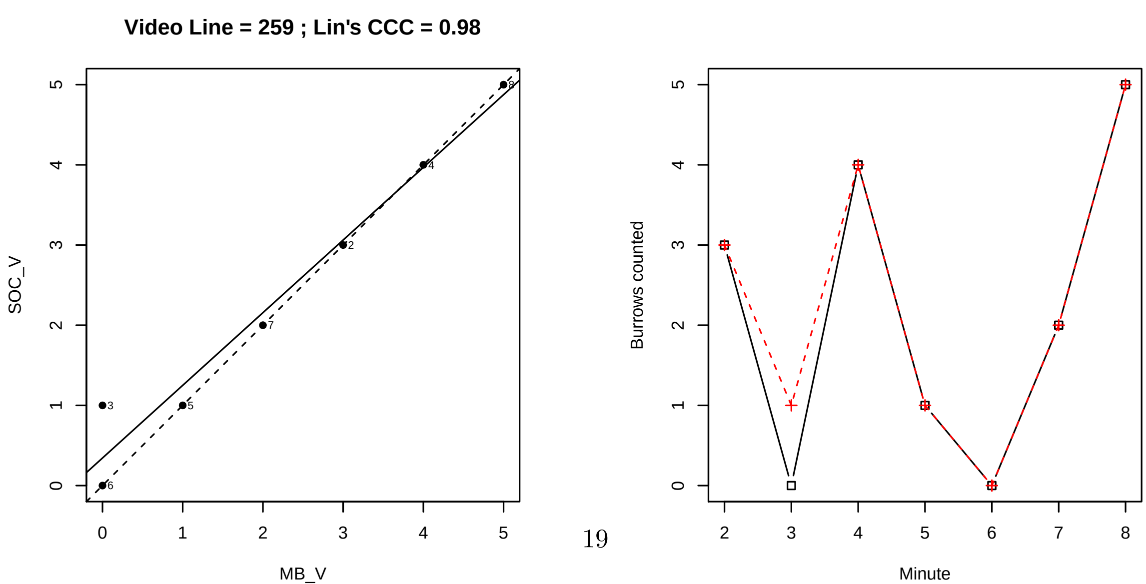
Video Line = 259 ; Lin's CCC = 1



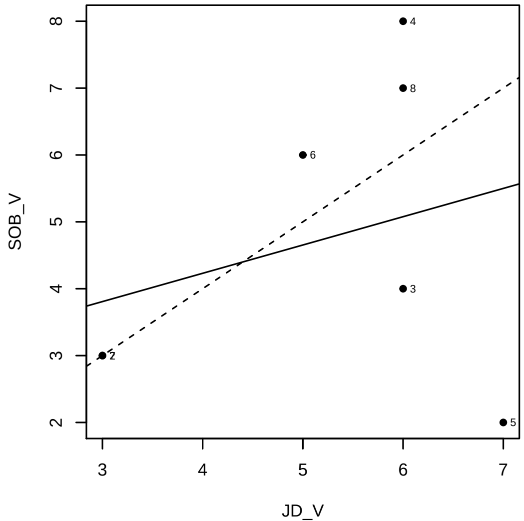


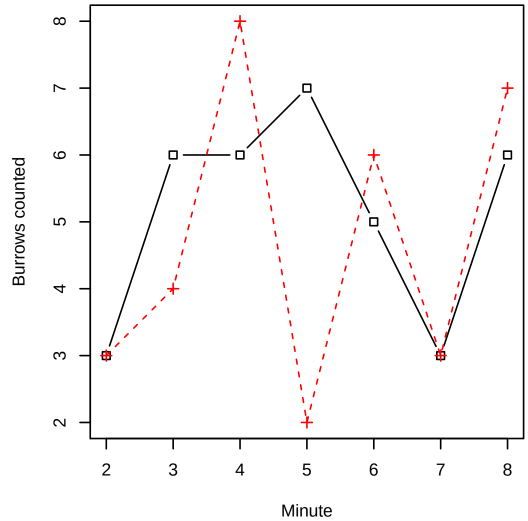

Video Line = 259 ; Lin's CCC = 0.98
MB_V
SOB_V
Burrows counted
Minute


Video Line = 259 ; Lin's CCC = 1
SOC_V
SOB_V
Burrows counted
Minute

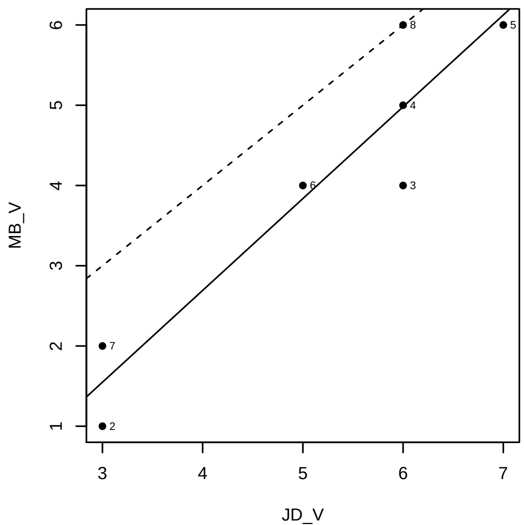

Video Line = 259 ; Lin's CCC = 0.98
SOC_V
MB_V
Burrows counted
Minute

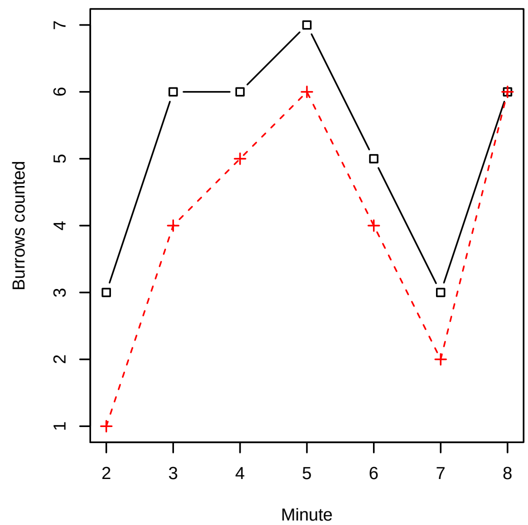
Video Line = 1850 ; Lin's CCC = 0.26



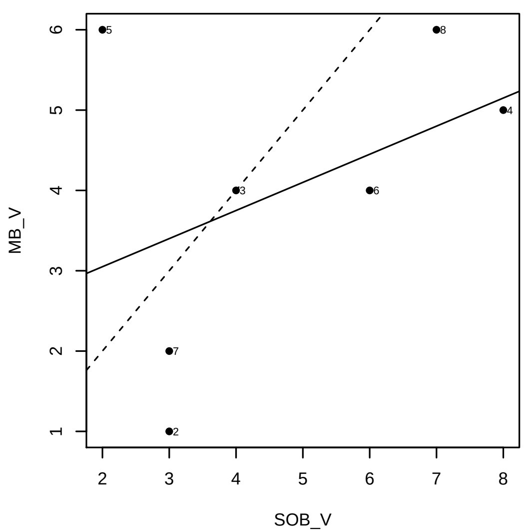


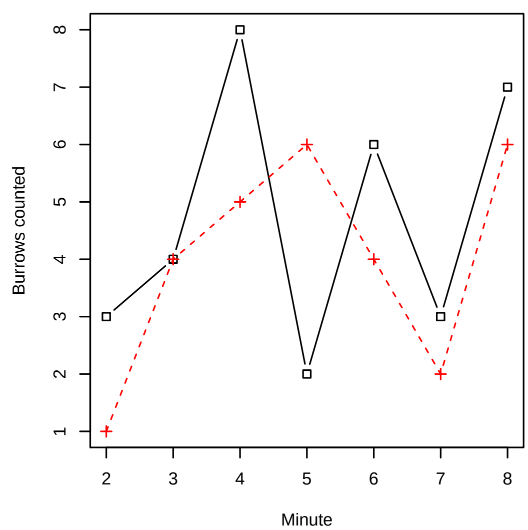
Video Line = 1850 ; Lin's CCC = 0.74





Video Line = 1850 ; Lin's CCC = 0.39





Lin's CCC results

- 2/19 station was below the cutoff counts, where Lin's cannot be used on stations with very low counts
- 5/16 stations passed LINS CCC threshold (0.5) with the first 2 counters.
- 10/16 stations required a third review where 7 of these stations all 3 reviewers data was used to calculate final density. This is the standard practice on UWTV surveys by the Marine Institute.

Now we will remove the 3rd reviewer from the other stations (3 stations).

```
## stn 210 SOB = 19
## stn 256 JD = 18
## stn 1850 SOB = 19

Recounts1 <- Recounts[-which(Recounts$Video_Line_Name==210 & Recounts$VideoOperatorID==19),]
Recounts1 <- Recounts1[-which(Recounts1$Video_Line_Name==256 & Recounts1$VideoOperatorID==18),]
Recounts1 <- Recounts1[-which(Recounts1$Video_Line_Name==1850 & Recounts1$VideoOperatorID==19),]
```

Compare percentage difference between the 2019 original (sea) counts vs. the validation (lab) counts

```
# calculate average count per station for historical review
rec.1 <- Recounts1 %>% group_by(Video_Line_Name, Minute) %>% summarise(ct = mean(BurrowCount))
val.data <- rec.1 %>% group_by(Video_Line_Name) %>% summarise(av.count = sum(ct))
val.data$method <- "review"

# next extract sea counts (onboard reviewers from 2019)
orig.data <- subset(rec, ! VideoOperatorID %in% c(18,19,20,21))

orig.minute <- with(orig.data, aggregate(BurrowCount, by=list(Minute, Video_Line_Name), FUN=mean))
names(orig.minute) <- c("Minute", "Video_Line_Name", "ct")
orig.data <- with(orig.minute, aggregate(ct, by=list(Video_Line_Name), FUN=sum))
names(orig.data) <- c("Video_Line_Name", "av.count")
orig.data$method <- "original"

final2019 <- rbind(orig.data, val.data)

# merge both datasets
wide <- merge(orig.data, val.data, by="Video_Line_Name")
wide <- wide[,-c(3,5)]
wide <- rbind(wide, c("Total", colSums(wide)[2:3]))
names(wide) <- c("stn", "orig.count","valid.count")
wide[,2] <- as.numeric(wide[,2])
wide[,3] <- as.numeric(wide[,3])
wide$perc.change <- with(wide, (valid.count/orig.count)-1)
```

Barplot of the 2019 original counts and the validation counts by station.

```
knitr::kable(wide[,1:4])
```

stn	orig.count	valid.count	perc.change
173	5.5	6.50000	0.1818182
176	15.0	27.00000	0.8000000
181	20.5	29.00000	0.4146341
183	10.5	19.00000	0.8095238
194	91.5	58.00000	-0.3661202
198	6.5	7.00000	0.0769231
204	28.0	43.00000	0.5357143
209	14.0	21.00000	0.5000000
210	6.0	20.00000	2.3333333
216	14.5	17.00000	0.1724138
223	30.5	21.66667	-0.2896175
225	8.5	14.00000	0.6470588
232	64.0	47.50000	-0.2578125
240	28.0	46.50000	0.6607143
253	11.0	30.00000	1.7272727
256	27.0	25.50000	-0.0555556
258	14.0	11.00000	-0.2142857
259	11.5	15.75000	0.3695652
1850	19.0	32.00000	0.6842105
Total	425.5	491.41667	0.1549158

```
mean(wide$perc.change)
```

```
## [1] 0.4442353
```

```
ggplot(final2019, aes(x=as.factor(Video_Line_Name), y=av.count, fill = method, col=method))+
  geom_bar(width=0.8, stat="identity",position=position_dodge())+
  xlab("Station ID") + ylab("count")+
  theme_bw()
```

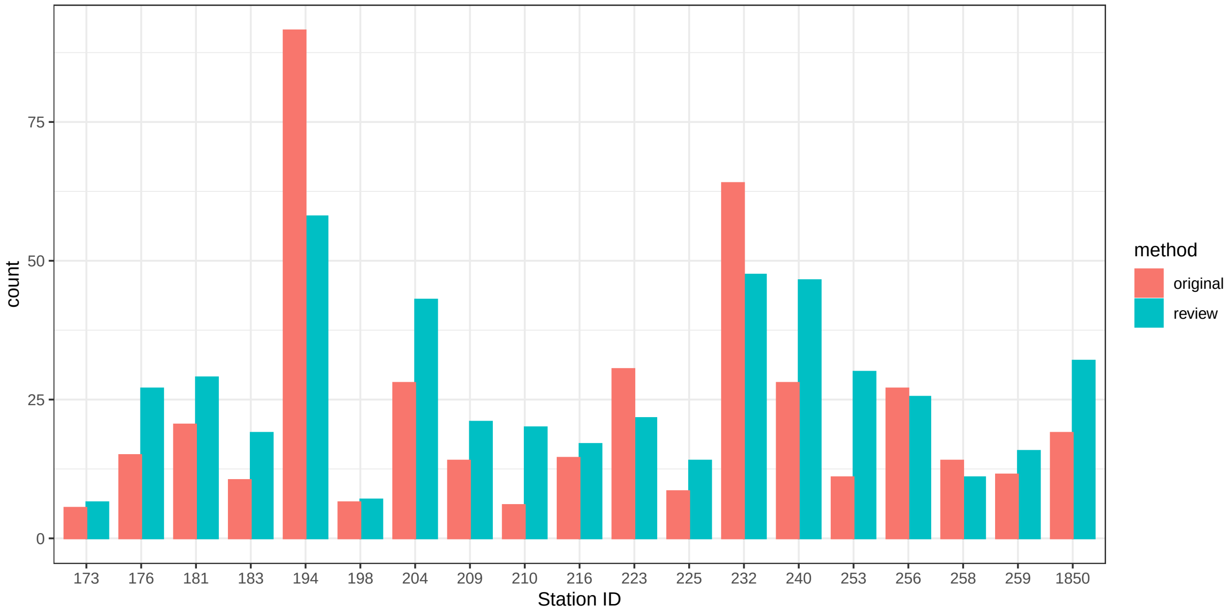


Figure 2: Bar plot showing 2019 original (onboard) counts and the validation (lab) counts

Violin plot of the 2019 original counts and the validation counts.

```
#final2016 <- cbind(final2019, wide[-nrow(wide),])

ggplot(final2019,aes(x=as.factor(method),y=av.count))+
  geom_violin(aes(group=method,colour=method,fill=method),alpha=0.5,
            kernel="rectangular")+           # passes to stat_density, makes violin rectangular
  geom_boxplot(aes(group=method), width=.2)+
  stat_summary(fun.y=mean, geom="line", colour="blue", aes(group=1)) +
  xlab("method")+                              # label one axis
  ylab("av.count")+                        # label the other
  theme_bw()+                                # make white background on plot
  theme(legend.position = "none")            # suppress legend
```

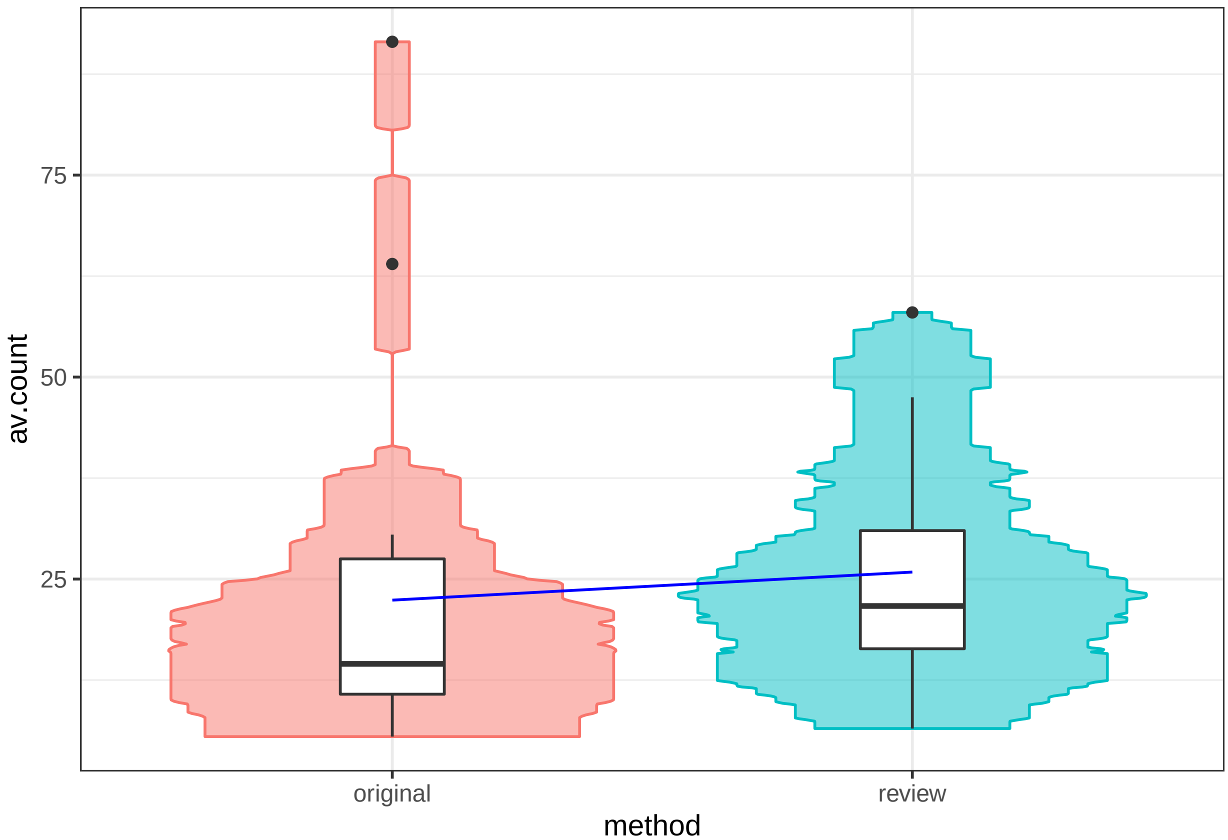


Figure 3: Violin and box plot of counts distributions of 2019 original counts and validation counts. The blue line indicates the mean density over time. The horizontal black line represents the median, white box is the inter quartile range, the black vertical line is the range and the black dots are outliers.

UWTV camera calibration test. Marine Institute

Introduction

The Marine Institute (MI) has been carrying out UWTV surveys since 2002 to estimate *Nephrops norvegicus* abundances in several Functional Units (FU). These surveys are key to the stock assessment of *Nephrops*. In order to use the latest technology available, in 2019 the MI replaced the standard definition camera (SDc) used in the last years with a new high definition camera (HDc). This document presents the results of a calibration test conducted by the MI to compare burrow counts from both cameras.

Material & Methods

14 stations were recorded with both cameras at the same time during the Porcupine bank *Nephrops* grounds (FU16) 2019 UWTV survey (Aristegui *et al*., 2019). Both cameras were mounted in the same sledge used in previous UWTV surveys: the SDc was set up as in previous surveys at an angle of 40° to the bottom, while the HDc was set up at an angle of 75° (Table 1). In each station 10 minutes of good quality footage were recorded by each camera, assuming that both cameras recorded exactly the same track of seafloor.

Table 1. UWTV camera calibration test. Features of the two camera systems.

	Standard Definition camera	High Definition camera
Camera angle to the bottom	40°	75°
Field of View (FOV)	0.75 m	1.01 m
Footage format	DVD	Digitalized stills (12 frames per second)
Counting method	Hand writing time stamped	Image annotation R Shiny app (Aristegui, 2019)

The HDc footage was counted at sea by five trained scientists using an inhouse developed image annotation R Shiny app (Aristegui, 2019). The SDc footage was counted back at the MI office by four of the five scientists who counted the HDc, using the same method as in previous FU16 UWTV surveys (hand writing the time stamp of each burrow). The 14 stations from each camera were assigned randomly and equally to the scientist team. Each station was counted independently by two scientists.

Both SDc and HDc count data were analysed in the same way independently one from the other. The counts were screened to check for any unusual discrepancies using Lin's Concordance Correlation Coefficient (CCC) with a threshold of 0.6 (Lin, 1989). Those stations that did not pass the threshold were counted by a third scientist.

Count data that passed the threshold were averaged in order to get a mean burrow count per minute for each of the 28 stations. As the cameras differ in their field of views (FOV) (Table1), the counts were standardized dividing them by their corresponding FOV. Finally, a paired t-test was used to compare both datasets.

Results

The standardized counts for both methods were in a similar range of burrows per minute divided by FOV: from 0.4 to 7.9 for SDc, and from 0.4 to 6.7 for HDc (Figure 1). The conducted test suggests that, in average, there is not significance difference between the two methods (p-value = 0.06563 > 0.05).

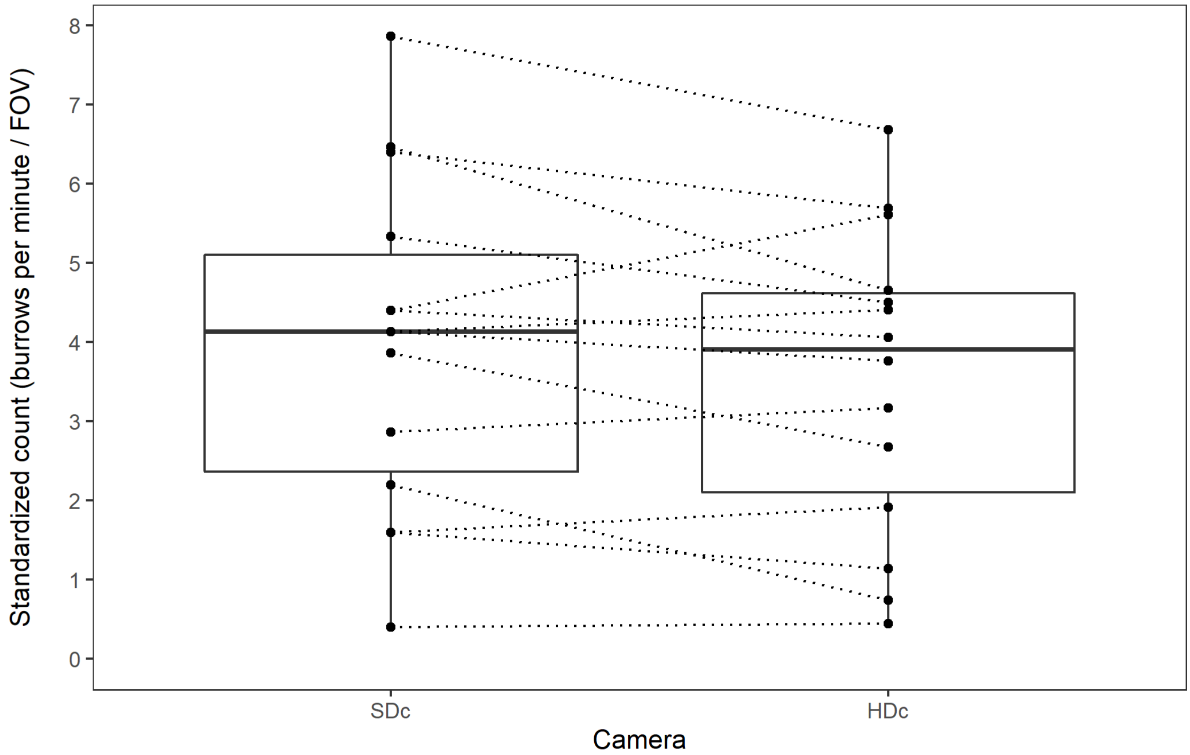


Figure 1. UWTV camera calibration test. Standardized counts of each station and boxplots. Standard Definition camera counts (left) and High Definition camera counts (right). Same stations are linked with a dotted line.

Conclusion

The independent results of each camera system are very similar, and the new HD camera performed appropriately, in line with the SD camera used in UWTV surveys by the MI until 2018.

On top of the obvious better quality of the footage, the HDc system also allows a smoother workflow onboard, as all the footage is now digitalized. Together with the image annotation app, the HDc system makes the survey process paperless and less prone to errors, as there is no need of inputting manually the count data into the databases any more.

References

Aristegui, M. (2019) Image annotation R Shiny app. Marine Institute. http://doi.org/c8jt

Aristegui, M., O'Brien, S., Tully, D., Galligan, S., McCorriston, P., Bentley, K. and Lordan, C. (2019). Porcupine Bank *Nephrops* Grounds (FU16) 2019 UWTV Survey Report and catch scenarios for 2020. Marine Institute UWTV Survey report.

Lin, L. I-K. (1989). A Concordance Correlation Coefficient to Evaluate Reproducibility. Biometrics, 45(1), 255-268. doi:10.2307/2532051

SIAMISS Estimates of Anglerfish Biomass in Subareas IV and VI for 2019

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- We report the anglerfish results for the Scottish Irish Anglerfish Megrim Industry Science Survey (SIAMISS) in 2019. ICES have used this survey as the basis for advice under the data-limited approach for category 3 stocks since 2012.
- The estimated biomass for 2019 in ICES Subareas IV & VI is 59 kt (95% CI: 46 – 71kt), a decrease of 25% from 78 kt in 2018, and 34% to 2017 levels.
- The average biomass over the last two years (2018 – 2019) is 68 kt, compared to an average biomass of 78 kt in the previous 3 years (2015 – 2017). This is a decrease in average biomass (last two years *versus* previous three years) of 13% (95% CI: 1% – 25%).

Introduction

Anglerfish are a group of fish of the order Lophiiformes which include several families, amongst which the Lophiidae comprise some of the important commercially fished species of the genus Lophius (Fernandes *et al*. 2007). *Lophius piscatorius* and *Lophius budegassa* (black-bellied anglerfish) are more commonly known collectively as "monkfish". In 2017, 12.944 tonnes of monkfish were landed into Scotland by UK vessels, with a value of £36.80 million (Anon, 2018).

This document focuses on the anglerfish that occur on the Northern Shelf. They are considered and assessed as one stock covering ICES Division IIIa (Skagerrak & Kattegat), ICES Subarea IV (North Sea), and ICES Subarea VI (West of Scotland and Rockall). In 2005, Fisheries Research Services (FRS, now Marine Scotland Science - MSS) started a new survey to estimate the abundance and distribution of anglerfish on the Northern Shelf. Initially, and again in recent years, the survey has included contribution from research vessel of the Marine Institute in Ireland and is called the Scottish Irish Anglerfish Megrim Industry Science Survey (SIAMISS). This survey covers much of the area of the known distribution of northern shelf anglerfish (ICES Divisions IVa, VIa and VIb at Rockall), with the exception of the central and southern parts of Subarea IV and the Skagerrak and Kattegat (Division IIIa).

Because it covers such a large area, the current design incorporates multiples vessels to survey the whole area.

Material and Methods

The survey area covers the northern shelf of the British Isles, north of latitude 56° to a northerly limit of 62° 30' north. This area was limited to zones where the depth was less than 1000 m (trawling only occurred in waters up to a maximum of 1000 m).

The survey area was stratified based on knowledge from fishermen (Fig. 1). The sampling effort within each stratum was allocated roughly according to its expected biomass, and the sample locations were chosen at random from grids of points within strips of equal area. This is to ensure equal probability of selection and even coverage within a stratum (ICES 2013). The aim was for a minimum of 3 stations within a stratum.

The 2019 anglerfish multi-vessel survey took place from 28th April to 7th May 2019 and involved two vessels: Scottish commercial fishing vessel MFV Genesis – surveying Division IVa, Division VIa North of 58°N, and Rockall and the Irish Marine Institute research vessel FRV Celtic Explorer, surveying Division VIa South of 58°N. One haul with the duration of 60 minutes was made at each sampling station (n=128). Each vessel on the survey employed exactly the same gear, the specification of which was drawn up in partnership with industry. Until 2017, every anglerfish caught was measured for length, sex, maturity, total and gutted weight, and the otolith was removed, however due to increasing numbers caught, from 2018, a length-stratified approach to sampling for sex, maturity, weight and age was applied

All Scottish cruises used a Scanmar system to monitor trawl parameters such as wing spread, door spread and headline height. A self-recording tilt meter rigged at ground gear centre monitored touch-down/lift-off at block up/knockout and to check if the ground gear lifted off during the haul. For the FRV Celtic Explorer, door spread, wing spread, headline height and bottom contact were monitored using Scanmar and Marport trawl sensors (distance sensors in the doors and wing-ends, headline sensor and a trawl-eye sensor positioned on the topsheet directly over the footrope) (Gerritsen et al., 2018).

For the Scottish data, the swept areas of the wings and doors were then calculated as the sum of the individual wing/door spread measurements multiplied by the distance travelled between successive measurements (Fernandes et al., 2007). For the Irish data, the median values of the door spread, wing spread and headline height were recorded at the end of the tow. These measurement as well as bottom depth and GPS position are recorded in a SQL database at intervals of approximately 1 per second (Gerritsen et al., 2018).

The estimation of abundance for anglerfish takes into account the following factors:

1) herding of anglerfish by the trawl doors and sweeps;
2) escapes of fish under the trawl footrope;
3) anglerfish abundance and biomass in the southern part of Division VIa not covered in 2005, 2008 and 2010;
4) variability due to: a) sampling, b) herding (based on experimental data), c) footrope escapes (based on experimental data).

Herding corrections were based on a model derived from observations of anglerfish behaviour using video cameras mounted on the sweeps: full details are described in Reid et al (2007a). The number of fish escaping under the footrope has been estimated from experimental data using catching bags under the footrope (Reid et al 2007b). The number and size of anglerfish passing under and into these bags were measured. A size based model of footrope selectivity was then developed. This model was then applied to the length data from each survey to correct for those fish that were likely to escape under the net (ICES 2009). Prior to 2011, Scotland only surveyed the Northern part of ICES Division VIa, with this area being covered by Ireland in 2006, 2007 and 2009. Estimates of the proportion of anglerfish in the southern part of ICES Division VIa for 2005, 2008 and 2010 were derived from 2006, 2007 and 2009 when Ireland contributed to the survey and covered this area completely, using averages of the proportions of the abundance in this area relative to the whole Northern shelf. The averages of these proportions (8.7% for abundance and 5.1% for biomass) were used to estimates of the surveys in 2005, 2008 and 2010 when the Irish did not participate. Since 2011, Scotland has surveyed the whole of ICES Division VIa.

