ICES WGCSE REPORT 2017

ICES ADVISORY COMMITTEE

ICES CM 2017/ACOM:13

Report of the Working Group on Celtic Seas Ecoregion (WGCSE)

9–18 May 2017

Copenhagen, Denmark

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Executive Summary

The ICES Working Group for the Celtic Seas Ecoregion (WGCSE) met from 9th–18th May 2017 at ICES Headquarters in Copenhagen. The participants were from five countries; Belgium, France, Ireland, the Russian Federation and the UK. Of the 29 participants, 14 attended all of the meeting, eight attended part-time, and seven contributed by correspondence. The WG was supported throughout by a professional from ICES secretariat who assisted the WG with their advice drafting tasks. The meeting was chaired by Tim Earl and Helen Dobby (UK).

In total the WG is responsible for the provision of updated fisheries data, assessments and draft advice for 39 demersal fish and *Nephrops* stocks across ICES subareas 6 and 7 (with the distribution of megrim extending into Division 4.a, sea bass into 4.b,c and anglerfish into Subarea 4 and Division 3.a). This includes twelve *Nephrops* stocks, five sole and plaice stocks, four cod and whiting stocks, three haddock stocks, two each of megrim and sea bass, one anglerfish and one putative pollock 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 sea bass has been delayed until autumn this year, to allow changes in the assessment data to be fully reviewed. Advice from the remaining stocks was scheduled for release on the 30th June.

Since the last Working Group meeting five stocks have gone through an Inter-benchmark procedure; cod.27.7.a, had.27.7.a, ple.27.7.a, whg.27.7.a and bss.27.4.b.c7.a.d–h the results of which were presented to the group. The Working Group considered reference points for all category 3 and 4 stocks.

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 shows a slight improvement relative to that presented last year. Of the 39 stocks assessed, 20 were fished below F_{MSY} and 18 were above MSY $B_{trigger}$, ten stocks were fished above F_{MSY} and ten were below MSY $B_{trigger}$, nine stocks had unknown status relative to F_{MSY} and eleven relative to $B_{trigger}$ (see table below).

Number of stocks relative to reference points by WG year:

	2011	2012	2013	2014	2016	2017
F Below F_{MSY}	17	11	14	16	19	20
F Above F_{MSY}	9	14	13	11	10	10
Unknown	10	11	12	12	10	9

	2011	2012	2013	2014	2016	2017
SSB Above $B_{trigger}$	13	13	11	13	15	18
SSB Below $B_{trigger}$	5	4	5	7	11	10
Unknown	18	19	23	19	13	11

West of Scotland cod remains severely depleted, but the *Nephrops* stocks within functional units 11–13 and megrim in divisions 6.a and 4.a are exploited below F_{MSY} and have biomass or abundance above MSY $B_{trigger}$. The assessment of Northern Shelf anglerfish stock also shows an increase in stock size and decrease in harvest rate, although reference points have not been defined for this stock.

In the Irish Sea, the WKIrish benchmark has resulted in an upgrading of the assessments for haddock, plaice and whiting from category 3 to category 1, and the adoption of a model for cod that allows forecasts to be performed. Sole remains below B_{lim}, but fishing is below F_{lim}, and there are initial signs of increasing biomass and recruitment. Whiting in 7.a remains at a very low level relative to the past and remains severely depleted. Cod, haddock and plaice biomass are above possible reference points and increasing. The two *Nephrops* stocks FU15 and FU14 are above $B_{trigger.}$ FU14 and below F_{MSY}.

Further south, in the Celtic Sea and West of Ireland areas, the biomass of haddock and whiting stocks have been at a high level well above MSY $B_{trigger}$ in recent years following some high or moderate recruitment. The cod stock is slightly below B_{lim}, but forecast to increase above B_{lim} during 2017, despite fishing pressure being consistently above F_{MSY}. Among the *Nephrops* stocks in this area, three stocks are below MSY $B_{trigger}$: functional units 17, 19 and 22, and the remaining have no biomass reference points. Functional units 16, 19 and 20–21 are estimated to be exploited below F_{MSY}, while the remaining functional units are above F_{MSY}.

Celtic Sea sole is now assessed as being fished above F_{MSY} although the SSB remains above MSY $B_{trigger}$. Reference points were adopted at the Working Group for ple.27.7.fg, ple.27.7.h–k and sol.27.7.h–k. Both sol.27.7.h–k and ple.27.7.fg are above MSY $B_{trigger}$ and below F_{MSY}, whereas ple.27.7.h–k is below B_{lim} and fishing pressure remains above F_{lim}.

The assessment for sea bass in 4.b.c, 7.a and 7.d–h could not be updated at WGCSE 2017 due to a substantial revision to the calculation of lpue data used as tuning for the assessment.

1 Introduction

1.1 Terms of reference

1.1.1 Generic ToRs

2016/2/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:

i) descriptions of ecosystem impacts of fisheries

ii) descriptions of developments and recent changes to the fisheries

iii) mixed fisheries overview, and

iv) emerging issues of relevance for the management of the fisheries;

c) Conduct an assessment to update advice on the stock(s) 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:

i) Input data and examination of data quality;

ii) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;

iii) For relevant stocks (i.e. all stocks with catches in the NEAFC area) estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in the last year.

iv) 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;

v) The state of the stocks against relevant reference points;

vi) Catch options for next year;

vii) Historical performance of the assessment and catch options and brief description of quality issues with these;

d) Produce a first draft of the advice on the fish stocks and fisheries under considerations according to ACOM guidelines.

e) Review progress on benchmark processes of relevance to the expert group;

f) Prepare the data calls for the next year update assessment and for the planned data evaluation workshops;

g) Identify research needs of relevance for the expert group.

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

1.1.2 Specific ToRs

2016/2/ACOM13 The **Working Group for the Celtic Seas Ecoregion** (WGCSE), chaired by Timothy Earl, UK and Helen Dobby, Scotland, UK will meet at ICES Headquarters, Copenhagen, Denmark, 9–18 May 2017 and by correspondence September / October 2017 to:

a) Address generic ToRs for Regional and Species Working Groups;

b) Report on reopened advice if appropriate;

c) Estimate MSY proxy reference points for the category 3 and 4 stocks in need of new advice in 2017 (see table below).

  i) Collate necessary data and information for the stocks listed below prior to the Expert Group meeting. An official ICES data call was made for length and select life-history parameters for each stock in the table below;

  ii) Propose appropriate MSY proxies for each of the stocks listed below by using methods provided in the ICES Technical Guidelines (i.e. peer reviewed methods that were developed by WKLIFE V, WKLIFE VI, and WKProxy) along with available data and expert judgement.

Stock Code	Stock name description	EG	Data Category
anf.27.3a46	Anglerfish (*Lophius piscatorius* and *L. budegassa*) in subareas 4 and 6, and in Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat)	WGCSE	3
had.27.7a	Haddock (*Melanogrammus aeglefinus*) in Division 7.a (Irish Sea)	WGCSE	3.2
lez.27.6b	Megrim (*Lepidorhombus* spp.) in Division 6.b (Rockall)	WGCSE	3
nep.fu.2021	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h, functional units 20 and 21 (Celtic Sea)	WGCSE	4
ple.27.7a	Plaice (*Pleuronectes platessa*) in Division 7.a (Irish Sea)	WGCSE	3.2
ple.27.7e	Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel)	WGCSE	3.2
ple.27.7fg	Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)	WGCSE	3.2
ple.27.7h–k	Plaice (*Pleuronectes platessa*) in divisions 7h–k (Celtic Sea South, southwest of Ireland)	WGCSE	3.2
pol.27.67	Pollack (*Pollachius pollachius*) in subareas 6–7 (Celtic Seas and the English Channel)	WGCSE	4.12
sol.27.7h–k	Sole (*Solea solea*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)	WGCSE	3.2
whg.27.7a	Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea)	WGCSE	3.14

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 no later than 25 April 2017 according to the Data Call 2017.

WGCSE will report by 25 May 2017 for the attention of ACOM, and by 7 October 2017 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.

1.1.3 Additional ToR

The Workshop on the Development of the ICES approach to providing MSY advice for category 3 and 4 stocks (WKMSYCat34) met on 6 to 10 March 2017. One of the ToRs was "*Defining a set of criteria for the identification of category 3 and 4 stocks that should be candidates for full analytical assessment with forecast, and identifying some candidate stocks*."

In response to this ToR, WKMSYCat34 developed a template to evaluate if a stock could be a candidate for a full analytical assessment with forecast (i.e. category 1) after a benchmark-type or similar process. The template was tested on three example stocks and was found to provide the necessary information to identify the potential candidate stocks.

WKMSYCat34 recommended that the template be used by the stock assessment expert groups in 2017 to identify candidate stocks for category 1.

Below I have included the relevant chapter of the WKMSYCat34 report.

The ACOM leadership has discussed the recommendation and agrees that the template is a useful tool to identify candidate category 3 and 4 stocks for full analytical assessment. The leadership also supports the recommendation to request stock assessment groups to apply the template.

The ACOM leadership is aware that adding a new ToR to your group at this stage is not optimal and that it may be difficult to find time to address the request. However, the input from your group is crucial to be able to move forward with this. For this reason, I would like to request that you read the chapter below from the WKMSYCat34 report and consider to what extent your group will be able to apply (fully or partly) the template for category 3 and 4 stocks assessed by your group.

1.2 Participation

The number of participants able to attend the Working Group for the full duration of the meeting continues to decline (Figures 1.2.1 and 1.2.2) but this year showed an increase in the total number of people participating due to an increase in numbers participating part-time (this includes members working by correspondence). As last year, seven institutes were represented by full-time participants at the meeting.

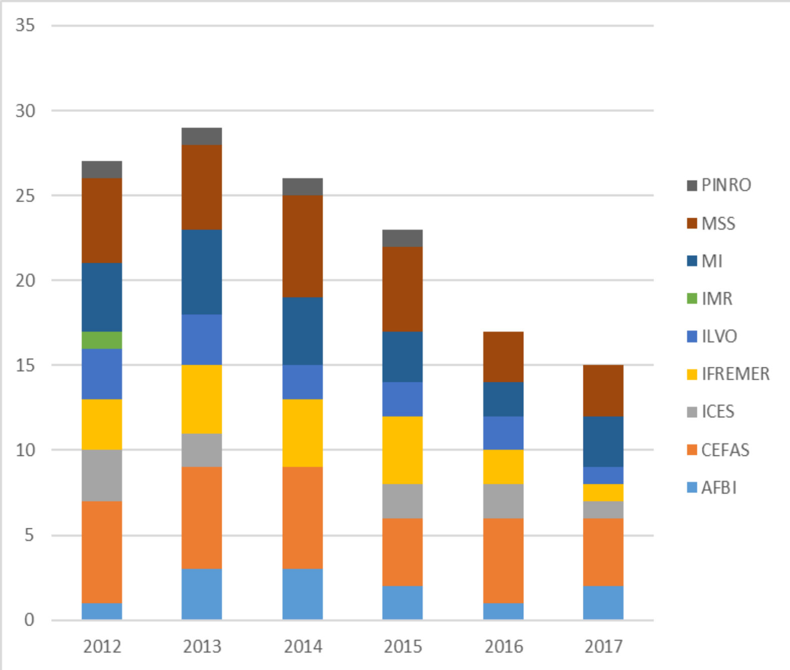

Figure 1.2.1. Numbers of WGCSE full-time participants by institute over time.

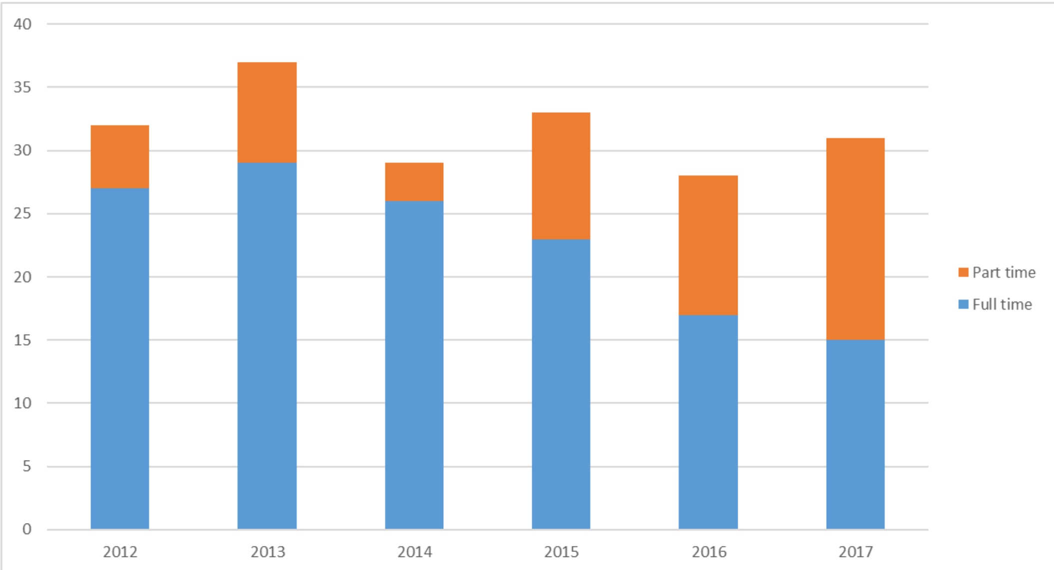

Figure 1.2.2. Numbers of WGCSE participants over time and whether they were full-time or part-time (part-time includes working by correspondence).

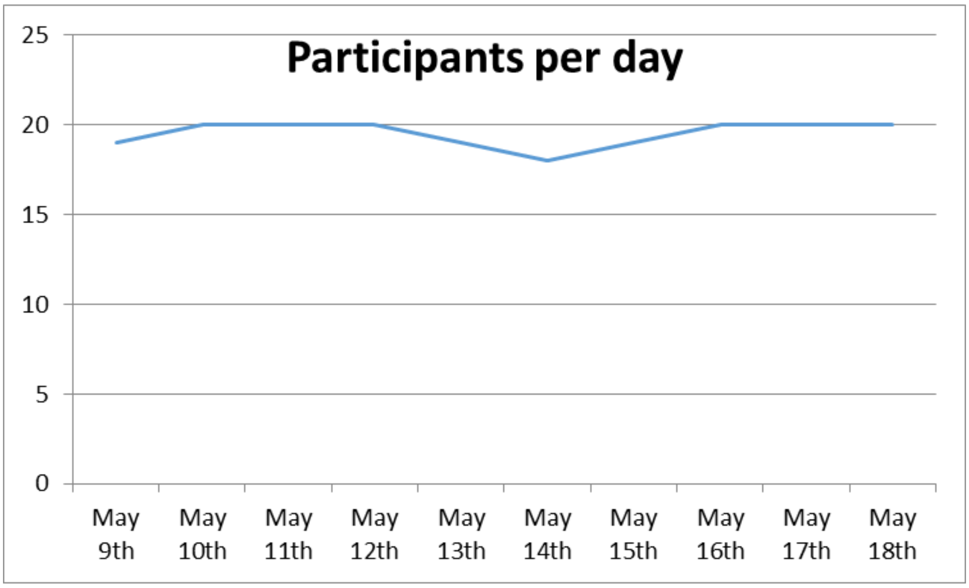

Figure 1.2.3. Number of participants in WGCSE 2017 by day.

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 cod.27.6.a, cod 27.7.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.fg, sol.27.7.e, whi.27.6.a, whi.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: Assessments based on survey data (Surba model or survey index) are used as the assessment and advice basis for anf.27.3a46, lez.27.6b, and ple.27.7fg.
- Category 4: Depletion corrected average catch was used for pol.27.67.
- Category 5 & 6: No assessments were carried out in 2016 for bss.27.6bc7ad–h, ple.27.7bc, sol.27.7bc, cod.6b, whi.27.6b, nep.27.6aoutFU and nep.27.7outFU; only landings statistics were updated.
- No assessment could be performed at the working group for bss.27.4bc7ad–h due to changes in the calculation of the lpue index, which the Working Group considered needed an external review.

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 Internal auditing and external reviews

This year ICES reinstated the external review process, establishing a Review Group (RG) with the responsibility of auditing all category 1 stocks ahead of the ADG. 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, the WG again carried out its own internal audit process using the standard ICES template. Stocks audited by the WG included: cod.27.6b, cod.27.7a, cod.27.7e–k, had.27.7a, had.27.7b–k, ple.27.7e, ple.27.7fg, sol.27.7bc, sol.27.7e, sol.27.7fg, sol.27.7h–k, whg.27.6a, whg.27.6b, whg.27.7bce–k. 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. Lack of thorough review (due to time pressures) for a number of more minor category 3 stocks resulted in assessment errors being identified at the ADG and assessments and having to be re-run as a result.

1.5 ToR e WGCSE recommendations for stocks to be benchmarked

WGCSE recommend that cod, haddock and whiting in the Celtic Sea should be benchmarked together in 2018, and that sole in the Celtic Sea, haddock in Rockall, anglerfish in 3a46 should also be benchmarked in 2018. The WG also agreed that there is a need to benchmark both West of Scotland whiting and West of Scotland cod in the near future. However, given the issues associated with stock structure (for cod in particular), it may be appropriate to conduct West of Scotland and North Sea cod benchmarks concurrently. The focus of the benchmarks would be on 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 should also relook at the assessment methods and diagnostics given the potential for changes in selectivity in the commercial fishery. The benchmark should also investigate mixed fisheries and multispecies interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species. Further details are given in the stock sections.

1.6 ToR c(ii) Estimation of MSY proxy reference points

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

- For three stocks (haddock, plaice and whiting in the Irish Sea), the WKIrish benchmark had already addressed this issue by calculating reference point based on category 1 assessments, and the results were presented to the Working Group and adopted.
- For three stocks (plaice in 7.e and in 7.h–k, sole in 7.h–k) age-based assessments are performed, although only used as relative indicators of stock status. For these stocks, reference points were estimated using the package EqSim, and the method of WKMSYREF4.
- For pollack in subareas 6–7, the current DCAC assessment provides indication of whether the stock is being exploited below F_{MSY}. But no indication of a how biomass compares to any reference point. Alternative proxies using length-based methods and SpiCT were presented to the Working

Group, but judged to be unsatisfactory, and so the DCAC estimation was used.

- For plaice in 7.fg, 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 *Nephrops* in functional units 20–21, proxy reference already exist, and there were no alternative approaches proposed.
- For megrim in Rockall, the majority of work for this stock is completed later in the year in time for Autumn advice.
- For anglerfish in subareas 4 & 6, none of the DL approaches for estimating proxy reference points proved entirely satisfactory. This stock is scheduled to be benchmarked in 2018, and so the work of finding suitable reference points was deferred until the assessment has been reviewed.

1.7 Completion of checklist for upgrading category 3 and 4 stocks

To address the additional ToR regarding completing the checklist for upgrading the category 3 and 4 stocks, the following progress was made:

- For plaice in 7.e and anglerfish in subareas 4 & 6 a checklist was completed and is included in this report in the relevant sections.
- For and plaice in 7.fg, which are planned to be benchmarked this winter, the issues lists were updated, and so the checklist was considered redundant.

For plaice in 7.h–k, sole in 7.h–k, pollock in subareas 6–7, *nephrops* in functional units 20–21 (which is now a category 1 stock) and megrim in Rockall no checklists were completed.

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

Assessment in 2017

In 2016, the assessment was based on a stock size indicator from survey data and the advice followed the agreed procedures for category 3.2.0 of ICES RGLIFE data-limited stock (DLS) methods as set out in the stock annex. The advice is issued in October each year following the work up of the spring survey which is not available in time for the WG. This report therefore summarises last year's assessment and describes the commercial data available for 2016. The survey work up will be provided in a working document ahead of the autumn ADG.

ICES advice applicable to 2016 and 2017

ICES advice for 2016

ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 18 435 tonnes. If discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 17 642 tonnes.

ICES advice for 2017

ICES advises that when the precautionary approach is applied, catches in 2017 should be no more than 22 007 tonnes. If discard rates do not change from the average of the last three years (2013–2015), this implies landings of no more than 21 171 tonnes.

4.1 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. The WGNSDS in 2004 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 2016 and 2017

Species:	Anglerfish	Zone:	Union waters of IIa and IV
	Lophiidae		(ANF/2AC4-C)
Belgium		398 (1)	
Denmark		878 (1)	
Germany		429 (1)	
France		82 (1)	
The Netherlands		301 (1)	
Sweden		10 (1)	
United Kingdom		9169 (1)	
Union		11 267 (1)	
TAC		11 267	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		45	
Denmark		1152	
Germany		18	
The Netherlands		16	Analytical TAC
United Kingdom		269	Article 3 of Regulation (EC)
Union		1500	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		229	
Germany		262	
Spain		245	
France		2818	
Ireland		638	
The Netherlands		221	
United Kingdom		1962	
Union		6375	
TAC		6375	Precautionary TAC

COUNCIL REGULATION (EU) No 72/2016 of 22 January 2016 fixing for 2016 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		478 (1)	
Denmark		1054 (1)	
Germany		515 (1)	
France		98 (1)	
The Netherlands		361 (1)	
Sweden		12 (1)	
United Kingdom		11 003 (1)	
Union		13 521 (1)	
TAC		13 521	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		45	
Denmark		1152	
Germany		18	
The Netherlands		16	Analytical TAC
United Kingdom		269	Article 3 of Regulation (EC)
Union		1500	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		275	
Germany		314	
Spain		294	
France		3383	
Ireland		765	
The Netherlands		265	
United Kingdom		2354	
Union		7650	
TAC		7650	Precautionary TAC

COUNCIL REGULATION (EU) No 127/2017 of 20 January 2017 fixing for 2016 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 2003–2017.

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 in 2017 to tables using the ICES Historical Nominal Catches 1950–2010 catch statistics datset for the time period 1991–2010 and the most up to date values from the ICES Official Nominal Catches 2006–2014 catch statistics dataset for the time period 2011–2014. Preliminary catch statistics were used for 2015–2016. Total officially reported landings of anglerfish from the Northern Shelf are shown in Figure 4.1.

The fishery in 2016

Official landings in 2016 for subareas 6 and 4 were 18 919 t (6042 t and 12 877 t), giving a 1% undershoot of the combined TAC of 19 142 t (95% and 101% TAC uptake respectively). In Subarea 6 Belgium (0%), the Netherlands (0%) and France (62%) had noticeably low uptakes. These were the same countries, along with Germany observed to significantly undertake their quota in Subarea 4; Belgium (57%), France (44%), Germany (51%) and the Netherlands (47%). The UK exceeded its quota in Subarea 6 (by 56%) as did Ireland (by 15%). In Subarea 4 Denmark exceeded its quota by 3%. Over quota landings were most likely due to countries obtaining additional quota from other EU member states, or carrying forward unutilised quota from 2015 and using a flexibility allowance whereby 10% of four TAC can be utilised to reattribute landings from Subarea 6.

Uptake of EC quota in 2016, 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(total)	Landings 4	Uptake (%)
Belgium	229	-	0%	45	398	443	253	57%
Denmark	-	-	-	1152	878	2030	2088	103%
France	2818	1734	62%	-	82	82	36	44%
Germany	262	258	98%	18	429	447	226	51%
Ireland	638	735	115%	-	-	-	-	-
Netherlands	221	-	0%	16	301	317	148	47%
Norway	-	12	-	-	-	-	624	-
Russia	-	-	-	-	-	-	-	-
Spain	245	234	96%	-	-	-	-	-
Sweden	-	-	-	-	10	10	10	100%
UK (total)	1962	3069	156%	269	9169	9438	9429	100%
Total Union TAC	6375	6042	95%	1500	11 267	12 767	12 877	101%

[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, targeting either white fish (77% of total landings by weight) or *Nephrops* (3%). Alongside these fleets there was also a significant gillnet fishery (13%), 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 (7%). A larger proportion of the landings were taken by demersal trawls in 2016 in comparison with 2015 (69%) and a lower proportion, by both the N*ehrops* and gillnet fleets.

UK (Scottish) vessels accounted for the majority of reported anglerfish landings from the combined Northern Shelf area, taking approximately 62% of the landings overall. Scottish, Danish and Norwegian vessels took 75%, 17% and 5%, respectively, of the North Sea (Divisions 4.a–4.c) landings. Scottish, French and Irish vessels took 46%, 29% and 12%, 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 60%. Anecdotal information on the fishery in 2016 from industry representatives is that catches are increasing and subsequently quota uptake is higher on the same time in previous years. There are also reports of a large amount of small juveniles being seen in the inshore areas.

Landings in Division 3.a are not regulated: Table 4.5 shows the official landings which had fluctuated between 400–500 t since 2005, in 2016 they have increased significantly to 596 t.

4.2 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 due to, i) less restrictive TACs, ii) the introduction of buyers and sellers legislation in the UK Ireland and iii) the offshore gillnet fishery for anglerfish historically conducted by Spanish flagged vessels and thought to under-report landings, is now 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 are leading to an increase in suspected misreporting, discarding and black landings. During the period 2005–2010, landings data were not provided to the Working Group by some of the major nations exploiting the fishery and hence WG estimates of the actual subarea 6 and 4 landings have not been calculated for this period.

Discards

Discard estimates have been available within InterCatch since 2012. The breakdown of landings and discards by main gear group and area for 2016 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 4.24% of total catch in 2016, an almost twofold increase on the 2015 rate of 2.6%. Demersal TR2 trawlers had the highest discard rate due to more restrictive quota share, 43.9% in 2016 up from 22.8% in 2015. In comparison TR1 trawlers, gillnets and miscellaneous gear types had much lower rates of 2.5%, 4.8% and 3.1% respectively. Discards in Subarea 4 (508 t) were higher than in Subarea 6 (314 t), however the percentage of discards was higher for Subarea 6 (5.3% compared to 3.9%).

Figures 4.3(a–c) show the percentage of landed weight by fleet, country and area. Length–frequency samples for catch in 2016 were submitted by Denmark, France, Germany, Ireland and the UK. 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 four samples for landings (Ireland: 292 fish) and five for discards (UK (Scotland): 308 fish). The gillnet fleet on the whole was poorly sampled in all areas, with only two discard samples (Danish) totalling three fish measured and no samples from UK-flag vessels which alone accounted for approximately 8% of all landings.

Discard data are used in the provision of catch advice which is based on the DLS approach (ICES, 2012).

Biological

An anglerfish ageing exchange was held in 2011 to investigate the possibility of the collation of an international landings-at-age dataset, 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). Recommendations of this report included examining the suitability of growth model for this stock, exploring simple harvest control rules with appropriate biological reference points and collating an international catch-at-length dataset for use in an integrated stock synthesis assessment as is applied in southern anglerfish stocks.

Research vessel surveys

The 2016 SCO-IV-VI-AMISS-Q2 survey is described in detail in the Stock Annex and the most recent results of the 2016 SCO-IV-VI-AMISS-Q2 can be found in the working document (Barreto, E and Clarke, L., 2016). 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 2015 and 2016 were 67 915 t and 77 946 t respectively.

Both total numbers and total biomass had been increasing since 2011 (Table 4.8 and Figure 4.6) however in 2016 there was a reduction in total numbers whilst biomass continued to increase. The substantial increases in numbers (2014–2015) and biomass (2014–2016) is 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 SCO-IV-VI-AMISS-Q2 survey (for years for which length data are currently available 2007–2015) (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 is the first year in which the year class's contribution to total biomass-at-length is markedly apparent (Figure 5.2.9).

After a period of low surveyed abundance in both subareas 4 and 6.a for the years 2009–2012 there has been a significant increasing trend in the years following, however 2016 has shown the first decline in abundance in five years. Whilst the abundance and biomass of anglerfish in subareas 4 and 6.a have tracked each other relatively well over the time-series, in 2015–2016 the areas have shown divergent trends with a decline 6.a and 4 continuing to increase.

Estimates of the ratio of survey biomass between subareas 4 and 6 have fluctuated around 1:1, (time-series average of 48% in Subarea 4, Table 4.7). However, the proportion of biomass in Subarea 4 has been steadily increasing in recent years (reaching 57.7% in 2016). (Figure 4.10).

Commercial catch-effort data

Trends in nominal international fishing effort in Skagerrak, North Sea and Eastern Channel and 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 since 2012 and in the West of Scotland increasing in the past two years driven by marked increases in long-line fisheries. A significant change in this overall trend of anglerfish fleets is not anticipated with the introduction of 2016 data.

There is now a time-series of commercial catch-at-length data for 2012–2016 (Figure 4.4). 2012–2014 show similar landing length–frequency profiles, while both the number of and mean length of fish being discarded reduced during this period. In 2015 we saw the strong 2013 cohort enter 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. Corresponding discard levels in 2015 were the lowest in the time-series however the landings of <30 cm fish were also lower, suggesting this reduction was due to catch composition rather than fisher behaviour. The strong year 2013 year class can again be observed in the 2016 survey length–frequency plots, now between 50 and 60 cm in length. There is evidence that more larger fish are now being discarding with the tail of the discard distribution extending to 50 cm suggesting high grading practices. Generally there are less larger individuals in the profiles of the recent years.

4.3 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 (SCO-IV-VI-AMISS-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).

4.4 Short-term projections

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

4.5 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 used there (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 SCO-IV-VI-AMISS-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. Harvests by number and biomass have increased in 2016, the rate by number of individuals shows a steeper increase than harvest rate by biomass which has been fairly stable since 2014. 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 fish which make up the bulk of catch.

4.6 Management plans

There is no management plan for this stock.

4.7 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. Given that there is now a longer time-series of survey data the benchmark in 2018 will attempt to develop a suitable analytical assessment for this stock.

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).
- Lack of catch information submitted to ICES by several key exploiters of the fishery between 2006–2010.

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.

Biological information

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

In addition, ageing has not been validated and should still be regarded as uncertain. An ageing exchange, carried out in 2011 found little agreement between methods or readers using the same method (ICES, 2013).

Stock structure

Currently, anglerfish on the Northern Shelf are split into Subarea 6 (including 5.b (EC), 7 and 14) and the North Sea (& 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.

4.8 Recommendations for next Benchmark

This stock was last benchmarked in February 2013 at WKROUND and is due to be benchmarked in 2018. WKROUND recommended significant work to be carried out before the next benchmark. WGCSE short-listed the following tasks:

- Compile historical catch-at-length data.
- 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.
- Assess within reader variability for otolith readers used on the SCO-AMISS-IV-VI-Q2 survey.
- Investigate an age-aggregated production/depletion model.
- Determine the best way to incorporate *Lophius budegassa* into assessment and advice.

At this stage the focus of the current benchmark process moving forward is to ascertain what commercial sampling data (length, age, weight) are currently held internationally, to construct an appropriate data call to compile length–frequency, age composition and additional pertinent survey data.

4.9 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 SCO-IV-VI-AMISS-Q2 surveys (Table 4.9) shows that the mean biomass in subareas 4 and 6 combined has increased by 71.5% from 2012–2014 to 2015–2016. Application of the uncertainty cap implied advice for catches in 2017 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 2016, 10% of the TAC for 4 and 2.a could be taken from Division 5.b, or subareas 6, 7 and 9. However the stock is fairly evenly distributed across the two areas (Table 4.7 and Figure 4.10). Over the survey time-series the 4:6 split has fluctuated around 50:50 (48% on average), increasing as the stock in 4 has increased. 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.

4.10 References

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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 below F_{pa}	3180	49% reduction	4126	7000	49% reduction	8268
2004	<8800[2]	Reduce F below F_{pa} [2]	3180	48% reduction	3296	7000	48% reduction	9027
2005	-	No effort increase[2]	4686	-	-	10 314	-	-
2006	-	No effort increase[2]	4686	-	-	10 314	-	-
2007	-	No effort increase[2]	5155	-	-	11 345	-	-
2008	-	No effort increase[3]	5155	-	-	11 345	-	-
2009	-	No effort increase[3]	5567	-	-	11 345	-	-
2010	-	No effort increase[3]	5567	-	-	11 345	-	-
2011	-	Decrease effort	5456	-	-	9643	-	-
2012	-	Reduce catches	5183	-	4763	9161	-	7211
2013	-	20% reduction in TAC[2]	4924	-	4730	8703	-	6874
2014	-	20% reduction in TAC[2]	4432	-	4328	7833[6]	-	8465
2015	-	20% increased in TAC[2]	5313	-	5140[7]	9390[6]	-	10 918[7]
2016	-	20% increased in TAC[2]	6375	-	6280	11 267	-	13 396
2017	-	20% increased in TAC[2]	7650	-	-	13 521	-	-

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 2011–2016.

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	-	-
1998	626	16859	2088	78	4506	1313	19026	5819	25471	-	-
1999	660	13344	1517	24	4284	1401	14885	5685	21230	-	-
2000	602	12338	1617	31	3311	1074	13986	4385	18973	-	-
2001	621	12861	1832	21	2660	1309	14714	3969	19304	-	-
2002	667	11048	1244	21	2280	718	12313	2998	15978	-	-
2003	478	8523	847	20	2493	643	9390	3136	13004	-	-
2004	519	8987	851	15	2453	671	9853	3124	13496	-	-
2005	458	8424	688	5	3019	958	9117	3982	13557	-	-
2006	425	10339	683	3	2785	915	11026	3700	15151	-	-
2007	433	10632	749	4	3353	1260	11384	4613	16430	-	-
2008	486	11038	769	5	3373	1247	11812	4620	16918	-	-
2009	479	10067	652	9	2983	1821	10729	4804	16012	-	-
2010	434	8134	614	11	3040	1606	8759	4646	13839	-	-
2011	406	7759	764	9	2871	1871	8532	4741	13679	13770	-
2012	422	6460	714	3	2835	1831	7177	4666	12265	12449	498
2013	407	6392	546	4	2666	2124	6943	4789	12139	12054	787
2014	439	7629	823	27	2610	1755	8482	4366	13287	13283	416
2015*	480	9668	961	9	3365	1559	10639	4924	16043	16552	420
2016*	586	11671	1194	12	4676	1368	12877	6042	19505	19446	825

***Preliminary.**

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

Division 6.a (West of Scotland)

*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*
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	-	-	-	-	-
France	1910	2308	2467	2382	2648	2899	2058	1634	1814	1132	943	739	1212	1191	1392	1314	1764	1746	1513	1206	1168	1166	1114	1098	1107	1734
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
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	576
Netherlands	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	6	14	8	6	4	4	1	3	1	3	2	1	+	+	1	1	1	2	+	1	1	-	1	1	1	1
Spain	7	11	8	1	37	33	63	86	53	82	70	101	196	110	82	76	3	174	185	197	138	69	123	54	105	226
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	2058
Total	5061	5479	5553	5273	6354	6408	5330	4506	4284	3311	2660	2280	2493	2453	3019	2785	3353	3373	2983	3040	2871	2835	2666	2610	3365	4676
Unallocated	296	2638	3816	2766	5112	11148	7506	5234	3799	3114	2068	1882	985	1938	-	-	-	-	-	-	110	59	-37	-58	-5	137
As used by WG	5357	8117	9369	8039	11466	17556	12836	9740	8083	6425	4728	4162	3478	4391	-	-	-	-	-	-	2981	2894	2629	2552	3360	4783

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*
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
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
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
Portugal	-	-	-	132	128	-	91	413	429	20	18	8	4	19	63	-	-	-	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	2	4	1	1	35	-	-	-	-	-	1	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	44	9
UK(E,W&NI)	99	173	76	50	105	144	247	188	111	272	197	133	133	54	93	46	146	1	48	15	-	120	395	-	-	-
UK(Scot)	201	224	182	281	199	68	156	189	344	374	367	317	160	294	355	477	475	624	1141	1177	-	895	732	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1129	1015	1127	1347	993	1011
Total	923	1089	681	909	958	602	990	1313	1401	1074	1309	718	643	671	958	915	1260	1247	1821	1606	1871	1831	2124	1755	1559	1368
Unallocated	-	-	-	-132	-128	-	-91	-413	-9	17	-178	-47	145	121	-	-	-	-	-	-	-296	-214	-25	-50	-7	129
As used by WG	923	1089	681	777	830	602	899	900	1392	1091	1131	671	788	792	-	-	-	-	-	-	1575	1617	2099	1705	1552	1497

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

Subarea 6 (West of Scotland and Rockall)

***Preliminary.**

^ indicates landings assigned to subarea 6 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*
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	+	-
France	1910	2308	2496	2382	2648	2899	2059	1635	1814	1180	1135	782	1403	1366	1689^	1538	2091	2073	1852	1374	1676	1622	1777	1246	1326	1734
Germany	1	2	163	140	160	113	249	269	194	158	78	38	91	105	116	73	222	147	211	166	149	142	136	151	201	258
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	735
Netherlands	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	24	24	25	30	18	15	5	9	6	14	7	4	6	5	5	7	8	7	9	13	7	6	10	4	8	12
Portugal	-	-	-	132	128	-	91	413	429	20	18	8	4	19	63	-	-	-	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	2	4	1	1	35	-	-	-	-	-	1	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
UK(E,W&NI)	369	524	299	420	425	345	403	307	171	316	237	165	164	84	113	70	188	6	60	18	-	132	401	-	-	-
UK(Scot)	2814	2609	2528	2414	2732	2583	2478	1962	2032	1870	1486	1417	865	1156	1482	1451	1546	1720	2005	2217	-	2073	1770	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2145	2205	2171	2310	2636	3069
Total	5984	6568	6234	6182	7312	7010	6320	5819	5685	4385	3969	2998	3136	3124	3982	3700	4613	4620	4804	4646	4741	4666	4789	4366	4924	6042
Unallocated	296	2638	3816	2634	4984	11148	7415	4821	3790	3131	1890	1835	1130	2059	-	-	-	-	-	-	-185	-155	-61	-109	-12	238
As used by WG	6280	9206	10050	8816	12296	18158	13735	10640	9475	7516	5859	4833	4266	5183	-	-	-	-	-	-	4556	4511	4728	4257	4912	6280

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*
Belgium	2	9	3	3	2	8	4	1	5	12	-	8	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	1504
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
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
Netherlands	23	44	78	38	13	25	12	-	15	12	3	8	9	38	13	14	14	12	5	8	5	5	-	16	-	21
Norway	587	635	1224	1318	657	821	672	954	1219	1182	1212	928	769	999	880	1006	831	860	859	735	494	485	545	521	406	608
Sweden	14	7	7	7	2	1	2	8	8	78	44	56	8	6	5	5	20	67	-	-	-	-	-	-	6	4
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	7983	9291
Total	9235	10209	12309	14505	17891	25176	23425	16859	13344	12338	12861	11048	8523	8987	8424	10339	10632	11038	10067	8134	7759	6460	6392	7629	9668	11671

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*
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	189	251
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
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
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	74	119
Norway	17	4	3	11	15	29	6	13	17	9	15	10	12	22	16	12	24	15	21	10	11	11	26	11	9	16
Sweden	-	-	-	3	2	1	3	3	4	3	2	9	2	1	4	4	6	9	-	-	-	-	-	-	3	6
UK(E, W&NI)	669	998	1285	1277	919	662	664	603	364	423	475	236	167	120	96	108	122	105	85	88	-	85	70	-	-	-
UK (Scotland)	845	733	469	564	472	475	574	424	344	318	378	210	241	138	88	98	172	142	108	125	-	115	72	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	284	200	142	175	294	200
Total	2522	3053	3143	3445	2627	1847	2172	2088	1517	1617	1832	1244	847	851	688	683	749	769	652	614	764	714	546	823	961	1194

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*
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	4	2
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	4	8
Norway	-	-	-	-	+	-	-	-	+	-		-	+	-	-	+	-	-	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	2	1	1
Total	26	39	66	210	402	304	160	78	24	31	21	21	20	15	5	3	4	5	9	11	9	3	4	27	9	12

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 6 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*
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	193	253
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	2088

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	13	13	24	30	24	15	15	30	26	36
Germany	75	70	113	99	623	301	619	892	463	196	104	112	76	31	93	187	198	366	233	145	63	275	284	339	309	226
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	79	148
Norway	604	639	1227	1329	672	850	678	967	1236	1191	1227	938	781	1021	896	1018	855	875	881	745	505	496	572	533	415	624
Sweden	14	7	7	10	4	2	5	11	12	81	46	65	10	7	9	10	26	76	-	-	-	-	-	-	9	10
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	7618	5855	-	4736	4226	-	-	-
UK (Total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6638	5069	4847	6120	8277	9492
Total	11790	13301	15519	18162	20920	27327	25757	19026	14885	13986	14714	12313	9390	9853	9117	11026	11384	11812	10729	8759	8532	7177	6943	8482	10639	12877
Unallocated	-1224	-1573	-2441	-2732	-5126	11087	-7540	-4999	-3166	-2422	-2037	-1979	-1117	-826	-	-	-	-	-	-	167	-269	-59	-17	89	519
WG estimate	10566	11728	13078	15430	15794	16240	18217	14027	11719	11564	12677	10334	8273	9027	-	-	-	-	-	-	8699	6908	6884	8465	10728	13396

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*
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	391
Germany	-	-	1	+	-	1	1	1	2	1	-	1	-	1	1	2	1	1	1	1	2	-	1	-	1	2
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	3	4	4	3	1	3	-	5	-	-	-	4	9	17
Norway	64	170	154	263	440	309	186	177	260	197	200	242	189	130	100	139	132	144	134	158	153	115	108	126	91	124
Sweden	23	62	89	68	36	25	39	33	36	27	46	55	71	73	79	54	44	51	-	-	-	-	-	-	43	52
Total	595	938	843	811	823	702	776	626	660	602	621	667	478	519	458	425	433	486	479	434	406	422	407	439	480	586
Unallocated	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	53	43	50	12	9
As used by WG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	441	475	450	489	492	595

Table 4.6. Breakdown of WG estimates of commercial catches for 2016 by main gear group and area.

	3.a		4		6.a		6.b		Total		Percentage of Total	
Fleet	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards
Demersal trawl	64	0.21	10547	233	3780	93	607	49	14999	376	77	46
Nephrops trawl	335	1.67	231	200	89	86	0	0	655	287	3	35
Gillnets	137	0.42	1532	56	81	3.60	767	61	2517	121	13	15
Other/Not specified	56	0.20	577	19	631	20	12	0.95	1276	40	7	5
Total	593	3	12887	508	4580	203	1386	111	19446	825	100.0	100.0

Table 4.7. Total biomass estimates with confidence intervals and relative standard errors from the 2005–2016 SCO-IV-VI-AMISS-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%

Table 4.8. Abundance and biomass estimates from the 2005–2016 SCO-IV-VI-AMISS-Q2 surveys by ICES subareas and divisions.

	Abundance (millions)											
ICES Subarea/Division	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
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
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
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
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
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

	Biomass (kilo tonnes)											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
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
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
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
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
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

Table 4.9. Percentage change in mean stock biomass from 2012–2014 to 2015–2016 in ICES subareas 4 and 6 combined.

Average Biomass 2012–2014	Average Biomass 2015–2016	Percentage Change in Biomass
42.535	72.930	71.5%

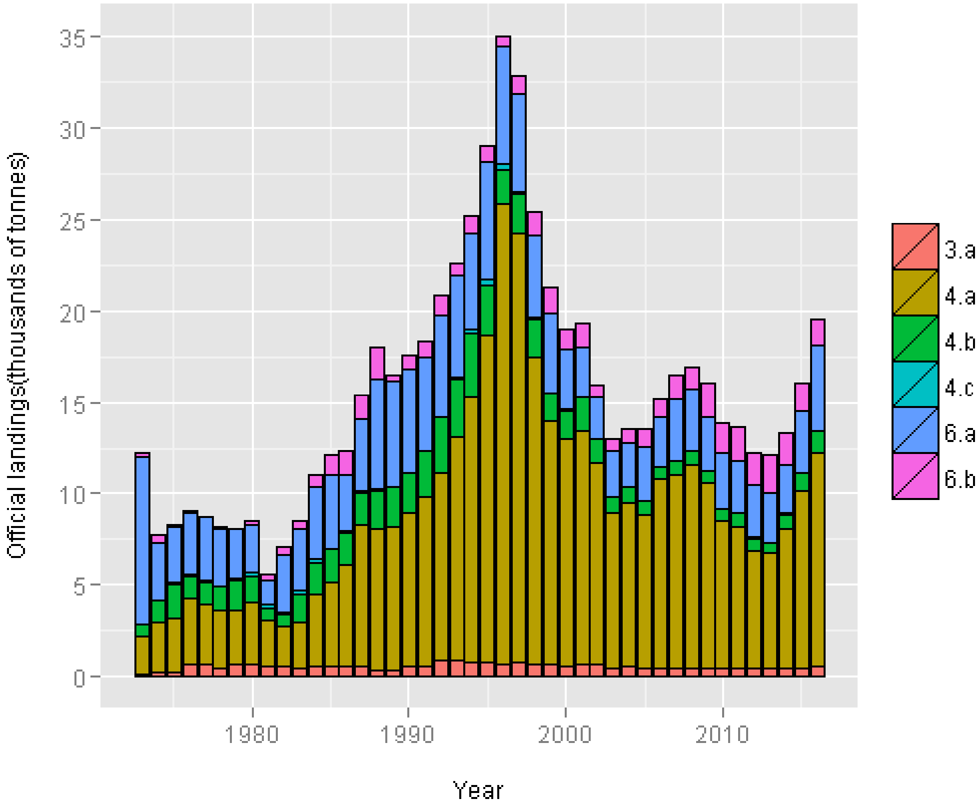
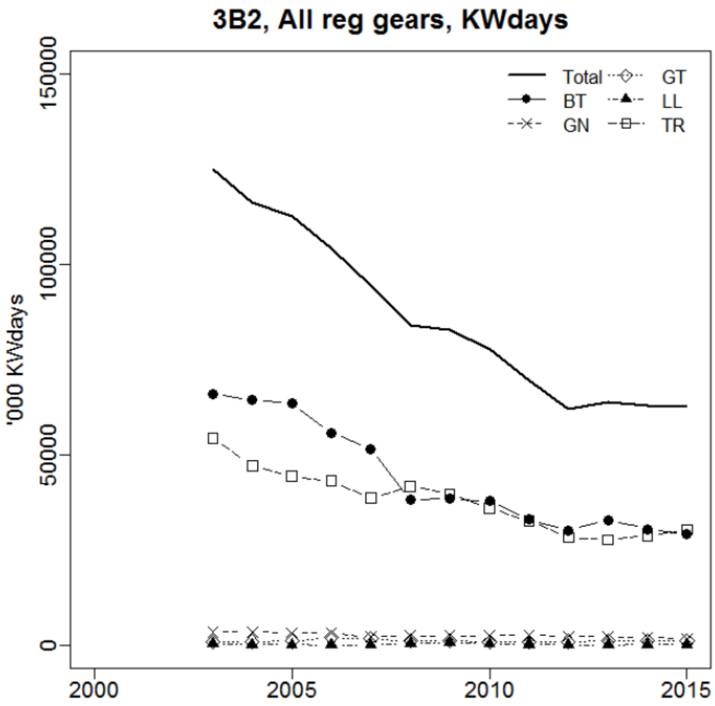


Figure 4.1. Northern Shelf anglerfish. Officially reported landings by ICES area (1973–2016).



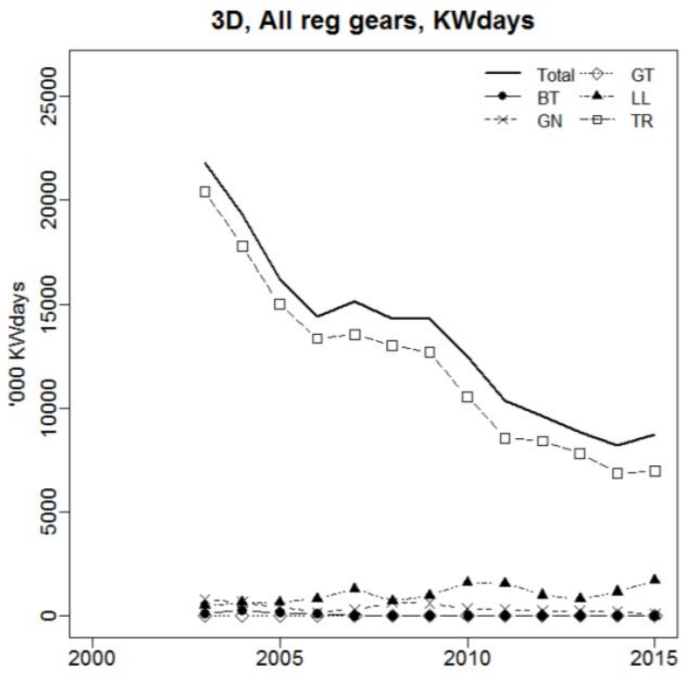


Figure 4.2. Trends in nominal international fishing effort (kW*days at sea) in North Sea and II (EU) (left) and West of Scotland (right) collated by STECF for the Evaluation of Fishing Effort Regimes in European Waters (STECF, 2016).

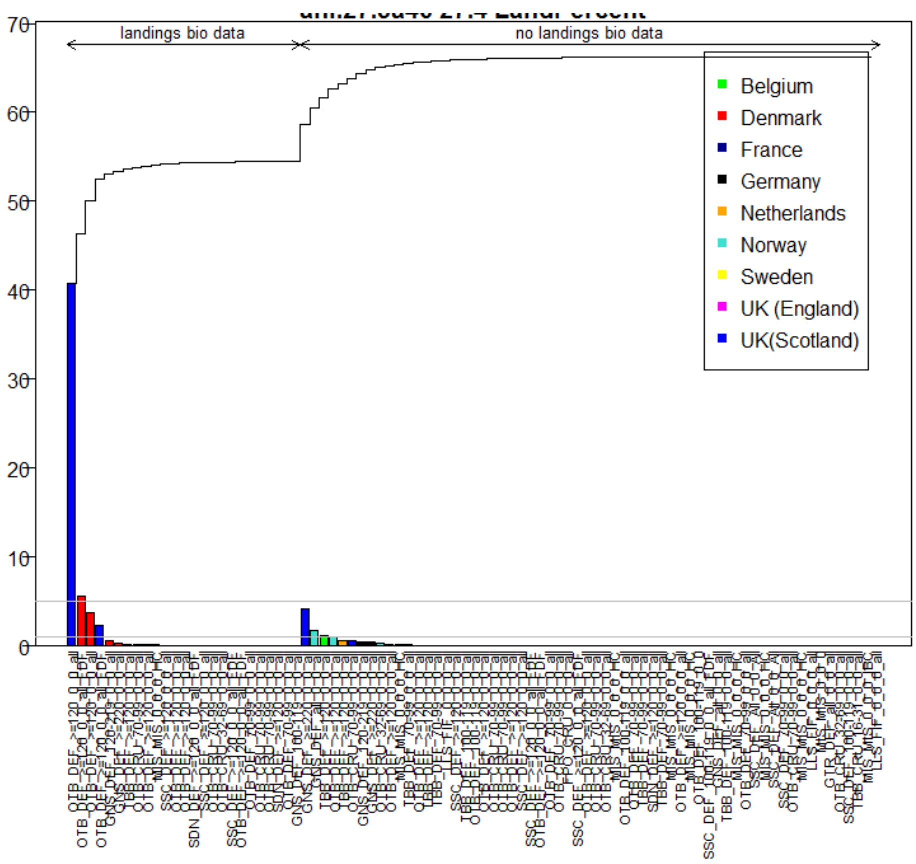


Figure 4.3a. Percentage of total landings weight by fleet and country in 2016; Subarea 4.

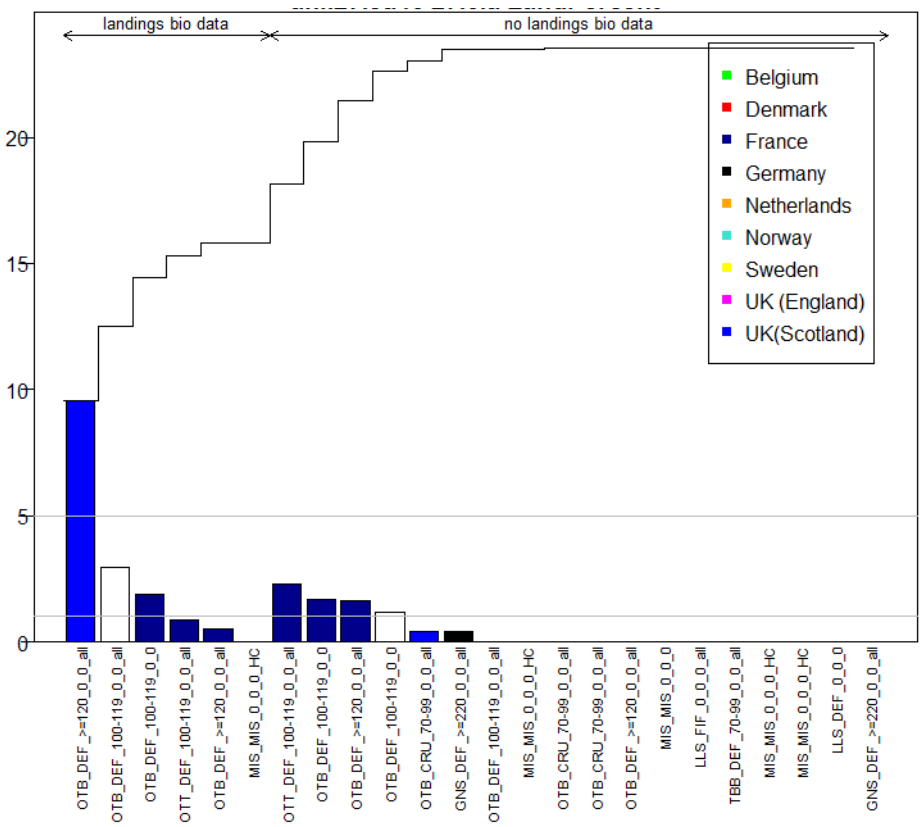


Figure 4.3b. Percentage of total landings weight by fleet and country in 2016; Division 6.a.

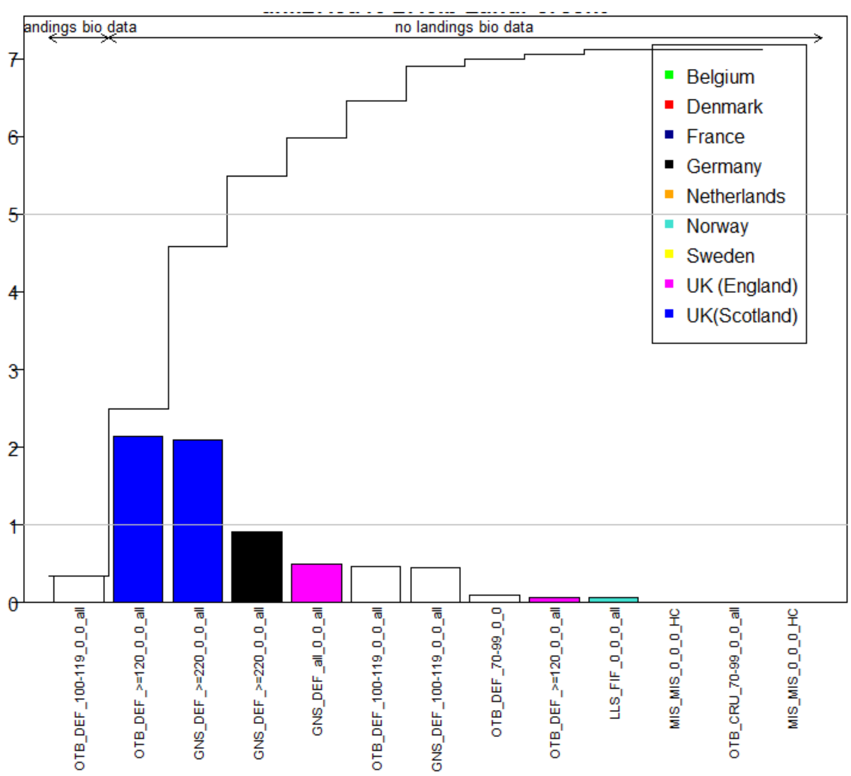


Figure 4.3c. Percentage of landings weight by fleet and country in 2016; Division 6.b.

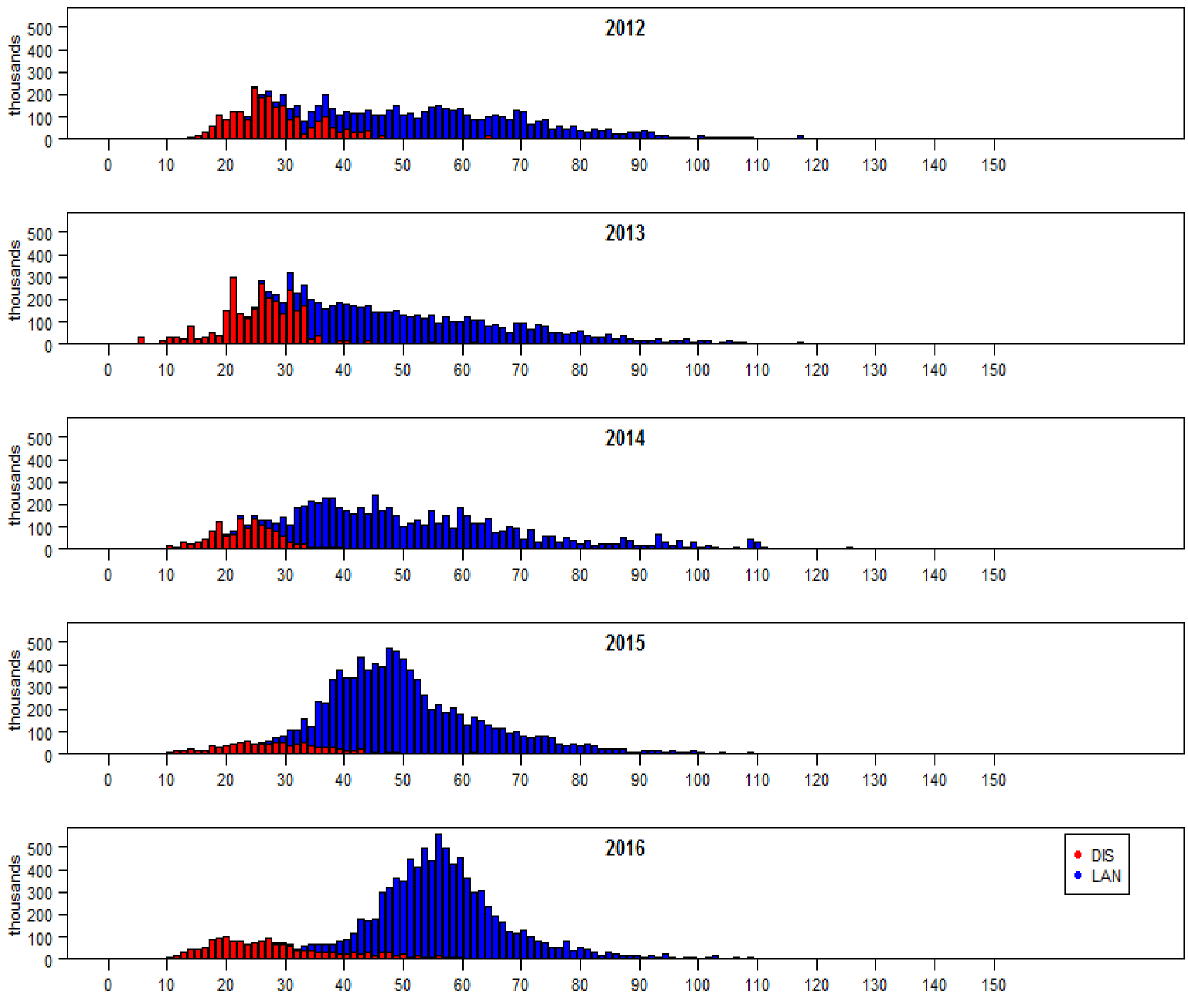


Figure 4.4. WGCSE Landed numbers ('00 thousands) at-length (cm) 2012–2016.

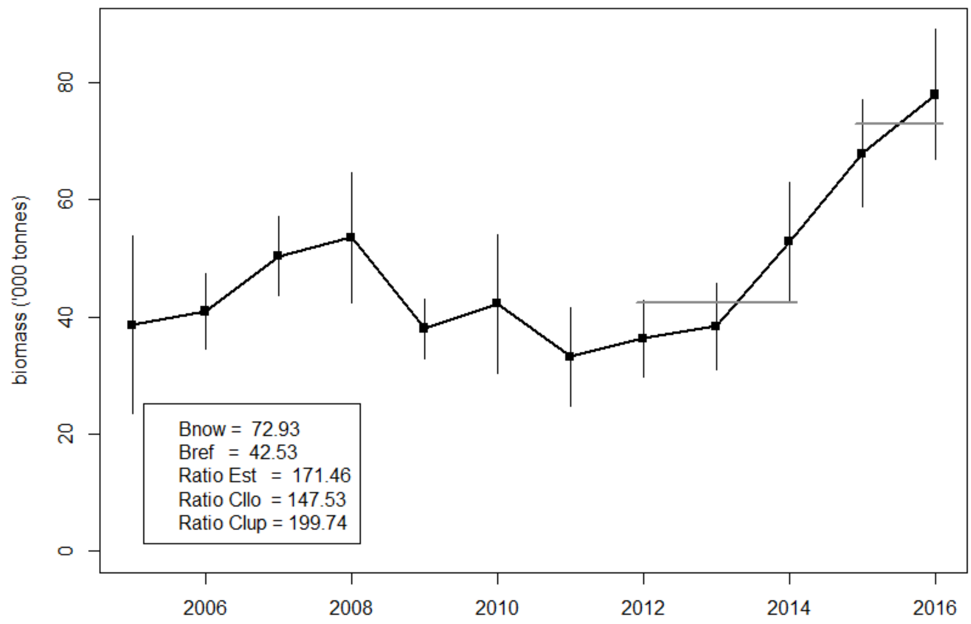


Figure 4.5. SCO-IV_VI-AMISS-Q2 estimates of total biomass, with confidence intervals, for sub-areas 4 and 6 combined, 2005–2016. Bnow is the average biomass for 2015–2016, Bref is the average biomass for 2012–2014; both marked on the graph in their respective years. Ratio Est is the ratio of Bnow to Bref, expressed as a percentage, with confidence intervals (Ratio CIlo, Ratio CIup).

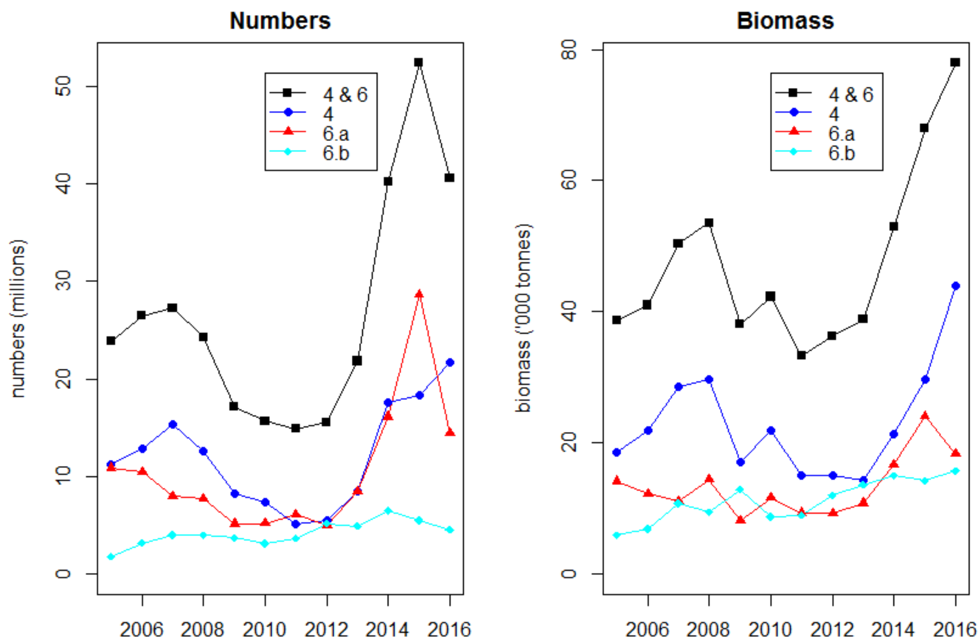


Figure 4.6. SCO-IV-VI-AMISS-Q2 estimates of total abundance (left) and biomass (right) of anglerfish for the Northern Shelf (black filled squares) 2005–2016. Estimates are also provided for ICES Subarea 4 (blue filled circles), Division 6.a (red triangles) and Division 6.b (turquoise diamonds).

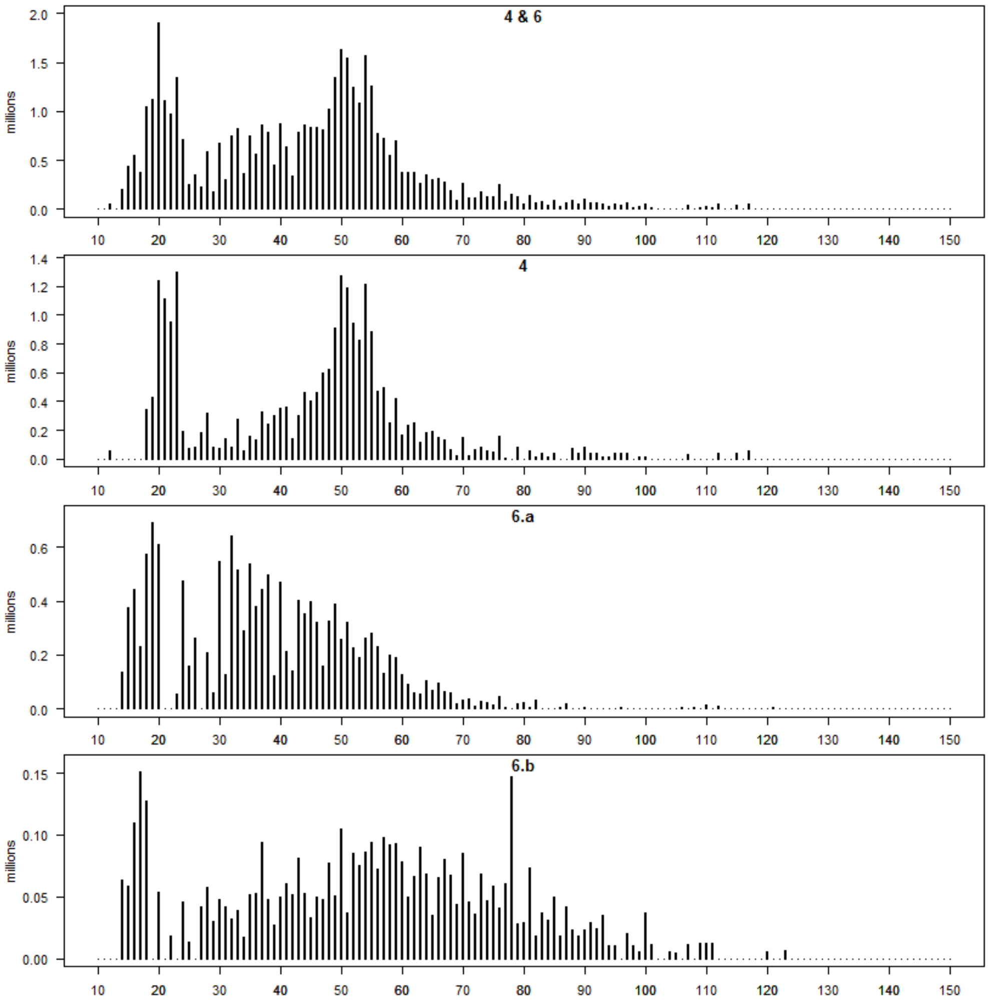


Figure 4.7. SCO-IV-VI-AMISS-Q2 estimates of total numbers (millions) at-length (cm) for Subareas 4.a-c and 6.a–b, 2016.

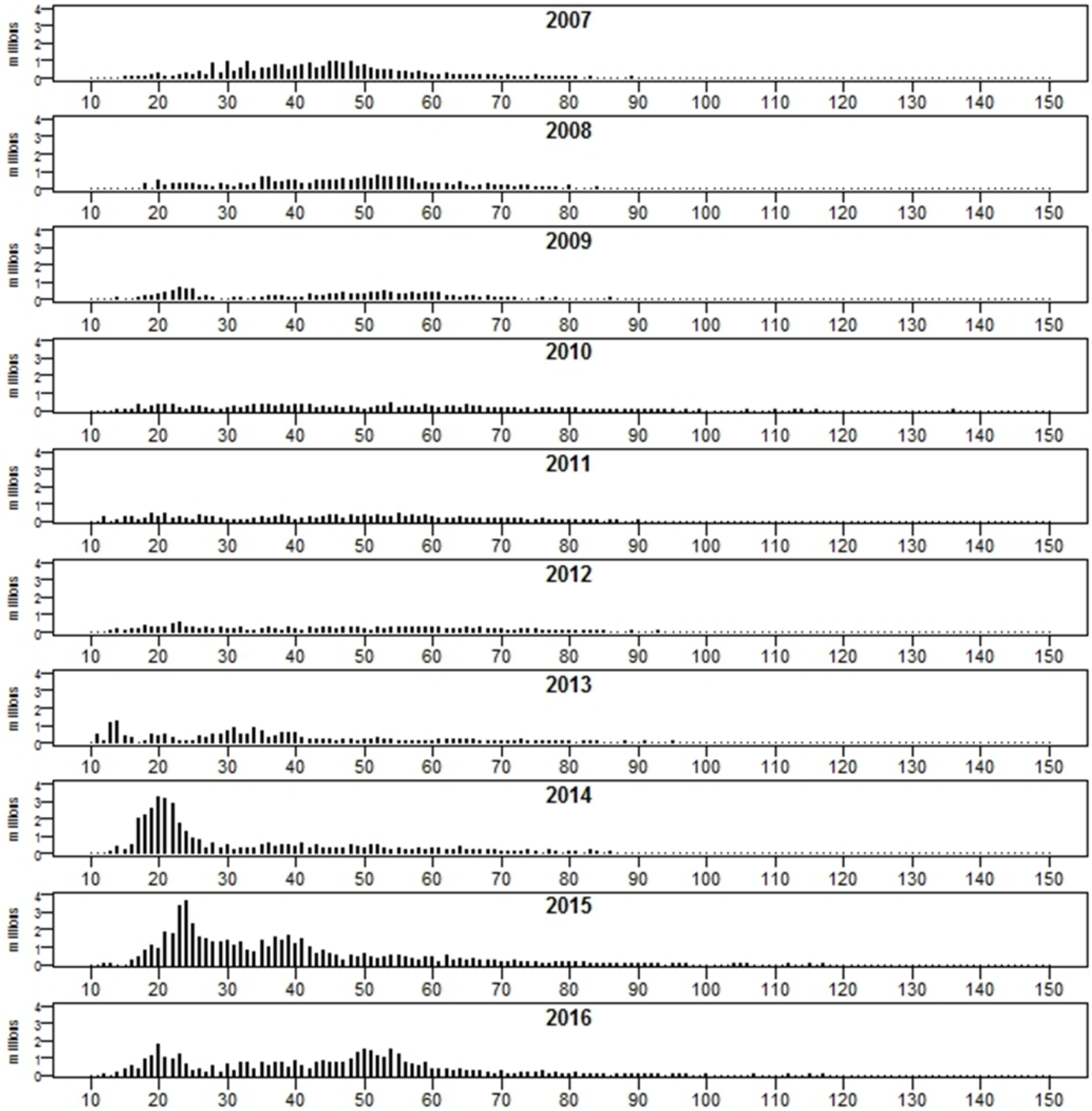


Figure 4.8. SCO-IV-VI-AMISS-Q2 estimates of total numbers (millions) at-length (cm) for Subareas 4.a–c and 6.a–b combined, 2007–2016.

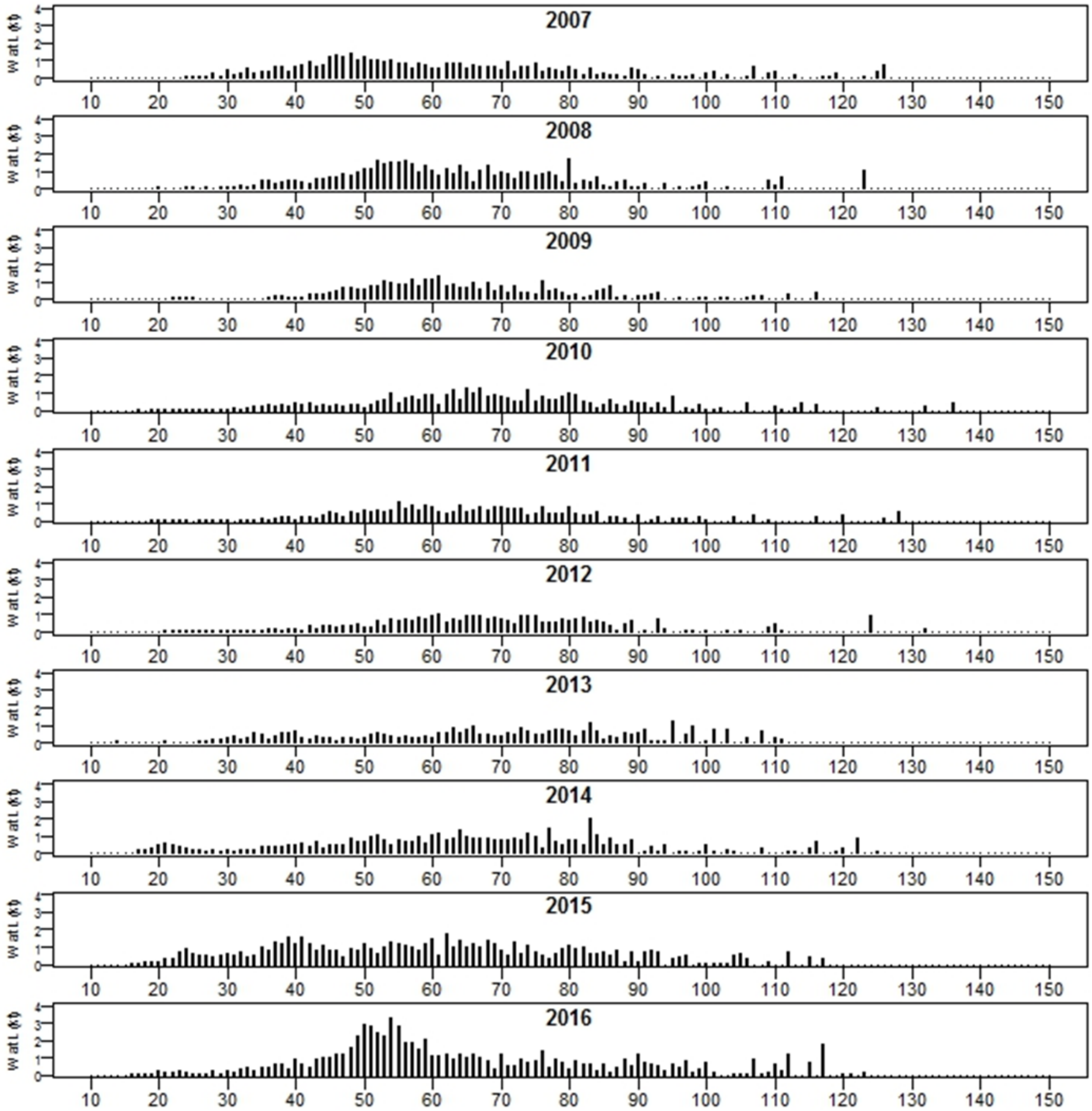


Figure 4.9. SCO-IV-VI-AMISS-Q2 estimates of total biomass (kt) at-length (cm) for Subareas 4.a–c and 6.a–b combined, 2007–2016.

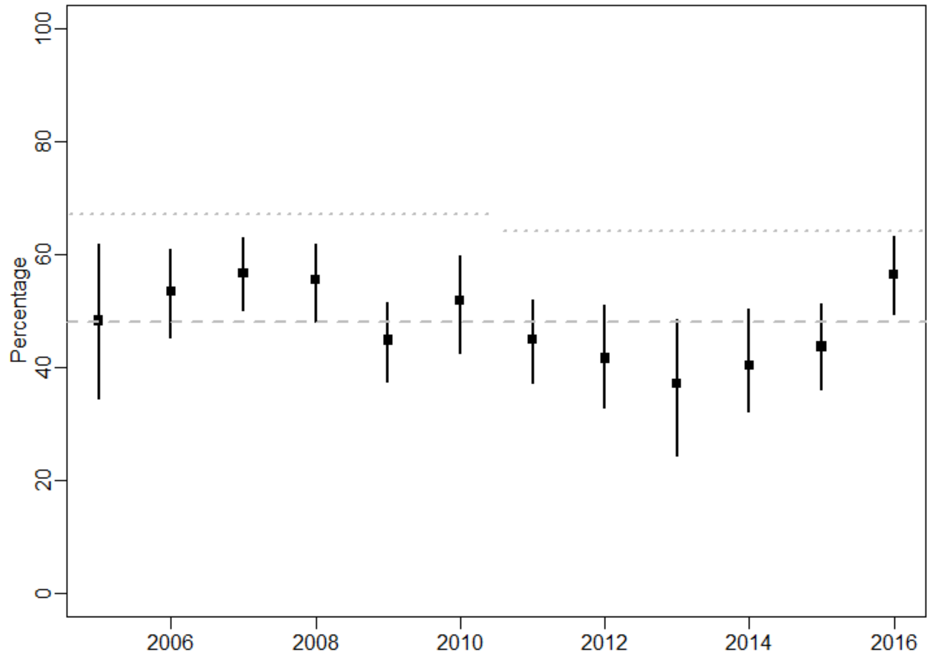


Figure 4.10. Percentage of SCO-IV-VI-AMISS-Q2 total biomass, with confidence intervals, estimated to be in subareas 4.a–c compared with subareas 4.a–c and 6.a–b combined. The full grey line represents the average of these percentages over the time-series (2005–2016) 4 (48%). The dotted grey lines represent 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 2011–2016).

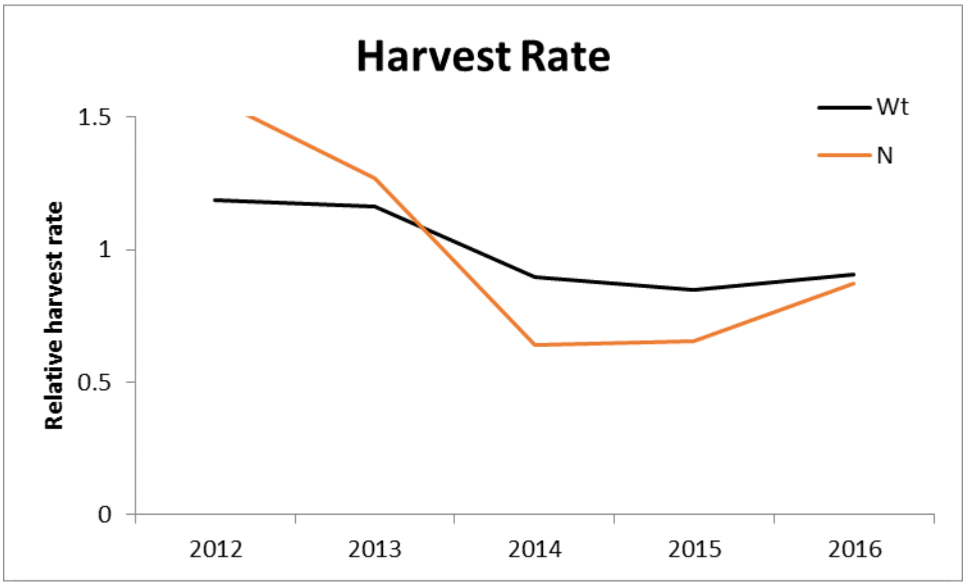


Figure 4.11. Northern Shelf anglerfish harvest rate 2016 (mean standardised WG catch total numbers of biomass)/SCO-IV-VI-AMISS-Q2 total numbers or biomass).