The estimates currently do not take account of the following:

• areas in the central and southern North Sea (eastern part of ICES Division IVa and all of IVb and IVc);

• areas inaccessible to the trawl in Division VIa.

Further details of the survey methods are given in Fernandes et al. (2007). Also for a full description of the estimation of abundance and catchability components see Annex 2 - Stock Annex in ICES (2013).

Results

Figures 2 and 3 show the survey haul locations and mean numbers and weight per km^2 caught at these locations. Larger numbers of anglerfish were caught along the shelf-edge below 58°N, with large weights of fish being caught at the same locations and also at Rockall, indicating that the fish at Rockall are larger than those caught on the shelf-edge. This is reflected in the estimated population total numbers-at-length and total weight-at-length by Division (Figure 4), which show small fish (~20cm) in Divisions IVa and VIa, and a much higher proportion of large fish at Rockall. Comparison of numbers-at-length and weight-at-length over time show a larger proportion of larger fish in all areas compared to recent years (Figures 5-8).

Tables 1 – 3 give point and variance estimates for total numbers and biomass for 2019 and previous years, by Division and for Subareas IV & VI combined. Biomass in Divisions IVa and VIa had a slight decrease, whilst that in VIb had a substantial drop compared to last year. (Table 2, Figure 9). The total biomass estimate for the survey area for 2019 is 58.575kt, an overall decrease of 25% compared to 2018. Although this value of biomass is the lowest since 2014, it is in line with the values from previous years (2005-2013).

The average biomass over the last two years (2018-2019) was 68.118Kt, compared to an average biomass of 77.919kt in the previous 3 years (2015-2017). This leads to a decrease in average biomass (last two years *versus* previous three years) of 13% (95% CI: 1% – 25%) (Table 4).

The percentage of the biomass in area IV compared to the biomass for areas IV and VI combined has oscillated around 50% for the years 2005-2018 (Figure 11). This is in contrast to the division of the TAC across ICES subareas IV and VI, which has been in the ratio 64:36 (IV:VI) since 2011.

References

Anon. (2018). Scottish Sea Fisheries Statistics 2017. Scottish Government, Edinburgh, 104pp.

Fernandes, P.G., Armstrong, F., Burns, F., Copland, P., Davis, C., Graham, N., Harlay, X., O'Cuaig, M., Penny, I., Pout, A.C. and Clarke, E.D. (2007). Progress in estimating the absolute abundance of anglerfish on the European northern shelf from a trawl survey. ICES CM 2007/K: 12. 16 pp.

Gerritsen, H.D, Kelly, E., Stokes, D., O'Hea, B., & Ni Chonchuir, G. (2018). Cruise report: Irish Anglerfish & Megrim Survey 2017. FEAS Survey Series: IAMS 2017. Marine Institute.

ICES. 2013. Report of the Working Group for Celtic Seas Ecoregion (WGCSE), 8–17 May 2013, Copenhagen, Denmark. ICES CM 2013/ACOM: 12. 1986 pp.

Reid, D. G., Allen, V. J., Bova, D. J., Jones, E. G., Kynoch, R. J., Peach, K. J., Fernandes, P. G., and Turrell, W. R. (2007). Anglerfish catchability for swept-area abundance estimates in a new survey trawl. ICES Journal of Marine Science 64:1503-1511.

Reid, D.G., Kynoch, R.J., Penny, I. and Peach, K. (2007). Estimation of catch efficiency in a new angler fish survey trawl. ICES CM 2007/Q: 22. 20 pp.

Acknowledgements

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Table 1: Abundance of anglerfish from the 2019 survey by region. CI= Confidence Interval; RSE = relative standard error.

Sector	Area	Numbers (millions)	CI lower	CI upper	RSE	Biomass (kt)	CI lower	CI upper	RSE
Division IVa (partial)	159828	14.606	11.758	17.454	9.948	23.719	17.206	30.232	14.010
Division VIa	116307	21.032	5.885	36.179	36.746	18.864	9.004	28.723	26.667
Division VIb	39567	3.592	2.785	4.399	11.460	15.992	12.277	19.707	11.852
Subarea VI	155874	24.624	9.456	39.793	31.430	34.856	24.320	45.392	15.423
IV & VI	315703	39.231	23.797	54.664	20.073	58.575	46.189	70.962	10.789

Table 2: Survey estimates of anglerfish abundance for 2005-2019, by region.

Year	Month	Numbers (millions)					Biomass (kt)				
		IVa	VIa	VIb	VI	Total	IVa	VIa	VIb	VI	Total
2005	November	11.168	10.866	1.800	12.666	23.834	18.642	14.096	5.879	19.975	38.617
2006	November	12.844	10.459	3.174	13.633	26.477	21.921	12.175	6.889	19.064	40.985
2007	November	15.304	7.956	4.000	11.956	27.26	28.534	11.072	10.786	21.858	50.392
2008	April	12.613	7.718	3.952	11.67	24.283	29.721	14.383	9.442	23.825	53.546
2009	April	8.279	5.144	3.688	8.832	17.111	17.058	8.150	12.852	21.002	38.060
2010	April	7.366	5.161	3.131	8.292	15.658	21.944	11.59	8.745	20.335	42.279
2011	April	5.150	6.057	3.669	9.726	14.876	14.949	9.330	8.974	18.304	33.253
2012	Abril	5.432	4.961	5.135	10.096	15.528	15.106	9.213	12.005	21.218	36.325
2013	October	8.470	8.461	4.885	13.346	21.816	14.369	10.801	13.626	24.427	38.796
2014	April	17.553	16.096	6.488	22.584	40.136	21.284	16.633	14.967	31.60	52.884
2015	April	18.266	28.604	5.496	34.100	52.366	29.653	24.047	14.215	38.262	67.915
2016	April	21.648	14.383	4.538	18.922	40.569	43.956	18.273	15.717	33.99	77.946
2017	April	23.691	16.332	4.360	20.683	44.374	46.995	29.297	11.604	40.901	87.896
2018	April	11.819	13.528	6.240	19.768	31.586	29.353	22.350	25.958	48.308	77.661

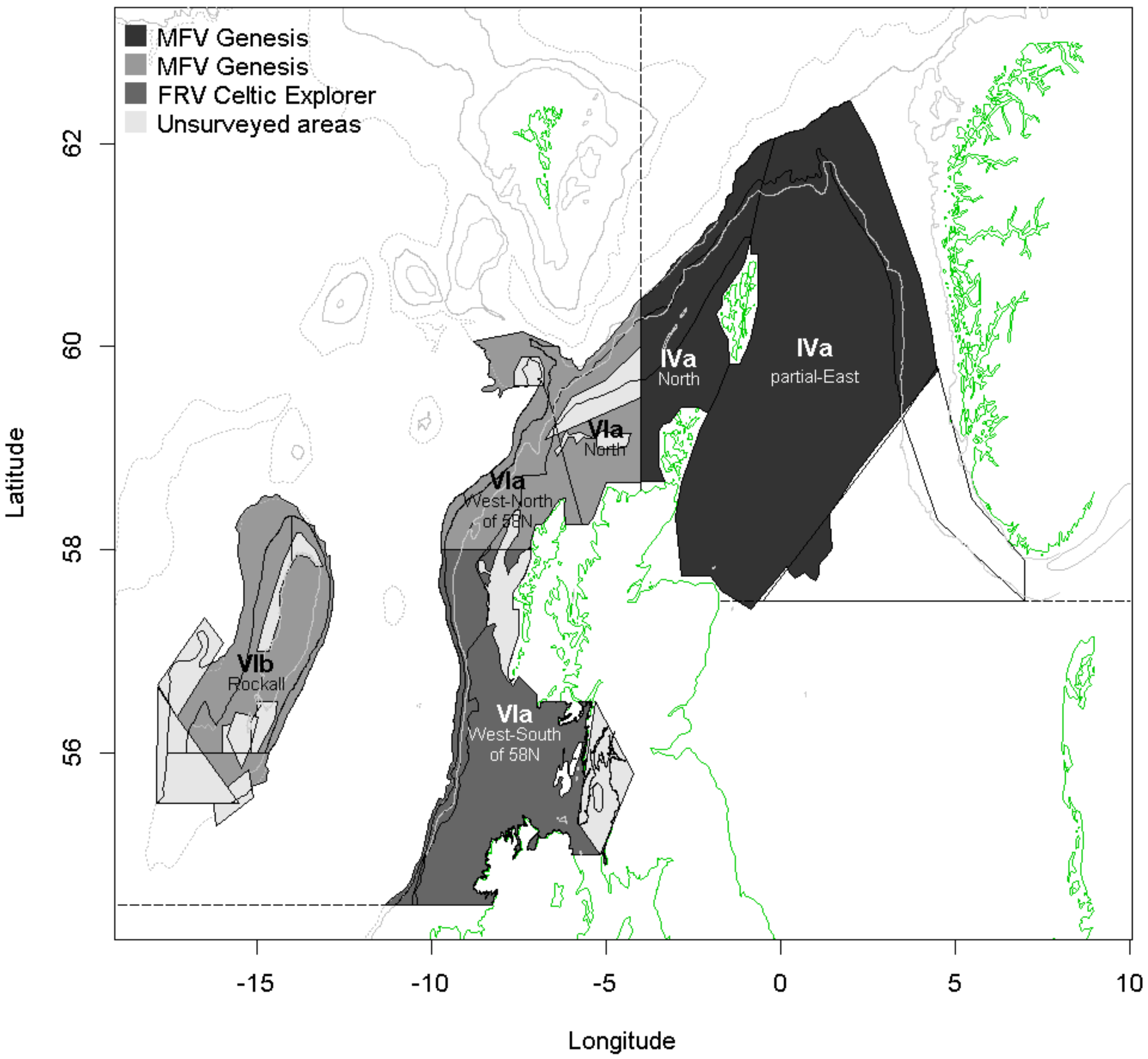
2019	April/May	14.606	21.032	3.592	24.624	39.231	23.719	18.864	15.992	34.856	58.575

Table 3: Total biomass of anglerfish (kt) in Subareas IV & VI estimated from the surveys for 2005-2019. RSE = relative standard error; CI= Confidence Interval.

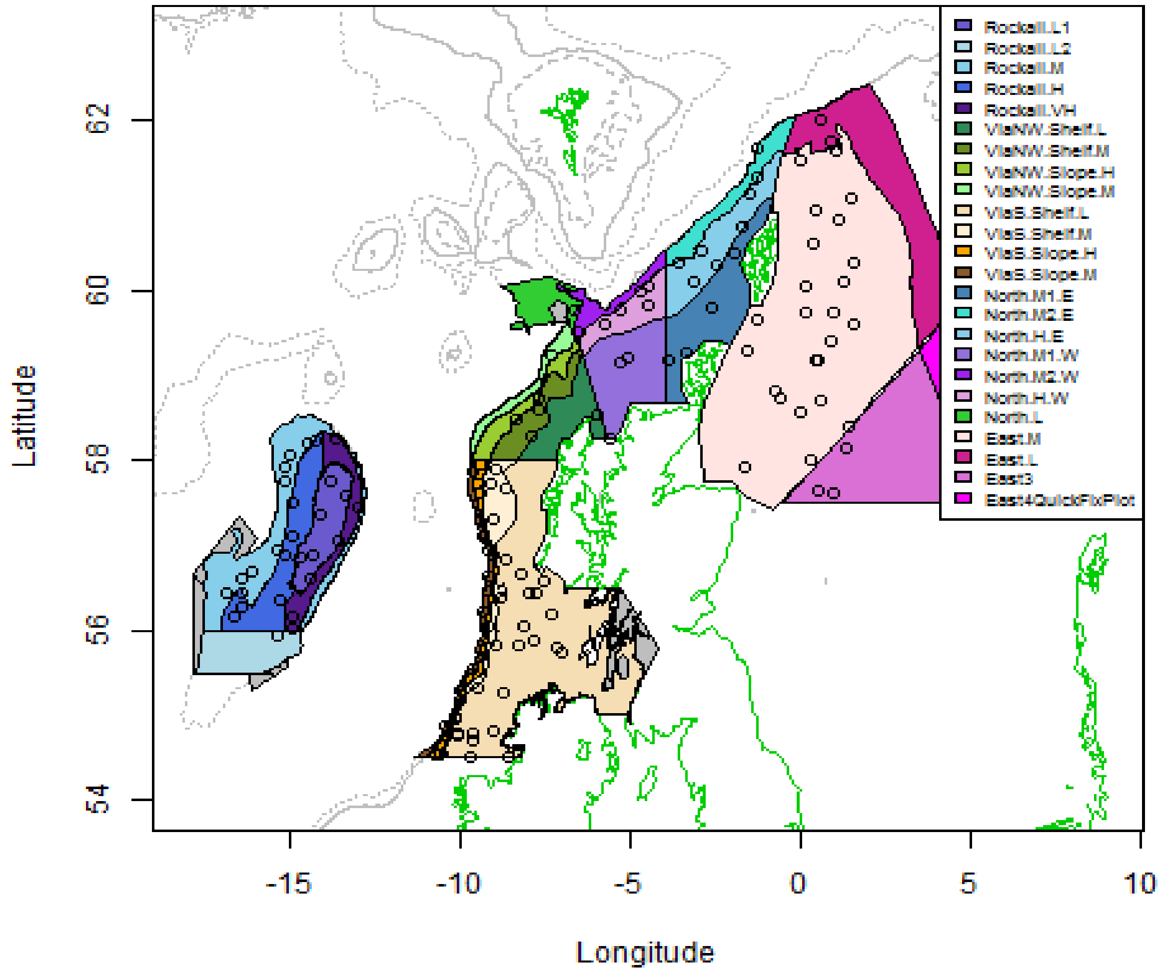
Year	Number hauls	Number measured	Biomass	RSE	CI lower	CI upper
2005			38.617	20.000	23.479	53.755
2006			40.985	8.100	34.478	47.492
2007	156	1569	50.392	6.583	43.676	57.108
2008	167	2219	53.546	7.338	42.421	64.671
2009	206	1643	38.060	6.555	32.987	43.133
2010	168	1280	42.279	8.583	30.429	54.129
2011	153	1037	33.254	7.466	24.846	41.662
2012	169	1461	36.325	9.551	29.704	42.946
2013	93	984	38.395	11.526	31.020	45.770
2014	106	1568	52.884	9.275	42.769	62.999
2015	117	2198	67.915	6.861	58.782	77.047
2016	108	2025	77.946	7.275	66.831	89.060
2017	153	3265	87.896	7.937	74.222	101.569
2018	142	2714	77.661	7.491	66.258	89.064
2019	128	1860	58.575	10.789	46.189	70.962

Table 4: Average biomass 2018-2019 (last two years) compared to average biomass 2015-2017 (previous 3 years).

Sector	Period	Average Biomass Estimate (kt)	% change
IV & VI	2015-2017	77.919	13% (95% CI: 1% – 25%)
	2018-2019	68.118	


MFV Genesis
MFV Genesis
FRV Celtic Explorer
Unsurveyed areas
IVa
North
IVa
partial-East
VIa
North
VIa
West-North
of 58N
VIb
Rockall
VIa
West-South
of 58N
Latitude
Longitude
62
60
58
56
-15
-10
-5
0
5
10

a)



b)

Figure 1: Map of the northern continental shelf around Scotland showing the sectors (a) and stratums (b) with haul locations, covered by the three survey cruises 2019.

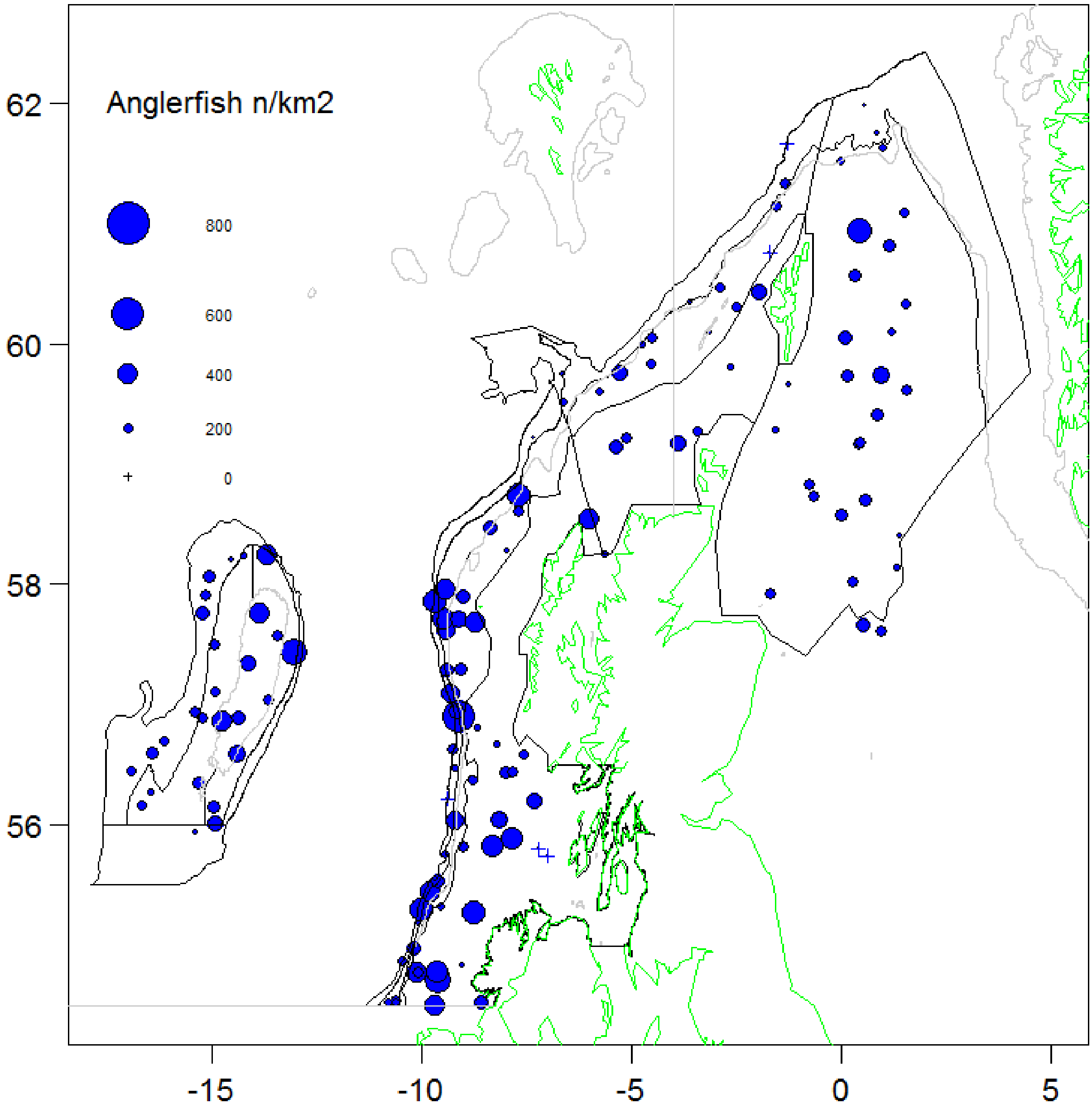


Figure 2: Map of the northern continental shelf around Scotland showing the density of anglerfish (in numbers) caught in SIAMISS 2019. Each blue circle is centred on the sample location and circle size is proportional to the number density caught per haul in n/km^2 according to the legend (top left). The green lines represent the coastline, the grey lines the depth contours, and the black lines the stratum boundaries.

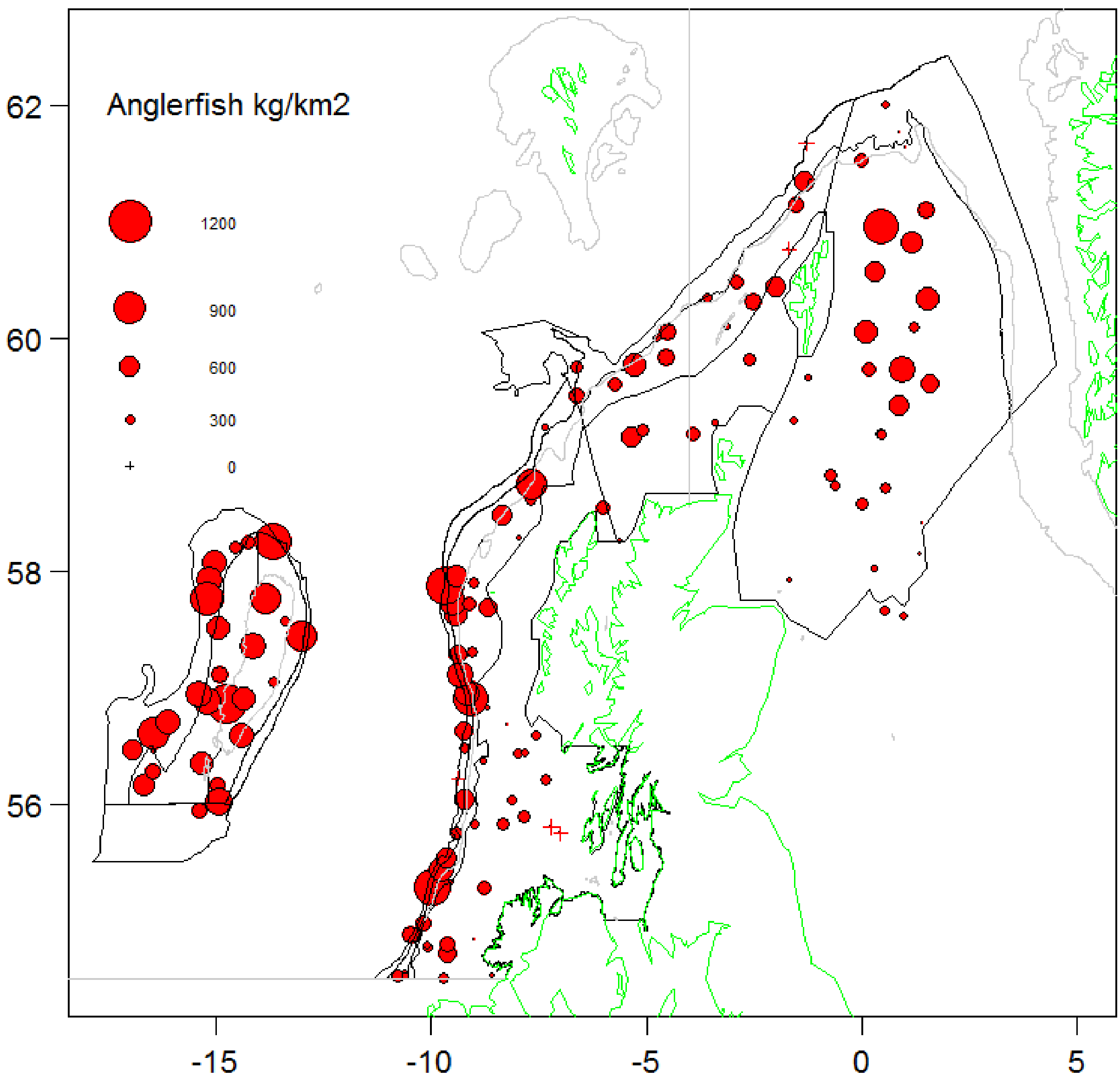


Figure 3: Map of the northern continental shelf around Scotland showing the density of anglerfish (in terms of biomass) during SIAMISS 2019. Each red circle is centred on the sample location and circle size is proportional to the density caught per haul in kg/km^2 according to the legend (top left). The green lines represent the coastline, the grey lines the depth contours and the black lines the stratum boundaries.

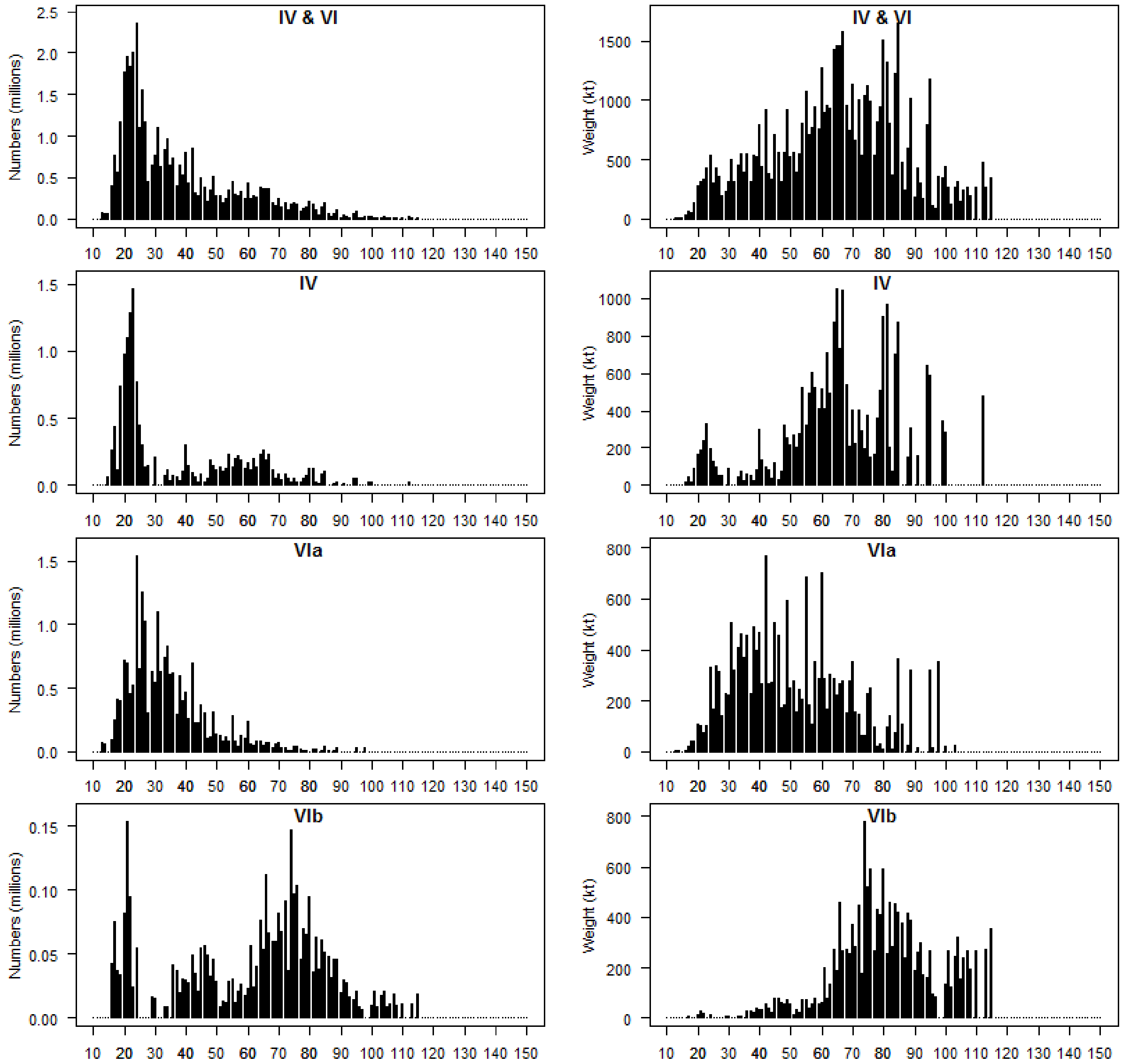


Figure 4: SIAMISS estimates of anglerfish numbers-at-length (left) and weight-at-length (right) by region for 2019.

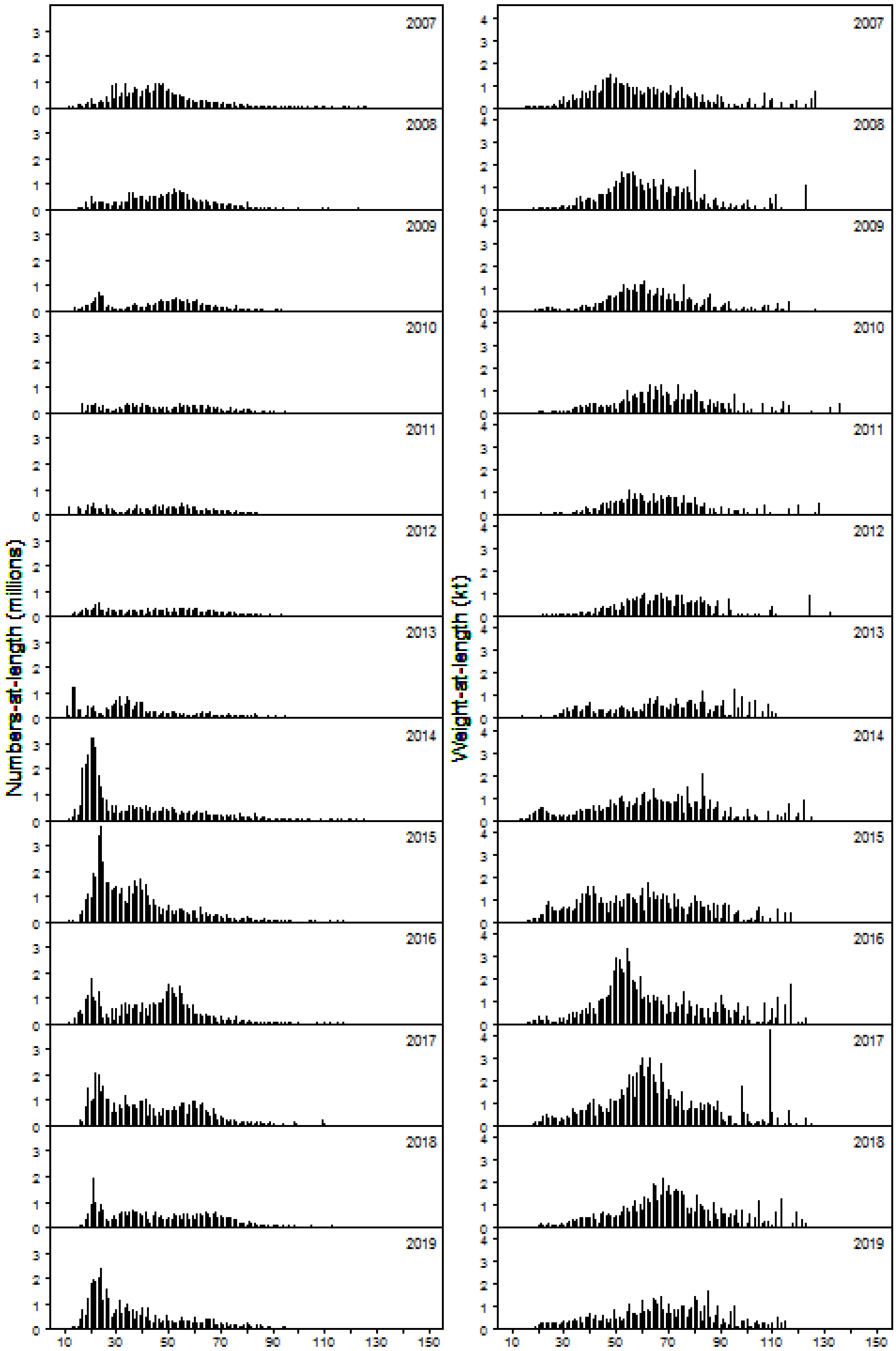


Figure 5: SIAMISS estimates of total numbers-at-length (left) and total weight-at-length (right) by year (2007-2019) for all areas combined.