5 Cod in Division 6.a

5.1 Introduction

Cod in Division 6.a is included in the EU long-term management plan for cod stocks and the fisheries exploiting those stocks (Council Regulation (EC) 1342/2008). This plan was amended in 2016 by Council Regulation (EU) 2016/2094.

A benchmark assessment was conducted in February 2012 (ICES, 2012) and an inter-benchmark in February 2015 (ICES, 2015). In general the assessment carried out at the WG follows the procedure outlined in the stock annex developed at the benchmark and updated at the inter-benchmark. There are minor deviations in terms of weighting of individual datapoints which are described in Section 5.3.1.

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.

5.2 General

Stock definition and the management unit

The assessment unit is Division 6.a although there are known to be at least two subpopulations of cod in Division 6.a. 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.

Management applicable to 2012–2017

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

Since 2012 the TAC for cod in Division 6.a has been 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 onboard per fishing trip. Since 2015, this provision has not been allowed for catches subject to the landing obligation.

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 2015–2017

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.

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) and 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 multi-species fisheries. The amended regulation discontinues the previous fishing effort regime and removes reference to the previous F_{mgt} of 0.4.

The fishery in 2016

The table of official landings statistics is given in Table 5.1. Official landings in 2016 were 250 tonnes, an increase of over 50% on the 2014 value which was the lowest of the time-series. Approximately 70% of the official landings are reported by UK vessels with the remainder from Norway and Ireland. 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 (TR1) fleet. Total estimated area misreported Division 6.a cod landings in 2016 were 499 t (largely reported into Division 4.a and to a lesser extent 5.b), more than double the estimate for 2014 and representing almost 60% of the total landings in 2016.

5.3 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. The French OTB_DEF≥120 métier is the largest unsampled métier (~ 8% of the total landings in 2016).

There are no age composition samples from the misreported landings. Following discussions at last year's WG, the WG this year followed a slightly modified procedure for handling the misreported landings within InterCatch (a deviation from the Stock Annex). Previously landings numbers-at-age from the Scottish demersal fleet (TR1) 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 hence the 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).

It can be seen that landings by Scottish trawl ≥120 mm dominate, and discards are also highest from this fleet. However the discard rate is higher from the Scottish trawl 70–100 mm fleet (TR2) (Figure 5.4). The discard rate observed in the Irish fleet is considerably lower than in the other demersal fleets. The proportions of the catch discarded (by weight) for the sampled fleets are given below.

Fleet	Scottish Demersal Trawl^ (TR1)	Scottish Nephrops Trawl(TR2)	Irish Demersal (TR1)	French Demersal trawl (TR1)	N Irish Nephrops (TR2)
Discard proportion	70%	97%	35%	60%	95%

^ The calculation of this discard proportion excludes the area misreported component of landings from this fleet which are assumed not to discard.

Discard proportions and landings and discard age distributions were assigned within InterCatch to unsampled fleets on the same basis (and as described in the Stock Annex). The discard percentages assigned to fleets without discard estimates 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. 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. Observer sampling coverage is similar to last year. Sampling of the Scottish TR1 landings is still relatively poor. The small sample sizes (which include a few very large fish with high raising factors) result in a sum of products (SOP, landings-at-age x weight-at-age) of 1.07 times the landings in this fleet in 2015 and 2016.

	Scotland			Ireland	Northen Ireland	France
Year	Demersal trawl (TR1)	*Nephrops* trawl (TR2)	Total	Total	Total	Total
Landings	12	0	12	24		14
Observer	12	29	41	10	14	33

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 under one tonne of age zero fish were also estimated to have been discarded in 2016.

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 has declined in 2015 and 2016 compared to 2014 although these estimates are uncertain (CV of over 60% for the Scottish TR1 discard weight estimate in 2016). Given the 1.5% bycatch regulation, the landings are potentially 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 TR1 fleet.

Discarding occurs across most of the age classes in the catch including age five and six in recent years. The discard rate (proportion by number caught) at age three showed a marked decline in 2016, but was fairly stable for other age classes compared to 2015 (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. The age composition in the catch is very truncated with few individuals over age three apparent in the catch in recent years (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. 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. Mean weight-at-age in the discards shows no real trend, although there are higher values for ages three and four when they first began to be discarded around ten years ago.

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. Survey indices for the two new Scottish surveys (UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-Q4) are provided with an estimate of variance. In 2017, the indices for age four, five and six cod 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.

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 (UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-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. The Q1 surveys catch cod in the Clyde region and the Q4 surveys show moderate catch rates 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.

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 UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-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+
	0.539	0.386	0.307	0.263	0.238	0.224	0.211

Figure 5.15 shows the resulting M-at-age values used in the assessment and the values calculated in each year individually for comparison. Proportion of fish

mature-at-age are unchanged from the last meeting and is as detailed in the stock annex.

A study by the sea mammal research unit (SMRU) on seal predation has indicated that seal predation on cod probably constitutes significant natural mortality. A version of the TSA assessment model incorporating a seal predation model element was developed for WKROUND 2012. The specification of the seal feeding model is provided in the stock annex. Because only two years of seal consumption data were available at the time, WKROUND considered estimation of the seal feeding parameters likely to be highly uncertain and inclusion of seal predation in the model to be potentially adding little other than noise to the assessment. WKROUND 2012 concluded the final assessment of 6.a cod should not include seal predation estimation but that additional model runs including the seal feeding model could be performed to test the sensitivity of the assessment.

5.3.1 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 for 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. There is some evidence of a decreasing mortality in recent years here too, particularly over age ranges including age two.

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 the highest of the time-series 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 strong 2009 year class in that area.

Figures 5.19 and 5.20 show the log mean standardised indices from the ScoGFS-WIBTS-Q1 survey by year and by cohort respectively. 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 5.21 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 5.22) 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 (Figure 5.23) for any of the age ranges considered.

Figures 5.24 and 5.25 show 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 real 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 in trend in mortality through catch curve gradients (Figure 5.26).

Figures 5.28 and 5.29 shows log mean standardised indices by year and cohort from the UKSGFS-WIBTS-Q1. There is little evidence of successful tracking of cohorts and some evidence of survey year effects. There appears to be a general increase in the catch rates of older ages over time (four and above), but no equivalent increase in the catch rates of younger ages (from the same cohort). An increase in catches of larger fish has also ben reported anecdotally by the fishing industry.

The log catch curves from the UKSGFS-WIBTS-Q1 are also very noisy (Figure 5.30) 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 5.31).

Overall, information on mortality trends from all survey series (including the ScoGFS-WIBTS-Q1) appears to be fairly poor.

The high variability and large CVs (ranging from 35% to 80% depending on age class) for WKSGFS-WIBTS-Q1suggest that this survey is unlikely to contribute significantly to the assessment.

Final assessment

Model settings and input parameter settings for the final run are given in Table 5.10 and final parameter estimates from the TSA run are given in Table 5.11. There is a minor deviation from the stock annex in that landings-at-age 7+ are allowed to have higher variance in order to be able to address the inconsistencies in the age composition of the 2016 landings data observed in Figure 5.18 (and described above). (A similar approach was taken for the landings-at-age five and six in 2015 at the 2016 WG) This datapoint is unexpectedly high, not consistent with other data and could potentially be due to migration of fish from the adjacent North Sea stock. A run of TSA (not shown), with this point unweighted, gives very high prediction errors. Standardised prediction errors at-age from the update assessment run for landings and discards are shown in Figure 5.32 and for the two surveys in Figure 5.33. These are the main diagnostic tools for time-series Kalman filter models like TSA, and indicate the discrepancy between the model prediction and observation as the model steps through the data from the start to the end. They are a useful guide to suggest observations which might need to be down-weighted. Errors within ±2 are considered reasonable.

Figures 5.34 and 5.35 show the residuals by age class for landings and discards and the two surveys respectively. The landings residuals show tendency for positive residuals at younger ages and an increase in the variance of the residuals in more recent years. This latter effect may be associated with the assumption of constant cv in the landings data which may be violated in recent years (the very low level of landings in recent years would imply very precise landings which is unlikely to be the case). The high precision of the landings (in recent years) compared to the UKSGFS-WIBTS-Q1 survey (the TSA model makes use of the CVs associated with the indices) also results in a poor distribution of survey residuals (although the magnitude of these is low). Essentially the model thinks the catch data are much more plausible than the survey data and the survey data have an extremely low contribution to the likelihood. A fuller and more systematic evaluation of the weightings and uncertainty associated with the input data is currently underway. This is being guided by the cv estimates (for landings and discards) which are now available as part of the catch estimation procedure which takes place in national laboratories. Initial model runs are promising in terms of model diagnostics, but an (inter) benchmark process would be required for these changes to be reviewed and agreed as the final assessment.

The time-series of observed and fitted discard proportions-at-age is shown in Figure 5.36. The predictions follow the general trend in the data which are quite noisy.

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 on the log of this mortality are given in Table 5.15. Full summary output is given in Table 5.16. Note that catch, landings and discard weights presented in this table are the sum-of-products of numbers and weights at age rather than reported total weights. A summary plot for this run is shown in Figure 5.37.

Retrospectives for the final assessment run are shown in Figure 5.38. In recent years estimates of mean F have been revised downwards with the incorporation of addition data however this bias does not persist for earlier years. In general retrospective bias is small retrospective runs fall within the confidence intervals of the final model run (which for mean F in particular are very wide). The slight shift in historical SSB for the 2011 peel marks the inclusion of only a single year of the current survey series.

Stock status

Historical stock trends are shown in Figure 5.37 and the stock–recruitment relationship is shown in Figure 5.39. 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, but given that mean F is still estimated to be high, this results in only minor increases in SSB in recent years. Recruitment in 2016 and 2017 is also estimated to be above the recent average, but with continued high mean F will result in only small increases in SSB.

Estimated SSB in the final year is well below B_{lim} (= 14 000 tonnes).Mean F is above F_{lim} (= 0.82) in 2016, an increase on the values for 2015 and 2016 where F is estimated to be below F_{lim} for the first time since 1995. Overall there is a general downward trend (but with significant annual fluctuations) in mean F since 2005, although points estimates are very uncertain. This trend agrees with the indications from the commercial catch data (when considered alone) that there has been a reduction in mortality across some age groups at least, although this is not apparent in the survey data and the age structure remains very truncated. Partial mean F for landings and discards separately is shown in Figure 5.42. Over the last three years, discarding has accounted on average for over 50% of the mean F.

The TSA estimated stock–recruit relationship is shown in Figure 5.39. It includes the datapoint of the 1986 year class which appears as an outlier. The relatively high strength of the 2005 year class (considering the size of SSB) can also be seen.

The precautionary approach plot for this stock is given in Figure 5.40. It shows clearly how the stock has moved and remained in the zone indicating reduced reproductive capacity and unsustainable removals.

Comparison with supplementary (seal predation) assessment

New data on seal consumption have recently become available to update the model, but not in time for this year's WG.

5.3.2 Short-term stock projections

The inputs for the short-term forecast follow the specifications in the Stock Annex. The recruitment in 2017 was taken as the TSA model estimate while future recruitment (2018 and 2019) was taken as a ten year geometric mean (excluding the final year estimate).

Fishing mortality in the intermediate year (2017) was taken as a three year average over 2014 to 2016. Mean weights-at-age and the partition of fishing mortality-at-age between landings and discards were also averaged over the most recent three years.

Variable	Value	Notes
F ages 2–5 (2017)	0.79437	Average of 2014–2016
SSB (2018)	2835 tonnes	Short-term forecast
Rage1 (2017)	3614 thousand	Assessment model estimate.
Rage1 (2018)	2610 thousand	$GM_{2007–2016}$
Catch (2017)	1627 tonnes	Landings + Discards
Landings (2017)	535 tonnes	Average discard pattern (2014–2016)
Discards (2017)	1092 tonnes	Average discard pattern (2014–2016)

The short-term forecast inputs are shown in Table 5.17 and the outputs in Tablse 5.18 and 5.19. Note that the numbers-at-age in 2017 in Table 5.17 are the survivors from 2016 which differ slightly to the TSA numbers-at-age in 2017 (Table 5.12) which are smoothed estimates.

Under the forecast assumption of *status quo* F, landings in 2017 are predicted to be 535 t and discards to be around twice that. The SSB in 2018 is forecast to be 2835 t which is well below B_{lim} (Table 5.18).

The forecast of landings in 2018, and SSB in 2019 in particular is sensitive to the recruitment assumptions. The TSA estimate of recruitment in 2017 and GM recruitment in 2018 contribute 43% and 24% respectively to the forecast SSB in 2019. (Figure 5.43).

5.3.3 Reference points

Both MSY and precautionary reference points were updated at WKMSYREF4 in November 2015 in accordance with ICES guidelines and are shown below (weights in tonnes). There are small differences to those used in the advice for 2015.

	Advice 2015	WKMSYREF4	Rationale (WKMSYREF4)
B_{lim}	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	1.4 x B_{lim}
F_{lim}	0.8	0.82	Based on simulation with segmented regression recruitment with B_{lim} as the breakpoint
F_{pa}	0.6	0.59	F_{lim}/1.4
F_{MSY}	0.19	0.167	
MSY $B_{trigger}$	22 000	20 000	B_{pa}
F_{MSY} upper		0.254	
F_{MSY} lower		0.108	

5.3.4 Management plans

Cod in 6.a is included in Council Regulation No. 1342/2008 (amended by Council Regulation No. 1243/2012 and then further amended by Council Regulation (EU) 2016/2094) establishing a long-term plan for cod stocks and fisheries exploiting those stocks. The plan and its evaluation by ICES are discussed in Section XXX.

5.3.5 Uncertainties and bias in assessment and forecast

Figure 5.41 shows a comparison between this year's and last year's assessments. The assessment presented this year is very consistent with that presented last year in terms of estimates of SSB. The 2016 assessment estimated SSB in 2015 to be 2849 t while this year's assessment estimates it at 2762 t. Mean F in that year is now estimated at 0.69 which is a significant downward revision compared to last year's assessment (0.88). The 2014 mean F has also been revised downwards.

The estimate of recruitment in 2015 is revised down from 2.682 million to 2.020 million. The estimate of SSB in 2016 from this year's assessment is 2741 t with a s.e. of 373 t. Short-term forecasts of SSB conducted at previous WGs have not shown particularly good consistency with estimates of SSB in assessments conducted in successive years. (WGCSE, 2015).

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 60% 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 (TR1) 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 = 60% for Scottish TR1) 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

Down-weighting of various input datapoints to allow for inconsistencies in the data has been conducted on a rather *ad hoc* basis in the past and could potentially have introduced bias. A more systematic approach which uses estimates of CVs derived as part of the catch estimation process conducted in national laboratories may improve the assessment model diagnostics.

5.3.6 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.
Assessment method	Consideration of variance structures used in the TSA model to improve diagnostics	Scientists from MSS	Intersessionally

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

5.3.7 Management considerations

The fishery is managed by a combination of landings limits, area closures, technical measures and effort restrictions. These do not seem to have been effective in controlling catches. Despite considerable reductions in fishing effort over the past decade, the stock structure is still truncated with few older fish present.

The fishing opportunities regulation has explicitly made the stock a bycatch species from 2012. 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. In 2008, Scotland introduced a voluntary programme known as “Conservation Credits”, which involved seasonal closures, real-time closures (RTCs) and various selective gear options. This was designed to reduce mortality and discarding of cod. RTCs are determined by lpue, based on fine scale VMS data and daily logbook records and also by on-board inspections. There have been no RTCs to the west of Scotland in the years since 2012 due to the lack of occurrence of high lpue in the area. Estimates of continuing high discard rates in Division 6.a indicate the scheme has not been as effective as in the North Sea. Figure 5.42 highlights the problem from discards. Since 2006 mortality from landings is estimated to have decreased rapidly but over the same period mortality from discards has increased just as rapidly. It also needs to be remembered that mortality estimates arising from an assessment heavily based on survey and/or discard data are poorly estimated. In contrast, historical trends in spawning biomass and recruitment appear to be robust measures of stock dynamics.

Estimates of misreporting from Marine Scotland Compliance imply ICES landings estimates which are in excess of TACs during the mid-2000s. Misreported landings make a significant contribution to the fishing mortality on this stock.

Cod is taken in mixed demersal fisheries, and in Division 6.a is now regarded as 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 2015, trawl gear vessels targeting finfish (TR1) are responsible for around 85% of cod catches in Division 6.a, the *Nephrops* fleet (TR2) take approximately 12% and the remainder are taken by other gears, mainly longliners.

The EU cod long-term management plan, (Council Regulation No. 1342/2008) was 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. The amended regulation discontinues the previous fishing effort regime and removes reference to the previous F_{mgt} of 0.4.

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).

5.3.8 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.

5.4 Sources

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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
Belgium	48	88	33	44	28	-	6	-	22	1	2	+	11	1	+
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
Germany	66	53	12	25	281	586	60	5	94	100	18	63	5	6	8
Ireland	2,564	1,704	2,442	2,551	1,642	1,200	761	761	645	825	1,054	1,286	708	478	223
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-
Norway	204	174	77	186	207	150	40	171	72	51	61	137	36	36	79
Spain	28	-	-	-	85	-	-	-	-	-	16	+	6	42	45
UK (E. W. N.I.)	260	160	444	230	278	230	511	577	524	419	450	457	779	474	381
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
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

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*	2016*
Belgium	+	2	+	-	-	-	-	-	-	-	0	0	0	0	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Faroe Islands	-	-	-	-	2	0	0.8	12	1		0.2	0	-	-	-	-	-
France	236	391	208	172	91	107	100.7	92	82	74	60.3	46	4.21	3.36	5	-	-
Germany	6	4	+	+			2	2	1	0	0	0	0.04	0	-	-	-
Greenland																	1
Ireland	357	319	210	120	34	27.9	18	70	58.2	24.4	48.7	41.3	17.8	13.7	11.68	17.47	28
Netherlands	-	-	-	-	-	-	-	-	-	0		0	0	0	-	-	-
Norway	114	40	88	45	10	17	30	30	65	18	20.7	8.3	56.2	24.017	13.848	59.12	39
Spain	14	3	11	3	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E. W. N.I.)	280	138	195	79	46	25	-	21	6	14	-	-	-	-	-	-	-
UK (Scotland)	2,057	1,544	1,519	879	413	243	-	260	232	-	-	-	-	-	-	-	-
UK	-	-	-	-	-	-	332.1	-	-	104	118.6	110	137.2	131.266	129.995	167.89	182
Total landings	2,767	2,439	2,231	1,298	596	419.9	483.6	487	445.2	234.4	248.5	205.6	215.5	172.343	160.523	244.48	250

*** Preliminary.**

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		
1978	13521		161	13682
1979	16087		39	16126
1980	17879		423	18302
1981	23866		303	24169
1982	21510		571	22081
1983	21305		197	21502
1984	21271		329	21600
1985	18608		963	19571
1986	11820		263	12083
1987	18975		2388	21363
1988	20413		368	20781
1989	17171		2076	19247
1990	12176		571	12747
1991	10926		622	11548
1992	9086		1779	10865
1993	10315		139	10454
1994	8929		661	9590
1995	9438		141	9579
1996	9425		63	9488
1997	7033		499	7532
1998	5714		538	6252
1999	4201		69	4270
2000	2977		821	3798
2001	2347		92	2439
2002	2242		480	2722
2003	1241		34	1275
2004	540		72	612
2005	479		41	520
2006	463	25	464	952
2007	525	70	1879	2474
2008	451	231	695	1377
2009	222	186	945	1353
2010	239	320	785	1344
2011	206	248	1671	2125
2012	160	306	1166	1632
2013	172	123	1202	1497
2014	156	205	1311	1672
2015	256	461	983	1700
2016	334	499	851	1684

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.

UKSGFS-WIBTS-Q1 (index)

2011	2017							
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

UKSGFS-WIBTS-Q1 (variance)

2011	**2017**							
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

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.

UKSGFS-WIBTS-Q4 (index)

2011	2016									
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

UKSGFS-WIBTS-Q4 (variance)

2011	2016									
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

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	2016					
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

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

	Age						
Year	1	2	3	4	5	6	7+
1966	384	2883	629	999	825	78	52
1967	261	2571	3705	670	442	264	67
1968	333	1364	3289	1838	215	171	151
1969	64	1974	1332	1943	759	149	170
1970	256	1176	1638	571	476	153	74
1971	254	1903	550	841	240	201	95
1972	735	2891	1591	409	501	108	110
1973	1015	1524	1442	583	161	193	104
1974	843	2318	778	1068	288	72	102
1975	1207	1898	1187	533	325	90	35
1976	970	3682	1467	638	256	215	56
1977	1265	1314	1639	624	269	87	79
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

	AGE						
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

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

	AGE						
YEAR	1	2	3	4	5	6	7+
1966	0.730	1.466	3.474	5.240	4.868	8.711	9.250
1967	0.681	1.470	2.906	4.560	6.116	7.394	8.058
1968	0.745	1.776	2.766	4.721	6.304	7.510	8.278
1969	0.860	1.284	2.821	4.259	6.169	6.374	7.928
1970	0.595	0.955	2.533	4.678	6.016	7.120	8.190
1971	0.674	1.046	2.536	4.167	6.023	6.835	8.100
1972	0.609	1.192	2.586	4.417	6.226	7.585	8.538
1973	0.597	1.181	2.784	4.601	5.625	7.049	8.611
1974	0.611	1.103	2.834	4.750	6.144	7.729	9.339
1975	0.603	1.369	3.078	5.302	6.846	8.572	10.328
1976	0.616	1.397	3.161	5.005	6.290	8.017	9.001
1977	0.629	1.160	2.605	4.715	6.269	7.525	9.511
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

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
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

Table 5.6. Cod in Division 6.a. Discard numbers at age (thousands). Data from 1978–2001 raised from Scottish sampling only; later data use samples from other nations when available.

	Age						
Year	**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

Table 5.7. Cod in Division 6.a. Mean weight-at-age in discards (kg). Data from 1978–2001 raised from Scottish sampling only; later data use samples from other nations when available.

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1978	0.37	0.321	0	0	0	0	0
1979	0.276	0.43	0	0	0	0	0
1980	0.361	0	0	0	0	0	0
1981	0.135	0.326	0	0	0	0	0
1982	0.314	0.392	0	0	0	0	0
1983	0.223	0.374	0	0	0	0	0
1984	0.298	0.435	0	0	0	0	0
1985	0.178	0.346	0	0	0	0	0
1986	0.267	0.305	0	0	0	0	0
1987	0.166	0.37	0	0	0	0	0
1988	0.296	0.283	0	0	0	0	0
1989	0.332	0.59	0	0	0	0	0
1990	0.132	0.454	0	0	0	0	0
1991	0.245	0.351	0	0	0	0	0
1992	0.22	1.03	2.382	0	0	0	0
1993	0.239	0.812	3.723	0	0	0	0
1994	0.24	0.365	0	0	0	0	0
1995	0.203	0.256	0	0	0	0	0
1996	0.226	0.389	0	0	0	0	0
1997	0.321	0.328	0	0	0	0	0
1998	0.23	0.367	0.59	0	0	0	0
1999	0.294	0.299	0	0	0	0	0
2000	0.28	0.421	0	0	0	0	0
2001	0.248	0.417	0	0	0	0	0
2002	0.263	1.021	0	0	0	0	0
2003	0.272	0.57	0.39	0	0	0	0
2004	0.258	0.581	0	0	0	0	0
2005	0.285	0.501	0	0	0	0	0
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	0
2008	0.22	0.976	2.046	4.047	7.937	0	0
2009	0.261	1.312	2.248	3.324	0	6.448	0
2010	0.253	1.312	2.268	3.218	3.245	0	0
2011	0.212	1.023	2.207	2.993	4.891	4.168	0
2012	0.151	1.197	2.18	3.222	8.537	0	0
2013	0.111	0.945	2.119	3.05	5.029	0	6.27
2014	0.145	1.124	2.415	3.066	4.007	4.731	0
2015	0.344	0.994	2.32	3.409	4.414	6.103	0
2016	0.205	1.111	2.228	3.759	4.435	0	0

Table 5.8. Cod in Division 6.a. Total catch-at-age (thousands). Values for 2006 onwards include an adjustment for area misreporting.

	AGE						
Year	**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

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

	AGE						
Year	**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

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

Parameter	Setting	Justification
Age of full selection.	$a_m = 4$	Carried over from previous TSA. Based on inspection of XSA runs.
Multipliers on variance matrices of measurements.	$B_{landings}(a) = 2$ for ages 6, 7+ $B_{survey}(a) = 2$ for age 1, 5, 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.	Landings: Age 2 in 1987 age 6 in 1982 and 2009, age 7 in 1982,1983,1989. Age 5 & 6 in 2015 Age 7 in 2016 Discards: age 1 in 1988 and 1992, age 2 in 1988, 1992,1998,2002. Survey: age 2 in 2007 and 2010, age 3 in 2008 (large haul near 4W line), age 4 in 2001 and 2008, age 5 in 2001.	Large values indicated by exploratory prediction error plots. Down-weighting in 2001 resulted from a single large haul, 24 fish >75 cm in 30 minutes.
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 η1 S exp(−η2 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.	
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 5η1 S exp(−η2 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	2015 WG	2016 WG	2017 WG
Initial fishing mortality	*F* (1, 1981)	Fishing mortality-at-age *a* in year *y*	0.3063	0.3307	0.314
	F (2, 1981)		0.603	0.6863	0.676
	F (4, 1981)		0.9469	1.0448	1.025
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.113	0.153	0.142
	σ_U	Persistent changes in selection (age effect in F)	0.0304	0.0145	0.005
	σ_V	Transitory changes in the year effect in fishing mortality	0.0822	0.1463	0.162
	σ_Y	Persistent changes in the year effect in fishing mortality	0.0971	0	0
Measurement CVs	$CV_{landings}$	CV of landings-at-age data	0.1245	0.1174	0.121
	$CV_{discards}$	CV of discards-at-age data	0.5079	0.446	0.561
Recruitment	η_1	Ricker parameter (slope at the origin)	1.3184	1.2655	1.133
	η_2	Ricker parameter (curve dome occurs at $1/\eta_2$)	0.0234	0.0239	0.021
	cv_{rec}	Coefficient of variation of recruitment data	0.3922	0.3934	0.405
Discards	$\sigma_{logit\ p}$	Transitory trends in discarding	0.7504	0.7607	0.794
	$\sigma_{persistent}$	Persistent trends in discarding	0.5145	0.3383	0.224
	Step fn age 1	Amount by which discards increase in 2006	3.6191	3.9398	4.214
	Step fn age 2		5.8156	5.75	5.911
	Step fn age 3		0.8856	0.9198	0.958
	Step fn age 4		-0.4122	-0.4842	-0.510
Survey selectivities SCOWIBTS.Q1	Φ(1)	Survey selectivity-at-age *a*	0.536	0.5602	0.580
	Φ(2)		2.8965	2.8965	2.903
	Φ(3)		6.6972	6.9061	6.928
	Φ(4)		10.0868	10.6042	10.455
	Φ(5)		14.0764	15.2594	14.998
	Φ(6)		19.2501	20.5213	20.315

PARAMETER	NOTATION	DESCRIPTION	2015 WG	2016 WG	2017 WG
Survey CVs	σ_{survey}	CV parameter controlling gamma type dispersion	0.0891	0.2657	0.283
	η_{survey}	CV parameter controlling poisson type dispersion	1.3844	1.1524	1.148
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 UKGFSWIBTS.Q1	$\Phi(1)$	Survey selectivity-at-age *a*	1.6459	0.6683	0.438
	$\Phi(2)$		20.7721	20.8016	16.565
	$\Phi(3)$		28.6685	44.3821	38.961
	$\Phi(4)$		40.9166	49.9699	40.331
	$\Phi(5)$		37.9549	93.113	56.989
	$\Phi(6)$		35.556	68.1332	38.429
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	0.3729	0.5386	0.698
	σ_{β}	Persistent changes in survey catchability	0	0	0
Misreporting		Transitory changes in misreporting	0	0	0
		Persistent changes in misreporting	0.1716	0.2279	0.246

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

	Age						
Year	1	2	3	4	5	6	7+
1981	10983	19350	6908	1885	350	54	38
1982	25925	5282	7265	2466	673	119	32
1983	15108	12451	2259	2747	876	240	55
1984	25952	6458	4943	789	892	291	96
1985	13472	12010	2396	1604	235	235	113
1986	21714	4768	4090	717	345	64	80
1987	59151	10123	1903	1449	228	110	49
1988	6788	19639	3780	580	354	63	45
1989	23900	2764	6398	1151	184	100	32
1990	7967	9624	973	1656	313	50	34
1991	12931	3262	3505	356	493	105	30
1992	22630	5300	1079	1150	120	153	40
1993	9076	10246	2020	340	324	39	65
1994	18700	4158	3943	606	114	94	34
1995	15212	8201	1676	1399	176	35	38
1996	6776	6938	2891	559	441	58	25
1997	24280	2948	2253	805	159	125	21
1998	7088	10644	825	559	221	45	38
1999	5086	2911	3026	205	148	71	24
2000	18662	2157	806	742	52	39	27
2001	4314	7243	681	242	204	15	18
2002	9421	1853	2369	184	55	54	10
2003	2515	3447	542	634	44	13	14
2004	3167	880	835	134	153	11	6
2005	1794	1085	207	202	39	30	3
2006	5906	663	305	28	31	6	5
2007	1844	2549	235	100	7	10	4
2008	1471	725	797	56	23	2	3
2009	3462	632	237	231	14	5	1
2010	3927	1522	226	77	68	4	2
2011	2317	1851	580	65	21	23	2
2012	2532	990	643	136	10	6	7
2013	3538	1100	368	221	35	3	3
2014	2719	1328	387	123	70	7	1
2015	2020	1233	522	134	43	23	3
2016	3494	958	495	197	47	15	9
2017*	3614	1449	334	149	54	13	7
GM(81-16)	7273	3271	1213	385	111	32	15

***2017 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).

	Age						
Year	1	2	3	4	5	6	7+
1981	916	1290	464	125	36	10	7
1982	1380	287	508	180	49	21	5
1983	1227	653	123	191	66	26	8
1984	1363	451	276	50	68	33	11
1985	1211	578	156	111	19	35	15
1986	1626	365	239	50	34	9	13
1987	6150	723	122	102	21	18	7
1988	878	2004	212	47	39	12	9
1989	2020	225	633	76	15	15	6
1990	1232	691	75	184	26	7	6
1991	1601	455	369	36	68	14	4
1992	1988	605	148	138	13	27	7
1993	868	835	220	44	43	6	10
1994	1934	370	386	79	13	16	5
1995	1556	866	164	148	25	6	7
1996	944	675	341	64	52	10	4
1997	2319	379	280	115	21	20	5
1998	1073	1027	132	87	33	8	8
1999	760	413	410	37	25	11	4
2000	2020	296	132	116	9	9	5
2001	674	897	100	39	32	3	4
2002	1356	279	330	32	12	12	2
2003	646	527	89	100	9	4	4
2004	706	234	179	26	29	3	2
2005	447	238	62	48	7	10	2
2006	818	153	54	9	6	2	3
2007	295	345	46	13	2	2	1
2008	283	113	104	9	3	1	1
2009	490	119	36	27	2	2	0
2010	444	212	40	10	6	1	1
2011	314	209	75	10	3	3	0
2012	420	128	69	18	2	1	1
2013	631	177	43	20	4	1	1
2014	571	273	58	13	7	2	0
2015	698	268	101	16	5	4	1
2016	954	328	105	35	5	2	2
2017*	1245	460	125	45	17	4	2

***2017 values are standard errors on TSA-derived projections of population numbers.**

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

	Age						
Year	1	2	3	4	5	6	7
1981	0.206	0.605	0.735	0.756	0.850	0.862	0.866
1982	0.179	0.438	0.673	0.768	0.778	0.776	0.788
1983	0.330	0.518	0.736	0.863	0.860	0.905	0.904
1984	0.204	0.612	0.823	0.956	1.123	1.031	1.015
1985	0.512	0.683	0.906	1.302	1.080	1.302	1.238
1986	0.185	0.544	0.740	0.904	0.930	0.918	0.860
1987	0.488	0.577	0.889	1.145	1.068	1.069	1.057
1988	0.368	0.720	0.879	0.891	1.057	1.034	0.993
1989	0.371	0.670	1.024	1.043	1.075	1.164	1.122
1990	0.361	0.632	0.695	0.976	0.845	0.812	0.801
1991	0.360	0.728	0.817	0.817	0.951	1.001	1.055
1992	0.235	0.581	0.858	1.017	0.882	0.854	0.922
1993	0.243	0.567	0.909	0.828	1.023	0.943	0.913
1994	0.290	0.516	0.729	0.988	0.941	1.019	1.001
1995	0.246	0.662	0.798	0.899	0.889	0.902	0.865
1996	0.307	0.747	0.970	1.008	1.040	1.162	1.129
1997	0.285	0.858	1.071	1.038	1.052	1.152	1.082
1998	0.356	0.870	1.043	1.068	0.907	1.038	0.997
1999	0.336	0.875	1.096	1.128	1.112	1.036	1.120
2000	0.414	0.777	0.908	1.048	1.033	1.050	1.153
2001	0.307	0.733	0.985	1.177	1.101	0.971	0.963
2002	0.465	0.836	1.013	1.149	1.201	1.254	1.341
2003	0.389	0.918	1.053	1.146	1.115	1.174	1.161
2004	0.396	0.838	0.985	0.961	1.259	1.263	1.201
2005	0.392	0.812	1.177	1.329	1.432	1.316	1.246
2006	0.305	0.666	0.841	1.057	0.963	0.958	0.951
2007	0.391	0.788	1.049	1.206	1.223	1.214	1.220
2008	0.319	0.738	0.947	1.118	1.224	1.183	1.225
2009	0.292	0.658	0.835	0.985	1.005	1.051	0.974
2010	0.212	0.584	0.904	1.034	0.856	0.844	0.858
2011	0.321	0.680	1.112	1.504	1.128	1.148	1.247
2012	0.304	0.609	0.757	1.108	1.042	1.036	1.073
2013	0.445	0.675	0.773	0.877	1.271	1.183	1.217
2014	0.258	0.565	0.767	0.759	0.912	0.897	0.813
2015	0.218	0.527	0.678	0.779	0.768	0.797	0.768
2016*	0.352	0.684	0.919	1.072	1.103	1.143	1.108

***2016 values are TSA-derived projections of fishing mortality.**

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

	Age						
Year	1	2	3	4	5	6	7+
1981	0.027	0.055	0.065	0.069	0.123	0.135	0.136
1982	0.023	0.041	0.061	0.070	0.089	0.124	0.127
1983	0.052	0.045	0.060	0.075	0.097	0.121	0.143
1984	0.031	0.056	0.066	0.079	0.120	0.138	0.153
1985	0.068	0.053	0.071	0.097	0.119	0.169	0.181
1986	0.042	0.058	0.066	0.085	0.111	0.141	0.129
1987	0.088	0.072	0.073	0.093	0.129	0.151	0.161
1988	0.090	0.069	0.067	0.081	0.113	0.159	0.154
1989	0.071	0.065	0.090	0.085	0.118	0.155	0.178
1990	0.078	0.070	0.077	0.104	0.107	0.125	0.127
1991	0.084	0.098	0.102	0.102	0.131	0.158	0.181
1992	0.061	0.082	0.113	0.124	0.130	0.138	0.161
1993	0.060	0.075	0.113	0.116	0.145	0.162	0.151
1994	0.068	0.071	0.094	0.127	0.137	0.162	0.173
1995	0.061	0.087	0.099	0.110	0.130	0.153	0.146
1996	0.077	0.095	0.122	0.126	0.143	0.187	0.193
1997	0.068	0.110	0.129	0.135	0.150	0.179	0.187
1998	0.087	0.105	0.136	0.142	0.133	0.175	0.170
1999	0.085	0.114	0.135	0.156	0.159	0.167	0.194
2000	0.093	0.106	0.130	0.144	0.156	0.175	0.200
2001	0.078	0.100	0.129	0.152	0.156	0.167	0.164
2002	0.110	0.115	0.130	0.156	0.179	0.199	0.236
2003	0.099	0.120	0.137	0.147	0.168	0.202	0.199
2004	0.100	0.120	0.135	0.134	0.167	0.212	0.208
2005	0.106	0.133	0.181	0.189	0.206	0.215	0.229
2006	0.083	0.113	0.136	0.148	0.114	0.150	0.149
2007	0.101	0.119	0.150	0.135	0.144	0.168	0.193
2008	0.087	0.120	0.137	0.144	0.152	0.187	0.183
2009	0.080	0.110	0.129	0.121	0.115	0.169	0.159
2010	0.058	0.094	0.128	0.119	0.098	0.126	0.137
2011	0.085	0.104	0.138	0.162	0.132	0.150	0.202
2012	0.082	0.100	0.109	0.132	0.125	0.157	0.160
2013	0.116	0.111	0.119	0.102	0.134	0.181	0.183
2014	0.072	0.095	0.116	0.108	0.147	0.135	0.138
2015	0.063	0.095	0.115	0.110	0.121	0.146	0.138
2016*	0.106	0.142	0.189	0.219	0.223	0.234	0.231

***2016 values are TSA-derived projections.**

Table 5.16. Cod in Division 6.a. TSA summary table. "Obs." denotes sum-of-products of numbers and mean weights-at-age, not reported caught, landed and discarded weight.

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
1981	24168	24220	1516	23865	24047	1519	303	173	105	0.736	0.047	40438	1605	10983	916
1982	22082	20407	1271	21511	19667	1277	571	741	181	0.664	0.039	38122	1626	25925	1380
1983	21503	20394	1007	21305	20115	996	197	279	136	0.744	0.041	34059	1185	15108	1227
1984	21601	21121	1000	21272	20570	1001	329	551	221	0.878	0.047	31788	1104	25952	1363
1985	19570	18407	855	18607	17760	851	963	647	155	0.993	0.050	25146	886	13472	1211
1986	12083	12068	785	11820	11544	747	263	523	181	0.779	0.051	19582	767	21714	1626
1987	21358	18939	1297	18971	17091	1172	2388	1848	731	0.920	0.054	20856	823	59151	6150
1988	20781	20063	1665	20413	19753	1646	368	310	155	0.887	0.048	26822	1355	6788	878
1989	19246	17424	1352	17169	16031	1285	2076	1393	465	0.953	0.054	23007	1445	23900	2020
1990	12746	12063	799	12175	11862	789	571	201	74	0.787	0.065	18891	1165	7967	1232
1991	11549	10531	1442	10927	10089	1387	622	441	187	0.828	0.087	15623	1518	12931	1601
1992	10865	9311	1331	9086	8675	1271	1779	637	239	0.834	0.090	13206	1368	22630	1988
1993	10453	11005	1410	10314	10630	1374	139	375	132	0.832	0.092	16511	1434	9076	868
1994	9588	10885	1446	8928	10223	1375	661	662	225	0.794	0.087	17265	1569	18700	1934
1995	9580	11630	1527	9439	11254	1488	141	375	135	0.812	0.087	17722	1608	15212	1556
1996	9489	12380	1642	9427	12120	1613	63	260	93	0.941	0.098	17742	1685	6776	944
1997	7533	10727	1556	7034	9788	1443	499	938	357	1.005	0.106	12953	1447	24280	2319
1998	6252	9757	1383	5714	9430	1348	538	327	126	0.972	0.106	11199	1205	7088	1073
1999	4270	7513	1242	4201	7257	1205	69	255	97	1.052	0.116	10013	1250	5086	760
2000	3798	6402	1025	2977	5299	900	821	1103	342	0.942	0.111	7007	946	18662	2020
2001	2439	5951	983	2347	5710	950	92	241	85	0.999	0.110	7696	937	4314	674

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**
2002	2722	6270	1064	2243	5717	988	480	552	201	1.050	0.119	7521	1008	9421	1356
2003	1275	4539	835	1241	4372	802	34	167	71	1.058	0.117	5787	823	2515	646
2004	612	2746	638	540	2557	598	72	189	81	1.011	0.114	3665	678	3167	706
2005	552	1952	515	511	1827	489	41	125	55	1.187	0.151	2335	474	1794	447
2006	954	1286	224	488	386	58	465	900	192	0.882	0.086	1435	179	5906	818
2007	2474	1972	296	595	538	71	1880	1434	278	1.067	0.087	2400	232	1844	295
2008	1377	1651	231	682	586	76	695	1066	217	1.007	0.090	2450	242	1471	283
2009	1353	1405	182	408	453	57	945	952	179	0.871	0.078	1942	175	3462	490
2010	1344	1567	215	559	542	51	785	1025	195	0.845	0.070	2219	197	3927	444
2011	2124	2052	249	454	444	45	1670	1608	243	1.106	0.084	2648	216	2317	314
2012	1632	1657	202	466	453	50	1166	1203	192	0.879	0.075	2564	198	2532	420
2013	1501	1471	164	299	349	44	1202	1123	169	0.899	0.074	2214	155	3538	631
2014	1668	1407	210	357	416	43	1311	991	200	0.751	0.081	2296	228	2719	571
2015	1752	1575	242	770	575	82	983	1000	206	0.688	0.079	2762	321	2020	698
2016	1745	1894	264	892	826	83	852	1069	240	0.944	0.155	2741	373	3494	954
2017		1788	433		586	177		1201	339	0.915	0.164	2483	548	3614	1245
Min	552	1286	164	299	349	43	34	125	55	0.664	0.039	1435	155	1471	283
GM	4761	5901	690	3230	3959	446	444	563	171	0.897	0.080	8260	692	7273	948
AM	8446	9018	891	7722	8304	810	723	714	198	0.905	0.085	13073	901	11273	1189
Max	24168	24220	1665	23865	24047	1646	2388	1848	731	1.187	0.155	40438	1685	59151	6150

***Estimates for 2017 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.

2017

Age	N	M	Mat	PF	PM	SWt	LSel	LWt	DSel	DWt
1	3614	0.54	0	0	0	0.232	0.000	0.847	0.276	0.231
2	1433	0.39	0.52	0	0	1.170	0.058	1.819	0.534	1.076
3	329	0.31	0.86	0	0	2.377	0.249	2.489	0.538	2.321
4	145	0.26	1	0	0	3.537	0.461	3.615	0.409	3.411
5	52	0.24	1	0	0	4.909	0.660	5.140	0.268	4.285
6	12	0.22	1	0	0	5.847	0.878	5.891	0.068	3.611
7	6	0.21	1	0	0	7.924	0.896	7.924	0.000	0.000

2018

Age	N	M	Mat	PF	PM	SWt	LSel	LWt	DSel	DWt
1	2610	0.54	0	0	0	0.232	0.000	0.847	0.276	0.231
2	1600	0.39	0.52	0	0	1.170	0.058	1.819	0.534	1.076
3	539	0.31	0.86	0	0	2.377	0.249	2.489	0.538	2.321
4	110	0.26	1	0	0	3.537	0.461	3.615	0.409	3.411
5	47	0.24	1	0	0	4.909	0.660	5.140	0.268	4.285
6	16	0.22	1	0	0	5.847	0.878	5.891	0.068	3.611
7	6	0.21	1	0	0	7.924	0.896	7.924	0.000	0.000

2019

Age	N	M	Mat	PF	PM	SWt	LSel	LWt	DSel	DWt
1	2610	0.54	0	0	0	0.232	0.000	0.847	0.276	0.231
2	1156	0.39	0.52	0	0	1.170	0.058	1.819	0.534	1.076
3	602	0.31	0.86	0	0	2.377	0.249	2.489	0.538	2.321
4	180	0.26	1	0	0	3.537	0.461	3.615	0.409	3.411
5	35	0.24	1	0	0	4.909	0.660	5.140	0.268	4.285
6	15	0.22	1	0	0	5.847	0.878	5.891	0.068	3.611
7	7	0.21	1	0	0	7.924	0.896	7.924	0.000	0.000

Table 5.18. Cod in Division 6.a. Single-option output of the short-term forecast (F = mean F2014–2016). Numbers in thousands, weights in tonnes.

2017

Age	F	LandNos	Yield	DF	DiscNos	DYield	StockNos	Biomass	SSNos	SSB
1	0.276	1	1	0.276	681	158	3614	839	0	0
2	0.592	53	96	0.534	488	526	1433	1678	745	872
3	0.788	50	124	0.538	107	250	329	781	283	672
4	0.870	40	145	0.409	36	121	145	514	145	514
5	0.928	20	104	0.268	8	35	52	254	52	254
6	0.946	6	37	0.068	0	2	12	72	12	72
7	0.896	3	27	0.000	0	0	6	50	6	50
Total	0.794	173	535	0.437	1320	1092	5591	4188	1243	2434

2018

Age	F	LandNos	Yield	DF	DiscNos	DYield	StockNos	Biomass	SSNos	SSB
1	0.276	1	1	0.276	492	114	2610	606	0	0
2	0.592	59	107	0.534	545	587	1600	1873	832	974
3	0.788	82	203	0.538	176	409	539	1281	463	1102
4	0.870	30	110	0.409	27	92	110	389	110	389
5	0.928	18	94	0.268	7	32	47	230	47	230
6	0.946	8	49	0.068	1	2	16	94	16	94
7	0.896	3	25	0.000	0	0	6	47	6	47

Total	0.794	201	590	0.437	1248	1236	4928	4520	1474	2835

2019

Age	F	LandNos	Yield	DF	DiscNos	DYield	StockNos	Biomass	SSNos	SSB
1	0.276	1	1	0.276	492	114	2610	606	0	0
2	0.592	43	78	0.534	394	424	1156	1353	601	703
3	0.788	91	227	0.538	197	457	602	1430	517	1230
4	0.870	50	180	0.409	44	151	180	638	180	638
5	0.928	14	71	0.268	6	24	35	174	35	174
6	0.946	8	44	0.068	1	2	15	85	15	85
7	0.896	4	30	0.000	0	0	7	55	7	55
Total	0.794	211	631	0.437	1134	1172	4605	4341	1355	2886

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	Unwanted.catch	Ftotal	F.wanted	F.unwanted	SSB	Perc.SSB
Fsq x 0	0	0	0	0.000	0.000	0.000	5324	87.757
Fsq x 1	1826	590	1236	0.794	0.357	0.437	2886	1.770
Fmsy	490	164	326	0.167	0.075	0.092	4665	64.513
Fpa	1464	478	986	0.590	0.265	0.325	3365	18.665
Flim	1866	602	1264	0.820	0.369	0.451	2831	-0.151
Fmsy.up	719	239	480	0.254	0.114	0.140	4357	53.676
Fmsy.low	325	109	216	0.108	0.049	0.059	4887	72.342
Fmsy.low + 0.01	353	118	235	0.118	0.053	0.065	4848	70.986
Fmsy.low + 0.02	382	128	254	0.128	0.058	0.070	4810	69.643
Fmsy.low + 0.03	410	137	273	0.138	0.062	0.076	4772	68.311
Fmsy.low + 0.04	437	146	291	0.148	0.067	0.081	4735	66.991
Fmsy.low + 0.05	466	156	310	0.158	0.071	0.087	4698	65.682
Fmsy.low + 0.06	493	165	328	0.168	0.076	0.092	4661	64.384
Fmsy.low + 0.07	520	174	346	0.178	0.080	0.098	4624	63.098
Fmsy.low + 0.08	548	183	365	0.188	0.085	0.103	4588	61.822
Fmsy.low + 0.09	573	191	382	0.198	0.089	0.109	4552	60.558
Fmsy.low + 0.1	600	200	400	0.208	0.094	0.114	4517	59.304
Fmsy.low + 0.11	627	209	418	0.218	0.098	0.120	4482	58.062
Fmsy.low + 0.12	652	217	435	0.228	0.103	0.126	4447	56.830
Fmsy.low + 0.13	679	226	453	0.238	0.107	0.131	4412	55.608
Fmsy.low + 0.14	704	234	470	0.248	0.111	0.137	4378	54.398
Fmsy.low + 0.15	729	242	487	0.258	0.116	0.142	4344	53.197

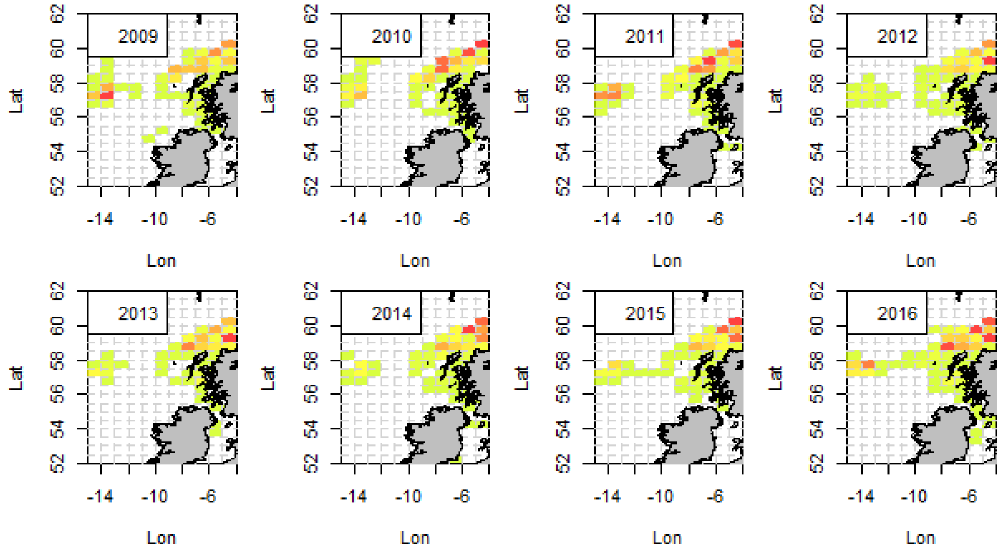

Figure 5.1. Distribution of Scottish reported landings by statistical rectangle by year.

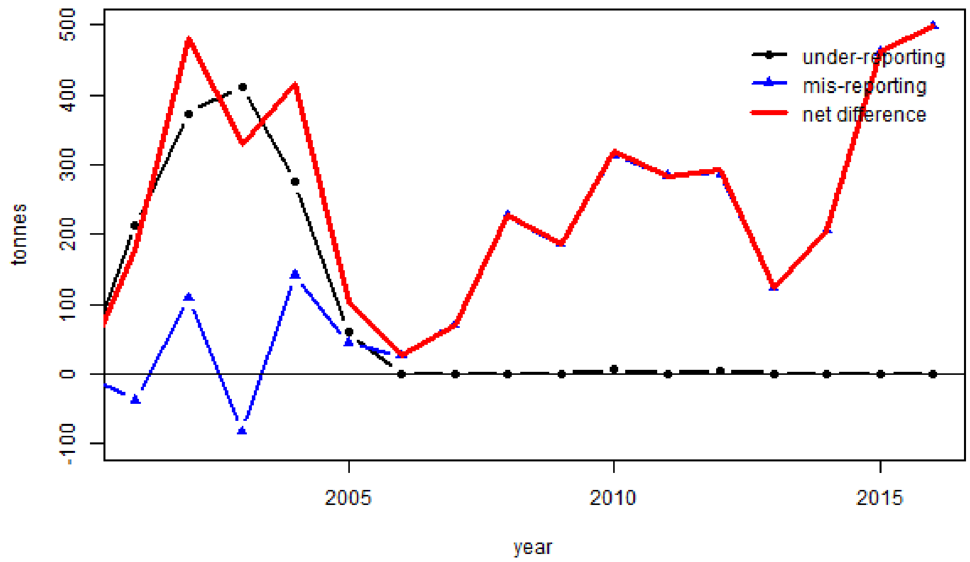

Figure 5.2. Cod in Division 6.a. Estimates of underreporting and area misreporting of cod caught in ICES Division 6.a by Scottish vessels. Negative values of area misreporting indicate a net balance of misreporting into Division 6.a from other areas.

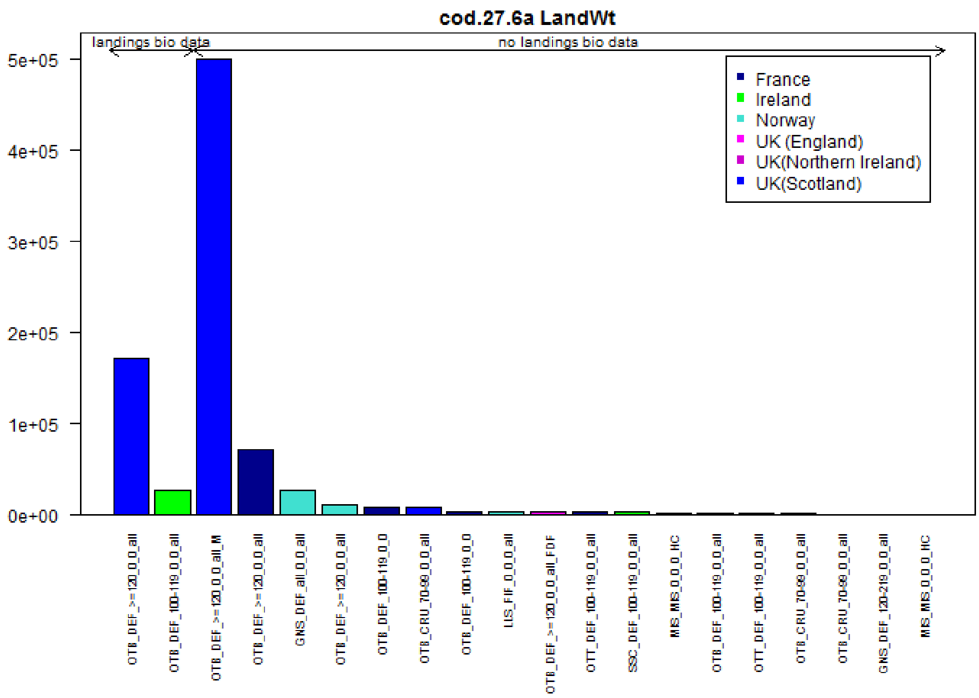

Figure 5.3. Cod in Division 6.a. Amounts landed by métier (kg) in 2016 as entered into InterCatch.

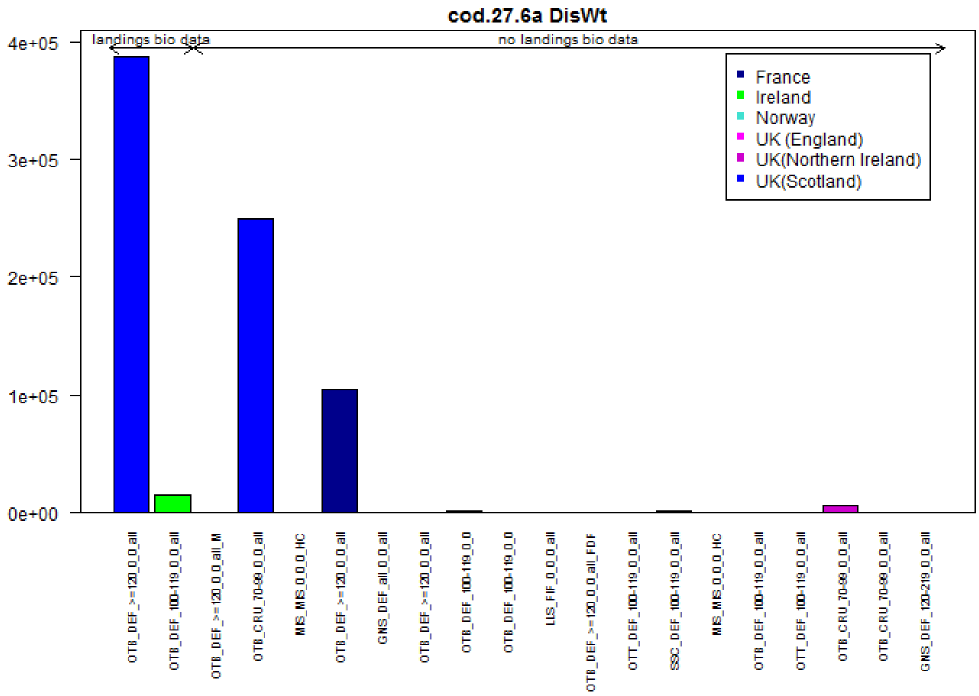

Figure 5.4. Cod in Division 6.a. Amounts discarded by métier (kg) in 2016 as entered into InterCatch.

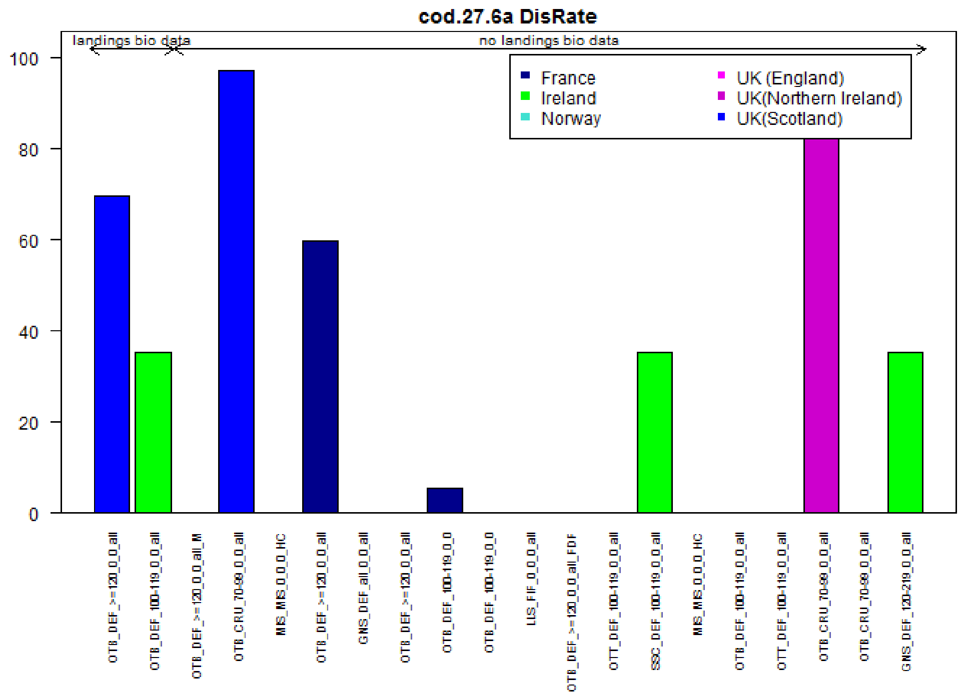

Figure 5.5. Cod in Division 6.a. Discard rates before allocations within InterCatch.

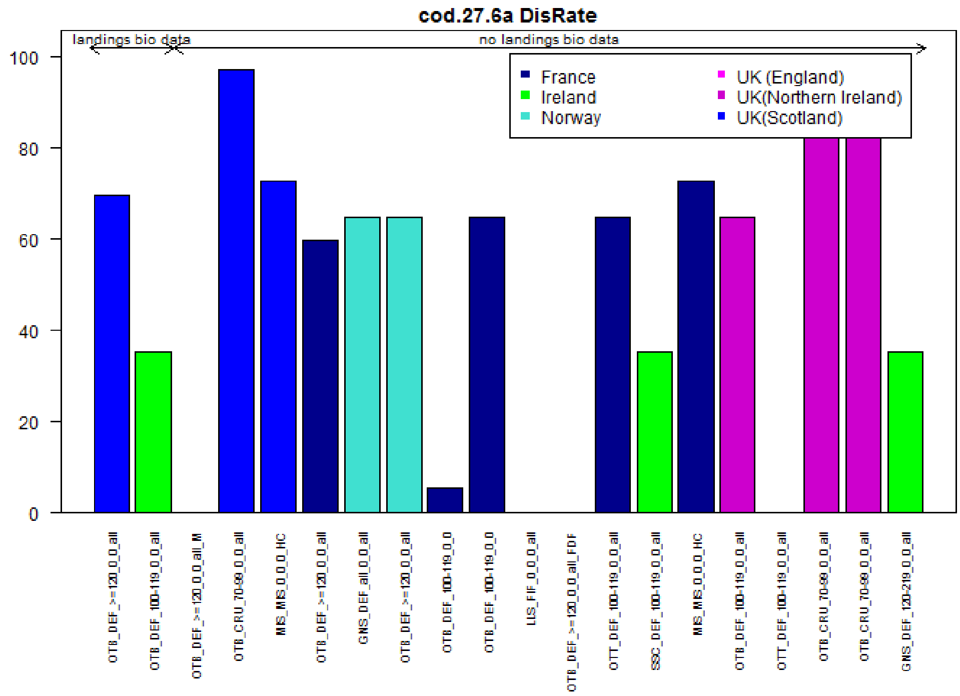

Figure 5.6. Cod in Division 6.a. Discard rates for all fleets after allocations within InterCatch.

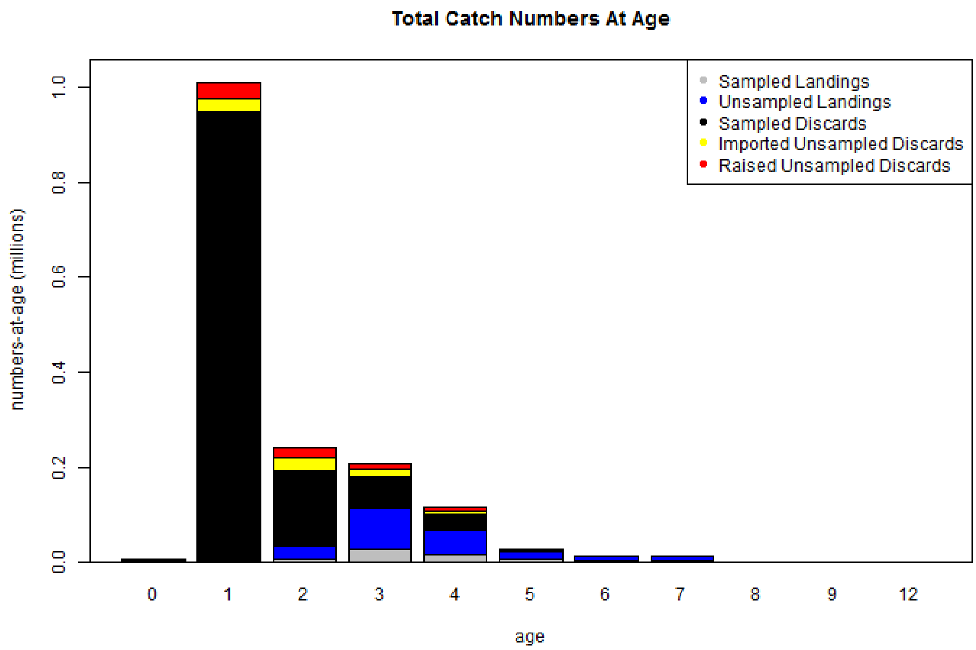

Figure 5.7. Cod in Division 6.a. Number-at-age constituted by sampled and unsampled landings and sampled and raised (unsampled) discards after allocations within InterCatch.

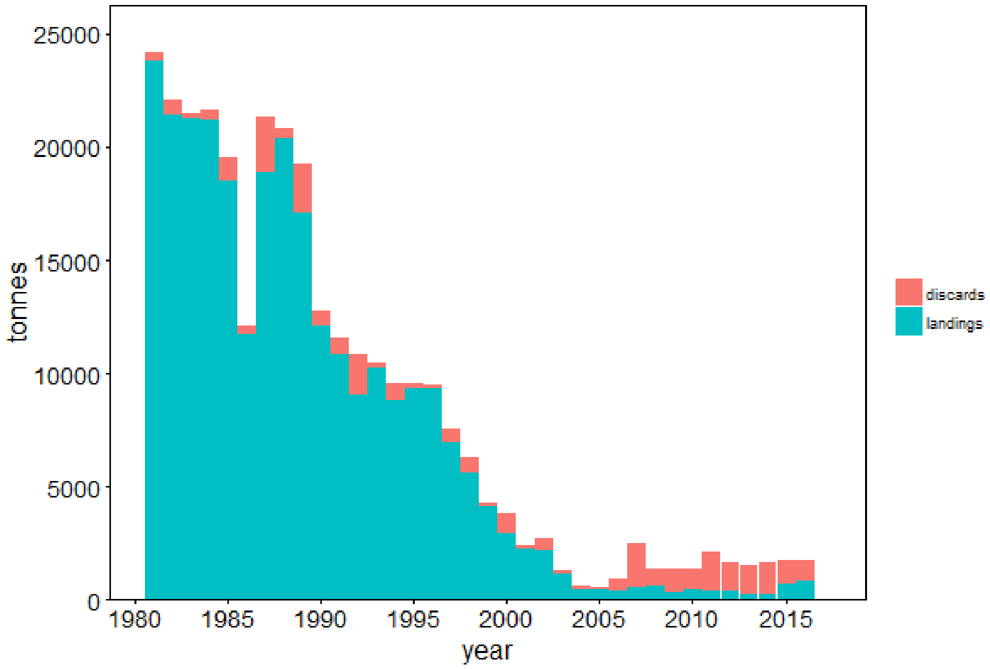

Figure 5.8. Cod in Division 6.a. Landings and discards estimates by weight, as used by the WG. Values are totals for fish aged 1 to 7+.

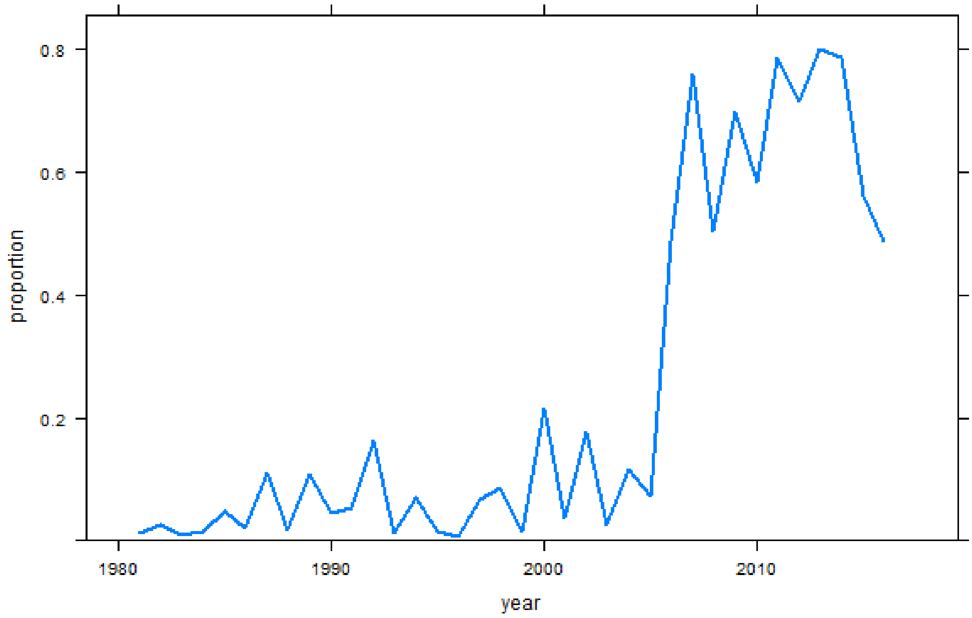

Figure 5.9. Cod in Division 6.a. Discard proportion (of total catch) by weight. Includes fish aged 1 to 7+.

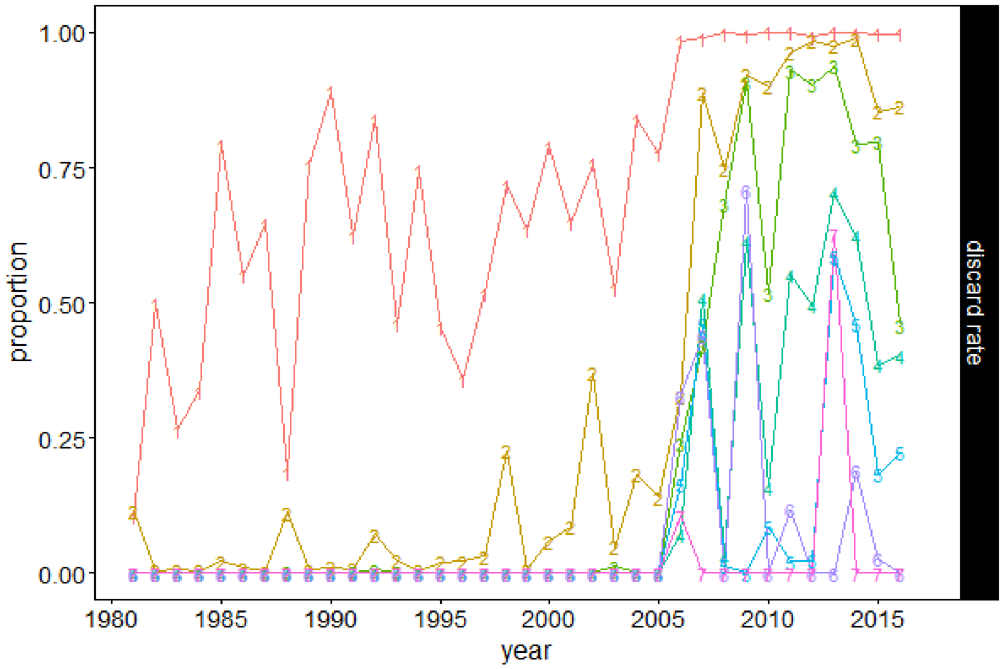

Figure 5.10. Cod in Division 6.a. Discard proportion by number.

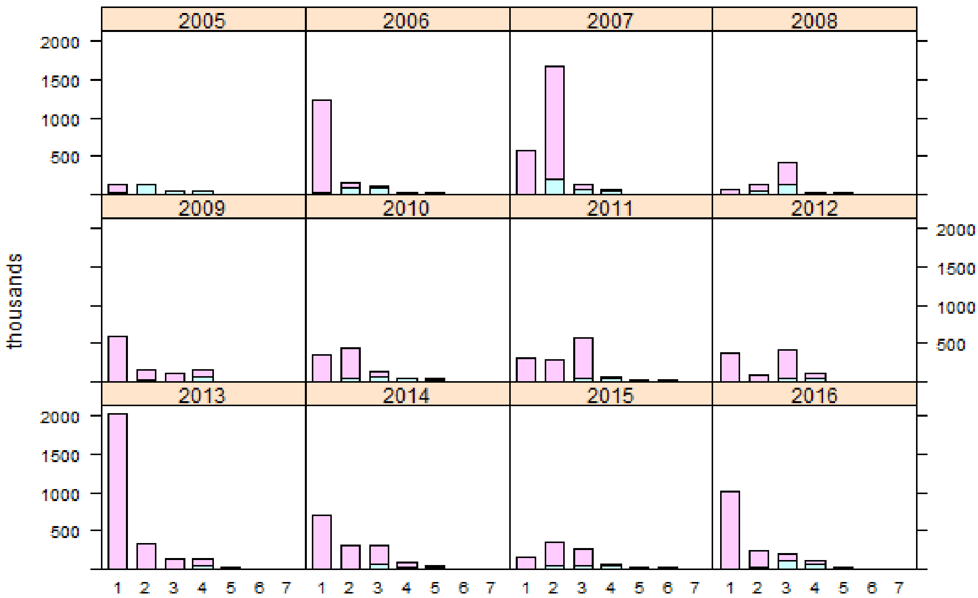

Figure 5.11. Cod in Division 6.a. Catch-at-age in numbers by year. Pink: discards, blue: landings.

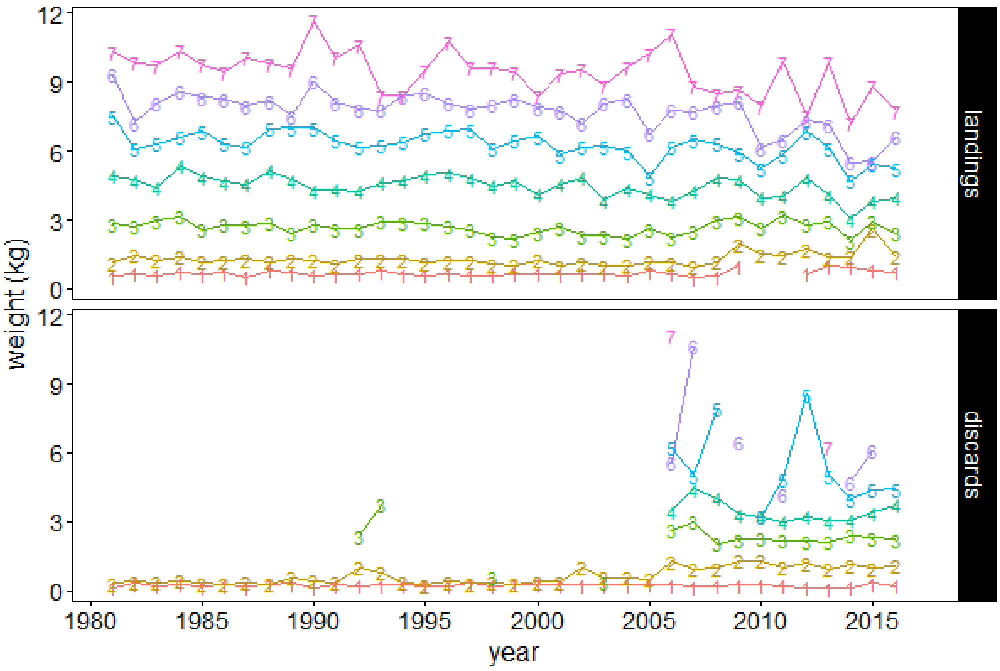

Figure 5.12. Cod in Division 6.a. Mean weights-at-age in landings and discards.

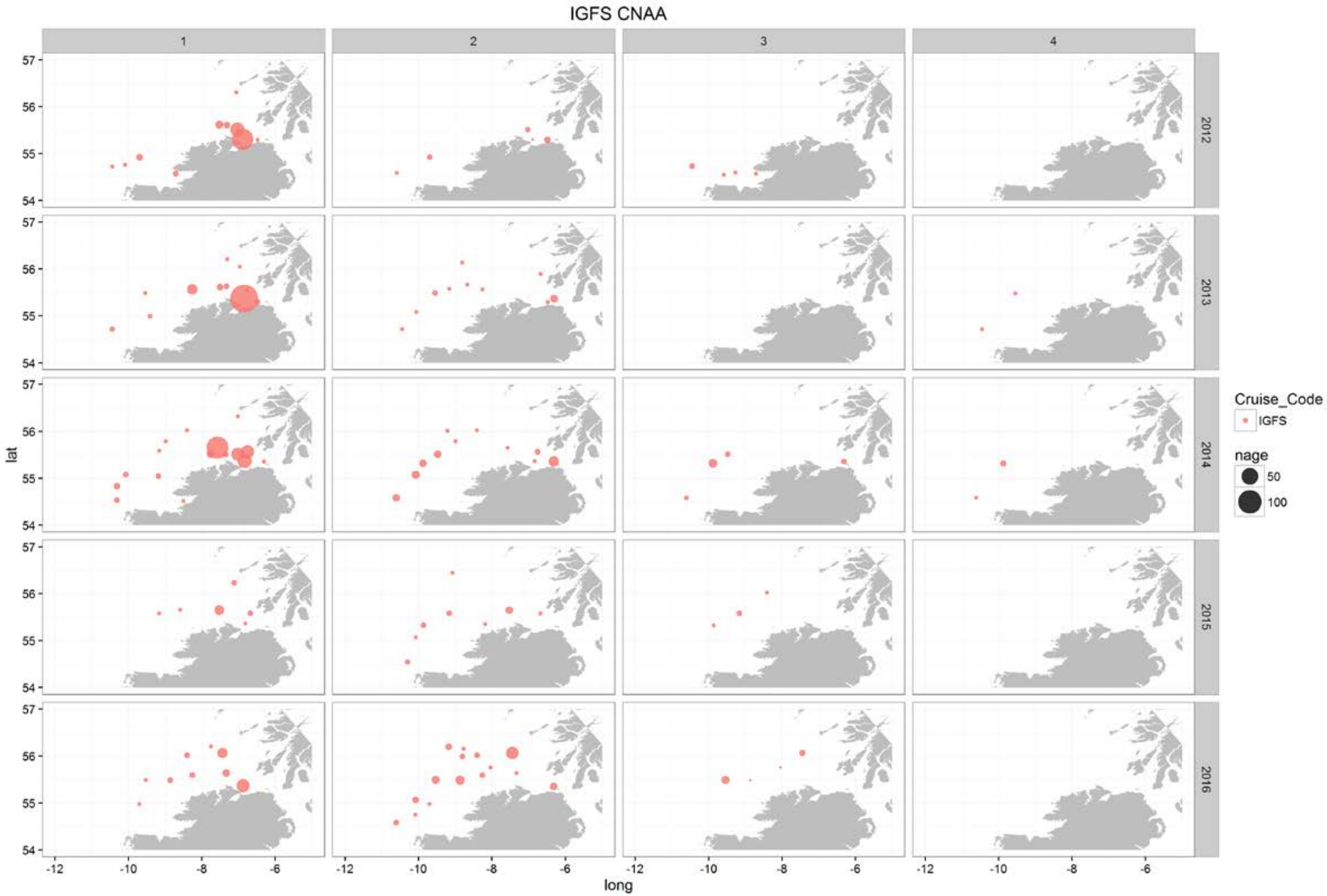

Figure 5.13. Cod in Division 6.a. Catch numbers for fish aged at 1+ per haul resulting from quarter four Irish ground fish survey (IRGFS-WIBTS-Q4). Values are standardised to 60 minutes towing. Zero shown as a black + symbol.