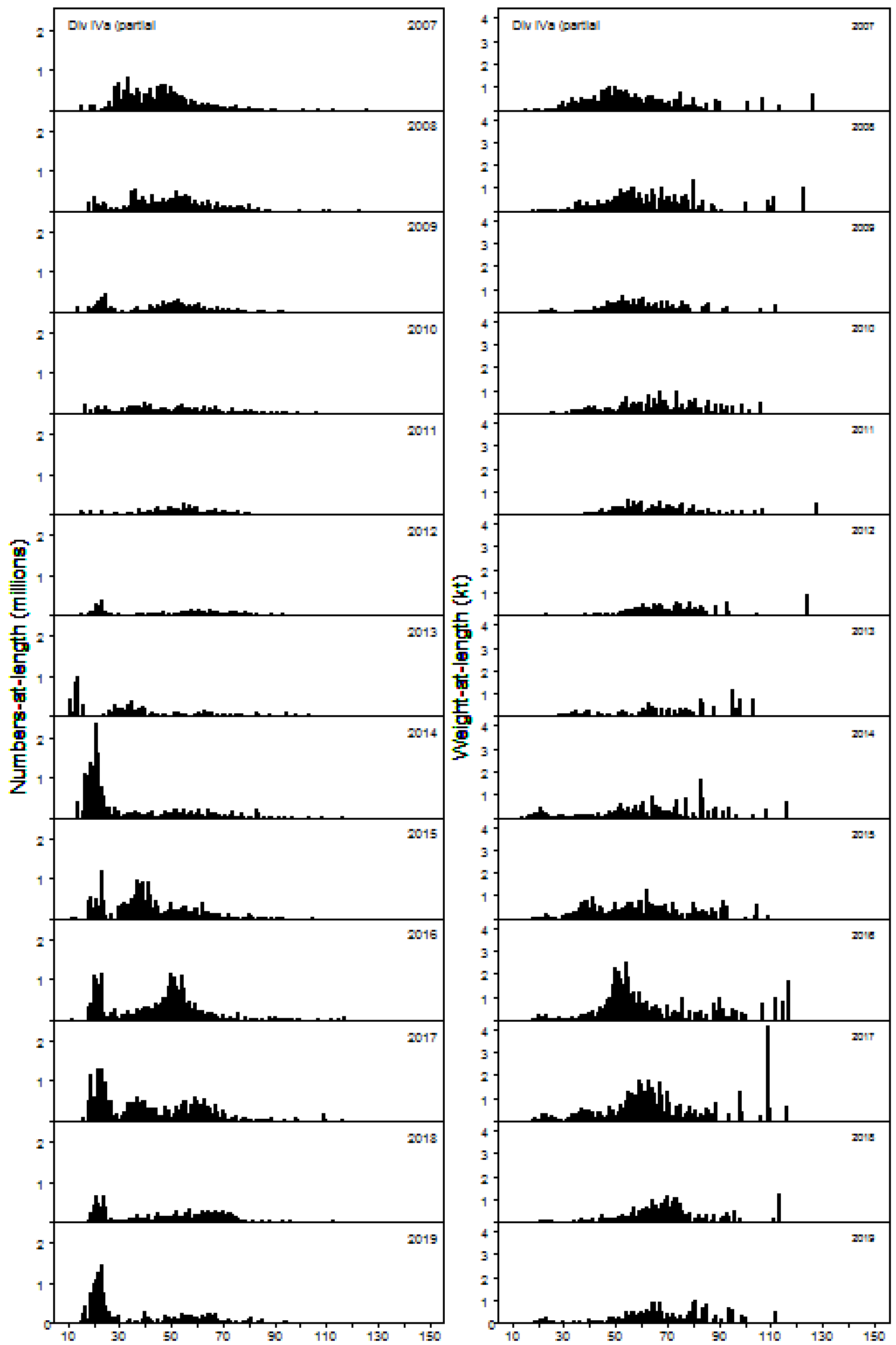


Figure 6: SIAMISS estimates of total numbers-at-length (left) and total weight-at-length (right) by year (2007-2019) for Division IVa.

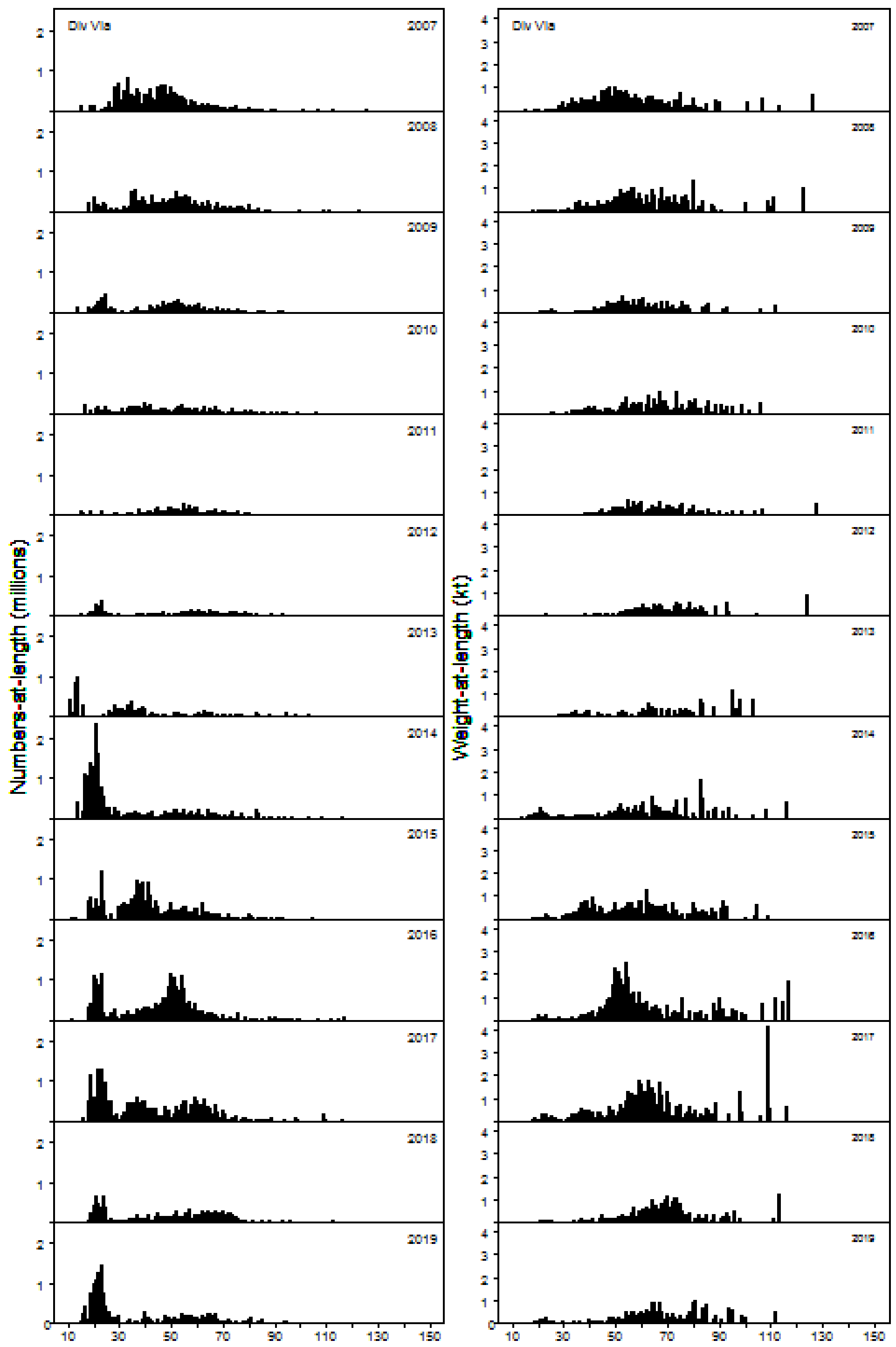


Figure 7: SIAMISS estimates of total numbers-at-length (left) and total weight-at-length (right) by year (2007-2019) for Division VIa. (Note the different scale on numbers-at-length for 2014 & 2015.)

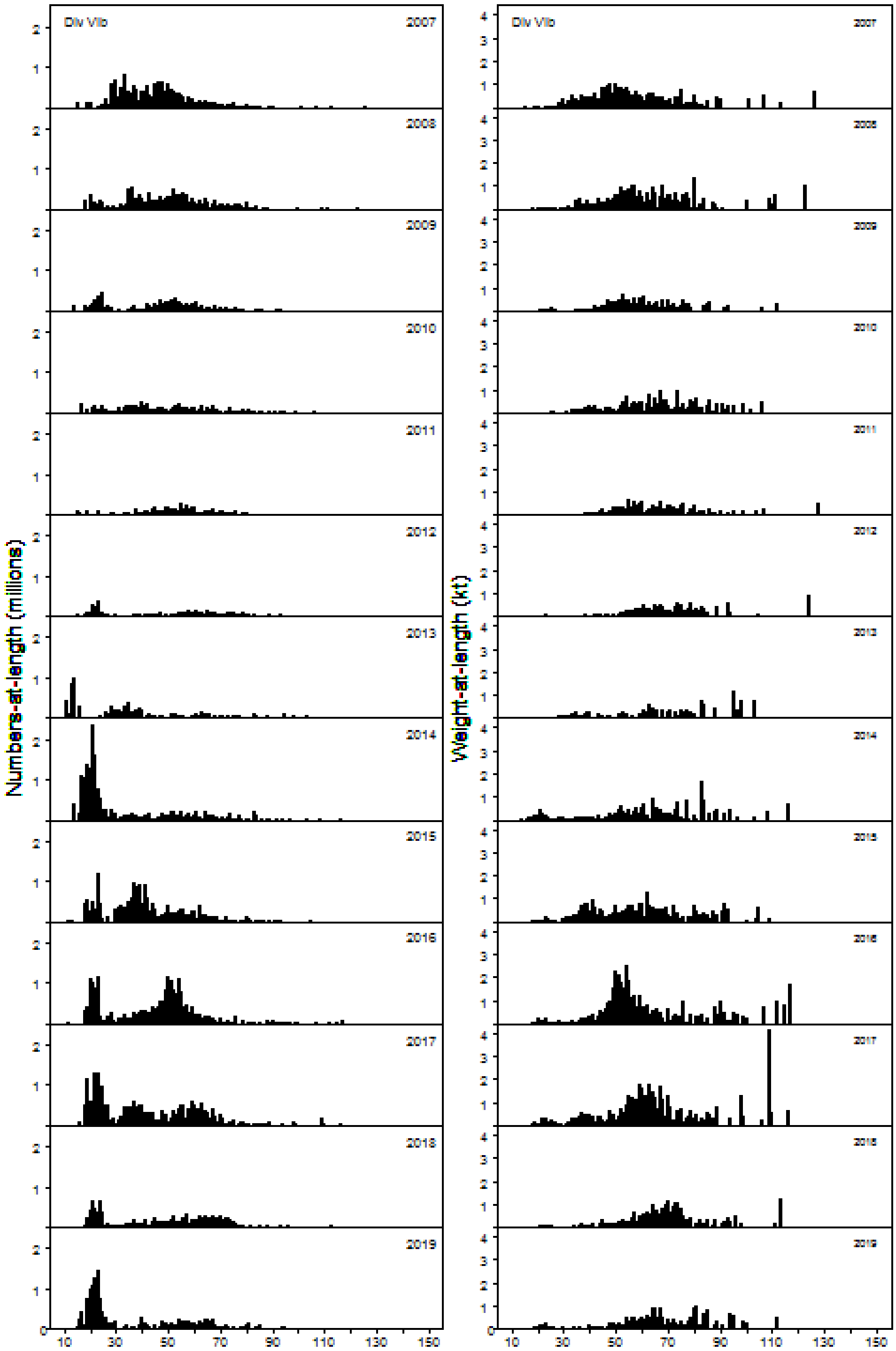


Figure 8: SIAMISS estimates of total numbers-at-length (left) and total weight-at-length (right) by year (2007-2019) for Division VIb.

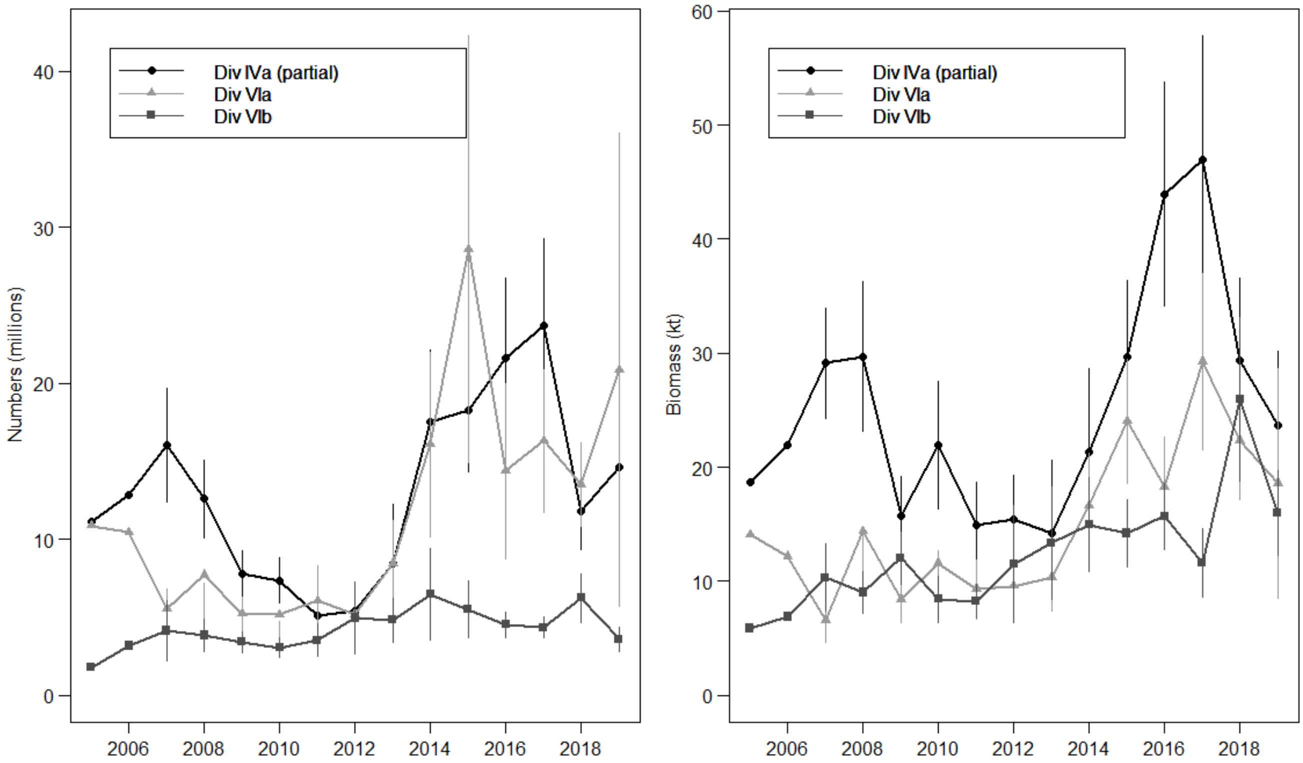


Figure 9: SIAMISS estimates of total numbers (left) and biomass (right) for anglerfish by region and year (2005 – 2019).

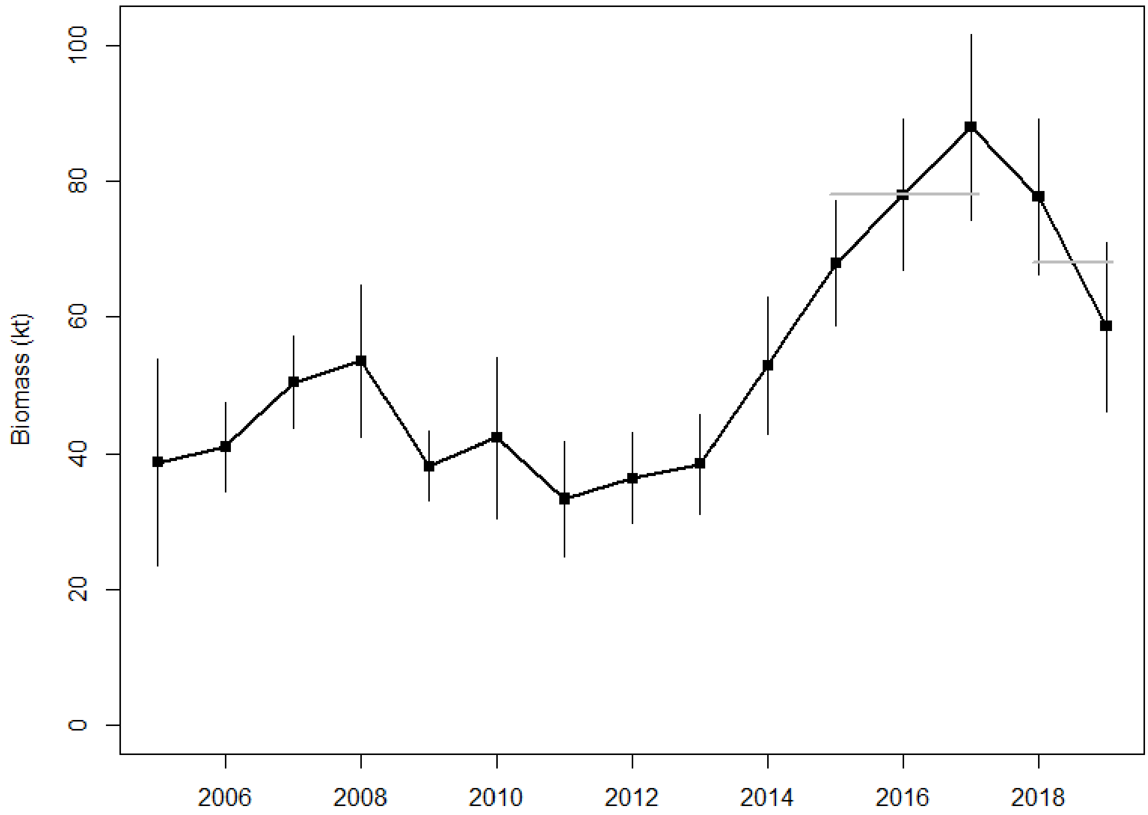


Figure 10: SIAMISS anglerfish biomass estimates for 2005 – 2019. The horizontal grey lines represent the average biomass for 2015 – 2017 and the average biomass for 2018 – 2019.

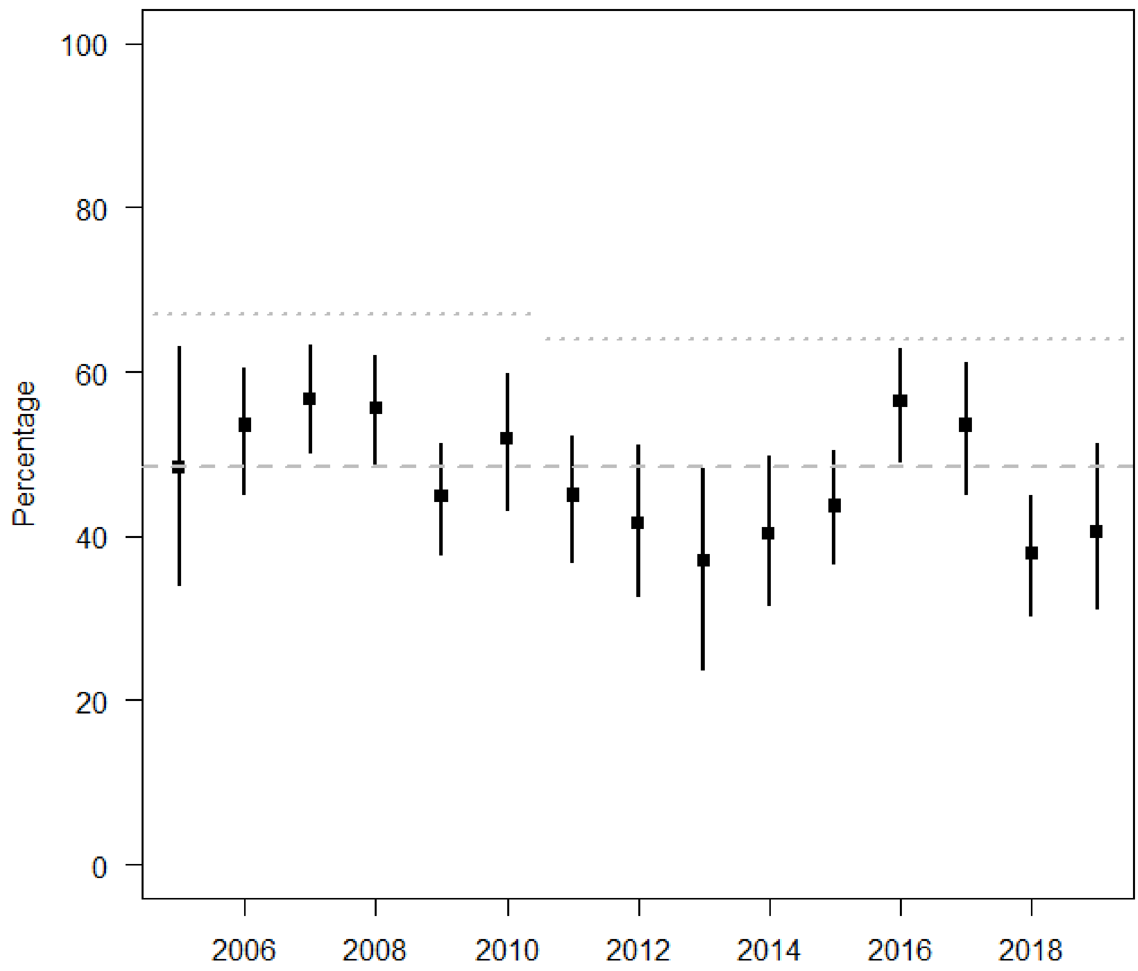


Figure 11: Biomass from ICES subarea IV as a percentage of biomass from ICES subareas IV and VI combined for 2005 – 2019. The dashed line shows the mean percentage across the years (48.32%), the dotted lines show the percentage used for setting TACs in the two areas.

Annex 4: Technical Minutes

The following pages consist of the Review of the relevant stocks conducted at the University of Maine Orono, Maine, USA from May 28–June 7, 2019/

Technical Minutes of the University of Maine Review Group for the Advice Drafting Group for the Celtic Seas

May 28- June 7, 2019
University of Maine Orono, Maine, USA

Reviewers:
Mackenzie Mazur (Chair), Dr. Bai Li (Co-Chair), Luoliang Xu (Co-Chair), Ming Sun (Co-Chair), Cameron Hodgdon (Co-Chair), Jamie Behan, Bowen Chang, Hsiao-Yun Chang, Ning Chen, Marina Cucuzza, Libin Dai, Yanan Li, Yunzhou Li, Robyn Linner, Dr. Qiuyun Ma, Shu Su, Harriett Train, Jaelee Vanidestine, Jiaqi Wang, Nathan Willse, Lei Xing, and Qilei Zhao

Faculty Advisor:
Dr. Yong Chen (Professor, School of Marine Sciences, University of Maine)

ICES Secretariat:
Liese Carleton

Review Process

The University of Maine Review Group (UMaine RG) met on May 28th, 2019 to examine the review materials, discuss the review process, and assign individuals to a subgroup of 4-5 reviewers focusing on a particular stock(s). The relevant materials were distributed to each RG subgroup when they became available on May 31st on the ICES SharePoint website. Reviews were carried out after the working group (WG) completed the final report for WGCSE and HAWG stocks. In general, the ICES guidelines for review groups (RG) were followed. The RG focused on the consistency between the WG report and the stock annex, i.e., checking whether the assessment, calculation of biological reference points (BRPs), and forecast were carried out in accordance to stock annex, Terms of reference (ToRs), and RG guidelines. Furthermore, the RG examined the data quantity and quality, assessment method, technical measures, uncertainty, and BRPs for each reviewed stock to ensure that management measures are based upon the best scientific information available. The RG finalized their reports on June 7th to determine the status of each group's report as well as their final decision of accepting or rejecting the assessment and discuss any remaining issues. Table 1 lists the stocks reviewed by the UMaine RG along with the suggestion (accept, accept with caveats, or reject).

Table 1. List of stocks reviewed by the University of Maine RG.

Stock code/draft advice link	Assessment method	Data category	Expert group	RG suggestion
bss.27.4bc7ad–h	SS3	1	WGCSE	Accept with caveats
cod.27.6a	TSA	1	WGCSE	Accept with caveats
cod.27.7a	TSA	3	WGCSE	Accept with caveats
cod.27.7e-k	XSA	3	WGCSE	Accept with caveats
had.27.7b–k	ASAP	1	WGCSE	Accept with caveats
lez.27.4a6a	Bayesian state-space surplus production model	1	WGCSE	Accept with caveats
ple.27.7a	SAM	1	WGCSE	Accept with caveats
ple.27.7e	XSA	3	WGCSE	Accept
ple.27.7fg	SPiCT	3	WGCSE	Accept with caveats
ple.27.7h–k	XSA	3	WGCSE	Accept with caveats
pol.27.67	DCAC	4	WGCSE	Accept with caveats
sol.27.7a	XSA	1	WGCSE	Accept with caveats
sol.27.7e	XSA	1	WGCSE	Accept
sol.27.7fg	XSA	1	WGCSE	Accept with caveats
sol.27.7h–k	XSA	3	WGCSE	Accept with caveats
whg.27.7a	ASAP	1	WGCSE	Accept with caveats
whg.27.7b-ce-k	XSA	1	WGCSE	Accept
pok.27.7-10	DCAC	4	WGCSE	Accept with caveats
her.27.6a7bc	SAM	1	HAWG	Accept with caveats
her.27.irls	ASAP	1	HAWG	Accept with caveats
her.27.nirs	FLSAM	1	HAWG	Accept with caveats
spr.27.67a-cf-k	N/A	5	HAWG	Accept with caveats
spr.27.7de	Biomass trend	3	HAWG	Accept

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General Comments

The RG identified some common issues regarding the reports, data, models, and BRPs among the stocks, and they are summarized as follows:

The RG recommends clearly justifying why some stocks are combined and some are not. Often, the descriptions of stock area need further justification.

The RG recommends trying multiple scenarios regarding landing data: one with ICES adjusted landings and one with official landings, since these landings values often differ.

When making assumptions about discards, it would be beneficial to provide detailed justification for the assumptions, as they can have a large effect on the assessment results and modeling residuals. The RG commends the WG for utilizing discard data, but sometimes the assumptions about discards in years where discard data are not available are not clear. Additionally, the RG recommends running structured sensitivity analyses with discard data and with different discard rate assumptions.

Ecosystem and growth rate changes were a common thread to many of the reports. Thus, the RG was disappointed that few assessments considered a structured sensitivity analysis for natural mortality (Butterworth and Rademeyer 2008). Natural mortality is a major source of uncertainty in all fishery stock assessment and with the ecosystem changes present in these regions, it is especially important to explore how growth and predation-mediated changes in M affect determination of stock status and projection. In instances where M is expected to change, the RG suggests exploration of M-RAMP or time block natural mortality (Brooks et al. 2016, Legault and Palmer 2016). More thorough knowledge will inform the WG of changes in stock productivity. This may be particularly crucial to stocks that have seen distributional or growth shift in recent years.

The RG recommends presenting parameters and their justifications in a table, which would make the reports easier to read. Providing figures and a table to present results from sensitivity analyses would also benefit the reports.

Quantifying uncertainty of the estimates of biomass and recruitment would be beneficial to the assessments. Additionally, the XSA assessments would benefit from a structured framework for incorporating uncertainties. A paper by Scott et al. (2015) provides such a framework: 1) generating the candidate assumptions, 2) estimating parameters of the stock assessment model, and 3) averaging across the model results.

It would be helpful for readers if the relationships between BRPs were summarized in the assessment reports. The RG would like to know how Fpa relates to Fmsy. Also, the harvest control rules (HCRs) based on these reference points should be described.

The RG appreciates that retrospective analysis was conducted for most stocks as consistent with the ToRs. The RG agrees with the ICES advice and concur it should be routinely checked in the assessment process. However, it is unclear how many years were peeled in the retrospective analysis. The RG also recommends that the number of retrospective peels should be justified and should reflect the average lifespan of recruited individuals in the stock area. For example, there should be more than a 5 year peel for retrospective analyses for cod stocks. The RG also suggests that a guideline be developed to correct retrospective errors in the determination of stock status and projection.

As many of the stocks are driven by high recruitment events that are usually not highly related to the spawning stock biomass (SSB), the RG recommends exploring relationships between recruitment and environmental variables. This may fill in large gaps in information about recruitment. Also, for stocks with highly variable recruitment due to environmental conditions, recruitment scenarios in the projections should not only include the geometric mean of recruitment values but also reflect high and low recruitment events that could be related to environmental scenarios.