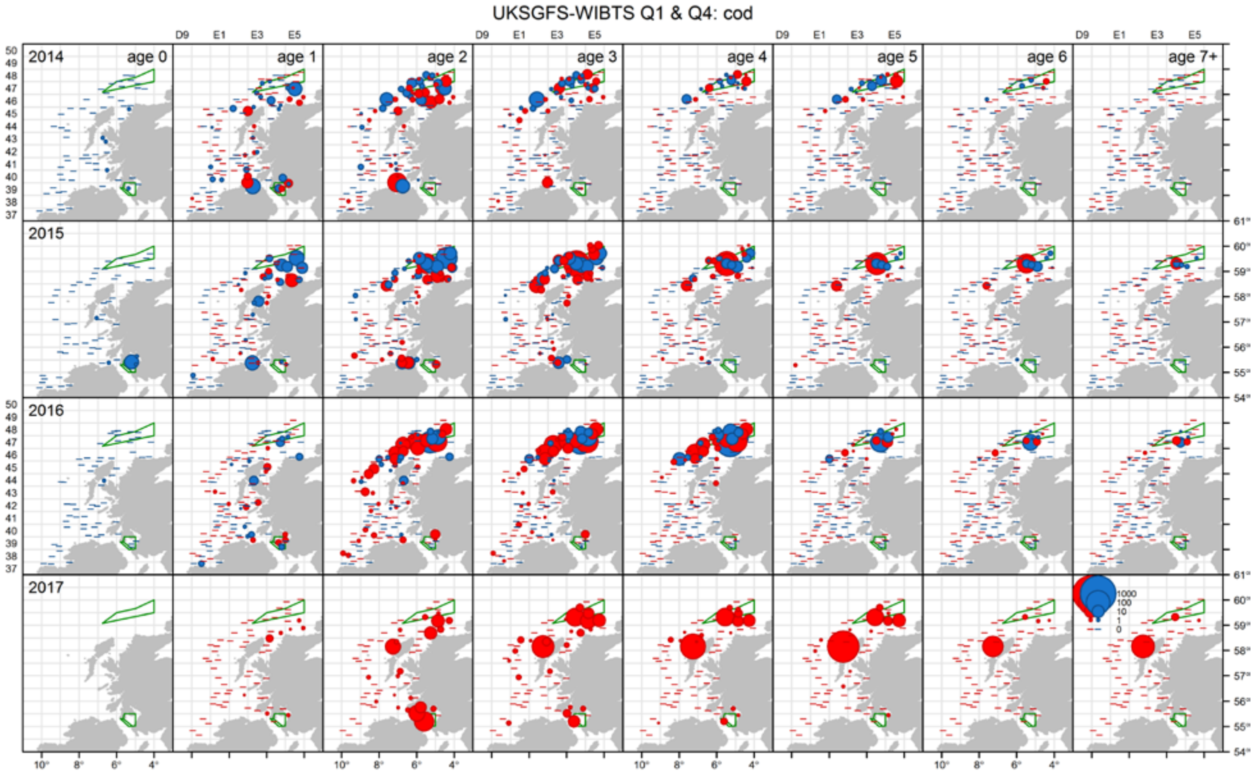

Figure 5.14. Cod in Division 6.a. Cpue numbers for fish aged at 1+ per tow resulting from Scottish quarter one survey (UKSGFS-WIBTS-Q1) in red and (UKSGFS-WIBTS-Q4) in blue. Numbers are standardised to 30 minutes towing. Green polygons are areas closed to fishing.

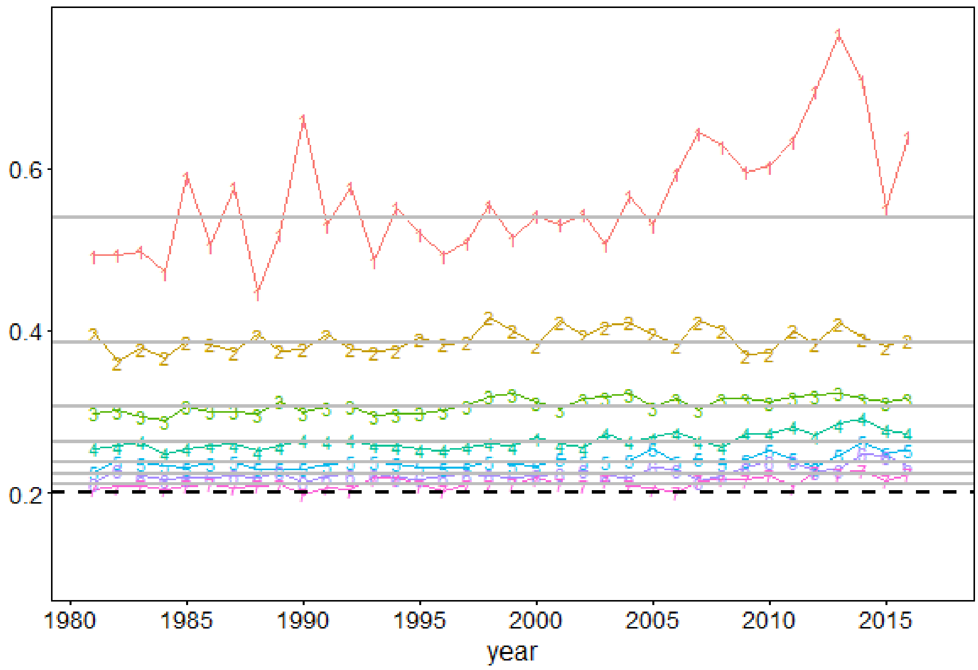

Figure 5.15. Cod in Division 6.a. Natural mortality-at-age based on mean weight-at-age and mortality–weight relationship. Solid horizontal lines show the time averaged values at each age used in the assessment. Dotted horizontal line shows value of 0.2 previously used at all ages in all years.

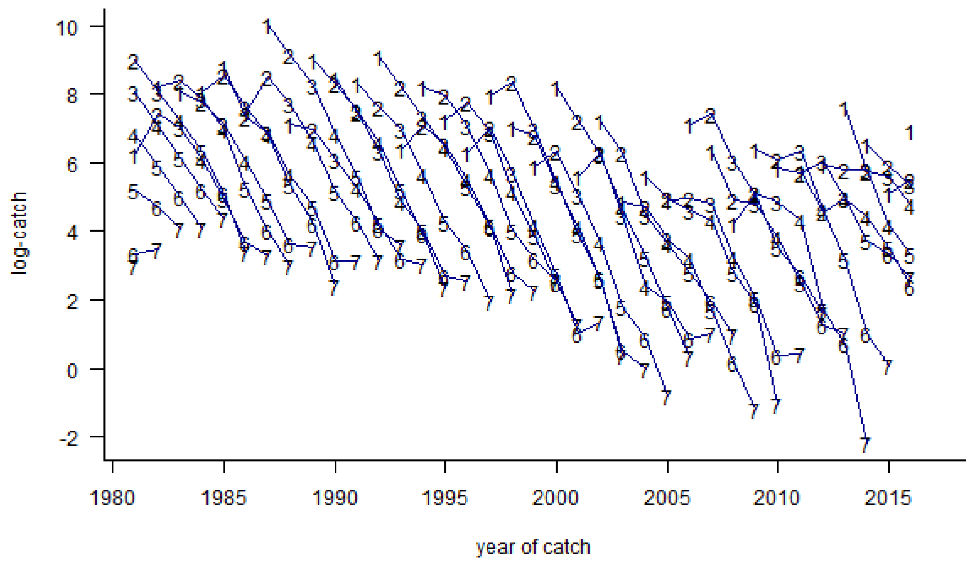

Figure 5.16. Cod in Division 6.a. Catch curves from commercial catch-at-age data.

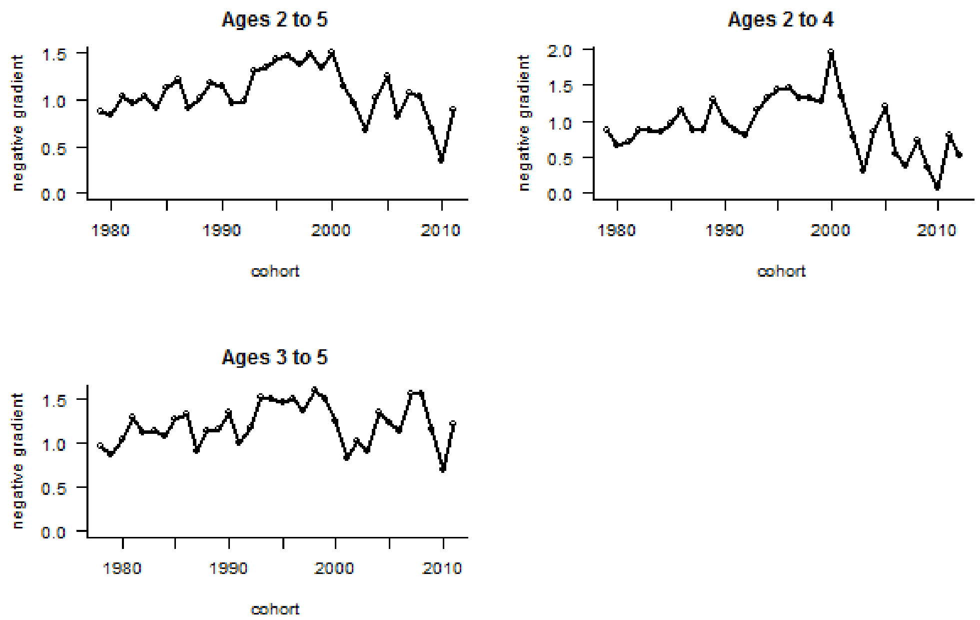

Figure 5.17. Cod in Division 6.a. Log catch (landings + discards) curve gradient plot using WG commercial catch-at-age data over different age ranges.

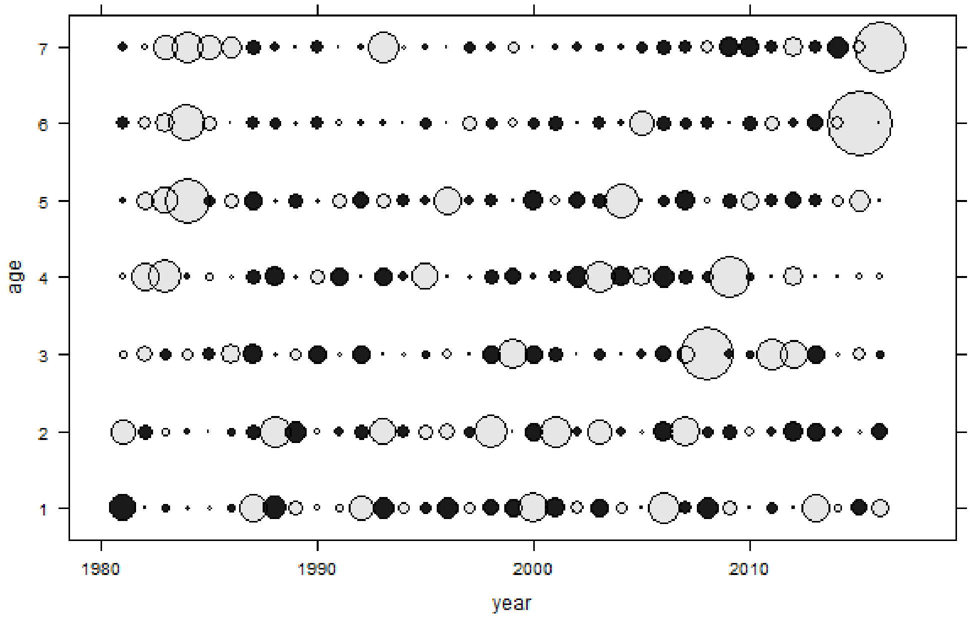

Figure 5.18. Cod in Division 6.a. Mean standardised catch-at-age proportions by number.

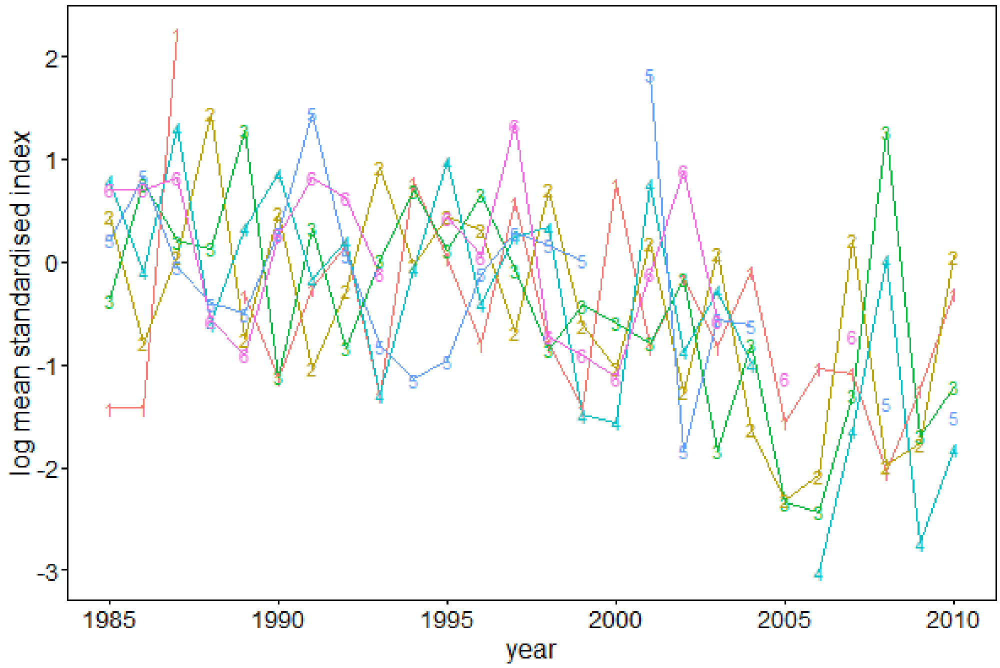

Figure 5.19. Cod in Division 6.a. Log mean standardised index values, by year, from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

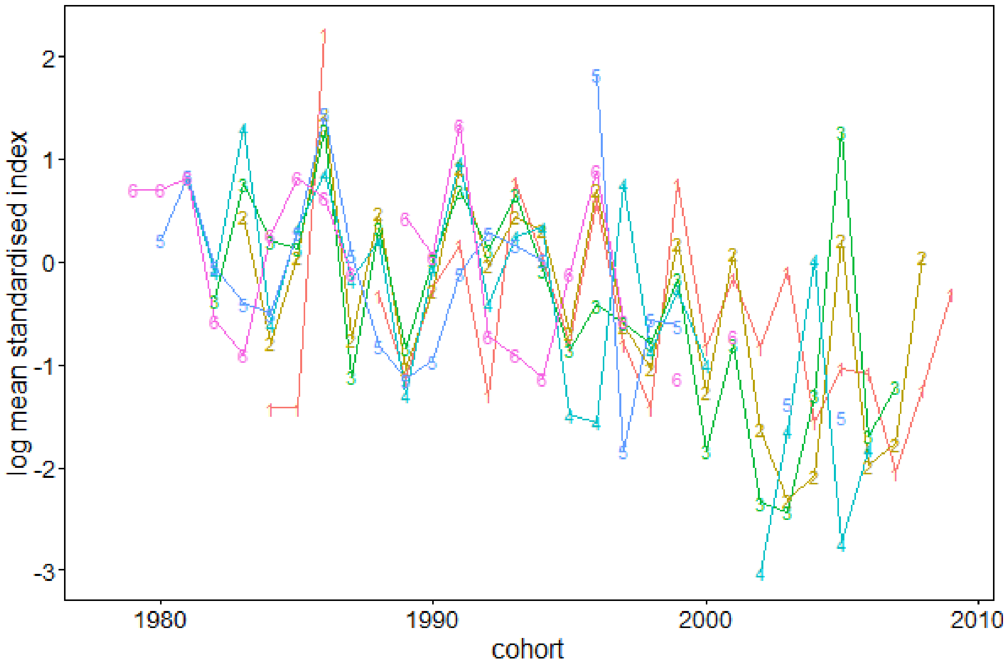

Figure 5.20. Cod in Division 6.a. Log mean standardised index values, by cohort, from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

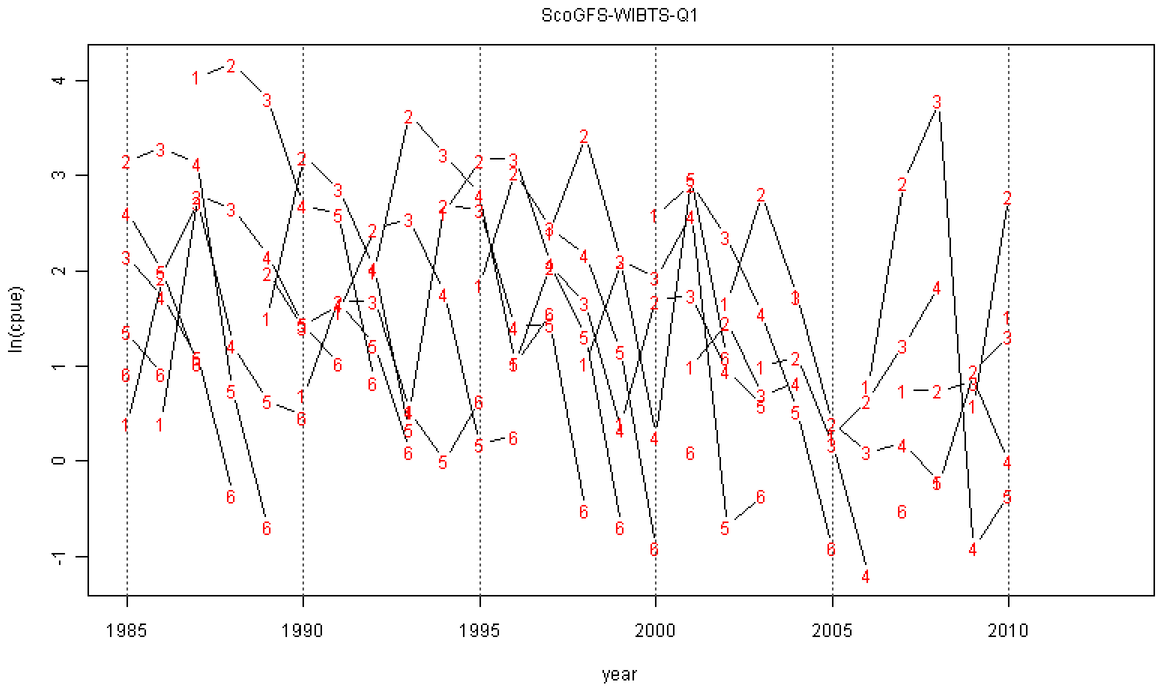

Figure 5.21. Cod in Division 6.a. Log catch curves from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

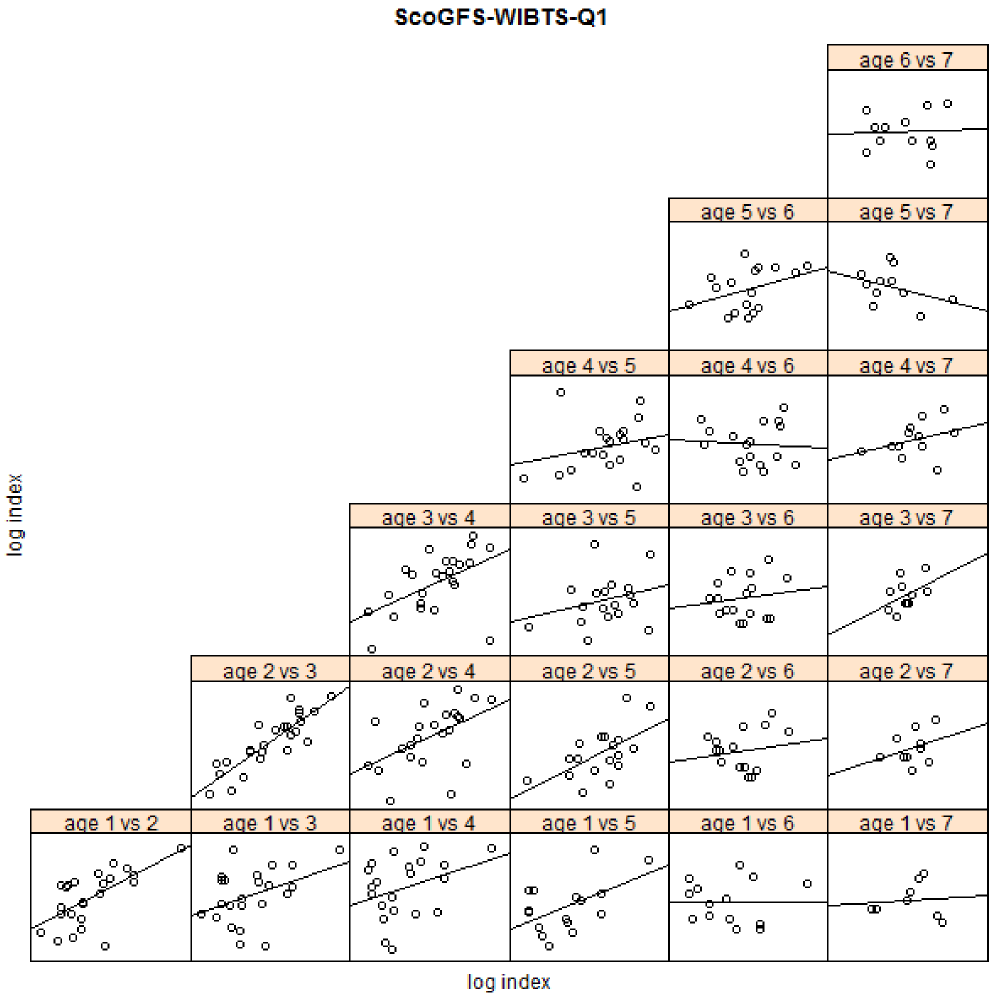

Figure 5.22. Cod in Division 6.a. Within-survey correlations for the Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1), comparing index values at different ages for the same cohorts. The straight line in a linear regression. Survey finished in 2010.

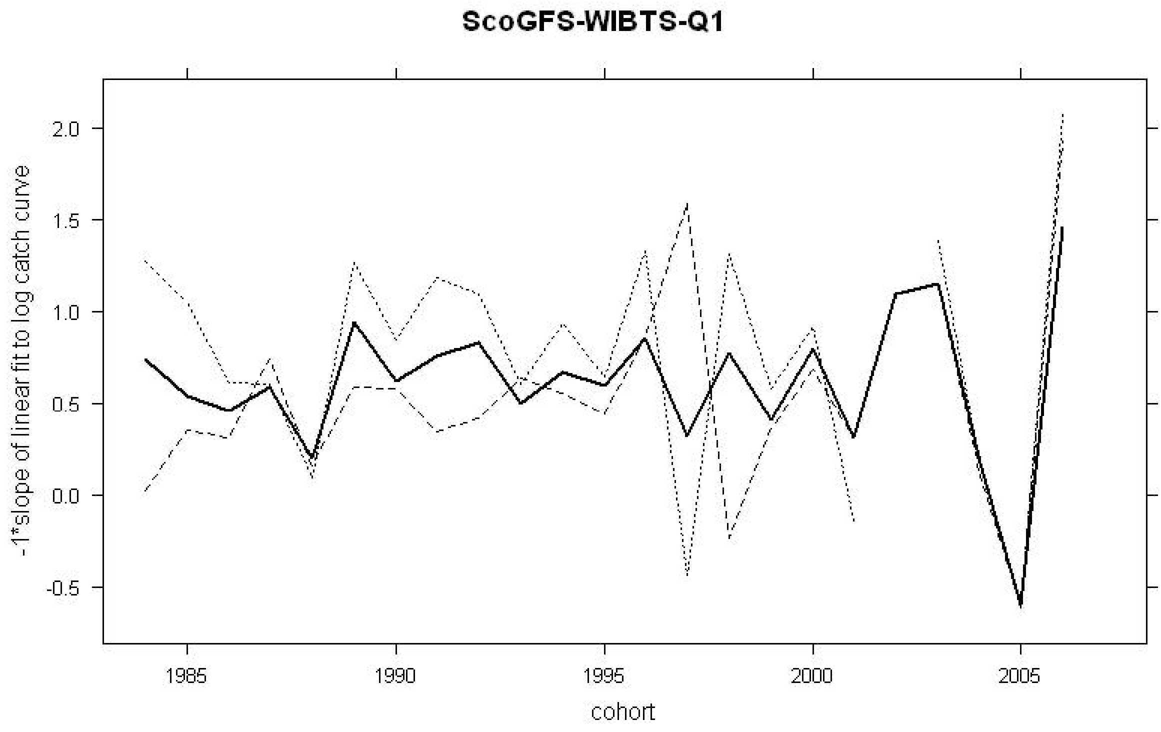

Figure 5.23. Cod in Division 6.a. Log catch curve gradient plot using ScoGFS-WIBTS-Q1 index data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. Last cohort shown was at-age 5 in 2010, the last year of the ScoGFS-WIBTS-Q1 survey.

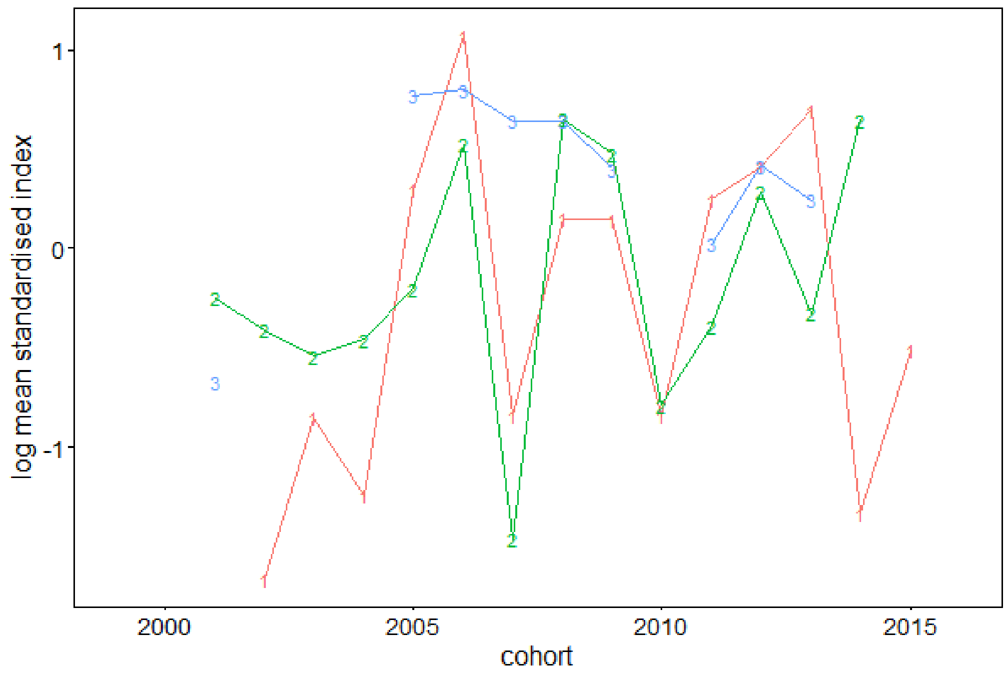

Figure 5.24. Cod in Division 6.a. Log mean standardised index values, by cohort, from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 1–3. Survey started in 2003.

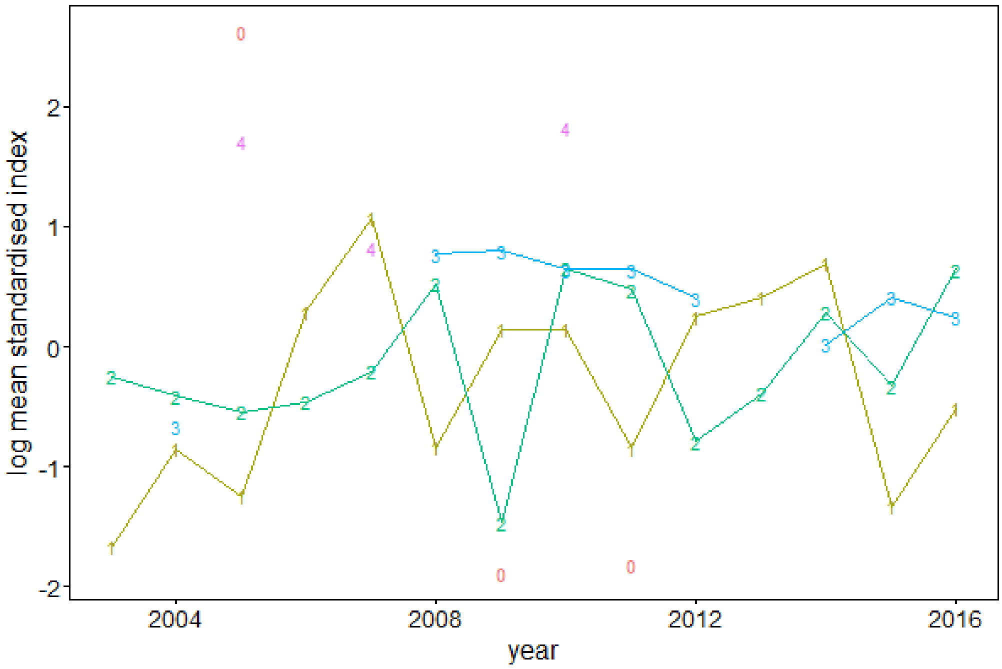

Figure 5.25. Cod in Division 6.a. Log mean standardised index values, by year, from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 0–4. Survey started in 2003.

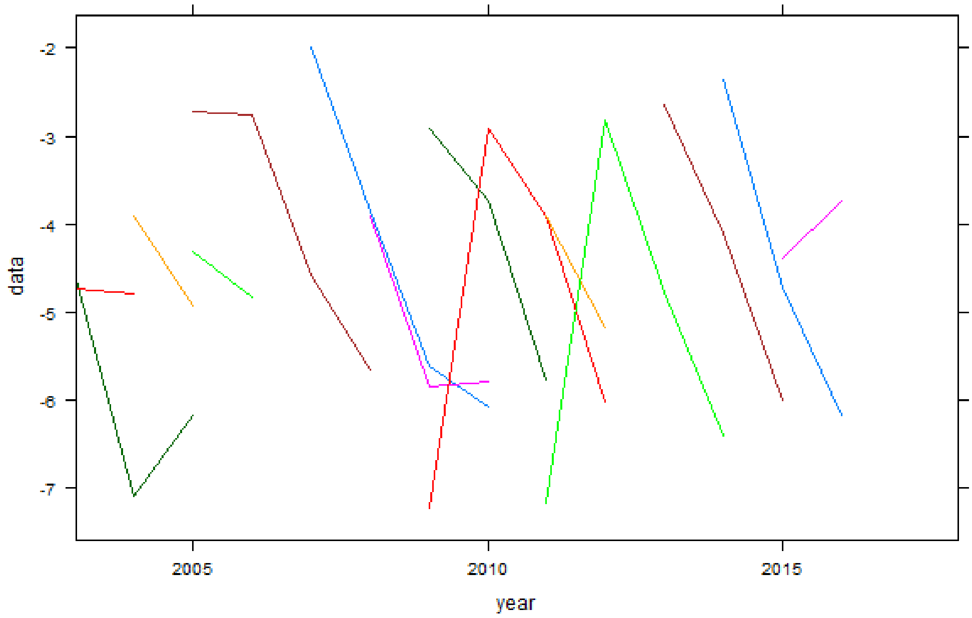

Figure 5.26. Cod in Division 6.a. Log catch curves from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 1–4. Survey started in 2003.

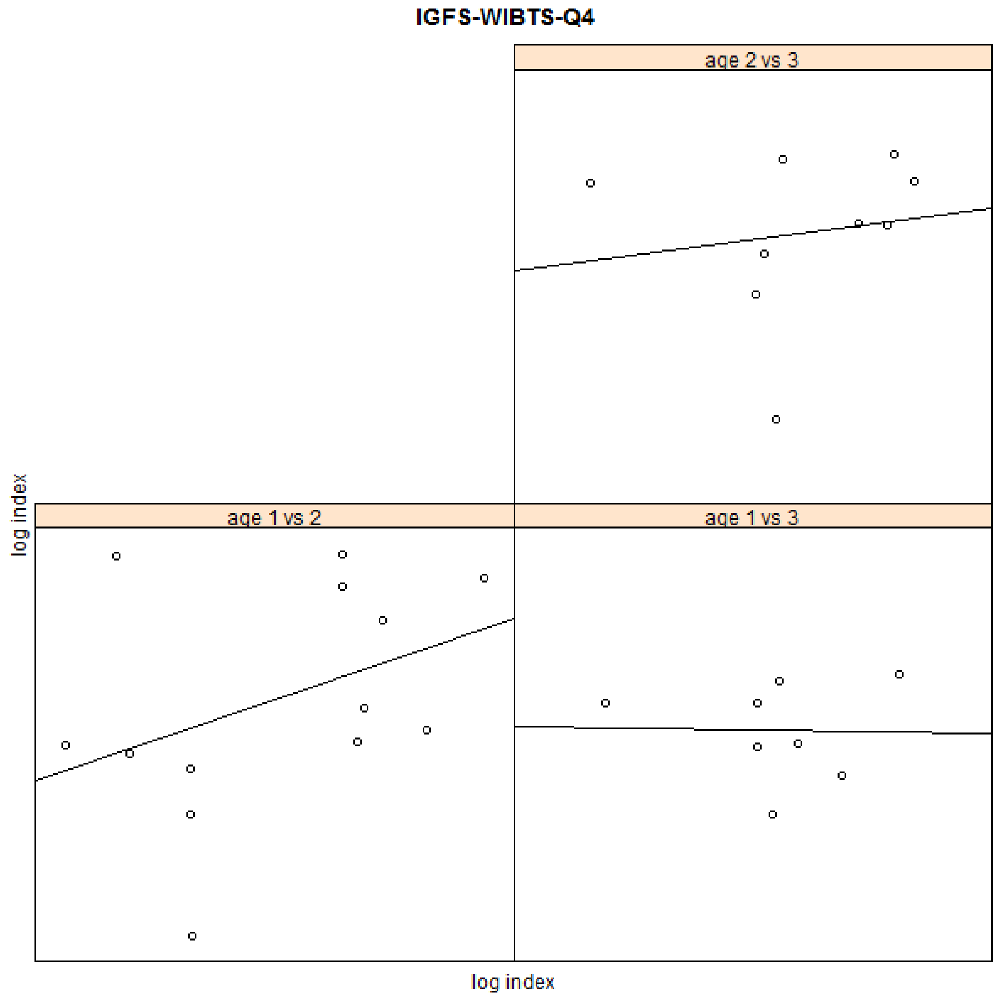

Figure 5.27. Cod in Division 6.a. Within-survey correlations for the Irish quarter four ground fish survey (IRGFS-WIBTS-Q4), comparing index values at different ages for the same cohorts. The straight line is a linear regression.

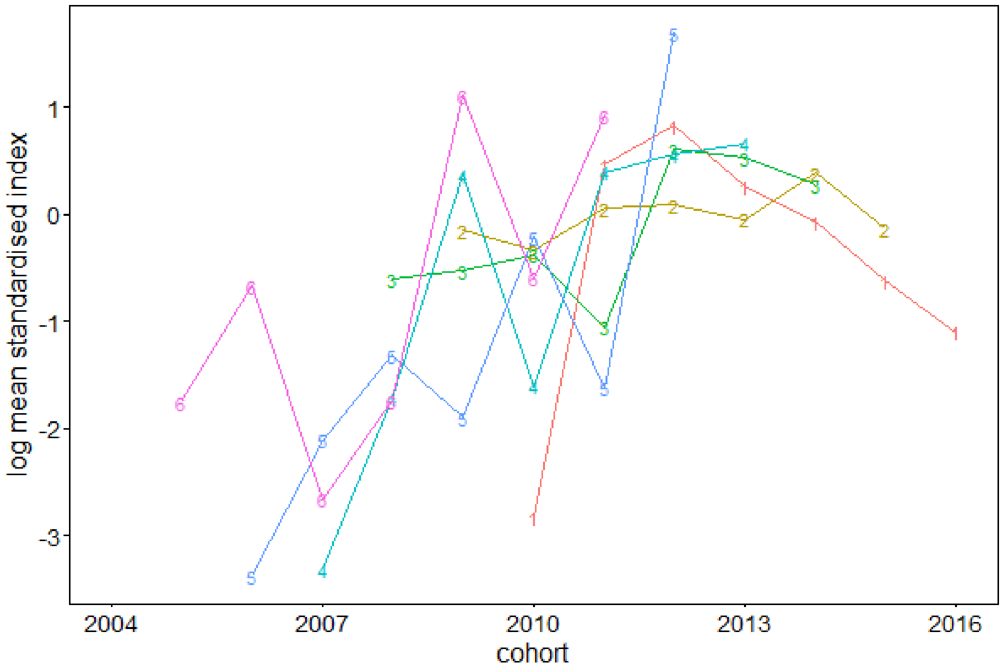

Figure 5.28. Cod in Division 6.a. Log mean standardised index values, by year, from Scottish quarter one ground fish survey UKS-IBTS-Q1); ages 1–6.

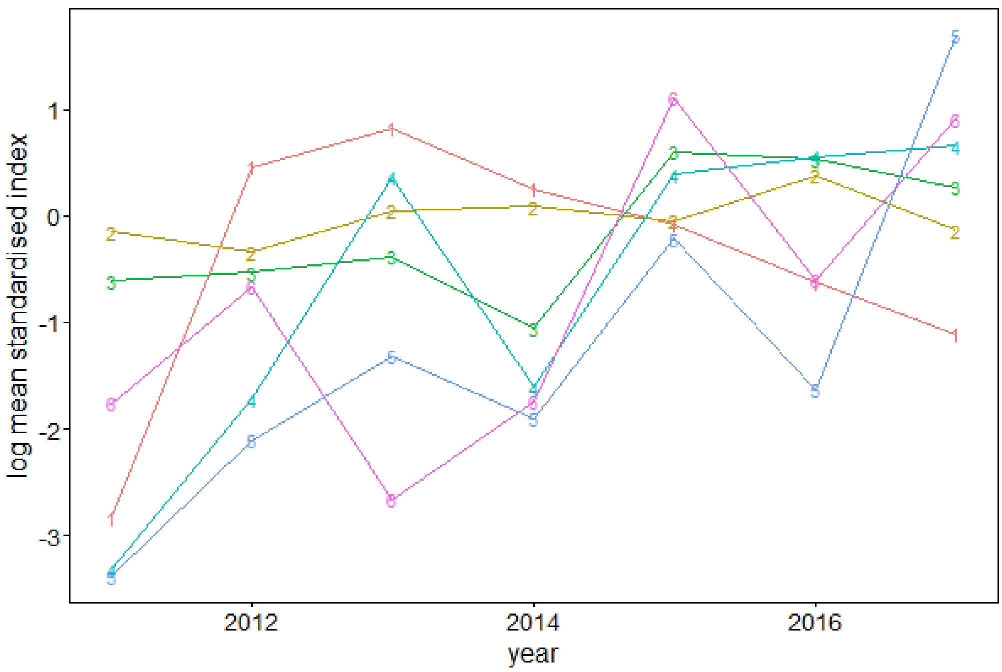

Figure 5.29. Cod in Division 6.a. Log mean standardised index values, by cohort, from Scottish quarter one ground fish survey UKS-IBTS-Q1); ages 1–6.

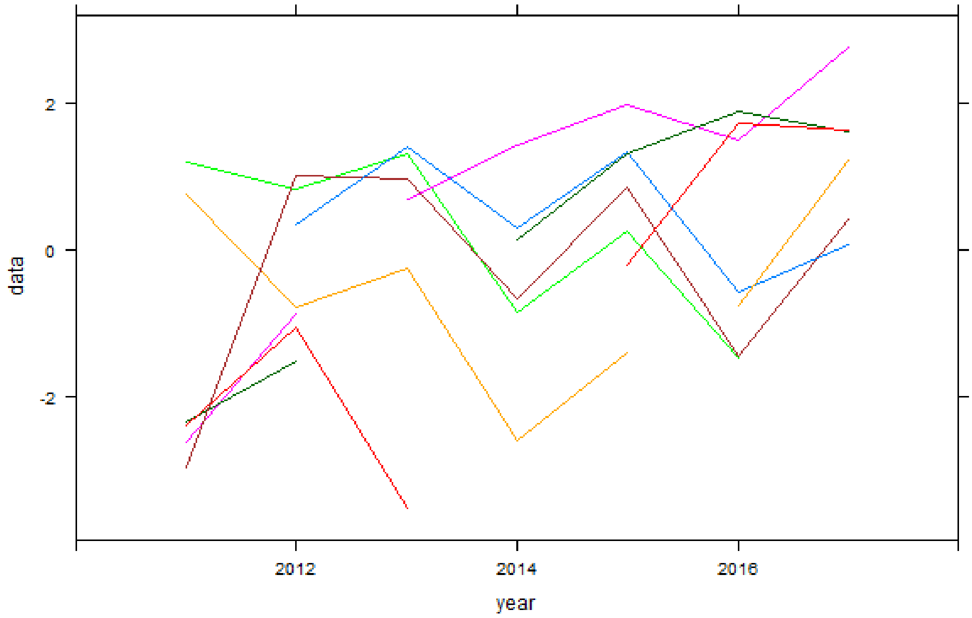

Figure 5.30. Cod in Division 6.a. Log catch curves from new Scottish quarter one ground fish survey (UKS-IBTS_Q1); ages 1–7. Survey started in 2011.

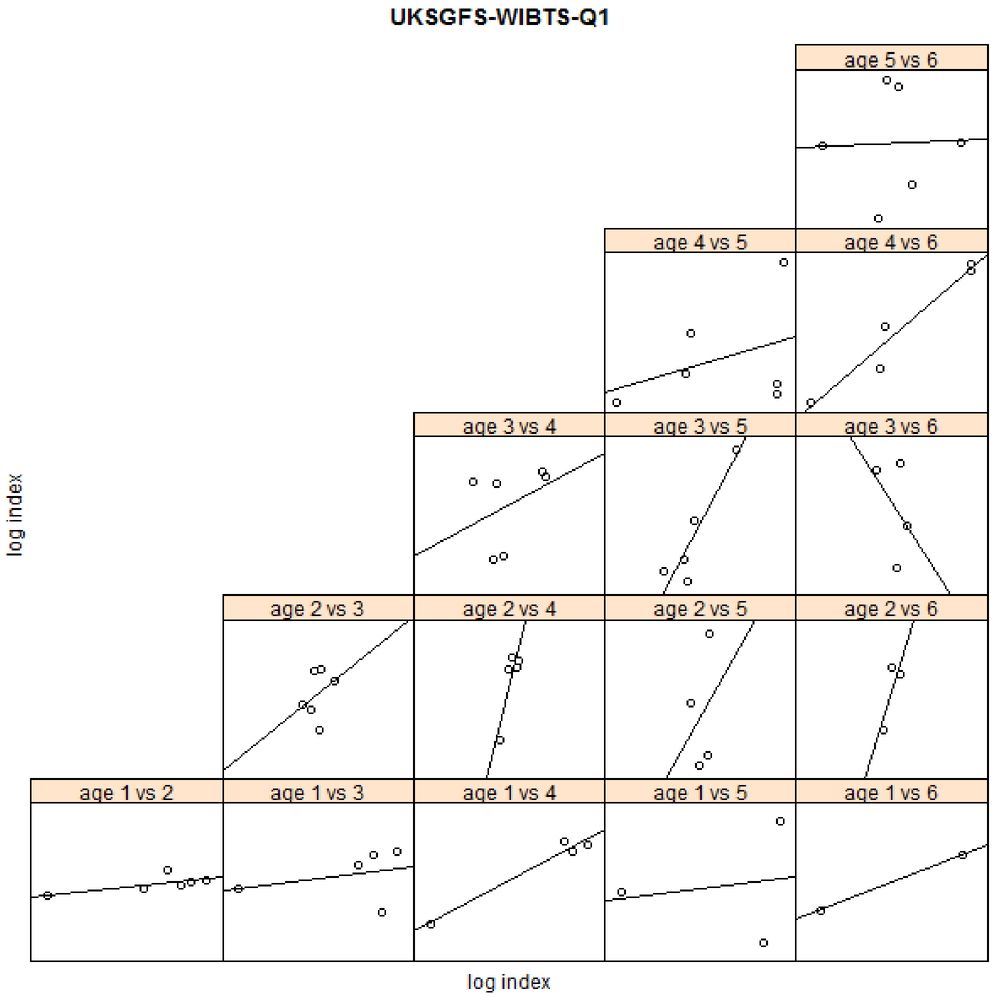

Figure 5.31. Cod in Division 6.a. Within survey scatterplots from new Scottish quarter one ground fish survey (UKS-IBTS_Q1), comparing index values at different ages for the same cohorts. The straight line in a linear regression.

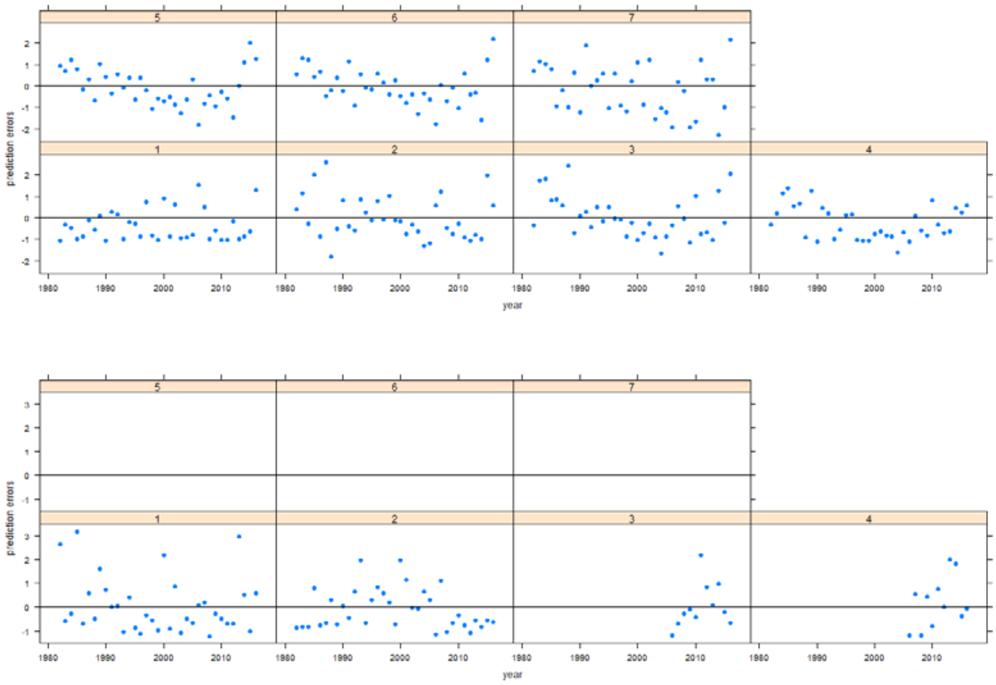

Figure 5.32. Cod in Division 6.a. TSA final run. Standardised prediction errors at-age plots for landings (upper) and discards (lower).

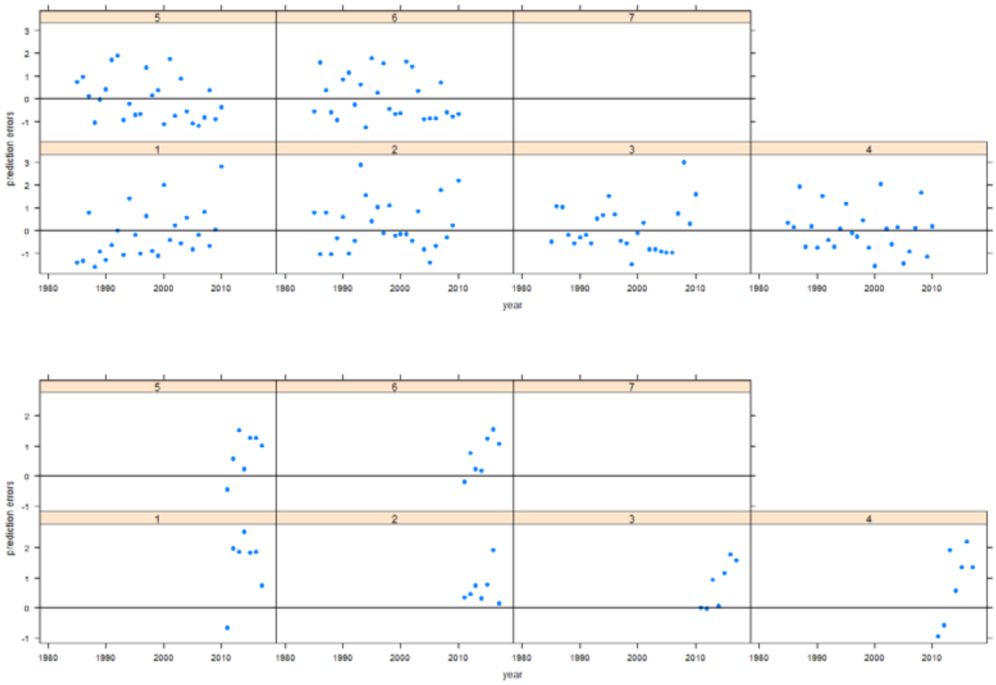

Figure 5.33. Cod in Division 6.a. TSA run. Standardised prediction errors at-age plots for ScoGFS-WIBTS-Q1 (upper) and UKSGFS-WIBTS-Q1 (lower).

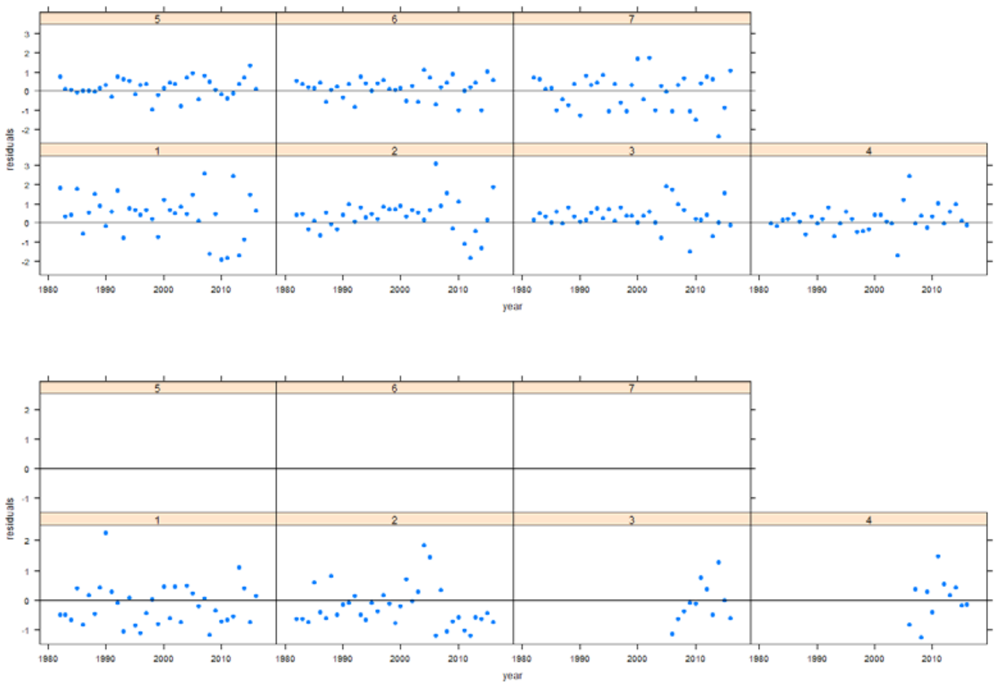

Figure 5.34. Cod in Division 6.a. TSA final run. Residuals at-age plots for landings (upper) and discards (lower).

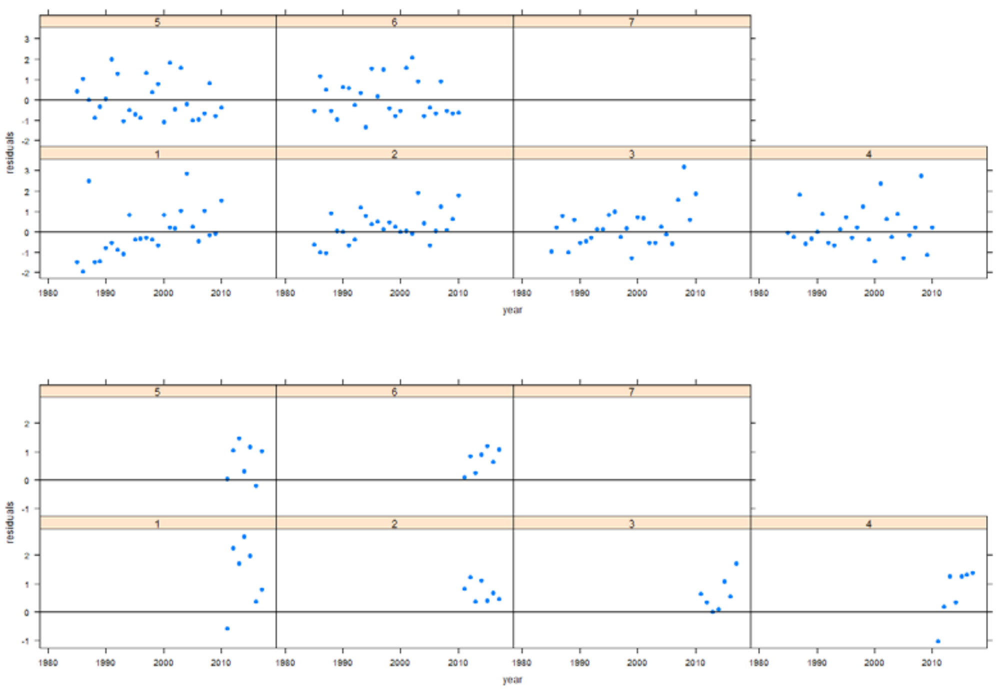

Figure 5.35. Cod in Division 6.a. TSA final run. Residuals at-age plots for ScoGFS-WIBTS-Q1 (upper) and UKSGFS-WIBTS-Q1 (lower).

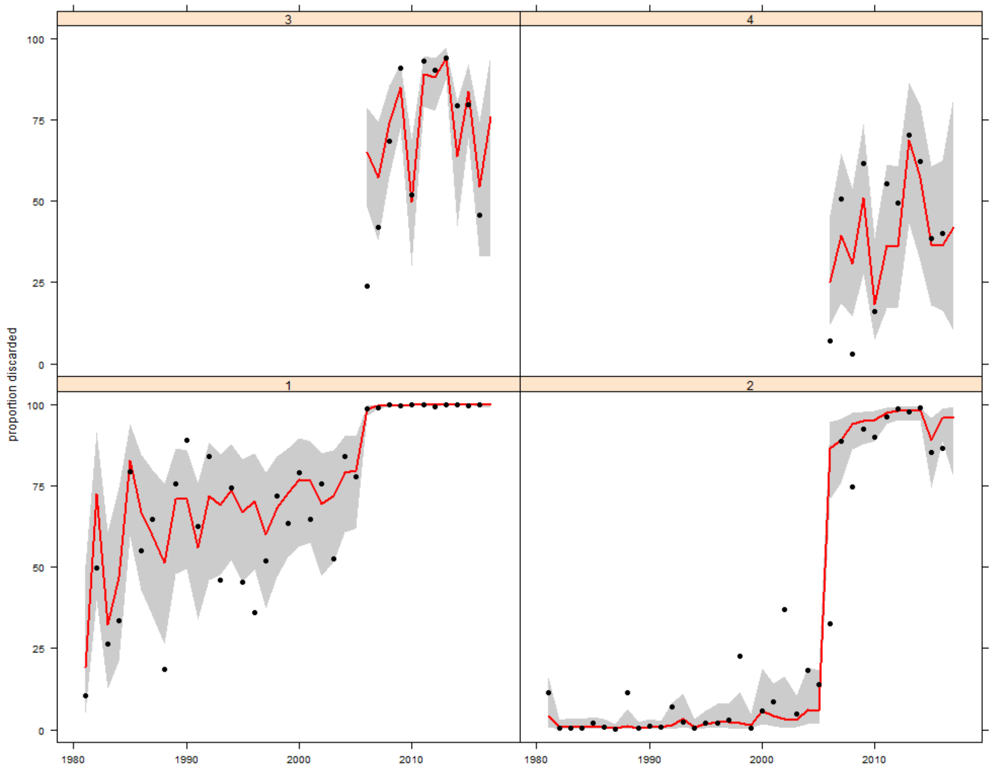

Figure 5.36. Cod in Division 6.a. Observed (points) and fitted (red lines with 95% CI indicated by grey bands) for the proportion discarded by age. Note that the plot also shows the TSA projection of discards for 2017.

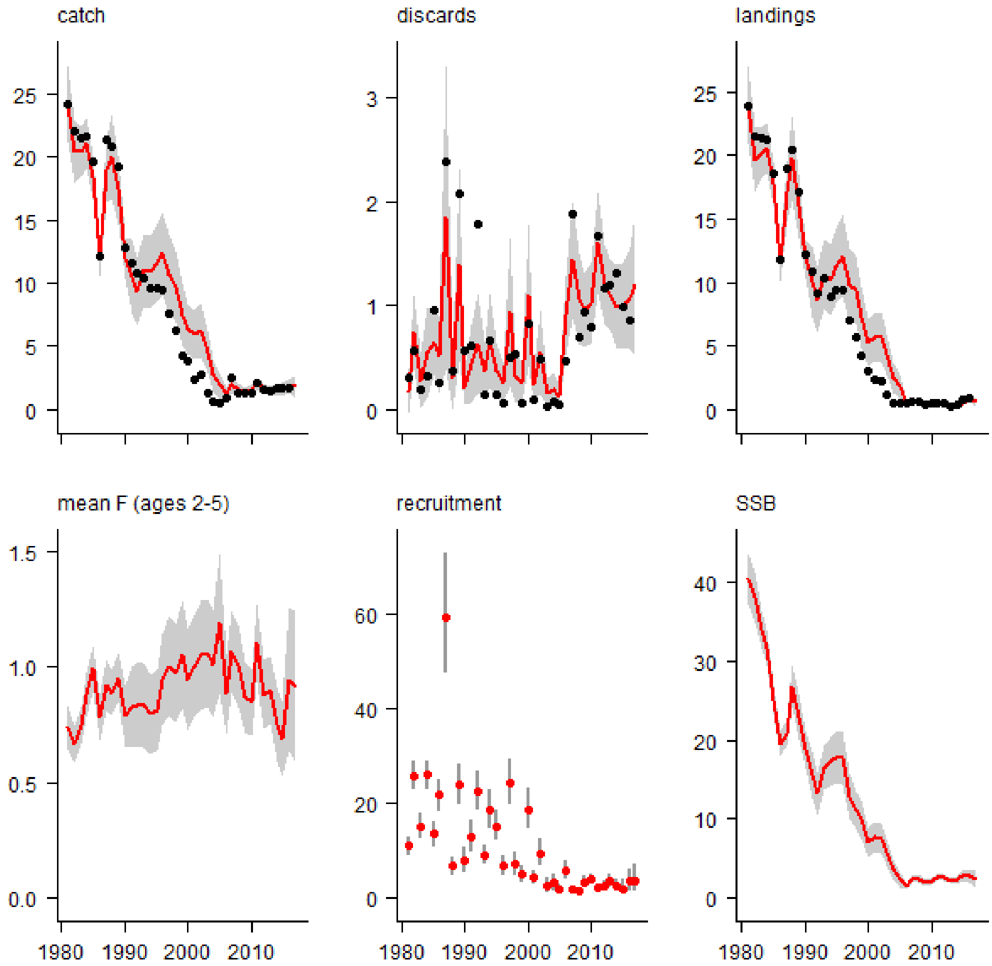

Figure 5.37. Cod in Division 6.a. Summary plot of final TSA run. Stock summary from final TSA assessment. Red lines (or points) give best estimates, grey bands (or lines) give approximate pointwise 95% confidence intervals, and black points give observed values.

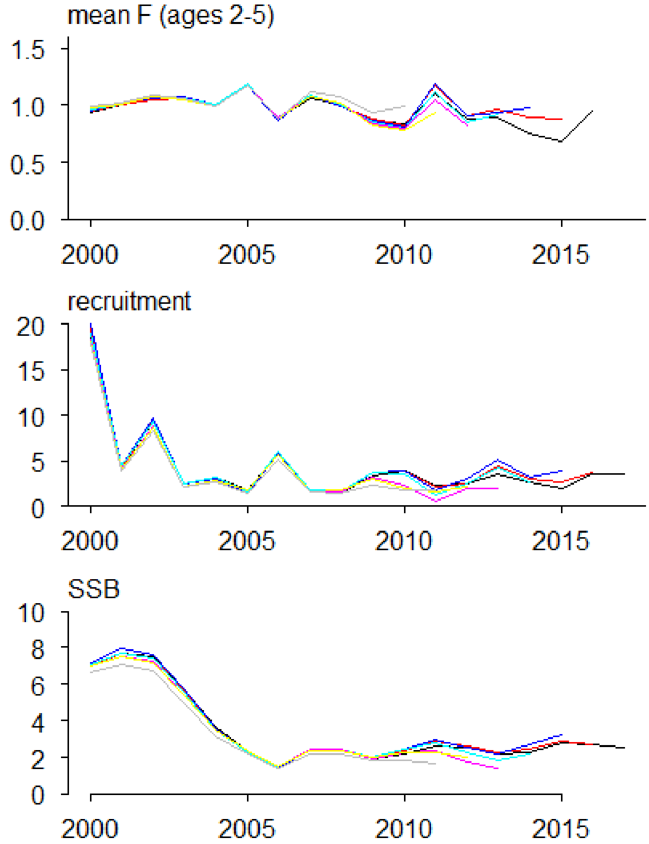

Figure 5.38. Cod in Division 6.a. Retrospective plots of TSA run presented over a shortened time interval (to allow narrower y-axis range to be used).

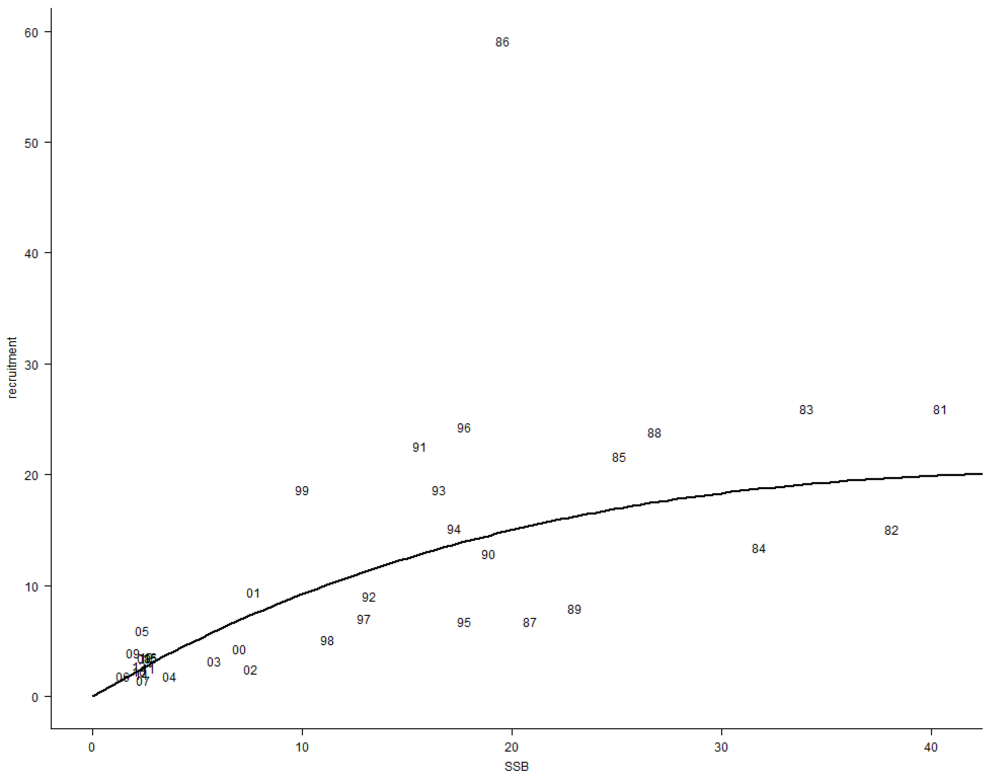

Figure 5.39. Cod in Division 6.a. TSA final run. Stock–recruit relationship. Numbers indicate year class.

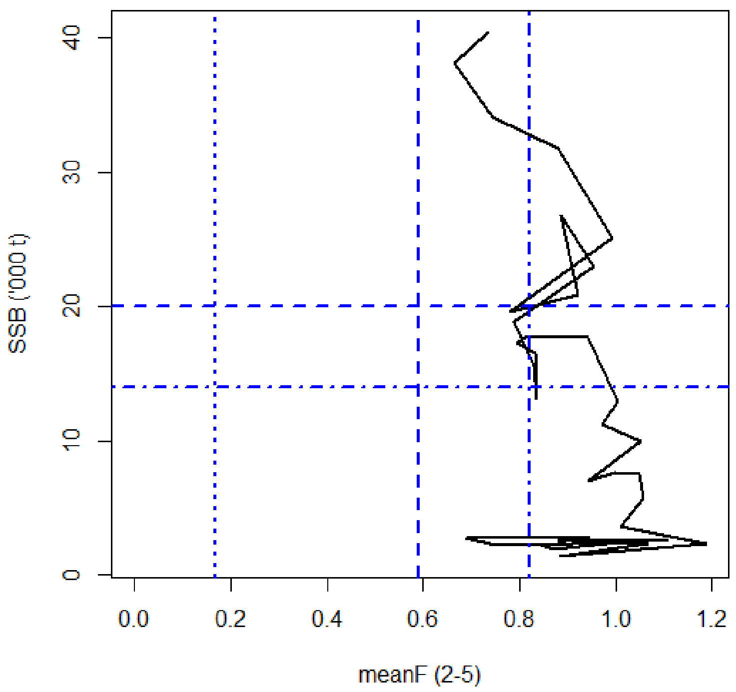

Figure 5.40. Cod in Division 6.a. Trajectory of SSB against mean F. Horizontal lines are B_{lim} (dot-dashed) and B_{pa}/MSY $B_{trigger}$ (dashed). Vertical lines are F_{MSY} (dotted), F_{pa} (dashed) and F_{lim} (dash-dotted).

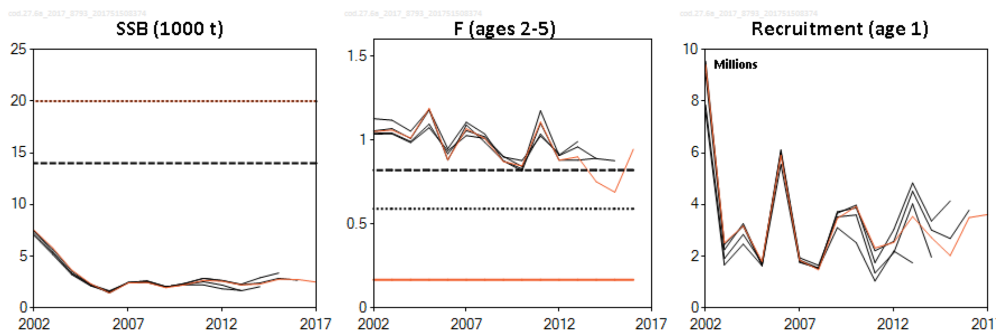

Figure 5.41. Cod in Division 6.a. Comparison of SSB, mean F (2–5) estimates and recruitment-at-age one produced by final run assessments between this year's assessment and previous four assessments.

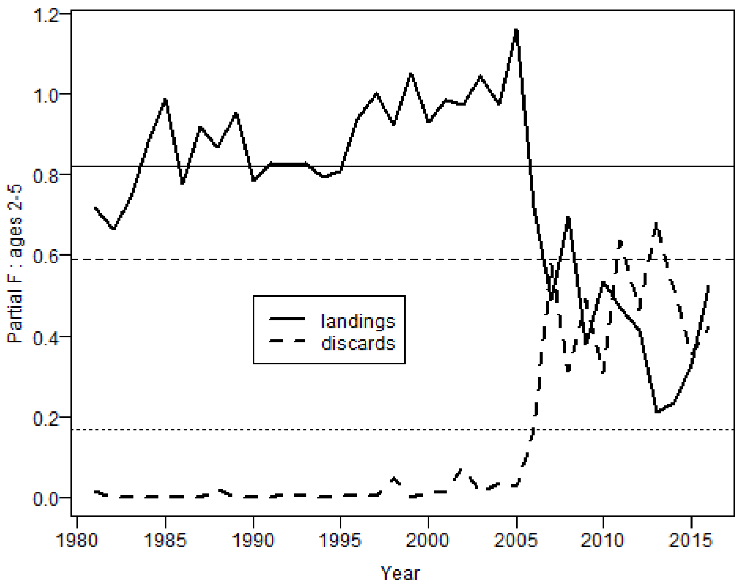

Figure 5.42. Cod in Division 6.a. Partial mean F attributed to landings and discards. Horizontal lines represent F_{lim} (solid), F_{pa} (dashed) and F_{MSY} (dotted) values for the stock.

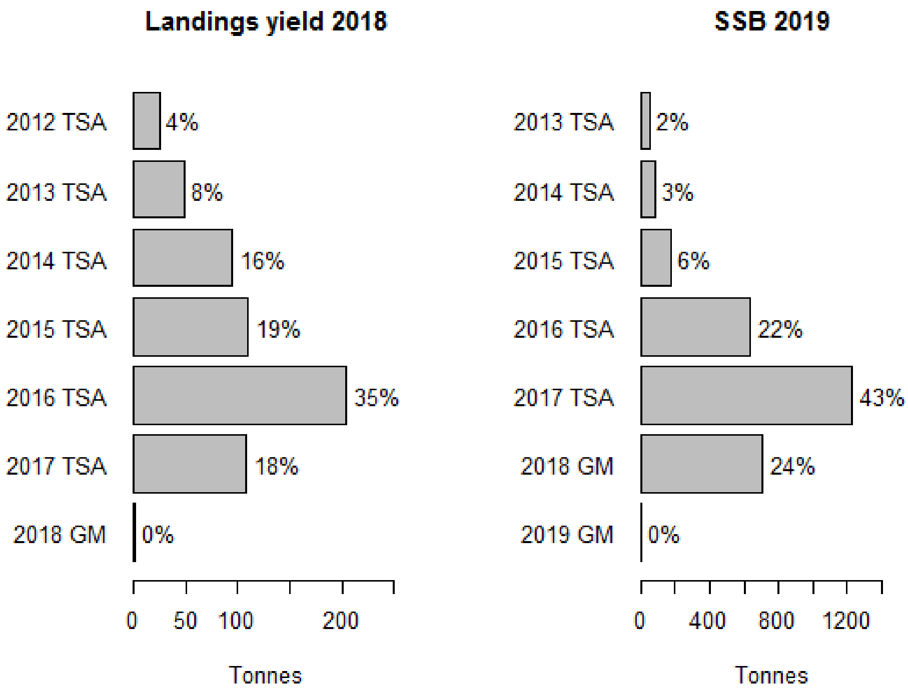

Figure 5.43. Cod in Division 6.a. Percentage contribution to landings yield in 2018 and SSB in 2019 by recruitment year (not year class).

6 Cod in Division 27.6.b

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 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 advice applicable in 2013–2015

ICES first provided quantitative advice for data limited stocks in 2012, this resulted in biennial advice for this stock in 2013 and 2014. With no new data available that changed the perception of the stock in 2014 the same catch advice was considered to be applicable for 2015 and is given below.

Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 70 tonnes.

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.

6.1 General

Management applicable to 2013–2017

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 2013–2017:

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 2016

No specific information is available for 2016. Cod at Rockall are taken as a bycatch in fisheries for other species such as haddock and anglerfish.

6.2 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 62.3 tonnes in 2016. There were no updates to landings from previous years. 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 2016. In addition, some landings age compositions and discard data were also uploaded to IC. Data uploaded to IC are shown below.

Country	Discards (t)	Landings (t)
Ireland	0.3	14.6
Norway		10.6
UK (Scotland)	7.9	38.0
Grand Total		71.4

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 2014–2016 however there is high inter annual variability in the estimated discard rate for this fleet (0%, 53.6% and 23.4%). In 2017 information provided by Ireland suggested much lower discard rates for both the Irish demersal otter trawl fleet (2.3%) and the Irish seine fleet (2.3%). 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 4.2.2 and 4.2.3 and Tables 4.2.2 and 4.2.3. Figure 4.2.2 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. 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 with a marked increase in 2015 and 2016 which given the magnitude of increase seems unlikely to be completely attributable to an increase in stock size (an almost five-fold increase over two years). 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 4.2.4).

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

6.3 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	93	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	1600	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*
Faroe Islands	-	-	-	-	-	-	-	-	3	5	-	-	-	-	-	-
France	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	40	18	11	7	12	23	24	41	20	6	12	1	2	6	5	15
Norway	89	28	25	23	7	7	12	12	25	27	49	11	3	+	18	11
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russia	26	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Spain	1	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E. & W. & N.I.)	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Scotland)	176	67	57	45	43	29	26	41	48	23	37	11	9	-	-	-
UK	-	-	-	-	-	-	-	-	-	-	-	-	-	10	18	37
Total	334	115	102	75	62	58	62	94	97	61	98	23	14	15	41	62

*** 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	415	9.14225	45.39
1996	402	7.219	55.68
1997	130	7.169	18.20
1998	207	7.337	28.16
1999	138	8.68	15.88
2000	101	9.883	10.23
2001	33	7.232	4.60
2002	16	2.626	6.18
2003	10	4.542	2.18
2004	7	2.233	3.08
2005	9	3.283	2.68
2006	22	5.9	3.76
2007	24	6.587	3.62
2008	40	9.898	4.08
2009	22	4.353	4.97
2010	7	3.28	2.03
2011	9	2.534	3.56
2012	1	3.248	0.31
2013	1.8	3.809	0.46
2014	5.6	4.2	1.34
2015	4.1	4.7	0.87
2016	11.4	6.2	1.83

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

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

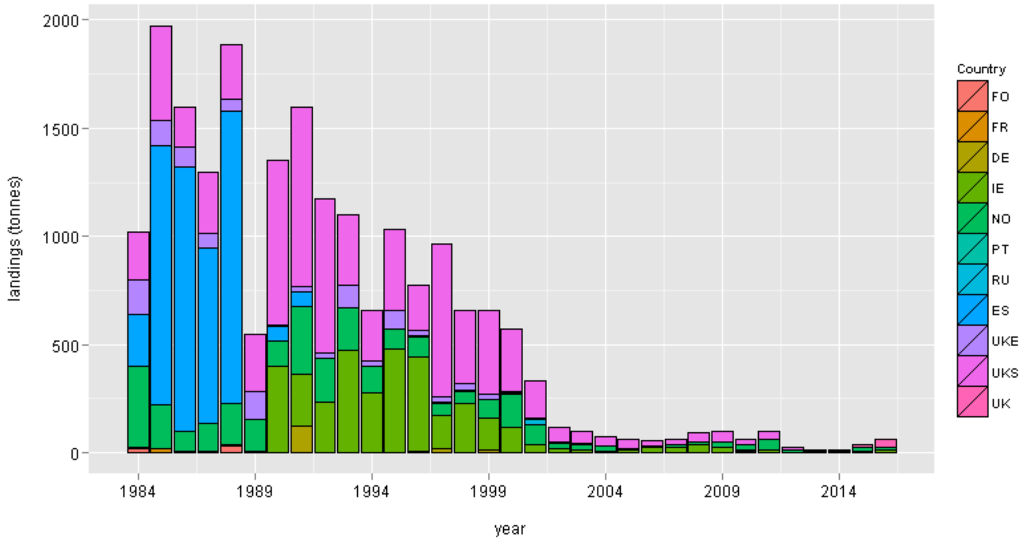

Figure 6.1. Cod in Division 6.b. Total of official catch (all nations combined). Values for 2016 are provisional.

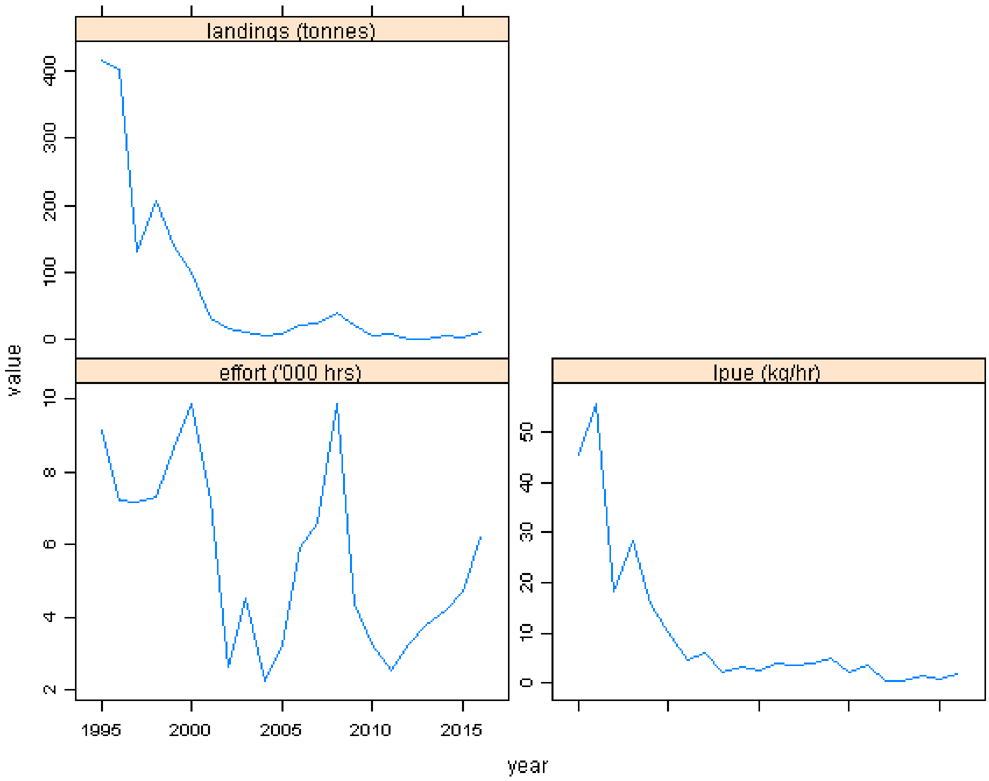

Figure 6.2. Cod in Division 6.b. Landings, effort and lpue (kg/hr) from the Irish Otter-trawl fleet.

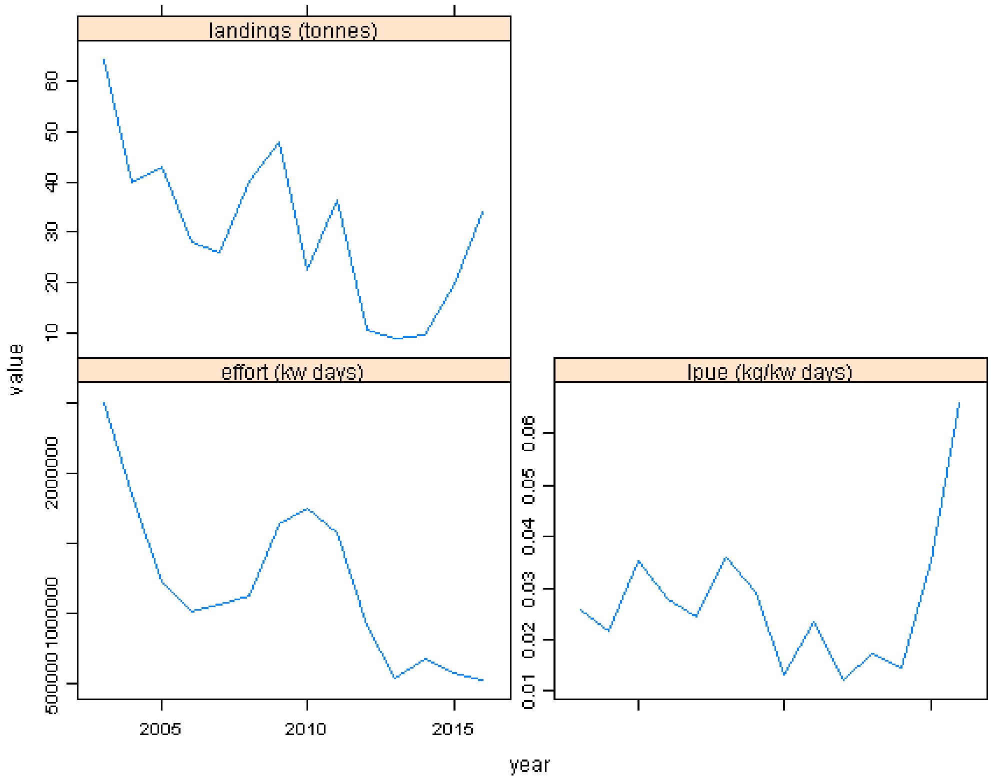

Figure 6.3. Cod in Division 6.b. Landings, effort and lpue (Kg/kWday) from the Scottish TR1 fleet.

7 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

A full analytical assessment benchmarked at ICES WKIRISH 3 (ICES, 2017a). The assessment and data are detailed in the stock annex (ICES, 2017b).

ICES advice applicable to 2016 and 2017

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 2016 and 2017.

7.1 General

Stock description and management units

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

Management applicable to 2016

TACs and quotas set for 2016

Zone 7a (COD/07A)	Analytical TAC	Weight tonnes	Landed
	Belgium	2	2.98
	France	5	0.04

Ireland	97	84.23
The Netherlands	0	0
United Kingdom	42	35.48
EU	146	122.83
TAC	146	

Management of cod 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 2016

The landings in 2016 were the lowest observed in the time-series at 122.83 t, 82.33 t after re-allocation of 40.5 t of Irish landings and continue the general downward trend in recorded landings (Table 7.1). 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:

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

The total quota uptake was less than the TAC advice for all nations except Belgium. Landings by UK vessels have realised 84% of TAC in 2016 (Table 7.2), with the majority taken as bycatch in *Nephrops* trawlers, landings and discards by métier and country can be seen in Table 7.3.

A Fishery–Science Partnership Survey (FSP) was repeated in the western Irish Sea in spring 2016 and 2017 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, start to show an increase of cod older than three years of age in the Irish Sea (Figures 7.1 and 7.4). Historically the proportion-at-age from the data collected during the sentinel fisheries supports a very steep age profile. The very low catches in the last couple of years in combination with two "strong" year classes in 2013/2012 is leading to a slightly less steep age profile. However, the question remains what is happening to the four plus year old fish in the Irish Sea.

7.2 Data

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) 2006–2016. 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). Year classes rapidly disappeared from the commercial landings data, returning slowly with the 2013 cohort (Figure 7.1). 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.

Discards data

Discard data (Table 7.6 a–b) have been included for the first time in the most recent assessment. 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). 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	2016
NIGFS-WIBTS-Q4	0–2	1993	2016
UK-FSPw	2–6	2005	2016 (except 2014)
NIMIK	0	1994	2016

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 Figures 7.4–7.7.

Commercial cpue

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

7.3 Historical stock development

Model used: ASAP, the full model input can be found at the end of the section.

Deviations from Stock Annex

None, stock annex was followed.

Software used and model options chosen

ASAP model with the parameters as in the recent stock annex was applied.

Input data types and characteristics

New data added to the ASAP assessment are the fishery catch data and survey data for 2016. Maturity ogive smoother was applied to the most recent NIGFS-Q1 data to produce a new maturity ogive. Full model description and inputs are at the end of the chapter.

Final update assessment: diagnostics

The diagnostics of the update ASAP run are given in Figure 7.8–7.18.

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. The fit to the surveys (except the MIKNET) still has some pattern in the early years but is much improved in recent years.

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. The noise in the estimates increases with age such that at oldest ages of the NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 surveys are not included in the assessment. The NIGFS-WIBTS-Q1 survey has a dome-shaped selectivity curve catching fewer older fish whereas UK-FSP survey has an increasing catch selectivity with age. Further information is in the stock index (ICES, 2017b) and Figure 7.15 shows the index catchability (constant across years).

Figure 7.16 shows the fit of the model RMSE. The fit to the total catch and MIKNET index is not perfect.

Retrospective summary for 2011–2016 is displayed in Figure 7.18. F_{bar} and SSB have been re-adjusted annually; F_{bar} is revised upwards, while SSB is revised downwards considerably.

Final assessment: long-term trends

Stock numbers of fishes at all ages have declined since the 1970s, however more recent years, starting from 2010, shows and increase in 3+ (Figure 7.17).

Figure 7.19 presents the ASAP estimated spawning–stock biomass, average F and recruitment. Population numbers and F-at-age from the assessment are given in Tables 7.9 and 7.10, and the summary data are presented in Table 7.11.

SSB is estimated to have increased above B_{lim} and F is well below historic and reference levels. Recruitment in 2016 was very low, reaching a historic minimum.

The state of the stock

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 and surpassed B_{lim} for the first time in 2016 (Figure 7.19).

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 7.19).

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 7.19).

Figure 7.20 indicates that under the *status quo* fishing pressure and geometric mean recruitment the SSB in 2019 will consists to 61% of the 2013 year class. This year class will be in the 6+ group, an age group poorly understood and with hardly any commercial and survey data available.

7.4 Short-term predictions

Short-term forecasts have been carried out in 2017 for the first time following benchmarking of the stock in 2017.

A geometric mean (GM) approach was chosen for the recruitment at age 0. As recruitment over the past 15 years has been below the historical average, GM was estimated from years 2005 to 2014 as 5513 thousands.

FSQ (F status quo for the interim year) was taken as a 3 year average (2014 – 2016) F as 0.07076.

Input values are displayed in Tables 7.11 and 7.12 in combination with maturity ogives and natural mortality.

STF results of catches, landings, discards and SSB in 2019 under a range of management options can be seen in Table 7.13.

Table 7.14 shows the number at age under FSQ regime over the years 2017 to 2019.

7.5 Biological reference points

F_{MSY} evaluations

An evaluation of F_{MSY} reference points was carried out at WKIRISH3 and re-visited at WGCSE 2017 and the suggested level of F_{MSY} for this stock was within the range of 0.213 and 0.408.

The current reference points for Irish Sea cod were benchmarked at WKIRISH 3:

B_{lim} 6000 t

MSY	0.309 (range 0.213–0.408)
B_{PA}	8161 t
F_{lim}	0.614
F_{PA}	0.442

7.6 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).

7.7 Uncertainties and bias in assessment and forecast

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 has 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 *Nephrop* 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.

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 2005–2016 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.

Model formulation

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. In spring of 2016 976 cod were caught and tagged aboard a chartered commercial fishing vessel using semi-pelagic fishing gear. 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.

Spawning-stock biomass estimate

The SSB retrospective plot shows a consistent downgrading of the estimated SSB from the previous years (Figure 7.18). This should be taken into consideration when considering future development of the stock.

7.8 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. At this point in time all sources of information on age composition in the stock, from the fishery as well as surveys using research vessels and chartered commercial vessels, indicate a trend towards a recovery of the stock and a decline in fishing pressure.

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Table 7.1. Nominal landings (t) of COD in Division 7.a as officially reported to ICES and figures used by ICES from 1997.

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011[1]	2012	2013	2014	2015	2016
Belgium	183	316	150	60	283	318	183	104	115	60	67	26	19	21	36	23	13	9	12	3
France	268	269	n/a	53	74	116	151	29	35	18[2]	17[2]	3	12	1	3	1	<1	<1	<1	<1
Ireland	1,492	1,739	966	455	751	1,111	594	380	220	275	608	618[2]	323[2]	289	275	193	160	148	137	84.2
Netherlands	29	20	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (England, Wales & NI)	2,370	2,517	1,665	799	885	1,134	505	646	594	5892	423	5432	3872	282	169	109	107	79	50	35.5
UK (Isle of Man)	19	34	9	11	1	7	7	5	n/a	n/a	n/a	22	12	1	1	<1	<1	<1	<1	<1
UK (Scotland)	80	67	80	38	32	29	23	15	3	6	2	12	12	-	-	-	-	-	-	
Total	4,441	4,962	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
Unallocated	1,418	356	1,909	-143	226	-20	-192	-107	-57	-108	-415	-563	-286	-130	-117	-128	-75	-33	-38	-40.5
Total as used by WG	5859[3]	5318[3]	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

[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

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%	

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

Table 7.3. Landings and discard proportions by métier.

Catch (2016)	Estimated landings					
142 tonnes	otter trawls		Scottish seines	mid-water trawl	Beam Trawls	Other gear-types
	74% *Nephrops* directed	7% demersal fish directed	1%	2%	14%	2%
	82 tonnes					
	Estimated discards					
	otter trawls		Scottish seines	mid-water trawl	Beam Trawls	other gear types
	77% *Nephrops* directed	<1% demersal fish directed	<1%	1%	20%	1%
	60 tonnes					

Table 7.4. Cod in 7a. Total catch numbers-at-age used in the 2017 update ASAP assessment.

	0	1	2	3	4	5	6+
1968	17.81	438.71	1563	1003	456	177	30
1969	20.85	969.45	1481	1050	269	186	113
1970	22.13	1809.83	1385	352	204	163	71
1971	22.94	2835.2	2022	904	144	67	51
1972	26.51	900.18	3267	824	250	58	59
1973	27.17	2376.96	1091	1783	430	173	81
1974	16.94	601.04	3559	557	494	131	74
1975	26.38	1809.62	642	1407	294	249	117
1976	26.77	1247.28	3007	363	500	61	104
1977	31.05	946.23	511	1233	163	218	71
1978	39.96	854.57	1092	310	311	39	65
1979	44.35	1947.98	1288	608	127	164	71
1980	24.6	2636.16	2797	729	243	49	55
1981	37.67	1456.97	3635	1448	244	99	47
1982	46.04	538.1	2284	1455	557	102	79
1983	46.98	1011.05	932	751	499	154	46
1984	37.3	1733.45	1195	439	240	161	75
1985	33.89	1360.12	2105	703	158	84	77
1986	49.15	1180.15	2248	699	203	64	65
1987	47.38	4521.69	1793	841	252	75	43
1988	42.59	2970.64	4734	702	263	71	38
1989	41.03	754.09	2163	1886	231	86	37
1990	37.85	868.74	1075	545	372	70	30
1991	46.64	2168.61	1408	442	127	98	22
1992	36.74	1529.1	1243	664	132	42	49
1993	39.4	388.24	2907	403	119	16	13
1994	39.92	916.44	569	848	68	20	10
1995	42.97	678.2	1283	180	163	7	6
1996	87.95	446.79	1113	700	38	39	6
1997	5.28	650.79	1149.5	501	213	17	16
1998	0	231.47	1928	335	80	28	8
1999	141.42	235.79	843	871	66	21	7
2000	62.36	1106.69	176	107	50	4	1
2001	7.22	403.15	841	53	13	9	2
2002	0	238.49	564	405	7	2	3
2003	50.43	120.68	471.62	108.83	36.25	1.13	0
2004	50.43	160.78	133.81	173.83	22.25	6.13	3
2005	50.43	118.34	256.36	77.83	34.25	5.13	1
2006	50.43	89.08	174	127.83	17.25	8.13	3
2007	16	216	209.6	56	11	1	0
2008	5.5	77.4	169.4	87	9	3	0
2009	329.3	59.8	57.4	66.1	17	3	0
2010	48.7	220	188.3	16.4	7.5	2.1	1

	0	1	2	3	4	5	6+
2011	9.7	53.7	105.9	36	2	1	1
2012	7.5	83.9	135.2	144.9	9.9	0.2	0
2013	36.1	37	58.5	30	9	1.5	0
2014	1.09	40.66	85.93	26.3	5.53	1.1	0
2015	0	37.3	79.8	25.8	4.3	1.3	0
2016	0	10.84	24.55	30.146	2.28	1.191	0.176

Table 7.5. Cod in 7a. 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	5.79	8.45	9.14
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	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	0.949	1.88	3.745	5.536	6.754	9.036
2012	0.1	0.93	1.88	3.37	5.34	7.6	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	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

Table 7.6. Cod in 7.a. Estimates of numbers discarded (a) and the discarded proportions (b) from 1968–2016. 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
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

Year	0	1	2	3	4	5	6+
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	4.6	0	0	0	0
2008	5.5	63.4	3.4	0	0	0	0
2009	329.3	39.8	4.4	0.1	0	0	0
2010	48.7	180	60.3	1.4	0.5	0.1	0
2011	9.7	42.7	0.9	0	0	0	0
2012	7.5	79.9	100.2	112.9	5.9	0.2	0
2013	36.1	31	26.5	11	2	0.5	0
2014	1.09	34.66	41.93	10.3	1.53	0.1	0
2015	0	37.3	45.8	6.8	1.3	0.3	0
2016	0	9.84	14.15	13.45	0.91	0.74	0

b)

Year	0	1	2	3	4	5	6+
1968	1	0.17029	0	0	0	0	0
1969	1	0.09021	0	0	0	0	0
1970	1	0.05129	0	0	0	0	0
1971	1	0.03393	0	0	0	0	0
1972	1	0.12351	0	0	0	0	0
1973	1	0.04794	0	0	0	0	0
1974	1	0.11820	0	0	0	0	0
1975	1	0.06113	0	0	0	0	0
1976	1	0.09002	0	0	0	0	0
1977	1	0.13763	0	0	0	0	0
1978	1	0.19609	0	0	0	0	0
1979	1	0.09547	0	0	0	0	0
1980	1	0.03913	0	0	0	0	0
1981	1	0.10842	0	0	0	0	0
1982	1	0.35886	0	0	0	0	0
1983	1	0.19490	0	0	0	0	0
1984	1	0.09025	0	0	0	0	0
1985	1	0.10449	0	0	0	0	0
1986	1	0.17468	0	0	0	0	0
1987	1	0.04394	0	0	0	0	0
1988	1	0.06014	0	0	0	0	0
1989	1	0.22821	0	0	0	0	0
1990	1	0.18272	0	0	0	0	0
1991	1	0.09020	0	0	0	0	0
1992	1	0.10078	0	0	0	0	0
1993	1	0.42561	0	0	0	0	0
1994	1	0.18271	0	0	0	0	0
1995	1	0.26570	0	0	0	0	0

Year	0	1	2	3	4	5	6+
1996	1	0.28826	0	0	0	0	0
1997	1	0.19636	0.00043	0	0	0	0
1998	NA	0.11868	0.00104	0	0	0	0
1999	1	0.70313	0	0	0	0	0
2000	1	0.73886	0	0	0	0	0
2001	1	0.16160	0	0	0	0	0
2002	NA	0.17816	0	0	0	0	0
2003	1	0.62711	0.06917	0.14546	0.03448	0.11504	NA
2004	1	0.57706	0.24520	0.09107	0.05618	0.02121	0
2005	1	0.64509	0.12623	0.20339	0.03650	0.02534	0
2006	1	0.84284	0.18391	0.12384	0.07246	0.01599	0
2007	1	0.77315	0.02195	0	0	0	NA
2008	1	0.81912	0.02007	0	0	0	NA
2009	1	0.66555	0.07666	0.001513	0	0	NA
2010	1	0.81818	0.32023	0.085366	0.066667	0.047619	0
2011	1	0.79516	0.00850	0	0	0	0
2012	1	0.95232	0.74112	0.779158	0.59596	1	NA
2013	1	0.83784	0.45299	0.36667	0.22222	0.33333	NA
2014	1	0.85243	0.48796	0.39163	0.27667	0.09091	NA
2015	NA	1	0.57393	0.26357	0.30233	0.23077	NA
2016	NA	0.90775	0.57637	0.44616	0.39912	0.62133	0

NA= not available.

Table 7.7. Maturity ogive updated for 2016. Prior to 1995 maturity was considered constant.

	1	2	3+
1996	0	0.27	1
1997	0	0.34	1
1998	0	0.41	1
1999	0	0.48	1
2000	0	0.55	1
2001	0	0.6	1
2002	0	0.63	1
2003	0	0.66	1
2004	0	0.69	1
2005	0	0.7	1
2006	0	0.71	1
2007	0	0.71	1
2008	0	0.71	1
2009	0	0.7	1
2010	0	0.7	1
2011	0	0.7	1
2012	0	0.69	1
2013	0	0.67	1
2014	0	0.66	1
2015	0	0.65	1
2016	0	0.64	1

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

Northern Irish Groundfish Q1

year	c.v.	0	1	2	3	4	5	6+
1993	0.783171	0	138.121	648.763	44.599	10.421	1.417	2.769
1994	0.340965	0	1380.438	109.71	120.271	8.45	1.367	0
1995	0.675194	0	700.728	386.153	20.039	10.779	0	0.994
1996	0.429215	0	1106.129	329.282	111.668	1.394	8.808	0
1997	0.644885	0	537.298	415.843	66.723	21.392	1.394	0
1998	0.839964	0	169.385	769.234	56.874	11.984	0	0
1999	0.861441	0	49.499	253.08	241.874	15.286	2.787	0
2000	0.653815	0	629.595	101.053	34.576	33.014	0	2.258
2001	0.890678	0	406.682	561.441	18.438	5.775	4.042	0
2002	0.644334	0	662.163	253.311	333.543	0	0	1.129
2003	0.543658	0	73.865	1079.204	104.05	32.702	3.652	3.049
2004	0.755489	0	216.956	171.956	88.622	5.375	4.381	0
2005	0.759642	0	63.533	225.07	29.407	27.963	18.27	0
2006	0.63449	0	169.989	130.752	58.304	2.523	0	0
2007	0.948715	0	164.351	124.393	30.601	5.148	0	0
2008	0.902387	0	40.658	217.151	13.018	5.172	4.178	0.994
2009	0.761727	0	144	59	33	9	0	0
2010	0.817134	0	1022.117	208.961	14.656	2.258	0	0
2011	0.494292	0	353.981	414.689	46.006	2.258	2.01	0
2012	0.807196	0	161.898	222.819	99.271	14.25	0	0
2013	0.805923	0	276.592	213.675	60.082	1.491	15.547	0
2014	0.632073	0	314.41	222.799	53.294	13.657	5.375	0
2015	0.843748	0	78.96	719.35	69.19	8.56	3.05	0
2016	1.057	0	349.2	175	148.3	10.7	1.12	0

Northern Irish Groundfish Quarter 4

year	c.v.	0	1	2	3	4	5	6+
1991	1207.03	1109.37	50.06	47.6	8.64	0	0	0
1992	700.43	553.23	146.44	0.76	0	0	0	0
1993	1708.37	1672.49	25.44	10.44	0	0	0	0
1994	1240.12	1206.8	33.32	0	0	0	0	0
1995	543.34	486.65	50.15	6.54	0	0	0	0
1996	1419.39	1322.2	97.19	0	0	0	0	0
1997	546.13	376.51	163.9	5.72	0	0	0	0
1998	100.44	58.47	32.48	9.49	0	0	0	0
1999	303.67	301.64	2.03	0	0	0	0	0
2000	616.7	506.79	109.91	0	0	0	0	0
2001	538.1	487.89	37.68	12.53	0	0	0	0
2002	190.85	161.45	29.4	0	0	0	0	0
2003	602.68	578.97	23.71	0	0	0	0	0
2004	831.13	706.13	107.72	17.28	2.89	0	0	0
2005	138.25	130.2	1.47	6.58	0	0	0	0
2006	89.97	86.99	0	2.98	0	0	0	0
2007	34.56	17.28	17.28	0	0	0	0	0
2008	219.72	213.62	6.1	0	0	0	0	0
2009	174.78	171.8	2.98	0	0	0	0	0
2010	149.39	92.48	53.86	3.05	3.05	0	0	0
2011	115.11	107.05	1.69	6.37	2.98	0	0	0
2012	374.936	321.82	32.791	20.325	0	0	3.049	0
2013	142.28	41.67	79.95	20.66	0	0	0	0
2014	94.5	0	55.35	39.15	6.78	0	0	0
2015	325.56	224.27	0	55.42	39.06	6.81	0	0
2016	229.46	14.98	0	181.79	26.6	6.1	0	0

UK FSP

year	c.v.	0	1	2	3	4	5	6+
2005	0.4	0	0	0.427	1.409	0.99	0.084	0.025
2006	0.4	0	0.003	0.536	2.815	0.427	0.104	0.01
2007	0.4	0	0.008	0.611	1.322	0.585	0.055	0.058
2008	0.4	0	0.003	0.221	0.824	0.147	0.084	0.02
2009	0.4	0	0.009	0.171	1.152	0.377	0.099	0.018
2010	0.4	0	0	0.735	0.452	0.467	0.13	0.023
2011	0.4	0	0	0.407	1.681	0.144	0.095	0.039
2012	0.4	0	0	0.364	2.3	0.803	0.072	0.021
2013	0.4	0	0	0.844	1.883	1.348	0.37	0.057
2014								
2015	0.4	0	0	0.602	2.041	1.169	0.256	0.045
2016	0.4	0	0	1.001	6.388	1.434	0.413	0.028

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

Table 7.9. Estimated stock numbers-at-age (Thousands).

YEAR/AGE	0	1	2	3	4	5	6+
1968	49674.18	8039.637	4422.795	1850.133	768.6935	317.9662	249.2741
1969	70867.25	9064.336	3385.784	1717.089	804.2671	340.5472	254.3023
1970	116580.2	12926.71	3632.366	1081.937	612.3718	292.3084	218.7745
1971	41586.53	21273.18	5447.518	1413.883	471.5701	272.011	229.7268
1972	110042.5	7587.707	8830.458	1998.517	580.2442	197.2277	212.3604
1973	25392.02	20080.93	3213.368	3504.235	888.3403	262.8512	187.7907
1974	87805.45	4632.123	8146.546	1077.509	1312.457	339.072	174.0537
1975	27896.68	16020.21	1916.257	2949.115	436.2444	541.5243	214.2045
1976	42578.83	5089.042	6500.742	643.1701	1105.611	166.6714	292.0927
1977	45998.53	7767.273	2059.515	2159.064	238.5559	417.914	175.5514
1978	95705.8	8390.757	3126.582	669.7963	783.8835	88.2664	222.1441
1979	113802.6	17465.19	3565.785	1257.697	301.8628	360.0365	144.3545
1980	64895.01	20763.99	7251.085	1309.103	516.521	126.3415	213.5648
1981	28807.17	11840.05	8578.16	2611.002	527.1447	211.9667	141.2088
1982	41802.87	5255.061	4795.204	2857.383	971.3249	199.8515	135.4855
1983	65428.57	7624.472	2081.034	1462.693	971.9743	336.7189	117.6285
1984	62616.64	11935.14	3071.672	679.0212	532.831	360.8365	170.6262
1985	49833.85	11422.86	4845.227	1032.761	255.0113	203.9324	205.7907
1986	140518.6	9089.733	4555.447	1519.27	361.2952	90.91584	147.8373
1987	67126.98	25630.77	3626.435	1430.632	532.3348	129.012	86.30422
1988	30462.54	12241.04	9897.925	1002.357	440.2415	166.94	68.32466
1989	35901.61	5554.686	4687.04	2645.903	298.1457	133.4468	72.14452
1990	39450.48	6544.961	2062.809	1111.391	696.6962	80.0026	55.81647
1991	66321.05	7194.777	2561.475	600.8145	360.7042	230.4317	45.45627
1992	15409.64	12090.21	2663.111	599.6007	156.1419	95.52913	73.89883
1993	42991.74	2808.828	4407.645	587.3438	146.6686	38.92222	42.7385
1994	34653.82	7835.026	1000.164	886.3805	130.7989	33.28495	18.75667
1995	33070.61	6314.713	2745.158	188.7854	185.0771	27.83126	11.20392
1996	48933.8	6030.621	2437.541	757.5098	57.99599	57.94214	12.36302
1997	14946.65	8922.219	2288.448	629.055	217.3924	16.96147	20.79614
1998	3773.449	2724.988	3341.556	560.9454	171.3214	60.33575	10.60695
1999	28403.1	688.0844	1046.542	903.8995	168.871	52.56027	22.01206
2000	11677.27	5171.019	213.8912	123.5676	117.1326	22.29921	9.961976
2001	14502.5	2073.384	1826.765	35.7932	16.7373	29.86744	20.95129
2002	5017.56	2598.108	811.4246	479.0481	8.437425	6.127457	36.11972
2003	8672.125	891.6603	926.8044	141.7072	68.39474	2.226662	31.77445
2004	4910.127	1552.978	347.3501	238.181	32.58178	24.63487	26.53139
2005	5377.05	880.5865	615.2764	96.13452	60.00643	12.45726	37.3363
2006	6144.66	964.1867	348.307	169.0621	24.00502	22.80975	37.78965
2007	1260.928	1097.967	366.3111	80.19489	33.94313	7.914008	44.22347
2008	4514.998	225.5568	422.3928	89.10374	17.22994	11.69656	39.93376
2009	8499.888	806.9498	85.91363	98.35653	18.14045	5.732251	38.86832

YEAR/AGE	0	1	2	3	4	5	6+
2010	4585.899	1519.779	308.8153	20.42333	20.54135	6.136463	34.26514
2011	5451.636	820.9394	589.6445	77.96567	4.594036	7.293659	31.01416
2012	8777.311	989.1638	371.783	293.4373	40.50313	2.817107	30.59473
2013	13951.27	1584.86	423.6612	144.8465	112.7142	20.39414	26.53478
2014	5943.277	2539.88	745.931	249.6593	92.6898	79.19327	37.6138
2015	6750.108	1083.251	1211.421	465.9763	171.681	68.25602	93.71876
2016	49.39489	1231.514	522.5106	795.0443	340.543	131.5486	131.4952

Table 7.10. Estimated fishing mortalities F-at-age.

Year	0	1	2	3	4	5	6+
1968	0.00114	0.15080	0.59114	0.60108	0.60114	0.60114	0.60114
1969	0.00151	0.20046	0.78583	0.79905	0.79912	0.79912	0.79912
1970	0.00113	0.15014	0.58854	0.59844	0.59850	0.59850	0.59850
1971	0.00125	0.16524	0.64775	0.65865	0.65871	0.65871	0.65871
1972	0.00110	0.14521	0.56923	0.57881	0.57886	0.57886	0.57886
1973	0.00142	0.18818	0.73767	0.75007	0.75014	0.75014	0.75014
1974	0.00127	0.16864	0.66109	0.67220	0.67227	0.67227	0.67227
1975	0.00142	0.18793	0.73672	0.74911	0.74918	0.74918	0.74918
1976	0.00144	0.19062	0.74724	0.75981	0.75988	0.75988	0.75988
1977	0.00148	0.19598	0.76825	0.78117	0.78124	0.78124	0.78124
1978	0.00107	0.14175	0.55566	0.56500	0.56506	0.56506	0.56506
1979	0.00125	0.16506	0.64704	0.65792	0.65798	0.65798	0.65798
1980	0.00128	0.17000	0.66642	0.67762	0.67769	0.67769	0.67769
1981	0.00143	0.18987	0.74431	0.75683	0.75690	0.75690	0.75690
1982	0.00160	0.21233	0.83234	0.84633	0.84641	0.84641	0.84641
1983	0.00147	0.19514	0.76497	0.77783	0.77790	0.77790	0.77790
1984	0.00141	0.18749	0.73499	0.74734	0.74742	0.74742	0.74742
1985	0.00155	0.20529	0.80476	0.81830	0.81837	0.81837	0.81837
1986	0.00155	0.20490	0.80321	0.81671	0.81679	0.81679	0.81679
1987	0.00179	0.23747	0.93090	0.94655	0.94664	0.94664	0.94664
1988	0.00186	0.24599	0.96431	0.98053	0.98062	0.98062	0.98062
1989	0.00209	0.27657	1.08419	1.10242	1.10252	1.10252	1.10252
1990	0.00169	0.22411	0.87854	0.89331	0.89339	0.89340	0.89340
1991	0.00211	0.27986	1.09708	1.11552	1.11563	1.11563	1.11563
1992	0.00223	0.29506	1.15664	1.17609	1.17620	1.17620	1.17620
1993	0.00240	0.31860	1.24895	1.26995	1.27007	1.27007	1.27007
1994	0.00253	0.33477	1.31231	1.33437	1.33450	1.33450	1.33450
1995	0.00179	0.23789	0.93256	0.94824	0.94833	0.94833	0.94833
1996	0.00192	0.25498	0.99953	1.01633	1.01643	1.01643	1.01643
1997	0.00202	0.26811	1.05101	1.06868	1.06878	1.06878	1.06878
1998	0.00183	0.24297	0.95247	0.96849	0.96858	0.96858	0.96858
1999	0.00343	0.45444	1.78146	1.81141	1.81158	1.81159	1.81159
2000	0.02846	0.32652	1.43271	1.76715	1.15354	0.32153	0.05229
2001	0.01954	0.22415	0.98350	1.21308	0.79186	0.22072	0.03590
2002	0.02761	0.31680	1.39003	1.71451	1.11917	0.31195	0.05073
2003	0.01994	0.22875	1.00371	1.23801	0.80813	0.22525	0.03663
2004	0.01847	0.21186	0.92958	1.14658	0.74845	0.20862	0.03393
2005	0.01861	0.21350	0.93681	1.15549	0.75426	0.21024	0.03419
2006	0.02212	0.25380	1.11363	1.37358	0.89663	0.24992	0.04065
2007	0.02103	0.24128	1.05868	1.30581	0.85239	0.23759	0.03864
2008	0.02190	0.25123	1.10234	1.35966	0.88754	0.24739	0.04023
2009	0.02149	0.24652	1.08166	1.33416	0.87090	0.24275	0.03948

Year	0	1	2	3	4	5	6+
2010	0.02029	0.23280	1.02148	1.25992	0.82243	0.22924	0.03728
2011	0.00681	0.07814	0.34286	0.42289	0.27605	0.07694	0.01251
2012	0.01167	0.13393	0.58764	0.72481	0.47313	0.13188	0.02145
2013	0.00345	0.03962	0.17384	0.21442	0.13996	0.03901	0.00634
2014	0.00229	0.02632	0.11550	0.14246	0.09299	0.02592	0.00422
2015	0.00131	0.01508	0.06615	0.08159	0.05326	0.01485	0.00241
2016	0.00055	0.00637	0.02793	0.03445	0.02249	0.00627	0.00102

Table 7.11. Estimated recruitment (age 0), total stock biomass (TSB), spawning–stock biomass (SSB), and average fishing mortality for ages 2 to 4 (F_{Bar}).

year	Recruitment Low	Recruitment	Recruitment High	TSB	SSB low	SSB	SSB high	catch	F low	F_{bar}	F high
1968	45981.38	49674.18	53366.98	30965.26	14895.48	15734.12	16572.76	9826.43	0.570171	0.597787	0.625403
1969	64306.95	70867.25	77427.55	32002.22	14462.86	15283.35	16103.84	9889.34	0.731874	0.794667	0.85746
1970	107843.4	116580.2	125317	35670.87	10736.8	11725.85	12714.9	7133.87	0.541942	0.595161	0.64838
1971	36017.33	41586.53	47155.73	36606.1	11738.5	12869.5	14000.5	9609.42	0.602834	0.655036	0.707238
1972	101417.3	110042.5	118667.7	42666.64	15110.14	16333.14	17556.14	10779.94	0.535681	0.575634	0.615587
1973	21372.72	25392.02	29411.32	39285.15	19178.82	20602.62	22026.42	13040.64	0.692245	0.745961	0.799677
1974	80733.45	87805.45	94877.45	38774.33	16072.4	17296.2	18520	11999.59	0.624942	0.668521	0.7121
1975	24131.18	27896.68	31662.18	32646.2	16565.48	17762.08	18958.68	10720.16	0.690357	0.745002	0.799647
1976	38036.93	42578.83	47120.73	29037.06	12796.57	13797.27	14797.97	10628.04	0.705529	0.755642	0.805755
1977	40961.63	45998.53	51035.43	25086.96	12293.48	13253.35	14213.22	8255.27	0.711615	0.776889	0.842163
1978	87835.3	95705.8	103576.3	28243.04	8825.038	9765.308	10705.58	5662.05	0.508006	0.561905	0.615804
1979	104837.6	113802.6	122767.6	36986.24	9567.49	10631.19	11694.89	7548.09	0.594728	0.654316	0.713904
1980	58177.71	64895.01	71612.31	40429.98	11374.18	12487.58	13600.98	10599.14	0.625434	0.673909	0.722384
1981	24854.77	28807.17	32759.57	38098.9	16413.43	17600.73	18788.03	13958.08	0.708288	0.752681	0.797074
1982	37201.67	41802.87	46404.07	34910.3	18889.84	20101.64	21313.44	13694.07	0.788675	0.841694	0.894713
1983	59438.07	65428.57	71419.07	33481.95	15325.37	16519.37	17713.37	10387.16	0.711696	0.773568	0.83544
1984	56359.14	62616.64	68874.14	30065.92	10550.17	11629.77	12709.37	8384.85	0.677092	0.743249	0.809406
1985	43984.35	49833.85	55683.35	32936.04	10813.85	11898.05	12982.25	10544.33	0.747156	0.813811	0.880466
1986	129974.6	140518.6	151062.6	39702.46	11090.1	12202.3	13314.5	10006.06	0.741503	0.812237	0.882971
1987	60458.78	67126.98	73795.18	43649.21	11702.21	13020.51	14338.81	13021.91	0.864214	0.941361	1.018508

year	Recruitment Low	Recruitment	Recruitment High	TSB	SSB low	SSB	SSB high	catch	F low	F_{bar}	F high
1988	26471.94	30462.54	34453.14	34232.99	11395.44	12447.94	13500.44	14276.98	0.913634	0.975153	1.036672
1989	31381.71	35901.61	40421.51	29175.32	13069.73	14033.91	14998.09	12952.54	1.023713	1.096377	1.169041
1990	34430.68	39450.48	44470.28	22217.98	8985.987	9853.817	10721.65	7537.94	0.8062	0.888414	0.970628
1991	60650.35	66321.05	71991.75	22988.9	6285.216	7102.686	7920.156	7258.45	0.996167	1.109407	1.222647
1992	13377.54	15409.64	17441.74	21181.63	5253.158	6037.218	6821.278	7832.71	1.070103	1.169643	1.269183
1993	39433.24	42991.74	46550.24	17933.89	5204.177	5745.147	6286.117	7709.97	1.172774	1.26299	1.353206
1994	31627.42	34653.82	37680.22	16065.18	4420.329	4929.949	5439.569	5543.64	1.201041	1.327061	1.453081
1995	30179.31	33070.61	35961.91	16205.71	3118.051	3528.111	3938.171	4753.16	0.863312	0.943041	1.02277
1996	45312.4	48933.8	52555.2	18121.79	3972.07	4417.97	4863.87	5104.06	0.928592	1.010763	1.092934
1997	13308.95	14946.65	16584.35	17244.61	4753.883	5235.933	5717.983	5978.56	0.986975	1.062821	1.138667
1998	3153.969	3773.449	4392.929	11960.81	5413.81	5796.22	6178.63	5347.25	0.90731	0.963181	1.019052
1999	26541.3	28403.1	30264.9	9546.336	4905.577	5239.547	5573.517	4943.34	1.624334	1.801484	1.978634
2000	10556.47	11677.27	12798.07	7274.955	1245.232	1520.322	1795.412	1973.14	1.270762	1.451132	1.631502
2001	13280.8	14502.5	15724.2	7488.226	2428.03	2655.44	2882.85	2316.45	0.902813	0.996147	1.089481
2002	4457.04	5017.56	5578.08	6542.072	2779.666	3045.676	3311.686	2740.7	1.266583	1.407903	1.549223
2003	7993.185	8672.125	9351.065	4697.307	1992.117	2228.097	2464.077	1500.41	0.913728	1.016618	1.119508
2004	4469.517	4910.127	5350.737	4472.339	1799.977	2020.627	2241.277	1326.44	0.843859	0.941538	1.039217
2005	4970.16	5377.05	5783.94	3617.68	1719.131	1920.551	2121.971	1114.1	0.859205	0.948852	1.038499
2006	5725.67	6144.66	6563.65	3231.173	1459.515	1630.575	1801.635	1025.03	1.027164	1.127944	1.228724
2007	1101.748	1260.928	1420.108	2707.05	1279.589	1473.119	1666.649	847.16	0.978298	1.072295	1.166292
2008	4141.728	4514.998	4888.268	2208.973	1188.132	1361.962	1535.792	723.47	1.013301	1.116511	1.219721
2009	7694.658	8499.888	9305.118	2652.74	734.3308	863.3008	992.2708	554.36	0.966323	1.095573	1.224823
2010	3978.839	4585.899	5192.959	3666.491	910.493	1080.823	1251.153	850.31	0.89505	1.03461	1.17417

year	Recruitment Low	Recruitment	Recruitment High	TSB	SSB low	SSB	SSB high	catch	F low	F_{bar}	F high
2011	4552.106	5451.636	6351.166	3079.686	1208.822	1422.892	1636.962	412.71	0.289418	0.347265	0.405112
2012	7147.811	8777.311	10406.81	3985.077	1660.378	1970.748	2281.118	875.65	0.471732	0.595192	0.718652
2013	11213.97	13951.27	16688.57	5565.687	1786.201	2308.891	2831.581	358.02	0.135225	0.176072	0.216919
2014	4628.577	5943.277	7257.977	7331.912	3035.856	3929.316	4822.776	396.53	0.090635	0.116984	0.143333
2015	5119.608	6750.108	8380.608	8092.306	4473.241	5759.241	7045.241	308.02	0.052228	0.067002	0.081776
2016	23.43289	49.39489	75.35689	8645.197	5576.015	7173.115	8770.215	142.23	0.022183	0.028288	0.034392
2017		5513				10299.23				0.109364	

Table 7.12: Forecast input, including landing, discard, total catch numbers (in thousands) and total F at age for 2016.

Age	Landings	Discards	Catch	F (total catch)
0	0	0	0	0.000555
1	1	9.84	10.84	0.006365
2	10.4	14.15	24.55	0.027928
3	16.696	13.45	30.47	0.034448
4	1.37	0.91	2.28	0.022486
5	0.451	0.74	1.191	0.006268
6	0.176	0	0.176	0.001019

Table 7.13 STF results with catches, landings and discards and associated F for 2018 under a range of options (Basis). Change in SSB from 2018 to 2019 under the option and how much of the TAC will be taken up by the total catch. F_{MSY} range reaches from F_{MSYmin} to F_{MSYmax} in steps of 0.01.

FMULT	CATCH18	LAND18	DIS18	BASIS	FCATCH18	FLAND18	FDIS18	SSB19	DSSB	DTAC
0.01	3	2	1	FMultiplier	0.00071	0.00041	0.00029	10899.41	-0.93%	-97.95%
0.02	5	4	2	FMultiplier	0.00142	0.00083	0.00059	10895.94	-0.96%	-96.58%
0.03	8	5	3	FMultiplier	0.00212	0.00124	0.00088	10892.47	-1.00%	-94.52%
0.04	11	7	4	FMultiplier	0.00283	0.00166	0.00117	10889	-1.03%	-92.47%
0.05	14	9	5	FMultiplier	0.00354	0.00207	0.00147	10885.54	-1.06%	-90.41%
0.06	16	11	6	FMultiplier	0.00425	0.00248	0.00176	10882.08	-1.09%	-89.04%
0.07	19	12	7	FMultiplier	0.00495	0.0029	0.00206	10878.62	-1.12%	-86.99%
0.08	22	14	8	FMultiplier	0.00566	0.00331	0.00235	10875.16	-1.15%	-84.93%
0.09	25	16	9	FMultiplier	0.00637	0.00372	0.00264	10871.7	-1.18%	-82.88%
0.1	27	18	10	FMultiplier	0.00708	0.00414	0.00294	10868.25	-1.22%	-81.51%
0.11	30	20	11	FMultiplier	0.00778	0.00455	0.00323	10864.8	-1.25%	-79.45%
0.12	33	21	12	FMultiplier	0.00849	0.00497	0.00352	10861.35	-1.28%	-77.40%
0.13	36	23	13	FMultiplier	0.0092	0.00538	0.00382	10857.9	-1.31%	-75.34%
0.14	38	25	14	FMultiplier	0.00991	0.00579	0.00411	10854.46	-1.34%	-73.97%
0.15	41	27	14	FMultiplier	0.01061	0.00621	0.00441	10851.01	-1.37%	-71.92%
0.16	44	28	15	FMultiplier	0.01132	0.00662	0.0047	10847.57	-1.40%	-69.86%
0.17	47	30	16	FMultiplier	0.01203	0.00704	0.00499	10844.14	-1.43%	-67.81%
0.18	49	32	17	FMultiplier	0.01274	0.00745	0.00529	10840.7	-1.47%	-66.44%
0.19	52	34	18	FMultiplier	0.01344	0.00786	0.00558	10837.26	-1.50%	-64.38%

0.2	55	35	19	FMultiplier	0.01415	0.00828	0.00587	10833.83	-1.53%	-62.33%
0.21	57	37	20	FMultiplier	0.01486	0.00869	0.00617	10830.4	-1.56%	-60.96%
0.22	60	39	21	FMultiplier	0.01557	0.0091	0.00646	10826.97	-1.59%	-58.90%
0.23	63	41	22	FMultiplier	0.01627	0.00952	0.00676	10823.55	-1.62%	-56.85%
0.24	66	42	23	FMultiplier	0.01698	0.00993	0.00705	10820.13	-1.65%	-54.79%
0.25	68	44	24	FMultiplier	0.01769	0.01035	0.00734	10816.7	-1.68%	-53.42%
0.26	71	46	25	FMultiplier	0.0184	0.01076	0.00764	10813.28	-1.72%	-51.37%
0.27	74	48	26	FMultiplier	0.0191	0.01117	0.00793	10809.87	-1.75%	-49.32%
0.28	76	50	27	FMultiplier	0.01981	0.01159	0.00822	10806.45	-1.78%	-47.95%
0.29	79	51	28	FMultiplier	0.02052	0.012	0.00852	10803.04	-1.81%	-45.89%
0.3	82	53	29	FMultiplier	0.02123	0.01242	0.00881	10799.63	-1.84%	-43.84%
0.31	85	55	30	FMultiplier	0.02193	0.01283	0.00911	10796.22	-1.87%	-41.78%
0.32	87	57	31	FMultiplier	0.02264	0.01324	0.0094	10792.81	-1.90%	-40.41%
0.33	90	58	32	FMultiplier	0.02335	0.01366	0.00969	10789.41	-1.93%	-38.36%
0.34	93	60	33	FMultiplier	0.02406	0.01407	0.00999	10786	-1.96%	-36.30%
0.35	95	62	34	FMultiplier	0.02477	0.01448	0.01028	10782.6	-1.99%	-34.93%
0.36	98	64	35	FMultiplier	0.02547	0.0149	0.01057	10779.2	-2.03%	-32.88%
0.37	101	65	36	FMultiplier	0.02618	0.01531	0.01087	10775.81	-2.06%	-30.82%
0.38	103	67	36	FMultiplier	0.02689	0.01573	0.01116	10772.41	-2.09%	-29.45%
0.39	106	69	37	FMultiplier	0.0276	0.01614	0.01146	10769.02	-2.12%	-27.40%
0.4	109	71	38	FMultiplier	0.0283	0.01655	0.01175	10765.63	-2.15%	-25.34%
0.41	112	72	39	FMultiplier	0.02901	0.01697	0.01204	10762.24	-2.18%	-23.29%
0.42	114	74	40	FMultiplier	0.02972	0.01738	0.01234	10758.86	-2.21%	-21.92%
0.43	117	76	41	FMultiplier	0.03043	0.0178	0.01263	10755.47	-2.24%	-19.86%

0.44	120	77	42	FMultiplier	0.03113	0.01821	0.01292	10752.09	-2.27%	-17.81%
0.45	122	79	43	FMultiplier	0.03184	0.01862	0.01322	10748.71	-2.30%	-16.44%
0.46	125	81	44	FMultiplier	0.03255	0.01904	0.01351	10745.33	-2.33%	-14.38%
0.47	128	83	45	FMultiplier	0.03326	0.01945	0.01381	10741.96	-2.36%	-12.33%
0.48	130	84	46	FMultiplier	0.03396	0.01986	0.0141	10738.58	-2.39%	-10.96%
0.49	133	86	47	FMultiplier	0.03467	0.02028	0.01439	10735.21	-2.42%	-8.90%
0.5	136	88	48	FMultiplier	0.03538	0.02069	0.01469	10731.84	-2.46%	-6.85%
0.51	138	90	49	FMultiplier	0.03609	0.02111	0.01498	10728.48	-2.49%	-5.48%
0.52	141	91	50	FMultiplier	0.03679	0.02152	0.01527	10725.11	-2.52%	-3.42%
0.53	144	93	51	FMultiplier	0.0375	0.02193	0.01557	10721.75	-2.55%	-1.37%
0.54	146	95	52	FMultiplier	0.03821	0.02235	0.01586	10718.39	-2.58%	0%
0.55	149	97	53	FMultiplier	0.03892	0.02276	0.01616	10715.03	-2.61%	2.05%
0.56	152	98	53	FMultiplier	0.03962	0.02317	0.01645	10711.67	-2.64%	4.11%
0.57	154	100	54	FMultiplier	0.04033	0.02359	0.01674	10708.32	-2.67%	5.48%
0.58	157	102	55	FMultiplier	0.04104	0.024	0.01704	10704.96	-2.70%	7.53%
0.59	160	103	56	FMultiplier	0.04175	0.02442	0.01733	10701.61	-2.73%	9.59%
0.6	162	105	57	FMultiplier	0.04245	0.02483	0.01762	10698.26	-2.76%	10.96%
0.61	165	107	58	FMultiplier	0.04316	0.02524	0.01792	10694.92	-2.79%	13.01%
0.62	168	109	59	FMultiplier	0.04387	0.02566	0.01821	10691.57	-2.82%	15.07%
0.63	170	110	60	FMultiplier	0.04458	0.02607	0.01851	10688.23	-2.85%	16.44%
0.64	173	112	61	FMultiplier	0.04528	0.02649	0.0188	10684.89	-2.88%	18.49%
0.65	176	114	62	FMultiplier	0.04599	0.0269	0.01909	10681.55	-2.91%	20.55%
0.66	178	116	63	FMultiplier	0.0467	0.02731	0.01939	10678.21	-2.94%	21.92%
0.67	181	117	64	FMultiplier	0.04741	0.02773	0.01968	10674.88	-2.97%	23.97%

0.68	184	119	65	FMultiplier	0.04812	0.02814	0.01997	10671.55	-3.00%	26.03%
0.69	186	121	66	FMultiplier	0.04882	0.02855	0.02027	10668.22	-3.03%	27.40%
0.7	189	122	67	FMultiplier	0.04953	0.02897	0.02056	10664.89	-3.06%	29.45%
0.71	192	124	68	FMultiplier	0.05024	0.02938	0.02086	10661.56	-3.09%	31.51%
0.72	194	126	68	FMultiplier	0.05095	0.0298	0.02115	10658.24	-3.12%	32.88%
0.73	197	128	69	FMultiplier	0.05165	0.03021	0.02144	10654.92	-3.15%	34.93%
0.74	200	129	70	FMultiplier	0.05236	0.03062	0.02174	10651.6	-3.18%	36.99%
0.75	202	131	71	FMultiplier	0.05307	0.03104	0.02203	10648.28	-3.22%	38.36%
0.76	205	133	72	FMultiplier	0.05378	0.03145	0.02232	10644.96	-3.25%	40.41%
0.77	207	134	73	FMultiplier	0.05448	0.03187	0.02262	10641.65	-3.28%	41.78%
0.78	210	136	74	FMultiplier	0.05519	0.03228	0.02291	10638.34	-3.31%	43.84%
0.79	213	138	75	FMultiplier	0.0559	0.03269	0.02321	10635.03	-3.34%	45.89%
0.8	215	140	76	FMultiplier	0.05661	0.03311	0.0235	10631.72	-3.37%	47.26%
0.81	218	141	77	FMultiplier	0.05731	0.03352	0.02379	10628.41	-3.40%	49.32%
0.82	221	143	78	FMultiplier	0.05802	0.03393	0.02409	10625.11	-3.43%	51.37%
0.83	223	145	79	FMultiplier	0.05873	0.03435	0.02438	10621.81	-3.46%	52.74%
0.84	226	146	80	FMultiplier	0.05944	0.03476	0.02467	10618.51	-3.49%	54.79%
0.85	229	148	81	FMultiplier	0.06014	0.03518	0.02497	10615.21	-3.52%	56.85%
0.86	231	150	81	FMultiplier	0.06085	0.03559	0.02526	10611.91	-3.55%	58.22%
0.87	234	151	82	FMultiplier	0.06156	0.036	0.02556	10608.62	-3.58%	60.27%
0.88	236	153	83	FMultiplier	0.06227	0.03642	0.02585	10605.33	-3.61%	61.64%
0.89	239	155	84	FMultiplier	0.06297	0.03683	0.02614	10602.04	-3.64%	63.70%
0.9	242	157	85	FMultiplier	0.06368	0.03725	0.02644	10598.75	-3.67%	65.75%
0.91	244	158	86	FMultiplier	0.06439	0.03766	0.02673	10595.47	-3.70%	67.12%

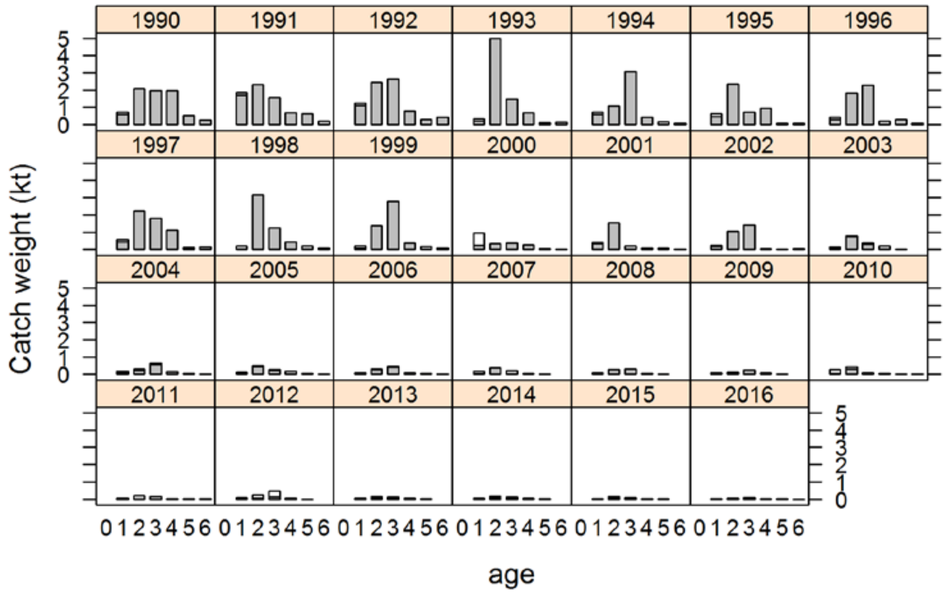
0.92	247	160	87	FMultiplier	0.0651	0.03807	0.02702	10592.18	-3.72%	69.18%
0.93	250	162	88	FMultiplier	0.0658	0.03849	0.02732	10588.9	-3.75%	71.23%
0.94	252	163	89	FMultiplier	0.06651	0.0389	0.02761	10585.62	-3.78%	72.60%
0.95	255	165	90	FMultiplier	0.06722	0.03931	0.02791	10582.34	-3.81%	74.66%
0.96	257	167	91	FMultiplier	0.06793	0.03973	0.0282	10579.07	-3.84%	76.03%
0.97	260	168	92	FMultiplier	0.06864	0.04014	0.02849	10575.79	-3.87%	78.08%
0.98	263	170	93	FMultiplier	0.06934	0.04056	0.02879	10572.52	-3.90%	80.14%
0.99	265	172	93	FMultiplier	0.07005	0.04097	0.02908	10569.25	-3.93%	81.51%
1	268	173	94	FMultiplier	0.07076	0.04138	0.02937	10565.98	-3.96%	83.56%
	1073	695	377	FMSY	0.309	0.18072	0.12828	9570.405	-13.01%	634.93%
	0	0	0	F = 0	0	0	0	10902.88	-0.90%	-100%
	268	173	94	F = Fsq	0.07076	0.04138	0.02937	10565.98	-3.96%	83.56%
	1924	1248	676	F = Flim	0.614	0.35911	0.25489	8549.879	-22.29%	1217.81%
	1466	950	515	F = Fpa	0.442	0.25851	0.18349	9094.614	-17.34%	904.11%
	765	496	269	Min FMSY	0.213	0.12458	0.08842	9947.688	-9.58%	423.97%
	1369	887	481	Max FMSY	0.408	0.23863	0.16937	9211.398	-16.28%	837.67%
	268	173	94	Blim	0.07076	0.04138	0.02937	10565.98	-3.96%	83.56%
	1868	1212	656	Bpa	0.59184	0.34615	0.24569	8616	-21.69%	1179.45%
	1868	1212	656	Btrigger	0.59184	0.34615	0.24569	8616	-21.69%	1179.45%
	268	173	94	Stable SSB	0.07076	0.04138	0.02937	10565.98	-3.96%	83.56%
	192	124	67	-15% TAC	0.05023	0.02938	0.02085	10661.61	-3.09%	31.51%
	225	146	79	Stable TAC	0.05929	0.03468	0.02461	10619.18	-3.48%	54.11%
	259	168	91	+ 15% TAC	0.06842	0.04002	0.0284	10576.8	-3.86%	77.40%
	765	496	269	FMSY range (min to max 0.01 steps)	0.213	0.12458	0.08842	9947.688	-9.58%	423.97%

798	517	281	FMSY range	0.223	0.13043	0.09257	9906.962	-9.95%	446.58%
831	539	292	FMSY range	0.233	0.13627	0.09673	9866.576	-10.32%	469.18%
864	560	304	FMSY range	0.243	0.14212	0.10088	9826.527	-10.68%	491.78%
896	581	315	FMSY range	0.253	0.14797	0.10503	9786.811	-11.05%	513.70%
928	601	327	FMSY range	0.263	0.15382	0.10918	9747.425	-11.40%	535.62%
960	622	338	FMSY range	0.273	0.15967	0.11333	9708.366	-11.76%	557.53%
992	643	349	FMSY range	0.283	0.16552	0.11748	9669.63	-12.11%	579.45%
1023	663	360	FMSY range	0.293	0.17137	0.12163	9631.213	-12.46%	600.68%
1054	683	371	FMSY range	0.303	0.17721	0.12579	9593.114	-12.81%	621.92%
1085	703	382	FMSY range	0.313	0.18306	0.12994	9555.328	-13.15%	643.15%
1116	723	393	FMSY range	0.323	0.18891	0.13409	9517.852	-13.49%	664.38%
1146	743	403	FMSY range	0.333	0.19476	0.13824	9480.684	-13.83%	684.93%
1177	763	414	FMSY range	0.343	0.20061	0.14239	9443.819	-14.16%	706.16%
1207	782	425	FMSY range	0.353	0.20646	0.14654	9407.255	-14.50%	726.71%
1237	802	435	FMSY range	0.363	0.21231	0.15069	9370.99	-14.82%	747.26%
1266	821	445	FMSY range	0.373	0.21815	0.15485	9335.018	-15.15%	767.12%
1296	840	456	FMSY range	0.383	0.224	0.159	9299.339	-15.48%	787.67%
1325	859	466	FMSY range	0.393	0.22985	0.16315	9263.949	-15.80%	807.53%
1354	878	476	FMSY range	0.403	0.2357	0.1673	9228.844	-16.12%	827.40%

Table 7.14: STF results on population numbers, biomass and spawning stock number and biomass by age group for the projected years 2017 to 2019 under FSQ fishing scenario.

Year	Age	F (landings)	Landings Nos	Landings (t)	F (discards)	Discard Nos	Discard (t)	Stock Nos	Biomass (t)	SS Nos	SSB (t)
2017	0	0	4	0	0.001	0	0	5513	551	0	0
	1	0.001	0	0	0.015	0	0	9	8	0	0
	2	0.032	15	29	0.038	19	35	599	1125	389	731
	3	0.055	17	63	0.032	10	36	356	1340	356	1340
	4	0.038	20	125	0.018	10	60	609	3756	609	3756
	5	0.011	3	24	0.005	1	11	269	2508	269	2508
	6	0.003	0	5	0	0	0	214	1965	214	1965
	Total	0.041	59	246	0.029	40	142	7569	11253	1837	10300
2018	0	0	4	0	0.001	0	0	5513	551	0	0
	1	0.001	1	1	0.015	10	9	1006	892	0	0
	2	0.032	0	0	0.038	0	0	4	8	3	5
	3	0.055	18	69	0.032	11	40	392	1473	392	1473
	4	0.038	9	53	0.018	4	26	259	1598	259	1598
	5	0.011	4	42	0.005	2	19	465	4337	465	4337
	6	0.003	1	8	0	0	0	392	3588	392	3588
	Total	0.041	37	173	0.029	27	94	8031	12447	1511	11001
2019	0	0	4	0	0.001	0	0	5513	551	0	0
	1	0.001	1	1	0.015	10	9	1006	892	0	0
	2	0.032	13	24	0.038	15	28	485	910	315	591

3	0.055	0	0	0.032	0	0	3	11	3	11
4	0.038	9	58	0.018	5	28	285	1758	285	1758
5	0.011	2	18	0.005	1	8	198	1845	198	1845
6	0.003	2	15	0	0	0	694	6361	694	6361
Total	0.041	31	116	0.029	31	73	8184	12328	1495	10566



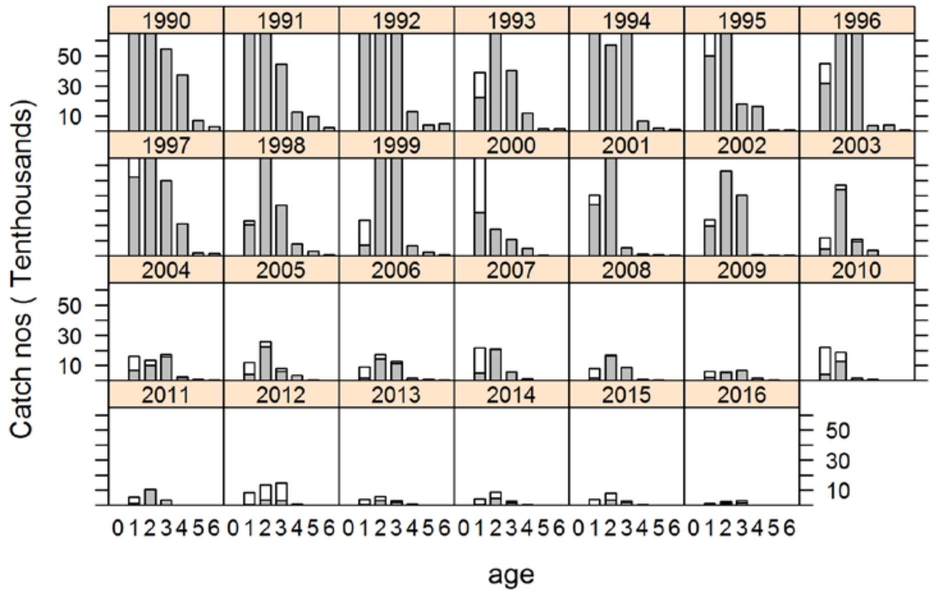


Figure 7.1. Landings (grey) and discards (white) at age in total weight and numbers from 1990 to 2016.

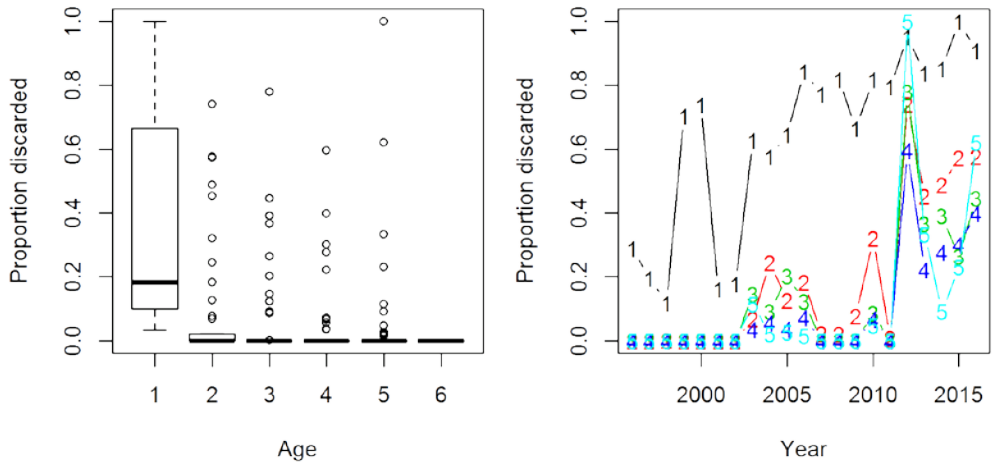


Figure 7.2. Discard proportions-at-age 1995–2016.

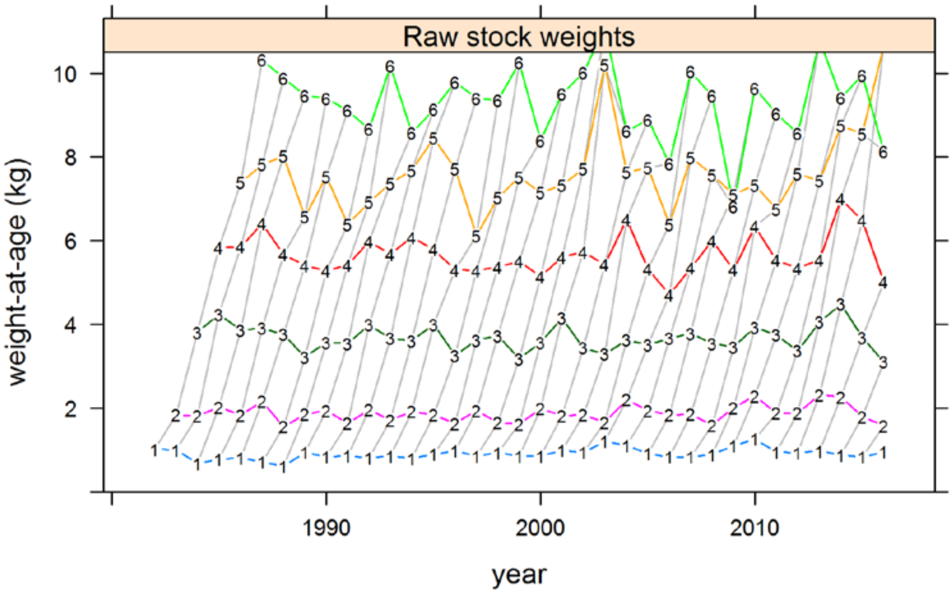


Figure 7.3. Weight-at-age, ages 1–6.

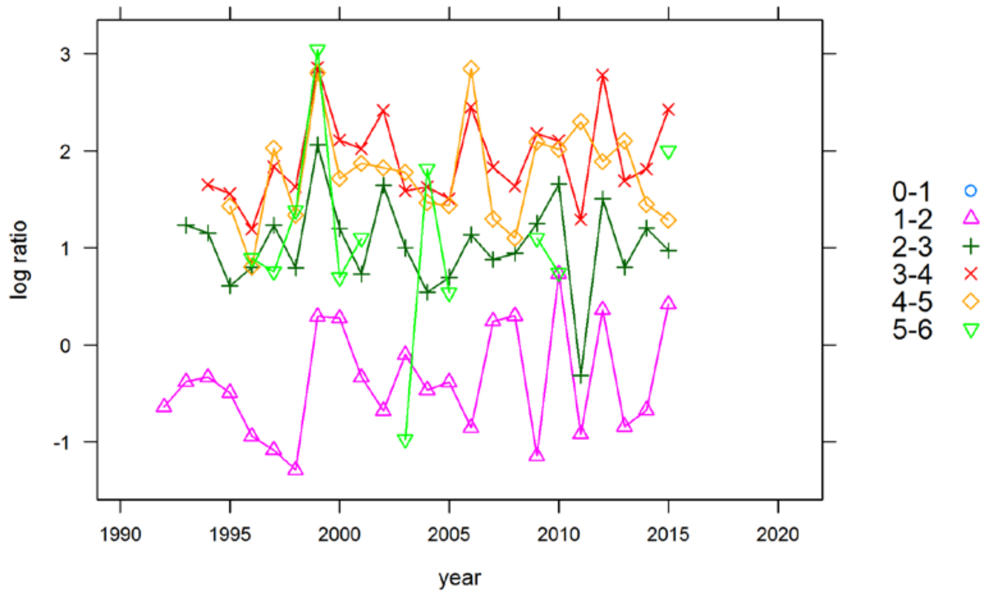


Figure 7.4. Log ratio of ages in commercial catches.

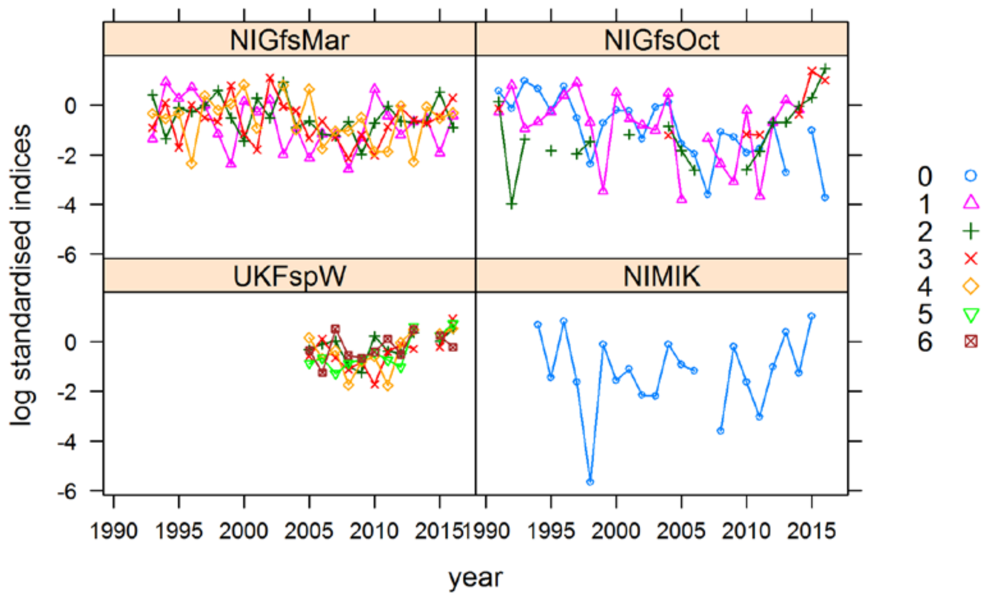


Figure 7.5. Log-standardised age distribution in survey indices.

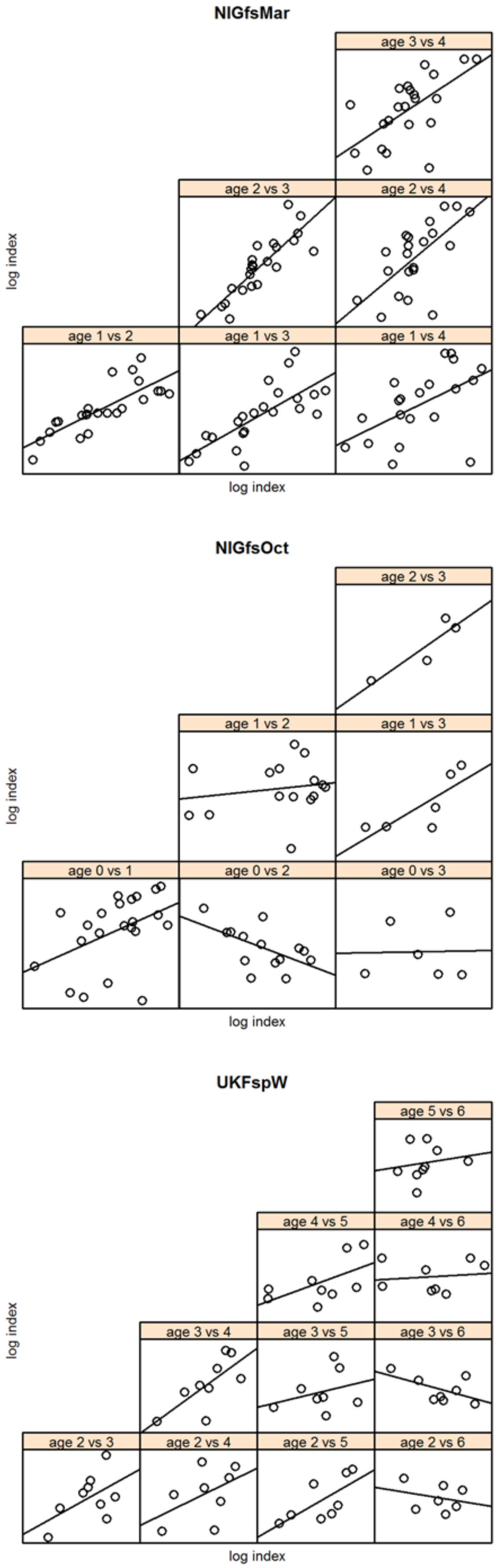


Figure 7.6. Survey age continuity.

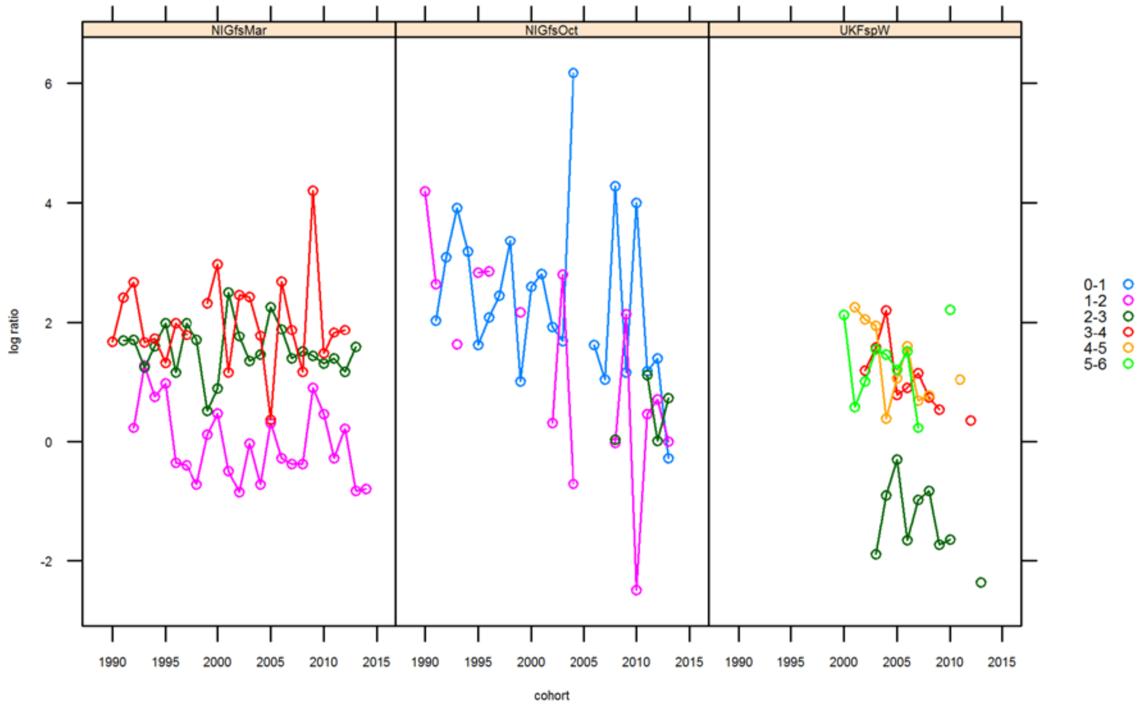


Figure 7.7. Log ratio of cohorts in surveys.

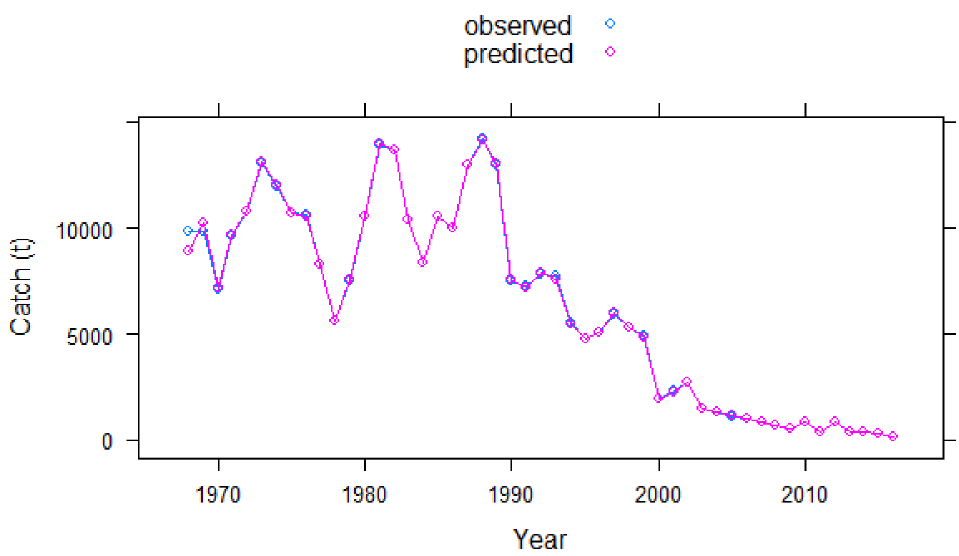
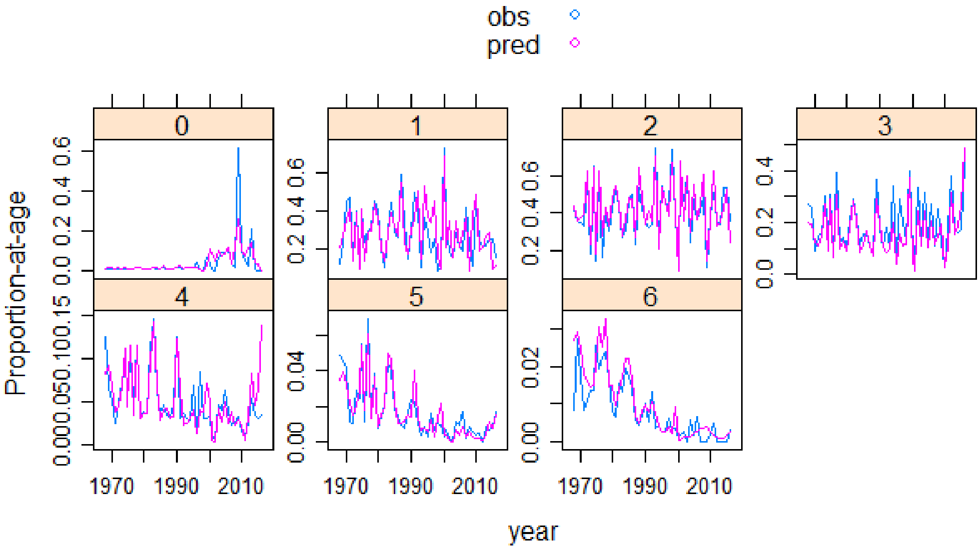


Figure 7.8. Observed and predicted catches.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pred
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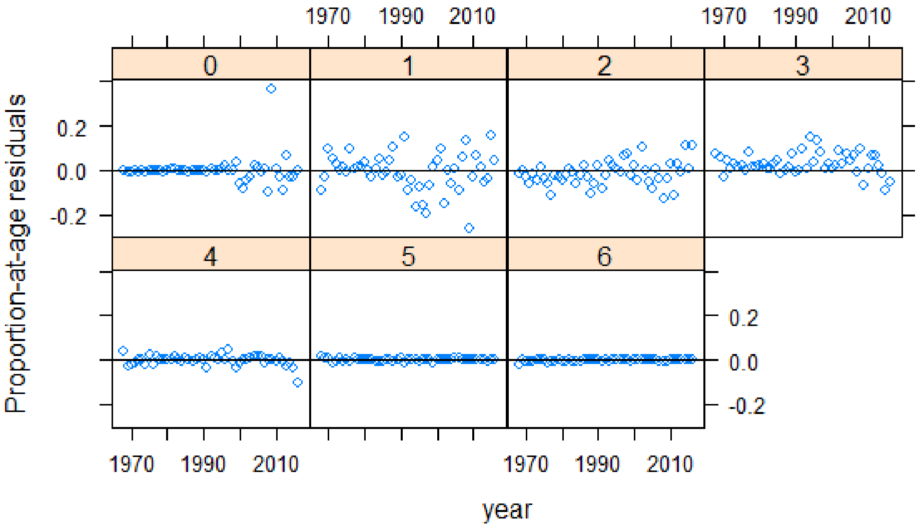
1
2
3
4
5
6
Proportion-at-age
year
1970
1990
2010


0
1
2
3
4
5
6
Proportion-at-age residuals
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0.0
-0.2
year
1970
1990
2010

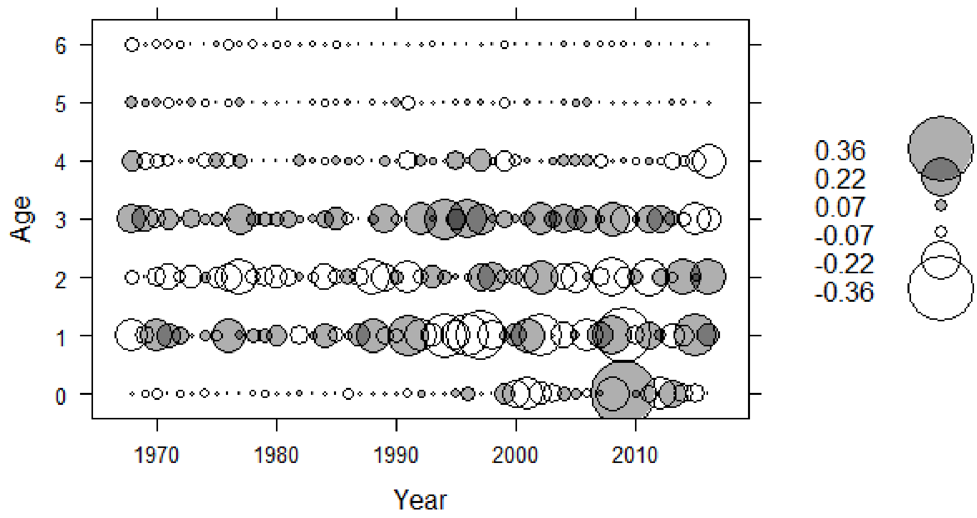

Figure 7.9. Commercial fleet catch at age residuals.