Stock Specific Issues

The RG suggested the following stocks to be accepted if certain suggestions are considered (accept with caveats). These stocks and suggestions are:

bss.27.4bc7ad–h

a) Update the assessment with more recent data (2016-2018)
b) Calculate Mohn's Rho

cod.27.6a

a) Provide more discussion on Cook (2019)'s methods, the uncertainties associated with TSA, and additional assessment methods

cod.27.7a

a) Provide more information about retrospective bias
b) Include complete methodology of the new method in the assessment report or update the stock annex
c) Provide more discussion on model comparisons

cod.27.7e-k

a) Address issues regarding the use of survey data
b) Address issues regarding the uncertainty in catch and discard data
c) Account for the high uncertainty in estimates of key parameters by using a stochastic projection

had.27.7b–k

a) Compare the retrospective bias between XSA and ASAP models
b) Research the relationship between environmental variables and recruitment
c) Reconsider recruitment configurations in the projections (i.e. scenarios with high and low recruitment values)

lez.27.4a6a

a) Conduct exploratory runs to capture the uncertainty of total catch by modeling catch with variance corresponding to a constant coefficient of variation
b) Use a generalized additive model (GAM) to derive model-based abundance indices and assign different indices with different weights in the stock assessment
c) Conduct the assessment with a more generalized approach by incorporating a shape parameter to control the level of biomass as a proportion of unfished biomass at which surplus production is maximized

ple.27.7a

a) Update the stock annex so that the reader can better understand the model
b) Evaluate impacts of stochastic effects of natural mortality on the model performance

ple.27.7fg

a) Provide more discussion on the environmental vulnerability of the stock

b) Provide a more detailed introduction for the input data and interpretations of assessment diagnostics

ple.27.7h–k

a) Discuss large retrospective bias
b) Conduct exploratory assessment runs to investigate uncertainties, especially in discards, natural mortality, and the stock-recruitment relationship
c) Use the data collected from 7h to make the outputs of the stock assessment representative of the entire management area
d) Provide a detailed explanation of the stock status and management plan

pol.27.67

a) Collect data on the recreational fishery
b) Explore other assessment models

sol.27.7a

a) Try and cross validate different parameter settings to ensure that the best prediction of the model is being used
b) Conduct a simulation study to test whether the low sample sizes would accurately reflect the size distribution and age structure of sole

sol.27.7fg

a) Conduct a LPUE standardization analysis to improve the reliability of the fishery dependent data
b) Provide more discussion on the consequences of ignoring discard or observation errors associated with the catch data
c) Explore alternative models (e.g., ASAP, SAM)
d) Justify the reference points and clearly describe the HCR

sol.27.7h–k

a) Reevaluate all information, tables, and figures presented in the report and annex to ensure that the information being presented is true for sol.27.7h-k and not information accidentally copied from a different stock
b) Consider more conservative BRPs
c) Provide more discussion on the expected effects of the new management plan

whg.27.7a

a) Conduct exploratory runs to investigate the sensitivities of results to changes in fishery input data, natural mortality values, and model parameter steepness (h)
b) Provide information on maximum fishing effort that can be expected under management based on Fmsy
c) Remove more years of data in the retrospective analysis

pok.27.7-10

a) Explore a stock assessment model
b) Identify and evaluate data gaps and quality

her.27.6a7bc

a) Provide more information about the existing sensitivity analysis and the difference in settings with the previous assessment
b) Conduct an alternative sensitivity analysis for the unavailable biology data and assumptions for catchability

her.27.irls

a) Address issues regarding the use of survey data
b) Conduct stochastic projections to account for extremely high uncertainty for key parameters

her.27.nirs

a) Research uncertainty related to spatial and temporal variability, stock mixing, natural mortality, and catchability assumptions
b) Describe the retrospective analysis
c) Revise figures and tables

spr.27.67a-cf-k

a) Add context for the 2013 3500 t limit decision

bss.27.4bc7ad-h: Sea bass (*Micromesistius poutasso*) in divisions 4.b-c, 7.a, and 7.d-h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel, and Celtic Sea)

1. **Assessment Type:** Update

2. **Assessment:** Accept with caveats

3. **Forecast:**
   - Short term projection - Carried out by Stock Synthesis 3 (SS3) from 2017 to 2019.
   - No medium or long term was carried out.

4. **Assessment Method:** Stock Synthesis 3 (SS3) was used.

5. **Consistency:**
   - There were small changes to the Solent bass survey in recent years to ensure consistency with values from previous years.
   - The Channel Ground Fish Survey (CGFS) switched vessels in 2015, and an index was estimated considering this change in catchability. However, since the index requires review, it was not used.
   - An extraction from French logbook data in 2019 indicated that discards are underestimated from on-board sampling.
   - The model is sensitive to recent data, because the recent data have higher influence given the higher sampling levels.
   - The most recent fishing mortality (F) estimates are the least precise, and the F estimate for 2014 could be revised downwards in future assessments.

6. **Stock Status:**
   - SSB is estimated to be below B_{pa} but above B_{lim} in 2015.
   - The combined commercial and recreational fishery F is well above the F_{MSY} proxy.
   - Total landings in 2018 was 912 t.
   - Catches decreased from 949 t in 2017.
   - SSB increased from the mid 1990's, peaked in 2009 and has declined rapidly in recent years.
   - Recruit is at a low-level, fluctuating without trend since 2008.

7. **Management and Biological Reference Points:**
   - Total removals in 2019 should be no more than 1789 t.
   - F_{MSY} proxy and B_{lim} reference points defined in 2016 have not been altered.
   - For the recreational fisheries, minimum sized increased from 36 cm to 42 cm in 2015, and bag limits and closed seasons were imposed.
   - No TAC has been defined.
   - MSY advice currently uses F35% as a proxy for F_{MSY}, while $B_{trigger}$ is considered as equivalent to B_{pa}.

- Current BRPs:
  - B_{lim} = 8075 t
  - B_{pa} = 12673 t
  - B_{loss}= 7507 t
  - $B_{trigger}$ = 12673 t
  - F_{lim} = NA
  - F_{pa} = NA
  - F_{max} = NA
  - $F_{0.1}$ = 0.11
  - F_{MSY} proxy = 0.13

8. General Comments:

- First, although unclear, it seems that 2015 is the final year of the assessment. The RG encourages the new index that includes CGFS data past 2015 to be reviewed for use in the assessment. With a different vessel, data from the CGFS from 2015 and later could possibly be used as an additional survey index that covers a different area and time. This will allow the assessment to be updated to 2018. Without running the model until 2018, the current stock status will remain unknown. The RG also recommends continuing efforts for surveying inshore areas and improving the design of the Solent spring and Thames surveys so that they can be used in future assessments. It could be beneficial to expand the survey range for the Solent and Channel trawl surveys, since they only cover a part of the stock range. The RG recommends conducting studies to find if the survey area coverage is still appropriate.
- The WG report is well written and follows the stock annex. The data and data issues are well documented and discussed at length. The WG does an excellent job providing the sources of uncertainty.
- There seem to be a lot of data gaps in at-sea sampling, especially in the French fishery. Because of this, a sensitivity analysis for discard rates is recommended. The RG highly recommends improving on-board sampling coverage and continuing the UK logbook program. A simulation study to find the optimal level of on-board sampling would be helpful.
- The RG recommends continuing and improving the recreational fishery surveys and studies on recreational fishing effort. There seems to be a lot of uncertainty with recreational F. The RG recommends a sensitivity analysis with different levels of recreational F including a time varying F.
- The RG recommends studies on differences in post-release mortality in the commercial and recreational fleets among sizes of sea bass.
- The RG recommends tagging studies to further understand migration.
- Studies focusing on changes in maturity ogives over time for sea bass are recommended, since there has been no sampling in recent years to determine if the current ogive is still valid.
- As recruitment is variable yet very important to the stock, and temperature has a large effect on recruitment, the RG recommends studies on the effect of temperature on recruitment habitat and the impact of temperature on the stock.
- It would also be useful to run multiple scenarios with changes in recreational F in

the projections. The RG recommends forecasts with changes in selectivity as well, given ICES recommendations for management.
- Model-based abundance indices should be considered. Models, such as a Vector Autoregressive Spatio-Temporal (VAST) model, can be used to model abundance indices and remove the effect of outliers in the survey data.

9. Technical Comments:
- In general, some statements need to be reworded. Figures need figure captions, and there are some duplicate figures.
- Mohn’s Rho needs to be calculated for the retrospective analysis.
- It is not clear why data from before 1985 are not used.
- The RG would like clarification on if a sensitivity analysis was performed with different natural mortalities. It is not clear from the text. If not, a sensitivity analysis should be performed. On pg. 854, there is a list of M’s that were tried in the benchmark (2017), but there are M’s that are of higher values in the table on pg. 885 than in the list on pg. 854. So, sensitivity analyses with higher M’s should be run as well if they have not been already. Later in the report, it was stated that M=0.24 in the benchmark, but it was also stated that the assessment assumed M=0.15. Which M was used in the update?
- On pg. 869 in section 27.2.1, the statement ‘fleet 5- other countries plus UK gears not included in fleet 1’ is not clear. It seems like a lot of UK gears were not included in fleet 1 but then were included in fleets 2 and 3.
- It is not clear which approach is used to estimate recreational catches from 1985-2014. On pg. 874, an approach is first described but shortly after, the text states ‘An average of the two UK effort methods was included’. This is confusing. Additionally, there was an estimate of 60 t of Belgium recreational catches, and it is not clear where this estimate came from.
- The report states that information on ageing precision and calibration will become available after a study in 2015, but this information should be available now, since it is 2019.
- The equation on pg. 891 seems wrong. Wouldn’t this result in just the mean abundance in strata s and not the mean abundance?
- The RG would like clarification as to why the first three years of composition data from the CGFS are excluded from use in the model.
- The final estimation year of the model is not clear. The text sometimes refers to the final year being 2016.
- The maximum age is not clear.
- On pg. 899, the sentence ‘A detailed short-term forecast is given in Table 10.1.5.2 assuming that F in 2015 and 2016 is the 2015 values scaled to the average of the previous three years from the assessment.’ is not clear. This makes it seem like the projection was carried out in 2015 and 2016. ‘Scaled to the average of the previous three years’ is also confusing.
- On pg. 899, the report states ‘the actual rate of decline in population abundance in recent years is likely to be more uncertain than indicated by the SS3 model confidence limits.’ Why is this the case?
- On pg. 899, the report states ‘the final package of technical and other

management measures for seabass in 2015, 2016, and 2017 are not fully known at this stage…' This sentence may need to be updated as the management measures from 2015-2017 should be known in 2019.

- It is not clear if the projected landings of 2305 t in 2016 is a result of F status quo or another F scenario.
- In the references, the citation for Then et al. (2015) is not complete.
- In Table 3, number of landings sampled is not clear. Is this hauls or trips? Additionally, does a blank cell represent 0 or not recorded?
- On pg. 916, the table caption should read 'Sampling of commercial fishery landings by gear…' not 'by area…'. This table format should be improved so that it is easier to read as well.

10. Conclusions:

- The assessment of sea bass in divisions 4.b-c, 7.a, and 7.d-h appears well done and describes data and uncertainties in depth. However, the assessment needs to be updated with more recent data (2016-2018).
- The RG suggests the sea bass assessment to be accepted as long as following suggestions are considered: a) update the assessment with more recent data (2015-2018); b) calculate Mohn's Rho; c) conduct a sensitivity analysis with discard rates; and d) research the effect of temperature on recruitment.

Cod.27.6a - Cod (Gadus morhua) in Division 6.a (West of Scotland)

1. **Assessment Type:** Update
   •Last inter-benchmark: 2019
   •Last Benchmark: 2012

2. **Assessment:** Accept with caveats

3. **Forecast:**
   •Short-term: Total biomass (& SSB) and catch for 2019, 2020, & 2021 (using Time Series Analysis (TSA))
   •Mid-term: N/A
   •Long-term: N/A

4. **Assessment Method:** TSA
   •As outlined in the stock annex
   •Data Input (follows benchmark)
   - All 5 potential surveys
   - Commercial landings data (some data downweighted)
   - Discards-at-age data (age compositions only from 1991-2005)
   - Recruitment modelled by a Ricker model (except for 1987 because of large 1986 year class)
   - Age at full selection = 6

5. **Consistency:**
   •All input data for assessment model was data agreed upon in the 2019 inter-benchmark (reflected in the stock annex).
   •Advice on stock remains unchanged from 2018 report.
   •Methodology of assessment was consistent with the stock annex except for:
   - "Additional down-weighting of individual data points to improve TSA assessment model diagnostics (the stock annex acknowledges the need to allow for changes to the variance structures used in the TSA models if they improve model diagnostics)" (Quote from Report).
   - "The forecast assumptions differ from those used at previous assessment WGs and those documented in the Stock Annex which have not been discussed or modified since 2008." (Quote from Report).

6. **Stock Status:**
   •SSB on decline since 2016.
   •Currently at 2,357 t (from TSA).
   •SSB currently below $B_{Trigger}$ (B_{pa}; 20,000 t) and B_{lim} (14,000 t).
   •SSB projected for:
   - 2019: 2,344 t
   - 2020: 2,013 t
   - 2021: 2,213 t

   •F has been relatively steady since 2014. Currently at 0.668 for 2019 (TSA).

7. Management and Biological Reference Points:

•No targeted fishery.
•No HCR found in report or annex (cod management plan discontinued in 2018).
•TAC (1,735 t) is set for bycatch only. Previously, TAC for bycatch of cod was set at 1.5% of live weight of total catch from trip.
•$B_{trigger}$ = 20,000 t
•B_{lim} = 14,000 t
•B_{pa} = 20,000 t
•F_{MSY} = 0.29
•F_{MSY} Lower = 0.2
•F_{MSY} Upper = 0.41
•$F_{p.05}$ = 0.64
•F_{lim} = 0.77
•F_{pa} = 0.55

8. General Comments:

•The RG appreciates the WG's efforts to clearly explain their justifications for deviations from the stock annex. The WG's justifications are viewed by the RG as satisfactory.
•The RG additionally appreciates the thorough outline of all TSA inputs and outputs.
•The WG discusses an additional methodology by Cook (2019) to initiate conversation concerning drastically different assessment outputs by different methodologies and states that the TSA used for this assessment may not adequately reflect certain aspects of this stock. The RG would appreciate more of a discussion on Cook (2019)'s methods. The RG understands that because of uncertainty in input data that an appropriate assessment type is hard to justify. The RG is not looking for a greater justification of why a TSA was chosen, but simply a larger discussion concerning the uncertainties and what other methodologies show for results.

9. Technical Comments:

•Methodology of setting the bycatch TAC for 2019 is not explained. The WG references the landings obligation but does not explain how the TAC was calculated.
•Table 5.16 is too large for the page and so some data cannot be seen.
•Table 5.17 needs further clarification of the abbreviations. The caption is not enough.
•Table 5.18 also needs further clarification of the abbreviations. The caption is not enough. This table also seems to be too large for the page.
•Figure 5.1 has no legend. The color of the grid cannot be used to discern any information.
•Figures 5.3, 5.4, 5.5, & 5.6 have no axes labels and need more clarification in the captions.
•It is unclear over what time series Figure 5.7 is portraying.
•There is no legend for Figure 5.10.
•Figure 5.11 has no x-axis label.
•Figure 5.12 has no legend.
•CPUE is not explained in terms of units in Figure 5.14.
•Figure 5.15 has no legend.

•Figure 5.18 has no legend.
•Figure 5.19 has no legend and the x-axis label on the second graph is wrong
•Figure 5.23 has no legend and the x-axis label on the second graph is wrong.
•Figure 5.25 has no legend and the x-axis label on the second graph is wrong.
•Figure 5.26 has no legend.
•Figure 5.28 has no legend and the x-axis label on the second graph is wrong.
•Figure 5.29 has no legend.
•Figure 5.31 has no legend and the x-axis label on the second graph is wrong.
•Figure 5.32 has no legend and the y-axis needs a new label.
•Figure 5.38 has no x-axis label.
•Figure 5.39 has no x-axis labels or y-axis labels.
•Figure 5.40 has no y-axis labels or legend.
•Figure 5.44 has no x- or y-axis labels or legend.

10. Conclusions:

•The RG commends the WG on a well put-together report. The WG followed the stock annex most of the time but provided enough justification when they deviated.
•The RG recommends this report to be accepted under these caveats:

- Address the general and technical comments, especially the third general comment. The RG feels this is an important aspect of the report and is left out of discussion.

Cod (*Gadus morhua*) in Division 7.a (Irish Sea)

1. Assessment Type: Update
- Last Benchmark: 2017
- Method changed in 2019

2. Assessment: Accept with caveats

3. Forecast:
- No short, medium or long term projections were carried out.

4. Assessment Method: Trend-based assessment using a relative biomass and harvest index

5. Consistency:
- A trend-based assessment was used for 2019 instead of using the analytical ASAP model used in 2017 and 2018 because the ASAP model provided a large retrospective bias. As the WG switched to a trend-based analysis this year, the 2019 assessment did not follow the stock annex.
- While the ASAP model showed an increasing trend in SSB since 2010, the biomass index estimated from the trend-based analysis shows no clear trend as these two approaches considered different age groups for SSB.

6. Stock Status:
- Biomass index is fluctuating without a clear trend.
- Catches since 2000 have been low and decreasing.
- Landings have been not exceeded the TACs since 2000 except year 2001, 2014 and 2015; the TAC uptake was 57% in 2017.
- Discards have been decreasing since 2015.
- The stock status in future years is very uncertain.

7. Management and Biological Reference Points:
- Catch advice for 2020 was setting TAC at 516.5 t.
- No reference points available in the assessment as stock has been re-classified as category 3.

8. General Comments:
- The RG considers the report to be very well written. The data and data issues are in general well documented, and moderately discussed.
- The WG added a trend-based analysis in the assessment this year due to large bias of ASAP model. The RG would like to see more comparisons between these two approaches and more discussion on how the new method was chosen over the ASAP model.
- As the assessment did not follow the stock annex, the RG recommends the WG to provide detailed information of the methodology in the report and update the stock annex.
- The RG noted that while ASAP showed an increasing trend in SSB since 2010, the biomass index estimated from the trend-based analysis showed a mostly stable biomass trend. The WG stated that it is because the biomass trend considered only fish from ages 1 to 4, of

which not all constitute the SSB. The RG recommends the WG to provide more evidence to support their selection of age range.

● More discussion of sources of uncertainty and quality of data, as well as further discussion of the alternative assessment model would strengthen this update.

9. Technical Comments:

● Section 7.1. “The landings in 2018 were observed at 235.9 t, 214.9 t after re-allocation of 20 t of Irish landings and despite the TAC of 695 t only increased slightly (Table 7.1).” The RG noted that the observed landings is 234.9 according to the Table 7.1.

● Table 7.2. - The unit of landings and TAC need to be added.

● Table 7.8. - Data for 2014 should be added or provide an explanation of why they are not available.

● Figure 7.1. - The whole plots should be well within the bounding box.

● Figure 7.2. - The axes should be labeled.

● Figure 7.3. - The figure will be clearer if the top block showing “Raw stock weights” is removed.

● Figure 7.4. - “Log ratio of ages in commercial catches.” The description seems to be inconsistent with the figure.

● Figure 7.9. “Commercial fleet catch-at-age residuals.” The RG is not clear with which figures are described by the caption. The RG suggests numbering the figures and then classifying the number in the caption.

● Figure 7.15. – The text on the plot is hard to read.

● Figure 7.7. - The legend to the right is not clear and needs to be clarified.

● Section 7.1. In the section of “Management applicable to 2018”, the WG stated that “Technical regulations in force in the Irish Sea, … are described in Section 7.2 and 7.10”. The RG noted that there is no such information available in Section 7.2, and there is no Section 7.10 in the report. The RG recommends the WG to revise and improve the content.

● Section 7.2. In the section of “Survey data used in assessment”, the WG stated that the age range of NIGFS-WIBTS-Q1 and UK-FSPw is 1-4 and 2-6, respectively. However, the stock annex states those age ranges are both 1-5. The RG recommends the WG to explain the reason for the inconsistency.

● Section 7.2. The WG stated that “NIGFS-Q1 was used as a biomass trend, multiplying the relative abundance at age/nautical miles by the weight at age and applying the two over three rule subsequently.” The RG recommends the WG to give more information to explain this clearer, such as a description of two over three rules.

10. Conclusions:

● The assessment of cod in Division 27.7.a. appears well done. However, some grammar and sentence structure errors can make interpretation of the output a bit challenging.

● The WG decided to use a trend-based analysis for assessment this year instead of using the conventional ASAP model due to its large retrospective bias. The RG suggests: a) provide more information about the retrospective bias; b) include complete methodology of the new method in the assessment report or update the stock annex; and c) conduct more discussion on model comparisons.

Cod (*Gadus morhua*) in Divisions 7.e–k (Eastern English Channel and southern Celtic Seas)

1. **Assessment Type:** Update
    - Benchmarked in 2012

2. **Assessment:** Accept with caveats

3. **Forecast:**
    - No short-term projection was performed.
    - No medium or long term were carried out.

4. **Assessment Method:** Extended Survivor Analysis (XSA)

5. **Consistency:**
    - To ensure the consistency of data processing at the international level, the same rules were applied each year for the allocation procedure for TAC: fill unsampled strata using as much as possible the same metier and quarter, regardless of area and country.
    - Biological parameters remain unchanged since the 2012 WKROUND benchmark.
    - The recent technical measures introduced in the Celtic Sea (square mesh panels) were not expected to significantly reduce catches of Celtic Sea cod or improve the selection pattern.
    - Recent recruitment was low and the short-term outlook was very dependent on recruitment for this stock.
    - The final assessment was run with the same settings as established by WKROUND 2012. Discards were not included in the assessment.
    - This year’s model output suggested a substantial downward revision in SSB and recruitment in recent years and substantial upward revision in F.
    - The advice remains the same, because the short-term outlook for the stock remains unchanged.

6. **Stock Status:**
    - The current SSB is below $B_{trigger}$ and B_{pa}. SSB has decreased from 12,492 t in 2012 to 1,783 t in 2018.
    - In 2018, F is estimated at 0.83 which is above F_{lim}, F_{pa} and well above F_{MSY}.
    - F was above F_{MSY} during the 1971-2018 period but decreased between 2000 and 2010 and increased again after. F fluctuated around F_{lim} in recent years.
    - Catches have been around 5,000 t since 2000. Total catch in 2018 was 1,385 t.

- SSB is below MSY $B_{trigger}$ and B_{pa} since 2000, except for SSB in 2012 as a consequence of a very good recruitment year. Since 2004, SSB has been below B_{lim}, except during the 2011-2013 period.
- Recruitment has been highly variable over time with occasional very high recruitment followed by a period of low recruitments. Since 2012, recruitment has been very weak except for the 2014 year class, which is above average. Recruitment estimated in 2017 and 2018 were remarkably low.

7. Management and Biological Reference Points:

- No management plan has currently been established for cod in Subareas 7e-k.
- Technical measures applied to this stock were a minimum mesh size (MMS) for beam and otter trawlers in Subarea 7 and a minimum landing size (MLS) of 35 cm.
- BRPs have been estimated using the agreed ICES guidelines in 2016.
- B_{lim} and B_{pa} remained unchanged.
- F_{lim} was defined according to segmented regression with B_{lim}, F_{pa} was equal to F_{lim}/1.4.
- A TAC of 1,610 t was set for 2019.
- $B_{trigger}$ is considered as equivalent to B_{pa}.
- Current BRPs:
  - B_{lim} = 7,300 t
  - B_{pa} = 10,300 t
  - F_{lim} = 0.8
  - F_{pa} = 0.58
  - F_{MSY} = 0.35
  - $B_{trigger}$ = 10,300 t

8. General Comments:

- The WG report is well written and follows the stock annex. The data and data issues are well documented and discussed. The WG did extensive work for this year's assessment.
- WG added up the quarterly data of catch numbers-at-age and catch weights-at-age for their landings of France, Ireland, and the UK (E+W) and raised to international landings with consideration of Belgian data. However, the WG mentioned that there is evidence that misreporting has increased from 2002 when quotas became restrictive with a maximum in 2008. Although misreporting has decreased since then, it still leads to certain uncertainty in the assessment results, because XSA assumes high quality catch-at-age and weight-at-age data for every time step.

- Discard estimates were available for countries; however, the assumption and estimation methods were different. For example, only data from the at-sea observer program were included in this report for France, and for Ireland, the assumption was that the discards are mainly at-age 1, and the estimates are very uncertain. For fleets from Belgium, the modal distribution of discards was around 30 cm. The RG believes that consistency analysis for discard estimation is necessary.
- In 2017, the French EVHOE survey was not conducted due to technical difficulties at the beginning of the survey. The IR-FR combined tuning index used in the assessment is only composed of Irish data for 2017. This change of survey design and data will introduce uncertainty and bias in the assessment and forecast. The RG suggests setting different levels of catchability to conduct a necessary sensitivity and uncertainty analysis.
- This year, no changes were made to the input data, and two ongoing surveys, both part of the DCF, IBTS Q4 (FR-EVHOE & IR-GFS7gj combined) were used to assess this stock. The survey index was a combined index based on both French IR-GFS and FR-Evhoe Q4 data. In addition, the WG evaluated the influence of having more symmetrical grid cells in data aggregation process through the comparison of new grid (0.25 deg lat x 0.5 deg long) and the historic grid (0.5 deg lat x 0.5 deg long). The RG suggests more detailed description of the comparison results.
- Natural mortality was assumed to be constant for the whole range of years and was age dependent. The RG suggests adding more biological clarification to justify the choice of fixed natural mortality, coupled with a structured sensitivity analysis to evaluate impacts of uncertainty in natural mortality.
- The initial time series of input data for retrospective analysis was 1971-2013 in the report. Due to the long time series of input data, the RG recommends removing more years of data to increase the number of retrospective peels to better reflect the performance of the methods.
- The WG indicated that a rescaling in SSB, recruitment and F is evident by comparing this year’s assessment results with last year’s results and by analyzing the retrospective analysis. The RG suggests a more detailed description of model performance according to retrospective analysis.

9. Technical Comments:

- No detailed description about the selectivity pattern was in the report.
- Page 7 Surveys and commercial tuning fleet - The RG believes that the standardization process should be clarified with more technical details and references. The purpose of standardization should also be clarified.

- Page 7- *"The comparison of runs with and without tuning indices indicates that the majority of the information comes from the catch-at-age matrix (Figure 8.12)"*. Replace Figure 8.12 with Figure 8.11b.
- Page 8-*"Length distributions of 2017 discards provided by countries for sampled strata and quarter are shown Figure 8.8a–d"*. Replace Figure 8.8a-d by Figure 8.3a-d.
- Figure 8.2.a. - "2018" is an incorrect abscissa scale.
- Table 8.3 – There should be a unit for the catch (landings) weight at age.
- Figure 8.3a-d – The landings and discards length distributions should be separate. Because the magnitudes of these are quite different, the combined figure will lead to unclear distribution of landings length distribution.
- Table 8.4 – There should be a unit for the stock weight at age.
- Figure 8.5a – Fleet information is needed.
- Figure 8.6 b – The label of the y-axis is incomplete.
- Table 8.6 – The format of the table should be reorganized.
- Figure 8.7 - The significance of bubbles needs to be defined.
- Table 8.7 – The format of the table should be reorganized.
- Table 8.8 – There should be a unit for the number-at-age.
- Figure 8.8 - The average F-at-age scaled by F_{bar} (2–5) was used, the RG recommends providing the reasons for this processing.
- Table 8.9 – There should be a unit for the number-at-age.
- Table 8.10a – There should be units for recruitment, SSB, catch, landings and TSB.
- Figure 8.11a - Types of input data for the assessment should be made clear earlier in the report.
- Figure 8.11a - The RG suggests that the caption should clearly indicate number of years considered in the retrospective analysis.
- Figure 8.11b - The color of lines representing runs with and without tuning indices are not obviously different.
- Stock annex: page 8 "*Figure 3 show that the correlation between the indices is very high, which further validates the use of the new index in the assessment. Details presentations of both estimates are presented in Table A*" - Replace Figure 3 by Figure C.

10. Conclusions:

- The assessment of Cod (*Gadus morhua*) in divisions 7.e–k (Eastern English Channel and southern Celtic Seas) appears well done and XSA residuals and diagnostics do not highlight any problems regarding the input data and model fit in the report. However, due to the uncertainty in catch-at-age and weight-at-age data, the RG suggests running other assessment models for comparison.

- Survey design and data were changed in 2017, which will introduce uncertainty and bias in the assessment and forecast. The RG suggests setting different levels of catchability to conduct a necessary sensitivity and uncertainty analysis.
- Given the strong retrospective pattern of this year assessment, the RG also suggests a more detailed description of model performance according to the retrospective analysis. In addition, the RG recommends removing more years of data to increase the number of retrospective peels.
- Although the WG mentioned that the non-inclusion of undersized discards in the assessment might cause retrospectives bias, more impact issues should be considered to illustrate the retrospective bias. For example, there was no description on whether the life history of cod has changed significantly during time series, which may result in strong retrospective patterns. In addition, the effect of environmental variables on cod should also be taken into consideration.
- The RG suggests cod (*Gadus morhua*) in divisions 7.e–k be accepted as long as the above concerns are addressed.

had.27.7b-k: Haddock in divisions 7.b,c,e-k

1. **Assessment Type:** Update

2. **Assessment:** Accept with caveats

3. **Forecast:**

   - Short term projection - Carried out by Age Structured Assessment Program (ASAP) from 2019 to 2021.
   - No medium or long term projections were carried out.

4. **Assessment Method:** ASAP was used. XSA was also used for quality control purposes.

5. **Consistency:**

- The combined French/Irish survey has nearly full spatial coverage of the assessment area. The survey has good internal consistency.
- Additional technical measures have been introduced to reduce the high levels of discards recently observed in the Celtic Seas.
- The estimate for SSB is biased in the most recent year.
- Recruitment was large in 2018 due to the large recruitment observed in the surveys.
- F has been overestimated and revised downwards since 2008 in the assessment due to the strong 2009 cohort causing a conflict with the catch data.

6. Stock status

- The SSB peaked in 2011 as the very strong 2009 year class matured; this cohort was followed by three years of below-average recruitment which led to a rapid decline in SSB after 2011. SSB has since stabilized.
- Recent recruitment has varied around the average, with a notable peak in 2009 and in 2018.
- F has been above F_{MSY} for the entire time-series.
- Although F is consistently over F_{MSY}, the stock size has not decreased, suggesting the stock is robust to overfishing. If recruitment were to be consistently low, then SSB could decline below $B_{trigger}$.
- Total landings in 2018 were 6590 t.
- Landings decreased from 6685 t in 2017.

7. Management and Biological Reference Points:

- The TAC in 2018 was 8329 t.
- MSY and PA reference points were defined in 2016 and have not been altered.
- The minimum size is 30 cm.

- MSY advice currently uses F_{MSY} (median point estimates of EqSim with a segmented regression stock-recruitment relationship), while $B_{trigger}$ is considered as equivalent to B_{pa}.
- Current BRPs:
  - B_{lim} = 6700 t
  - B_{pa} = 10000 t
  - $B_{trigger}$ = 10000 t
  - F_{lim} = 1.41
  - F_{pa} = 0.89
  - F_{max} = NA
  - F_{MSY} = 0.40

8. General comments:

- The WG report is well written and organized. The data and data issues are well documented and discussed at length. The WG used two different models to further understand the robustness of the results, which the RG commends.
- The retrospective patterns are concerning. The RG recommends conducting a retrospective analysis with the XSA model and comparing the retrospective bias between the XSA and ASAP models.
- The RG recommends research on variables, such as environmental conditions, that drive recruitment. Perhaps environmental variables should be incorporated into the assessment.
- Since recruitment is variable for this stock, it would be beneficial to reconsider recruitment configurations in the short-term projections or try scenarios with high and low recruitment values.

9. Technical comments:

- The RG would like more clarification as to why this stock is still suitable for category 1 although there are large retrospective patterns.
- The RG would like clarification on why recruitment in the short-term projection a geometric mean of recruitment from 1993-2016 and not until 2018.
- On pg. 6, the report states 'The results have been published earlier this year (ICES, 2016b)...'. This is an old citation, so this sentence needs to be updated.

10. Conclusions:

- The assessment of haddock in divisions 7.b-k appears well done and organized. The RG appreciates the use of two models for quality control purposes.
- Given the two model outputs are similar, the RG suggests the haddock assessment to be accepted as long as the following suggestions are considered: a) Compare the retrospective bias between XSA and ASAP models; b) research environmental variables that drive recruitment; and c) reconsider recruitment configurations in the projections (i.e. scenarios with high and low recruitment values).

lez.27.4a6a: Megrim (*Lepidorhombus ssp.*) in divisions 4.a and 6.a (northern North Sea, West of Scotland)

1. **Assessment Type:** Update

2. **Assessment:** Accept with caveats

3. **Forecast:**
   - Accept with caveats
   - Short-term projections - Carried out according to the methods described in the stock annex.
   - No medium or long term were carried out.

4. **Assessment Method:** Bayesian state-space surplus production model.

5. **Consistency:**
   - The model configuration is the same as the 2018 assessment. The 2019 assessment is only an update of 2018 assessment with new catch and survey data.
   - The 2019 assessment compares the estimates of key parameters with that of assessments from previous years. The estimated K, MSY, B_{MSY}, B_{lim}, and $B_{trigger}$ in 2019 are lower than their estimates in 2018. The estimated r and F_{MSY} in 2019 are similar but slightly less than the estimates in 2018.
   - The model outputs from the 2019 assessment suggest a downward revision of the biomass and a stable trend of fishing mortality compared with that of 2018.
   - The 2019 assessment presents the results of retrospective analysis, which was not conducted in 2018. There is no retrospective pattern detected and the magnitude of the Mohn's Rho values is less than 0.1.
   - The status of the stock has not changed since last year.

6. **Stock Status:**
   - Biomass has consistently been above B_{MSY} and shows an increasing trend since 2005. The estimated biomass in 2018 is 37,062 t and the B_{2018}/B_{MSY} is 1.681.
   - F has consistently been below F_{MSY} and shows a declining trend since the late 1990s. The estimated F_{2018} is 0.08 and F_{2018}/F_{MSY} is 0.40.
   - Total catch in 2018 was 3,258 t. The ICES estimated landings without discards in 2018 were 3,003 t, which is well below the TAC (7,958 t).

7. **Management and Biological Reference Points:**
   - ICES advised that when the EU multiannual plan is applied, catches in 2020 that correspond to the F ranges in the plan should be between 6450 t and 8350 t.

● F_{MSY}, B_{MSY}, and MSY were directly estimated in the model and the values varied when new catch and survey data are added into the assessment.

● B_{pa} and B_{lim} were defined as 50%×B_{MSY} and 30%×B_{MSY} respectively from the previous assessment and remained unchanged.

● F_{lim} is the F brings the stock to B_{lim} and is defined as 1.7×F_{MSY} from the previous assessment. It is remained unchanged in the 2019 assessment.

● MSY $B_{trigger}$ is set to B_{MSY} because the stock has been fished below F_{MSY} for more than 10 years.

● Current BRPs:
  - MSY = 5123 t
  - F_{MSY} = 0.25
  - B_{MSY} = 22058 t
  - B_{lim} = 6617 t
  - $B_{trigger}$ = 11029 t

8. General Comments:

●The WG report is well written and the stock assessment follows the methods that are described in the stock annex. Both fishery-independent and fishery-dependent data are well documented. In addition, the WG does an excellent job discussing the sources of uncertainties that are associated with the data and providing recommendations for next benchmark.

●The RG recommends addressing several identified data uncertainties through a structured sensitivity analysis.

○The WG documented that there are a few discrepancies with the two types of landing estimates. Because the current assessment only uses estimated landings from ICES and the discrepancies between the two types of landing estimates in Subarea 6.a. were relatively large before 2000, the RG recommends conducting an exploratory run using the official landings and quantifying the influence of different landing inputs on the assessment results. The RG also recommends providing explanations on how to adjust the official landings to InterCatch/ICES landings, especially when the estimated ICES landings in Subarea 4 and 2.a. were less than official landings reported to ICES.

○ The discards data were available since 2013, and the WG assumed a linear decline in discards from 30% to 15% over time from 1985 to 2012 in the assessment. The RG recommends providing justification on such a strong and specific assumption. The RG also recommends providing the estimates from the scenario of a fixed 15% discard proportion over the full landings, which is described as another assumption in the stock annex, as a sensitivity run. In addition, the RG recommends considering discards with a random-walk pattern since there is no documented supporting evidence on the trend of discards before 2013.

- ○ As both landings and discards were uncertain, the total catch of landings and discards could be modeled by a lognormal distribution with mean equal to the current catch input and variance corresponding to a constant coefficient of variation (Marandel et al. 2016). The RG recommends developing this scenario as a sensitivity run.
- ○ As two AMISS surveys collect data in the same season and same subregion (i.e. 6.a), the RG supports the recommendation from the WG on combining the information from the two surveys to develop one continuous index for the future benchmark assessment. However, the correlation between the indices of the two surveys needs to be carefully examined before combining the information. The depth ranges of the two surveys are different, and one of the surveys is not designed for monitoring megrim. The methodology of calculating the abundance index and difference in catchability of the two surveys needs to be explained.

● The WG uses a Bayesian state-space surplus production model with the assumption that the surplus production is maximized at 50% of unfished biomass. The RG recommends conducting the assessment with a more generalized approach by incorporating a shape parameter to control the level of biomass as a proportion of unfished biomass at which surplus production is maximized (i.e. Pella-Tomlinson model).

● The WG summarizes the results of the final run in various tables and figures. The RG recommends the WG conduct diagnostics to check the performance of the final run and interpret the results in the report.

- ○ If the WG conducted more than one run, the RG recommends providing values of DIC and mean error between predicted and observed indices for comparing results from multiple model runs.
- ○ The RG recommends the WG describe the posterior distributions in figure 13.10 and providing Gelman and Rubin statistics to verify the convergence of the model run.
- ○ The RG also notices the temporal pattern in the residuals from figures 13.8, 13.9, and 13.11. The model does not fit the two survey indices well. The RG recommends examining the issues from multiple aspects. Because the GLM model-based abundance indices from SCO Vla Q4 and SCO IVa Q3 already showed a trend of being larger than the arithmetic mean of the abundance indices, the RG recommends exploring a GAM to derive model-based abundance and check the performance of the model using cross validation. In addition, the WG could check the correlation among these abundance indices and assign different indices with different weights in the stock assessment.
- ○ The WG conducted the retrospective analysis and the results indicate no strong retrospective pattern. However, given the maximum age of the species is about 16 years, the RG recommends removing more years to cover at least the lifespan of the species.

● The WG provides results of short-term projections under various scenarios. It is not clear to the RG that whether the projections are stochastic or deterministic. The RG recommends using WinBUGs to conduct stochastic projections and plotting the projections of biomass from 2019 to 2021 with the median value and 95% confidence intervals.

9. Technical Comments:

● The WG uses different terms to describe the stock assessment model in the report. Both "*Schaefar Surplus production process model*" and "*Bayesian state-space production model*" appeared in different places. The RG recommends using the term "Bayesian state-space surplus production model" and consistently use this term in the report.

● The RG recommends moving all tables and figures in the main text to the Tables and Figures section after the references and providing captions.

● The WG uses InterCatch in the text to describe the catch estimates but uses ICES landings for catch estimates in the table 13.2 and 13.3. The RG recommends clarifying the differences between the two terms.

●The WG used two-stage GLM to derive abundance indices from various surveys because the IBTS surveys exhibit a large proportion of zeros. The RG recommends exploring other families such as Tweedie to account for the large proportion of zeros in the data and other model such as a GAM for comparison.

● The WG mentioned "*SSB*" under the section of uncertainties and bias in assessment and forecast. The RG recommends changing "*SSB*" to "*biomass*" because there is no clear definition of SSB in the report.

● Change "cpue" to uppercase "CPUE".

● For the table under the section 13.5-MSY reference points, please explain the superscript b) and d).

● Table 13.4: Change "surplus production model" to "Bayesian state-space surplus production model".

● Table 13.6: Clarify whether the estimated values are mean or median in the caption. Provide values for B_{pa}, F_{lim}, MSY F_{lower}, and MSY F_{upper} as well.

● Table 13.7: Clarify whether the estimated values are mean or median. Do the "high" and "low" represent 95% CI of the estimates? Provide figures of estimated B/B_{MSY} and F/F_{MSY} over time with 95% CI.

●Table 13.8: The RG suggests using the average values from 2016 to 2018 for the assumption of discard rate.

● Figure 13.1: Change "2017" to "2018" in the caption. Provide number of stations per year in each figure.

● Figure 13.2 - 13.5: Add the meanings of "+" and gray dot in the legend.

● Figure 13.6: Plot 95% CI of the abundance indices.

● Figure 13.8: Plot 95% CI of the Delta-Gamma mean indices. Change the range of y axis for the figure on the top left.

● Figure 13.9: Expand the range of the y axis for several figures. Clarify the scale of the values, are they on log scale?
● Figure 13.10: Explain the index number in the title of each figure and which survey index they are representing in the caption.
● Figure 13.14: Use different symbols to highlight the status in initial year and terminal year.

10. Conclusions:

● The assessment of megrim in divisions 4.a and 6.a appears well-done. Proper methods were used following the stock annex. The results indicate no large retrospective errors. The RG recommends this stock assessment to be accepted with caveats.

● Given the predicted survey indices in 4.a show that the model did not match the observed data well and there are a few potential issues with input data, the RG suggests megrim to be accepted as long as following concerns are addressed: a) conduct an exploratory run to capture the uncertainty of total catch by modeling catch with variance corresponding to a constant coefficient of variation; b) explore a GAM to derive model-based abundance indices, and assign different indices with different weights in the stock assessment; and c) conduct the assessment with a more generalized approach by incorporating a shape parameter to control the level of biomass as a proportion of unfished biomass at which surplus production is maximized.

Plaice (*Pleuronectes platessa*) in division 27.7.a (Irish Sea)

1. Assessment Type: Update

2. Assessment: Accept with caveats

3. Forecast:

- Short term projection (2 years) – Implementing the management plan for this stock with F_{MSY}=0.196 leads to a total catch of 3299 t in 2020 and SSB of 18354 t in 2021.
- No medium or long term forecast was carried out.

4. Assessment Method: Age-based analytical assessment using landings and discards (implemented in State-space Assessment Model (SAM))

5. Consistency:

- The Aarts and Poos (AP) model was replaced by the state-space assessment model (SAM) in 2017.
- The estimated selectivities are split into the landed and discarded components. Until the early 1990s, the fleet selectivity had the highest values for fish at age 4. This selectivity shifted to age 5 in the late 90s and early 2000s. Since the late 2000s, landings gradually fell over time to very low values relative to discards, which became dominant and expanded to the older aged fish during the most recent years.
- Recruitment is fluctuating without an overall trend, and it is estimated at its lowest values in 2017 and 2018.
- A Mohn's rho analysis for a 5-year peel resulted in values of 0.23% for recruitment, 4.64% for SSB and -5.47% for F_{bar}.
- The assessment methodology provided is robust. A serious retrospective pattern did not appear.

6. Stock Status:

- The stock is within safe biological limits. Fishing pressure was at a low level, and SSB was at a high level.
- F declined from high levels in the 1980s to very low levels in the early 1990s and has been less than 0.1 since 2013.
- F estimated for 2016–2018 has fluctuated around similar values, from 0.050 (2016) to 0.066 (2017) and 0.064 (2018).
- Catch has decreased to low levels and since 2006. Most of the catch was discarded.
- SSB increased reaching the highest value in 2016 and decreased in 2017.
- Estimated recruitments are highly variable. There was an increasing trend in recruitment before 2015. It dropped to the lowest values in 2017 and 2018.

7. Management and Biological Reference Points:

● Commission regulations included a prohibition on the use of demersal trawls, enmeshing nets or lines within the main cod spawning area in the northwest Irish Sea between the 14th of February and 30th of April.

● Some derogations were permitted for Nephrops trawls and beam trawlers targeting flatfish.

● There is a Minimum Conservation Reference Size (MCRS) of 27 cm.

● Plaice is managed by TAC in 2018 (1793 t) and 2019 (3075 t).

● There is a mismatch between the minimum landing size and the mesh size of the gear being used.

● Implementing the management plan for this stock with F_{MSY} leads to a total catch of 3299 t (1931 t of landings and 1368 t of discards (including dead and survivors)) in 2020 and a SSB of 18354 t in 2021.

● Current BRPs:

- B_{lim} = 3958 t
- B_{pa} = 5294 t
- F_{lim} = 0.495
- F_{pa} = 0.355
- F_{msy} = 0.196

8. General Comments:

● The data and data issues are well documented and discussed at length. The data were abundant to support the SAM model to assess the plaice stock. The WG did extensive work for this year's assessment including running other assessment models for comparison.

● The RG encourages the WG to update the stock annex to provide information needed to understand the assessment.

● The WG analyzed diagnostic outputs regarding residuals of catch and survey data and retrospective patterns for years 2007-2017. The results suggest the methodology seems to be robust without a serious retrospective pattern but the RG is still concerned about the model performance and reference points (e.g., F_{msy}). Plaice biomass surveyed in 2019 (NIGFS-WIBTS-Q1) is lower than that in 2018 (Table 21.3a). Plaice biomass surveyed in NIGFS- WIBTS-Q4 and UK(E&W)-BTS-Q3 had a downward trend since 2014 (Table 21.3b and 21.4). Therefore, the total biomass of plaice in the division 27.7.a may decline in 2019. The SAM model predicted the value of F_{msy} to be 0.196 for 2020 which was higher than F_{msy} (0.169) recommended for 2019. The RG recommends the WG to evaluate whether the BRPs are appropriate.

● Focusing on the most recent two years (2017 and 2018), the projections with the SAM model in 2019 are different from those in previous assessments. The SAM model (2017) predicted the SSB to be 21356 t in 2017 (ICES, 2017). This value was much higher than that from the SAM model in 2019 (Low: 11448; Mid: 15622; High: 21319). The SAM model (2018) predicted the SSB was 22077 t in 2018 (ICES, 2018). This value was close to 24422 (Low: 12572; Mid: 17522; High: 24422).

- The minimum Conservation Reference Size (27 cm) has been implemented for many years. As the model is age-based, is this management considered in the model? If so, please supplement relevant content in the report or annex.
- The data of discarded and retained catches are length-based (Fig. 21.4 and 21.5). As the model is age-based, how did the WG use them to estimate the discards at age? If using the von Bertalanffy growth model or other formulas to transform the data, please supplement formulas and parameters in the annex.
- The negative values of catch residuals are apparent in ages 8+ from 1998 on. A pattern of negative residuals between 2004 and 2009 is presented in the residuals of the NIGFS-WIBTS due to large fluctuations in the SSB indices. The RG recommend the WG to evaluate the causes of these residual patterns.
- As natural mortality is usually not invariant, the RG encourages the WG to evaluate the model performance when incorporating stochastic effects into natural mortality. A recent article (Aldrin et al., 2019) may be of interest to the WG.

9. Technical Comments:

- In some fish stock assessment models, age-structured observations are assumed to be statistically independent. The study of Berg and Nielsen (2016) suggested catch-at-age data should not be assumed independent. If correlation is not considered in this assessment, the RG encourages the WG to consider correlation in the model used for stock assessment.
- The report mentioned that "A total of 1000 samples are generated from the estimated distribution of survivors". What does the estimated distribution of survivors refer to?
- Table 21.13 – Please clarify the definition of "Low", "Mid", and "High".
- Figure 21.1, 21.2a, 21.2b, 21.7, 21.10, 21.11, 21.12 – Please add x-axis labels as "Year".
- Figure 21.13 and 21.14 – Please add the y-axis labels.

10. Conclusions:

- The assessment of plaice is well done and trains the model with updated observations such as discard data.
- Given the model shows an adequate fit to the data, the model can be used to assess the plaice stock. The methodology seems to be robust without a serious retrospective pattern. Based on the comments provided by the RG, the report can be accepted after the following concerns are addressed: a) update the stock annex so that the reader can better

understand the model; b) reevaluate some reference points (e.g., F_{msy}); and c) evaluate impacts of stochastic effect of natural mortality on the model performance.

27 7.e: Plaice (*Pleuronectes platessa*) in the Western English Channel

1. Assessment Type: Update

2. Assessment: Accept

3. Forecast:

- Plaice in 7.e continues to be treated as a category 3.2.0 stock and the assessment is indicative of trends only.
- No short, medium or long term forecasts were carried out.

4. **Assessment Method:**

- An XSA based on landings data only was used for the assessment.
- As this was an update assessment, full data screening, tuning data and extensive exploratory XSA trials were not carried out.

5. Consistency:

- The assessment shows a high consistency with last year's assessment. Relative values presented for recruitment, SSB, and F estimates had similar temporal trends to those presented in previous assessments.
- The Mohn's rho values for this assessment are very low and well below the threshold of 20% imposed by ICES for 2019 assessments (i.e. the current assessment indicates a very high consistency).
- The assessment contains a certain degree of uncertainty due to excluding discards and is likely to be overly optimistic. F is likely to be higher, and SSB lower than estimated by the current assessment.

6. Stock Status:

- F surpassed F_{MSY} in 2016 and has been above since then. The SSB is well above $B_{trigger}$, B_{pa} and B_{lim}.
- A combination of above average recruitment and a reduction in F has increased SSB since 2008 to reach the highest level on record in 2016. However, since then, the SSB has decreased but is still a high level.
- F gradually increased from the 1980s up until the 2000s, peaking briefly in 2007. Following a large reduction in F in 2009, this assessment shows a general decline that has reached the lowest levels on record in 2015. Since then, F has increased again.
- This assessment estimates that recruitment has been above the long-term geometric mean (1980–2018) between 2010 and 2015 and below afterward. However, the optimistic stock development in recent years is uncertain due to assessment uncertainty and omitting

discard information. The decision to omit discard data is mainly due to uncertainty in the actual discard rate and an unknown proportion of surviving plaice in the discards.

7. Management and Biological Reference Points:

- There is no management plan in place for this stock.
- The current reference points are the ones calculated at WKMSYREF4 (ICES, 2016a) and shown in the following table:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$*	2443 t	B_{pa}	ICES (2016a)
	F_{MSY}	0.238	Eqsim run with segmented regression with breakpoint at B_{loss}. F_{MSY} was taken as the peak of the median landings yield curve.	ICES (2016a)
Precautionary approach	B_{lim}	1745 t	B_{loss}	ICES (2016a)
	B_{pa}	2443 t	1.4*B_{lim}	ICES (2016a)
	F_{lim}	0.88	Based on segmented regression simulation of recruitment without error	ICES (2016a)
	F_{pa}	0.63	Flim*exp(-1.645*σ); σ=0.2	ICES (2016a)

* The value for MSY $B_{trigger}$ is not the value published in WKMSYREF4. The advice drafting group in 2017 and 2018 decided to base MSY $B_{trigger}$ on B_{pa}.

- The TAC for the management area for 2016 was doubled compared to 2015 but was reduced for 2017 and increased again slightly for 2018 and 2019.
- The decision to exclude discards in the assessment is based on the uncertainty in the available discards data and unknown discard survival rate of plaice.
- A landing obligation is being phased in between 2019 and 2021 for plaice in 7.e with a discard plan. Prior to the introduction of the landing obligation, a substantial part of plaice in 7.e catches has been discarded and not accounted for in the stock assessment.

8. General Comments

- The WG report is well written, organized, and follows the annex. The data and data issues are well documented and discussed in detail. The WG did an excellent job providing the sources of uncertainty and bias in the assessment.
- The WG did extensive work for this year's assessment including running an exploratory assessment with a full catch time series and discards for the first time.
- The assessment results depend on assumptions on the mixing rate, which is estimated from a 2010 tagging survey. The RG agrees that spawning structure and mixing rate between 7.d and 7.e need to be investigated and updated to determine if the current mixing rates are still valid assumptions given a general increase in plaice stocks in the English Channel in recent years.
- The RG suggests running a sensitivity analysis with discard data.
- The WG identified an issue related to biological parameters, where natural mortality is borrowed from values of plaice in 7.a stocks but these values have changed since the last benchmark of 7.a. The RG agrees that the biological parameters need to be updated.
- The RG appreciates the recommendations for the next benchmark including the development of a discard time-series into the assessment as discarding was substantial in recent years.

9. Technical Comments:

- Figures 23 and 22 are separate and need separate captions.
- Figure 23.24 should read "discard estimate" in legend.
- Short-term projections: "The fishing mortality derived from XSA is above F_{MSY} and the precautionary buffer has never been applied since this stock is treated as category 3, therefore the precautionary buffer should be applied and reduce the advised catch by 20%." It is not clear why the precautionary buffer should be applied from this statement.
- Figure 23.4 figure title is missing.
- The RG would like Figures 23.11 and 23.12 to be easier to read.
- The scientific name is not listed under stock description and is only mentioned in the TAC table.
- The RG would like clarification on the FSP survey (definition and description).
- The RG would like clarification about how the tagging data were incorporated into the model.

10. Conclusions:

- The assessment of plaice in Western English Channel (ICES division 7.e) appears well done based on all the available information. The RG appreciates the WG's detailed recommendations for the next benchmark. The RG accepts this assessment.

ple.27.7fg. Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)

1. **Assessment Type:** Update
    - Benchmark: 2011

2. **Assessment:** Accept with caveats

3. **Forecast:**
    - Short term projection - SPiCT
    - No medium or long term was carried out.

4. **Assessment Method:** Biomass dynamic model (SPiCT-Stochastic Production model in Continuous Time).

5. **Consistency:**
    - The model configuration is different from the 2011 benchmark, though the new model fits the stock better.
    - This model is the same as that used in the 2018 assessment.

6. **Stock Status:**
    - SSB is estimated to have been increasing between 2005 and 2018 and began to decline in 2018.
    - The 2018 catch was 421.7 t, ~17.5% below the TAC of 511 t .

7. **Management and Biological Reference Points:**
    - No management plan has currently been established for Celtic Sea plaice.
    - TAC for 2019 is 1662 t where the TAC for 2018 was 511 t.
    - There was no early closure of the fishery in 2018.
    - The uncertainty cap was not applied.
    - Current BRPs:
        - B/B_{MSY} = 1.586
        - F/F_{MSYS} = 0.276

8. **General Comments:**
    - The WG report is well written and follows the stock annex.
    - The RG would like to know if there are environmental varibles influencing the stocks.
    - Much of the report may need to be updated slightly to newer years and data. These include the input data, survey data, and the assessment diagnostics.
    - More solid reference point interpretations and rational in the report may be helpful. Currently most presented information from the report is not discussed in depth.
    - The RG suggests the WG discuss the robustness of the currently used model with more detailed interpretation of diagnostics.

9. Technical Comments:

- Units are needed on the TAC tables.
- The assessment table shows data being used up to 2017, but it is not clear if more recent data were used in the assessment.
- Many figures need edits:
    - Figure captions or descriptions are needed.
    - Figure 28.4 title needs edits
    - Figure 28.7 is small and hard to read, and the legend does not match the figures.
    - Figure 28.10 is small and hard to read, and the legend does not match the figures.
    - Figure 28.11 legend does not match the figure.
    - Figures 28.10 and 28.11 are not clear.
    - Figures 28.8 and 28.9 are missing.

10. Conclusions:

- The assessment of Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea) seems to follow the annex well. The RG suggests this report accepted with caveats.
- The environmental vulnerability of this species remains unclear.
- The RG would like to suggest the WG provide more detailed introduction to the input data and interpretations of assessment diagnostics. Many figures and tables attached to the report were not discussed in depth.

Plaice (*Pleuronectes platessa*) in divisions 7h–k (Celtic Sea South, southwest of Ireland)

1. **Assessment Type:** Update

2. **Assessment:** Accept with caveats

3. **Forecast:** No forecast was carried out.

4. **Assessment Method:** XSA (Category: 3.2.0)

5. **Consistency:**
   - Estimation methodology for MSY reference points changed in 2017, from a data-limited approach to WKMSYREF4.

6. **Stock Status:**
   - SSB increased from 60 t in 2018 to 109 t in 2019 but was below B_{lim} and B_{pa}. F bar was 0.68 in 2018 and was above F_{MSY} and F_{pa}.
   - Total landings of plaice in divisions 7h-k have been declining with fluctuations since 1993 and were 95 t in 2018.
   - Discarding is significant but has not been quantified.
   - Landings of young fish show a decreasing trend, but it is unclear whether this decrease is due to increased discarding or poor recruitment.
   - Recruitment dramatically declined since 1993 but increased from 26,000 in 2018 to 216,000 in 2019.

7. **Management and Biological Reference Points:**
   - Plaice in divisions 7h-k are managed by the TAC system.
   - TAC set for 2019:

Species:	Plaice *Pleuronectes platessa*	Zone:	7h, 7j and 7k (PLE/7HJK.)
Belgium	7 [1]		
France	14 [1]		
Ireland	47 [1]		
The Netherlands	27 [1]		
United Kingdom	14 [1]		
Union	109 [1]		
TAC	109 [1]		Precautionary TAC Article 8 of this Regulation applies Article 13(1) of this Regulation applies

[1] Exclusively for by-catches of plaice in fisheries for other species. No directed fisheries for plaice are permitted under this quota.

   - ICES advises that when the precautionary approach is applied, there should be zero catches in 2019.
   - BRPs were derived in 2017:

FRAMEWORK	REFERENCE POINT	VALUE	TECHNICAL BASIS
MSY approach	MSY $B_{trigger}$	282	B_{pa}
	F_{MSY}	0.289	Median point estimates of Eqsim with segmented regression S–R relationship
Precautionary approach	B_{lim}	203	Break point segmented regression S–R relationship
	B_{pa}	282	B_{lim} x esp(1.645 x σ); σ = 0.20
	F_{lim}	0.471	F with 50% probability of SSB < B_{lim}
	F_{pa}	0.339	F_{lim} x exp(-1.645 x σ); σ = 0.20
Management plan	SSB_{mgt}	Not applicable	
	F_{mgt}	Not applicable	

8. General Comments:

- The WG report is well written overall. The data and uncertainty issues are discussed well. Recommendations made by the WG on the future benchmark and management can make an impact on the stock. However, the RG noticed that most of the report seems to be the report from 2018 and the assessment results are presented without a detailed explanation of stock status in the text. The RG encourages the WG to update stock status based on assessment results.
- Although the retrospective analysis was conducted and presented in the assessment report, the methodology was not explicitly mentioned in either the annex or the assessment report. The RG suggests the methodology of retrospective analysis should be at least briefly mentioned in the annex, including the justifications of number of peeling years, specific formulation of Mohn’s Rho, and criteria for if the relative quantities (e.g., SSB) should be adjusted based on the outcome of retrospective analysis. Both Mohn’s Rho values of SSB and recruitment appear higher than the threshold of 20% imposed by ICES for 2019 assessment. However, the WG did not discuss how to deal with the bias.
- As the discard of the stock is significant and it is not included in the present assessment, the RG suggests that more exploratory assessment runs should be performed to investigate the uncertainty (e.g., sensitivity analysis with different discarding scenarios given the currently available data). It is also worthwhile to explore an alternative model that is less sensitive to catch data, such as ASAP, in the future assessment.
- Both the management plan and HCR for the stock are not clear. The RG recommends this section have a more detailed description (not just the tables).
- The stock annex has not been updated since 2014 and is not consistent with the current report. The RG recommends updating of the annex, even in the absence of a benchmark. More details of survey designs for the commercial tuning index should also be included in the annex.
- The RG appreciates the WG’s extensive efforts in checking the sensitivity of the tuning index with respect to spatial stratification of fishing efforts. As the WG mentioned, the precision of stratified estimates was relatively low and needed

improvement in the future benchmark. The RG agrees that more sophisticated modelling approach and structured sensitivity analysis should be performed in the future.

- As the stock-recruitment relationship is not clearly defined, recruitment may be strongly influenced by environmental factors and stock mixing. The RG suggests that it is worthwhile to explore the relationship between recruitment and the environmental factors, as well as the interaction with plaice in division 7e.
- Natural mortality is assumed to be fixed and 0.12 for all ages. The RG suggests adding more biological clarifications to justify the choice of the fixed natural mortality, coupled with a structured sensitivity analysis to evaluate impacts of uncertainty in natural mortality.
- The RG agrees with the WG's suggestion regarding the use of new datasets from Irish surveys as an updated tuning index. However, the RG suggests the consistency of survey designs should be carefully considered in the future assessment. The current assessment is primarily on the stock in divisions 7j and 7k, which is unrepresentative of the whole stock area (7h-k). The RG agrees to use age-structured data in 7h for the future benchmark.