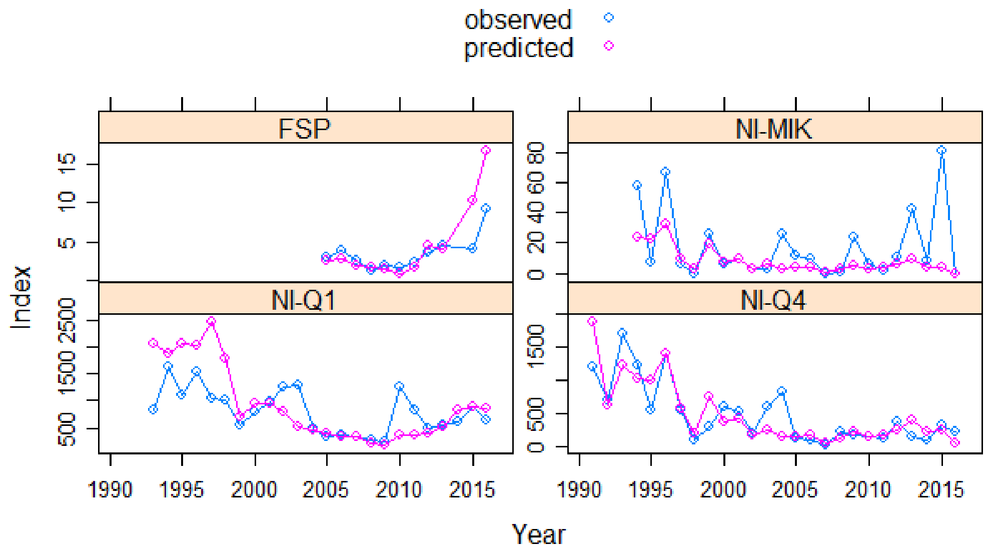

Figure 7.10. Index Fit.

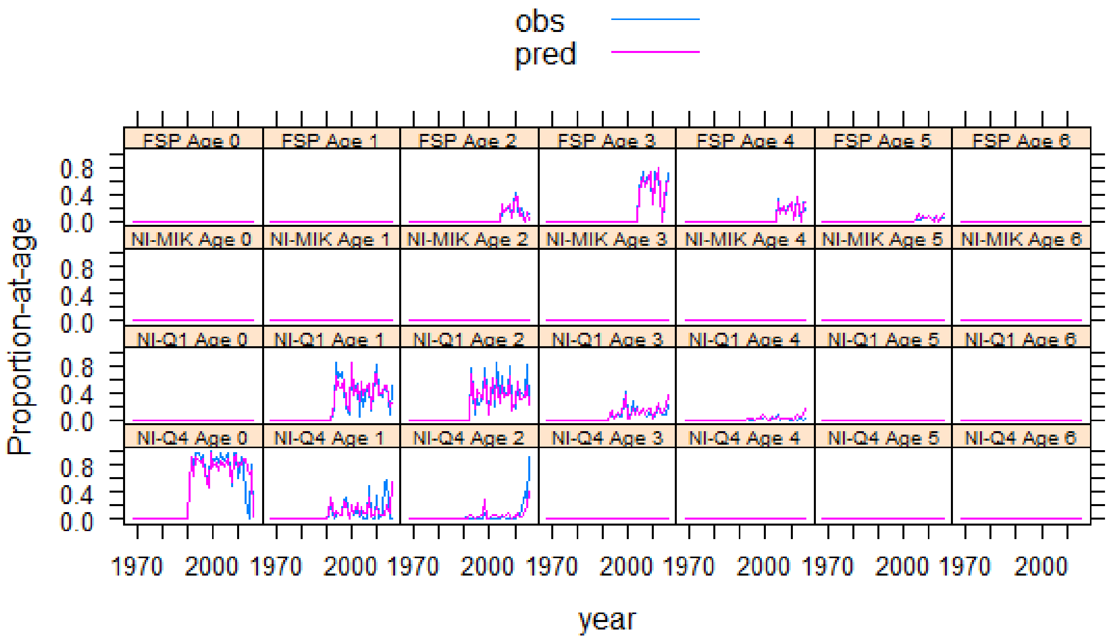

Figure 7.11. Index fit at-age.

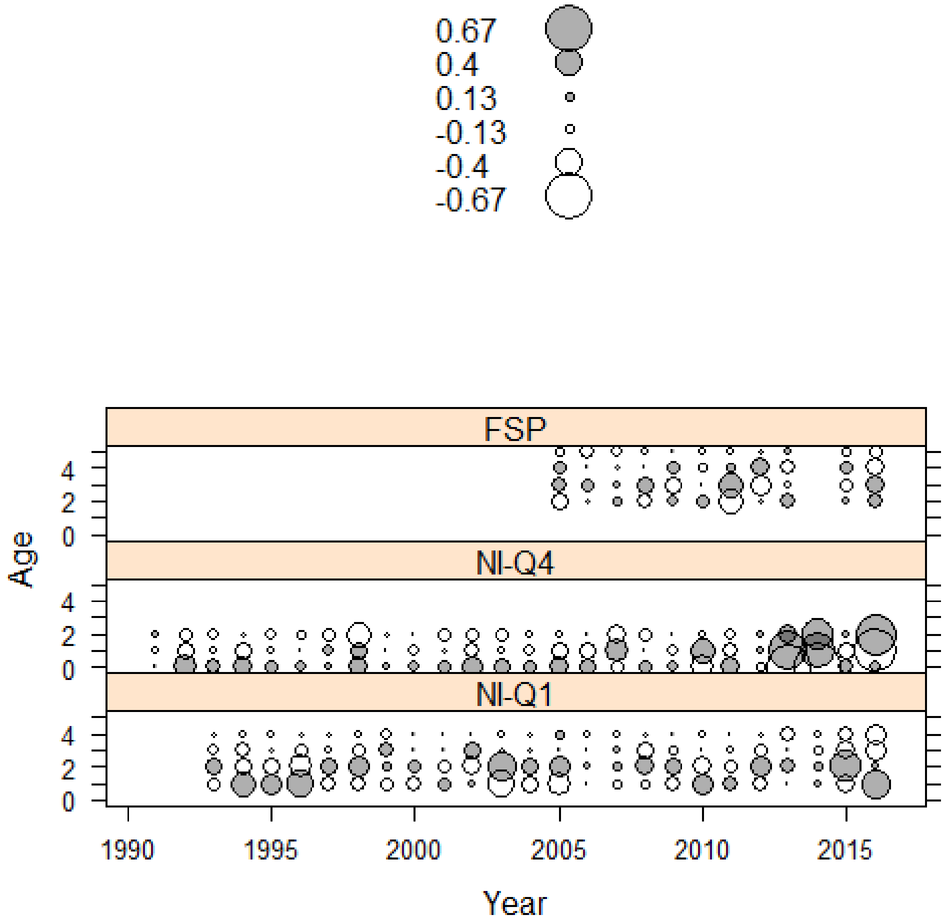

Figure 7.12. Index residuals catch-at-age (NIMIK is not included as only targets age 0 group.

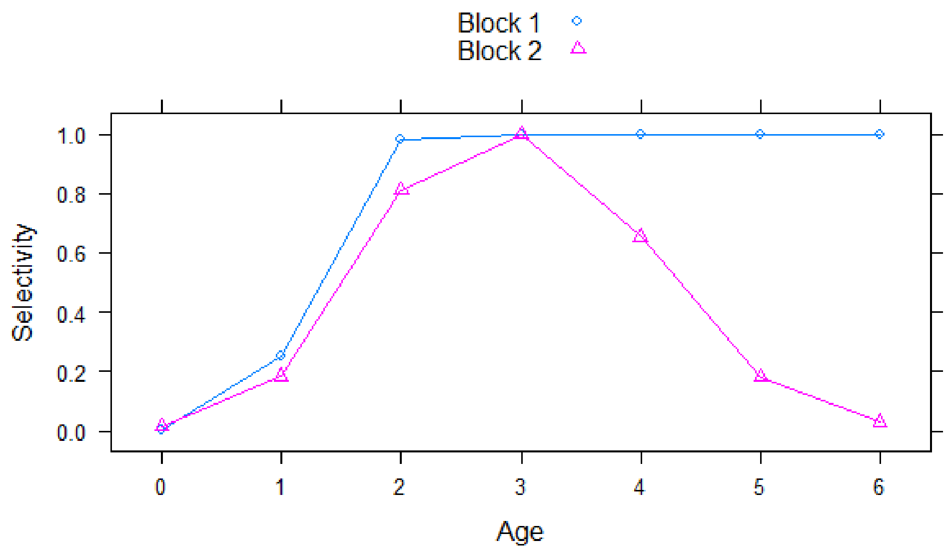

Figure 7.13. Cod in ICES Division 7.a: ASAP Fishery selectivity-at-age, Block 1: 1968–1999, Block 2: 2000–today.

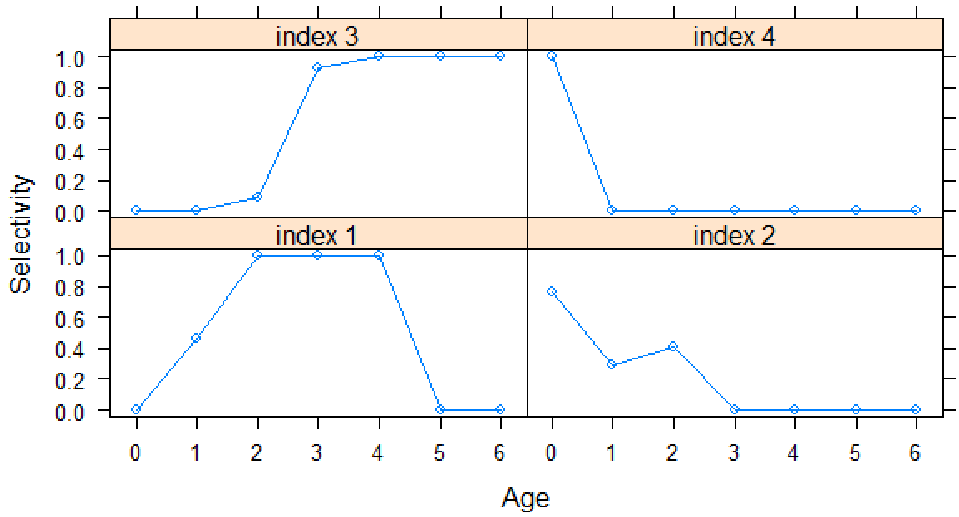

Figure 7.14. Cod in ICES Division 7.a: ASAP Index selectivity-at-age, Index1: NIGFSQ1, Index 2: NIGFSQ4, Index3: UK-FSP, Index 4: Miknet.

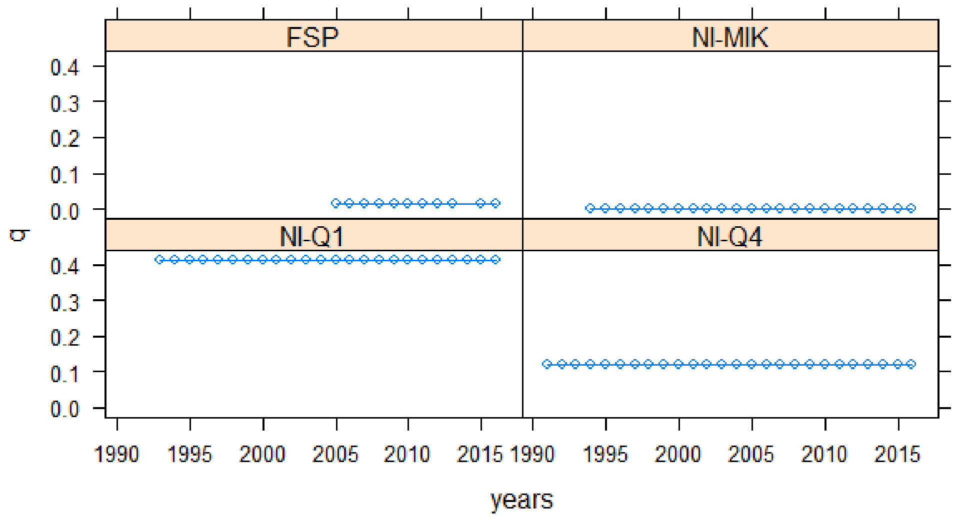

Figure 7.15. Index catchability (q).

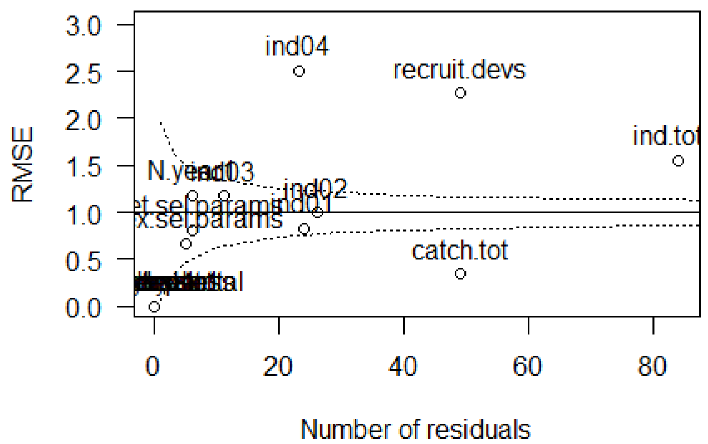

Figure 7.16. Model RMSE fit.

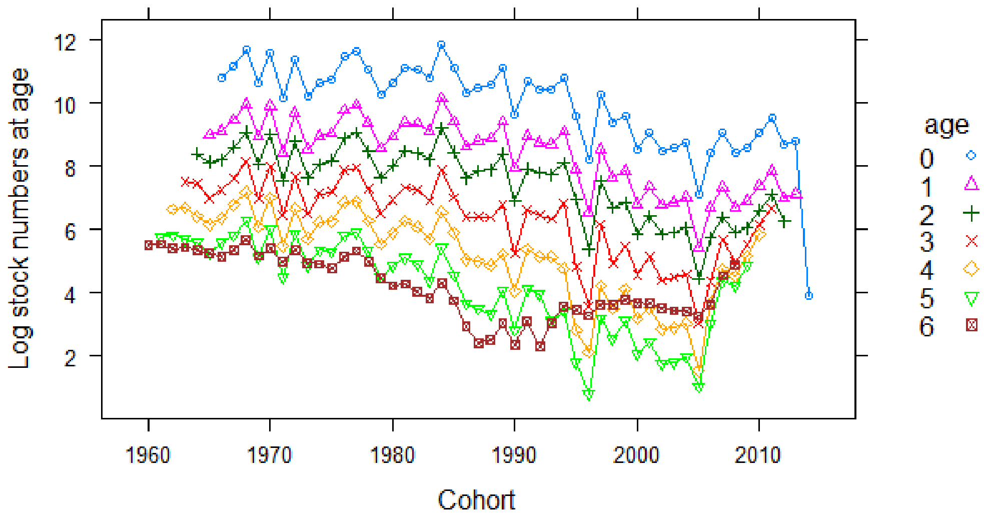

Figure 7.17. Estimated stock numbers-at-age.

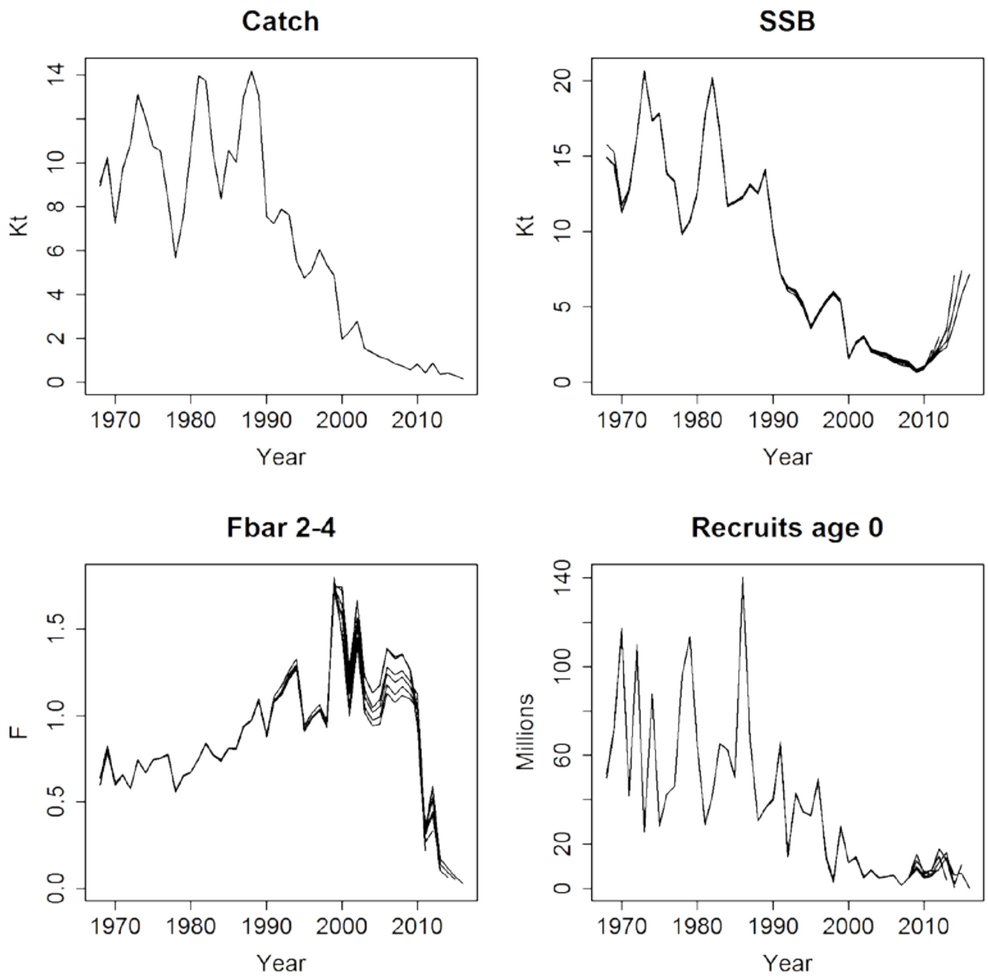

Figure 7.18. ASAP retrospective summary 2011–2016.

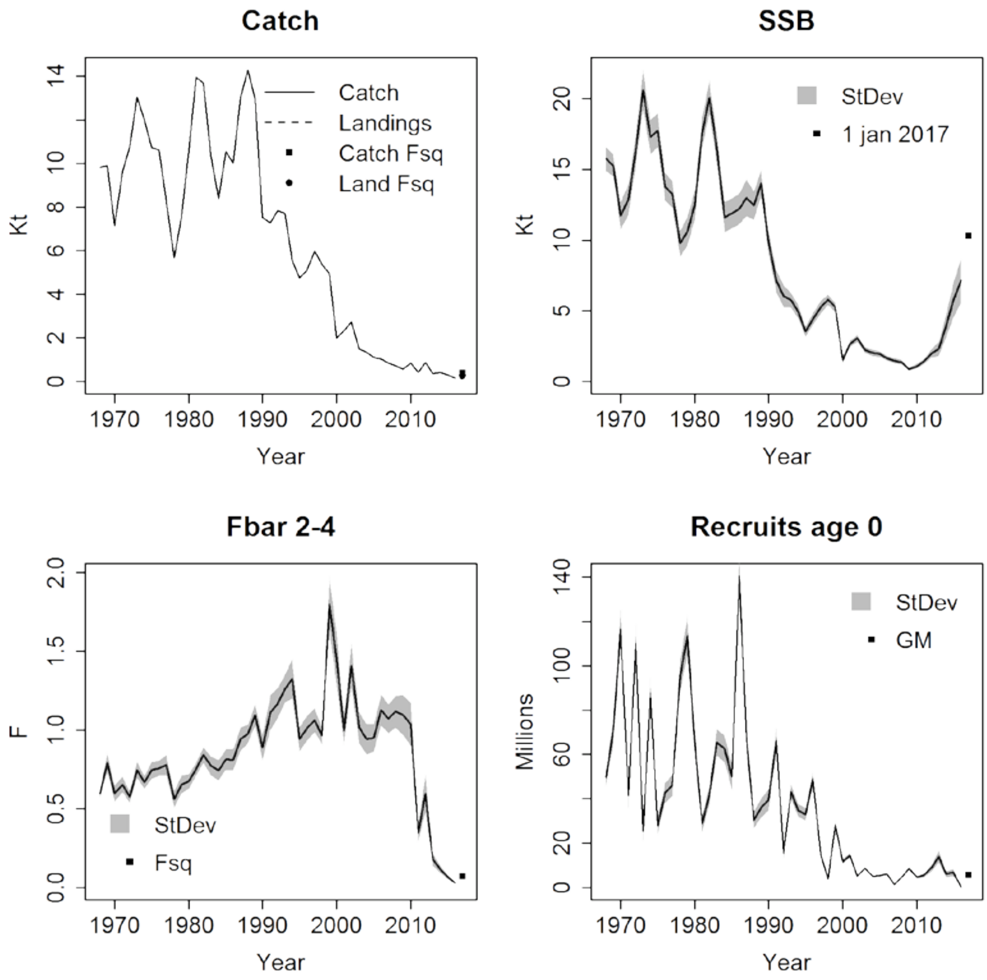

Figure 7.19. ASAP assessment results and short-term forecast using *status quo* F (Fsq) and Geometric mean (GM) recruitment.

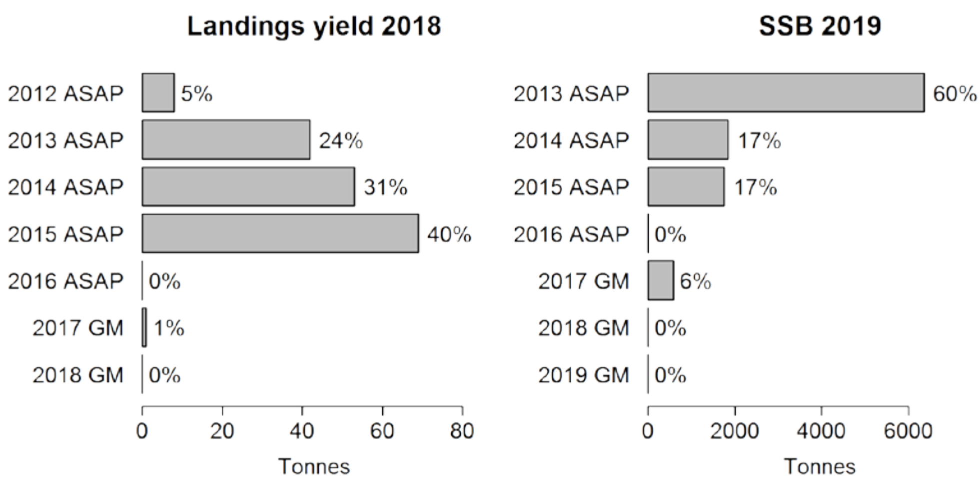

Figure 7.20. Contribution to SSB and Landings with short-term forecast using *status quo* F (Fsq) and Geometric mean (GM) recruitment.

Full ASAP model setup

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#nages
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#nselblocks
 2
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#fracyearSSB
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#mature
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 0.1 0.84 1.94 3.57 5.28 7.53 9.4
 0.1 0.86 1.64 3.54 5.42 6.39 9.11
 0.1 0.81 1.96 3.99 5.98 6.92 8.67
 0.1 0.85 1.71 3.67 5.68 7.37 10.17
 0.1 0.8 1.92 3.61 6.08 7.68 8.57
 0.1 0.9 1.84 4 5.79 8.45 9.14
 0.1 0.98 1.63 3.26 5.3 7.72 9.79
 0.1 0.85 1.94 3.62 5.29 6.12 9.4
 0.1 0.93 1.65 3.73 5.37 7.03 9.35
 0.1 0.85 1.62 3.18 5.51 7.52 10.25
 0.1 0.85 1.99 3.57 5.14 7.15 8.39
 0.1 0.99 1.82 4.15 5.61 7.33 9.51
 0.1 0.94 1.84 3.44 5.73 7.71 10.01
 0.1 1.21 1.66 3.29 5.43 10.2 11.09
 0.1 1.11 2.2 3.63 6.51 7.64 8.61
 0.1 0.91 1.94 3.51 5.32 7.74 8.89
 0.1 0.83 1.84 3.67 4.71 6.39 7.84
 0.1 0.83 1.85 3.78 5.35 7.99 10.04
 0.1 0.89 1.59 3.54 6 7.57 9.46
 0.1 1.1 2.01 3.46 5.31 7.1 6.82
 0.1 1.26 2.29 3.93 6.34 7.33 9.64
 0.1 0.949 1.88 3.745 5.536 6.754 9.036
 0.1 0.93 1.88 3.37 5.34 7.6 8.56
 0.1 0.97 2.32 4.06 5.54 7.43 10.79
 0.1 0.88 2.26 4.49 7 8.75 9.41
 0.1 0.83 1.79 3.69 6.49 8.55 9.95
 0.1 0.95 1.58 3.1 5.01 10.7 8.13
#WAApointbio
  1 1 1 1 2 3
#sel_blocks
  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 1 1 1 1 1
1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
#sel_option
  2 3
#sel_ini
  0.1 -1 0 0.001
 0.25 2 0 0.3
 0.68 2 0 0.3
 1 -1 0 0.001
 1 -1 0 0.001
 1 -1 0 0.001
 1 -1 0 0.001
 2 2 1 0.8
 0.5 2 1 0.8
 2 2 0 0.8
 0.5 2 0 0.8
 2 2 0 0.8
 0.5 2 0 0.8
 0.1 -1 1 0.001
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 0.25 2 1 0.8
 0.68 2 1 0.8
 1 -1 1 0.001
 1 -1 1 0.001
 1 2 1 0.8
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 0 0 0 0.8
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 2 2 1 0.8
 0.5 2 1 0.8
 2 2 1 0.8
 0.5 2 1 0.8
#sel_start_age
  1
#sel_end_age
  7
#Freport_agemin
 3
#Freport_agemax
 5
#Freport_wtopt
 1
#use_likelihood_constants
 1
#release_mort
  0
#CAA_ini
  17.8128 438.706 1563 1003 456 177 30 9826.43
 20.8513 969.449 1481 1050 269 186 113 9889.34
 22.1338 1809.83 1385 352 204 163 71 7133.87
 22.9383 2835.2 2022 904 144 67 51 9609.42
 26.5101 900.182 3267 824 250 58 59 10779.9
 27.172 2376.96 1091 1783 430 173 81 13040.6
 16.9394 601.043 3559 557 494 131 74 11999.6
 26.3767 1809.62 642 1407 294 249 117 10720.2
 26.7721 1247.28 3007 363 500 61 104 10628
 31.0517 946.229 511 1233 163 218 71 8255.27
 39.9559 854.572 1092 310 311 39 65 5662.05
 44.3458 1947.98 1288 608 127 164 71 7548.09
 24.5978 2636.16 2797 729 243 49 55 10599.1
 37.6666 1456.97 3635 1448 244 99 47 13958.1
 46.0421 538.098 2284 1455 557 102 79 13694.1
 46.9844 1011.05 932 751 499 154 46 10387.2
 37.3035 1733.45 1195 439 240 161 75 8384.85
 33.888 1360.12 2105 703 158 84 77 10544.3
 49.1542 1180.15 2248 699 203 64 65 10006.1
 47.3752 4521.69 1793 841 252 75 43 13021.9
 42.5944 2970.64 4734 702 263 71 38 14277
 41.0327 754.089 2163 1886 231 86 37 12952.5
 37.8496 868.739 1075 545 372 70 30 7537.94
 46.6409 2168.61 1408 442 127 98 22 7258.45
 36.7427 1529.1 1243 664 132 42 49 7832.71
 39.3996 388.24 2907 403 119 16 13 7709.97
 39.9237 916.437 569 848 68 20 10 5543.64
 42.9668 678.2 1283 180 163 7 6 4753.16
 87.954 446.79 1113 700 38 39 6 5104.06
 5.27579 650.792 1149.5 501 213 17 16 5978.56
 0 231.465 1928 335 80 28 8 5347.25
 141.424 235.792 843 871 66 21 7 4943.34
 62.3589 1106.69 176 107 50 4 1 1973.14
 7.21846 403.153 841 53 13 9 2 2316.45
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 0 238.49 564 405 7 2 3 2740.7
 50.4318 120.685 471.624 108.834 36.2477 1.13333 0 1500.41
 50.4318 160.785 133.814 173.834 22.2477 6.13333 3 1326.44
 50.4318 118.345 256.364 77.8338 34.2477 5.13333 1 1114.1
 50.4318 89.0846 174.004 127.834 17.2477 8.13333 3 1025.03
 16 216 209.6 56 11 1 0 847.16
 5.5 77.4 169.4 87 9 3 0 723.47
 329.3 59.8 57.4 66.1 17 3 0 554.36
 48.7 220 188.3 16.4 7.5 2.1 1 850.31
 9.7 53.7 105.9 36 2 1 1 412.71
 7.5 83.9 135.2 144.9 9.9 0.2 0 875.65
 36.1 37 58.5 30 9 1.5 0 358.02
 1.08612 40.6615 85.9318 26.3044 5.52931 1.1 0 396.53
 0 37.3 79.8 25.8 4.3 1.3 0 308.02
 0 10.9 24.6 30.1 2.3 1.2 0.2 142.23


#index_month_ini
  3 10 3 5

#index_start_age_ini
  2 1 3 1
#index_end_age_ini
  5 3 7  1


#index_ini
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 1969 -999 0.2 -999 -999 -999 -999 -999 -999 -999 -999
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 1993 841.904 0.783171 0 138.121 648.763 44.599 10.421 1.417
2.769 50
 1994 1618.87 0.340965 0 1380.44 109.71 120.271 8.45 1.367 0 50
 1995 1117.7 0.675194 0 700.728 386.153 20.039 10.779 0 0.994
50
 1996 1548.47 0.429215 0 1106.13 329.282 111.668 1.394 8.808 0
50
 1997 1041.26 0.644885 0 537.298 415.843 66.723 21.392 1.394 0
50
```

```
 1998 1007.48 0.839964 0 169.385 769.234 56.874 11.984 0 0 50
 1999 559.739 0.861441 0 49.499 253.08 241.874 15.286 2.787 0
50
 2000 798.238 0.653815 0 629.595 101.053 34.576 33.014 0 2.258
50
 2001 992.336 0.890678 0 406.682 561.441 18.438 5.775 4.042 0
50
 2002 1249.02 0.644334 0 662.163 253.311 333.543 0 0 1.129 50
 2003 1289.82 0.543658 0 73.865 1079.2 104.05 32.702 3.652
3.049 50
 2004 482.909 0.755489 0 216.956 171.956 88.622 5.375 4.381 0
50
 2005 345.973 0.759642 0 63.533 225.07 29.407 27.963 18.27 0 50
 2006 361.568 0.63449 0 169.989 130.752 58.304 2.523 0 0 50
 2007 324.493 0.948715 0 164.351 124.393 30.601 5.148 0 0 50
 2008 275.999 0.902387 0 40.658 217.151 13.018 5.172 4.178
0.994 50
 2009 245 0.761727 0 144 59 33 9 0 0 50
 2010 1247.99 0.817134 0 1022.12 208.961 14.656 2.258 0 0 50
 2011 816.934 0.494292 0 353.981 414.689 46.006 2.258 2.01 0 50
 2012 498.238 0.807196 0 161.898 222.819 99.271 14.25 0 0 50
 2013 551.84 0.805923 0 276.592 213.675 60.082 1.491 15.547 0
50
 2014 604.16 0.632073 0 314.41 222.799 53.294 13.657 5.375 0 50
 2015 876.06 0.843748 0 78.96 719.35 69.19 8.56 3.05 0 50
 2016 649.63 1.057 0 349.2 175 148.3 10.7 1.12 0 50


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 1992 700.43 0.706612 553.23 146.44 0.76 0 0 0 0 50
 1993 1708.37 0.466294 1672.49 25.44 10.44 0 0 0 0 50
 1994 1240.12 0.384531 1206.8 33.32 0 0 0 0 0 50
 1995 543.34 0.599703 486.65 50.15 6.54 0 0 0 0 50
 1996 1419.39 0.818437 1322.2 97.19 0 0 0 0 0 50
 1997 546.13 0.553396 376.51 163.9 5.72 0 0 0 0 50
 1998 100.44 0.750048 58.47 32.48 9.49 0 0 0 0 50
 1999 303.67 0.68287 301.64 2.03 0 0 0 0 0 50
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2002 190.85 0.858148 161.45 29.4 0 0 0 0 0 50
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2004 831.13 0.818665 706.13 107.72 17.28 2.89 0 0 0 50
2005 138.25 0.726955 130.2 1.47 6.58 0 0 0 0 50
2006 89.97 1.22263 86.99 0 2.98 0 0 0 0 50
2007 34.56 0.618457 17.28 17.28 0 0 0 0 0 50
2008 219.72 1.09287 213.62 6.1 0 0 0 0 0 50
2009 174.78 0.834397 171.8 2.98 0 0 0 0 0 50
2010 149.39 0.823742 92.48 53.86 3.05 3.05 0 0 0 50
2011 115.11 0.753755 107.05 1.69 6.37 2.98 0 0 0 50
2012 374.936 0.720274 321.82 32.791 20.325 0 0 3.049 0 50
2013 142.28 0.78101 41.67 79.95 20.66 0 0 0 0 50
2014 94.5 0.78 0 55.35 39.15 6.78 0 0 0 50
2015 325.56 0.566643 224.27 0 55.42 39.06 6.81 0 0 50
2016 229.46 0.83 14.98 0 181.79 26.6 6.1 0 0 50
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2006 3.895 0.4 0 0.003 0.536 2.815 0.427 0.104 0.01 50
2007 2.639 0.4 0 0.008 0.611 1.322 0.585 0.055 0.058 50
2008 1.299 0.4 0 0.003 0.221 0.824 0.147 0.084 0.02 50
2009 1.826 0.4 0 0.009 0.171 1.152 0.377 0.099 0.018 50
2010 1.807 0.4 0 0 0.735 0.452 0.467 0.13 0.023 50
2011 2.366 0.4 0 0 0.407 1.681 0.144 0.095 0.039 50
2012 3.56 0.4 0 0 0.364 2.3 0.803 0.072 0.021 50
```

```
 2013 4.502 0.4 0 0 0.844 1.883 1.348 0.37 0.057 50
 2014 -999 0.4 -999 -999 -999 -999 -999 -999 -999 50
 2015 4.113 0.4 0 0 0.602 2.041 1.169 0.256 0.045 50
 2016 9.264 0.4 0 0 1.001 6.388 1.434 0.413 0.028 50


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 1969 -999 0.2 0 0 0 0 0 0 0 0
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 1994 57.4 0.7 0 0 0 0 0 0 0 0
 1995 6.9 0.7 0 0 0 0 0 0 0 0
 1996 66.3 0.7 0 0 0 0 0 0 0 0
 1997 5.7 0.7 0 0 0 0 0 0 0 0
 1998 0.1 0.7 0 0 0 0 0 0 0 0
 1999 26.2 0.7 0 0 0 0 0 0 0 0
 2000 6.1 0.7 0 0 0 0 0 0 0 0
 2001 9.6 0.7 0 0 0 0 0 0 0 0
 2002 3.4 0.7 0 0 0 0 0 0 0 0
 2003 3.2 0.7 0 0 0 0 0 0 0 0
 2004 25.8 0.7 0 0 0 0 0 0 0 0
 2005 11.4 0.7 0 0 0 0 0 0 0 0
 2006 9 0.7 0 0 0 0 0 0 0 0
 2007 0.01 0.7 0 0 0 0 0 0 0 0
 2008 0.8 0.7 0 0 0 0 0 0 0 0
 2009 23.6 0.7 0 0 0 0 0 0 0 0
 2010 5.7 0.7 0 0 0 0 0 0 0 0
 2011 1.4 0.7 0 0 0 0 0 0 0 0
 2012 10.6 0.7 0 0 0 0 0 0 0 0
 2013 42.6 0.7 0 0 0 0 0 0 0 0
 2014 8.2 0.7 0 0 0 0 0 0 0 0
 2015 80.4 0.7 0 0 0 0 0 0 0 0
 2016 0.01 0.7 0 0 0 0 0 0 0 0

#phase_Fmult_year1
 1
#phase_Fmult_devs
 3
#phase_recruit_devs
```

```
 3
#phase_N_year1_devs
 2
#phase_q_year1
 1
#phase_q_devs
 -5
#phase_SR_scaler
 1
#phase_steepness
 1
#recruit_CV
  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
0.5 0.5
#lambda_ind_ini
  1 1 1 1 1 1 1 1 1
#lambda_catch_tot
  1
#lambda_Discard_tot
  0
#catch_tot_CV
  0.05
 0.05
 0.05
 0.05
 0.05
 0.05
 0.05
 0.05
 0.05
 0.05
 0.05
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#input_eff_samp_size_catch_ini
  100
 100
 100
 100
 100
 100
 100
 100
 100
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```
 50