9. Technical Comments:

- The pdf link for ICES advice applicable to 2019 is unavailable and needs to be updated.
- "*This distance would suggest that 7.h stock may constitute a spate stock, and may be a continuation of the plaice caught in the western English Channel (7.e).*" The "spate stock" seems to be a typo and needs to be corrected.
- "*With plaice forming only a small component (<5%) of the overall landings per trip (Figure 27.1)*" Figure 27.1 does not support the statement and needs to be updated.
- The WG should provide the unit for both TAC tables for 2018 and 2019.
- "*Irish Beam Trawl Ecosystem Survey (IBES)*" There are two forms of abbreviation: IBES and IBTS. Please make sure they are consistent throughout the report.
- "*A summary of relative trends in landings, recruitment, SSB and F is given in Table 27.10 and Figure 27.7*". It should be "recruits" instead of "recruitment". Table 27.10 is missing. Figure 27.7 does not provide any trend information.
- "*Details on this evaluation can be found in the working document in appendix xxx*" Please specify the appendix.
- "*From this Blim was estimated to be 203.57 (Blim <- median(fit$sr.sto$b.b)) and a Bpa at 282.88 (Bpa <- Bpa(Blim, 0.2).*" Please provide the unit of Blim and Bpa.
- "*Figures 7.11.12 and 7.11.13 summarise the MSY evaluation.*". These two figures are missing.
- "*The apparent reduction in SSB in 2015 is mainly driven by a reduction in relative abundance of young fish in recent years, there is a slight increase in 2016, but is*

again showing a downward trend in 2018" No evidence is provided with this statement. The RG encourages the WG to present supporting data and materials to justify the statement.

- "*It is unclear, whether this lack of young fish in the landings (and commercial tun-ing lpue index) is due to increased discarding or poor recruitment (Table 27.1).*" Table 27.1 does not present the landings of young fish. Please update it and ensure consistency between the text and the table.
- "*Because plaice are caught in spatially distinct areas, restricting effort in these areas will be more effective than limiting landings.*" The RG is not clear how the effort restriction is more effective than landings regulations. Please justify this statement.
- " *It is likely that the plaice from Division 7.h are part of the divisions 7.e or 7.fg stocks.*" Please provide supporting references.
- Tables and Figures need to be listed in descending order according to their number.
- Table 27.5 - The ages and years used in the assessment are not marked in bold.
- Table 27.7 – It should be "recruit" instead of "recruitment" in the table caption. Blanks cells need to be filled with NAs.
- Figure 27.1.a and Figure 27.1.b should be Figure 27.1 and Figure 27.2 respectively. Figure 27.1.b needs to be updated with landings in 2018 and 2019. Please consider adding a figure of landing trends in divisions 7.h and 7.k.
- Figure 27.4 – The size of bubbles needs to be clarified in the figure caption.
- Figure 27.7- The legend is not complete.
- Figure 27.11 – The WG needs to provide the unit of y-axis. A legend of lines is also missing.
- Figure 27.12 and Figure 27.13 - X-axis needs to be labeled. The unit of y-axis is not provided. The caption is not clear, e.g., does b represent SSB or biomass?

10. Conclusions:

- In general, the WG report is well written. Data and data issues are well documented and stated. However, the retrospective analysis shows large systematic bias and was not explicitly discussed by the WG. The RG suggests adding a correction. More exploratory assessment runs need to be conducted to investigate uncertainties, especially in discards, natural mortality, and stock-recruitment relationship.
- The current assessment is primarily on the stock in divisions 7j and 7k, which is considered unrepresentative of the whole stock area (7h-k). As age-structured data became available for 7h, the RG recommends adding quantified analysis to illustrate the uncertainty.
- A detailed explanation of stock status and management plan is lacking. The RG suggests including more discussion of stock status based on the current assessment and clarifying management plan for the stock.

- The RG suggests assessment of plaice in divisions 7h-k to be accepted as long as the above concerns are addressed.

pol.27.67. Pollack (*Pollachius pollachius*) in subareas 6–7 (Celtic Seas and the English Channel or West of Scotland)

1. **Assessment Type:** Update (category 4 stock, no benchmark)

2. **Assessment:** Accept with caveats

3. **Forecast:** N/A

4. **Assessment Method:**
    - Depletion-Corrected Average Catch (DCAC) method was used.

5. **Consistency:**
    - The method was applied during WGCSE 2019 with the same model settings as applied the previous year's assessment
    - Subarea 6 and 7 are run independently.
    - Discarding is negligible.
    - Recreational catch is unknown and therefore cannot be estimated or incorporated into the assessment. In 2018, the recreational catches may be similar to or above commercial landings.
    - A model test is constructed in the WG report which highlights that the DCAC model will not take any account of the state of the stock.
    - The results are consistent with the range of DCAC values estimated when the method was previously applied.

6. **Stock Status:**
    - Stock status is unknown due to the lack of reliable data.
    - Commercial catches have declined since the late 1980's, and in 2018 is the lowest in the time-series.

7. **Management and Biological Reference Points:**
    - The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters. This plan applies to demersal stocks including Pollack in ICES subareas 6 and 7.
    - ICES advices that when the precautionary approach is applied, commercial catches should not exceed 3360 tonnes in 2020.
    - The WG suggests that yield in subarea 6 could be increased up to 148 tonnes and 4010 tonnes in subarea 7.

8. General Comments:

- The WG report is well written. The data and data issues are well documented and discussed at length.
- The RG suggests that a stock annex for pol.27.67 should be developed.
- The stock in the WG report relates to a species in a water region where data are available. The stock structure of Pollack populations in this eco-region is not clear. The RG suggests that further work is required for identifying a management unit.
- The use of DCAC is not recommended if M is greater than 0.2, above which the depletion correction becomes small. Natural mortality is fixed at M = 0.2 with a standard deviation of 0.4 in the WG report. The RG suggests adding more biological clarification to justify the choice of natural mortality.
- The result from the model tests highlights that the DCAC model will not take any account of the state of the stock. The RG suggests that the purpose, assumption, and the process for testing the uncertainties should be shown more in detail.

9. Technical Comments:

- There is no scientific term for the species and the format of the species name is not uniform in the report. The RG suggests providing the scientific term and unifying the format of species name.
- No caption for the first figure in the report. The RG suggests providing the figure title or change the figure into a table with a title.
- Section 28.1-Fishery in 2018- *Landings by division*-“In subarea 7, the division with the highest proportion of landings derived from 7.e (40%) followed by 7.j (27%), 7.h (13%) and 7.f (9%). Landings in divisions 7.a, b, c, d, g and h were negligible (8.9%)”. There are two 7.h. One of them may be 7.k. The RG suggests to make sure which 7.k is.
- The RG suggests discarding from subarea 6 and 7 should be estimated independently. The total estimated discarding is at 19.9 tonnes in 2018. It might not be a small part of the landings for subarea 6.
- The RG suggests using the three-line forms for the table in WG report.
- The RG suggests providing the meanings of the parameters in table 28.3 and 28.4 and explain the basis for setting these parameters
- The text use “tonnes”, as a unit label, while in figure 28.1 uses “1000 tons”. Keep the unit label consistent and use “tons” as the unit.
- In Table 28.1, 28.2, 28.3, 28.4, Unit label of the landings should be provided.

10. Conclusions:

- In general, the WG report is well written and organized. The data and data issues are well documented and discussed at length.

- The results are consistent with the range of DCAC values estimated when the method was previously applied. The RG recommends this stock assessment to be accepted.
- As the WG noted, the model cannot estimate reference points and it continues to be the reference model for the pollack assessment in the coming year. The RG suggests that the recreational fishery should be monitored and agrees that future assessments should consider exploring new models.

Sole (Solea solea) in Division 7.a (Irish Sea)

1. **Assessment Type:** Update

2. **Assessment:** Accept with caveats

3. **Forecast:**
   - Short term projection - Carried out by an age structured deterministic projection. The geometric mean is assumed for age 2 in the short-term forecast. The procedure for setting the fishing mortality is to take the mean over the last three years, without rescaling.
   - Medium-term projection – Carried out by an age structured model, using IFAP single option prediction software.
   - Long-term projection – Carried out by an age structured deterministic projection, using MFYPR software. The inputs for the long-term projections are the same as for the short-term projection.

4. **Assessment Model:** Extended Survivor Analysis (XSA) was used.

5. **Consistency:**
   - The model configuration is the same as the 2018 assessment, but since the last benchmark (2010) these have been some changes, as follows: the time interval of the UK Sept BTS was changed to reflect the actual period for the 2019 survey, the UK Mar BTS was omitted in the 2019 survey, the time ser. Wts in the 2019 benchmark have been changed to no taper weighting, and the Q plateau has been changed from 7 to 4.
   - Fishing mortality, SSB and recruitment displayed trends that were very similar. In last year's assessment, F and SSB for 2017 were estimated to be 0.0188 and 1941 t respectively; this year's estimates for 2017 are 0.0193 and 1891 tonnes.
   - This year's model output suggested a downward revision of the historical trends for SSB, and an upward revision of F and recruitment.
   - A TAC constraint was recommended for 2019 as SSB rose above B_{lim}. As the stock is projected to slowly recover but remain close to B_{lim} in 2020, there is a further increase in non-zero catch advice for the year 2020.

6. **Stock Status:**
   - The current SSB is below B_{pa} that is set at 3500 tonnes. SSB has increased from 883 tonnes in 2014 to 3079 tonnes in 2019. The SSB is predicted to be 3204 tonnes in 2020, when F = 0.138.
   - Since the 1980s, F has been declining and in 2018, F was close to 0, at 0.0138. F_{lim} for 2020 = 0.29.
   - Total catch in 2018 was 38 tonnes while the TAC was 40 tonnes.

- Catches have steadily decreased since the late-1980s.
- SSB peaked in the mid-1980s and was well below B_{lim} between 2004 and 2017.
- Since 1970, recruitment was at an all-time low during 2011-2014. Since then, recruitment has increased above recent average at 3670 tonnes in 2018.

7. Management and Biological Reference Points

- Biological reference points were re-evaluated in 2015.
- B_{lim} and B_{pa} have increased from 2200 t to 2500 t and 3100 t to 3500 t respectively. B_{pa} was decided by using the lowest value with above-average recruitment. B_{lim} was calculated by taking the approximate B_{pa} value and multiplying it by 1.4.
- F_{pa} and F_{lim} have decreased from 0.3 to 0.21 and from 0.4 to 0.29 respectively.
- Catches in 2020 should be no more than 558 tonnes.
- No minimum landings size has been defined.
- MSY advice is currently based upon stochastic simulations with a segmented regression stock-recruitment relationship, while $B_{trigger}$ is considered as equivalent to B_{pa}.
- Current biological reference points;
  - B_{lim} = 2500 tonnes
  - B_{pa} = 3500 tonnes
  - F_{lim} = 0.29
  - F_{pa} = 0.21
  - F_{max} = NA
  - $F_{0.1}$ = NA
  - F_{MSY} = 0.20
  - F_{MSY} lower = 0.16
  - F_{MSY} upper = 0.24
  - MSY $B_{trigger}$ = 3500 tonnes

8. General Comments:

- The report is well written and follows the stock annex. The data and data issues are documented clearly and discussed at length. The tables provided were labeled clearly and were easy to read. The WG also did a great job on providing the necessary information while also keeping the report concise.
- The RG supports the WG in their recommendation to study how environmental changes are impacting the distribution of sole. The RG suggests that the WG incorporate environmental variables into the estimation of the survey abundance index.
- The RG suggests that the WG conduct a sensitivity analysis on the discards data and assuming different discard rates so that the WG can compare and interpret the results of the comparisons.
- A limitation with using this assessment is that the prediction ability may not always the best (Sole-bisc review report from 2018). The RG suggests that the WG try different

settings or parameters and to cross-validate to find the scenario that produces the best prediction output of the model.

● The WG noted that different effort unit results were used in different trends of LPUE. The RG is wondering if both units were tried, and what the comparison of the results would look like.

● The WG could provide more insight into the sources of uncertainty relating to this stock, such as how natural mortality was assumed to be constant even though there are no estimates of natural mortality to provide data, as mentioned in section B.2 of the stock annex. Another source of uncertainty that could be elaborated on are the low sampling level and sample size of sole in recent years and how that could be altering the results of the assessment. The WG could conduct a few more exploratory runs to address the issues regarding any uncertainties. On that note, the WG mentioned that in recent years, both sampling level and sampling size have been low. The RG suggests that the WG conduct a simulation study to test whether the low sample sizes would accurately reflect the size distribution and age structure of sole, as imprecise data could affect the assessment results. In addition, the WG could conduct a sensitivity analysis considering these uncertainties of input data. The WG also noted that there were particularly low sampling levels in the first quarter. The RG suggests that the WG consider using different weights from different quarters.

● Though a five-year retrospective analysis was performed, which concluded the assessment to have a high consistency, the RG suggests conducting a longer retrospective analysis to better cover the lifespan of sole.

9. Technical Comments:

● The WG should write out "Extended Survivor Analysis" before writing "(XSA)", at least for the first time the model type is mentioned.

● The description of Figure 1 does not mention the Catches graph.

● It would help clarify if the F_{lim}, F_{pa}, and F_{MSY} reference points on the Fishing Mortality graph, as well as the B_{lim}, B_{pa}, and MSY $B_{trigger}$ reference points on the SSB graph in Figure 1 had their corresponding reference point numbers next to the labels in the legends of the graphs. Also make sure the appropriate letters are subscripted on the legend I Figure 1. For example: "F_{MSY}" instead of "FMSY".

● Section B-2-"*Males and females of this stock are strongly dimorphic, with males showing much reduced rates of growth after reaching maturity, whilst females continue to grow. Given the minimum landing size of 24 cm the majority of landings represent mature females*." The RG suggest that the WG provide references to support this statement.

● The RG suggests making Table 1 larger, if possible so that it is easier to read.

● Figure 2 needs axis labels on graphs. The SSB and Fishing mortality graphs in Figure 2 need legends that provide labels for F_{lim}, B_{lim}, F_{pa}, B_{pa}, F_{MSY}, and MSY $B_{trigger}$.

● *"The assessment has shown consistency over the recent years in estimating SSB, fishing mortality, and recruitment. Discards are currently not included in the assessment, but given the low discard rates of sole (3.5% in 2016–2018) it is unlikely that the inclusion of discards would change the perception of the stock."* No comma is needed between "assessment" & "but".

● *"The stock is slowly recovering and is projected to remain close to* B_{lim} *in 2020 and 2021, and may fall below* B_{lim} *if recruitment is below average"* No comma is needed between "2021" & "and".

● At the bottom of table 7, some cells were left blank. It would be helpful to either mark them as 0, N/A, No data, or with any other appropriate entry, as blank cells could become confusing to the audience. It is recommended no cells be left blank in any table.

● The RG found the note at the bottom of table 10 "GM(2009-2017)" to be unclear. The RG suggests that the WG define what "GM" stands for.

● In the stock annex, it was stated *"For 2009 Council Regulation (EC) N°43/2009 allocates different amounts of kW*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The areas are Kattegat, part of IIIa not covered by Skaggerak and Kattegat, ICES zone IV…"* The RG suggests the WG provide a map of the coverage of Kattegat, Skaggerak, ICES zone IV, etc.

● *Figure 29.4a:* It would be helpful to describe the effort that was used to represent the graph, perhaps in a description of the figure.

● *Figure 29.6:* Explain legend on the right (2-7 represent age?). Also, "Standardised" in figure title is spelt incorrectly.

● *Figure 29.9:* Need y axis labels, no underscores in titles of graphs.

● *Figure 29.10:* Needs axis labels, could add separate x axis to each graph to make clearer.

● *Figure 29.11:* Graphs need axis labels with units on all.

● *Figure 29.12:* Percentages do not sum to 100.

● *Table 29.3:* "Length" is misspelled in title.

10. Conclusions:

● The assessment of Sole in division 7.a appears well done and indicates no large retrospective errors. Sources of uncertainty could be discussed in greater detail. Minor formatting and grammar errors should be revised. The RG suggests sole in division 7.a to be accepted if the following concerns are addressed: a) different parameter settings are tried and cross validated to ensure that the best prediction scenario of the model is being used; b) a simulation study be conducted to test whether the low sample sizes would accurately reflect the size distribution and age structure of sole.

Sole (*Solea solea*) in Division 7.e (Western English Channel)

1. **Assessment Type:** Update

2. **Assessment:** Accepted

3. **Forecast:**
   - Short-term projection – performed in the XSA forecast based on MSY approach for 2019 - 2021.The SSB was estimated to be 4756 tonnes in 2019, 4731 tonnes in 2020, and 4334 tonnes in 2021.The landings was estimated to be 1216 tonnes in 2019, 1469 tonnes in 2020, and 1349 tonnes in 2021.
   - Mid-term projection: N/A
   - Long-term projection: N/A

4. **Assessment Method:** Extended Survivors Analysis (XSA)

5. **Consistency:**
   - The last benchmark assessment was in 2012 and the assessment was inter-benchmarked in 2015 for examining the impact of excluding UK Wester Channel beam trawl survey data and revising the model setting to increase the robustness of the assessment.
   - Seasonal onshore-offshore spawning migrations were briefly mentioned in the stock annex; however, spawning season as well as fishery seasonality were not clear in the stock annex. The RG expects to see more information regarding life history of sole in 7.e and their relation to fishery.
   - There appeared to be changes in fishing patterns in recent years where the fishery opted for smaller and more flexible vessels which allow fishermen to exploit other species in this Division. The RG suggests the changes in fishing patterns in recent years and the impact of that on sole stock should be evaluated.
   - A new management plan, EU multiannual plan (MAP), is implemented in 2019. And the landing obligation also fully applies in 2019. The RG suggests the stock annex should be updated regarding the recent changes in fishery management.
   - The maturity ogive used for this sole stock was a maturity ogive from area 7.f and 7.g estimated in 1997. The RG would like to see more information on maturity as different stocks may present different life history traits. It might not be appropriate to use the maturity ogive from other stocks estimated two decades ago, although it is not an urgent concern as the sole stock in this division seems to have been in healthy status.
   - The methodology of how effort, lpue, and cpue were standardized seemed to be missing from the stock annex and the assessment report. The RG suggests it should be added to the documents.

6. Stock Status:

- MSY $B_{trigger}$ = B_{pa} = MAP $B_{trigger}$ = MAP B_{pa} = 2900 tonnes.
- B_{lim} = MAP B_{lim} = 2000 tonnes
- F_{MSY} = 0.29; F_{pa} = 0.32; F_{lim} = 0.44
- MAP range F_{lower} = 0.16, MAP range F_{upper} = 0.34
- SSB has been increasing since 2009 and is currently well above MSY $B_{trigger}$
- Recruitment variability has decreased since 1991, and has been at or above the long term geometric mean in the last four years.
- Fishing mortality has remained low since 2009 and stayed at around 0.2-0.25. Fishing mortality was estimated to be well below all reference points.

7. Management and Biological Reference Points:

- The EU landing obligation which aims to reduce unwanted catches fully applies to sole in Division 7.e in 2019. However, given the low discards observed in the fishery, this management plan is not expected to have a considerable impact on this sole stock.
- A new management plan (EU multiannual plan) is implemented in 2019. This management plan imposes the effort restrictions on the number of days at sea for certain vessels.

8. General Comments:

- The WG report is well written and followed by the Terms of References. The input data sources were clearly provided and most data issues were also discussed in the stock annex and the assessment report.
- The assessment model was tuned with two survey indices (UK-FSP and Q1SWBeam) and lpue time series from two commercial fleets (UK-CBT and UK-COT). However, the UK-COT effort had been in continual decline since 1970s and zero effort and landings were reported since 2016, a result of the shift to smaller fishing vessels. Although a new data base has been used since 2017, the new data were not consistent with historical data. The RG suggests the effects of changing commercial fishing vessel sizes should be further examined and taken into account into the assessment. Furthermore, the impact of the loss of information derived from UK-COT which seemed to provide a good independent time series from the main commercial catches should also be evaluated. The inconsistency for new data base also needs to be examined.
- The impact of fishing effort restriction implemented by the new EU multiannual plan should be evaluated and the consequent changes in fishing pattern should also be examined.
- The RG would like to see further discussion on residuals diagnosis regarding model fitting.

- The RG agrees that assessment parameterization may need to be re-evaluated in the future when the tuning time series get longer.

9. Technical Comments

- Table 31.6 has some numbers that seem to be skewed in relation to the table and where they are supposed to be. Perhaps a revision of the table format is necessary.
- Figure 31.20.What is WG year?
- Figure 31.21.What is fshk? Was it mentioned in the assessment report? The tick labels on x-axis were not clear.
- Figure 31.22. The RG suggests the time series in the figures should be standardized to help visualize the deviation from the full model.
- Figure 31.24. What is STF?
- Figure A2.1 in stock annex. The x-axis is not clear.

10. Conclusions

- The assessment for sole in Division 7.e appears well done with the revised XSA model.
- The major issues of the input data had been discussed in the stock annex, however the impact of the loss of information from UK-COT may need to be further evaluated.
- The WG may need to examine the impact of changes in fishing pattern on sole and the consequences resulted from the new management plan, and take these into account for the assessment.

Sole in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)

1. **Assessment type:** updated; next benchmark 2020

2. **Assessment:** Accepted with caveats

3. **Forecast:**
   - Short-term: prediction of SSB in 2020~2021 given certain catches in 2019 and 2020
     - (2019catch: 841t, 2020catch: 1236t; 2020SSB: 5366t, 2021SSB: 5459t)
   - Medium-term: no
   - Long-term: no

4. **Assessment Method:**
   - XSA (Extended Survivors Analysis)
   - Main model configurations:
     - SSB-R relationship: Segmented regression
     - b.2. Natural mortality: the natural mortality was assumed to be 0.1 for sole of all the ages in all the assessment years.
     - b.3. The maturity ogive is based on samples taken during the UK(E&W) beam trawl survey of March 1993 and 1994
   - Input data sources:
     - c.1. Survey data from UK
     - c.2 Commercial fishery data from UK and Belgium

5. **Consistency:**
   - The Mohn's rho values (SSB:0.071; F:-0.05; Recruitment:0.105) for the assessment model are low and well below the threshold of 20%.
   - The internal consistency plots for the commercial LPUE series show high consistencies for the entire age range.
   - However, comparing with the last year's stock assessment results, there is a substantial increase in the SSB and a decrease in the F. This may be due to the change of the input data.

6. **Stock Status:**
   - In 2018, SSB and F were 3557 tons and 0.229, respectively. F was below Fpa and SSB was above Bpa.
   - Recruitment has fluctuated around 5 million recruits with occasional strong year classes.
   - SSB has declined almost continuously from the highest value of 7385 t in 1971 to the lowest observed in the time-series in 1998 (1592 t).

7. Management and Biological Reference Points:

- Reference points

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	2228 tonnes	B_{pa}
	F_{MSY}	0.297	EQsim analysis based on the recruitment period 1971–2017
Precautionary approach	B_{lim}	1592 tonnes	B_{loss} estimated in 2018, corresponding to SSB in 1998
	B_{pa}	2228 tonnes	$B_{lim} \times 1.4$
	F_{lim}	0.587	EQsim analysis, based on the recruitment period 1971–2017
	F_{pa}	0.420	$F_{lim} \times \exp(-1.645 \times 0.2) \approx F_{lim} / 1.4$
Management plan*	MAP MSY $B_{trigger}$	2228 tonnes	MSY $B_{trigger}$
	MAP B_{pa}	2228 tonnes	B_{pa}
	MAP B_{lim}	1592tonnes	B_{lim}
	MAP F_{MSY}	0.297	F_{MSY}
	MAP range F_{lower}	0.165-0.297	Consistent with ranges provided by ICES (2019a), resulting in no more than 5% reduction in long-term yield compared with MSY
	MAP range F_{upper}	0.379-0.499	Consistent with ranges provided by ICES (2019a), resulting in no more than 5% reduction in long-term yield compared with MSY

- Celtic Sea sole has been managed by TAC since 1983
- Technical measures including minimum landing size and minimum mesh sizes
- Temporal closures

8. **General Comments:**
   - The average discard rate for 2016-2018 is 8.9%, while the discard rate for 2018 is 14.8%. We recommend considering discard in the stock assessment model as it becomes a relatively important component of the total catch.
   - The natural mortality was assumed to be 0.1 for sole of all the ages in all the years. This strong assumption needs more justification or the consequences of violation of the assumption need to be understood by conducting sensitivity analysis.
   - Please justify the reason for not including some available data (e.g., abundance indices of the Irish ground-fish survey) in the model.
   - The RG appreciates that the WG tuned the abundance index from the commercial fishery with the factor of engine power. The RG believes that the quality of the abundance index data could be further improved by conducting an LPUE standardization analysis which is aimed to exclude impacts on nominal LPUE other than stock abundance.
   - The uncertainty of the estimates of the biomass and recruitments should be quantified.
   - The RG agrees that alternative models (e.g., ASAP, SAM) should be explored in the next benchmark stock assessment.
   - It will be great to provide the justification of the precautionary approach and the reference points setting as well as the clear description of the harvest control rule.

9. **Technical Comments:**
   - "the proportional contributions of recent year classes to the predicted landings and SSB are given in Figure 36.15. The assumed GM recruitment accounts for about 2.3% of the landings in 2020 and about 11.3% of the 2021 SSB." The description is not consistent with Figure 36.15. Specifically, the percentage 11.3% is higher than the data shown in the figure.
   - Figure captions are missing

10. **Conclusions:**
   - The assessment of Sole in divisions 7.f and 7.g is well organized. In this year's update stock assessment, the stock is assessed using an XSA model, which is one version of virtual population analysis.
   - The RG suggested conducting LPUE standardization analysis to improve the reliability of the fishery dependent data. The consequence of ignoring the discard or other observation errors associated with the catch data should be understood.
   - The RG agrees that alternative models (e.g., ASAP, SAM) should be explored in the next benchmark stock assessment.
   - It will be great to provide the justification of the precautionary approach and the reference points setting as well as the clear description of the harvest control rule.

Sole (*Solea solea*) in Division 7.h-k (Celtic Sea South, southwest of Ireland)

1. **Assessment Type:** Update
   - Last benchmark: unknown

2. **Assessment:** Accepted with Caveats

3. **Forecast:**
   - Short-term projections: N/A
   - Mid-term projections: N/A
   - Long term projections: N/A

4. **Assessment Method:** Extended Survivors Analysis (XSA)
   - Follows the Annex
   - Commercial landings data
   - Survey data starting in 2016
   - Annex says survey may not even be representative because of highly variable catchability of sole with gear type.

5. **Consistency:**
   - It is unclear when the last benchmark assessment was. It is known that this stock is scheduled to be benchmarked in 2020.
   - The information provided in the annex was incomplete and considerable errors were found (e.g. the caption of the first figure stated it was a map for Plaice international landings). The RG suggests the WG to considerably update the annex for the coming benchmark assessment.

6. **Stock Status:**
   - SSB declined from 800 tonnes to 400 tonnes 2000-2009, but has recovered to 800 tonnes again in recent years, only to drop to 425 tonnes.
   - MSY Btrigger = Bpa = 590 tonnes.
   - B_{lim} = 425 tonnes
   - $F_{MSY} = F_{pa} = 0.161$; $F_{lim} = 0.222$
   - Current SSB is 460 tonnes.
   - Current F is 0.111.

7. **Management and Biological Reference Points:**
   - The EU landing obligation. However, given the low discards observed in the fishery, this management plan is not expected to have a considerable impact on this sole stock in these areas.

- A new management plan (EU multiannual plan) is implemented in 2019. This management plan imposes the effort restrictions on the number of days at sea for certain vessels.
- MSY Btrigger = Bpa = 590 tonnes.
- B_{lim} = 425 tonnes
- F_{MSY} = F_{pa} = 0.161; F_{lim} = 0.222

8. General Comments:

- Considering there is no clear stock-recruitment relationship and given the fact that the recruitment has been declining in recent years and drops to a record low level last year, which could be a sign of stock collapsing, the RG suggests the biological reference points (BRPs) should be determined more conservatively. The RG suggests two alternatives: (1) consider B_{loss} (the lowest SSB where large recruitment was observed) as a B_{lim} candidate. This BRP is usually adopted for stocks which do not have a clear S-R relationship with occasional large year classes observed. (2) consider B_{loss} (the biomass corresponding to the lowest observed SSB) as a B_{lim} candidate. This BRP is usually adopted for stocks without apparent S-R signal. Either of these two BRPs would be more conservative than the B_{lim} adopted in the current assessment. The RG suggests that B_{lim} should be taken with extra caution as the F_{lim}, B_{pa}, and F_{pa} are all estimated from B_{lim}.
- The WG stated that restricting effort will be more effective than limiting landings as sole in these areas are caught in spatially distinct waters. The RG would like to see more discussion on the expected effects of the new management plan (EU multiannual plan) which imposes the effort restrictions on the number of days at sea for certain vessels for sole stocks in these areas.
- The maturity ogive used for this sole stock seemed to be estimated over two decades ago from other stocks. The RG suggests the maturity ogive needs to be further investigated as different stocks may have different reproductive traits. Furthermore, the declining weight-at-age of older fish (Fig. 33.5) might also have an impact on age-at-maturity.

9. Technical Comments:

- Many of the table numbers and Figure numbers were not matched with those in the text.
- What are Irish OTB vessels?
- The WGCSE report section 37.7 has duplicate sentence errors.
- Figure 33.2. It is unclear what are the labels and units on x-axes and y-axes of these figures. The values in the graph also need to be explained.
- Figure 33.8. Please provide (Pearson’s?) correlation coefficients and p-values for each correlation.
- Figure 33.9. Please add legend and scale for black and white circles in this figure.

- Retrospective analysis did not seem to be conducted in this assessment. The output of retrospective analysis in section 37.3.2 appeared to be copied and pasted from other stock assessment report?
- Section 37.4. Please correct the appendix number of document for details on MSY evaluation.
- It is unclear why F_{cv} and F_{phi} used in the assessment were the same as those used for plaice in Division 7.e. Please add explanation.

10. Conclusions:

- The RG accepts this report under the following caveats:
    - The WG reevaluate all information, tables, and figures present in the report and annex to ensure that the information being presented is true for Sol.7.h-k and not information accidently copied from a different stock.
    - The above general and technical comments are addressed, with high attention given to general comments 1 and 2.

Whg.27.7a : Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea)

1. **Assessment Type:** Update (benchmarked in 2017，ICES 2017)

2. **Assessment:** Accepted with caveats

3. **Forecast:**
   - Short term projection - Using FLAssess.
   - No medium or long term was carried out.

4. **Assessment Method:** Age-Structured Assessment Program (ASAP) model was used of basis for advice (V3.0.17 NOAA Fisheries toolbox).

5. **Consistency:**
   - The assessment configuration is the same as the 2018. A full analytical assessment procedure was developed during WKIRSH 3 (ICES, 2017) using ASAP.
   - There is no new source of data used in this assessment compared to the previous assessment. An additional year of catch and survey data were included in 2018.
   - The majority of catches have been discarded for the last couple of decades. Despite increased sampling levels, discard information remains very imprecise. This has contributed to the highly fluctuating fishing pressure estimates in recent years.
   - The result of the update assessment is consistent with last year's assessment and indicates that fishing mortality has declined significantly, but the stock size remains extremely low.
   - This stock is now subject to the landings obligation by way of the Commission Delegated Regulation (EU) 2018/2034 compared to the previous assessment (2018). In 2019, the TAC was increased to 727 tonnes.
   - The 2019 assessment includes a retrospective analysis. The Mohn's rho values for this assessment are below the threshold of 20% imposed by ICES for 2019 assessments.

6. **Stock Status:**
   - Information from commercial data in recent years suggests that the present stock size is extremely low.
   - Total catch has increased from 703 tonnes in 2017 to 899 tonnes in 2018.
   - Landings have increased from 36 tonnes in 2017 to 46 tonnes in 2018, and reported discard levels appear stable in recent years (Figure 1).
   - SSB has been declining since the beginning of the time-series and has been well below B_{lim} since the mid-1990s.
   - Recruitment has been low since the early 1990s. Fishing pressure (F) has declined since 2015 but remains above F_{MSY} and F_{lim} in 2018.

7. Management and Biological Reference Points:

- No management plan has been agreed or proposed.
- The Whiting fishery is currently managed by TAC and technical measures
- Agreed TAC for 2019 was 727 tonnes (2018 was 80 tonnes)
- When the precautionary approach is applied, there should be zero catches in 2020.
- Discarding in the Nephrops fishery is the main management issue.
- Minimum conservation reference size (≥27 cm), whiting now mature well below this MCRS.
    - MSY $B_{trigger}$ = 16300t
    - F_{MSY} = 0.22
    - B_{lim} = 10000t
    - B_{pa} = 16300t
    - F_{lim} = 0.37
    - F_{pa} = 0.22
    - SSB_{MGT} = Not applicable
    - F_{MGT} = Not applicable

8. General Comments:

- The report is very systematic, and well written. This stock had a benchmark assessment in 2017 (ICES 2017) and the assessment follows the stock annex. The input fisheries data and data issues are generally well documented and discussed. The WG does a good job discussing the sources of uncertainty and as well as further discussion of data issues.
- The RG found that the majority of catches have been discarded for the past couple of decades and discards information remains very imprecise. This statistical bias of data will have influence on the stock assessment. The RG suggests considering of a sensitive analysis to evaluate the impact of a variety of mis-specifications in fishery data on stock assessment results.
- The RG noticed that there are five surveys monitoring the Whiting, but the RG noticed that the assessment only includes three surveys as input data. The RG suggests providing the reasons for excluding other surveys data in the assessment report or stock annex. For the survey index that does not have a good fit in the model, the RG suggests providing more explanations in the assessment.
- Regarding Figure 1, what maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort before? The RG recommends clarifying this question.
- The RG noted that M is fixed to be a constant rate of 0.2. However, the RG suggests adding more biological clarification to justify the choice of fixed M. In addition, the RG recommends (1) comparing the rate employed to the rates used for similar species in the same area or the same species in different areas, and (2) conducting a structured sensitivity

analysis to evaluate impacts of uncertainty in time-varying and age-varying M in the future assessments.

● The RG noticed that there is no explanation about model parameter steepness (h) in this stock assessment. Because the value of h may have a strong effect on the ASAP model outputs, The RG suggests clarifying the determination of the value.

●In this assessment, the WG conducted a retrospective analysis by removing 5 years of data. The RG suggests removing more years to cover the lifespan of the species for the retrospective analysis.

●The RG noticed that the report didn't include the comparison of the ASAP assessment and XSA run. The RG also suggests consideration of an XSA run with the ASAP run about uncertainty bounds comparison.

9. Technical Comments:

● "*The observed and predicted catches are shown in Figure 40.7. Fit to the overall catch is reasonably good. There is some deviation in the early to mid-1990's. This is most likely due to the introduction of the survey data into the assessment model.*" Although fit of the overall catch is reasonably good, there is a great discrepancy between observed and predicted catch in the early to mid-1990's (Figure 40.7). The RG suggests checking the settings for the early years and conducting diagnostics on this issue.

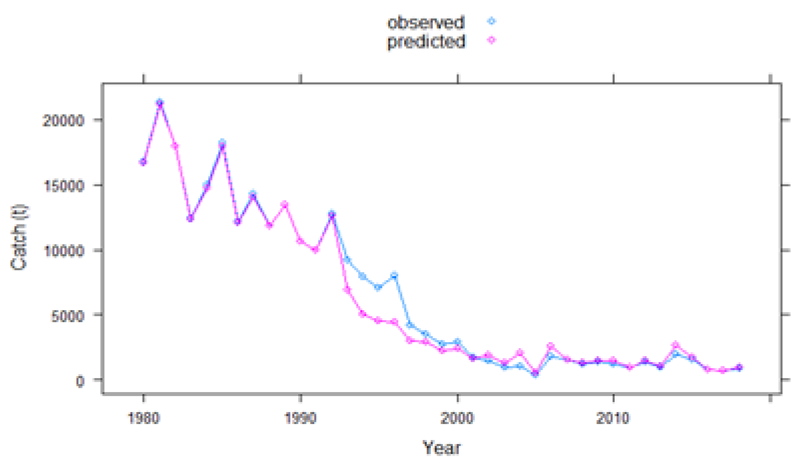


Figure 40.7 Whiting 7.a. Observed and Predicted Catches

● "*The observed and predicted index cpue values are shown in Figure 40.8. There is poor fit to the Northern Irish ground fish survey indices in the first half of the series but it improves in recent years.*" The RG noticed that there is a discrepancy between the Northern Irish ground fish survey indices Q1 and Q4 during 1980-2005 year (Figure 40.8), the RG suggests the WG to make various assumptions of the quality of the input data by testing different levels of CVs, as the RG could not find any discussion of this issue in the report.

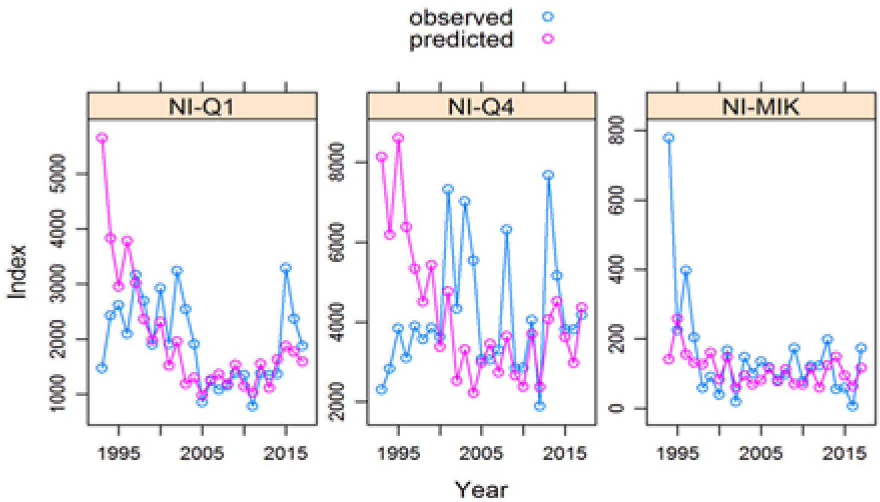


Figure 40.8 Whiting 7.a. Observed and Predicted index cpue

● *"Figure 40.9 shows the retrospective analysis. The predicted catch shows no obvious retrospective pattern, neither does the recruitment estimate. There is some deviation in the early part of the time series when the surveys were first introduced. However, recent estimates of SSB and F are consistent with no apparent bias."* The RG appreciates that a retrospective analysis was provided for this stock, and used Mohn's Rho to quantify the uncertainty for this retrospective analysis. However, the Mohn's rho values for SSB (0.129) and recruitment (0.29) are still high. So the RG suggests the WG to adjust the estimated stock status using the estimated Mohn's rho value.

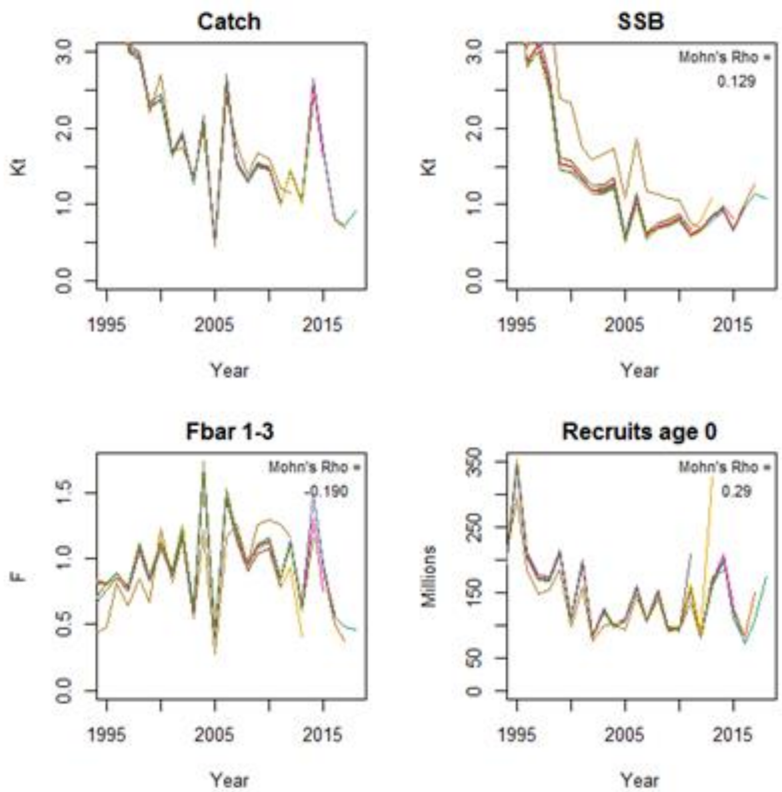


Figure 40.9 Whiting 7.a. Retrospective analysis of the final ASAP run with Mohn's Rho calculation.

●The RG also has the same question with the EG about ICES stock data category reference (ICES, 2018a).The link is correct but we don't know where the advice ended up in the end. The RG suggests please marking the page number or chapter in the Table 6.

● "Benchmarked" is misspelled in the whg.27.7a assessment report.

● Figure 40.8 The icon should be placed inside the chart.

● Figure 40.9 extra descriptions should be addressed for color code as there is no legend.

● Section 40.1- There is no caption on the map, and the coverage of the survey data should be provided.

10. Conclusions:

● The assessment of haddock in Whiting (*Merlangius merlangus*) in Division 7.a appears well done and follows the stock annex. The RG suggests the stock assessment to be accepted with caveats.

● The RG suggests conducting exploratory runs to investigate the sensitivities of the results to changes in fishery input data, natural mortality values, and model parameter steepness (h).

● The RG recommends providing information on maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges).

- For the retrospective analysis, the RG suggests removing more years of data that cover the lifespan of the species and check the retrospective patterns.

39 Whiting (*Merlanglus merlangus*) in divisions 7.b-c and 7.e-k *(Southern Celtic Seas and eastern English Channel)*

1. Assessment Type: Update

2. Assessment: Accepted

3. Forecast:

- Short term – Forecast for the next three years from 2017 (2018-2020); tuned with a single combined survey index.
- No medium or long term projections.

4. Assessment Method: Extended survivor analysis (XSA) with landings and discard data

5. Consistency:

- The model (XSA) used the same settings as last year's assessment, using a truncated time-series from 1999-2017.
- Overall, the model estimates are reasonably consistent for ages 1+ (given whiting stocks are prone to yearly effects in survey catches).
- The internal consistency of the surveys was examined using pairwise scatterplots of log numbers-at-age. The index is reasonably consistent for older ages (Ages 1-5).
- Cohort and year effects were examined with mean log standardized plots.
- In the past three years, F experienced generally upward revisions and SSB generally downward revisions.

6. Stock Status:

- Whiting is a category 1 stock with considerable data inputs on a yearly basis.
- Whiting is prone to year effects in survey catches. Recruitment is episodic. Strong recruitments occurred in 2009 and 2013. Overall, catches and SSB tend to fluctuate depending on year-class strength.
- Fishing mortality has increased since 2012 and is now assessed to be above Fmsy.
- In the current time-series, SSB displayed a peak biomass in 2012 (due to strong recruitment in 2009) and again in 2015.
- SSB is now estimated to be below Blim, the precautionary limits for this stock.
- Mean weight-at-age appears to have declined during the period of recent high fishing effort and landings between 2005-2008.
- Different gear types are used in this fishery, including trawl nets (mostly otter trawlers, also including bottom, beam, pelagic, and midwater trawls) and seines nets.
- Whiting stocks are some of the least limiting stocks for most fleets in Celtic Sea mixed fisheries. Still, discards are a prominent feature in this fishery.

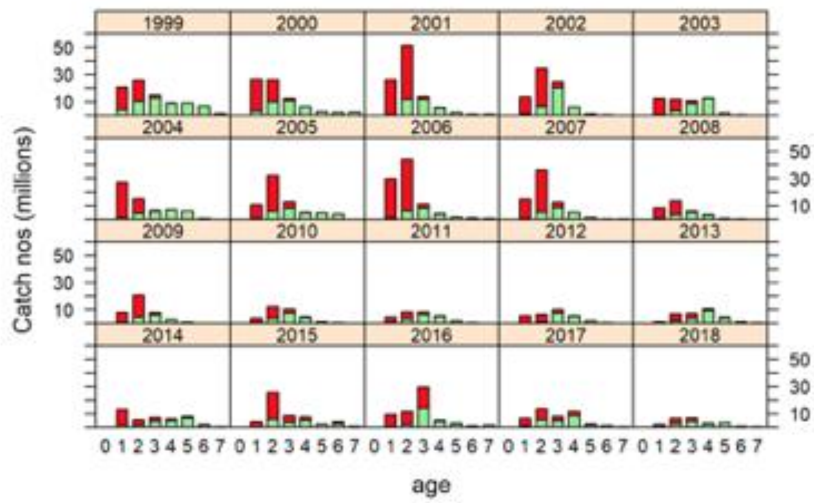
7. Management and Biological Reference Points:

- The management of this stock follows the multiannual management plan (MAP) for the Western Waters by the European Parliament and the Council in 2019.
- The whiting stocks have been managed through a TAC system covering 7.b-k, which encompasses those considered in this assessment area, 7.b,c,e-k.
- A TAC of 19 184 t is set for 2019, down from 22 213 t set for 2018. All are allocated within the EU.
- In 2016, the catch total (22 457 t) approached the TAC level (22 778 t). In 2017 and 2018, TAC (27 500 t for 2017, 22 213 t for 2018) has far exceeded catch levels (17 780 t for 2017, 12 625 t for 2018).
- Since 2017, a landings obligation has been applied to these fisheries in accordance with EU laws. Thus, all catches of whiting in the Celtic Sea and Western Channel must be landed. ICES estimates of discard rates indeed have been reduced to 15% in 2018 from 26-32% from the three preceding years.
- Minimum Conservation Reference Size for whiting at 27cm. The report does note, however, that a significant portion of the unwanted catch is above this size.
- Current biological reference points:
    - B_{lim} = 25 000 t
    - B_{pa} = 35 000 t
    - F_{lim} = 1.120
    - F_{pa} = 0.900
    - F_{max} = N/A
    - F0.1 = N/A
    - F_{MSY} = 0.524
    - MSY $B_{trigger}$ = 35 000 t

8. General Comments:

- This report is concise and follows the stock annex.
- Data used and potential data issues are discussed in depth. There are fairly detailed discussions of sources of uncertainties.
- The report uses appropriate and extensive data for XSA models, such as catch-at-age data and landings data.
- The report remarks that bycatch and discards are a prominent feature in this fishery. In this case, a small paragraph on post-release mortality rate would be helpful to better understand this fishery and model projections.
- The RG recommends investigating the effects of environmental conditions on recruitment to better understand what causes high recruitment events.

- In this figure below (Figure 3 from the assessment), it seems that the total catch has experienced an inconsistent but prolonged decline from the beginning of the survey data in 1999. This assessment should discuss the reasons for this observation.



9. Technical Comments:

- Overall, the text should be double-checked for grammar and clarity issues.
- Overall, the report will benefit from more graphic representations of extensive data tables to make explicit discernible patterns, such as year effects.
- Table 4 detailing catch and landings data is formatted in a confusing way, lacking column headings and row headings.
- Table 9, which details the output results from XSA diagnostics, should be made clearer with better formatting (.g. the yearly fishing mortality data, the XSA population number, and all other data-heavy charts should be put into a table format for better alignment).
- This report will benefit from a more in-depth discussion of the use of survey data to "tune" the model.
- Each panel in Figure 1 (Irish landings for the main gear types) are too small and appear illegible. Maybe include a legend to explain the x-axis values for the small graphs in each panel, as the average annual landings for each gear type are sometimes an order of magnitude different, making the graphic representation misleading.
- In Figure 2, the figure under OTB, the panel that shows UK(England) is squished and the y-axis values overlaps and are illegible.
- Overall, the graphs and figures included for data representation are well labeled and clear.

10. Conclusions:

- The assessment of whiting appears well done and indicates no large retrospective errors.
- The assessment uses an appropriate model (XSA)and is supported by precise, extensive fishery data.
- The RG accepts the assessment, although more details about this fishery (biology, ecosystems, fishery) could enrich this report and inform future revisions.
- The RG also recommends investigating the effects of environmental conditions on recruitment to better understand what causes high recruitment events.

Pok.27.7-10 Saithe in ICES subareas 7-10

1. **Assessment Type:** New assessment – never been assessed

2. **Assessment:** Accept with caveats

3. **Forecast:**
   - Short-term projection – N/A
   - Mid-term projection – N/A
   - Long-term projection – N/A

4. **Assessment Method:**
   - Depletion-Corrected Average Catch (DCAC).
   - Model Input: commercial catch data - time series of official landings reported.

5. **Consistency:**
   - Saith in subareas 7-10 is considered a new stock to the WGCSE and has never been assessed.
   - The average DCAC value was used to provide advice for 2019. The DCAC method estimated a yield likely to be sustainable utilizing the same model settings applied for Pollack in subarea 7.
   - The average DCAC value was not used to provide advice for 2020. A TAC of no more than 582 tonnes was suggested for years 2020, 2021, and 2022 using the precautionary approach. The precautionary approach applies a 20% buffer to the average landings from years 2016-2018.

6. **Stock Status:**
   - Current level of catch is well under the maximum sustainable yield and 95% confidence intervals derived from the DCAC assessment method applied to commercial landings data since 1986.
   - Insufficient information was provided to evaluate trends in saithe. In general, commercial catches have declined over time with the lowest values reported both in 2008 and 2018 and the largest values reported in 1986 at the beginning of the data set.
   - 2018 values of landings reported 496 tonnes, a decrease of 33.8% when compared to landings reported in 2017.

7. **Management and Biological Reference Points:**
   - No formal management plan has currently been established for saithe in subareas 7-10.

- Reference points have not been established as they cannot be estimated using the current assessment method.
- Total TAC of 3,176 tonnes was set for 2019. The precautionary approach suggests a TAC of no more than 582 tonnes in years 2020, 2021, and 2022.

8. General Comments:

- The WG report is well written. Data and model limitations are well documented. No stock annex was provided.
- "The DCAC-method was applied during WGCSE 2019 with the same model settings as was applied to Pollack in subarea 7 due to the similarities of landings data". DCAC method settings should be further justified in the WG report.
- The RG suggests exploring the addition of discard rate utilizing data provided from the Irish fleet.
- The DCAC method is solely based on catch data and assumes accurate catch information. Discard and potential observation errors associated with the catch data for the saithe fishery should be considered when using this method.
- Explanation of why the DCAC method was not used to provide advice for 2020 is missing.
- The RG agrees with the WG that different assessment models should be explored over the coming year. The quality of supplementary biological or survey data that is available should be evaluated. All data gaps should be identified for potential models that are explored in the future.

9. Technical Comments:

- Scientific name (Pollachius virens) belongs in the title or beginning of the advice document.
- Table X.1: caption should indicate units of landings officially reported to ICES. Meaning of asterisks located next to year 2017 and 2018 should be defined.
- Units should be provided for the figure displaying TAC values by country. This figure is embedded in the text under section "Management applicable to 2019".

10. Conclusions:

- The RG suggests that the report be accepted with caveats.
- Saithe in ICES subareas 7-10 are classified as a category 4.1.2. stock which is a data-limited species. The data-limited method DCAC was explored this year to attempt to provide advice about the TAC. The performance of the DCAC is subject to the quality of catch data and accuracy of the pre-specified parameters and stock status (e.g. Fmsy.M, depletion level). The quality of data was not well discussed in the report. The setting of relevant parameters and stock status lacks justification. The sensitivity analysis the WG conducted was not sufficient to address the uncertainty

issues. The RG agrees with the WG that a stock assessment model should be explored since there are some available data other than catch. Before any model being applied for this stock, the RG recommends that the data gap be identified and the data quality evaluated.

Her 27.6a7bc: Herring (*Clupea harengus*) in divisions 6.a (combined) and 7.b–c (West of Scotland, West of Ireland)

1. **Assessment Type:** update

2. **Assessment:** Accept with caveats

3. **Forecast:**

- No projections were carried out in 2019.

4. **Assessment Method:** Multi-fleet implementation of the State–space Assessment Model (Multi Fleet SAM) was used.

5. **Consistency:**

- The model was changed to a multi fleet SAM assessment with data from 6.aN and 6.aS 7.bc treated separately.
- Improvements were made to the input data. The IBTS data series was recalculated using the delta GAM method and the acoustic surveys were combined into a single tuning index.
- The model remains sensitive to assumptions on age-dependent catchabilities, lack of information on recruitment and the abundance of fish of younger ages.
- The changes applied to the assessment following the interbenchmark in early 2019 have improved the results from the retrospective analysis but the bias is still present.
- The assessment in 2019 shows a very different perception of stock status with the 2018 assessment. The SSB has been significantly revised downwards and F has been revised upwards. Recruitment has also been revised downwards. SSB and recruitment are at very low levels with decreases in F evident in recent years.

6. **Stock Status:**

- The assessment provides information for the combined stocks.
- Fishing mortality has been reduced since the introduction of zero catch advice and in line with the monitoring TAC in 2016
- Catch has been declining from 27123 tonnes in 2014. Recent catches have been amongst the lowest in the time-series. Total catch in 2018 was 5558 tonnes while the fishery has been restricted to a monitoring fishery with a combined TAC of 5800 tonnes since 2016.
- SSB has decreased steadily since 2003. The Malin Shelf herring estimate of SSB for 2018 is 159 000 tonnes and 925 million individuals, a slight increase compared to the 145 000 tonnes and 798 million herring estimate in 2017. However, the estimate SSB for 2018 is still very low in the time-series.
- Recruitment has been declining from 2,602,809 tonnes since 2000 and is predicted to be at their lowest level in the assessment period (230,732 t for 2018). Recruitment has been low with no big cohorts evident in recent years.

7. Management and Biological Reference Points:

● The managers are advised to ensure that any exploitation pattern imposed in this area will not overexploit the smaller and more vulnerable stock.

● No MSY and PA reference points were provided.

● ICES advises that when the precautionary approach is applied, there should be a zero catch in 2020.

● The 2019 TAC is agreed as 5800 tonnes.

8. General Comments:

● The assessment of Herring in divisions 6.a (combined) and 7.b–c (West of Scotland, West of Ireland) appears well done, and the WG report is well written, following the procedure agreed by the recent interbenchmark (IBP6a7bc, ICES 2019). The data and data issues are well documented and the updated assessment provides the best statistical fit to the input data. The WG did extensive work for providing the sources of uncertainty.

● The WG thinks that the new model remains sensitive to assumptions on age-dependent catchabilities, and lack of information on recruitment and the abundance of fish of younger ages.

○ The RG realizes the extensive work have been done for the sensitivity analysis, and suggests providing more information about the methodology, results and discussion of the reasons and solutions for the sensitivity issues.

○ Specifically, the model is sensitive to age-dependent catchabilities while the pattern of increasing catchability with age cannot be explained. The catchability of one index WOS_MSHAS is very high. The RG suggests the WG conducting sensitivity analysis to test more assumptions for the catchability (e.g. logistic, random walk, and exponential pattern).

○ The age structure varies from different data sources. The RG suggests that the WG could further explore which index is more representative and could weighting the data sources with consideration for their variance (Figure 4.6.6).

● The updated assessment provides the best statistical fit to the input data, but the assessment still has a strong retrospective bias, especially for fishing mortality. The Mohn's Rho on 5-year peels is -23. The RG realizes that the updated assessment following the interbenchmark has improved the retrospective but bias is still present.

○ The RG recommends briefly listing the changes to assessment model and the comparison of the two retrospective biases, which could contribute to explore the explanation of bias and to further improve the assessment.

○ Given the different standard bias for SSB, F and R, the RG recommends adding a "relative" difference compared to the terminal year among retrospective peels.

○ Since herring have a maximum lifespan of 10 years, the WG is suggested to remove more years of data during the retrospective analysis.

○ Since the retrospective error has a strong pattern and the magnitude of error is big, the final estimates of this assessment may need to be adjusted with the estimated bias. Also, the RG recommends that simpler models (such as surplus production and VPA) could be applied to double check the results.

● The assessment in 2019 shows a very different perception of stock status with the 2018 assessment, especially for SSB, F and R after 1991, while the patterns of SSB, F and R before 1991 are much similar. The RG suggests more discussion about the different patterns and different settings between the two assessments.

● In this WG report, no short-term projections were carried out in 2019. Since the monitoring TAC taken in 2016, there are a little recovery for this stock, such as the increasing SSB and decreased F. Given the differentiating pattern of this stock and its continuing strict TAC management strategy, the RG suggests conducting a simple short-term projection following the Stock Annex, in order to explore the performance of this strategy and to predict the population dynamics in the next short term.

● Since some input data are not available for early years, these data are assumed to be the same with the first year of available data. For example, the proportions of maturity before 1991 are assumed to be the same with 1991, while the weight-at-age in stock before 1991, and weight-at-age in catch for stock 6.aN before 1984, the catch-at-age for stock 6.aS, the 7.b-c before 1983. The RG suggests conducting a sensitivity analysis for quantifying the impact of these unavailable data in early years on the assessment results, such as using average values among the adjacent 2 or 3 years.

9. Technical Comments:

● The RG suggests providing the references list after this section 4, which will improve understanding of this stock assessment report.

● Section 4.2- *The 2013 year class (age 4-wr) dominates both in the catches and the acoustic survey in 2018.* For the acoustic survey, the 2010 year class (age 1-wr) is the most dominated cohort for both abundance and biomass. The RG recommends reflecting this issue.

● Section 4.10- *There is anecdotal evidence that the stocks are not the same size and managers are ad-vised to ensure that any exploitation pattern imposed in this area ensures that the smaller, more vulnerable, stock is not over-exploited.* This sentence can revise to be more concise and clarified.

● Tables need to be listed in descending order according to table number. Some tables cited are not available in this WG report, such as Tables 5.1.2, 5.2.4 and 5.2.5.

● Does the Fbar in Tables 4.6.9 and 4.6.12, and Figure 4.6.10, means fishing mortality, same with F in the text and other tables and figures? Clarification may need for this consistent issue.

● Table 4.3.1.2- More information should be provided in the caption. The data source (Acoustic surveys) can be stated to be consistent with Table 4.3.1.3. It's better to add decimals for the biomass of Immature, Mature and Total, in order to clear make Total=Immature +Mature.

● Table 4.3.1.3- The RG suggests using consistent Age (Rings) with Table 4.3.1.2, which is to add Age 0 and to replace Age 9 with Age 9+.

● Table 4.6.1a- The RG suggests using integer to represent individual numbers and being consistent format with table 4.6.1b.

● Table 4.6.5- The maturity in 2007 is not reasonable. The RG suggests adding some explanation for this, or to test the sensitivity of the original value, average value of 2006 and 2008, etc.

● Fractions of harvest and nature mortality before spawning in Tables 4.6.6 and 4.6.7 are 0.67 for all ages and all years. The RG recommends providing more information of this fixed value.

● Table 4.6.8. SURVEY INDICES are duplicate with Table 4.3.1.3. However, the units million and number in Table 4.6.8 and 4.3.1.3, respectively, make values inconsistent.

● Figures 4.6.1~5- Is there different meaning for black and red bubbles? It's better to clarify this issue in the caption.

● Figure 4.6.6- The x axis labels are not shown completely for *WOS-MSHAS*. It's better to indicate that in x axis labels the numbers after data sources represent age (wr). Alternative order in the figure is to list the observation variances by the data source.

● Figure 4.6.7- The ages after the data sources are overlapped and unavailable to clarify.

● Figure 4.6.10- The uncertainties for key parameters (SSB, Fbar, and Rec) are extremely high in recent years. The RG suggests providing more discussion about this issue, not only for recruitment.

10. Conclusions:

● The WG did an excellent job in their assessment of herring in divisions 6.a (combined) and 7.b–c (west of Scotland, west of Ireland) by providing the best statistical fit to the input data. However, the assessment still has a strong retrospective bias, especially for fishing mortality.