#lambda_Fmult_year1
  0
#Fmult_year1_CV
  0.1
#lambda_Fmult_devs
  0
#Fmult_devs_CV
  0.1
#lambda_N_year1_devs
 1
#N_year1_CV
 0.1
#lambda_recruit_devs
 0.01
#lambda_q_year1_ini
  0 0 0 0 0 0 0 0 0
#q_year1_CV_ini
  0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
#lambda_q_devs_ini
  0 0 0 0 0 0 0 0 0
#q_devs_CV_ini
  0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
#lambda_steepness
 0
#steepness_CV
 0.1
#lambda_SR_scaler
 0
#SR_scaler_CV
 0.1
#NAA_year1_flag
 1
#NAA_year1_ini
  10000 10000 10000 10000 10000 10000 10000
#Fmult_year1_ini
  0.2
#q_year1_iniavail
  0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
#is_SR_scaler_R
 0
#SR_scaler_ini
 10000
#SR_steepness_ini
 0.7
```

7.10 Audit of Cod 27.7a

Date: 8th June 2017

Auditor: Colm Lordan

General

The key background documents are listed below:

Stock annex

https://community.ices.dk/ExpertGroups/benchmarks/2016/wkirish/2017%20Meeting%20docs/03.%20Report%202017/Draft%20report%20sections%20-%20do%20not%20edit/COD%20Stock%20Annex%20Update%201405.docx

WKIRISH3

https://community.ices.dk/ExpertGroups/benchmarks/2016/wkirish/2017%20Meeting%20docs/03.%20Report%202017/DRAFT_wkirish3_2017.pdf

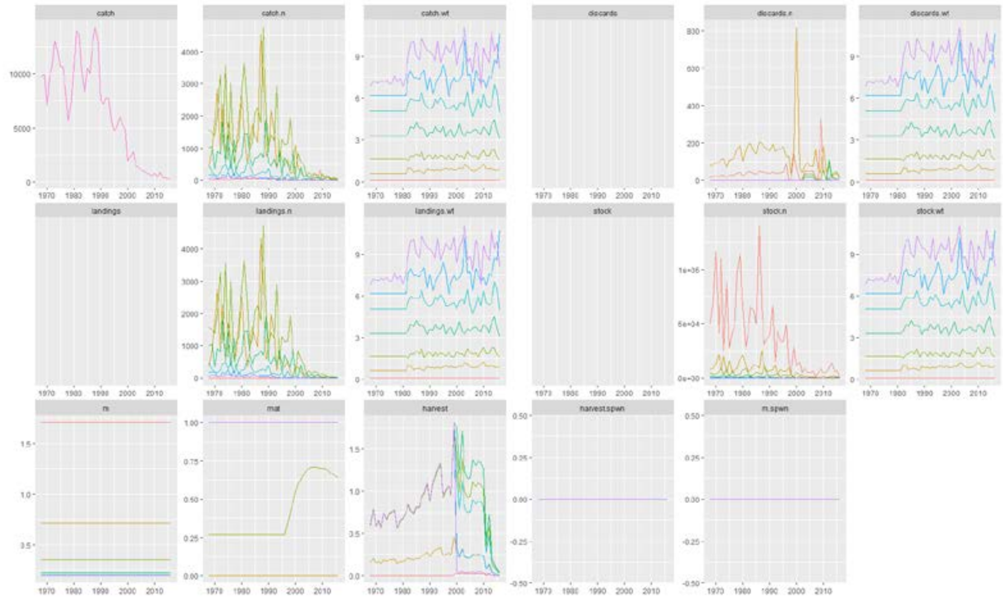
WKIRISH2

https://community.ices.dk/ExpertGroups/benchmarks/2016/wkirish/2016%20Meeting%20documents/03.%20Report%202016/Final%20consolidated%20report/WKIRISH2_Final%20Report.docx

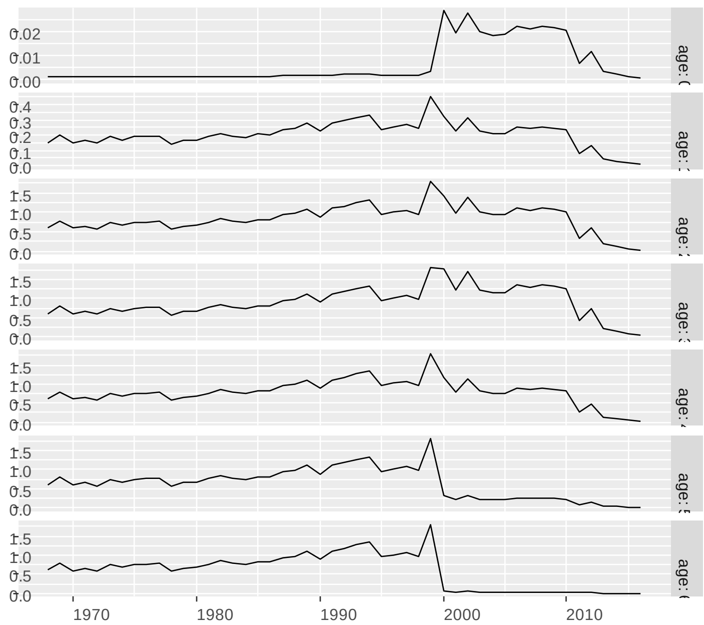
For single stock summary sheet advice

- **Assessment type**: update of benchmark procedure
- **Assessment**: ASAP
- **Forecast**: Short-term Forecast (R script)
- **Assessment model**: ASAP
- **Data issues**:

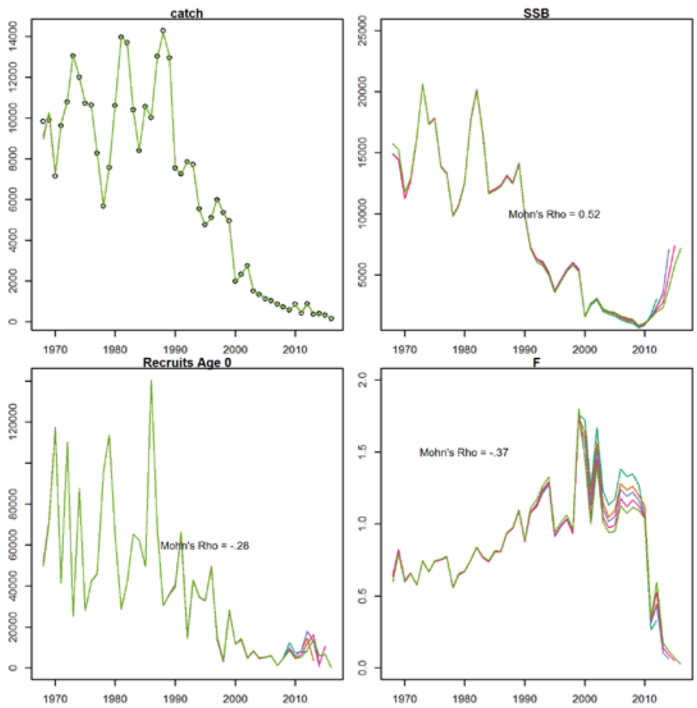
  The mean weights for catch, landings and discards are the same. The rational for this is not explained in the stock annex or WKIRISH2 report. The WG report contains a very unclear sentence "Landings and discards are combined to catch weight and numbers". The dataset is consistent with that used at WKIRISH3.



- **Consistency**: The settings are consistent with the ASAP settings outlined in the WKIRISH3 report and stock annex. The two selectivity blocks used in the assessment result in a very sudden change in F-at-age post 1990 for ages 5 and 6 especially. This is a concern in the STF since the 2013 year class will be subjected to relatively low Fs in 2017 and 2018.



The update assessment has a significant retrospective pattern of over estimation of SSB and underestimation of F. This feature was not presented or discussed in the WKIRISH3 report. The retrospective bias was considered by the WG. To address the problem the bias corrected F was used in the STF.



- **Management Plan**: None

General comments

Generally well-written report, clear and concise.

Technical comments

Assessment follows the stock annex. The main concern is the retrospective bias and impact of low Fs on recent slightly better recruitments.

Conclusions

The assessment & STF has been performed correctly

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? YES
- Is the assessment according to the stock annex description? YES
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? The management plan is not considered precautionary.
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? The short-term forecast is not documented properly in the stock annex or in the WG report. There are code and stock objects on the SharePoint site to evaluate how the STF has been performed. However it is very important that the STF settings properly documented in the stock

annex. The STF used a bias corrected F in the interim year rather than an FSQ.

- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? The assessment follows the model settings chosen at the benchmark (WKIRISH3). The retrospective bias in the update assessment presents an issue when forecasting. The STF setting appear not to have been considered by WKIRISH3 as they are not documented in the WKIRISH3 report or stock annex. WGCSE 2017 used the standard forecasting approach used for other stock with a modification in the interim year F to take account of the retrospective bias in F. The retrospective bias in SSB is also an issue since the stock size may well be revised down in future assessments and forecasts and might be below B_{pa} and B_{lim}.

The estimation of B_{pa} follows the standard approach but the $\sigma = 0.21$ is almost certainly not a true reflection of the uncertainty on terminal biomass given the bias.

8 Cod in Divisions 7.bc

Type of assessment: No assessment

The nominal landings are given in Table 8.1.

Table 8.1. Landings (t) of cod in Division 7.bc for 1995–2016 as officially reported to ICES.

Year	FR	IE	ES	UK	Others	Total
1970	1889	158	0	0	2	2049
1971	1188	114	0	0	0	1302
1972	589	77	15	4	50	735
1973	453	253	28	19	256	1009
1974	284	77	22	16	6	405
1975	365	215	42	14	56	692
1976	331	290	120	0	15	756
1977	143	132	14	3	0	292
1978	256	173	4	2	0	435
1979	203	286	0	2	20	511
1980	585	320	9	13	5	932
1981	841	765	15	11	0	1632
1982	587	1234	11	9	0	1841
1983	645	579	16	0	1	1241
1984	435	524	24	288	1	1272
1985	381	494	17	115	22	1029
1986	1012	619	0	142	104	1877
1987	591	758	0	104	1	1454
1988	591	388	0	28	2	1009
1989	na	915	0	41	10	966
1990	na	795	0	312	29	1136
1991	na	612	0	210	11	833
1992	223	507	0	210	39	979
1993	118	357	0	90	0	565
1994	155	289	0	122	6	572
1995	91	282	6	91	3	473
1996	115	353	3	47	1	519
1997	71	177	0	44	9	301
1998	44	234	6	34	0	318
1999	na	154	2	5	11	172
2000	44	141	3	4	0	192
2001	38	107	1	2	1	149
2002	54	59	1	2	5	121
2003	33	59	0	9	1	102
2004	13	60	0	10	0	83
2005	13	32	0	0	0	45
2006	10	16	0	1	1	28

YEAR	FR	IE	ES	UK	OTHERS	TOTAL
2007	18	11	0	2	1	32
2008	14	18	0	1	0	33
2009	5	29	0	1	0	35
2010	17	37	0	1	0	55
2011	43	36	0	0	0	79
2012	47	39	0	1	1	88
2013	32	51	0	2	0	85
2014	29	45	0	2	0	76
2015*	38	41	0	2	0	81
2016*	21	30	0	1	0	52

*** Preliminary, na = not available.**

9 Cod in Division 7.e–k (Celtic Sea)

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.

ICES advice

"ICES advises on the basis of the MSY approach that landings in 2016 should be no more than 3569 t."

"ICES advises that when the MSY approach is applied, wanted catch in 2017 should be no more than 1447 tonnes. ICES cannot quantify the corresponding total catches."

9.1 General

Stock description and management units

The 2017 TAC was set for ICES Areas 7.b–c, 7.e–k, 8, 8, 10, and CECAF 34.1.1(1), excluding 7.d. This is more representative of the stock area than in previous years 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 2016 and 2017

TAC 2016 (Council regulation 608/2013)

L 22/46 EN Official Journal of the European Union 28.1.2016

Species:	Cod *Gadus morhua*	Zone:	VIIb, VIIc, VIIe-k, VIII, IX and X; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	193		
France	3 166		
Ireland	864		
The Netherlands	1		
United Kingdom	341		
Union	4 565		
TAC	4 565		Analytical TAC Article 12(1) of this Regulation applies

TAC 2017 (Council regulation 127/2017)

L 24/46 FR Journal officiel de l'Union européenne 28.1.2017

Espèce:	Cabillaud *Gadus morhua*	Zone:	Zones VII b, VII c, VII e-k, VIII, IX et X; eaux de l'Union de la zone Copace 34.1.1 (COD/7XAD34)
Belgique	109		
France	1 789		
Irlande	739		
Pays-Bas	0		
Royaume-Uni	193		
Union	2 830		
TAC	2 830		TAC analytique L'article 12, paragraphe 1, du présent règlement s'applique.

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 shown in Table 9.1 and Figure 9.1. Landings in 2016 were 3299 t. The agreed TAC was not entirely taken (72% uptake). TAC uptake varies among countries. Belgium and France did not use their TAC entirely whereas Ireland, Netherlands and United Kingdom use their national quota entirely. The low uptake rate for France is the consequence of the mixed nature of its fisheries. Cod is no longer a target species but is bycaught in haddock and whiting dedicated fisheries.

France is fishing in all area, whereas Ireland mostly fishes in area 7.g, UK in 7.e and Belgium in area 7.f (Figure 9.2). At the stock level, 51% of the landings are taken from area 7.g, 16% in 7.e, 17% in 7.h and 8% in 7.f and j respectively. No landings are reported in 7.k.

Landings and discards by countries.

COUNTRY	CATCHCATEGORY	CATON	TAC_C	TAC_UPTAKE
Belgium	Discards	10.5	NA	NA
France	Discards	67.8	NA	NA
Ireland	Discards	84	NA	NA
Netherlands	Discards	0	NA	NA
United Kingdom	Discards	57.7	NA	NA
Belgium	Landings	96.8	193	50
France	Landings	2013	3166	64
Ireland	Landings	823.7	864	95
Netherlands	Landings	0.8	1	80
United Kingdom	Landings	364.8	341	107
Ireland	Logbook Registered Discard	0	NA	NA

Given the rapid growth of this species in this area, discards are mostly composed of one year old fish. Since 2011 quotas were not restricted and the discard rate has stabilized around 10–15%. Discards in 2016 were 220 t; leading to 6.3% discard in weight, which is lower than the previous years. This is likely to be the result of low recruitment and low stock size.

Cod 7.ek are mainly caught by OTB_DEF_100–119 and OTT_DEF_100–119 métiers. OTB_DEF_70–99 and beam trawlers also contribute significantly to the catches. The discard rate in weight varies among fleets depending on mesh size range and targeted species.

The group advices to follow métier definition specified in the Appendix 2 of the ICES data call to reduce the number of metier upload in InterCatch. Metiers which contribute to less than 1% of the landings should be included in the MIS_MIS_0_0_0_HC métier.

Landings and discards by fleets.

Fleet	Landings_t	Discards_t	Discard_rate
OTB_DEF_100-119_0_0_all	1497	85	5.4
OTT_DEF_100-119_0_0_all	571	15	2.6
OTB_DEF_70-99_0_0_all	286	19	6.2
TBB_DEF_70-99_0_0_all	247	66	21.1
OTT_CRU_100-119_0_0	159	2	1.2
GNS_DEF_all_0_0_all	158	1	0.6
SSC_DEF_100-119_0_0_all	141	4	2.8
GNS_DEF_120-219_0_0_all	71	0	0
OTB_DEF_>=120_0_0_all	65	12	15.6
GTR_DEF_all_0_0_all	39	0	0
OTB_CRU_70-99_0_0_all	33	2	5.7
MIS_MIS_0_0_0_HC	10	0	0
LLS_FIF_0_0_0_all	7	0	0
SSC_DEF_All_0_0_All	1	0	0
OTB_CRU_32-69_0_0_all	0	0	NA
OTB_SPF_32-69_0_0_all	0	0	NA
OTM_SPF_32-69_0_0_all	0	0	NA
SSC_DEF_70-99_0_0_all	0	0	NA
SSC_DEF_70-99_0_0_all_FDF	0	0	NA
TBB_CRU_16-31_0_0_all	0	0	NA
TBB_DEF_>=120_0_0_all	0	0	NA

Information from the industry

No specific information was reported to the group in 2017.

9.2 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 (/data/Cod7ek/Allocationscheme2017). 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. 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 2016 landings provided by countries for sampled strata and quarter are shown Figure 9.3 a–d.

Age distribution of 2016 landings is shown in Figure 9.4. 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 9.2). 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, and in 2016 landings are dominated by fish of age 3.

Discards

The landings/discards pattern is known to be strongly variable between fleets and years due to metier, recruitment intensity, TACs constraints and mixed fisheries concerns. In 2009, age 1 individuals (30–45 cm) 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 MLS. 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%, which is considered lower than average.

Length distributions of 2016 discards provided by countries for sampled strata and quarter are shown Figure 9.3a–d. In recent years, due to quota constraints at vessels levels, length distribution of discards for the UK fleet show high-grading pattern (cod being a non-target species). However, this fleet has little contribution to both, landings and discards quantities.

Raised age distribution of landings and discards are shown in Figure 9.4. Discards are mainly composed of age 1 fish.

Biological

Catch (landings) in numbers-at-age, catch and stock weights are given respectively in Tables 9.2, 9.3 and 9.4.

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 9.5 a–c show the trends of landings, fishing effort and lpue dataseries for the French (a), Irish (b) and UK fleets (c). Figure 9.5 (a,b,c) shows their trends.

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 stabilise, 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 effort for the French tuning fleet decreased and lpue has stabilized. Effort of Irish fleet targeting gadoids (otter trawlers 7.g) remains at a high level and increased in recent years as a consequence of mixed fisheries interaction with increased whiting and haddock fisheries opportunities. In the meantime SSB is low in recent year, as such lpue is decreasing. Effort of the UK trawl fleet in 7.e shows a decreasing trend (down to zero in 2016) while beam trawl effort in 7.e–k is stable and slightly increased in 2016.

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 was recorded from this fleet. The zero figures provided for 2016 have been checked and are correct.

Surveys and commercial tuning fleet

Table 9.6 presents the survey dataseries. 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 Figure 9.6 and Table 9.6.

Data issues

No important issues were reported this year.

Remark: When for a métier/strata landings are upload annually, there are not information available in IC 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.

This is not a relevant issue for 2016 cod 7.ek data as the annual landings upload in InterCatch represents only 3% of the landings (UK Scotland and Belgium).

9.3 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 diagnostics is shown in Table 9.7. Residuals (Figure 9.7) and diagnostics do not highlight any problem regarding the input data and model fit. Outputs from the assessment are shown are in Tables 9.8–10 and in Figures 9. 8–10.

Last year's assessment shows strong upward revision in F and downward revision in SSB in recent years. The upward revision in F is likely due to strong recruitment dynamics (strong 2009 year class still included in F_{bar} range).

This year's assessment is consistent with last year assessment and the revisions of estimates of SSB and F are lower than has been observed in the recent past.

The comparison of runs with and without tuning indices indicates that both tuning indices contain little information and that the majority of the information comes from the catch-at-age matrix (Figure 9.11b).

State of the stock

Table 9.8 shows the estimated fishing mortality-at-age and Table 9.9 shows the stock numbers-at-age. The stock summary is given in Table 9.10 and Figure 9.10.

Catches are around 5000 t since 2000 (Figure 7.2.1), with some higher catches following strong recruitments. Reliable discard estimates are only available since 2011 and range between 200 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. The 2011, 2012 year classes are estimated well below the average of the time-series, but the 2013 year class is above average. The 2014 year class is the lowest observed in the time-series. The 2015 year class is a bit below average.

Spawning–stock biomass (SSB) is well below $MSYB_{trigger}$ since 2000 and often below B_{pa}, with the exception of 2012 as the consequence of a very good recruitment year. SSB is below B_{pa} since 2014 and is increasing slowly.

Fishing mortality (F) has declined between 2005 and 2010 and fluctuated in recent years with strong increases in 2011 and 2014 and has decreased since. In 2016, F was estimated lower than F_{pa}. Fishing mortality remains well above F_{MSY}.

9.4 Short-term projections

Because catches of Celtic Sea cod are often composed of a high proportion of age 2 and age 3 fish (due to their fast growth rate, age 2 fish range between 30 and 60 cm) and recruitment of cod is characterised by periods of low recruitment and sporadic events, the assumed geometric mean for recruitment introduces significant uncertainty in the short-term projections.

Recruitment (age 1) in 2017 and thereafter, is assumed as the geometric mean of the time-series minus the last two years, as specified in the stock annex.

Because of the decreasing trend in the recent year, the three year averages F at age (range 2 to 5) were scaled (by the last year F).

Three year averages were used for weights-at-age. No TAC constraint was applied.

Input to the short-term predictions are presented in Table 9.11 and results in Table 9.12.

VARIABLE	VALUE	NOTES	SOURCE
F ages 2–5 (2017)	0.43852	F=F average (2014–2016), scale	ICES (2017a)
SSB (2018)	8755t	Short-term forecast	ICES (2017a)
R age 1 (2017/2018)	4505 thousand	GM (1971–2014)	ICES (2017a)
Catch (2017)	3703.7493 t	Landings + estimated discards	ICES (2017a)
Landings (2017)	3323t	Short-term forecast	ICES (2017a)
Discards (2017)	380.7493	Average discard rate 2014–2016 = 11.458%	ICES (2017a)

Under the forecast assumption, landings in 2017 are predicted to be 3323 t (higher than the TAC set at 2830 t and the 2016 ICES advice of 1447 t). SSB is predicted to be 8755 t in 2018 which would be above B_{lim} (7300 t) but still below B_{pa} (10 300 t) (Table 9.15).

The forecasts are sensitive to the recruitment assumption that contributes to 34% of the landings in 2018 and the half of the projected SSB in 2019 (Figure 9.13 and Table 9.12).

9.5 Medium-term projection

No medium-term projections were carried out.

9.6 Biological reference points

New value of F_{MSY} has been estimated using the agreed ICES guidelines (ICES, 2016, WKMSYref4).

The advice and forecasts are based on the following reference points:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	10 300 t	B_{pa}	ICES (2012)
	F_{MSY}	0.353	Segmented regression with B_{loss}, the lowest observed spawning–stock biomass (Eqsim).	ICES (2016)
Precautionary approach	B_{lim}	7 300 t	Lowest observed SSB (1976), rounded value	ICES (2012)
	B_{pa}	10 300 t	B_{lim} × 1.4	ICES (2012)
	F_{lim}	0.807	Based on segmented regression with B_{lim} as breakpoint	ICES (2016)
	F_{pa}	0.576	F_{lim}/1.4	ICES (2016)
Management plan	SSB_{MGT}	Not applicable.		
	F_{MGT}	Not applicable.		

9.7 Management plans

There are no specific management objectives or a management plan for this stock.

9.8 Uncertainties and bias in assessment and forecast

WGCSE recommend that cod, haddock and whiting in the Celtic Sea should be benchmarked together in 2019. 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.

Discards normally constitute about 10% of the total catch, but discard rates in recent years have fluctuated substantially due to variable recruitment and TACs constraints. This prevents the forecast of a discard rate for 2017 with any certainty.

9.9 Management considerations

Several management options can bring SBB above B_{pa} in 2019 under the current recruitment assumption. The retrospective pattern, even if limited, 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 30 and 50 cm).

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 $MSYB_{trigger}$. 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 by catch in the fleet targeting haddock, whiting and *Nephrophs*.

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

9.10 References

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. 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 9.1.Nominal landings of Cod in Divisions 7.e–k used by the Working Group.

YEAR	BELGIUM	FRANCE	IRELAND	UK	OTHERS	TOTAL	HIGHGRADED. DISCARD.ESTIMATES	DISCARD. ESTIMATES	LANDINGS. TAKEN.OR.REPORTED .IN.33E2.33E3
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

Year	Belgium	France	Ireland	UK	Others	Total	Highgraded. discard.estimates	Discard. estimates	Landings. taken.or.reported .in.33E2.33E3
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
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

'*'French high-grading estimates from self-sampling programme. ''International high-grading estimate. 3 croix Included in Ireland data.**

Table 9.2a. Cod in Divisions 7.e–k. Landings number-at-age (in thousands) (note: 2011 values represent actual catch) - InterCatch outputs.

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

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
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
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

Table 9.2b. Cod in Divisions 7.e–k. Landings number-at-age (in thousands) used in the assessment (note: 2011 values represent actual catch) - after sop correction.

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	11743	5745	625	142	129	101	32
1993	3700	5927	1812	179	53	39	32

YEAR	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7
1994	13716	2005	2128	539	68	20	33
1995	9675	7182	812	540	187	29	11
1996	7430	5161	2209	333	165	81	7
1997	10001	3975	1702	600	137	45	12
1998	5018	5077	1195	438	199	65	14
1999	2352	2512	1394	330	113	68	26
2000	10657	1025	788	378	114	36	29
2001	8841	5077	323	222	141	50	50
2002	2185	4455	1541	122	84	49	44
2003	1300	1147	1363	379	37	36	28
2004	2931	700	331	296	100	16	14
2005	4166	1492	236	94	79	26	5
2006	4585	2268	479	55	26	22	8
2007	3865	2463	742	140	20	8	8
2008	1610	1936	668	196	54	8	8
2009	3004	870	699	224	61	21	4
2010	13533	1676	368	237	87	15	3
2011	4897	7697	798	167	102	31	7
2012	830	1762	2702	389	82	51	25
2013	1461	470	812	835	106	41	11
2014	7711	790	163	227	243	25	3
2015	537	4043	280	51	76	74	24
2016	3385	294	1535	108	21	31	55

Table 9.3. Cod in Divisions 7.e–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

YEAR	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9	AGE 10
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
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

Table 9.4. Cod in Divisions 7.e–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

YEAR	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9	AGE 10
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
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

Table 9.5a. Cod in Divisions 7.e–k. Time-series of landings, effort, lpue for French OT-DEF fleets. Units in tonnes, Effort in 000s hours fished, 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

Table 9.5b. Cod in Divisions 7.e–k. Time-series of landings, effort, lpue for the Irish fleets. Units in tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.

	Otter trawlers 7.j			Beam trawlers 7.j			Scottish seiners 7.j			Gillnet 7.j		
year	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	339.3	93.2	3.6	0	0.2	0.2	75.5	5.3	14	178.8	21.3	8.4
1996	326.4	70.2	4.6	8.7	1.4	6.3	124.5	8.2	15	65	5.2	12
1997	352.7	82.7	4.3	3.4	1.7	2	115.8	10.7	11	45.5	8.3	5.5
1998	262.7	89.1	2.9	19.1	5.2	3.7	103.4	6.6	16	59.1	16	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	13.8	7	2
2001	148.5	67.4	2.2	10.7	3	3.6	31.3	4.4	7.1	14.8	6.6	2.3
2002	150	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	1	12	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	17.5	5.8	3	3.4	6.1	0.6
2006	39.6	64.5	0.6	2	1.5	1.3	15.6	5.3	2.9	7.2	7.3	1
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	0.4	4.7	2.8	1.7	8.9	3.3	2.7	8	10.9	0.7
2010	52.5	85.7	0.6	1.7	1	1.7	17	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	2.1
2012	62.8	65.6	1	0.4	0.3	1.5	29.8	5.4	5.6	25.2	8.3	3
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	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	50.5	1	0.3	0.2	1.6	25.2	5.3	4.7	15.8	17	0.9

	Otter trawlers 7.g			Beam trawlers 7.g			Scottish seiners 7.g			Gillnet 7.g		
x	Landings	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	114.9	6.3	18.1
1996	569.2	60.0	9.5	112.5	26.7	4.2	164.9	9.7	16.9	338.9	6.2	54.8
1997	401.9	65.0	6.2	131.5	28.1	4.7	215.2	16.1	13.4	52.8	1.9	27.7
1998	450.5	72.3	6.2	166.8	35.2	4.7	264.1	14.9	17.7	87.3	3.4	25.4
1999	300.7	51.5	5.8	190.6	40.8	4.7	64.6	8.0	8.1	200.4	8.4	23.9
2000	279.4	60.6	4.6	180.6	36.8	4.9	106.0	9.9	10.8	151.7	10.1	15.0
2001	358.5	69.4	5.2	101.2	39.5	2.6	115.0	16.3	7.0	115.8	8.8	13.2
2002	212.9	77.2	2.8	57.9	31.5	1.8	71.0	20.9	3.4	31.0	6.4	4.8
2003	167.2	86.8	1.9	56.8	49.2	1.2	35.6	20.1	1.8	31.3	11.1	2.8
2004	190.2	97.1	2.0	74.3	54.9	1.4	54.4	18.4	3.0	62.0	13.5	4.6
2005	292.5	124.7	2.3	118.9	49.6	2.4	64.4	14.6	4.4	77.9	10.9	7.2
2006	379.4	118.0	3.2	128.6	60.5	2.1	91.0	14.8	6.2	63.7	7.8	8.1
2007	316.1	135.4	2.3	96.2	55.8	1.7	58.5	15.8	3.7	85.4	9.4	9.1
2008	344.9	125.4	2.7	85.4	37.2	2.3	55.6	11.6	4.8	88.0	14.1	6.2
2009	405.9	137.1	3.0	74.4	37.9	2.0	34.6	8.2	4.2	81.1	13.8	5.9
2010	524.8	140.8	3.7	94.7	40.2	2.4	54.3	9.7	5.6	76.0	14.0	5.4
2011	438.4	120.3	3.6	82.5	35.3	2.3	46.7	11.0	4.2	76.6	11.3	6.7
2012	780.7	127.7	6.1	161.9	40.3	4.0	111.5	14.1	7.9	129.1	15.4	8.4
2013	721.4	118.2	6.1	195.8	38.5	5.1	111.3	13.2	8.5	92.5	14.4	6.4
2014	600.1	127.3	4.7	142.9	37.8	3.8	110.5	12.5	8.9	59.2	14.1	4.2
2015	526.3	132.7	4.0	160.1	37.8	4.2	59.2	9.3	6.4	48.7	12.5	3.9
2016	417.4	147.2	2.8	105.2	39.2	2.7	51.1	10.4	4.9	47.0	13.6	3.5

Table 9.5c. Cod in Divisions 7.e–k. Time-series of landings, effort, lpue for the UK fleets. Units: landings in tonnes, Effort in days fished and lpue in Kg/day.

	BEAM TRAWL 7.EK			TRAWL 7.E ONLY		
YEAR	LANDS..T	EFFORT..DAYS.	LANDS..T	EFFORT..DAYS.	LANDS..T	EFFORT..DAYS
1983	25.55	2853	40.93	2573	20.60	1871
1984	128.75	8427	235.68	8092	76.42	5618
1985	145.39	7706	250.67	7186	63.97	5411
1986	165.76	6651	232.19	6174	78.31	4425
1987	248.91	8060	210.36	5446	88.49	3701
1988	249.21	9487	262.68	5645	151.35	4265
1989	231.24	10071	177.12	5997	96.00	4607
1990	309.07	10477	305.78	6661	119.41	4423
1991	256.19	9017	242.33	5938	83.60	4004
1992	256.33	8183	231.85	6494	80.76	4108
1993	221.79	9511	183.05	5055	42.88	3761
1994	179.13	13925	78.23	4426	41.25	3423
1995	241.35	15076	115.05	4405	55.09	3294
1996	304.22	15748	120.46	4476	59.21	2589
1997	303.67	16373	150.01	5088	79.81	3011
1998	266.15	15574	119.56	4729	62.50	2699
1999	257.43	15614	90.68	6638	46.81	2486
2000	188.07	16456	110.79	7054	52.59	2681
2001	257.24	17335	109.75	5875	59.05	2732
2002	132.13	16503	82.70	5657	34.11	2448
2003	108.77	18285	58.80	5120	24.48	2273
2004	96.93	18250	44.06	5273	15.05	2334
2005	103.60	17157	41.13	5047	17.38	1762
2006	91.88	15412	55.43	5314	13.54	1699

	BEAM TRAWL 7.EK			TRAWL 7.E ONLY		
YEAR	LANDS..T	EFFORT..DAYS.	LANDS..T	EFFORT..DAYS.	LANDS..T	EFFORT..DAYS
2007	111.28	15085	49.65	5679	21.61	1917
2008	71.38	13734	49.34	4686	24.26	1750
2009	67.27	12170	27.56	4928	12.56	1847
2010	65.62	12150	31.13	5185	15.27	2213
2011	99.03	13205	47.73	4354	26.00	1931
2012	165.63	13411	79.03	4312	30.95	2068
2013	114.49	12950	37.30	2014	22.94	1587
2014	87.55	12807	17.07	1606	14.06	1440
2015	89.39	12769	16.68	1061	14.40	978
2016	73.81	13913	0.00	0	0.00	0

Table 9.6. Cod in Divisions 7.e–k. Time-series of survey indices scrutinized at WGCSE and used in the assessment.

COD		DIVISIONS	7.E–K	TUNING
102				
FR-OTDEF	Q2+3+4	trawlers	in	7.e–k
2000	2016			
1	1	0.25	1	
1	10			

Year	Effort	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10
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

IR-GFS	FR-EVHOE	Q4	combined	indices	new
2003	2016				
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	0.5	0.17	0	0
2004	1	0.24	0.88	0.24	0.15	0.14	0.07	0
2005	1	0.06	1.81	0.26	0.09	0	0	0
2006	1	0.04	1.39	0.67	0.08	0	0	0.02
2007	1	0	1.93	0.64	0.19	0.05	0	0
2008	1	0	0.55	0.88	0.24	0.12	0	0
2009	1	0.1	1.38	0.17	0.26	0.12	0	0.01
2010	1	0.12	7.34	0.76	0.04	0.06	0.07	0
2011	1	0.02	4.09	3.54	0.22	0.04	0.03	0
2012	1	0	0.39	1.32	0.8	0.19	0.04	0
2013	1	0.08	0.42	0.05	0.21	0.23	0	0
2014	1	0	3.64	0.27	0.12	0.15	0.2	0
2015	1	0	0.31	1.36	0.12	0	0.05	0.06
2016	1	0	2.27	0.18	0.81	0.07	0.02	0.07

Table 9.7. Cod in Divisions 7.e–k. Final XSA diagnostics (from FLR XSA).

FLR XSA Diagnostics 2017-05-11 09:50:58
CPUE data from indices
Catch data for 46 years. 1971 to 2016. Ages 1 to 7.

	fleet	first age	last age	first year	last year	alpha	beta
1	FR-OTDEF	1	6	2000	2016	<NA>	<NA>
2	IR-FR COMBINED SURVEY	1	4	2003	2016	<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	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

	year									
age	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.179	0.104	0.072	0.052	0.510	0.056	0.102	0.134	0.090	0.052
2	0.937	0.651	0.491	0.374	0.679	0.407	0.692	0.668	0.600	0.432
3	1.028	0.788	0.775	0.489	0.413	0.870	0.972	0.854	0.646	0.550
4	0.678	0.895	0.673	0.580	0.441	1.034	0.964	0.819	0.602	0.409
5	0.694	0.699	1.150	0.790	0.440	0.446	1.192	0.943	0.664	0.364
6	0.797	0.836	0.765	1.108	0.395	0.369	0.860	0.503	0.502	0.434
7	0.797	0.836	0.765	1.108	0.395	0.369	0.860	0.503	0.502	0.434

XSA population number (NA)

	age						
year	1	2	3	4	5	6	7
2007	3865	2463	742	140	20	8	8
2008	1610	1936	668	196	54	8	8
2009	3004	870	699	224	61	21	4
2010	13533	1676	368	237	87	15	3
2011	4897	7697	798	167	102	31	7
2012	830	1762	2702	389	82	51	25
2013	1461	470	812	835	106	41	11
2014	7711	790	163	227	243	25	3
2015	537	4043	280	51	76	74	24
2016	3385	294	1535	108	21	31	55

Estimated population abundance at 1st Jan 2017

	age						
year	1	2	3	4	5	6	7
2017	0	1927	132	654	55	12	16

Fleet: FR-OTDEF

Log catchability residuals.

age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	0.053	-0.336	1.645	0.053	-1.201	-1.292	-0.663	1.946	1.565	1.244	0.512	-1.617
2	-0.389	-0.586	-0.095	0.072	-0.302	0.068	-0.127	0.924	0.54	-0.22	-0.247	0.801
3	-0.591	-0.164	-0.169	0.013	0.193	-0.517	-0.257	0.391	-0.167	-0.165	-0.65	0.286
4	-0.526	0.2	0.93	0.344	-0.34	-0.226	-0.243	0.094	0.083	-0.312	-0.773	0.446
5	-0.58	0.455	0.222	0.37	0.309	0.311	-0.068	0.163	-0.101	0.221	-0.307	0.641
6	-0.001	0.209	0.106	0.143	-0.062	0.062	-0.17	0.005	-0.014	0.108	-0.297	0.078

age	2012	2013	2014	2015	2016
1	-1.245	0.717	0.486	-0.627	-1.238
2	-0.442	0.323	-0.091	0.077	-0.306
3	0.736	0.48	0.4	0.25	-0.066
4	1.307	0.447	0.239	0.136	0.02
5	0.32	0.848	0.725	0.378	0.058
6	0.051	0.255	-0.061	-0.138	-0.184

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	-8.9559	-6.6946	-6.6209	-6.6209	-6.6209	-6.6209
S.E_Logq	1.1526	0.4276	0.3942	0.5137	0.3611	0.1462

Fleet: IR-FR COMBINED SURVEY

Log catchability residuals.

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.011	-0.388	-0.075	-0.424	0.135	-0.309	-0.041	0.109	0.932	-0.031	-0.483	0.040	0.204	0.321
2	0.839	0.063	-0.573	-0.061	-0.029	0.286	-0.694	0.048	0.322	0.577	-1.132	0.015	-0.058	0.397
3	0.461	0.441	0.434	-0.578	-0.067	0.068	0.092	-1.384	-0.517	-0.056	-0.104	0.842	0.121	0.248
4	0.494	0.540	0.000	0.000	-0.059	0.662	0.339	-0.492	-0.662	0.554	-0.078	0.675	0.000	0.300

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	-7.1463	-7.1118	-7.0660	-7.0660
S.E_Logq	0.3628	0.5178	0.5497	0.4171

Terminal year survivor and F summaries:

Age 1 Year class = 2015

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in 7e-k	559	1	0.080
IR-GFS FR-EVHOE Q4 combined indices new	2655	1	0.801
fshk	513	1	0.119

Age 2 Year class = 2014

	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in 7e-k	94	2	0.336
IR-GFS FR-EVHOE Q4 combined indices new	173	2	0.575
fshk	83	1	0.089

Age 3 Year class = 2013

	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in 7e-k	653	3	0.477
IR-GFS FR-EVHOE Q4 combined indices new	718	3	0.433
fshk	418	1	0.089

Age 4 Year class = 2012

	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in 7e-k	61	4	0.468
IR-GFS FR-EVHOE Q4 combined indices new	58	4	0.445
fshk	23	1	0.086

Age 5 Year class = 2011

	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in 7e-k	13	5	0.729
IR-GFS FR-EVHOE Q4 combined indices new	12	3	0.155
fshk	5	1	0.117

Age 6 Year class = 2010

	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in 7e-k	15	6	0.834
IR-GFS FR-EVHOE Q4 combined indices new	28	4	0.082
fshk	15	1	0.084

Table 9.8. Cod in Divisions 7.e–k. Final XSA fishing mortality-at-age.

Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7+	Fbar(mean2-5)
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	0.792	0.602	0.831	0.831	0.749
1995	0.116	0.811	0.588	0.919	0.584	0.705	0.705	0.726
1996	0.113	0.741	0.999	0.617	1.058	0.903	0.903	0.854
1997	0.166	0.834	1.052	0.835	0.504	0.807	0.807	0.806
1998	0.180	0.925	0.982	1.090	0.829	0.980	0.980	0.956
1999	0.319	0.792	1.001	0.795	0.900	0.910	0.910	0.872
2000	0.230	0.785	0.965	0.716	0.574	0.763	0.763	0.760
2001	0.173	0.824	0.671	0.704	0.822	0.553	0.553	0.755
2002	0.133	0.817	1.099	0.917	0.590	0.326	0.326	0.856
2003	0.108	0.873	1.224	1.063	0.607	0.327	0.327	0.942
2004	0.163	0.719	0.956	1.053	1.102	0.838	0.838	0.958
2005	0.096	0.768	1.147	1.004	1.042	0.648	0.648	0.990
2006	0.110	0.749	0.930	0.729	0.921	1.119	1.119	0.832
2007	0.179	0.937	1.028	0.678	0.694	0.797	0.797	0.834
2008	0.104	0.651	0.788	0.895	0.699	0.836	0.836	0.758
2009	0.072	0.491	0.775	0.673	1.150	0.765	0.765	0.772
2010	0.052	0.374	0.489	0.580	0.790	1.108	1.108	0.558
2011	0.510	0.679	0.413	0.441	0.440	0.395	0.395	0.493
2012	0.056	0.407	0.870	1.034	0.446	0.369	0.369	0.689
2013	0.102	0.692	0.972	0.964	1.192	0.860	0.860	0.955
2014	0.134	0.668	0.854	0.819	0.943	0.503	0.503	0.821
2015	0.090	0.600	0.646	0.602	0.664	0.502	0.502	0.628
2016	0.052	0.432	0.550	0.409	0.364	0.434	0.434	0.439

Table 9.9. Cod in Divisions 7.e–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	11743	5745	625	142	129	101	32
1993	3700	5927	1812	179	53	39	32
1994	13716	2005	2128	539	68	20	33
1995	9675	7182	812	540	187	29	11
1996	7430	5161	2209	333	165	81	7
1997	10001	3975	1702	600	137	45	12
1998	5018	5077	1195	438	199	65	14
1999	2352	2512	1394	330	113	68	26
2000	10657	1025	788	378	114	36	29
2001	8841	5077	323	222	141	50	50
2002	2185	4455	1541	122	84	49	44
2003	1300	1147	1363	379	37	36	28
2004	2931	700	331	296	100	16	14
2005	4166	1492	236	94	79	26	5
2006	4585	2268	479	55	26	22	8
2007	3865	2463	742	140	20	8	8
2008	1610	1936	668	196	54	8	8
2009	3004	870	699	224	61	21	4
2010	13533	1676	368	237	87	15	3
2011	4897	7697	798	167	102	31	7
2012	830	1762	2702	389	82	51	25
2013	1461	470	812	835	106	41	11

Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7+
2014	7711	790	163	227	243	25	3
2015	537	4043	280	51	76	74	24
2016	3385	294	1535	108	21	31	55
GMST_71_2014	4505	2277	832	295	108	41	21
AMST_71_2014	6036	3051	1072	354	129	50	29

Table 9.10. Cod in Divisions 7.e–k. Final XSA summary table.

Year	Recruitment	SSB	Catch	Landings	TSB	Fbar_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	0.7
1981	5179	11212	10597	10597	20697	0.808	0.95
1982	2117	13547	8766	8766	18951	0.64	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	0.9
1988	12239	16607	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	19521	0.981	0.86
1992	11743	9074	9747	9747	21917	0.851	1.07
1993	3700	12281	10425	10425	20981	0.749	0.85
1994	13716	14360	10620	10620	26254	0.749	0.74
1995	9675	13027	11709	11709	26015	0.726	0.9
1996	7430	15916	12681	12681	26397	0.854	0.8
1997	10001	14101	12035	12035	23422	0.806	0.85
1998	5018	12590	11431	11431	19651	0.956	0.91
1999	2352	10985	8594	8594	16113	0.872	0.78
2000	10657	7673	6536	6536	15320	0.76	0.85
2001	8841	8590	8308	8308	18994	0.755	0.97
2002	2185	10858	9236	9236	15995	0.856	0.85
2003	1300	8873	6420	6420	11331	0.942	0.72
2004	2931	4641	3672	3672	7224	0.958	0.79
2005	4166	3397	3062	3062	7547	0.99	0.9
2006	4585	3769	3776	3776	8965	0.832	1
2007	3865	5121	4830	4830	10448	0.834	0.94
2008	1610	5455	3961	3961	9023	0.758	0.73
2009	3004	5092	3292	3292	9228	0.772	0.65
2010	13533	4956	3229	3229	17821	0.558	0.65
2011	4897	9064	7261	7261	17115	0.493	0.8
2012	830	13628	7692	7692	17219	0.689	0.56

Year	Recruitment	SSB	Catch	Landings	TSB	Fbar_2_5	Y/SSB
2013	1461	9604	6290	6290	11519	0.955	0.65
2014	7711	4929	3879	3879	9488	0.821	0.79
2015	537	5327	4154	4154	9358	0.628	0.78
2016	3385	7043	3299	3299	10254	0.439	0.47
2017	4505	7140					
Average_71_2014	5859	10188	7494	7494	17361	0.716	0.731

Table 9.11. Cod Division 7.e–k. Short-term forecast. Input table.

year	age	stock.n	stock.wt	catch.wt	mat	M	F
2017	1	4505	0.757	0.859	0.00	0.512	0.06389
	2	1927	1.424	2.094	0.39	0.368	0.39496
	3	132	3.850	4.412	0.87	0.304	0.47621
	4	654	7.249	7.458	0.93	0.269	0.42494
	5	55	9.917	9.284	1.00	0.247	0.45796
	6	12	10.899	10.977	1.00	0.233	0.33431
	7	44	12.380	11.689	1.00	0.223	0.33431
2018	1	4505	0.757	0.859	0.00	0.512	0.06389
	2	2533	1.424	2.094	0.39	0.368	0.39496
	3	898	3.850	4.412	0.87	0.304	0.47621
	4	61	7.249	7.458	0.93	0.269	0.42494
	5	327	9.917	9.284	1.00	0.247	0.45796
	6	27	10.899	10.977	1.00	0.233	0.33431
	7	32	12.380	11.689	1.00	0.223	0.33431
2019	1	4505	0.757	0.859	0.00	0.512	0.06389
	2	2533	1.424	2.094	0.39	0.368	0.39496
	3	1181	3.850	4.412	0.87	0.304	0.47621
	4	412	7.249	7.458	0.93	0.269	0.42494
	5	30	9.917	9.284	1.00	0.247	0.45796
	6	161	10.899	10.977	1.00	0.233	0.33431
	7	34	12.380	11.689	1.00	0.223	0.33431

Table 9.12. Cod Division 7.e–k. Short-term forecast. Single option output table.

[1]	Year :2017	F multiplier 1	Fbar=0.43852				
Age	F	CacthNos	CacthTons	StockNos	StockTons	SSBNos	SSBTons
1	0.0638890	219	188	4505	3412	0	0
2	0.3949597	532	1115	1927	2744	751	1070
3	0.4762059	44	193	132	509	115	443
4	0.4249403	200	1494	654	4740	608	4408
5	0.4579588	18	168	55	546	55	546
6	0.3343122	3	33	12	127	12	127
7	0.3343122	11	132	44	546	44	546
	Total	1027	3323	7329	12624	1585	7140
[1]	Year :2018	F multiplier 1	Fbar=0.43852				
Age	F	CacthNos	CacthTons	StockNos	StockTons	SSBNos	SSBTons
1	0.0638890	219	188	4505	3412	0	0
2	0.3949597	700	1466	2533	3607	988	1407
3	0.4762059	297	1311	898	3459	782	3009
4	0.4249403	19	138	61	439	56	408
5	0.4579588	107	997	327	3240	327	3240
6	0.3343122	7	76	27	296	27	296
7	0.3343122	8	95	32	394	32	394
	Total	1357	4271	8383	14847	2212	8754
[1]	Year :2019	F multiplier 1	Fbar=0.43852				
Age	F	CacthNos	CacthTons	StockNos	StockTons	SSBNos	SSBTons
1	0.0638890	219	188	4505	3412	0	0
2	0.3949597	700	1466	2533	3607	988	1407
3	0.4762059	390	1723	1181	4547	1027	3956
4	0.4249403	126	941	412	2985	383	2776
5	0.4579588	10	92	30	300	30	300
6	0.3343122	41	452	161	1759	161	1759
7	0.3343122	9	101	34	417	34	417
	Total	1495	4963	8856	17027	2623	10615

Table 9.13. Cod Division 7.e–k. Short-term forecast. Management options output.

	2017					
Biomasse	ssb	fmult	f2_5	landings		
12624	7140	1	0.43852	3323		
	2018				2019	
Biomasse	ssb	fmult	f2_5	landings	Biomasse.1	ssb.1
14848	8755	0.0	0.00000	0	22634	15663
14848	8755	0.1	0.04385	507	21962	15055
14848	8755	0.2	0.08770	994	21318	14473
14848	8755	0.4	0.17541	1913	20107	13382
14848	8755	0.5	0.21926	2345	19539	12870
14848	8755	0.7	0.30696	3161	18471	11910
14848	8755	0.8	0.35081	3546	17970	11460
14848	8755	0.9	0.39466	3915	17489	11028
14848	8755	1.0	0.43852	4271	17027	10615
14848	8755	1.1	0.48237	4613	16584	10219
14848	8755	1.3	0.57007	5258	15752	9475
14848	8755	1.4	0.61392	5563	15360	9126
14848	8755	1.5	0.65777	5856	14985	8792
14848	8755	1.6	0.70163	6138	14624	8471
14848	8755	1.8	0.78933	6671	13946	7870
14848	8755	1.9	0.83318	6923	13627	7587
14848	8755	2.0	0.87703	7166	13321	7317

Table 9.14. Catch option table.

Rationale	Wanted catch 2018.	Basis	F wanted catch 2018.	SSB (2019)	% SSB change	% TAC change
MSY Approach	3546	FMSY	0.35	11460	31	25
MSY Approach	2430	FMSY Min	0.23	12770	46	-14
MSY Approach	5102	FMSY Max	0.55	9655	10	80
Precautionary Buffer	3082	FBuff	0.30	12002	37	9
Zero catch	0	F=0	0.00	15663	79	-100
Other options	4271	F2017	0.44	10615	21	51
	2388	TAC2017-15% (F2017*0.51)	0.22	12820	46	-16
	2842	TAC2017	0.27	12284	40	0
	3239	TAC2017+15% (F2017*0.72)	0.32	11818	35	14
	6723	Flim	0.80	7812	-11	138
	5320	Fpa	0.58	9404	7	88
	7166	Blim	0.88	7317	-16	153
	4545	Bpa	0.47	10296	18	61

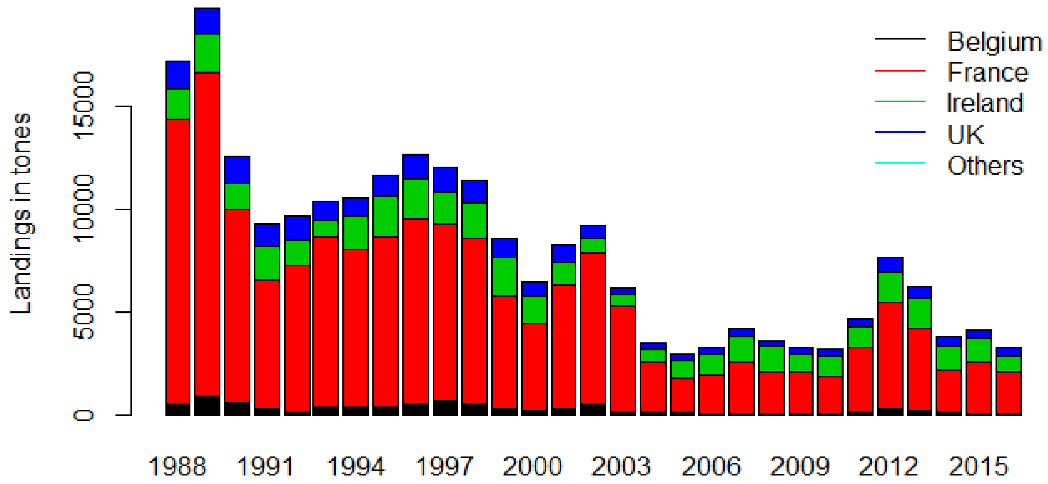


Figure 9.1. Cod in Divisions 7.e–k 2016. Historical landings by countries.

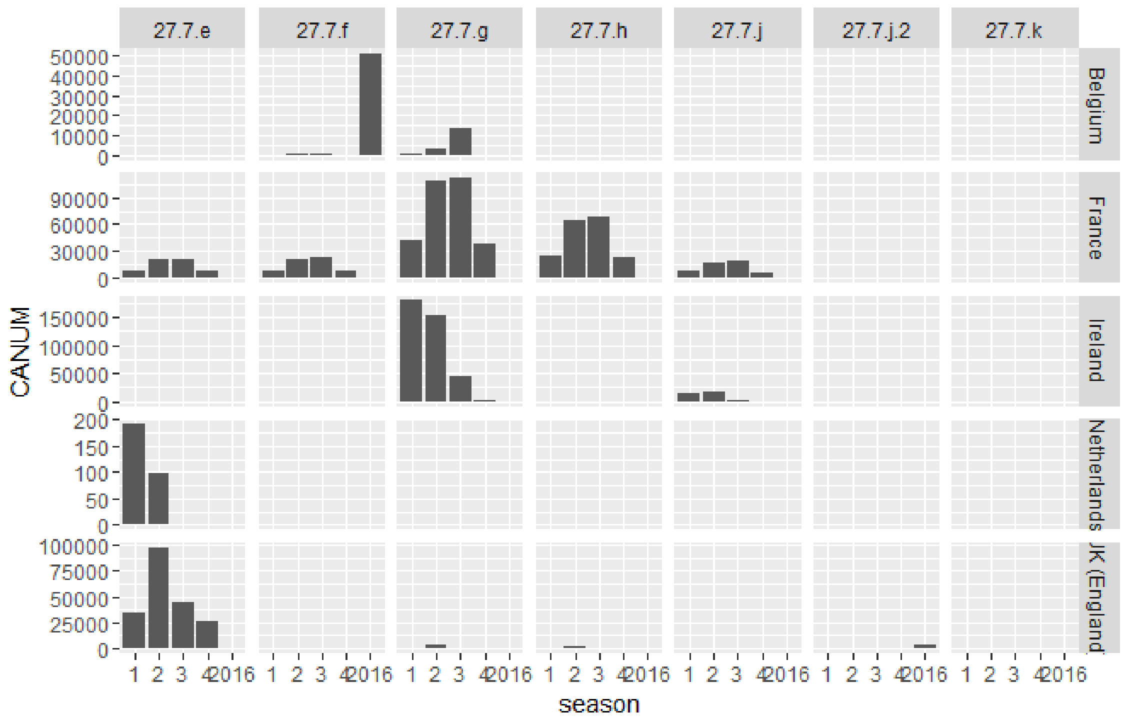


Figure 9.2. Cod in Divisions 7.e–k 2016. 2016 landings by area, season and country.

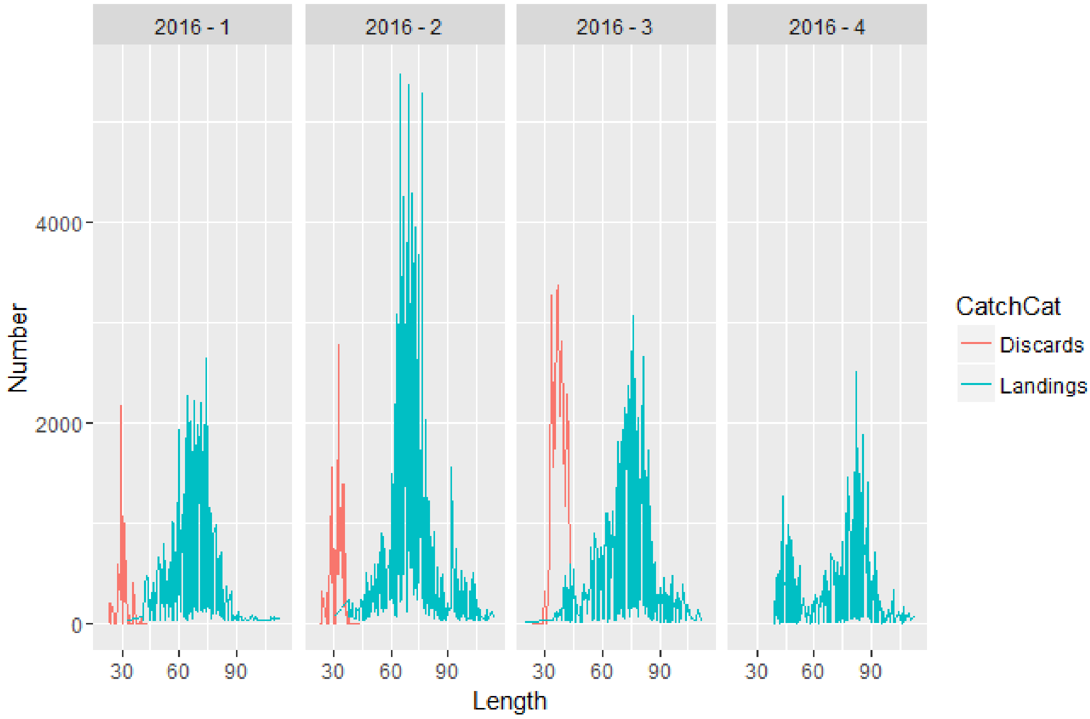


Figure 9.3.a. Cod in Divisions 7.e–k 2016. Raised French 2016 landings and discards length distribution - Sampled strata only (e.g.Q4 unsampled, or number of sampled to low).

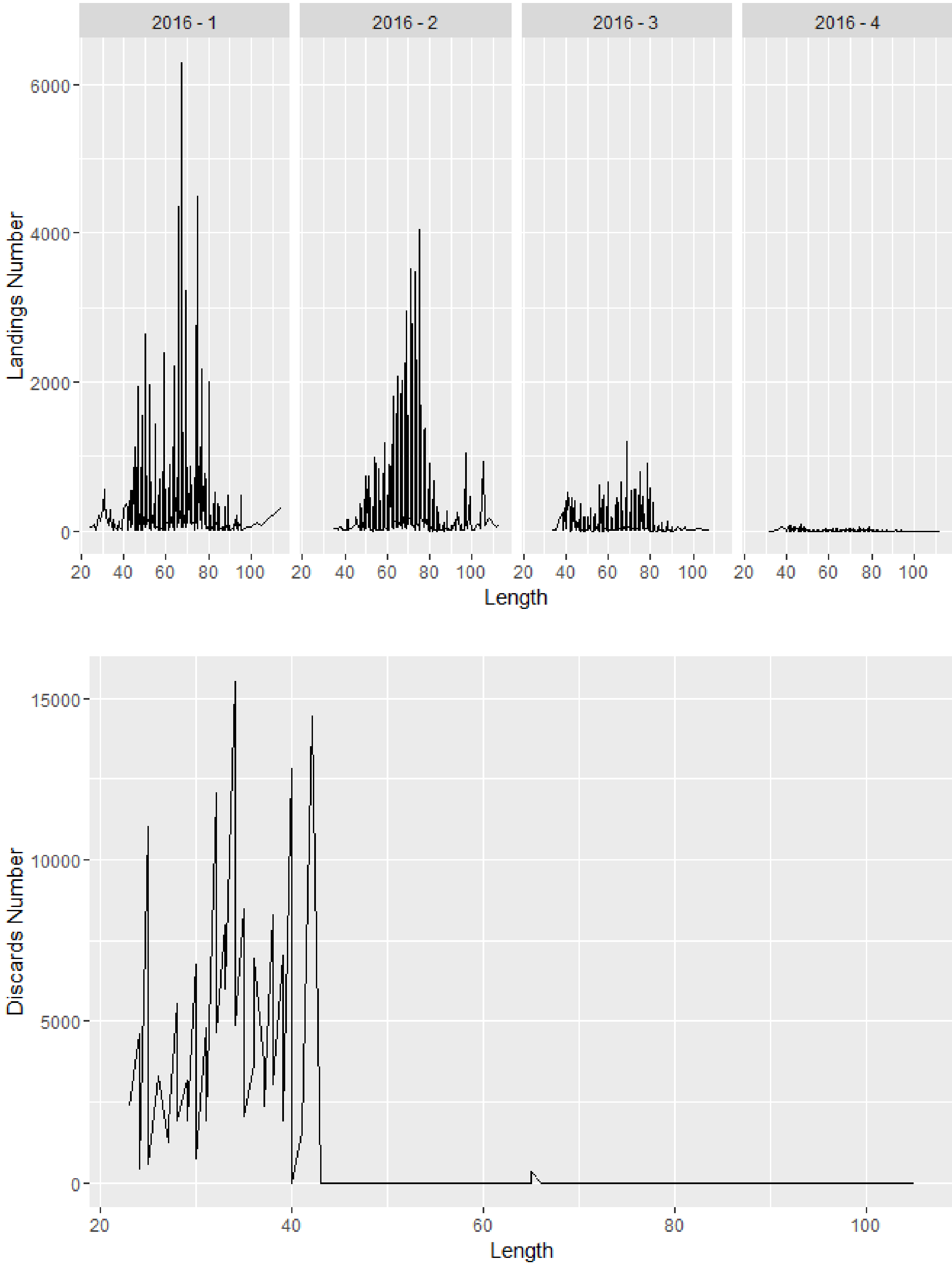


Figure 9.3.b. Cod in Divisions 7.e–k 2016. Raised Irish 2016 landings and discards length distribution- sampled strata only.

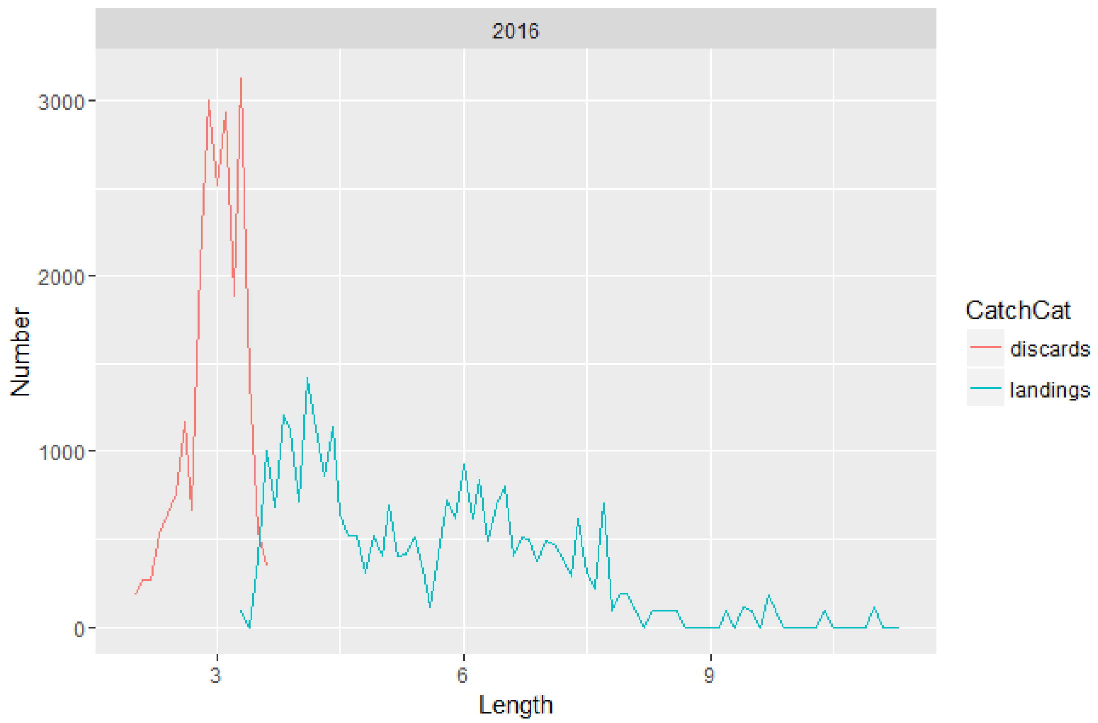


Figure 9.3.c. Cod in Divisions 7.e–k 2016. Belgian 2016 landings length distribution. Raised to the fleet.

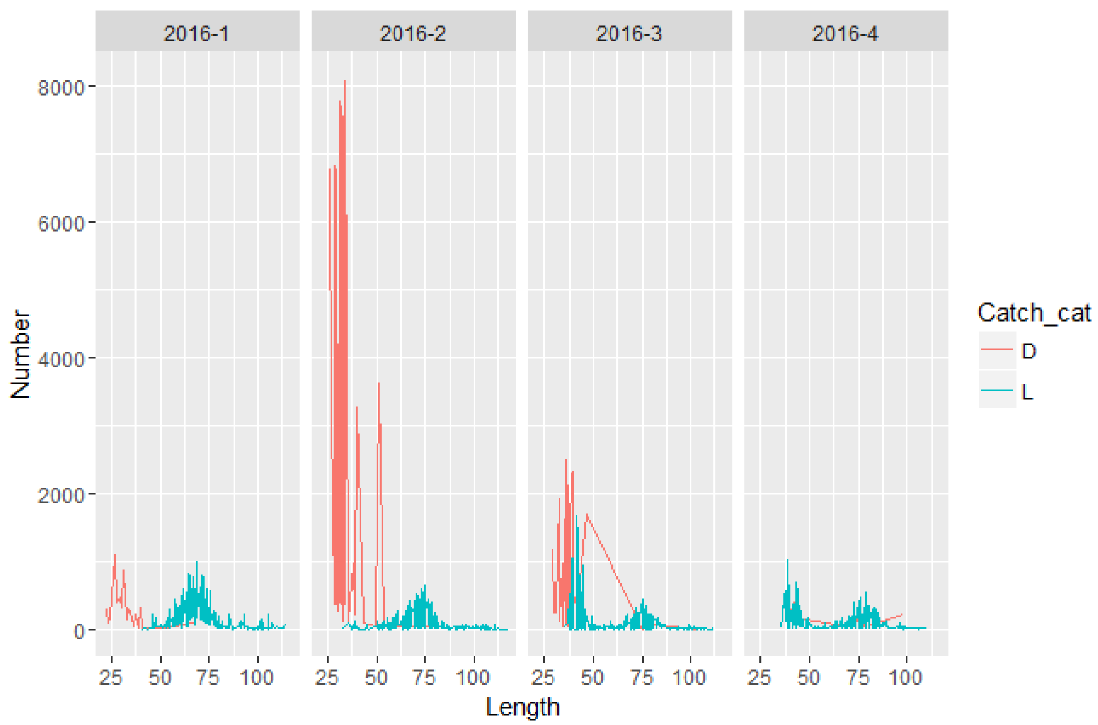
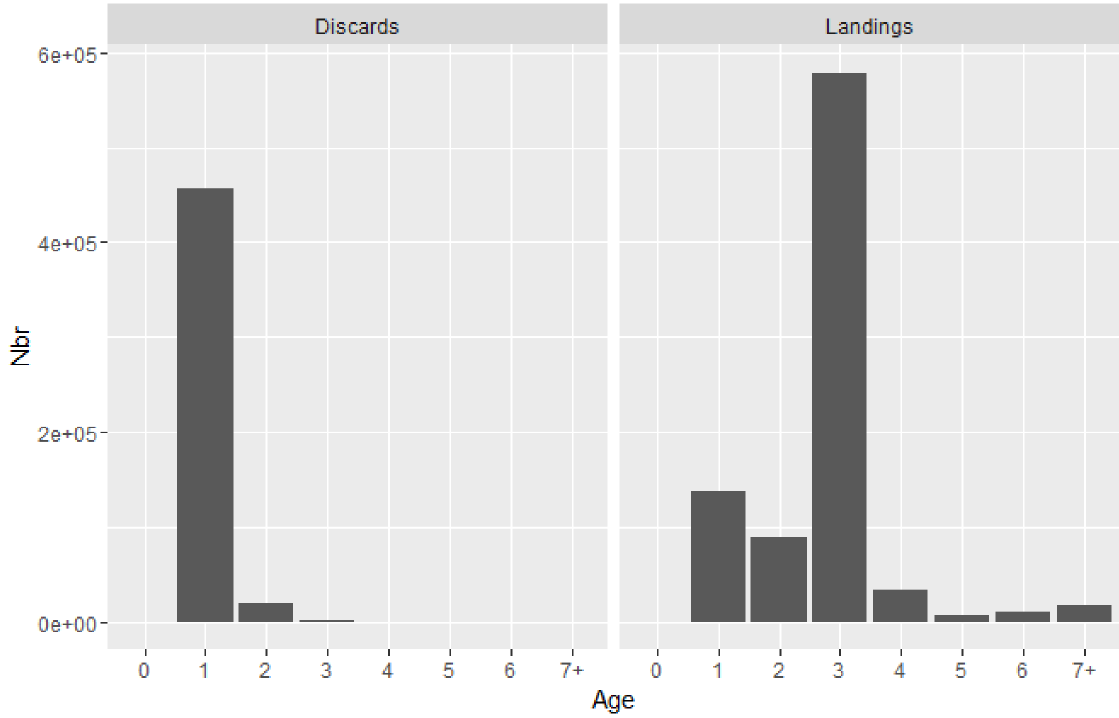


Figure 9.3.d. Cod in Divisions 7.e–k 2016. Raised United Kingdom 2016 landings and discards length distribution - Sampled strata only.



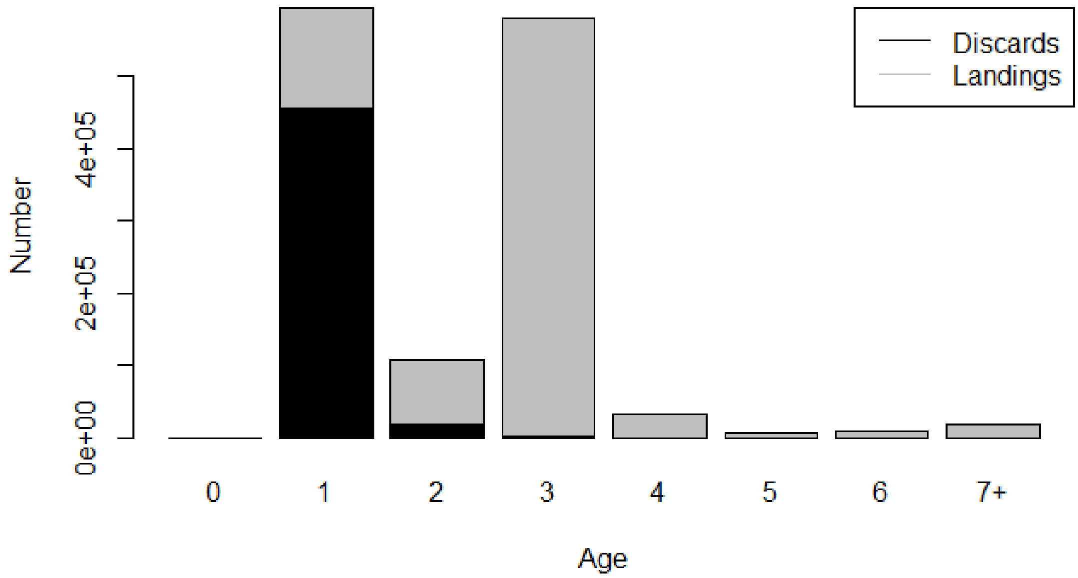


Figure 9.4. Cod in Divisions 7.e–k 2016. Raised age distribution of the catches (landings and discards).

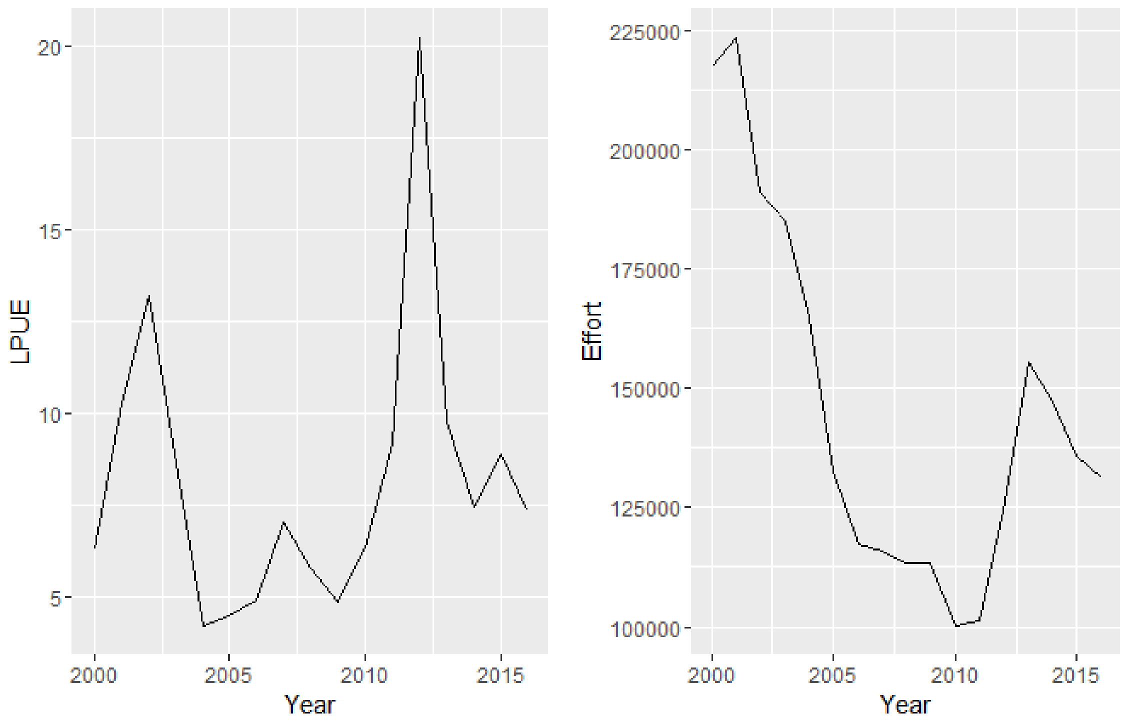


Figure 9.5a. Cod in Divisions 7.e–k. Time-series of landings, effort, lpue for the French fleets. Units: landings in tonnes, Effort in days fished and lpue in Kg/day.

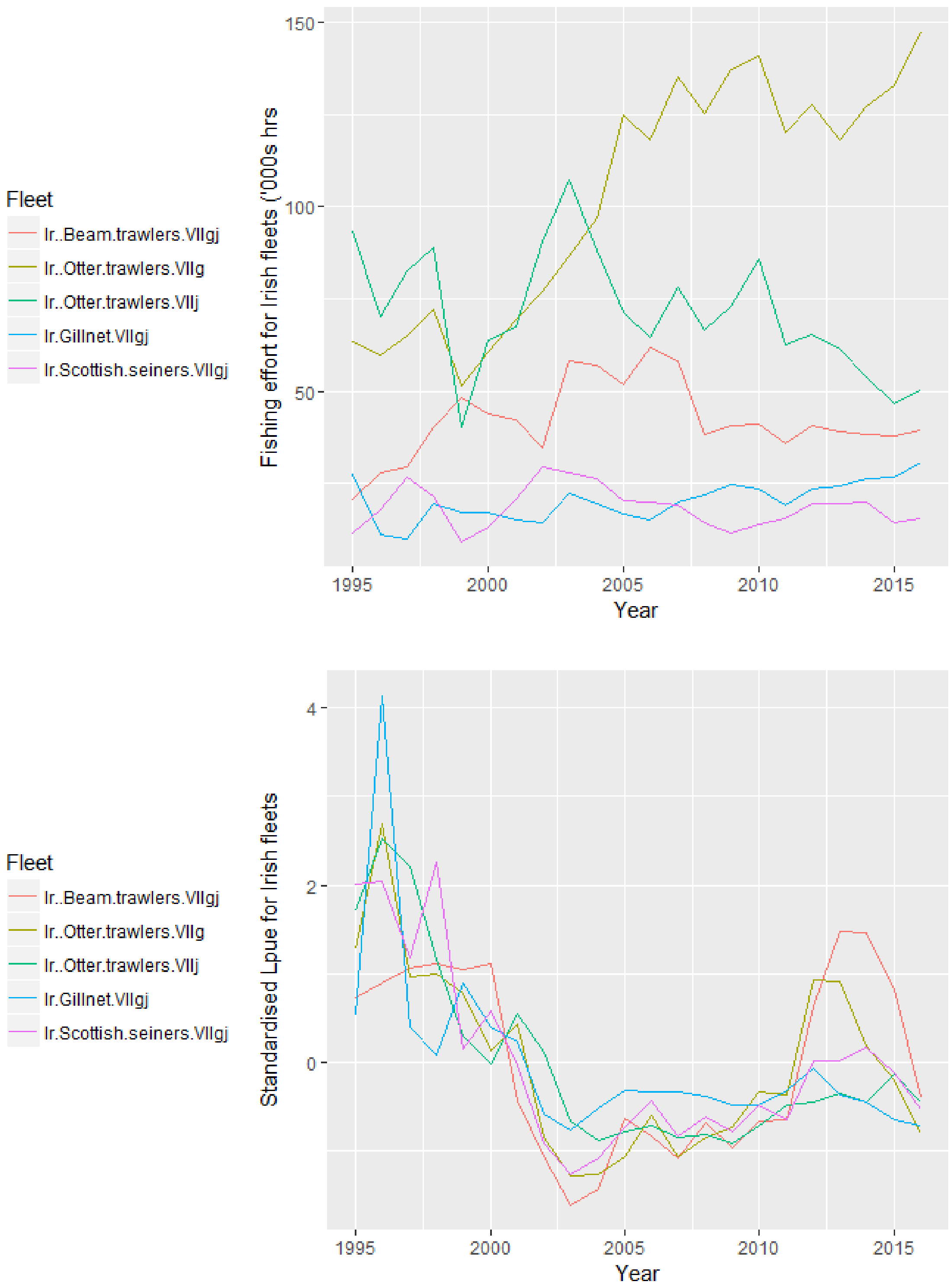
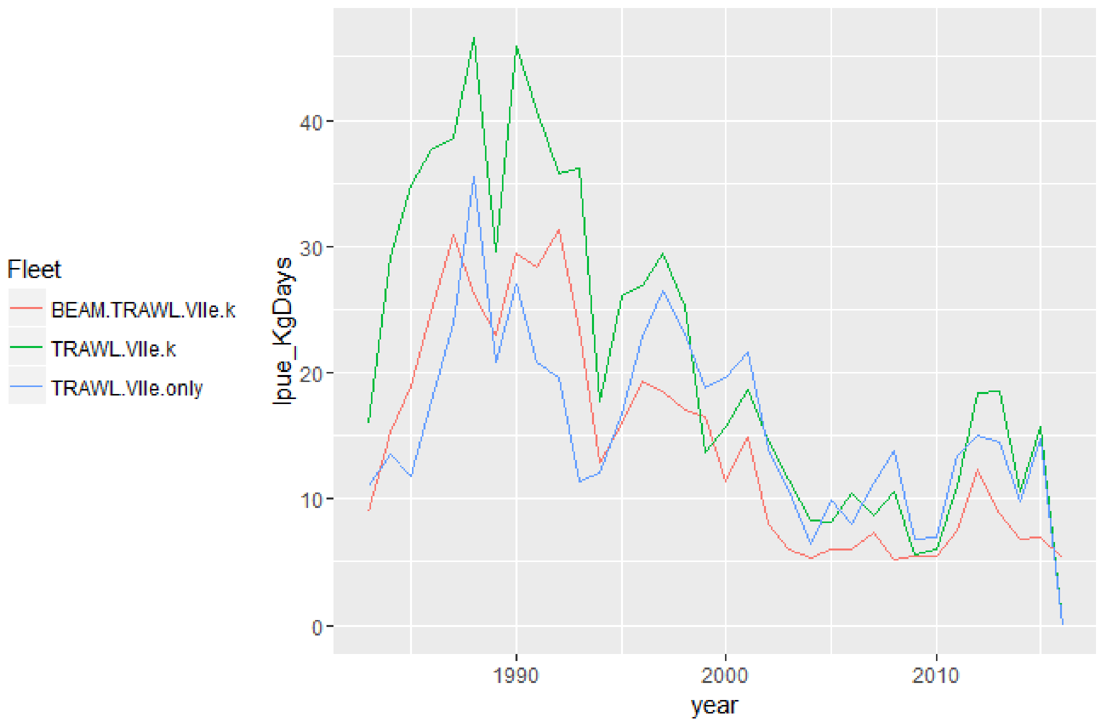


Figure 9.5b. Cod in Divisions 7.e–k. Time-series of landings, effort, lpue for the Irish fleets. Units in tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.



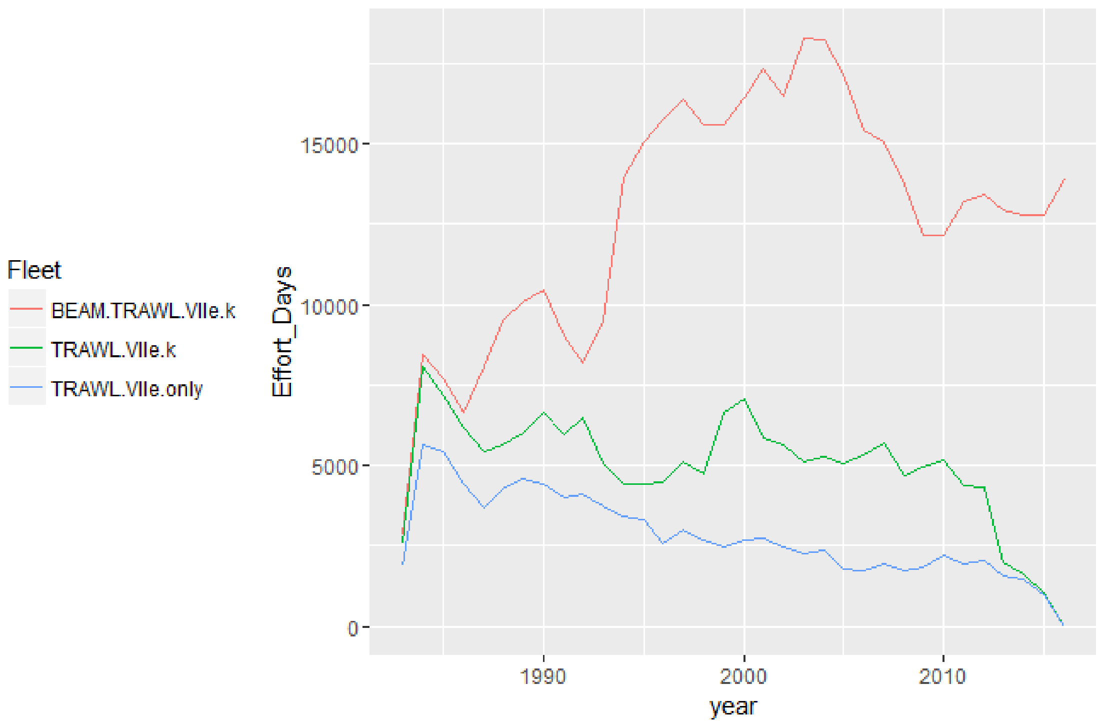


Figure 9.5c. Cod in Divisions 7.e–k. Time-series of landings, effort, lpue for the UK fleets. Units: landings in tonnes, Effort in days fished and lpue in Kg/day.

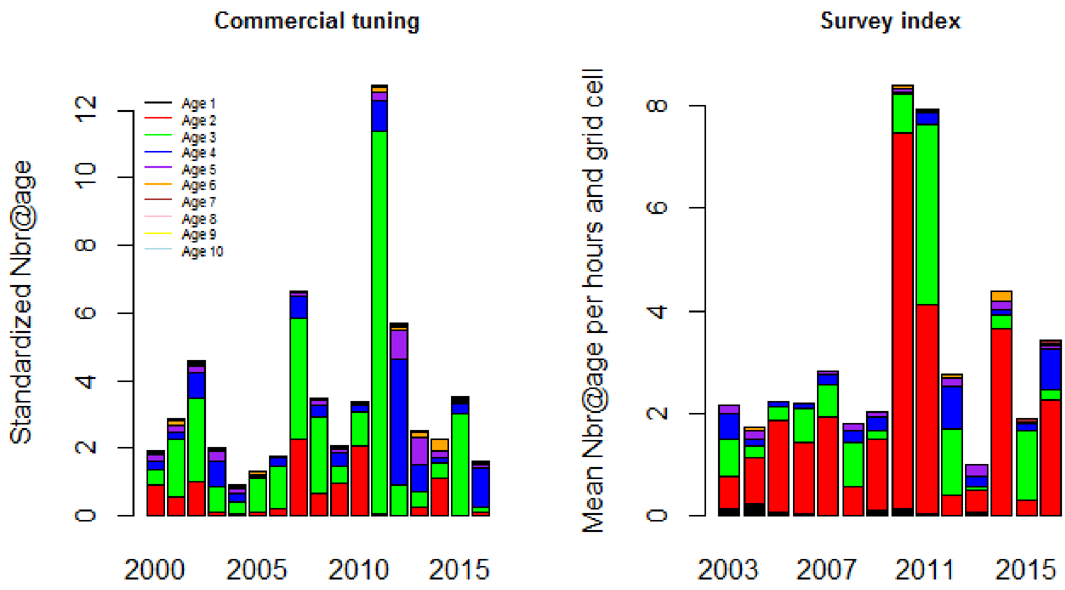
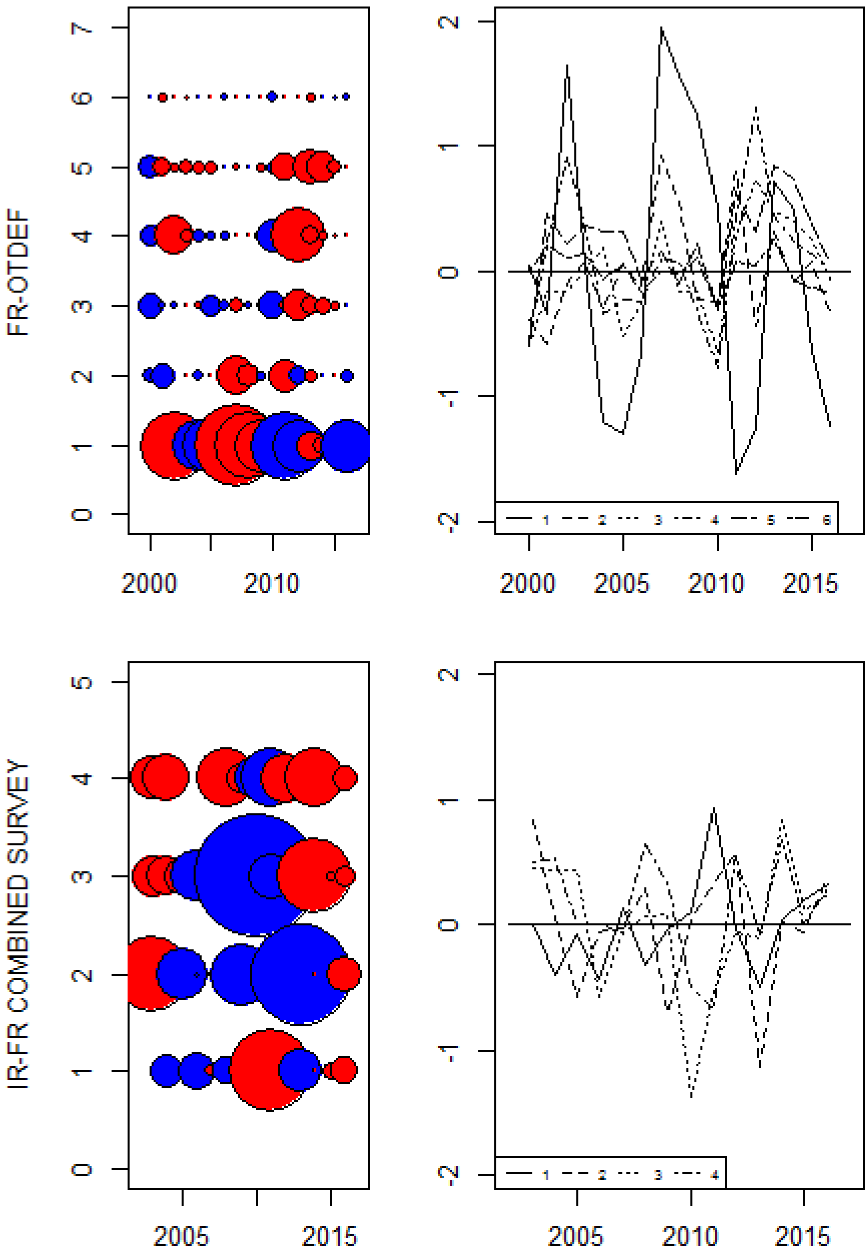


Figure 9.6. Cod in Divisions 7.e–k. Tuning indices used in the assessment. Commercial tuning fleet corresponds to French OTDEF Q2+3+4 where total number-at-age are plotted. The survey index is a combined index based on both French IR-GFS and FR-Evhoe Q4 data where mean number-at-age per hour and grid cell are plotted.


FR-OTDEF
IR-FR COMBINED SURVEY
1 2 3 4 5 6
1 2 3 4

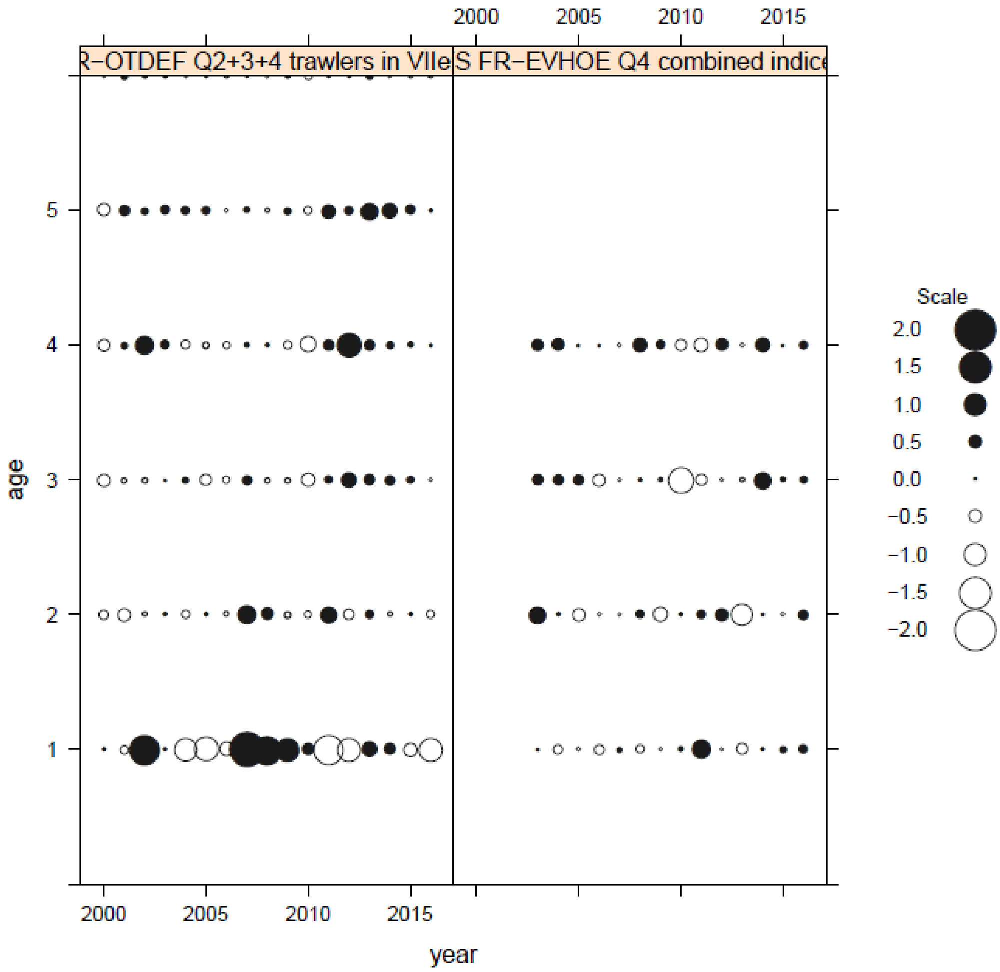


Figure 9.7. Cod in Divisions 7.e–k. Final assessment. Residuals (Left panel: French OTDEF demersal tuning fleet; Right Panel: Combined survey indices).

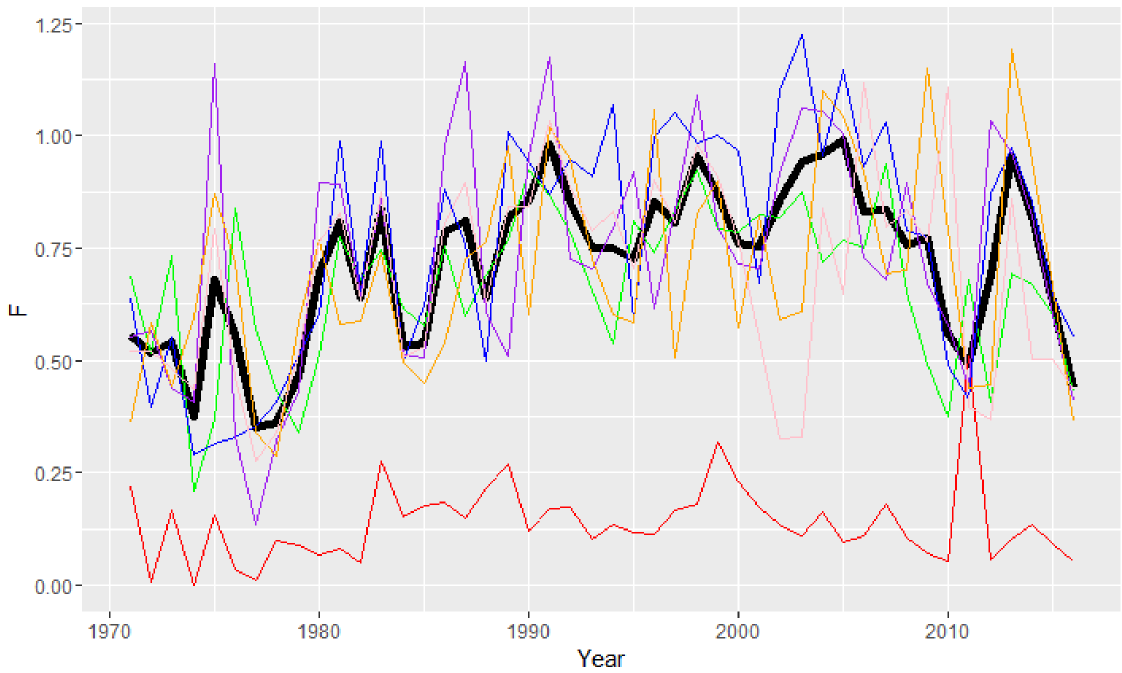


Figure 9.8. Cod in Divisions 7.e–k. Final XSA outputs. Fishing mortality. Fbar=Thick balck line. Age1=red, Age2=green, Age3=blue, Age4=purple, Age5=orange, Age6=brown, Age7=pink. Age 0 are not included in the assessment.

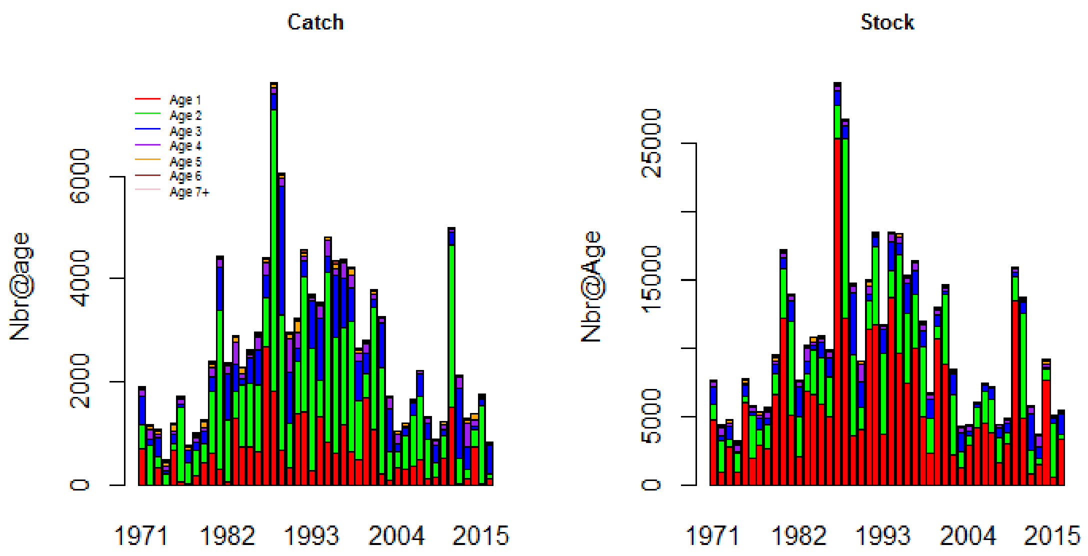


Figure 9.9. Cod in Divisions 7.e–k. Final XSA outputs. Catch and Stock number-at-age. Age 0 are not included in the assessment.

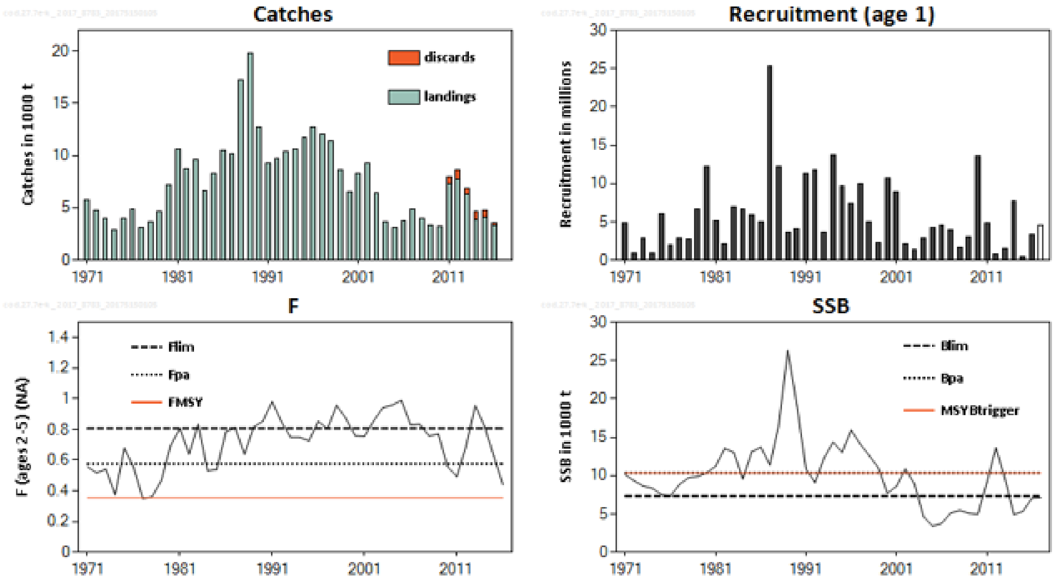


Figure 9.10. Cod in Divisions 7.e–k. Final XSA outputs. Summary plots.

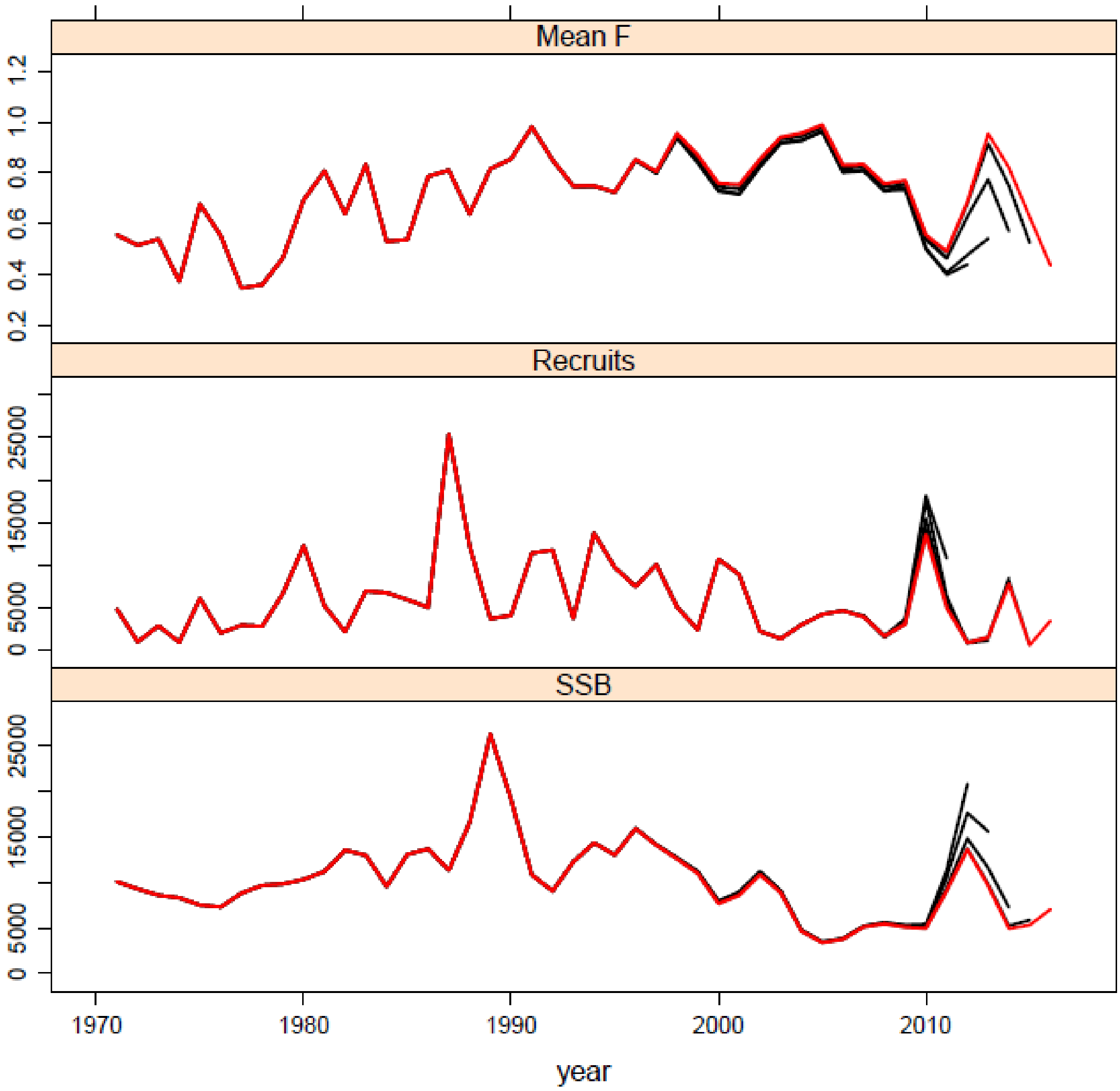


Figure 9.11a. Cod in Divisions 7.e–k. Final XSA. Retrospective plots.

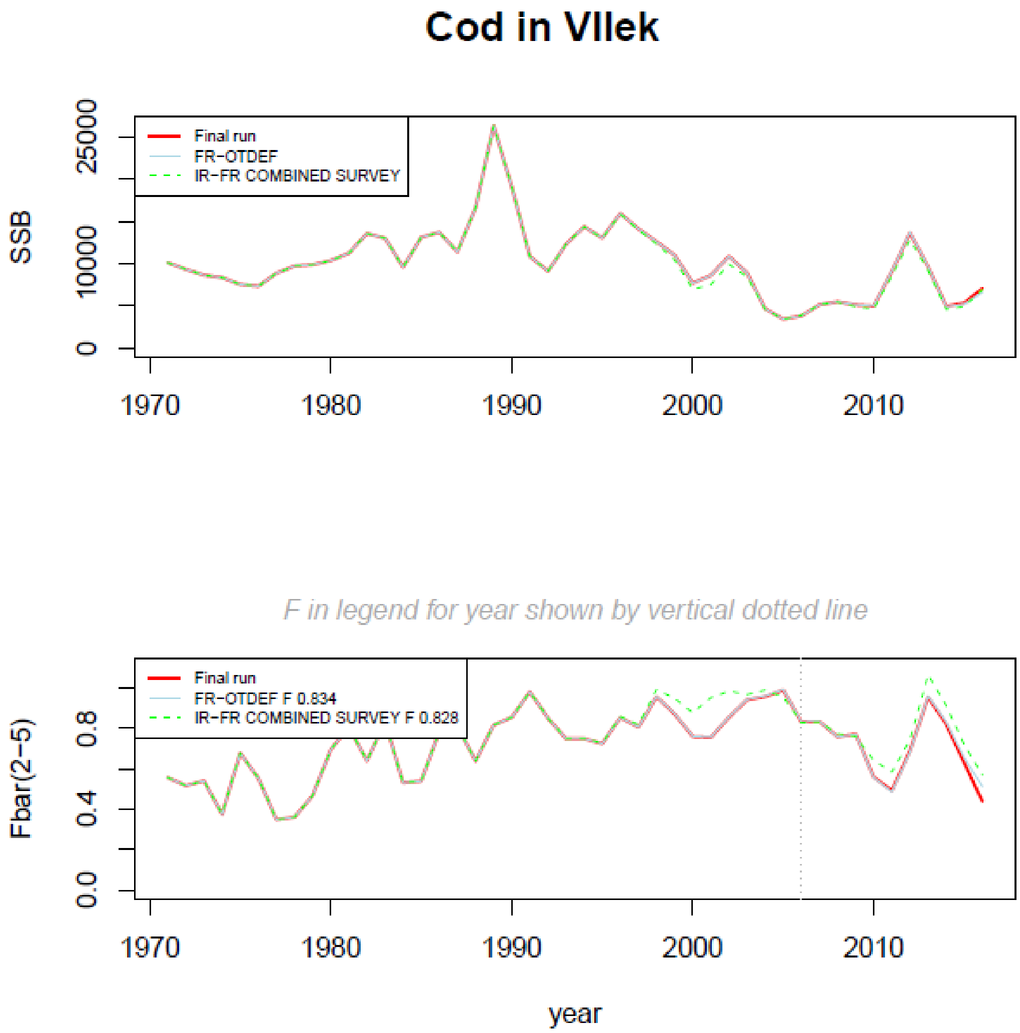


Figure 9.11b. Cod in Divisions 7.e–k. Final XSA. Comparison between runs (runs with the two tuning indices, with only the survey index and with only the commercial tuning index).

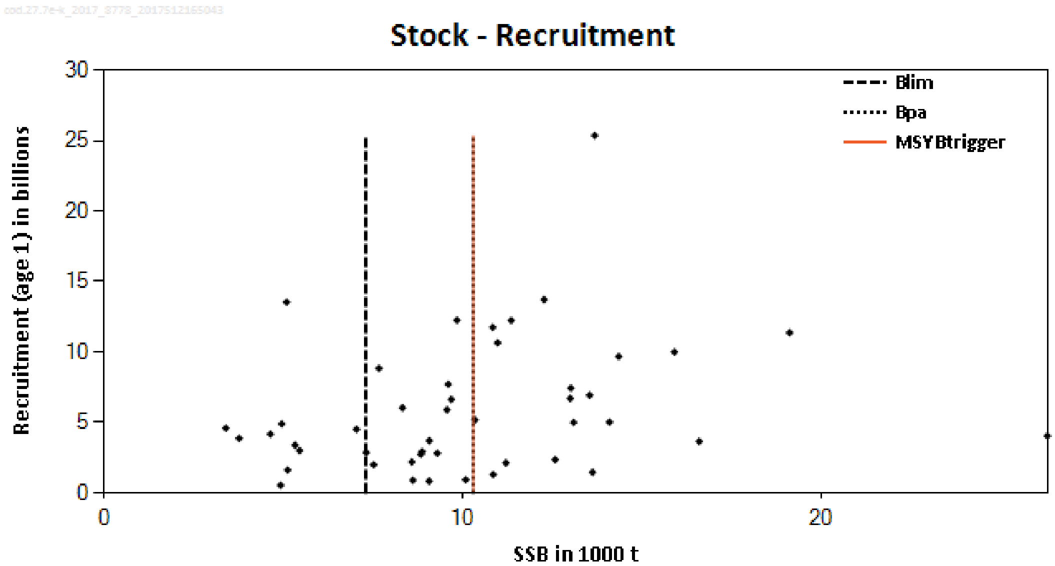


Figure 9.12. Cod in Divisions 7.e–k. Stock–recruitment plots and yield per recruits information yield per recruit not provides this year by sag outputs.

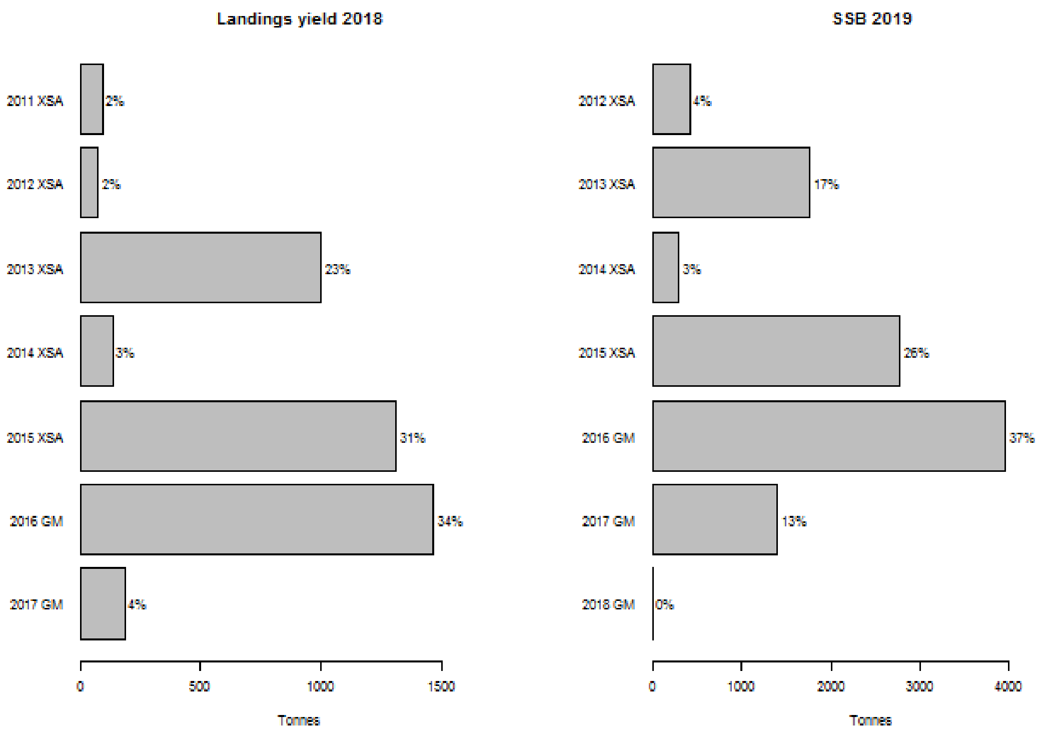


Figure 9.13. Cod in Divisions 7.e–k. Forecast yield in 2018 and SSB 2019.

9.11 Audit of Cod 27.7.e–k

Date: 26th May 2017

Auditor: Pia Schuchert

General

For single stock summary sheet advice

- Assessment type: update
- Assessment: XSA
- Forecast: Short-term Forecast
- Assessment model: XSA
- Data issues: Catch data only
- Consistency: XSA as last year
- Stock status: SSB has been below MSY $B_{trigger}$ since 2000 and is improving slowly since 2014. Fishing pressure is above F_{MSY} but has been declining in the past two years. Recruitment has been around average for the last few years.
- Management Plan: None

General comments

Well written report, clear and concise

Technical comments

Assessment follows the stock annex

Conclusions

The assessment has been performed correctly

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? YES
- Is the assessment according to the stock annex description? YES
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

10 Haddock in Division 6.b (Rockall)

Type of assessment in 2017: Update assessment

The current assessment is an update of last year's assessment. 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 2017

ICES advice applicable to 2017 can be found here:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/had-rock.pdf

10.1.1 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 2016 and 2017

The EU TAC for 6.b, 12 and 14 was set at 3225 t in 2016 (a 25% increasing compared to TAC for 2015).

Species:	Haddock *Melanogrammus aeglefinus*	**Zone:**	Union and international waters of VIb, XII and XIV (HAD/6B1214)
Belgium	7		
Germany	24		
France	332		
Ireland	353		
United Kingdom	2 509		
Union	3 225		
TAC	3 225		Analytical TAC

The EU TAC for 6.b, 12 and 14 was set at 4690 t in 2017 (a 45% increasing compared to TAC for 2016).

Species:	Haddock *Melanogrammus aeglefinus*	**Zone:**	Union and international waters of VIb, XII and XIV (HAD/6B1214)
Belgium	10		
Germany	36		
France	494		
Ireland	411		
United Kingdom	3 739		
Union	4 690		
TAC	4 690		Analytical TAC Article 7(2) of this Regulation applies

The ICES advice, agreed TAC for EU waters, and WG estimates of landings during 2002–2016 are 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	< 1.30		Reduce F below 0.2		3.0
2003	-		Lowest possible F		6.1
2004	-		Lowest possible F [b]	0.702	6.3
2005	-		Lowest possible F [b]	0.702	5.2
2006	-		Lowest possible F [b]	0.597	2.8
2007	< 7.10		Reduce F below F_{PA} [b]	4.615	3.3
2008	< 10.64		Keep F below F_{PA} [b]	6.916	4.2
2009		< 4.3	No long-term gains in increasing F [b]	5.879	3.8
2010		< 3.3	Little gain on the long-term yield by increasing F [b]	4.997	3.4
2011		<2.7	Reduction in F is needed to keep SSB to above B_{PA} in 2012	3.748	1.9
2012		< 3.3	MSY approach	3.300	0.7
2013	0	0	No directed fisheries, minimize bycatch and discards	0.99	0.8
2014	<1.62[c]	<0.98	MSY approch	1.21	1.7
2015	<4.31	<2.93	MSY approch	2.58	2.5
2016	< 3.932	< 3.225#	MSY approach	3.225	2.6
2017	≤ 4.69	≤ 4.13	MSY approach	4.690	

Before 2014 TAC was set for Divisions 6.a and 6.b (plus Vb1, 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 12 and 14. 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 are, including international waters of Rockall, was established a ban on discards.

Fishery in 2016

Russian fishery in 2016

Directed fishing of haddock in Rockall by Russian vessels was not conducted in 2016.

Scottish fishery in 2016

There were 22 Scottish vessels fishing in Division 6.b in 2016. Total Scottish demersal landings in 6.b in 2016 were estimated to be 2864 t, of which 1846 t were haddock (5% increase compared to 2015). Other important target species included anglerfish (*Lophius* spp.), ling, saithe and megrim. Scottish effort presented in Tables 4.3.2 and 4.3.3.

Irish fishery in 2016

Irish effort in Rockall declined in 2009–2015 (Table 4.3.2).

Landings totalling 362 t haddock were reported from Irish otter trawlers in 2016 (increased from 190 t in 2015; 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 2016

In 2008–2015 Norwegian landings of haddock at Rockall 36–66 t were reported. Total Norwegian landings 63 t of haddock at Rockall were reported in 2016. Norwegian demersal fleet fishing on the Rockall Bank consisted mainly of longliners and targeted mainly ling and tusk.

10.1.2 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 have 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 assessment BMS landings were include in total landings.

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 onboard 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. (Tables 4.3.4–4.3.7).

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.

Biological

There was no change in biological parameters compared to the 2016 assessment (see the Stock Annex).

Surveys

There is only one abundance index available for this stock the Scottish Rock-IBTS-Q3 survey (Figures 4.3.1–4.3.3). The survey is co-ordinated by IBTS and described further in the IBTS reports and Stock Annex.

The area which was covered by survey was not stable and moreover the survey coverage, has been extended in recent years (Figure 4.3.1). The 2016 indices were obtained from the standard survey area, i.e. same indices as last year's for the final run (Figure 4.3.2, 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 4.3.4–4.3.6).

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 Tables 4.3.2–4.3.3. Effort data in hours from the Scottish fleets are 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 Figure 4.3.8. The WG decided that the commercial cpue and lpue data, that 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.

10.1.3 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:

The same software was used as in the last year's assessment (XSA from Lowestoft suite of VPA programs).

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: 1991–2016

Age range: 1–7+

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

Year range: 1991–2016

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.

Mean weights-at-age in total catch, landings, discards and stock are shown in Tables 4.3.13–4.3.16. The mean weights-at-age in the stock are assumed to be the same as the catch weights. In 2012, the discard rate was relatively low and a small number of samples of discarded haddock were collected (especially for older ages). As a result, mean weights-at-age 3 and 7+ in discards were higher in 2012 compared to previous years (Figure 4.3.12). This increase in mean weight-at-age 3 and 7+ was observed in the Scottish samples. Mean weights and accordingly numbers of Scottish discards at-age 3 and 7+ for 2011 has been recalculated using linear regression by analogy with haddock 6.a as in last year's assessment (Figure 4.3.12). Given the low numbers of discards, these recalculations did not significantly affect the mean weights-at-age of the total catch.

Mean weight-at-age 6 in landings was significant higher in 2012 compared to previous years (Figure 4.3.12). Mean weights and accordingly numbers of landings at-age 6 for 2012 have been recalculated using linear regression (Figure 4.3.12).

In 2014 for runs weight-at-age in landings was used same as weight-at-age observed in samples without recalculations.

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.

In 2016 mean weight-at-age in catches was higher compare to previous years. It gave not real increasing of mean weight-at-age in stock because the mean weights-at-age in the stock are assumed to be the same as the catch weights. To mitigate against this a five year mean was used for weight-at-age in stock in 2016.

The mean weights-at-age in the total catch (including discards) and in the stock are shown in Figure 4.3.13.

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. But 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 catch by age show that these values are much less variable when discards are included (Figures 4.3.14–4.3.20). Data on catches, landings and discards-at-age are given in Tables 4.3.10–4.3.12.

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 and 4.3.23.

A SURBA 3.0 run was carried out to analyse the survey data. Previous working groups have concluded that the first three years of the survey should not be used in assessments and that age 0 data were a poor indicator of year-class strength. Here, the runs were actually conducted using the survey data from 1991 onwards to be consistent with the period over which the catch-at-age assessment could be run (the settings: lambda = 1.0, reference age = 3). A summary of the results are shown in Figure 4.3.25. SSB shows a declining trend from 1995, an increase in 2003–2004 and a general decrease in subsequent years. The estimates of the temporal component of Z are very noisy, but indicate a steep decline between 2000 and 2003 followed by an upward trend. Retrospective analysis showed consistent estimation of SSB and Z (2–5) (Figure 4.3.26).

Comparative scatter plots of log index at-age are shown in Figure 4.3.27. 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 4.3.28. Adjusted survey cpue against XSA population estimates are shown in Figures 4.3.30 and 4.3.31. The analysis of residuals and retrospective analysis (Figures 4.3.31 and 4.3.32) 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 and 2003 indicated that using shrinkage values of more than 0.5 improved the retrospective curves and showed convergence. In this year's analysis, only 22 years data were available for the retrospective analysis, but a good year-to-year consistency was obtained. Dynamics of fishing mortality-at-age are presented in Figure 4.3.34. The final XSA results are given in Tables 4.3.18–4.3.20. The final XSA and SURBA results are compared in Figure 4.3.35. The SURBA estimates are more variable, but there is a good overall consistency between estimates by the two methods.

Summary plots from the final XSA assessment are shown in Figure 4.3.36.

Further exploratory run

Haddock of 2007–2011 year classes are poor and rare caught in commercial and survey. That leads to the high variability of assessment of their numbers. This is especially evident when was assessed the number of haddock of the poor 2011 year class by the survey. In the first years of life a generation was underestimated. However, in 2015 the survey showed that year class is stronger and no typical tendency in dynamic of the Survey indices of that year class (Tables 4.3.8 and 4.3.17 and Figure 4.3.21). Analysis showed high catchability residual for these year classes in 2012–2015 (Figure 4.3.28).

To reconstruction of the indexes 2011 year class and two points of 2010 and 2009 classes was applied the linear regression. Corrected Survey indexes presented in the Table 4.3.9 and Figure 4.3.22. The exploratory runs with revised indexes led to a decreasing of catchability residual (Figure 4.3.29). The WG concluded as last year that the run without this adjustment was more appropriate and the assessment was not overly biased by this weak year class in the index.

Comparison of final and experimental XSA runs shown in Figure 4.3.37.

Comparison with previous assessments

The estimates from this year's assessment are reasonably consistent with the assessments carried out in previous years (Figure 4.3.38). SSB in 2016 has been revised down by 18% and F in 2015 has been revised down by 96% in this year's assessment. Probably it is result of changes in selectivity pattern due to underestimating discards rate in 2013–2014 when in stock dominated haddock with small size (year class 2012).

State of the stock

The stock summary relative to reference points is plotted in Figure 4.3.36.

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} since 2014. 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.

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.

StatCam model shows good conformity between observed and predicted survey index and catch biomass. Log residuals were less than 0.4 for total survey index (Figures 4.3.39–4.3.40).

StatCam summary plots are shown in Figure 4.3.41.

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. SSB and TSB plots from the XSA and SCAA assessment are compared in Figure 4.3.42.

10.1.4 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 in number 0-group. Year classes 2013 and 2014 were below average but above levels 2008–2012 (Figure 4.3.43). 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. 2012 year class was overestimated by survey assessment of 0-group 2015 (Figure 4.3.44). It is result in increasing of uncertainty assessment because above 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 was observed strong 0-group. But in 2016, a considerable number of 0-group fish were caught during a single haul, with these individuals contributing more than 69% towards the total numbers of 0-group fish caught in the entire survey (Figure 4.3.2). That increases the uncertainty of forecasting recruitment same as in 2012.

VPA abundance for age 1 has been highly correlated with age 0 indices for 1993–2015 (Figure 4.3.44). The recruitment (age 1) in 2013–2017 was therefore estimated using RCT3 regression (Shepherd, 1997) relating survey indices to stock abundance. The recruitment in 2017 was estimated at 94 770 thousand, one of the highest values of the time-series.

For forecasting recruitment (age 1) in 2018 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=25), and N the length of the time-series (here N=21). The rank of 25th percentile for the recruitment is then 7. The 6th lowest value of the time-series corresponds to a value of 10 387 thousand in 2016.

The input data for the short-term forecast can be found in Table 4.3.21.

Catch constraint

A catch constraint is used for 2017. The assumed catch in 2016 of 6990 t is estimated based on and EU TAC of 4990 t and estimated Russian catch 2000 t. Recent EU quota up take has been high and the Russian fishery has already taken place in 2016 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 4.3.22–4.3.23.

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. To mitigate against this in the forecast a five year mean was used for weight-at-age and fishing pattern was used (as last year).

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. According that results discard ratio-at-age varies considerably from year to year. As was done last year and mean discard ratio-at-age from 2006 was used for forecasting discards in the short term (Tables 4.3.7–4.3.10; Figure 4.3.45).

STF results

Results obtained from the forecast (including discards) are given in Tables 4.3.22–4.3.23. The short-term forecast is also shown in Figure 4.3.46.

The sensitivity analysis of the forecast and probability plots for yield in 2018 and SSB in 2019.are shown in Figures 4.3.47–4.3.48. 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.

10.1.5 MSY evaluations and biological reference points

ICES carried out and evaluation of MSY and PA reference points for this stock last year 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 $B_{trigger}$	13 690 t	B_{pa}.	ICES, 2016
	F_{MSY}	0.2	Based on the peak of the median landings yield curve (WKMSYREF4). (MSY Range 0.13–0.2)	ICES, 2016
Precautionary approach	B_{lim}	6800 t	$B_{lim} = B_{loss}$, the lowest observed spawning stock estimated in previous assessments.	ICES, 2016
	B_{pa}	10 200 t	$B_{pa} = B_{lim} \times 1.5$. This is considered to be the minimum SSB required to obtain a high probability of maintaining SSB above B_{lim}, taking into account the uncertainty of assessments.	ICES, 2016
	F_{lim}	0.69	Based on a 50% probability of being above B_{lim} in a stochastic simulation with a segmented regression using breakpoint at B_{lim}	ICES, 2016
	F_{pa}	0.46	$F_{pa} = F_{lim}/1.5$	ICES, 2016
Management plan	SSB_{MGT}	10 200 t	B_{pa}	ICES, 2013
	F_{MGT}	0.2	Based on harvest control rule evaluations.	ICES, 2013

10.1.6 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, were considered the necessary adjustments required to the draft plan. 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.

By NEAFC opinion the measures to reduce discards for whole area distribution of stock need to develop and to implement on 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).

10.1.7 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 uncertainty in recent years as catch and sampling levels have declined to low levels. In the catch options five-year average values were used and a catch constraint applied in the intermediate year.

10.1.8 Recommendation for next benchmark

In recent years WGCSE have highlighted an increasing number of issues to be addressed when this stock is benchmarked.

1) There are concerns over the accuracy of landings statistics from Rockall in earlier years.

2) The determination of the fishing mortality for last strong year class (2005) is uncertain because same time included in plus group. An improved time-series of landings and discards for ages 7 and older is needed for this assessment. It is necessary for separate estimation of fishing mortality of haddock included in the age plus group.

3) 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.

4) Haddock poor year classes 2007–2011 are rare in samples this leads to higher variability in catch and survey estimates of those year classes. Analysis showed high catchability residual for year classes 2009–2011 in 2012–2015. The linear regression was proposed to reconstruction of the indexes these year classes. Analysis on the possibility of applying proposed method of reconstruction of the indexes of those year classes need.

5) 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.

6) In 1999 and 2011 the gear and tow duration were changed on the Scottish survey. Analysis of that changing on stock assessment needed.

7) There are doubts on the level of agreement of age reading by international experts.

8) 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.

9) The survey covers only part of the currently known distribution area of haddock that raises uncertainty in the assessment.

10) The main conclusion of WGCSE is that a longer time-series of available landings and discard data is needed before progress can be made towards the next benchmark assessment of this stock.

11) 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.

12) It is recommended to analyse the opportunity of using new estimation models including Statistical catch-at-age analysis which could improve the quality of the assessment. Finally, it would be beneficial to develop and introduce standardization methods for reading the age for haddock.

No timeframe for the next benchmark could be proposed at this stage.

10.1.9 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 a 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). It would be beneficial to develop and introduce into fisheries practice measures aimed at preventing discards of haddock. 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).

10.1.10 References

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Table 4.3.1. Nominal catch (tonnes) of haddock in Division 6.b, 1996–2016, as officially reported to ICES.

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016[5]
Faroe Islands	-	-	-	-	n/a	n/a	-	-	-	-	2	2	16	-	42	2	53	-	<1	<1	-
France	-	-	-		5	2	-	1	-	-	-	-	-	-	-	<1	-	-	<1	-	-
Iceland	-	-	-	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	747	895	704	1,021	824	357	206	169	19	105	41	338	721	352	169	123	31	105	94	190	362
Norway	24	24	40	61	152	70	49	60	32	33	123	84	36	71	65	40	48	121	41	66	63
Portugal	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Russian Federation	-	-	-	458	2,154	630	1,630	4,237	5,844	4,708	2,154	1,282	1669	55	198	-	1	4	388	136	-
Spain	1	22	21	25	47	51	7	19	-	-	5	-	-	-	-	-	-	-	-	-	
UK (E, W & NI)	293	165	561	288	36	-	-	56	-	-	-	-	-	-	-	-	-	-	-	-	
UK (Scotland)	5,753	4,114	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]	2,585[3]
Total	6,818	5,220	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	3,009
Unallocated catch	-543	-591	-599	-851	-357	-279	299	94	139	1	0	0	0	-192	0	0	0	0	0	0	0
WG estimate	6,275	4,629	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	3,009

[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).

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

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 at Rockall (see the Section Cod 6.b).

YEAR	EFFORT(KWDAYS)
2003	2 504 466
2004	1 842 103
2005	1 217 357
2006	1 011 354
2007	1 060 551
2008	1 124 197
2009	1 631 239
2010	1 744 452
2011	1 565 753
2012	901 552
2013	532 767
2014	668 665
2015	563 098
2016	514 486

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	Discards	Retained Catch	Discards	Retained 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
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
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	
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

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
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
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
58		1.9		3.1		404.8		8962		16511		9506

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
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		
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 2013-2016.

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	-	-	-	
		Discards	163346	153742	88894	402	-	-	-
	Ireland	Landings	-	27955	138593	278405	3345	2294	8634
		BMS landings	-	-	-	-	-	-	-
		Discards	23629	177594	287589	108446	-	-	-

*** 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. Final runs.

HADDOCK WGCSE 2015 ROCKALL
101
SCOGFS
1991 2016
1 1 0.66 0.75
0 8

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**	**5634**	**3304**	**28**	**28**	**16**	2	19
1	67096	**1576**	**1483**	**2064**	**1526**	**11**	**1**	5	2

Table 4.3.9. Haddock in 6.b. Exploratory runs. Corrected tuning data available from the Scottish groundfish survey conducted in September. In bold, the data used in the assessment.

HADDOCK WGCSE 2015 ROCKALL
101
SCOGFS
1991 2015
1 1 0.66 0.75
0 8

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	*71*	**17**	**96**	**22**	**42**	**88**	**607**	4	4
1	39619	*55*	**12**	**73**	**14**	**75**	**50**	635	9
1	6035	**14179**	*39*	**8**	*36*	**9**	**11**	23	166
1	3044	**7232**	**4692**	*23*	**0**	**13**	**0**	11	10
1	1997	**2908**	**5634**	**3304**	*7*	*6*	**16**	2	19
1	67096	**1576**	**1483**	**2064**	*1526*	*11*	**1**	5	2

Table 4.3.10. 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	5656	13228	18884
1992	11418	55964	67383	5321	11871	17192
1993	8767	44656	53423	4781	9853	14634
1994	11400	46628	58028	5732	11023	16755
1995	11784	35467	47251	5587	9168	14756
1996	14066	41506	55572	7072	9356	16428
1997	9966	26980	36946	5167	5894	11061
1998	9034	47831	56865	4986	10862	15848
1999	12930	52881	65811	5356	11062	16418
2000	15999	26033	42031	5444	6609	12053
2001	5361	9222	14583	2123	1535	3658
2002	11167	21899	33066	3118	4152	7270
2003	24409	25087	49496	5969	5521	11490
2004	22705	3989	26694	6438	883	7321
2005	19505	1877	21382	5189	505	5694
2006	9605	1667	11272	2756	386	3142
2007	8936	12261	21197	3348	2242	5590
2008	10209	7603	17812	4221	2100	6321
2009	6709	4765	11474	3237	1557	4794
2010	5265	878	6144	3404	306	3710
2011	3156	389	3545	1905	152	2057
2012	749	44	793	711	16	727
2013	782	55	6323	825	1143	1968
2014	2862	1378	4240	1675	274	1949
2015	4097	2294	6391	2446	527	2973
2016	3830	1003	4833	2585	301	2886

[1] **Landings and discards.**

Table 4.3.11. Haddock in 6.b. International catch (landings and discards) numbers-(*103) at-age.

AGE	YEAR										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	21186	16084	11178	8170	2749	12096	9957	14224	17282	8222	7667
2	33847	24711	19375	20623	9831	18811	10535	19807	21949	12581	1961
3	15189	18584	15494	17868	21585	10911	5388	10173	12203	10697	1815
4	5341	5361	4938	8210	9756	9612	4098	4763	5499	4917	1018
5	1704	1761	1617	2449	2464	3299	5002	3740	3419	2050	1038
6	346	676	461	476	787	751	1758	2767	2684	1498	484
+gp	522	206	359	233	79	92	207	1391	2776	2066	601
TOTAL	78134	67383	53423	58028	47251	55572	36945	56865	65811	42031	14583

AGE	YEAR											
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	13364	6576	932	1061	2880	1491	476	223	0.05	4	4	5606
2	11119	23606	4112	3723	1475	9829	2207	707	118	59	6	51
3	4536	14559	10282	7420	1626	3605	11437	1237	264	107	156	11
4	2445	2063	9212	8124	2414	1503	1291	8046	426	186	63	43
5	898	1285	1386	753	2291	2213	507	495	4718	188	3	9
6	260	925	296	109	436	1816	964	263	308	2725	65	46
+gp	444	483	474	193	151	741	930	504	310	276	496	556
TOTAL	33066	49496	26694	21382	11273	21198	17812	11474	6144	3545	793	6323

AGE	YEAR		
	2014	2015	2016
1	370	74	314
2	2636	2741	944
3	418	3284	2530
4	44	105	1025
5	127	7	4
6	38	68	3
+gp	607	112	13
TOTAL	4240	6391	4833

Table 4.3.11. Haddock in 6.b. International landings numbers-(*10³) at-age.

AGE	YEAR										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	87	86	28	30	1	2	1	4	245	33	399
2	6807	3642	1919	1160	146	5149	319	392	2600	3445	941
3	3011	5624	4740	5299	5205	1861	2102	1815	2994	5081	1232
4	1344	964	1157	3665	4791	4149	2155	1340	1972	3006	752
5	558	580	489	1040	1319	2347	3658	1898	1228	1295	988
6	32	364	144	66	279	473	1540	2284	1600	1176	470
+gp	464	160	290	141	43	85	192	1301	2291	1963	579
TOTAL	12302	11418	8767	11400	11784	14066	9966	9034	12930	15999	5361

AGE	YEAR											
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	657	920	197	887	2344	31	17	5	0.03	2	0	139
2	2983	8103	1765	2835	768	1220	749	11	71	23	0	12
3	3998	11001	9502	6866	1290	2709	6191	244	196	102	147	1
4	2111	1846	9119	7913	2356	1074	1164	5243	352	180	56	39
5	809	1188	1364	725	2269	1539	479	460	4078	188	1	6
6	217	878	286	98	428	1623	761	261	274	2412	65	43
+gp	392	475	472	182	150	740	848	486	294	249	480	542
TOTAL	11167	24409	22705	19505	9605	8936	10209	6709	5265	3156	749	782

AGE	YEAR		
	2014	2015	2016
1	202	4	127
2	1425	656	613
3	418	3145	2153
4	44	105	916
5	127	7	4
6	38	68	3
+gp	607	112	13
TOTAL	2862	4097	3830

Table 4.3.12. Haddock in 6.b. International discards numbers (*10³) at-age.

AGE	YEAR										
	1991	1992	1993	1994	1995*	1996	1997*	1998	1999*	2000	2001*
1	21099	15998	11151	8140	2748	12094	9957	14220	17037	8189	7268
2	27040	21069	17456	19464	9685	13662	10216	19415	19349	9136	1020
3	12178	12961	10755	12570	16379	9051	3287	8357	9210	5616	583
4	3998	4397	3781	4545	4965	5463	1944	3423	3526	1912	266
5	1146	1182	1128	1409	1145	952	1344	1842	2191	755	50
6	313	312	317	410	509	278	218	483	1084	322	15
+gp	58	46	69	91	36	7	15	91	485	103	21
TOTAL	65832	55964	44656	46628	35467	41506	26980	47831	52881	26033	9222

AGE	YEAR											
	2002	2003	2004	2005	2006	2007	2008	2009	2010*	2011*	2012*	2013*
1	12706	5655	736	174	536	1459	458	218	0.02	2	4	5468
2	8136	15503	2346	888	707	8610	1458	696	47	36	6	39
3	539	3558	781	554	336	896	5246	993	68	4	9	10
4	334	217	93	210	58	429	128	2803	74	6	7	4
5	89	97	22	28	22	674	28	36	640	1	2	3
6	43	48	10	11	8	193	203	2	33	313	0.04	4
+gp	51	8	2	11	1	1	82	18	16	27	16	14
TOTAL	21899	25087	3989	1877	1667	12261	7603	4765	878	389	44	5541

AGE	YEAR		
	2014*	2015*	2016*
1	168	70	187
2	1211	2085	331
3	0	139	377
4	0	0	109
5	0	0	0
6	0	0	0
+gp	0	0	0
TOTAL	1378	2294	1004

*** 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	0.679
1992	0.133	0.239	0.318	0.362	0.423	0.567	0.844
1993	0.137	0.238	0.334	0.400	0.493	0.503	0.874
1994	0.153	0.233	0.319	0.420	0.469	0.477	0.721
1995	0.118	0.222	0.309	0.401	0.501	0.460	0.843
1996	0.136	0.278	0.314	0.395	0.553	0.575	0.763
1997	0.136	0.240	0.322	0.382	0.512	0.634	0.944
1998	0.141	0.250	0.308	0.354	0.436	0.546	0.662
1999	0.138	0.208	0.272	0.334	0.379	0.483	0.618
2000	0.189	0.250	0.267	0.321	0.382	0.451	0.707
2001	0.133	0.257	0.320	0.416	0.432	0.521	0.713
2002	0.135	0.239	0.237	0.325	0.509	0.580	0.753
2003	0.153	0.203	0.256	0.350	0.384	0.424	0.753
2004	0.147	0.198	0.244	0.294	0.444	0.609	0.753
2005	0.114	0.197	0.234	0.311	0.458	0.599	0.806
2006	0.093	0.198	0.245	0.329	0.441	0.595	0.787
2007	0.114	0.186	0.266	0.296	0.387	0.497	0.569
2008	0.199	0.241	0.291	0.437	0.571	0.669	0.932
2009	0.248	0.288	0.339	0.391	0.668	0.513	1.005
2010	0.100	0.352	0.460	0.437	0.560	0.741	0.902
2011	0.198	0.280	0.422	0.454	0.701	0.573	0.785
2012	0.263	0.295	0.544	0.708	0.529	0.817	1.088
2013	0.207	0.447	0.287	0.843	0.968	0.824	1.226
2014	0.117	0.285	0.268	0.488	1.031	1.099	1.396
2015	0.105	0.256	0.605	0.362	1.169	0.949	1.481
2016	0.308	0.468	0.612	0.735	1.576	1.808	2.615

Table 4.3.15. 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	0.000	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	0.274	0.338	0.390	0.440	0.505	0.601	0.665
2000	0.272	0.404	0.379	0.407	0.473	0.513	0.740
2001	0.274	0.426	0.383	0.518	0.426	0.518	0.677
2002	0.240	0.422	0.416	0.541	0.565	0.649	0.818
2003	0.100	0.164	0.246	0.350	0.387	0.423	0.758
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	0.824
2006	0.084	0.167	0.223	0.327	0.440	0.598	0.789
2007	0.096	0.238	0.275	0.322	0.450	0.523	0.570
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	1.020
2010	0.052	0.428	0.520	0.459	0.591	0.990	1.451
2011	0.214	0.329	0.427	0.459	0.702	0.595	0.817
2012	0.189	0.368	0.555	0.747	0.912	0.817	1.110
2013	0.507	0.531	0.665	0.887	1.358	0.836	1.233
2014	0.148	0.345	0.268	0.488	1.031	1.099	1.396
2015	0.115	0.349	0.617	0.362	1.169	0.949	1.481
2016	0.407	0.571	0.662	0.776	1.576	1.808	2.615

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	0.478
1992	0.133	0.217	0.258	0.298	0.330	0.342	0.464
1993	0.137	0.220	0.260	0.307	0.346	0.359	0.462
1994	0.153	0.226	0.263	0.308	0.345	0.356	0.458
1995	0.118	0.220	0.276	0.325	0.341	0.329	0.379
1996	0.136	0.218	0.276	0.326	0.370	0.348	0.524
1997	0.136	0.238	0.272	0.312	0.372	0.442	0.568
1998	0.141	0.248	0.267	0.291	0.327	0.336	0.436
1999	0.139	0.212	0.255	0.288	0.313	0.318	0.410
2000	0.189	0.267	0.289	0.311	0.330	0.334	0.462
2001	0.135	0.247	0.294	0.344	0.412	0.440	0.495
2002	0.137	0.254	0.308	0.335	0.398	0.338	0.367
2003	0.161	0.223	0.287	0.342	0.337	0.440	0.510
2004	0.148	0.218	0.282	0.343	0.324	0.371	0.469
2005	0.171	0.240	0.298	0.357	0.387	0.473	0.506
2006	0.132	0.233	0.334	0.420	0.495	0.435	0.435
2007	0.115	0.179	0.239	0.232	0.244	0.280	0.406
2008	0.202	0.264	0.279	0.370	0.351	0.358	0.392
2009	0.246	0.287	0.319	0.343	0.360	0.662	0.593
2010	0.161	0.239	0.289	0.335	0.359	0.404	0.458
2011	0.178	0.248	0.300	0.302	0.406	0.403	0.481
2012	0.263	0.295	0.356	0.372	0.340	0.733	0.440
2013	0.202	0.421	0.228	0.397	0.247	0.679	0.980
2014	0.080	0.216	-	-	-	-	-
2015	0.104	0.227	0.338	-	-	-	-
2016	0.241	0.276	0.325	0.393	-	-	-

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	0.679
1992	0.133	0.239	0.318	0.362	0.423	0.567	0.844
1993	0.137	0.238	0.334	0.400	0.493	0.503	0.874
1994	0.153	0.233	0.319	0.420	0.469	0.477	0.721
1995	0.118	0.222	0.309	0.401	0.501	0.460	0.843
1996	0.136	0.278	0.314	0.395	0.553	0.575	0.763
1997	0.136	0.240	0.322	0.382	0.512	0.634	0.944
1998	0.141	0.250	0.308	0.354	0.436	0.546	0.662
1999	0.138	0.208	0.272	0.334	0.379	0.483	0.618
2000	0.189	0.250	0.267	0.321	0.382	0.451	0.707
2001	0.133	0.257	0.320	0.416	0.432	0.521	0.713
2002	0.135	0.239	0.237	0.325	0.509	0.580	0.753
2003	0.153	0.203	0.256	0.350	0.384	0.424	0.753
2004	0.147	0.198	0.244	0.294	0.444	0.609	0.753
2005	0.114	0.197	0.234	0.311	0.458	0.599	0.806
2006	0.093	0.198	0.245	0.329	0.441	0.595	0.787
2007	0.114	0.186	0.266	0.296	0.387	0.497	0.569
2008	0.199	0.241	0.291	0.437	0.571	0.669	0.932
2009	0.248	0.288	0.339	0.391	0.668	0.513	1.005
2010	0.100	0.352	0.460	0.437	0.560	0.741	0.902
2011	0.198	0.280	0.422	0.454	0.701	0.573	0.785
2012	0.263	0.295	0.544	0.708	0.529	0.817	1.088
2013	0.210	0.466	0.665	0.887	1.358	0.836	1.226
2014	0.117	0.285	0.268	0.488	1.031	1.099	1.396
2015	0.105	0.256	0.605	0.362	1.169	0.949	1.481
2016	0.178	0.312	0.425	0.571	0.880	0.852	1.195

Table 4.3.17. XSA diagnostics from the assessment of Haddock in 6.b. Final runs.

Lowestoft VPA Version 3.1

4/05/2017 16:27

Extended Survivors Analysis

HADDOCK LANDISC 2004 ROCKALL

CPUE data from file had6b.tun

Catch data for 26 years. 1991 to 2016. Ages 1 to 7.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SCOGFS	1991	2016	0	6	0.66	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 4

Regression type = C
Minimum of 10 points used for regression
Survivor estimates shrunk to the population mean for ages < 4

Catchability independent of age for ages >= 5

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 4 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 24 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.185	0.202	0.295	0	0.022	0.004	0.156	0.013	0.005	0.034
2	0.172	0.459	0.522	0.251	0.064	0.043	0.066	0.101	0.121	0.079
3	0.66	0.31	0.509	0.375	0.378	0.237	0.111	1.144	0.176	0.157
4	0.829	0.526	0.374	0.328	0.496	0.4	0.095	0.857	1.06	0.076
5	0.418	0.759	0.392	0.392	0.235	0.014	0.09	0.443	0.323	0.09
6	0.428	0.323	1.271	0.453	0.414	0.118	0.277	0.666	0.45	0.186

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6
2007	9.74E+03	6.88E+04	8.25E+03	2.95E+03	7.16E+03	5.76E+03
2008	2.87E+03	6.62E+03	4.75E+04	3.49E+03	1.05E+03	3.86E+03
2009	9.63E+02	1.92E+03	3.43E+03	2.85E+04	1.69E+03	4.04E+02
2010	1.30E+03	5.87E+02	9.33E+02	1.69E+03	1.61E+04	9.34E+02
2011	1.85E+02	1.06E+03	3.74E+02	5.25E+02	9.94E+02	8.89E+03
2012	1.08E+03	1.48E+02	8.18E+02	2.10E+02	2.62E+02	6.44E+02
2013	4.33E+04	8.84E+02	1.16E+02	5.28E+02	1.15E+02	2.11E+02
2014	3.28E+04	3.03E+04	6.77E+02	8.52E+01	3.93E+02	8.61E+01
2015	1.68E+04	2.66E+04	2.25E+04	1.77E+02	2.96E+01	2.07E+02
2016	1.04E+04	1.37E+04	1.93E+04	1.54E+04	5.01E+01	1.75E+01

Table 4.3.17 cont.

Estimated population abundance at 1st Jan 2017

0.00E+00	8.22E+03	1.04E+04	1.35E+04	1.17E+04	3.75E+01

Taper weighted geometric mean of the VPA populations:

2.12E+04	1.64E+04	1.00E+04	4.76E+03	2.00E+03	9.99E+02

Standard error of the weighted Log(VPA populations) :

	1.7594	1.7577	1.6958	1.6508	1.6545	1.4193
1						

Log catchability residuals.

Fleet : SCOGFS

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.38	0.37	0.07	-0.13	0.11	0.31	-0.34	99.99	0.18	99.99
2	-0.51	0.58	0.49	-0.01	0.14	0.24	-0.49	99.99	-0.38	99.99
3	-0.61	0.49	0.55	0.43	0.45	-0.01	-0.96	99.99	-0.37	99.99
4	-0.24	0.54	0.45	0.46	0.76	-0.13	-1.21	99.99	-0.4	99.99
5	-0.29	-0.01	0.41	-0.54	0.79	-0.17	-1.01	99.99	-0.61	99.99
6	0.01	0.19	-0.06	-0.16	0.11	-0.14	-0.46	99.99	-0.28	99.99

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	-0.73	-0.16	0.07	99.99	0.39	-0.17	0.58	0.59	0.65	99.99
2	-0.94	-0.86	0.3	99.99	0.11	0.69	-0.35	0.62	0.96	99.99
3	-0.59	-1.08	-0.26	99.99	0.06	-0.16	0.3	0.04	0.94	99.99
4	-0.8	-0.89	-0.6	99.99	0.61	0.59	0.63	-0.09	-0.09	99.99
5	-0.62	-1.21	0.18	99.99	-0.57	0.89	0.07	-0.31	-1.06	99.99
6	-0.53	-0.12	0.14	99.99	0.07	0.2	-0.05	0.02	-0.5	99.99

Age	2011	2012	2013	2014	2015	2016
1	0.51	-2.4	0.38	0.05	0.01	0.02
2	0.25	0.45	-2.07	0.22	0.52	0.03
3	0.27	0.48	0.35	-1.18	0.58	0.29
4	0.32	0.07	-1.63	99.99	1.4	0.24
5	0.15	1.16	-0.08	-0.69	2.58	0.95
6	0.01	-0.07	-0.36	99.99	0.16	-0.33

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

Age	4	5	6
Mean Log q	-2.3551	-2.2634	-2.2634
S.E(Log q)	0.7307	0.8786	0.2512

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.78	2.747	3.39	0.89	22	0.66	-1.53
2	0.85	1.745	3.19	0.87	22	0.7	-2.02
3	0.9	1.277	3.03	0.9	22	0.6	-2.38

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4	1.01	-0.101	2.29	0.81	21	0.76	-2.36
5	1.4	-2.986	0.2	0.73	22	1.05	-2.26
6	0.95	1.483	2.59	0.98	21	0.21	-2.36
1							

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2015

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	8425	0.673	0	0	1	0.618	0.033
P shrinkage mean	16395	1.76				0.094	0.017
F shrinkage mean	6235	1				0.289	0.045

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8219	0.53	0.18	3	0.346	0.034

Table 4.3.17 cont.

Age 2 Catchability dependent on age and year class strength

Year class = 2014

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	10518	0.489	0.01	0.02	2	0.741	0.078
P shrinka	10015	1.7				0.067	0.082
F shrinka	9868	1				0.192	0.083

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
10356	0.43	0.02	4	0.043	0.079

Age 3 Catchability dependent on age and year class strength

Year class = 2013

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	17838	0.385	0.126	0.33	3	0.797	0.121
P shrinka	4756	1.65				0.054	0.393
F shrinka	4387	1				0.148	0.42

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
13483	0.35	0.32	5	0.911	0.157

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2012

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	16941	0.347	0.087	0.25	4	0.864	0.053
F shrinka	1108	1				0.136	0.608

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
11693	0.33	0.51	5	1.544	0.076

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2011

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	58	0.508	0.629	1.24	5	0.689	0.059
F shrinka	14	1				0.311	0.219

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
37	0.47	0.58	6	1.241	0.09

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2010

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	11	0.258	0.37	1.43	5	0.918	0.196
F shrinka	21	1				0.082	0.108

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
12	0.25	0.33	6	1.305	0.186

Table 4.3.18. Haddock in 6.b. Final XSA runs. Fishing mortality-at-age.

Run title : HADDOCK LANDISC 2004 ROCKALL

At 4/05/2017 16:28

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE											
	1	0.2417	0.1783	0.1055	0.1423	0.0508	0.2411	0.1668	0.2462	0.4995	0.3933
	2	0.6153	0.4934	0.3386	0.2885	0.2545	0.5715	0.3425	0.5818	0.7467	0.8583
	3	0.9062	0.8443	0.6706	0.605	0.5578	0.499	0.3143	0.6574	0.9013	1.0811
	4	0.9631	1.0101	0.5629	0.963	0.8082	0.5213	0.3523	0.5089	0.9513	1.2727
	5	0.4984	1.0565	1.0309	0.6121	0.9006	0.721	0.5707	0.6362	0.8713	1.2861
	6	0.7799	0.3752	0.9171	1.0456	0.4027	0.7848	1.1638	0.7339	1.5113	1.3612
+gp		0.7799	0.3752	0.9171	1.0456	0.4027	0.7848	1.1638	0.7339	1.5113	1.3612
FBAR 2- 5		0.7458	0.8511	0.6507	0.6171	0.6303	0.5782	0.395	0.5961	0.8676	1.1246

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE											
	1	0.1158	0.1577	0.1726	0.0758	0.0789	0.0371	0.1854	0.2021	0.2953	0
	2	0.1512	0.2454	0.4597	0.1553	0.485	0.15	0.1717	0.4593	0.5222	0.2506
	3	0.2738	0.6188	0.5883	0.3718	0.4627	0.405	0.6602	0.3096	0.5092	0.3749
	4	0.2566	0.7302	0.6461	0.9648	0.5701	0.2663	0.829	0.5261	0.3737	0.3278
	5	1.0872	0.3787	1.172	1.3674	0.1768	0.3074	0.4181	0.7587	0.392	0.3923
	6	1.4089	0.9215	0.8665	0.9881	0.3298	0.1471	0.4285	0.3233	1.2707	0.4532
+gp		1.4089	0.9215	0.8665	0.9881	0.3298	0.1471	0.4285	0.3233	1.2707	0.4532
FBAR 2- 5		0.4422	0.4933	0.7165	0.7148	0.4237	0.2822	0.5197	0.5134	0.4493	0.3364

		2011	2012	2013	2014	2015	2016	FBAR **-**
AGE								
	1	0.0217	0.0043	0.1562	0.0125	0.0049	0.034	0.0171
	2	0.0635	0.0434	0.0658	0.1009	0.1211	0.0793	0.1004
	3	0.3781	0.2369	0.1105	1.144	0.1762	0.1568	0.4923
	4	0.4956	0.4004	0.0949	0.8567	1.0604	0.0763	0.6645
	5	0.2348	0.0144	0.0902	0.4426	0.3233	0.09	0.2853
	6	0.4138	0.1183	0.2771	0.6656	0.4497	0.1865	0.4339
+gp		0.4138	0.1183	0.2771	0.6656	0.4497	0.1865	
FBAR 2- 5		0.293	0.1738	0.0904	0.6361	0.4203	0.1006	

Table 4.3.19. Haddock in 6.b. Final XSA runs. Stock numbers (*10³) at-age.

Run title : HADDOCK LANDISC 2004 ROCKALL

At 4/05/2017 16:28

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE											
	1	109055	108831	123425	68087	61367	62402	71614	72038	48578	27943
	2	81405	70117	74550	90938	48352	47755	40145	49623	46109	24135
	3	28168	36023	35048	43505	55793	30692	22077	23336	22706	17891
	4	9547	9318	12677	14675	19451	26149	15256	13200	9901	7549
	5	4798	2984	2778	5911	4587	7097	12712	8782	6497	3131
	6	705	2386	849	811	2624	1526	2826	5882	3806	2226
+gp		1050	722	651	389	261	184	325	2917	3836	2999
TOTAL		234728	230382	249979	224317	192435	175805	164955	175778	141433	85872

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE											
	1	77458	101235	45841	14107	15464	87273	9736	2872	963	1300
	2	15438	56480	70792	31582	10706	11701	68848	6622	1922	587
	3	8376	10865	36181	36600	22137	5397	8245	47474	3425	933
	4	4969	5215	4791	16449	20662	11410	2947	3488	28520	1685
	5	1731	3147	2057	2056	5132	9566	7158	1053	1688	16070
	6	708	478	1764	522	429	3521	5759	3858	404	934
+gp		858	801	906	820	754	1216	2328	3697	757	931
TOTAL		109537	178221	162333	102134	75284	130084	105021	69065	37677	22440

		2011	2012	2013	2014	2015	2016	2017	GMST 91-**	AMST 91-**
AGE										
	1	185	1084	43329	32849	16807	10387	0	22093	49460
	2	1064	148	884	30344	26560	13693	8219	16190	36677
	3	374	818	116	677	22458	19265	10356	9423	20702
	4	525	210	528	85	177	15416	13483	5195	9967
	5	994	262	115	393	30	50	11693	2785	4612
	6	8888	644	211	86	207	18	37	1262	2160
+gp		893	4895	2524	1362	338	84	69		
TOTAL		12923	8060	47707	65797	66576	58913	43857		

Table 4.3.20. Haddock in 6.b. Final XSA run. Summary table.

Run title : HADDOCK LANDISC 2004 ROCKALL

At 4/05/2017 16:28

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 5
1991	109055	50084	15060	5655	0.3755	0.7458
1992	108831	49286	18053	5320	0.2947	0.8511
1993	123425	53795	19143	4784	0.2499	0.6507
1994	68087	55087	23482	5733	0.2442	0.6171
1995	61367	46740	28765	5587	0.1942	0.6303
1996	62402	46671	24909	7075	0.284	0.5782
1997	71614	40918	21544	5166	0.2398	0.395
1998	72038	43395	20832	4984	0.2392	0.5961
1999	48578	32449	16154	5221	0.3232	0.8676
2000	27943	22835	11520	4558	0.3957	1.1246
2001	77458	20745	6476	1918	0.2962	0.4422
2002	101235	33918	6752	2571	0.3807	0.4933
2003	45841	34544	13160	5961	0.453	0.7165
2004	14107	23941	15614	6400	0.4099	0.7148
2005	15464	18693	14821	5191	0.3503	0.4237
2006	87273	22780	12347	2759	0.2235	0.2822
2007	9736	23938	10023	3348	0.334	0.5197
2008	2872	24134	21967	4205	0.1914	0.5134
2009	963	15199	14407	3237	0.2247	0.4493
2010	1300	12033	11697	3404	0.291	0.3364
2011	185	7221	6887	1905	0.2766	0.293
2012	1084	6912	6583	710	0.1078	0.1738
2013	43329	13484	3973	825	0.2076	0.0904
2014	32849	15116	2624	1675	0.6382	0.6361
2015	16807	22947	14383	2445	0.17	0.4203
2016	10387	23271	17150	2585	0.1507	0.1006
Arith. Mean	46701	29236	14551	3970	0.2902	0.5255
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 4.3.21. Haddock in 6.b. Detailed short-term forecast output.

MFDP version 1a												
Run: 02												
Time and date: 00:50 08.05.2017												
Fbar age range (Total) : 2-5												
Fbar age range Fleet 1 : 2-5												
Year:	2017	F multipli	0.815	Fleet1 HC	0.2479	Fleet1 DF	0.0663					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0039	334	74	0.01	855	152	94770	16869	0	0	0	0
2	0.0271	194	87	0.0547	392	112	8219	2564	0	0	0	0
3	0.2866	2231	1234	0.1146	892	278	10356	4401	10356	4401	10356	4401
4	0.4793	4563	2975	0.0623	593	229	13483	7699	13483	7699	13483	7699
5	0.1987	1886	2280	0.0338	321	94	11693	10290	11693	10290	11693	10290
6	0.3329	9	10	0.0207	1	0	37	32	37	32	37	32
7	0.3429	18	28	0.0108	1	0	69	82	69	82	69	82
Total		9236	6690		3054	867	138627	41937	35638	22504	35638	22504
Year:	2018	F multipli	0.5	Fleet1 HC	0.1521	Fleet1 DF	0.0407					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0024	23	5	0.0062	58	10	10387	1849	0	0	0	0
2	0.0167	1127	506	0.0336	2271	652	76517	23873	0	0	0	0
3	0.1759	880	486	0.0703	352	110	6200	2635	6200	2635	6200	2635
4	0.2941	1294	844	0.0382	168	65	5677	3241	5677	3241	5677	3241
5	0.1219	663	801	0.0208	113	33	6423	5652	6423	5652	6423	5652
6	0.2043	1267	1396	0.0127	79	56	7587	6464	7587	6464	7587	6464
7	0.2104	10	16	0.0066	0	0	61	73	61	73	61	73
Total		5264	4056		3041	926	112852	43788	25948	18066	25948	18066
Year:	2019	F multipli	0.5	Fleet1 HC	0.1521	Fleet1 DF	0.0407					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0024	23	5	0.0062	58	10	10387	1849	0	0	0	0
2	0.0167	124	56	0.0336	250	72	8432	2631	0	0	0	0
3	0.1759	8452	4674	0.0703	3379	1054	59580	25321	59580	25321	59580	25321
4	0.2941	905	590	0.0382	118	45	3969	2266	3969	2266	3969	2266
5	0.1219	344	416	0.0208	59	17	3334	2934	3334	2934	3334	2934
6	0.2043	762	839	0.0127	47	33	4559	3885	4559	3885	4559	3885
7	0.2104	867	1359	0.0066	27	19	5041	6023	5041	6023	5041	6023
Total		11476	7939		3937	1252	95301	44909	76482	40429	76482	40429
Input units are thousands and kg - output in tonnes												

Table 4.3.22. Haddock in 6.b. Input data for the short-term forecast.

Fbar age range (Total) : 2-5						
Fbar age range Fleet 1 : 2-5						
2017						
Age	N	M	Mat	PF	PM	SWt
1	94770	0.2	0	0	0	0.178
2	8219	0.2	0	0	0	0.312
3	10356	0.2	1	0	0	0.425
4	13483	0.2	1	0	0	0.571
5	11693	0.2	1	0	0	0.88
6	37	0.2	1	0	0	0.852
7	69	0.2	1	0	0	1.195
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0048	0.223	0.0123	0.178		
2	0.0333	0.449	0.0671	0.287		
3	0.3517	0.553	0.1406	0.312		
4	0.5881	0.652	0.0764	0.387		
5	0.2438	1.209	0.0415	0.293		
6	0.4085	1.102	0.0254	0.706		
7	0.4207	1.567	0.0132	0.71		
2018						
Age	N	M	Mat	PF	PM	SWt
1	10387	0.2	0	0	0	0.178
2	.	0.2	0	0	0	0.312
3	.	0.2	1	0	0	0.425
4	.	0.2	1	0	0	0.571
5	.	0.2	1	0	0	0.88
6	.	0.2	1	0	0	0.852
7	.	0.2	1	0	0	1.195
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0048	0.223	0.0123	0.178		
2	0.0333	0.449	0.0671	0.287		
3	0.3517	0.553	0.1406	0.312		
4	0.5881	0.652	0.0764	0.387		
5	0.2438	1.209	0.0415	0.293		
6	0.4085	1.102	0.0254	0.706		
7	0.4207	1.567	0.0132	0.71		
2019						
Age	N	M	Mat	PF	PM	SWt
1	10387	0.2	0	0	0	0.178
2	.	0.2	0	0	0	0.312
3	.	0.2	1	0	0	0.425
4	.	0.2	1	0	0	0.571
5	.	0.2	1	0	0	0.88
6	.	0.2	1	0	0	0.852
7	.	0.2	1	0	0	1.195
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0048	0.223	0.0123	0.178		
2	0.0333	0.449	0.0671	0.287		
3	0.3517	0.553	0.1406	0.312		
4	0.5881	0.652	0.0764	0.387		
5	0.2438	1.209	0.0415	0.293		
6	0.4085	1.102	0.0254	0.706		
7	0.4207	1.567	0.0132	0.71		
Input units are thousands and kg - output in tonnes						

Table 4.3.23. Haddock in 6.b. Short-term forecast ouput.

Fbar age range (Total) : 2-5								
Fbar age range Fleet 1 : 2-5								
2017								
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
41937	22504	0.815	0.2479	6690	0.0663	867		
2018							2019	
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
43788	18066	0.4	0.1217	3308	0.0326	748	45865	41380
.	18066	0.41	0.1247	3384	0.0334	766	45767	41284
.	18066	0.42	0.1278	3460	0.0342	784	45671	41187
.	18066	0.43	0.1308	3536	0.035	802	45574	41091
.	18066	0.44	0.1339	3611	0.0358	820	45478	40996
.	18066	0.45	0.1369	3686	0.0366	837	45382	40900
.	18066	0.46	0.1399	3760	0.0374	855	45287	40806
.	18066	0.47	0.143	3835	0.0383	873	45192	40711
.	18066	0.48	0.146	3909	0.0391	891	45097	40617
.	18066	0.49	0.1491	3982	0.0399	908	45003	40523
.	18066	0.5	0.1521	4056	0.0407	926	44909	40429
.	18066	0.51	0.1552	4129	0.0415	943	44816	40336
.	18066	0.52	0.1582	4202	0.0423	961	44722	40244
.	18066	0.53	0.1612	4274	0.0431	978	44629	40151
.	18066	0.54	0.1643	4347	0.044	996	44537	40059
.	18066	0.55	0.1673	4419	0.0448	1013	44445	39967
.	18066	0.56	0.1704	4490	0.0456	1031	44353	39876
.	18066	0.57	0.1734	4562	0.0464	1048	44261	39785
.	18066	0.58	0.1765	4633	0.0472	1065	44170	39694
.	18066	0.59	0.1795	4704	0.048	1083	44080	39604
.	18066	0.6	0.1825	4774	0.0488	1100	43989	39514
Input units are thousands and kg - output in tonnes								

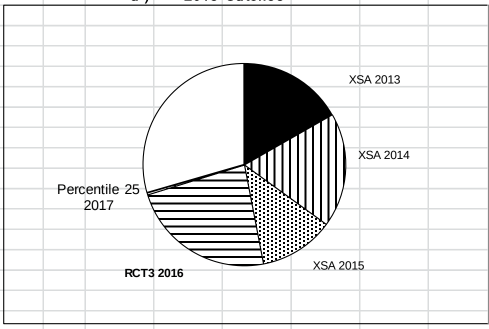
Table 4.3.24. Haddock 6.b. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class			2013	2014	2015	2016	2017
Stock No. (thousands)			32849	16807	10387	94770	10387
of	1	year-olds					
Source			XSA	XSA	XSA	RCT3	Percentile 25
F2017 = 0.31, F 2018=0.2:							
% in	2017	landings	42.4	20.0	2.6	3.0	-
% in	2018	landings	16.7	18.3	12.0	23.3	0.3
% in	2017	SSB	34.2	19.6	0.0	0.0	-
% in	2018	SSB	31.3	17.9	14.6	0.0	0.0
% in	2019	SSB	9.6	7.3	5.6	62.6	0.0

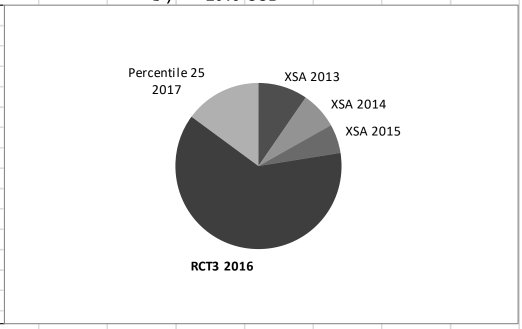
GM : geometric mean recruitment

Haddock V|b : Year-class % contribution to

a) 2018 Catches



b) 2019 SSB



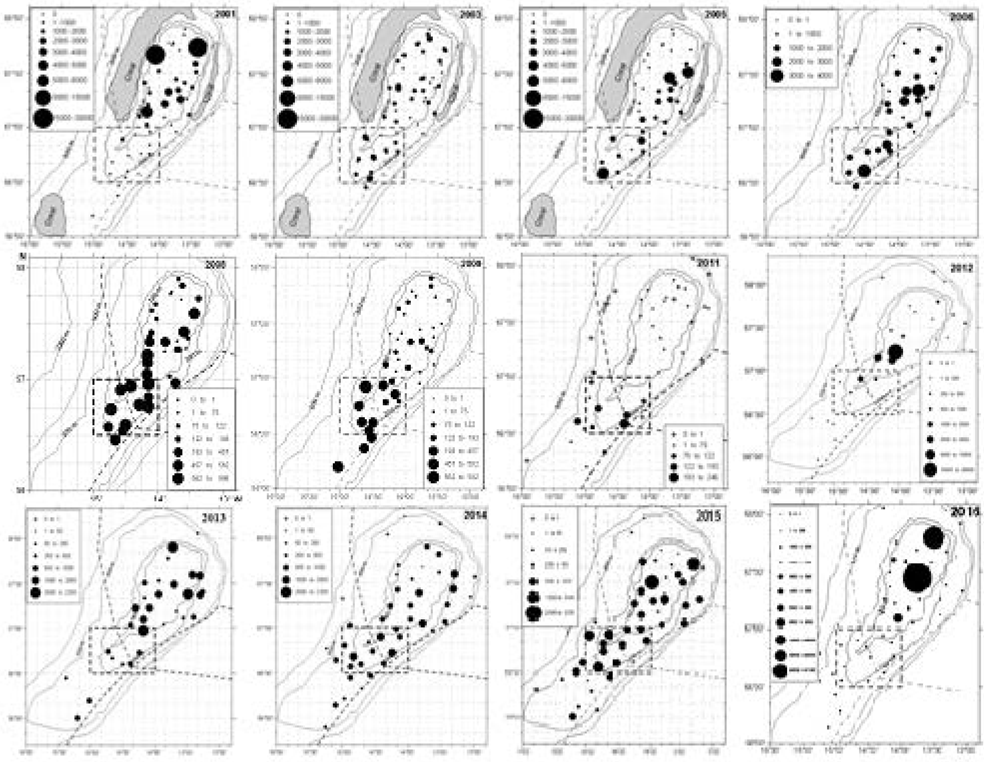


Figure 4.3.1. Distribution of haddock (catch N per 30 minutes) on the Rockall Bank in 2001–2016 from the Scottish trawl survey (Scottish Rock-IBTS-Q3).

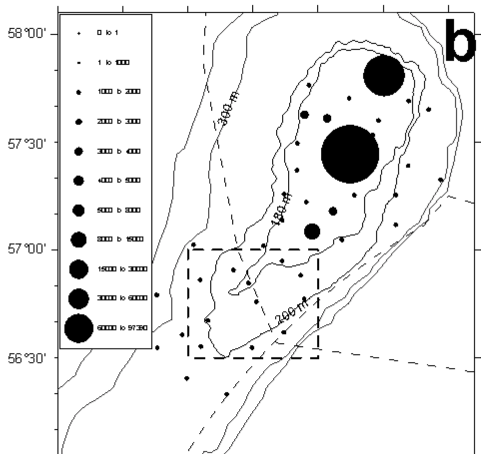


Figure 4.3.2. Haulings pattern during bottom survey by RV 'Scotia' in September 2016: a) the whole area; b) the standard area.

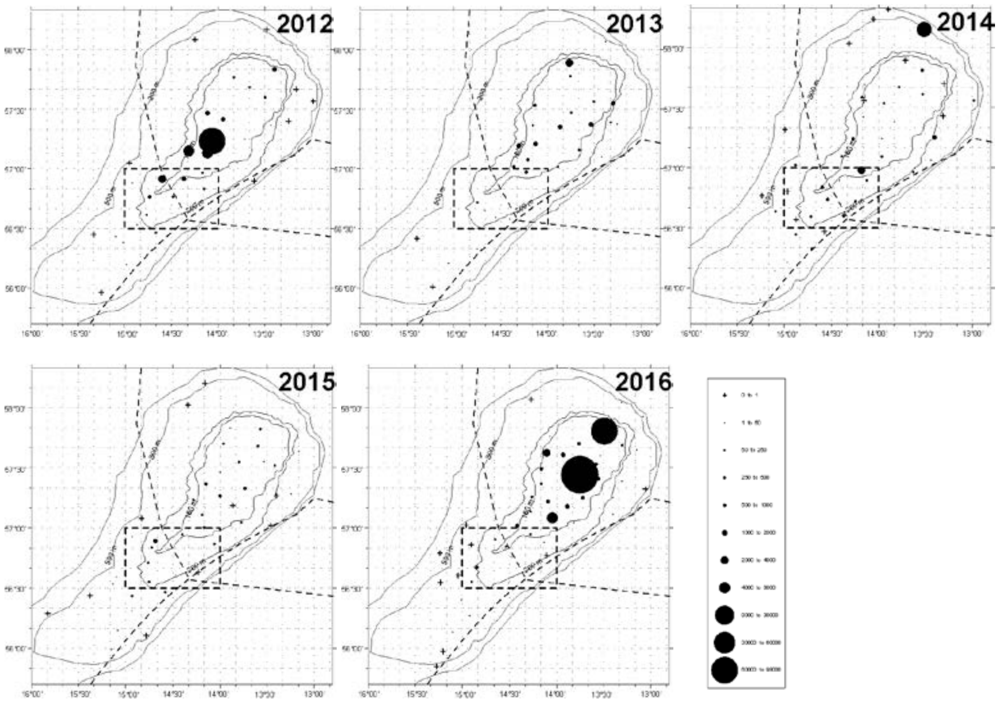


Figure 4.3.3. Distribution of 0-group haddock (number per 30 minutes) on the Rockall Bank in 2012–2016 from the Scottish trawl survey.

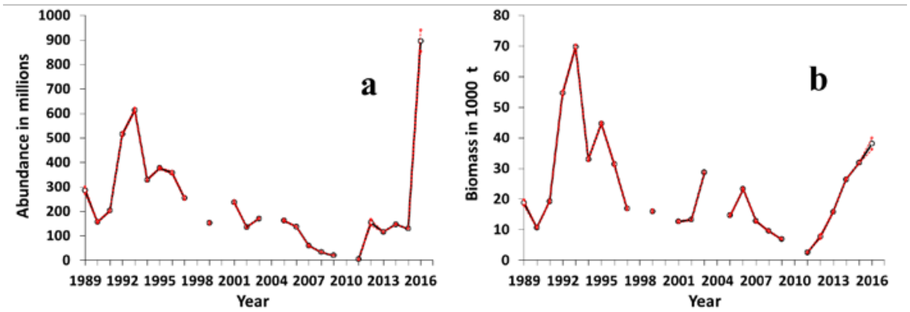


Figure 4.3.4. Abundance (a) and biomass (b) of haddock, assessed with the trawl survey method with geographical stratification based on rectangles of 15′ latitude and 15′ longitude by RV 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

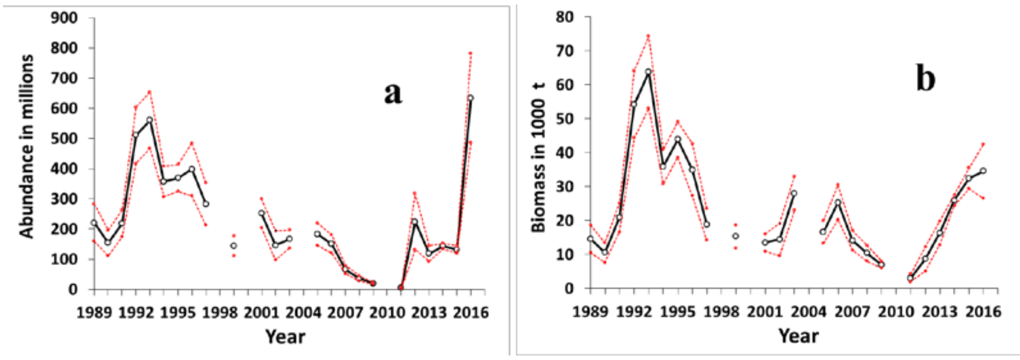


Figure 4.3.5. Abundance (a) and biomass (b) of haddock, assessed with the trawl survey method with geographical stratification based on bathymetry by RV 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

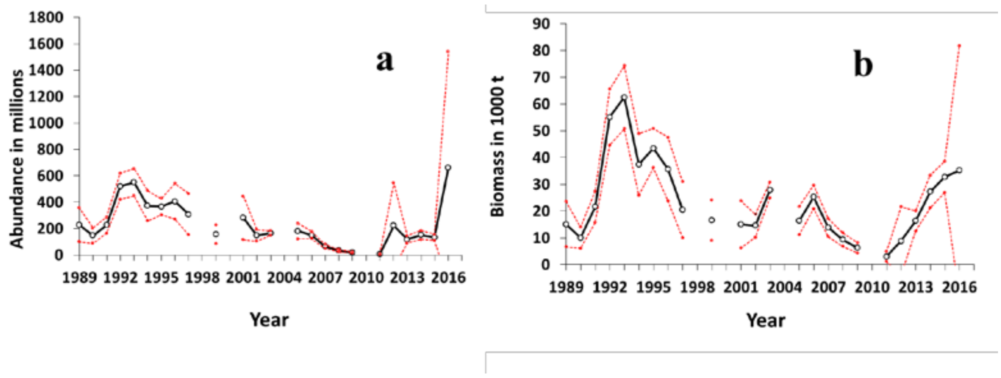


Figure 4.3.6. Abundance (a) and biomass (b) of haddock, assessed with the trawl survey method without geographical stratification by RV 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

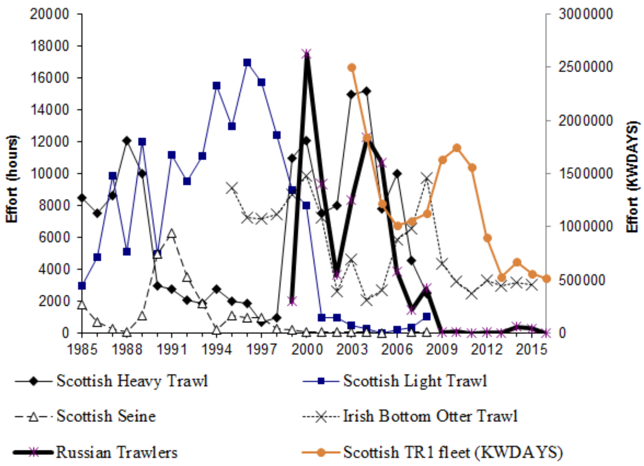


Figure 4.3.7. Rockall haddock in 6.b. Scottish, Irish effort in 1985–2016 and Russian effort in 1999–2016.

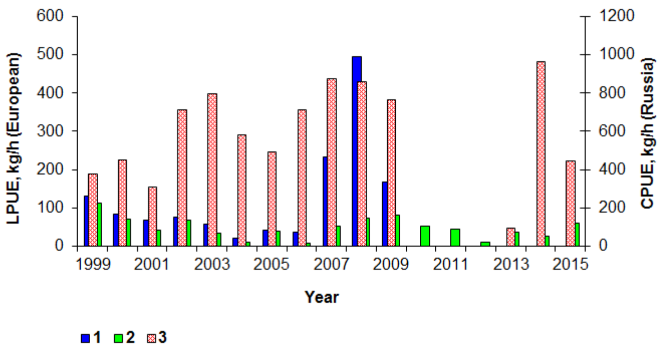


Figure 4.3.8. Lpue and cpue of the fleets fishing for Rockall haddock. Note that Scottish and Irish effort data are not reliable because reporting is not mandatory.

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).

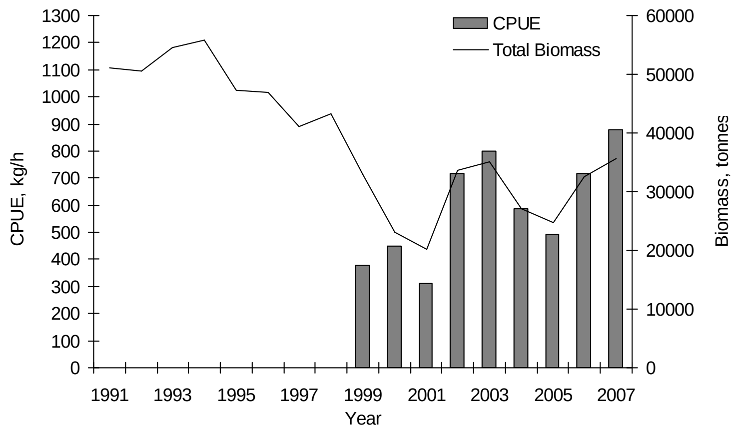


Figure 4.3.9. Dynamics of haddock total biomass (ICES, 2008a; ICES, 2008b) and directed fishing efficiency (t per a trawling hour) for tonnage class 10 vessels in 1999–2007.

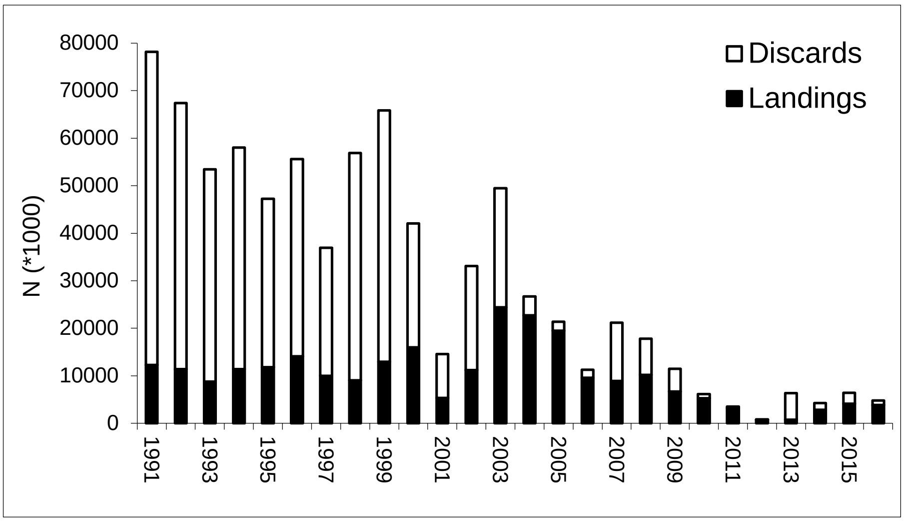


Figure 4.3.10. Total landings and discards of Rockall haddock ('000 individuals).

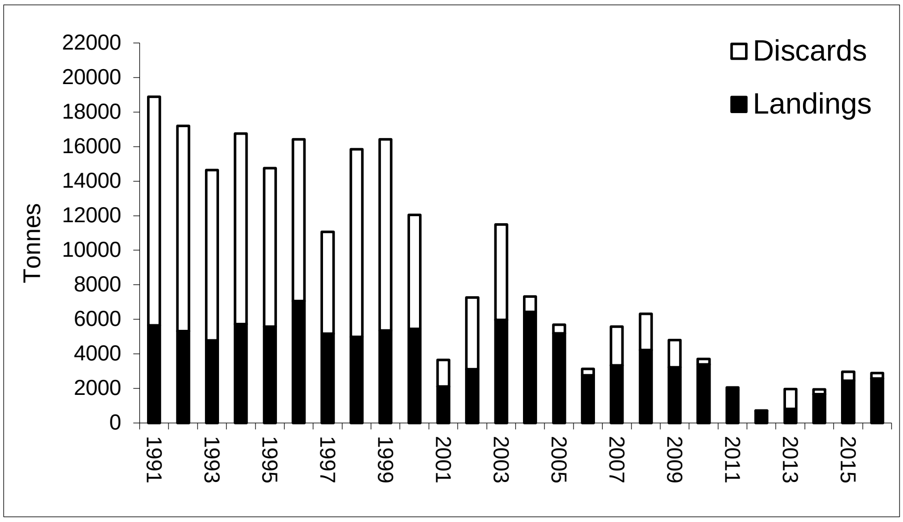


Figure 4.3.11. Total landings and discards of Rockall haddock (tonnes).

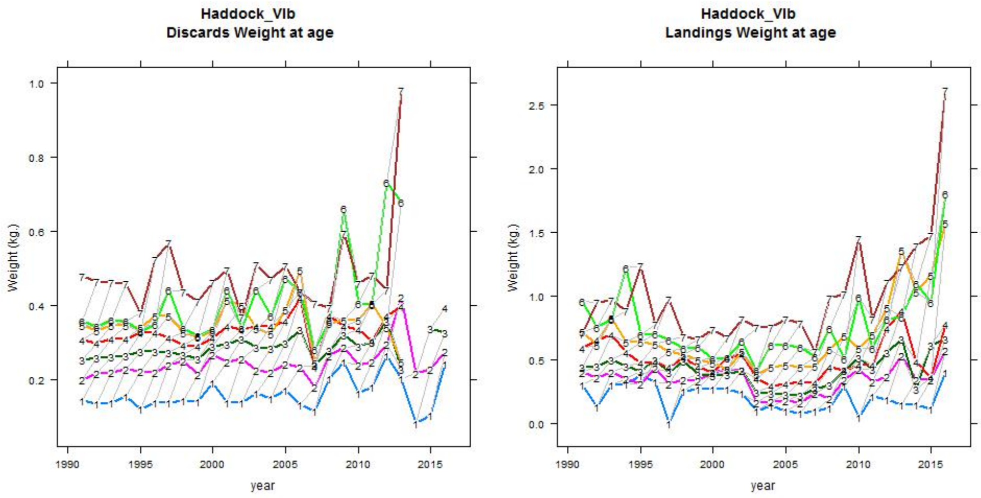


Figure 4.3.12. Haddock in 6.b. Mean weights-at-age in discards (left) and in landings (right).

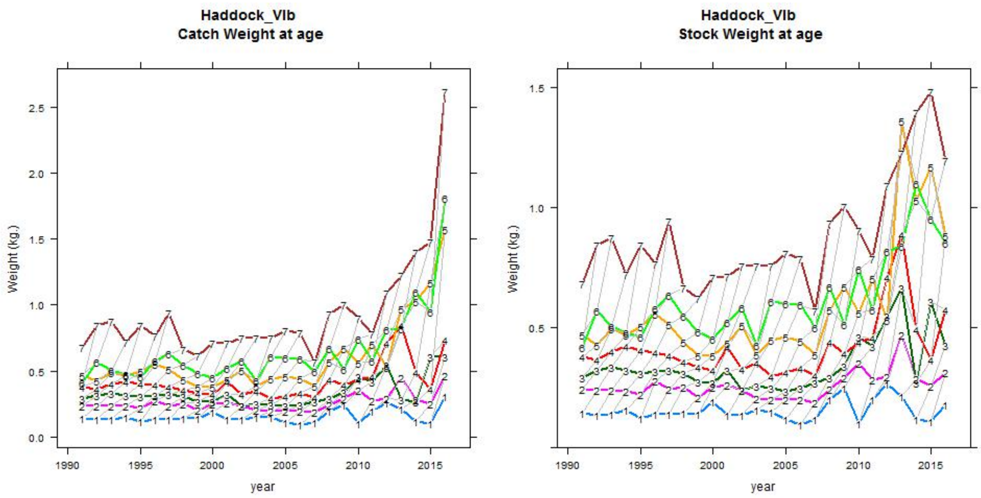


Figure 4.3.13. Haddock in 6.b. Mean weights-at-age in catch (left) and in stock (right).

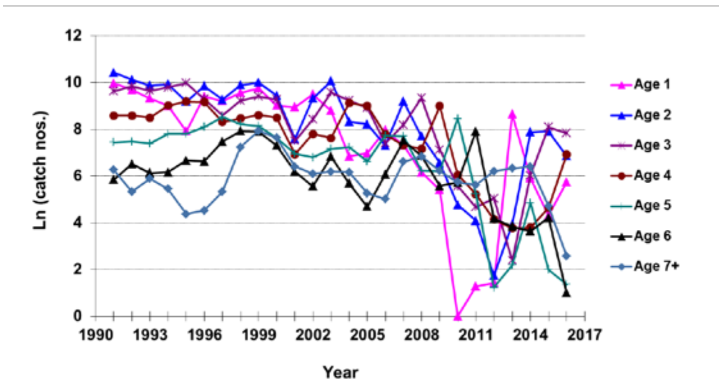


Figure 4.3.14. Haddock in 6.b. Log catch-(with discards in numbers) at-age by year.

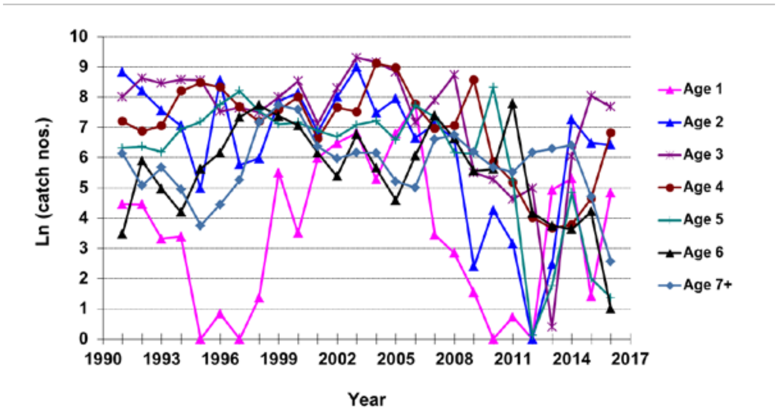


Figure 4.3.15. Haddock in 6.b. Log landings-(in numbers) at-age by year.

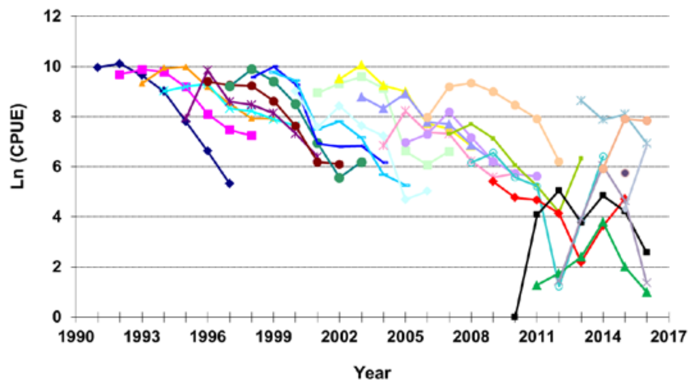


Figure 4.3.16. Haddock in 6.b. Log catch-(with discards, in numbers) at-age by year class.

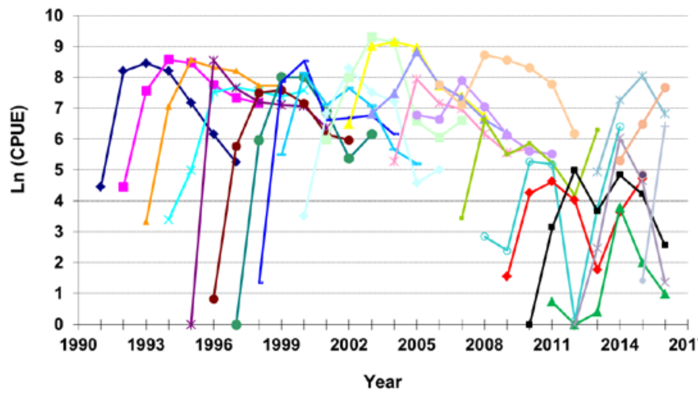


Figure 4.3.17. Haddock in 6.b. Log landings-(without registered discards, in numbers) at-age by year class.

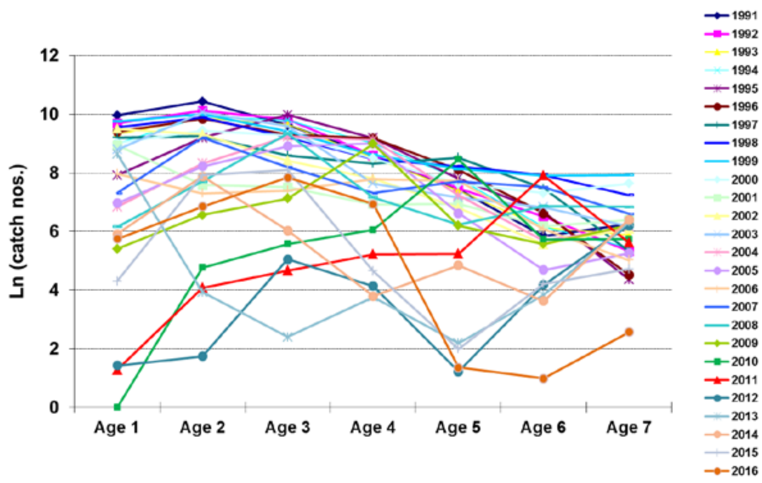


Figure 4.3.18. Haddock in 6.b. Catch curves (with registered discards).

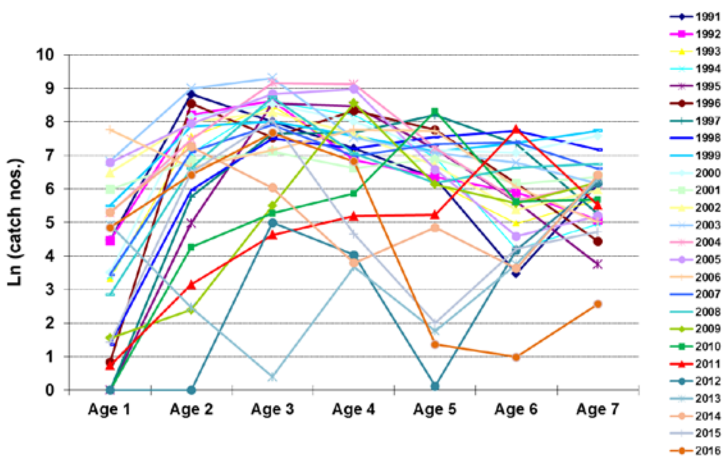


Figure 4.3.19. Haddock in 6.b. Catch curves (landings without registered discards).

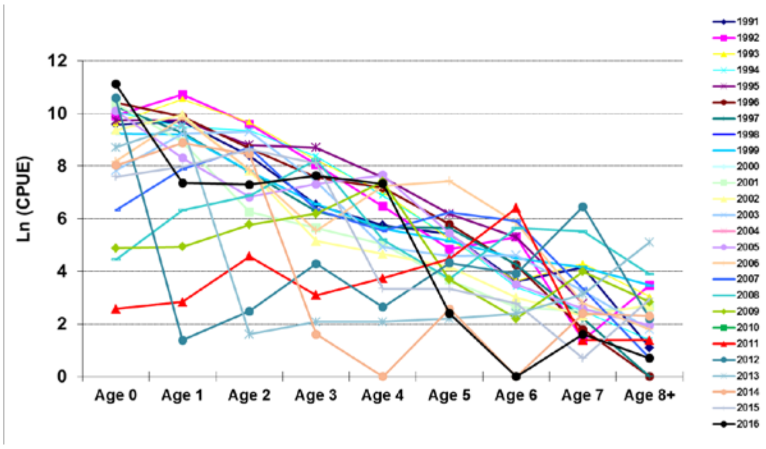


Figure 4.3.20. Haddock in 6.b. Log survey cpue at-age by year.

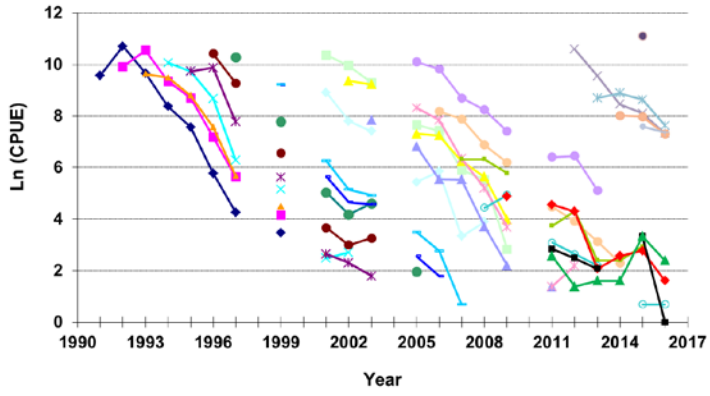


Figure 4.3.21. Haddock in 6.b. Final XSA run. Log survey cpue by year class.

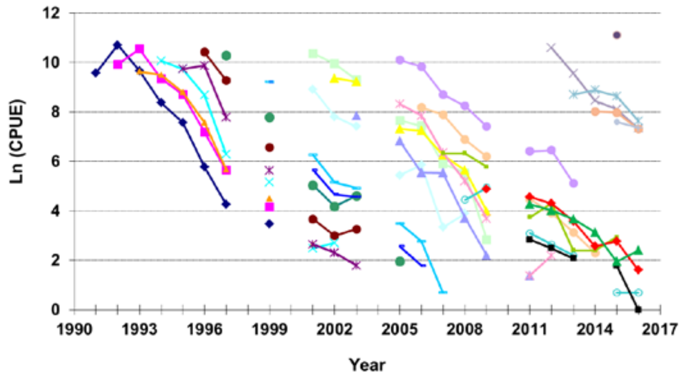


Figure 4.3.22. Haddock in 6.b. Exploratory run. Log survey cpue by year class.

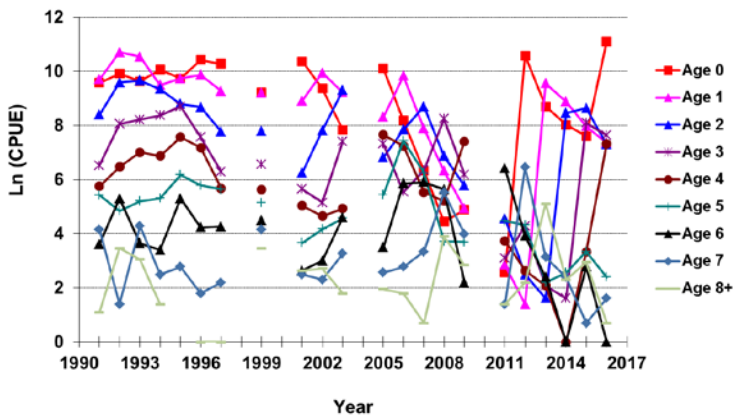


Figure 4.3.23. Haddock in 6.b. Final XSA run. Log survey cpue at-age.

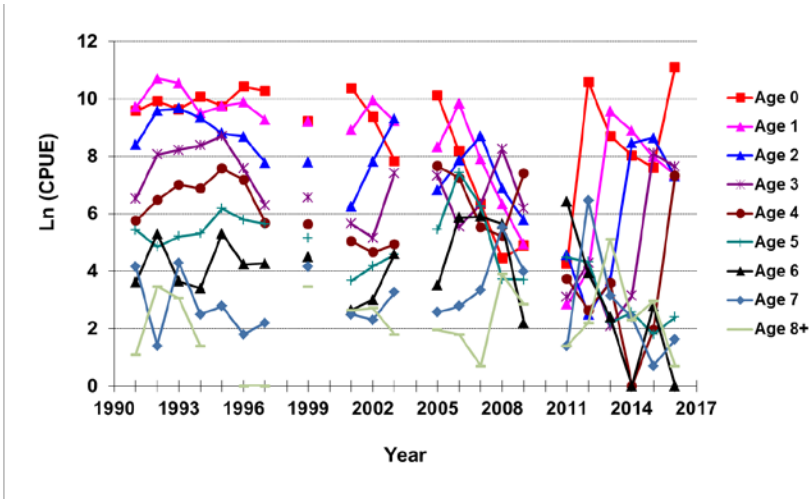


Figure 4.3.24. Haddock in 6.b. Exploratory run. Log survey cpue at-age.

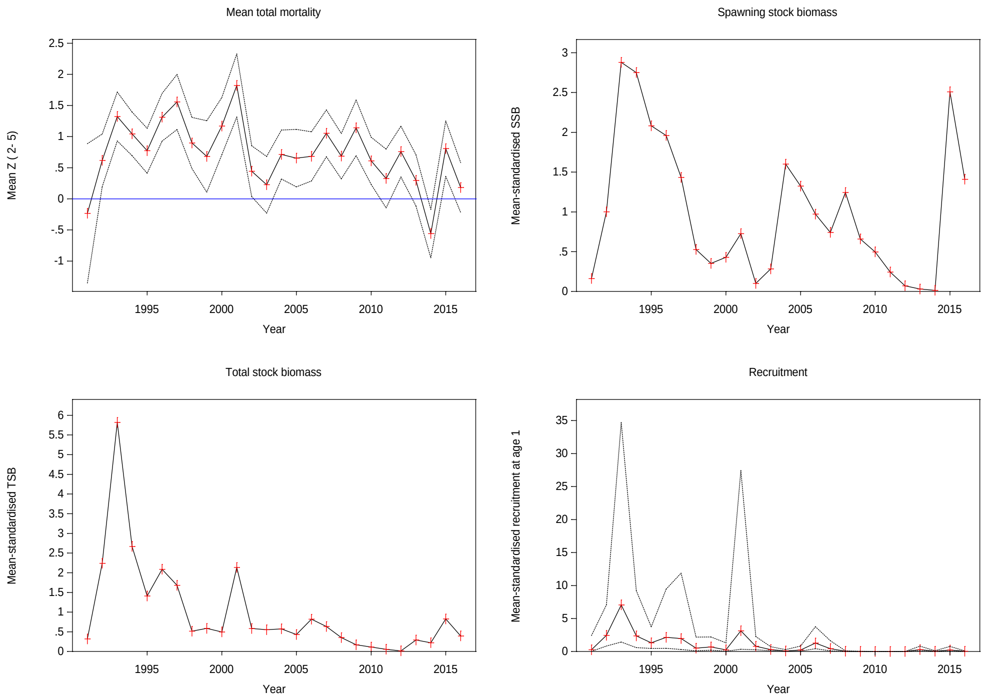


Figure 4.3.25. SURBA analysis for Rockall haddock.

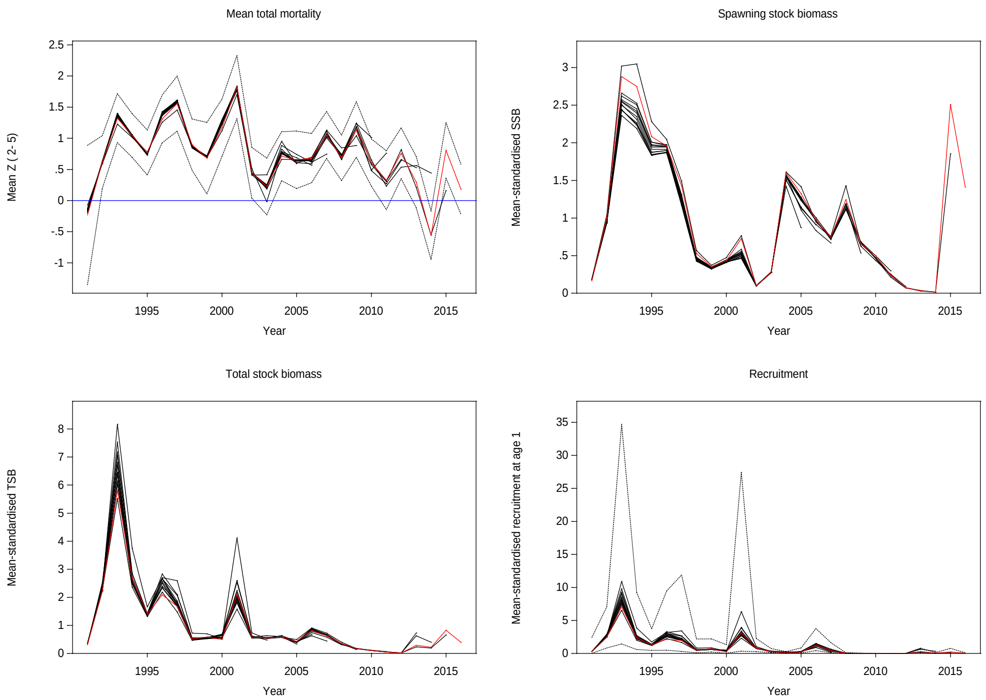


Figure 4.3.26. SURBA analysis for Rockall haddock. Retrospective plots.

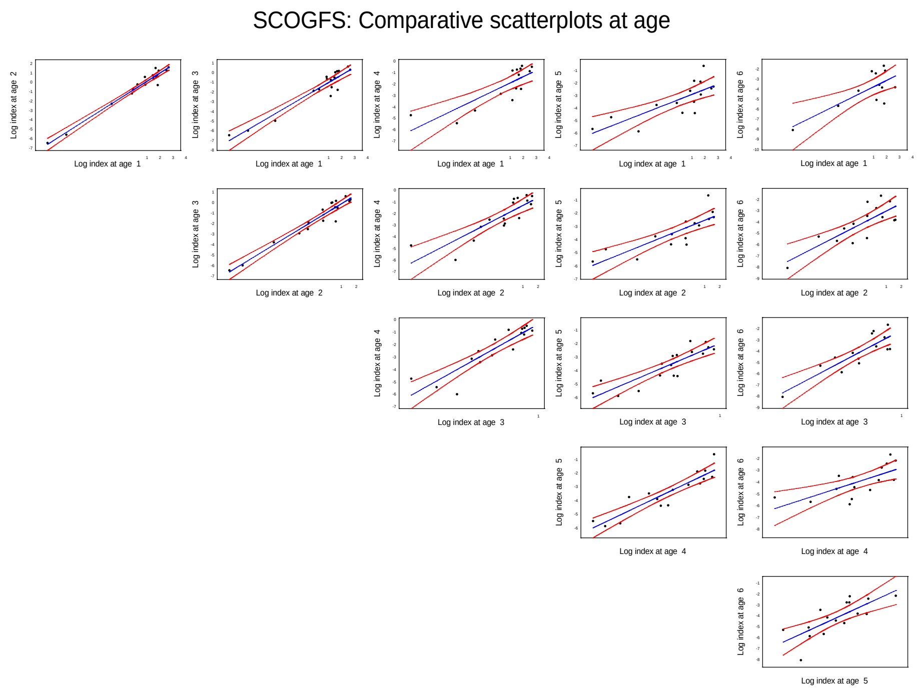


Figure 4.3.27. SURBA analysis for Rockall haddock. Pairwise plots of age.

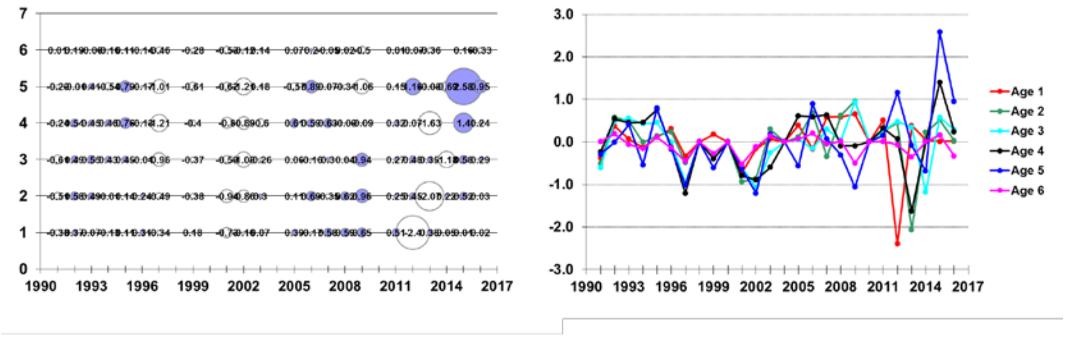


Figure 4.3.28. Haddock in 6.b. Log catchability residual plots (shrinkage 1.0, catchability dependent on stock size at-ages <4). Final XSA.

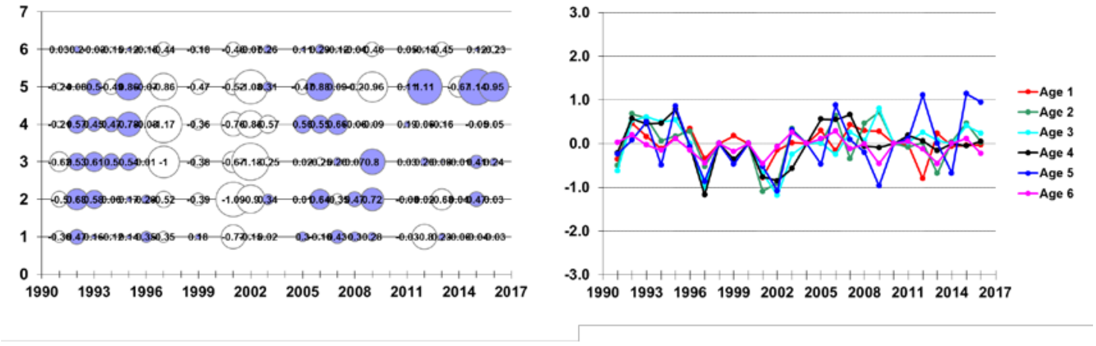


Figure 4.3.29. Haddock in 6.b. Exploratory run. Log catchability residual plots (shrinkage 1.0, catchability dependent on stock size at-ages <4).

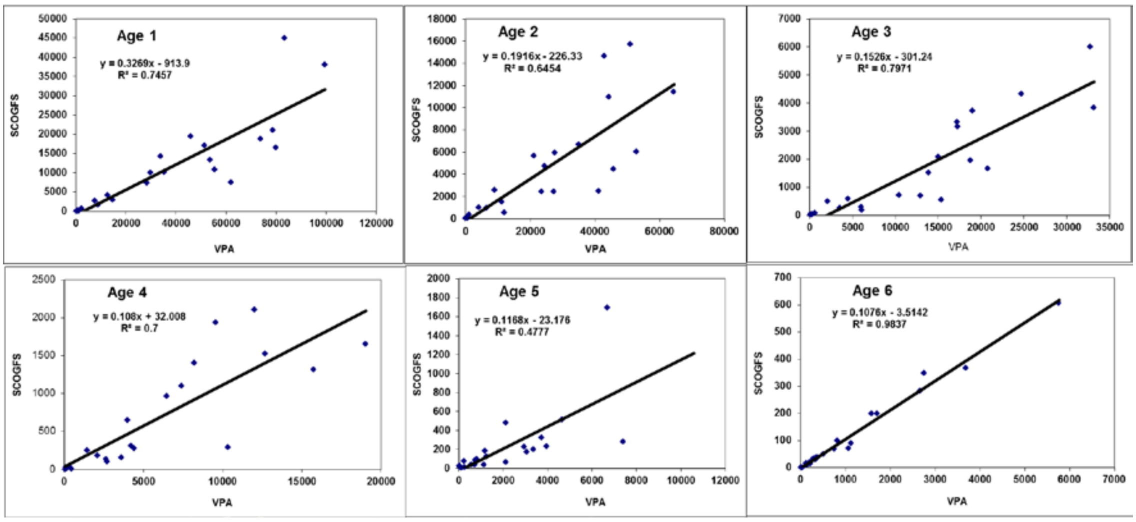


Figure 4.3.30. Haddock in 6.b. Adjusted Scottish groundfish survey cpue from the final XSA run plotted against VPA numbers-(shrinkage 1.0) at-age. Catchability dependent on stock size at-ages <4.

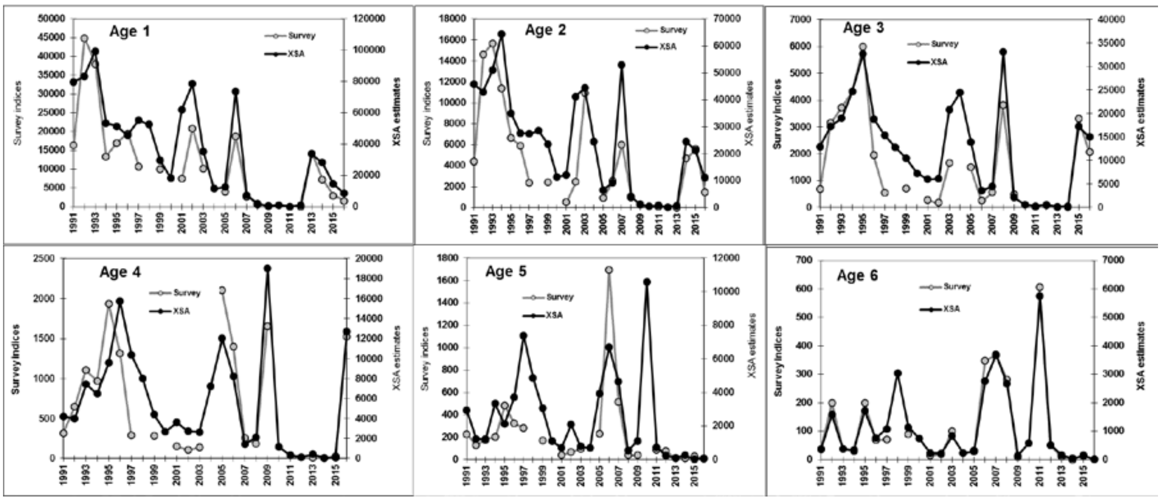


Figure 4.3.31. Haddock in 6.b. Survey indices and XSA estimates (shrinkage 1.0) at-age. Final XSA: catchability dependent on stock size at-ages <4.

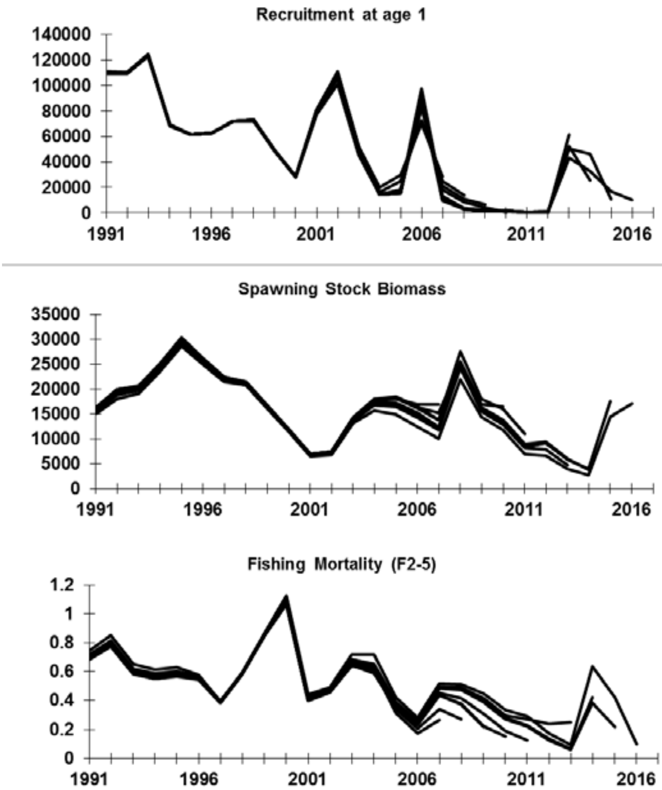


Figure 4.3.32. Haddock in 6.b. Retrospective analyses (F shrinkage 1.0).

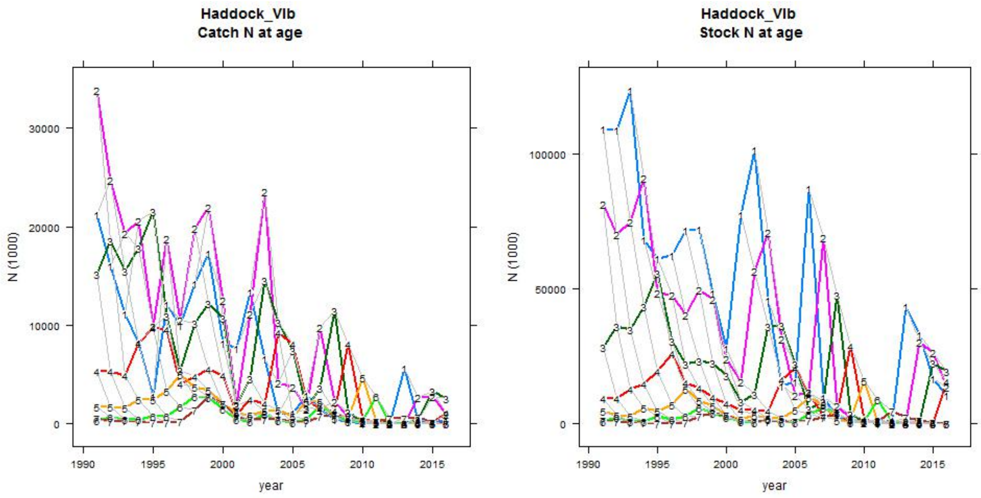


Figure 4.3.33. Haddock in 6.b. Catch (with discards, in numbers) at-age (left) and stock abundance-at-age (right)

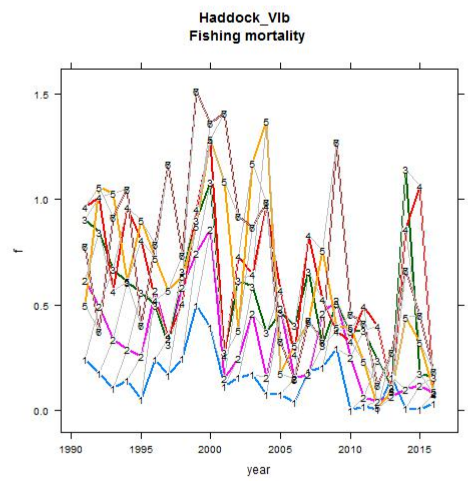


Figure 4.3.34. Haddock in 6.b. F at-age (F shrinkage 1.0).

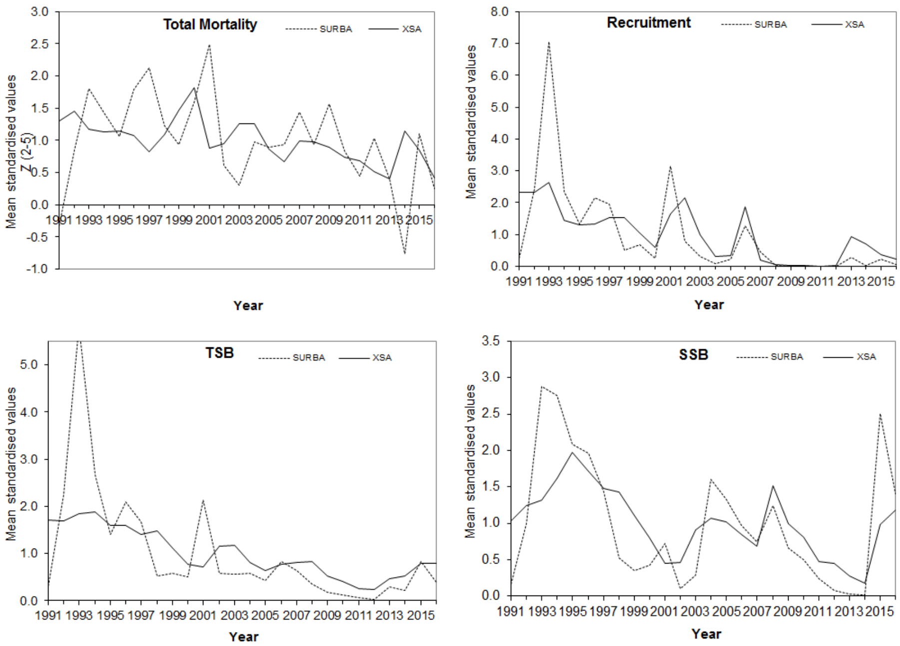


Figure 4.3.35. Haddock in 6.b. Comparison of the final runs XSA and SURBA output.

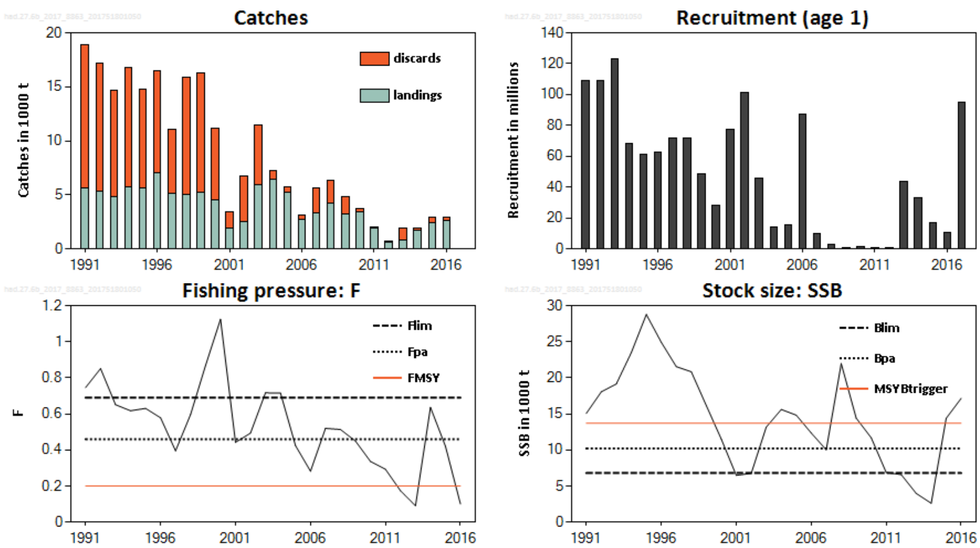


Figure 4.3.36. Haddock in 6.b. Summary plots.

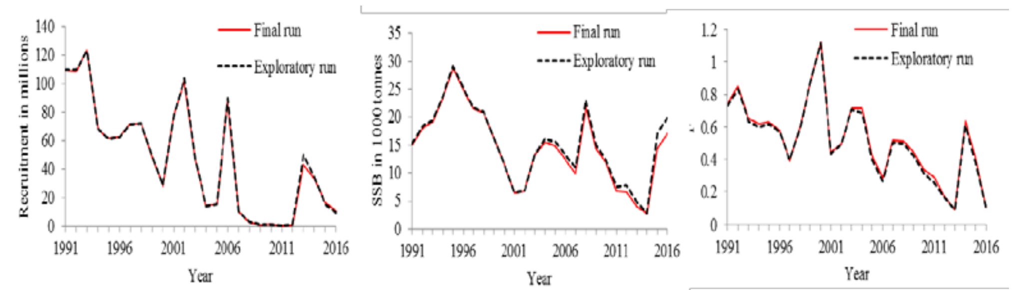


Figure 4.3.37. Haddock in 6.b. Comparison of the final XSA and exploratory XSA assessments.

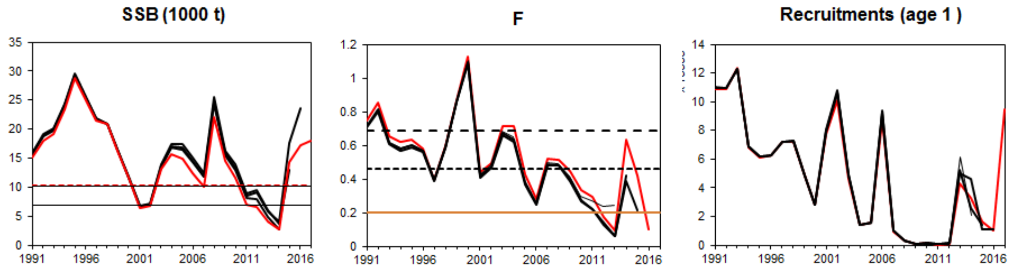


Figure 4.3.38. Haddock in 6.b. Comparison of the current final assessment (in red) with the previous one (in black). In the SSB plot, the solid blue line indicates B_{PA} and the dotted blue line refers to B_{lim}. In the fishing mortality plot, the solid blue line signifies F_{PA}.

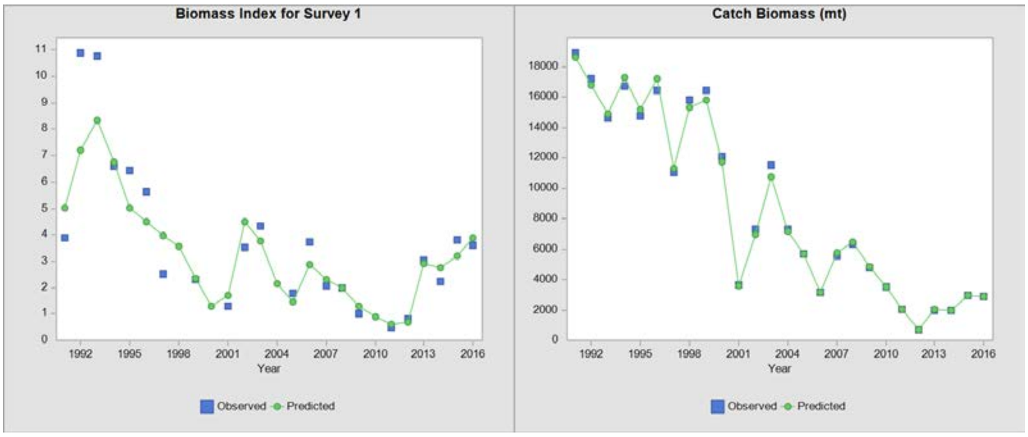


Figure 4.3.39. Haddock in 6.b. Comparison of observed and predicted survey and catch biomass derived from StatCam, Scenario 2.

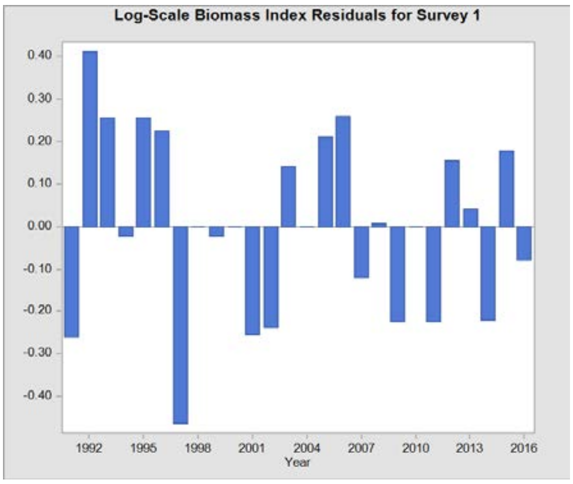


Figure 4.3.40. Haddock in 6.b. Log catchability residuals plot for survey biomass index. Scenario 2 of StatCam run.

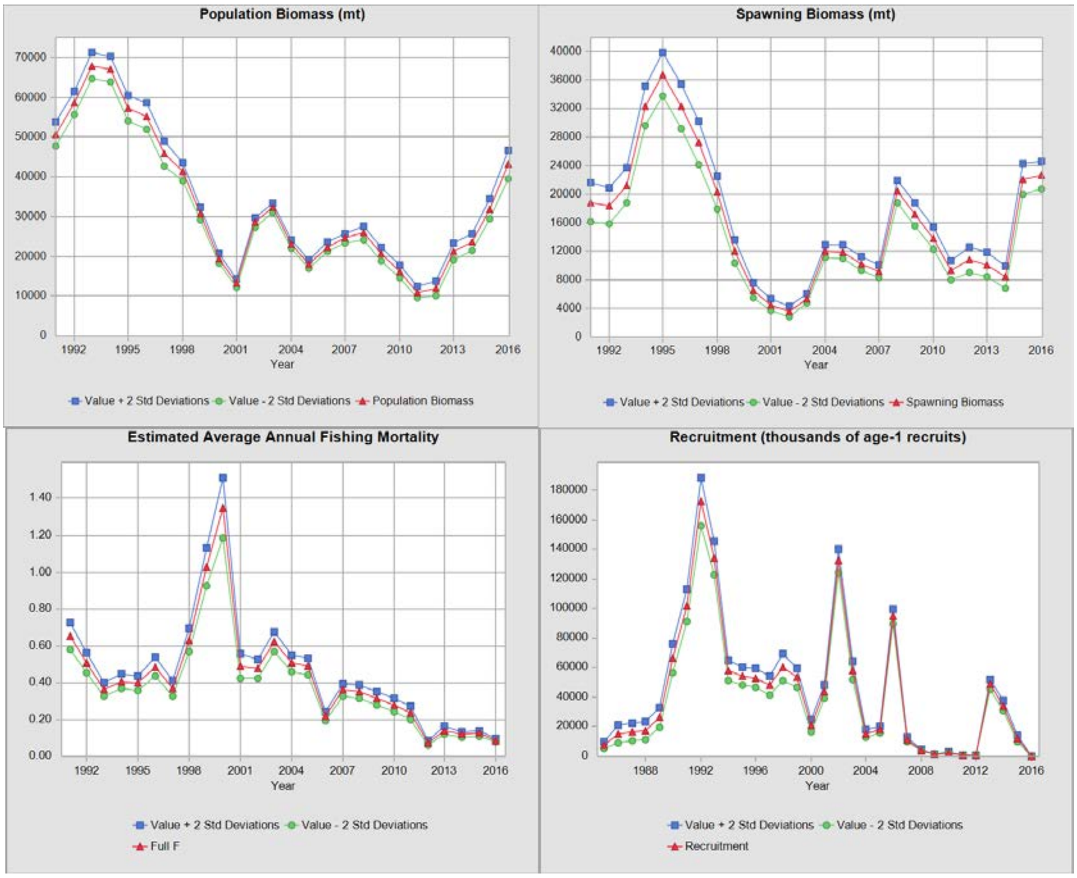


Figure 4.3.41. Haddock in 6.b. Population biomass, SSB, fishing mortality and recruitment by StatCam estimation. Scenario 2.

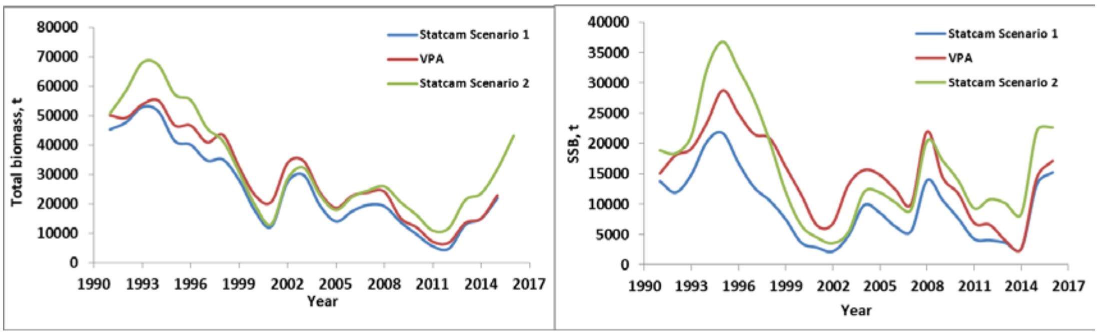


Figure 4.3.42. Haddock in 6.b. Comparison of the final XSA (VPA) assessment with the statistical catch-at-age model StatCam assessment.

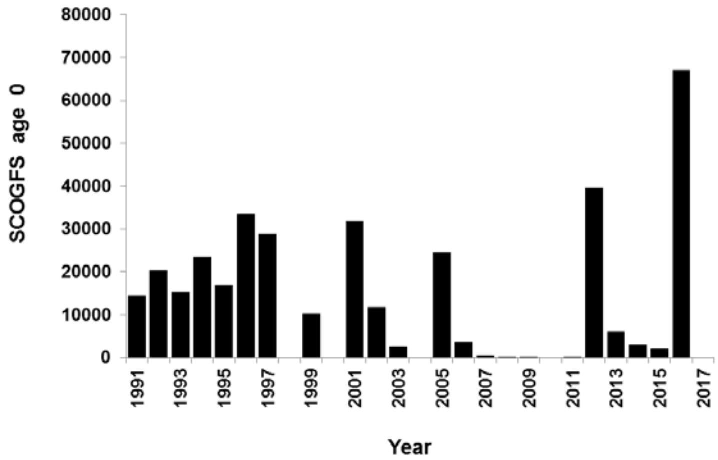


Figure 4.3.43. Haddock in 6.b. Scottish Groundfish survey indices of haddock abundance-at-age 0.

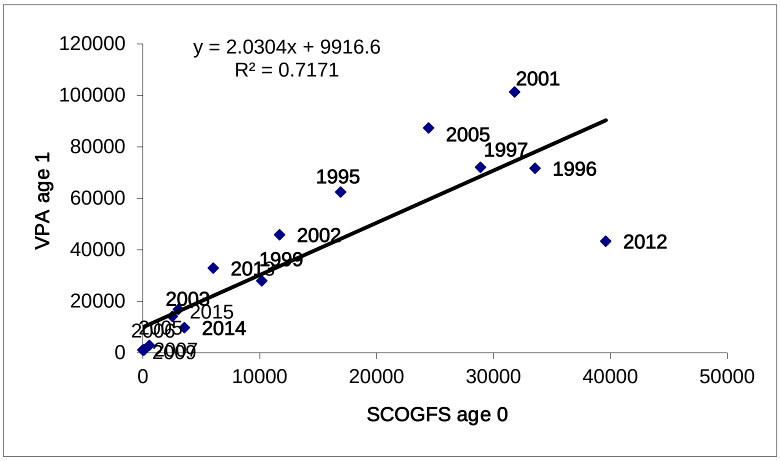


Figure 4.3.44. Haddock in 6.b. VPA numbers-at-age 1 from XSA plotted against Scottish Groundfish survey indices of haddock at-age 0.

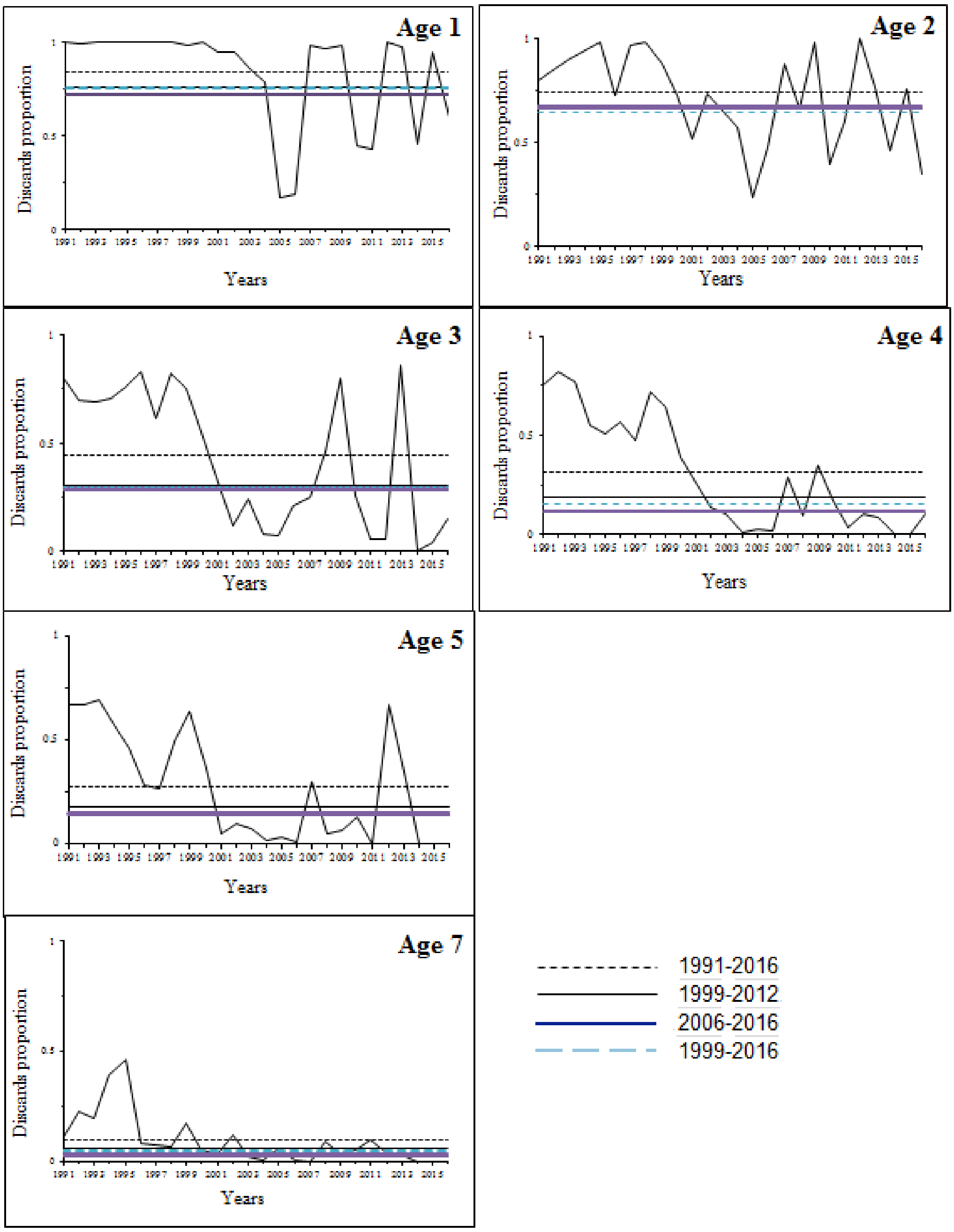


Figure 4.3. 45. Haddock in Division 6.b. Discard proportion-at-age by year, and mean discard proportion-at-age for periods: 1991–2016, 1999–2012, 2006–2016 and 1999–2016.

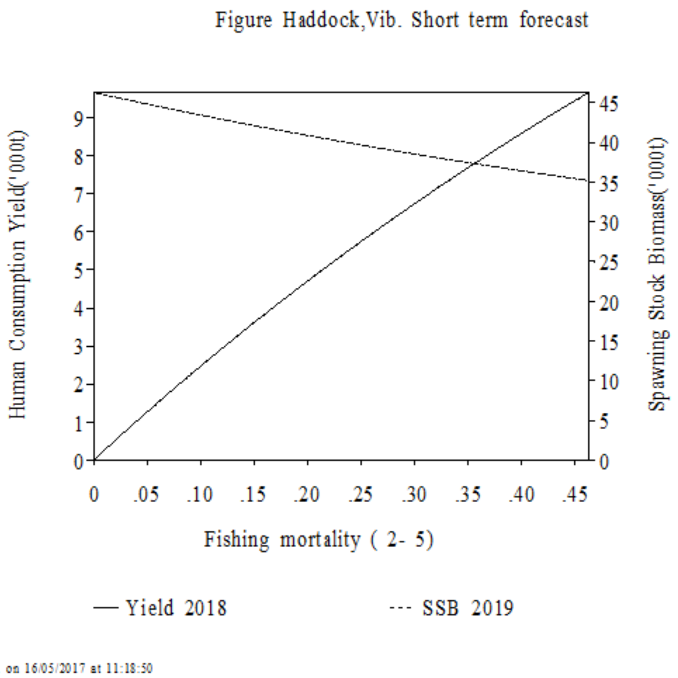


Figure 4.3.46. Haddock in 6.b. Short-term forecast.

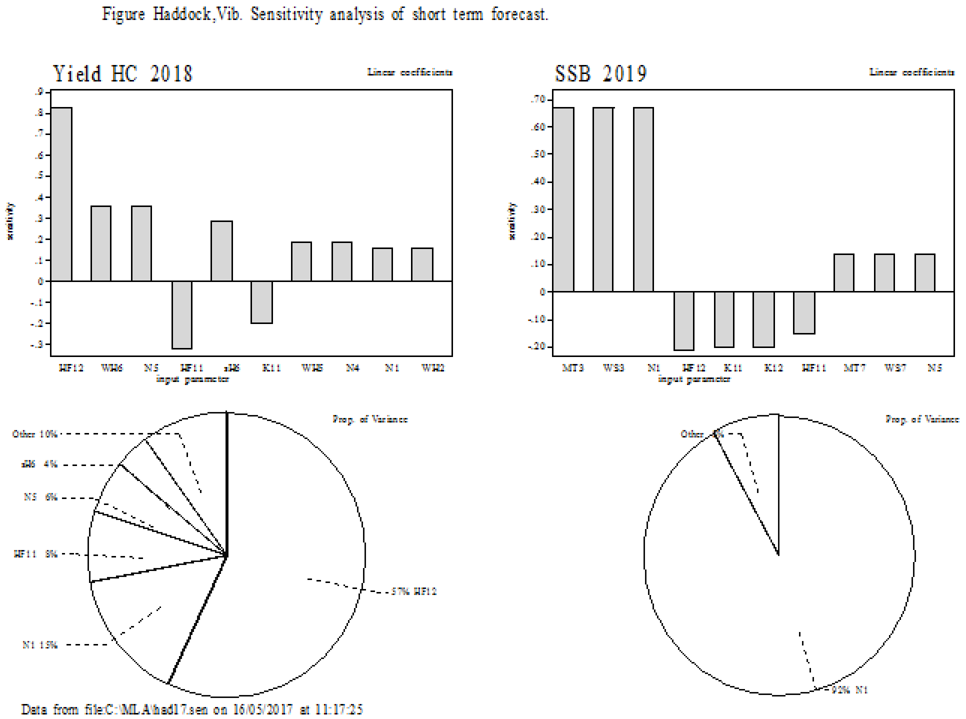


Figure 4.3.47. Haddock in 6.b. Delta plots from the sensitivity analysis of the short-term forecast.

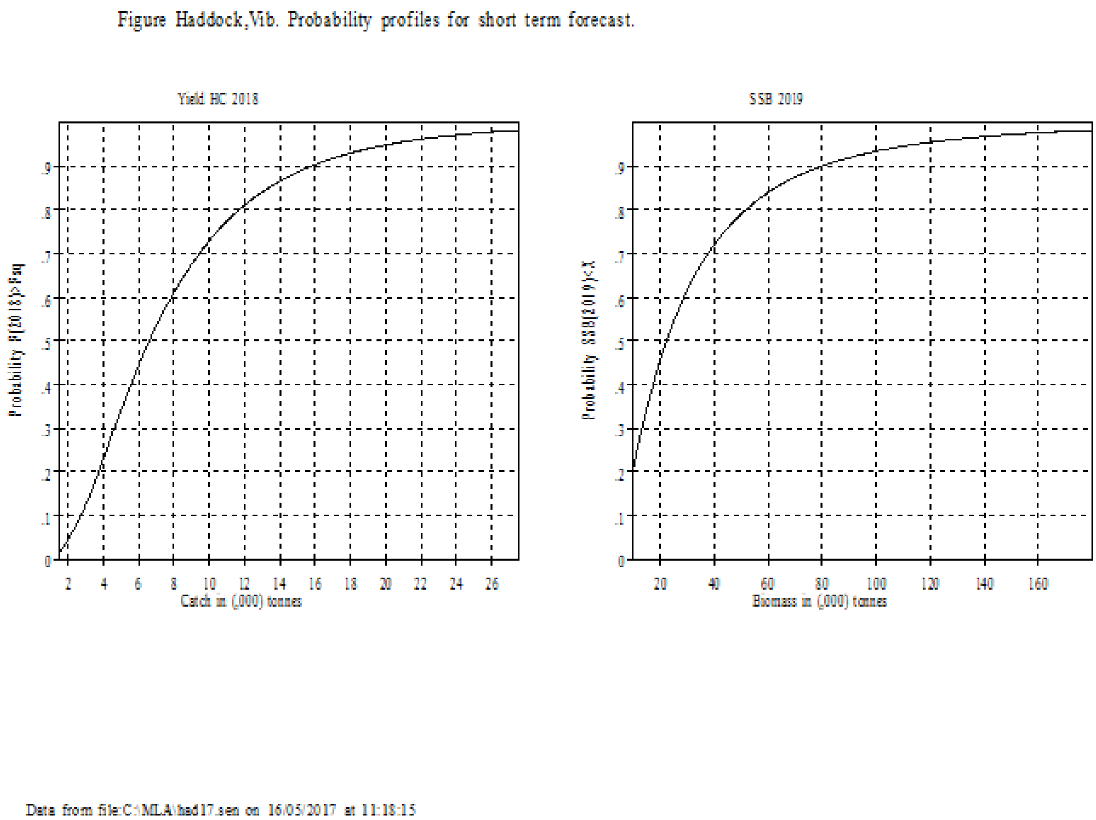


Figure 4.3.48. Haddock in 6.b. Probability plots for yield in 2018 and SSB in 2019.

11 Haddock in Division 7.a

Type of assessment

Age-structured assessment model using Age Structured Assessment Program (ASAP).

ICES advice applicable to 2016

ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 1072 tonnes[1]. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 481 tonnes.

ICES advice applicable to 2017 (June 2016)

ICES advises that when the precautionary approach is applied, catches in 2017 should be no more than 1286 tonnes[1]. Since this stock is only partially, under the EU landing obligation, ICES is not in a position to advise on landings corresponding to the advised catch.

ICES advice applicable to 2017 (Updated February 2017)

ICES advises that when the MSY approach is applied, catches in 2017 for the Division 7.a haddock stock should be no more than 3061 tonnes[1].

11.1 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 (See Section 7.4).

Management applicable to 2016 and 2017

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.

TAC regulations for 2016 and 2017 are given below:

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[1]. Catches taken or reported in rectangles 33E2 and 33E3 are not believed to belong to the haddock stock in Division 7.a but rather to the stock in divisions 7.b–k (Southern Celtic Seas and English Channel). Catches of haddock taken or reported in rectangles 33E2 and 33E3 are therefore included in the assessment of the stock in divisions 7.b–k.

2016 management (Council Regulation (EU) 2016/72)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	VIIa (HAD/07A.)
Belgium	26		
France	120		
Ireland	716		
United Kingdom	792		
Union	1 654		
TAC	1 654		Analytical TAC

2017 management (Council Regulation (EU) (amended) 2017/172)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	VIIa (HAD/07A.)
Belgium	42	Precautionary TAC	
France	189	Article 7(2) of this Regulation applies	
Ireland	1 132		
United Kingdom	1 252		
Union	2 615		
TAC	2 615		

The minimum landing size for haddock in the Irish Sea is 30 cm.

Landings obligation

In 2016 the landings obligation applied to the stock for the first time. According to the delegate regulation (EC, 2015) vessels where more than 25% of their landings using trawls and seines in the reference years (2013 & 2014) and area were specified gadoids (Cod, Haddock, Whiting & Saithe) were covered by the Landings Obligation. This implies that all catches of haddock in the Irish Sea by those vessels must be landed. However a 7% *de minimus* was applied, meaning that these vessels could discard up to 7% of the haddock they catch. This is unchanged for 2017.

Fishery in 2016

The characteristics of the fishery are described in the stock annex.

The fishery in 2016 was prosecuted by the same fleets 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 and was in continual decline underwent a slight increase in activity in 2014–2016 due to developing stock and increased fishing opportunity. This, however, continues to be pursued by a small number of vessel (<10). A large proportion of the TAC is taken as bycatch in the *Nephrops* fishery.

Recently the reported uptake of TAC had been poor since 2004, with the exception of 2007. The estimated percentage uptake, not considering international quota swaps, in the UK and Ireland in 2014 was UK 73% (412 t of 566 t), Ireland 105% (534 t of 511 t). In 2015 the uptake was UK 80% (633 t of 792 t), and Ireland 71% (507 t of 716 t). In 2016 the UK used 104% (824 t of 792 t) and Ireland 25%; 177 t of 716 t.

The figures for Ireland have been corrected to (pre-adjustment–632 t) account for real-location of 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.

11.2 Data

All requested data as detailed in the ICES data call were supplied as required. Data were submitted to InterCatch, which was used for allocation and raising of unsampled fleets. The unsampled fleets for discard estimates 10% of the total discard estimate. Age sampling was carried out on those fleets contributing 69% of the international landings and 89% of the international discards total in 2016. The assessment uses landings and discard information, updated proportion mature-at-age estimates and updated survey series.

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 include sampled-based estimates of landings into a number of Irish Sea ports. Sampled-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 (Annex 6.3). The series of numbers-at-age in the international commercial landings 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 landings is given Table 11.4.

Discards

The series of raised discard data was updated for Ireland and Northern Ireland. Discard numbers-at-age for the different sampled fleets are given in the stock annex (Annex 6.3). The proportions of discards-by-age for the different sampled fleets are given in the stock annex (Annex 6.3). Issues relating to the reliability of 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 (Annex 6.3). Sampling levels have increased in recent years. The very large estimates of discarding for *Nephrops* fleets observed by previous WG are still evident. A time-series of discard numbers-at-age was constructed at the benchmark (Annex 6.3), but this still need some refinement in terms of the raising methodology used. Discard rates are very variable between fleets.

Biological data

The derivation of biological parameters and variables is described in the stock annex. Natural mortality-at-age was calculated using the methods proposed by Lorenzen (1996) at WKIrish 2 (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 fit over time 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 all available survey estimates of mean length-at-age in March, described in the Stock Annex 6.3. The procedure was updated this year using NIGFS-WIBTS-Q1 (2017) and quarter one commercial landings data for 2015. 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

The following parameter estimates were obtained (last year's estimates in parentheses):

Mean LI_{yc} = 82.2 cm; K = 0.178; t_0 = -0.452

Year-class effects giving estimates of asymptotic length relative to the mean were as follows:

Year class	Effect	Year class	Effect
1990	1.022	2004	0.697
1991	0.977	2005	0.707
1992	0.919	2006	0.712
1993	0.931	2007	0.730
1994	0.942	2008	0.762
1995	0.921	2009	0.750
1996	0.846	2010	0.811
1997	0.827	2011	0.823
1998	0.837	2012	0.846
1999	0.797	2013	0.729
2000	0.814	2014	0.783
2001	0.835	2015	0.786
2002	0.805	2016	0.822
2003	0.756		

The year-class effects show a smooth decline from the mid-1990s coincident with the rapid growth of the stock and may represent density-dependent growth effects, although other environmental factors may contribute. Although there is some evidence in a reversal of this trend in recent years. The close fit of the model to observed length-at-age data is shown by year classes in Figure 11.1. The resultant stock weights-at-age are given in Table 11.5. The weight-at-age in the stock shows a very clear decreasing trend over time, stabilizing in more recent years.

Surveys

The survey data considered in the assessment for this stock are given in Table 11.7. Survey series for haddock available to the Working Group is described in the stock annex for 7a haddock. The following age-structured abundance indices were used in the assessment:

- UK (NI) groundfish survey (NIGFS) in March (age classes 1 to 5, years 1992–2016). Acronym NIGFS-WIBTS-Q1.
- UK (NI) groundfish survey (NIGFS) in October (age classes 0 to 3; years 1991 to 2016). Acronym NIGFS-WIBTS-Q4.
- UK (NI) Methot–Isaacs–Kidd (NI-MIK) net survey in June (age 0; years 1994–2016).
- UK Fishery Science Partnership (FSP) western Irish Sea roundfish survey, 2004–2016 (the survey was not conducted in 2014) (age classes 2 to 5, years 1992–2016) (UKFspW)

Additional Information:

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).

11.3 Historical stock development

Deviation from stock annex

The assessment presented is the single fleet ASAP model. The assessment does not deviate from the procedure described in the stock annex as defined through the WKIrish Benchmark meeting (WKIrish 2017).

ASAP was used for the assessment and model settings:

Option	Setting
Use likelihood constant	Yes
Mean F (Fbar) age range	2–4
Fleet selectivity block 1	Assymtotpic
Fleet selectivity block 2	Age coefficineits (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;8;0.6;0.4)
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)	Asytotpic
Index Selectivity (NIMIK)	NA (age 0 only)
Index Selectivity (UK-FSPW)	Aysmytotic
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); 2007–2015 (0.15)
Catch effective sample size	1993–2000 (50); 2003–2006 (1); 2007–2015 (50)
Lambda for recruit deviations	0 (freely estimated)
Lambda for total catch	1

Option	Setting
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)

Final update assessment

The final assessment was run with the same settings as established by WKIrish 2017 and described in the stock annex. Discards were combined with the landings and not supplied separately to the model.

Figure 11.4 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 under estimation of catch 1993–2000. Figure 11.5 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 11.6 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 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. For the UKFsPW survey a poor fit to the 2009 index is observed. 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 11.8 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 11.9 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 use of current specified selectivity blocks may require review at annual at regular intervals. With advice and management for haddock or other species it is possible that the character of the fishery may change. In recent years 2013–present it has been observed that targeted fishing of haddock has increased, due to the strength of the 2013 year class. As this year class has matured and the cohort progressed full selection of the older fish may need to be taken into consideration in model configuration. At present this selectivity period is too short to be parameterised robustly.

Comparison with previous assessments

Figure 11.10 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.

State of the stock

Following a period of sustained decline, since 2008, SSB increase during 2010–2013. A short-term decline was observed in 2014 but was reversed, and 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.

11.4 Short-term projections

Short-term projections were performed using FLR libraries. Recruitment for 2017–2019 was estimated at 337738 (GM 1993–2014; thousands). Following the introduction of the current ASAP model to provide advice for 2017 allowing a MSY approach to be applied the catch advice for the stock has been changed considerably comparable to previous years. The F used in the forecast was derived as the F related to the TAC for 2017. The TAC for 2017 (2615 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 last ten years (345 t) suggesting that landings in 2017 could be approximately 2270 equating to an F = 0.26.

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 7.4.9. The management options output is given in Table xx.xx.

Estimates of the relative contribution of recent year classes to the 2017 landings and 2018 SSB are shown in Figure 11.11. As the very strong 2013 year class continues move through the fishery the contribution to landings in 2018 is spread across three cohorts with the 2015 cohort contributing the most (40%) followed by the 2013 cohort (32%).

11.5 Biological reference points

MSY evaluations

At WKIrish 3 (2017) B_{lim} was set to the SSB in 1993, from which the fishery developed, an SSB of 2300 t in 1993. The S–R plot for Irish Sea haddock shows no obvious S–R relationship (Figure 9), mainly because the recruitment is highly variable. The S–R pairs from 1993:2012 were not used initially as the 2013 recruitment event and 2015 SSB were considered to be highly influential. The fitted relationship, compared to the selecting B_{lim} at 2300 t provides a B_{lim} of 4035 t, a value which has only been exceeded on eight occasions.

B_{lim} was estimated as 3093 t. $MSYB_{trigger}$ is set to B_{pa} as the stock has not been fished at or below F_{MSY} for more than five years. F_{MSY} median point estimates is 0.27 (0.273). The upper bound of the F_{MSY} range giving at least 95% of the maximum yield was estimated to 0.35(0.351) and the lower bound at 0.19(0.192). $F_{p.05}$, without assessment error or $B_{trigger}$ is estimated 0.39 (0.392) and therefore the upper bound does not need to be restricted because of precautionary limits. F_{lim} is estimated to be 0.47 (0.473) as F with 50% probability of SSB $<B_{lim}$ with F_{pa} as 0.34 (0.341) calculated as F_{lim} combined with the assessment error; F_{lim} x exp(-1.645 x σ); σ = 0.32.

Yield and biomass-per-recruit

Not available for this stock, previous explorations are detailed in the stock annex.

11.6 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).

11.7 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, the assessment relies on 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 one in five trips observed and 2.8% of (OTB_CRU) 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. 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.

11.8 Recommendations for next benchmark assessment

This stock was be benchmarked through the WKIRISH process in 2016–2017.

11.9 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. Nominal landings (t) of HADDOCK in Division 7.a, 1984–2012, 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*
Belgium	7	7	5
France	0	7	1
Ireland	541	507	632
Netherlands	-	-	
UK (England & Wales)[1]	-	-	
UK (Isle of Man)	<1	<1	
UK (N. Ireland)	...	-	
UK (Scotland)	-	-	
United Kingdom	426	633	825
Total	974	1154	1463

*** 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, 1972–2015, 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
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

Year	Official landings	WG landings	ICES discards**	ICES catch	% Discard	Landings taken or reported in rectangles 33E2 and 33E3
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	3006	10%	455

Table 11.3. 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

Table 11.4. 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

Table 11.7. 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 2016
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