● Given the updated model shows the best fit to the data, and high uncertainties of key parameters and sensitivity to many assumptions, the RG suggests the stock assessment to be accepted as long as following concerns are addressed: a) providing more information about the existing sensitivity analysis and different settings with the previous assessment; b) alternative sensitivity analysis for the unavailable biology data and more assumptions for catchability as discussed in the general comments.

Herring in the Celtic Sea (*Clupea harengus*) in Divisions 7.a South of 52°30'N, 7.g, 7.h, 7.j and 7.k (Irish Sea, Celtic Sea, and southwest of Ireland)

1. **Assessment Type:** Update, benchmarked in 2015, inter-benchmarked in 2018

2. **Assessment:** Accept with caveats

3. **Forecast:**
   - Short term projection - A deterministic version was carried out following the procedure of 2014 benchmark.
   - Long-term projection –Simulations were carried out to evaluate the long-term management plan. The plan was proved not precautionary and thusly not used to give advice. Development of rebuilding plan is in process.

4. **Assessment Method:** Age Structured Assessment Program (ASAP)

5. **Consistency:**
   - The model configuration is the same as the 2018 inter Benchmark,
   - The 2019 assessment was supported by the Celtic Sea herring acoustic survey (CSHAS). The survey had two spatial components and five replicates. Survey data from 2004 and 2017 were excluded in the 2019 assessment.
   - The 2018 survey showed the lowest estimate in the current time series because herrings have been moving below the detectable depth of acoustic survey since 2014.
   - The mean weight-at-age has been declining since 1990 and reached almost historical low in recent years. The shift towards late spawning in the region was reported by both scientists and fisherman. These were caused by adverse changes in the environment. However, herring in the region showed no sign of regime shift.
   - The 2019 ASAP output indicated a lower selection-at-age for 9-wr (winter rings) fish. This might be caused by its low abundance in catch.
   - The 2019 ASAP output indicated extremely high uncertainty of SSB, Fbar, and recruitment.
   - The 2019 ASAP output indicated more pessimistic outlook for the stock with downward revision of SSB and upward revision of F.
   - The long-term plan was reviewed and rejected in 2018. A new rebuilding plan is being developed.

6. **Stock Status:**

- The 2018 SSB estimate was 22977t, which was below B_{pa} and B_{lim}. SSB has been declining since 2011.
- The 2018 F_{bar} estimate was 0.33, which above F_{pa} and F_{MSY} and just below F_{lim}. Although it has decreased from 0.64 (2017).
- Total catch in 2018 was 4418t while the TAC was 10127t.
- Recruitment of recent years has fallen below the long-term average since 2013.

7. Management and Biological Reference Points:

- The closure (with limited fishing allowed) of the Subdivision 7.a.S was introduced since 2007-2008 to protect first time spawners. Currently only vessels shorter than 50 feet in registered length are permitted to fish in this area. A maximum catch limitation of 11% of the Irish quota is allocated to this fishery.
- No long-term management plan is currently adopted. The previous one was proved risky while the new rebuilding plan is still being developed.
- Reference points were re-estimated in 2018 under both MSY approach and Precautionary approach frameworks.
- TAC for 2019 is 4 742 t (based on the ICES MSY approach).
- Current reference points under MSY approach framework:
  - F_{MSY} = 0.26
  - MSY $B_{trigger}$ = 54000 t
- Current reference points under Precautionary approach framework:
  - B_{lim} = 34000 t
  - B_{pa} = 54000 t
  - F_{lim} = 0.45
  - F_{pa} = 0.27

8. General Comments:

- The WG report is well written and follows the stock annex. The input data and associated issues are well documented and discussed in depth. The WG extensively evaluated the quality of the assessment from multiple aspects.
- According to Figure 6.6.1.9, CVs of key parameters estimations are historically high. The underlying uncertainty is considerable.
- The WG comprehensively introduced the design of Celtic Sea herring acoustic survey (CSHAS). The RG agree with the WG that incorporating the adaptive surveys will improve the stock assessment. However, the RG still has several concerns:
  - The survey data was used following the statement from stock annex: "*The Celtic Sea Herring Assessment is tuned using a single acoustic survey*." The RG is not sure how did WG standardized the data sets from two different components into one. Were they treated as equally weighted?

  - The RG would like to know if the level of variation from the two survey components are comparable. This is unfortunately not available in the stock annex or the report.
  - According to the Table 1 from stock annex, the survey design was not consistent for the considered time-series. The RG is not sure if the consistency of survey design was violated in this case.
  - According to the Table 6.6.1.2, the survey CV was assumed constant for the whole time series. The RG is not sure how robust is this assumption given the change in survey design.
- The WG conducted short-term projections with deterministic simulation. However, given the considerable uncertainty associated with the estimates of recruitment and SSB in recent years, the RG would suggest conducting a stochastic simulation to incorporate these uncertainty.
- The WG discussed the changes in the environment that might influence the well-being of the stock. Building on this, the RG would like to know how these changes would directly or indirectly bias the stock assessment and survey. Were these changes contributing to the recently high uncertainty in assessment?

9. Technical Comments:

- "*NASC distribution plots from the broad-scale survey are presented in Figure 6.3.1.2 and from the adaptive mini survey in Figure 6.3.1.3.*" The RG suggests presenting the full spelling the abbreviation NASC since it is technical.
- "*Weights in the catch and in the stock at spawning time have shown fluctuations over time (Figures 6.4.4.1 and 6.4.1.2)……*" The first cited figure should be 6.4.1.1
- Table 6.6.1.1, unit is missing for stock and catch weight-at-age.
- Table 6.6.1.2, the RG is not sure if the presented age-specific values were standardized. Unit is also missing here.
- Table 6.6.1.3, "sample size" should be "No. of herring…." Instead of "No of herring….". Also, why Fbar was calculated for ages 2-5? The first fully selected age group is three according to Figure 6.6.1.4.
- Table 6.6.1.4, units are missing in this table. The full spelling of TSB should be noted as well.
- Table 6.7.1.1, unit is missing for "N".
- Table 6.7.1.2, units are missing in this table.
- Figure 6.2.1.1, y axis labels and units are missing.
- Figure 6.3.1.4, the label for x and y axis are the same here. Should they be "observed" and "predicted"?
- Figure 6.4.1.1, unit is missing in this figure.
- Figure 6.4.1.2, unit is missing in this figure.

- Figure 6.6.1.2, x axis label should be “Year”, y axis label should be “Value in tons”.
- Figure 6.6.1.8, there is no left or right panel in this figure.
- Figure 6.10.1, legend is missing for this figure.

10. Conclusions:

- The RG suggest this assessment should be accepted with caveats.
- The assessment of herring in the Celtic Sea in Divisions 7.a South of 52°30’N, 7.g, 7.h, 7.j, and 7.k appears well done and flawless in terms of the assessment process.
- However, there are also some issues regarding the use of survey data need to be further addressed. Furthermore, extremely high uncertainty was exhibited by estimates of key parameters. The RG suggests this should be considered in the future assessment and management using stochastic projection to for precautionary consideration.

her.27.nirs: Herring (*Clupea harengus*) in Division 7.a North (Irish Sea)

1. **Assessment Type:** Update, Benchmarked in 2017

2. **Assessment:** Accept with caveats

3. **Forecast:**
   - Short-term projection- Carried out by a FLSAM using data from 1980-2018 to predict 2019-2020. SSB is expected to be well above MSY $B_{Trigger}$ in 2019-2020, but will likely decrease if fished at F_{MSY}.
   - No medium or long term projection was carried out.

4. **Assessment Method:** State-Space Age-Structured Model, in the FLR environment (FLSAM) was used.
   - Model Configurations
     - SSB-R relationship: cohort back-tracking from older ages.
     - Natural mortality: Values from the North Sea, not the Irish Sea. Age specific mortalities were defined and held constant over the time series.
   - Major Input Data
     - Catch Survey (fisheries dependent): numbers-at-age, numbers-at-length, total landings, weights-at-age, abundance index
     - Acoustic Surveys (fisheries independent): SSB estimates, length frequencies
     - SSB Survey (fisheries independent): SSB index, recruitment

5. **Consistency:**
   - The assessment model did not change in 2018 after the stock was benchmarked in 2017 but the following changes occurred following the benchmark.
     - Future analyses will use landings data only dating back to 1980 instead of 1961 due to data quality concerns (justification in annex).
     - A random walk assumption on recruitment was removed and replaced with estimations of recruitment from cohort back-tracking from older ages.
     - The stock is considered mixed, and an SSB survey index using acoustic methods was implemented in place of a larval survey to eliminate some age and mixing issues. More weight was given to the SSB survey in an effort to give a more balanced model not simply based on catch.
   - There was a marked increase in in landings made by Irish vessels in 2018 comprising 19% of all landings compared to an average of 2% in the preceding three years.

6. **Stock Status:**
   - In 2018 SSB and the highest F value (experienced by age 2 and 4 fish- F_{bar} is not provided) were 39,997 tonnes and 0.19 respectively. SSB was above MSY $B_{Trigger}$ and F was below F_{MSY}.
   - Trends show an increase in SSB and recruitment since the mid-2000s, stabilizing in recent years (although uncertain).

- Landings in 2018 were estimated as 6804 tonnes, while TAC was 6896 tonnes
- Mean weights-at-age have shown a general downward trend.

7. Management and Biological Reference Points:

- TAC for 2019 was not defined, but 6896 tonnes or less was advised by ACOM.
- Year-round closures occur along the east coast of Ireland and within 12 nautical miles of the west coast of Britain (Scotland, England and Wales). The traditional gillnet fishery on the Mourne herring is exempted from these closures.
- Seasonal closures of the Douglas Bank spawning ground, to the east of the Isle of Man occur from September 21st to November 15th. Boats from the Republic of Ireland are also not permitted to fish east of the Isle of Man.
- No current long-term management plan is in place for this stock. The RG agrees with the WG in supporting the development of a long-term management plan.
- New Reference Points for 2018:

Reference point	Value	Technical Basis
B_{lim}	8500 t.	Set to lowest SSB that generated above average recruitment
B_{pa}	11800 t	$B_{lim} * e^{1.645\sigma}$, $\sigma = 0.201$
MSY $B_{Trigger}$	11800 t	B_{pa}
F_{MSY}	0.27 (median), 0.35 (upper), 0.20 (lower)	Upper and lower bounds giving at least 95% of the maximum yield
F_{lim}	0.40	F with 50% probability of SSB<B_{lim}
F_{pa}	0.29	$F_{lim} * e^{-1.645\sigma}$, $\sigma = 0.231$

8. General Comments:

- The report is well written, and the limitations and data issues are discussed in detail. This report does a good job of providing the sources of uncertainty.
- "*Currently, the model doesn't have the structure to specifically deal with the emigration of small herring from other stocks*". There is known mixing of young herring from the Celtic Sea into this area, and the annex for South Celtic Sea herring suggests that there is a difference in growth rates between these groups that is likely to impact recruitment. The mixing issue has not been addressed since the 2012 benchmark, and The RG suggests new mixing studies be performed and that an effort is made to account for this difference in growth when determining weight-at-age, particularly in younger fish when mixing occurs more frequently. The RG also suggests updating the annex to include information about growth rate discrepancies between Irish and Celtic herring.
- There is strong uncertainty surrounding catchability of herring in the SSB acoustic surveys. Catchability values of 1, 2.5 and 3 are mentioned in the report, but it is not clear which value was used in the analysis nor the justification for using this value.

The RG appreciates the sensitivity analysis performed on catchability, and suggests that the methods and the results of the sensitivity analysis also be included in the report. The RG also recommends that the WG revisit the results of this analysis since, "*the reviewers could not reach a consensus and posed that HAWG is the best place to propose a final assessment model"* and come to some consensus on how to use the results to better the model.

- "*Mohn's rho was reduced from 13.3 to 9% under shortened time series",* after removing years before 1980, but the WG is not clear what this value of Mohn's row is referring to (SSB, Fbar, or recruitment). The RG suggests providing Mohn's rho values for all 3 parameter's retrospective analysis. The RG also recommends that the WG include methods for the regressions analysis (number of peels etc.) and a description of results.
- Natural mortality data is taken from the North Sea due to a lack of understanding of natural mortality in the Irish Sea, and uses constant age-dependent M values from year to year. The RG recommends calculating the natural mortality of the Irish Sea Stock using life history parameters of the Irish Sea stock, and justifying the use of constant M over time.
- The SSB acoustic survey aims to better understand the spatial and temporal variability of herring, but optimal timing of the survey has not been determined due to interannual variation in migration patterns. The RG suggests evaluating the accuracy of this data and exploring different methods to gain better insight into movements of herring.
- Due to herring's sensitivity to changing environments, the RG recommends gathering information on how SSB and recruitment are affected by changes in temperature.

9. Technical Comments:

- The scientific name of the species, "*Clupea harengus*" should be included in the report.
- The RG recommends including a map of stock boundaries and study areas into the report.
- Section 7.2.2 - "*The 2017 benchmark concluded to conduct future assessments only "data" back to 1980"* should read, "*The 2017 benchmark concluded to conduct future assessments only "dating" back to 1980"*
- Section 7.3.2 – "*The 2012 benchmark (ICES WKPELA 2012) also suggested that the survey series could be used to fine tune the main survey used as the tuning fleet in the assessment The survey used a stratified design similar to the AC(7.aN."* should have a period after the word, "*assessment"* and should have closing parentheses in the last section reading, "*AC(7.aN)."*
- Section 7.3.2 – "*The results of the survey "is" reported in the WGIPS 2018 report (ICES 2018)"* should read, "*The results of the survey "are" reported in the WGIPS 2018 report (ICES 2018)"*
- Section 7.6.1 – "*This was completed post-benchmark, however, the reviewers could not reach a consensus and proposed that HAWG is best place to propose a final assessment model"* should read, "*This was completed post-benchmark, however, the*

reviewers could not reach a consensus and proposed that HAWG is "the" best place to propose a final assessment model"

- Section 7.6.1 – The additional period should be deleted.
- Table 7.6.3.3. Year 2018 should be in Times New Roman Font.
- Table 7.6.3.4. Natural mortality values for each age can be described in the report, and the model inputs can be placed in the annex.
- Table 7.6.3.6. The fraction of harvest before spawning can be described in the report, and the model inputs could be placed in the annex.
- Table 7.6.3.7. The fraction of natural mortality before spawning can be described in the report, and the model inputs can be placed in the annex.
- Tables 7.6.3.12 – 7.6.3.25. Times New Roman Font.
- Table 7.6.3.12. Table should be better centered on the page. Units needed.
- Table 7.6.3.14. Data from 1983-1986, 1990-1993, 1997-2000, 2003-2007, 2011-2016, and 2018 are missing from the data set. Age 8 of years 2001-2003 should not have bullet points. Units needed.
- Tables 7.6.3.15 & 7.6.3.16. Data is missing.
- Table 7.6.3.18. Units needed.
- Table 7.6.3.19. Format year 2000 data next to year 1999 data.
- Table 7.6.3.20. Units needed.
- Table 7.6.3.22. Units needed.
- Table 7.6.3.26. Not a table, just a single number. Put this number in the report or in the annex and delete.
- Table 7.7.1. No line at the bottom of page 559 or on the top of page 560.
- Table 7.7.2. Units needed.
- Figure 7.1.1. Label x-axis. Reformat figure caption. The figure should be moved so that the right border can be seen.
- Figure 7.3.2. Figure caption should be on the same page as figure.
- Figure 7.3.5. X-axis should be labeled. X-axis should have fewer increments, it is difficult to determine which tick marks belong to which year. Times New Roman Font.
- Figure 7.4.1. Each data point should not display the age at which it is referring to. The legend on the right should only show the age associated with a color. X-axis should start closer to the year of the first data point.
- Figures 7.6.1 – 7.6.16. Last word in each figure caption should have a space between "age" and the number, ex: "*age1*" should be "*age 1*".
- Figure 7.6.18. X-axis should have more increments, one for every year. Include legend or a description in the caption of what each line represents.
- Figure 7.6.19. Reformat figure caption. Describe age units (years, rings etc).
- Figure 7.6.20. Reformat figure caption.
- Figure 7.6.21. Reformat figure caption.
- Figure 7.6.22. Reformat figure caption. SSB and Recruitment units needed.
- Figure 7.6.23. Reformat figure caption.
- Figure 7.6.24. Reformat figure caption. SSB and Recruitment units needed.

- Figure 7.6.25. Reformat figure caption. Units needed.

10. Conclusions:

- The assessment of herring in division 7.a north (Irish Sea) is very well organized and did a great job identifying potential sources of uncertainty and bias in the sampling methods and model configuration. The current stock seems healthy and at little risk of biomass and fishing mortality levels being outside of acceptable biological limits in 2019 if the current trends continue. However, the RG agrees with the WG that a long-term management plan should be developed for herring in this region. The RG recommends continued research into uncertainty caused by spatial and temporal variability, stock mixing, natural mortality, and catchability assumptions to continue improving model fit. Description of the methods and discussion of results (including Mohn's rho values) of the retrospective analysis should be included in the report, and the RG recommends reviewing all figures and tables to ensure font, unit and figure caption consistency.

Spr.27.67a-cf-k – Sprat (*Sprattus sprattus*) in Subarea 6 and Divisions 7.a-c and 7.f-k

1. **Assessment Type:** Update
    - No analytical assessment used for this area.
    - Stock Annex last updated 2013

2. **Assessment:** Accepted with Caveats.

3. **Forecast:**
    - Short-term projection: N/A
    - Mid-term projection: N/A
    - Long-term projection: N/A

4. **Assessment Method:** None
    - None used

5. **Consistency:**
    - Seven survey efforts are referenced, but none provide sufficient data for region wide analysis.
    - Historical landings for Ireland may be inaccurate, but no scale of inaccuracy is suggested.

6. **Stock Status:**
    - There is no stock assessment for sprat in areas 7.a-c and 7.f-k.
    - Biomass predicted by intermittent survey effort shows a highly variable stock with large inter-annual variations in abundance determined by recruitment variability.
    - The state of this stock is currently unknown with insufficient data for determining status.
    - Uncertainty in stock structure may cause localized depletion.

7. **Management and Biological Reference Points:**
    - There is no sprat specific management plan.
    - Sprat fishing effort is not quota controlled outside of 7.d-e, and the relationship between 7.d-e, 7.a-c and 7.f-k population is unknown.
    - Sprat fishing effort is only controlled by a herring bycatch ceiling limit and bycatch percentage limits as herring and sprat are typically fished together.

8. **General Comments:**

    - The RG admires the attention to ecological importance of this species and mention of seabird and marine mammal prey dynamics.
    - There is biological data for area 6a but this data is not available electronically. Given the data deficiency of this species, access to this biological data may be useful for future assessments.

- Given the WG statement that there is uncertainty associated with Irish small vessel historical landings, the RG suggests including confidence intervals for these uncertain data.
- The ICES suggested catch limit of 2800 tonnes is given by referencing previous years, by applying a precautionary approach to the 2013 decision of 3500 tonnes. However there is no mention of how this initial 3500 tonnes limit was chosen. The RG suggests including information on how this limit was chosen.
- The Sprat Stock Annex has not been updated since 2013. Since the estimated biomass given in the HAWG report is several magnitudes larger than landings this species does not appear to be in peril, but survey data and biomass estimates have accumulated that may be worth updating in the Stock Annex.

9. Technical Comments:

- The HAWG report figures 13.2.1, 13.2.2, 13.2.3, 13.2.4, 13.2.5, 13.2.7, and 13.3.1 are missing axis labels.
- The HAWG report Section 13.1.2 Division 6.a cites a nonexistent figure (10.2.1) for landings by nationality from 1972-1978.
- The HAWG report 13.2.1-13.2.7 plots are difficult to interpret, area plots appear visually confusing. The RG suggests exploring different presentation methods for this data.

10. Conclusions:

- Based on the high variability in stock estimates for this species, and an unknown stock recruitment relationship, the RG supports the precautionary limit of 2800 tonnes for 2020 and 2021.
- The RG accepts this assessment under the following caveat.
    - The RG suggests adding some context for the 2013 3500 tonnes limit decision the current limit is based on.

Spr.27.7de: Sprat (Sprattus sprattus) in divisions 7.d and 7.e (English Channel)

1. **Assessment Type**: Update

2. Assessment: Accepted

3. Forecast: No forecast was carried out.

4. Assessment Method: Biomass trend

5. Consistency:

•The PELTIC acoustic survey was expanded to cover the southern area of division 7.e in 2017 and was extended into division 7.d in 2018.
•The age classes of the samples collected during the PELTIC acoustic survey decreased from 6 classes (0 to 5) in 2017 to 4 classes (0 to 3) in 2018.
•The stock identity for sprat in the English Channel is still unclear.
•Discards occurred but were considered negligible during 2014-2018.
•The biomass trend estimated by the PELTIC acoustic survey has been used as the index of stock development since 2016.
•The sprat landings were not exceeding the TAC in recent years, but the difference is getting closer.

6. Stock Status:

•The stock status relative to MSY and PA cannot be assessed because the reference points are unknown.
•The total landing has decreased from 2733 tonnes in 2017 to 2252 tonnes in 2018.
•The LPUE (kg/day) has decreased from 9457 tonnes in 2017 to 8373 tonnes in 2018.
•The biomass estimate in 2018 (17091 tonnes) is less than 2017 value (32751 tonnes) but is still twice of that of the lowest level of the time series.
•The harvest rate (the ratio between catches and the acoustic index) peaked in 2016 (34%), and was low (around 10%) throughout the recent 5 years.

7. Management and Biological Reference Points:

•The catch advice was based on the data limited method, "2 over 3" rule (the ratio between average biomass of the last 2 years and average biomass of the previous 3 years) which was used to determine whether the uncertainty cap should be applied.
•The ratio resulting from "2 over 3" rule was 0.47 and a 20% uncertainty cap was applied.
•The agreed TAC was set equal to 3296 tonnes and 2637 tonnes for 2018 and 2019, respectively.

•The advice catch was set equal to 1883 tonnes and 1506 tonnes for 2019 and 2020, respectively.
•No biological reference points were included in this assessment.

8. General Comments:

•The WG report was overall well written and followed the stock annex. The fishery-independent survey information for small pelagic fish community was well documented at length. The WG did a good job updating the assessment for this year. The spatial distribution of the stock was well investigated.
•The RG is not sure whether the data of oceanographic condition was collected during the PELTIC acoustic survey and whether any study has been done to understand the relationships between environmental variables and species using the survey data. It was not introduced in either WG report or stock annex. The RG recommends that the WG study how environmental factors (such as temperature and salinity that were mentioned in section 12.1.2 "Landings") affecting the biomass fluctuations, spatial distribution and fishery for sprat.
•There was a great discrepancy in the age composition from samples between the PELTIC acoustic survey and the FSP acoustic survey, which may be caused by gear selectivity. Further comparison of the representativeness of the samples from two surveys is needed. A careful comparison would also help the future analysis that requires the age composition data, which depend on the gear selectivity.
•The current assessment is primarily based on survey indices and the current precautionary approach is based on an empirical method. The RG recommends the WG apply various analytical assessment methods (e.g. SPiCT with environmental variables) based on best available survey information.
•The RG agrees with the WG's suggestion that further investigations are required to identify the stock structure of sprat populations in the English Channel. The RG also agrees with the WG's concerns on the connection between the Western English Channel stock and the Bristol Channel, where large numbers of juveniles were found. More investigations, such as morphometric and genetic analyses, are required to resolve this uncertainty.

9. Technical Comments:

•The WG stated the inter-annual variability in stock abundance for sprat was mainly driven by recruitment variability. The RG encourages WG to explore the effect of recruitment variability on large internal-annual fluctuations in stock biomass with the survey data.
•The stock annex states that "The trend in biomass from both the PELTIC acoustic survey and the CPUE index from IBTS Q4 survey will be monitored and compared to support the advice: in case of consistent signs of impaired biomass from both or from

either one of the two indices, a warning should be issued and additional measures should be taken", there is no description in the report.
•The RG notices the stock biomass in 2016 was very low and the total landings around 1980 was considerably high, however, the WG did not provide any explanation for these. The RG recommends the WG explain these historical variations in stock biomass.
•Table 12.1.1- The landings data in the table (since 2014) was slightly different between this year and last year. The different part was highlighted in yellow below. The RG recommends the WG clarify this data revision in the report.

Table 12.1.1 Sprat in 7.d-e. Landings of sprat, 1985–2018. (from HAWG Report 2019)

Country	Denmark	France	Netherlands	UK - Eng+Wales+N.Irl.	UK - Scotland	Other	Total
2012	6	2	8	4 458	0	0	4 474
2013	0	0	0	3 793	0	0	3 793
2014	45	0	275	3 338	0	0	3 658
2015	0	1	352	2 659	0	0	3 012
2016	185	7	231	2 867	0	49	3 339
2017	0	0	235	2 498	0	0	2 733
2018	474	1	0	1 776	0	0	2 252

Table 12.1.1 Sprat in 7.d-e. Landings of sprat, 1985–2017. (from HAWG Report 2018)

Country	Denmark	France	Netherlands	Germany	UK - Eng+Wales+N.Irl.	UK - Scotland	Total
2012	6	2	8	0	4 458	0	4 474
2013	0	0	0	0	3 793	0	3 793

2014	45	0	275	0	3 358	0	3 678
2015	0	1	346	0	2 657	0	3 003
2016	185	7	231	49	2 867	0	3 339
2017	0	0.03	235	0	2 498	0	2 733

•Table 12.6.1- The biomass estimates from the acoustic survey were slightly changed in report from 2018 to 2019. The RG recommends that the WG clarify this data revision in the report.

Table 12.6.1. Sprat in 7.d–e. Annual sprat biomass in ICES Subdivision 7.e (Source: Cefas annual pelagic acoustic survey). (from HAWG Report 2019)

Survey	**Area**	**Season**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Partial	Lyme Bay	Oct	33 861	24 246	62 040	67 538	12 212	6 181	29 996	15 310
FSP	Lyme Bay*	Oct	33 861	27 971						
PELTIC	W Eng Ch	May	85 358							
PELTIC	W Eng Ch	Oct			70 680	85 184	65 219	9 826	32 751	17 091

* ICES rectangles 29E6, 30E6

Table 12.6.1. Sprat in 7.d–e. Annual sprat biomass in ICES Subdivision 7.e (Source: Cefas annual pelagic acoustic survey). (from HAWG Report 2018)

Survey	**Area**	**Season**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Partial	Lyme Bay*	Oct	33 861	24 246	68 613	69 059	10 616	6 120	29 274
FSP	Lyme Bay**	Oct	33 861	27 971					
PELTIC	W Eng Ch	May	85 358						
PELTIC	W Eng Ch	Oct			79 149	93 839	73 574	11 804	34 694

* ICES rectangles 29E6, 30E6

•Figure 12.1.1- Figure needs both axis labels. The colors used in the figure (legend) also should be labeled.
•Figure 12.2.1- Figure needs a full-name label in x-axis (e.g. Total length).
•Figure 12.2.2- Please rearrange sub-figures in a time sequence (Nov. in left and Dec. in right) and use full names labels in x- (e.g. Total length) and y-axis (e.g. Numbers). The unit of x-axis label should also be added.
•Figure 12.2.3- Figure needs a full-name label in x-axis (e.g. Total length) and rename the titles of sub-figures (e.g. Quarter 1 and Quarter 4).
•Figure 12.3.2- Figure needs a full-name label in x-axis (e.g. Total length) and a label in y-axis.
•Figure 12.3.1- The figure caption indicated that there were stations designed for zooplankton and oceanographic survey. However, it was not mentioned in the WG report or stock annex. The RG recommends that the information related to zooplankton and oceanographic survey should be added in the WG report.
•Figure 12.6.1- Text is too small to read.
•Figure 12.6.3- Figure needs both axis labels.
•Figure 12.7.1- Figure needs both axis labels.

10. Conclusions:

•Given the available data, the assessment of sprat stock in subareas 7.de appears well done. The RG recommends the report be accepted. The major comments are listed below.

- ○The spatial distribution of the stock was well investigated, but the stock structure for sprat in the English Channel was still unclear. The RG believed that more investigations are required to identify the stock structure for sprat as well as the connection between the Western English Channel stock and Bristol Channel.
- ○It was unclear whether the zooplankton and oceanographic survey was conducted during the PELTIC acoustic survey. The RG would like to recommend the WG provide related information on that and encourage the WG to explore the relationship between oceanographic condition and large inter-annual fluctuations in stock biomass.
- ○The RG also recommends the WG apply various analytical assessment methods (e.g. SPiCT with environmental variables) based on best available survey information and develop more appropriate approach for providing catch advice.

References

Aldrin, M., Aanes, S., and Subbey, S. 2019. Comments on incongruous formulations in the SAM (state-space assessment model) model and consequences for fish stock assessment. Fisheries Research, 210: 224-227.

Berg, C.W., and Nielsen, A. 2016. Accounting for correlated observations in an age-based state-space stock assessment model. ICES Journal of Marine Science, 73: 1788-1797.

Brooks, E.N., Legault, C.M., and Wilberg, M. 2016. Retrospective forecasting — evaluating performance of stock projections for New England groundfish stocks. Canadian Journal of Fisheries and Aquatic Sciences, 73(6): 935–950.

Butterworth, D.S., and Rademeyer, R.A. 2008. Statistical catch-at-age analysis vs. ADAPT-VPA: The case of Gulf of Maine cod. ICES Journal of Marine Science, 65(9): 1717–1732.

ICES. 2017. Report of the Benchmark Workshop on the Irish Sea Ecosystem (WKIRISH3), 30 January-3 February, Galway, Ireland.

ICES. 2018. ICES Special Request Advice Celtic Seas Ecoregion. EU request to ICES to provide plausible and updated FMSY ranges for the stocks of species inhabiting western EU waters.

Legault, C.M., and Palmer, M.C. 2016. In what direction should the fishing mortality target change when natural mortality increases within an assessment? Canadian Journal of Fisheries and Aquatic Sciences, 73: 349–357.

Marandel, F., Lorance, P., and Trenkei, V.M. 2016. A Bayesian state-space model to estimate population biomass with catch and limited survey data: application to the thornback ray (*Raja clavata*) in the Bay of Biscay. Aquatic Living Resources, 9(209).

Scott, F., Jardim, E., Millar, C. P., & Cerviño, S. 2016. An applied framework for incorporating multiple sources of uncertainty in fisheries stock assessments. PloS one, 11(5), e0154922.