```
NIGFS-WIBTS-Q4
1991 2016
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	102.771	157.551	45.104	4.126	0.29

```
NIMIK
1994 2013
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	18000

```
UKFspW
2005 2016
1 1 0.15 0.25
1 7
1       0.000   1.774   1.506   4.981   0.291   0.256   0.018
1       0.308   7.749   7.336   0.546   1.115   0.043   0.048
1       0.208   42.727  37.286  6.289   0.697   0.147   0.020
1       0.000   4.657   12.836  7.213   0.794   0.126   0.062
1       0.000   0.662   3.990   1.443   0.541   0.115   0.031
1       0.627   1.422   3.780   2.753   0.866   0.104   0.037
1       0.048   0.598   1.976   1.121   0.810   0.184   0.058
1       0.270   4.135   4.772   0.790   0.226   0.443   0.054
1       0.035   3.684   7.674   1.742   0.176   0.162   0.045
1       0.434   32.100  19.729  5.160   0.563   0.189   0.036
1       0.000   0.000   59.769  12.592  6.205   0.832   0.531
```

Table 11.9. Forecast input data.

Variable	Value	Source	Notes
F ages 2–4 (2017)	0.26006	ICES (2017a)	F in 2017 predicted for TAC, adjusted for annual reallocation of landings from rectangles 33E2 and 33E3 (ten year average value)
SSB (2017)	18974 t	ICES (2017a)	Short-term forecast
$R_{age\ 0}$ (2017 and 2018) (thousand)	337738	ICES (2017a)	Geometric mean (1993–2014)
Catch (2017)	2171 t	ICES (2017a)	Short-term forecast, assuming F = 0.26006
Wanted catch * (2017)	1791 t	ICES (2017a)	Average discard pattern (2013–2016)
Unwanted catch *(2017)	380t	ICES (2017a)	Average discard pattern (2013–2016)

*** "Wanted catch" is used to describe fish that would be landed in the absence of the EU landing obligation.**

Table 11.10. Haddock in Division7.a. Annual catch options. All weights are in tonnes.

Basis	Total catch (2018)	Wanted catch* (2018)	Unwanted catch* (2018)	F_{total} (2018)	F_{wanted} (2018)	$F_{unwanted}$ (2018)	SSB (2019)	% SSB change **	% TAC change ***
ICES advice basis									
MSY approach: F_{MSY}	3914	3225	689	0.273	0.20542	0.06758	15023.18	-20.8223%	23.32696%
Other options									
F = 0	0	0	0	0	0	0	16460.91	-13.2449%	-100%
F_{pa}	4234	3437	798	0.34	0.25583	0.08417	12721.26	-32.9543%	31.4340%
F_{lim}	4987	4047	940	0.41	0.3085	0.1015	12075.67	-36.3568%	54.7610%
SSB (2019) = B_{lim}	18265	14603	3662	2.8967	2.17958	0.71712	2300	-87.8782%	458.4321%
SSB (2019) = B_{pa}	16899	13561	3338	2.4139	1.8163	0.59759	3093	-83.6988%	418.5851%
SSB (2019) = MSY $B_{trigger}$	16899	13561	3338	2.4139	1.8163	0.59759	3093	-83.6988%	418.5851%
F = F_{2017}	3258	2647	611	0.25224	0.18979	0.06245	13672.8	-27.9393%	1.2237%
F = $F_{MSY\ lower}$	2516	2043	473	0.192	0.14447	0.04753	14217.65	-25.0677%	-21.8738%
F = $F_{MSY\ upper}$	4355	3535	821	0.351	0.26411	0.08689	12617.29	-33.5022%	35.1816%

Table 11.8. Haddock in 7.a: SURBA fitted numbers-at-age, total mortality-at-age, SSB and Z using the NIGFS-WIBTS-Q1 survey data.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	3093 t	B_{pa}	ICES (2017)
	F_{MSY}	0.27	Median point estimates of EqSim with segmented regression stock–recruitment relationship	ICES (2017)
Precautionary approach	B_{lim}	2300 t	Lowest observed: SSB in 1993	ICES (2017)
	B_{pa}	3093 t	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.15$	ICES (2017)
	F_{lim}	0.47	F with 50% probability of SSB < B_{lim}	ICES (2017)
	F_{pa}	0.34	F_{lim} combined with the assessment error; $F_{lim} \times \exp(-1.645 \times \sigma)$; $\sigma = 0.2$	ICES (2017)
Management plan	SSB_{MGT}	Not applicable		
	F_{MGT}	Not applicable		

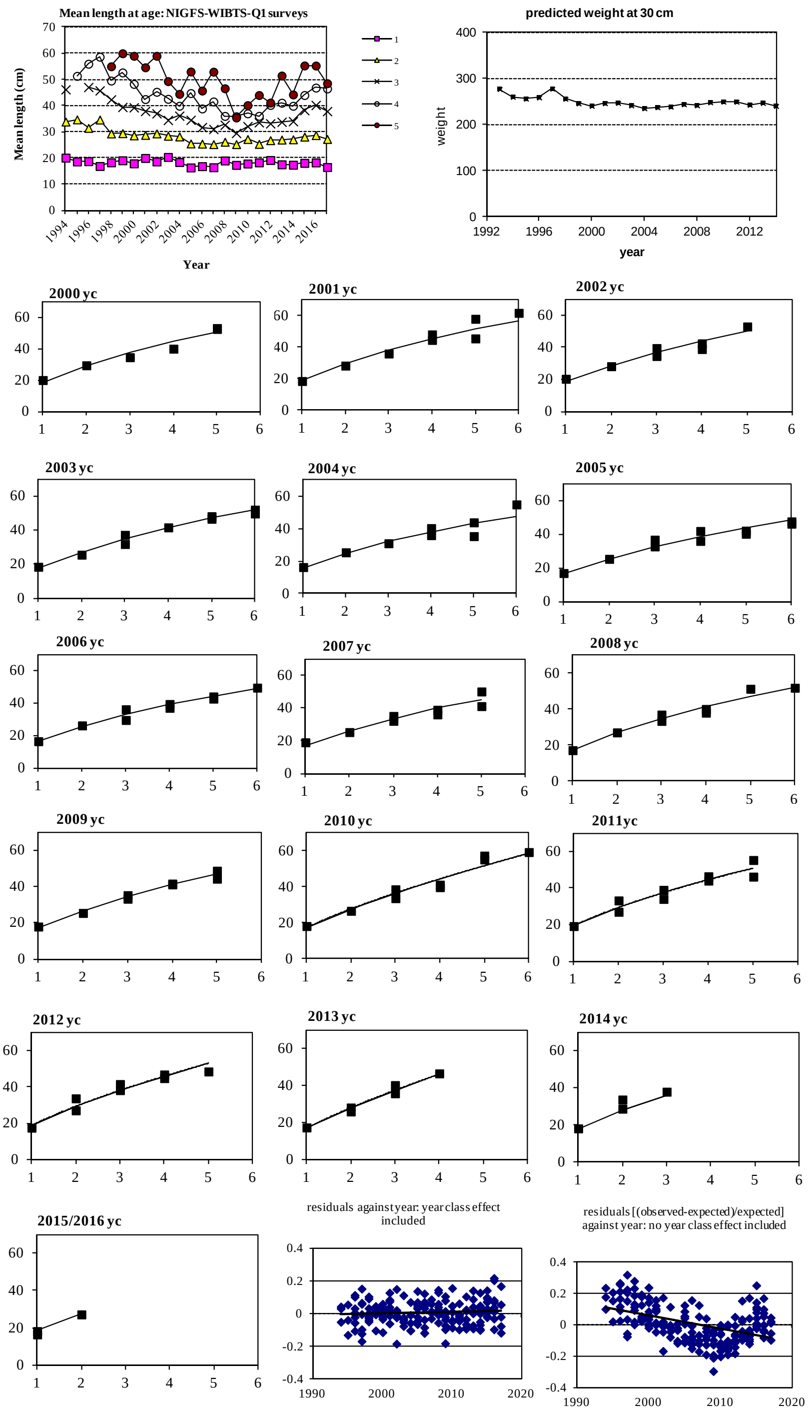


Figure 11.1. Haddock in 7.a: Growth of haddock in the Irish Sea. Top two panels: mean length-at-age in UK(NI) groundfish surveys in March (NIGFS-WIBTS-Q1), by year and age, and expected mean weight-at-length based on length–weight parameters from each survey. Lower panels: mean length-at-age from March 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.

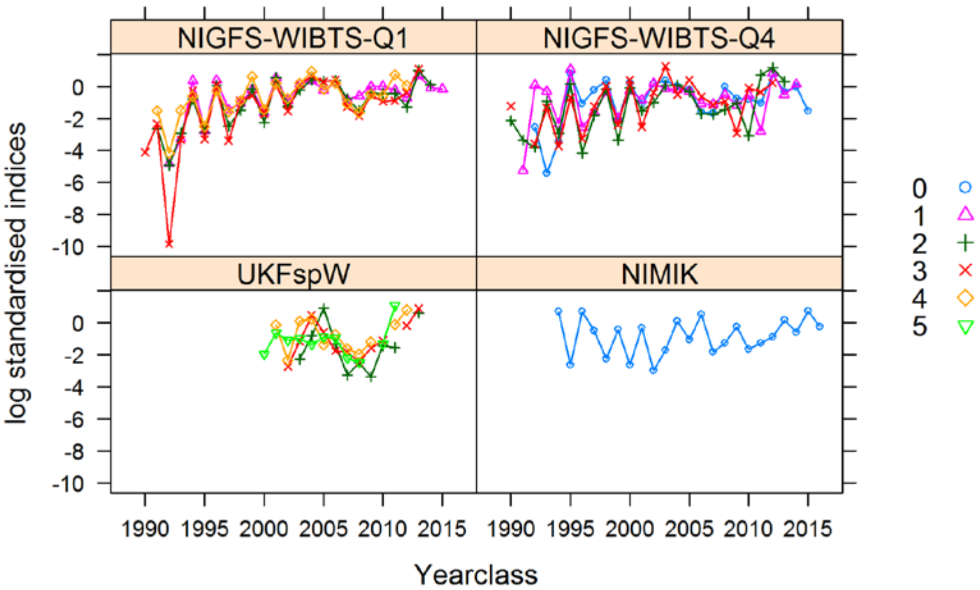


Figure 11.2. Haddock in 7.a: Trends in raw survey indices compared with international landings, by age class and year. All values are standardised to the mean for years common to all series in each plot (except for short FSP series).

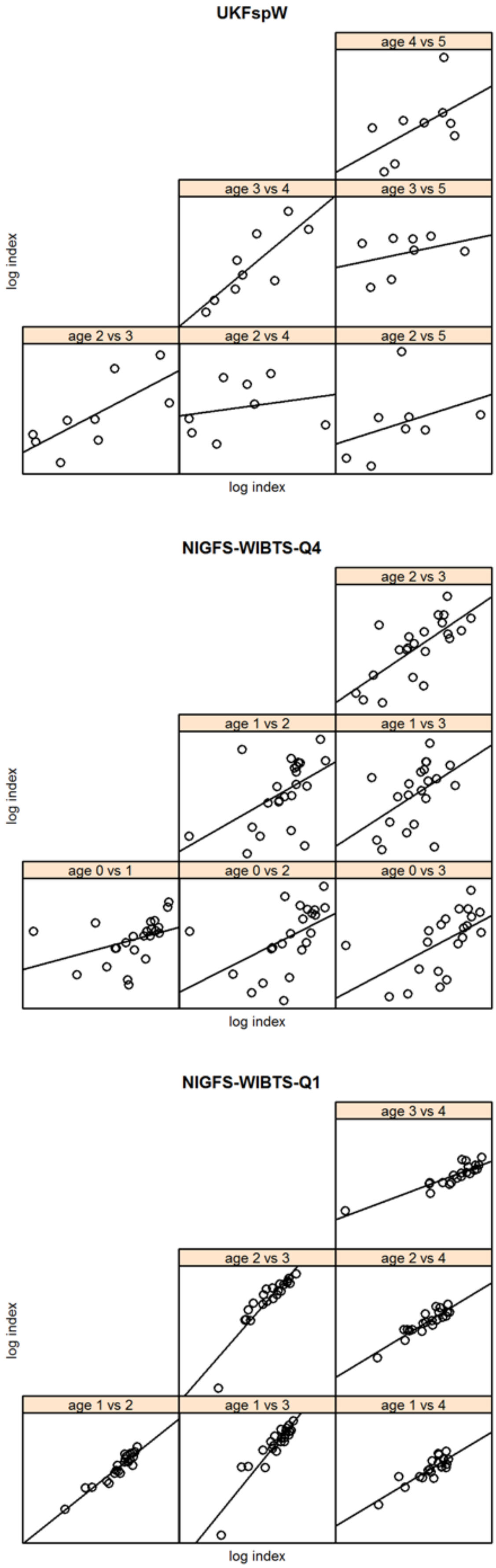


Figure 11.3. Haddock in 7.a: Scatterplot matrix of log indices of cohorts at different ages.

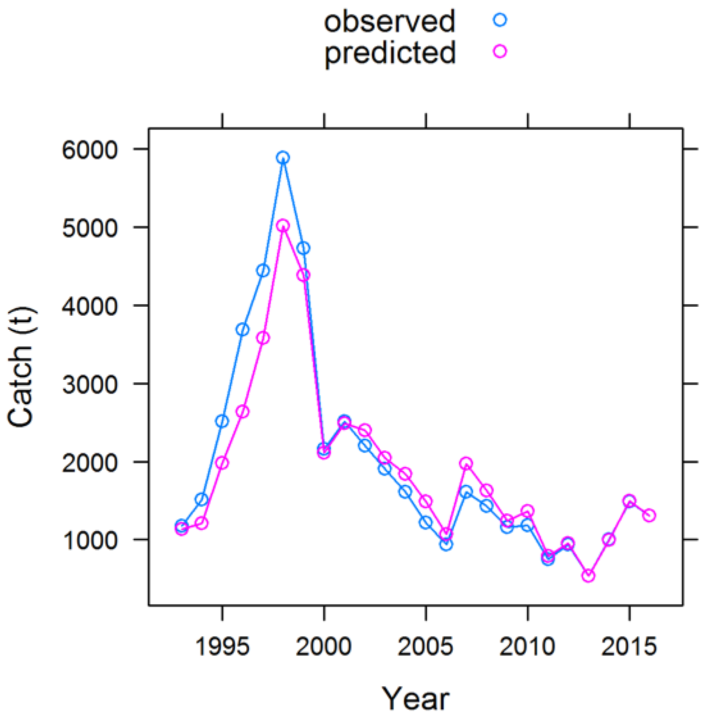


Figure 11.4. Fitted and observed catch from update assessment.

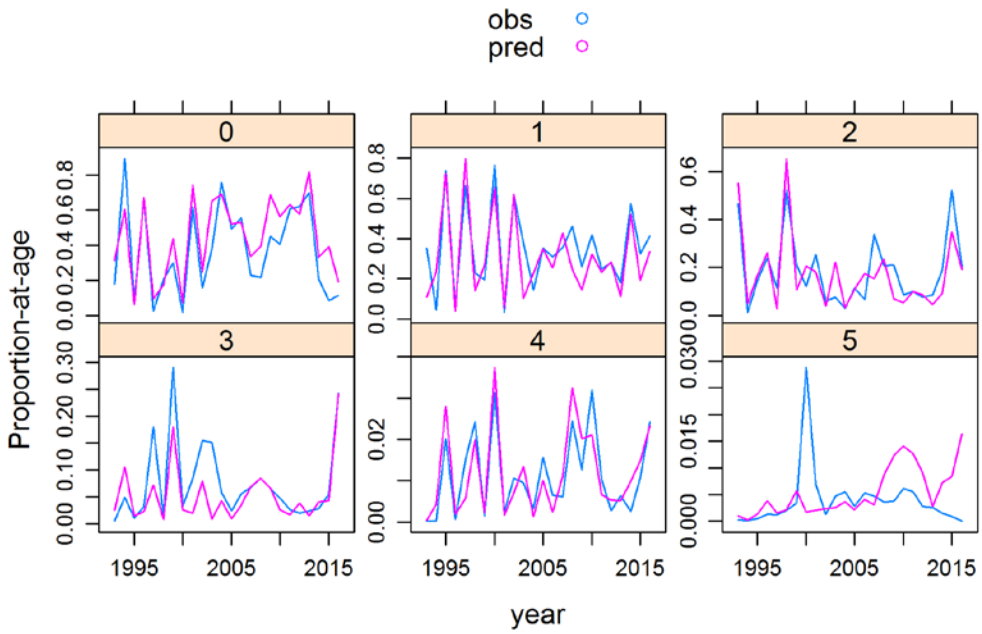


Figure 11.5. Fitted and observed catch age proportions from update assessment.

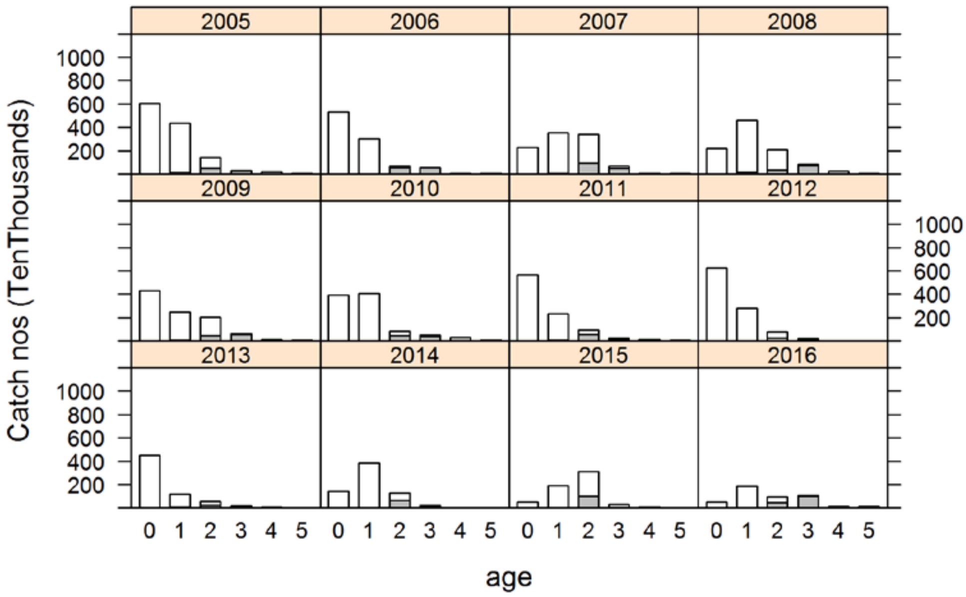


Figure 11.6. Observed catch numbers 2005–present.

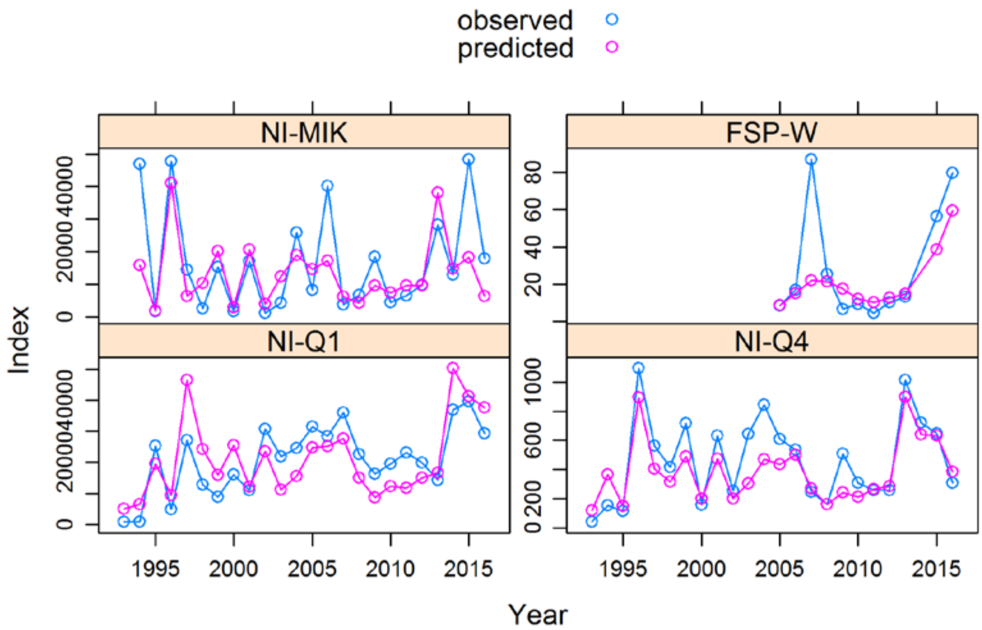


Figure 11.7. Fitted and observed index series from update assessment.

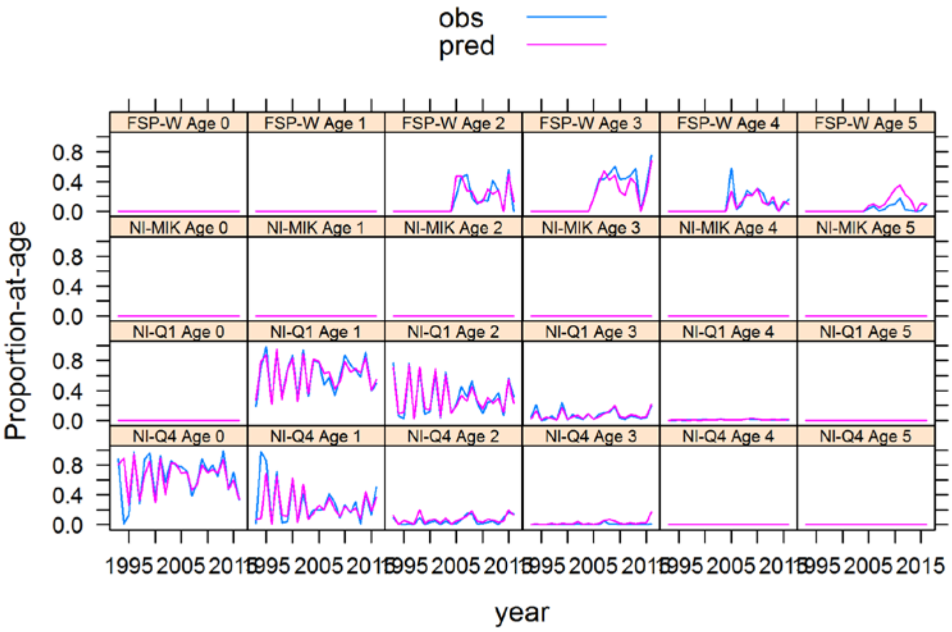


Figure 11.8. Fitted and observed index age proportions from update assessment.

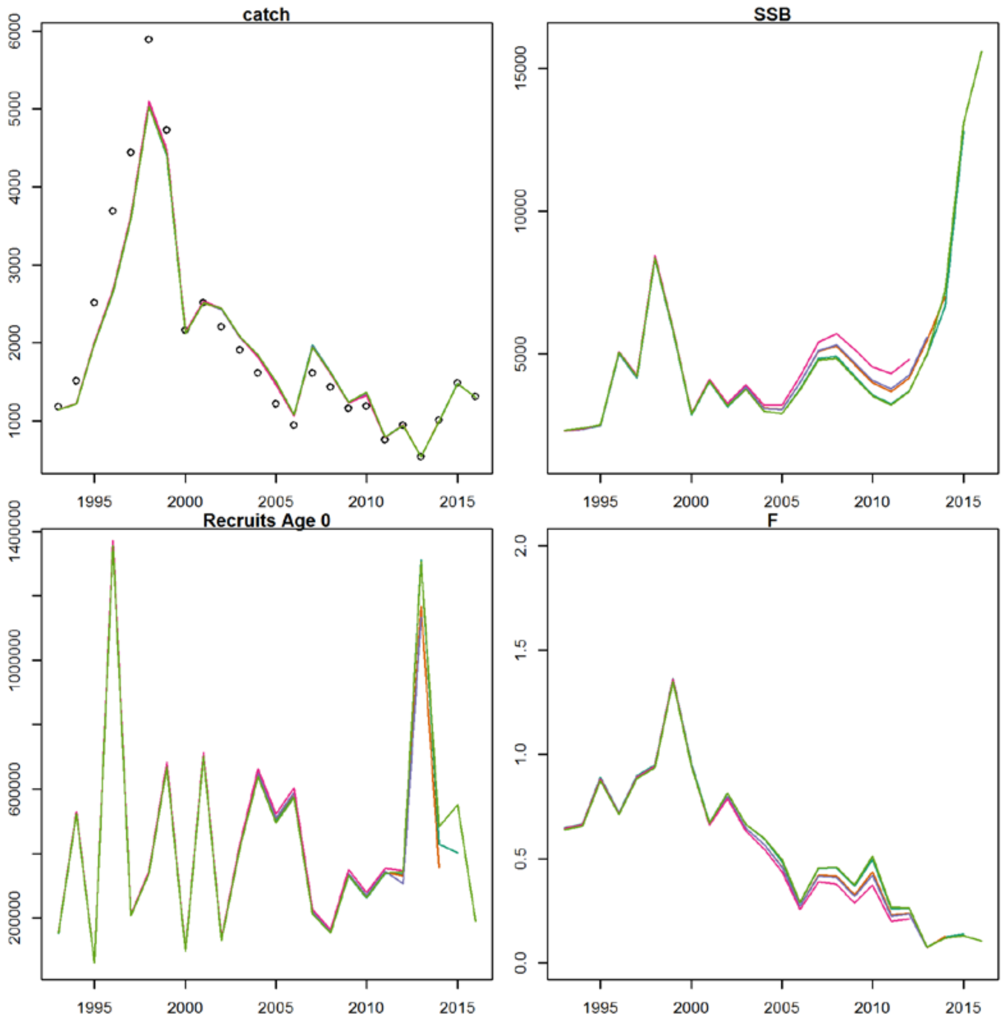


Figure 11.9. A retrospective plot the final update model.

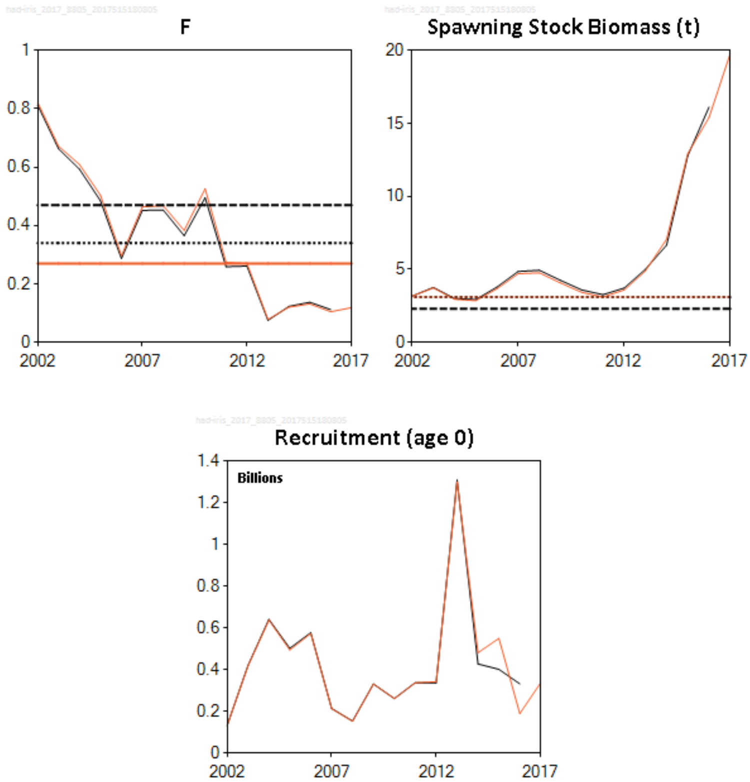


Figure 11.10. Haddock in Division7.a. Historical assessment results.

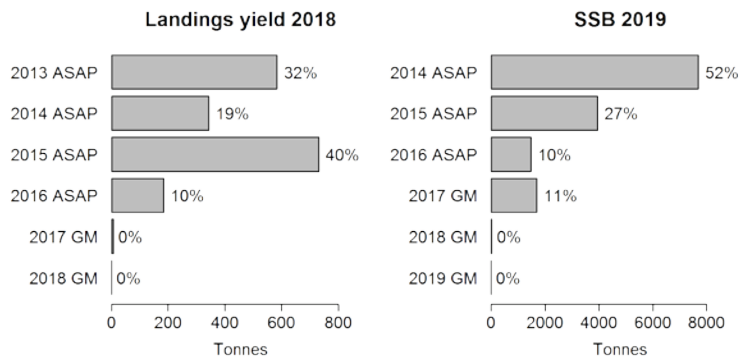


Figure 11.11. Haddock in 7a. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

11.10 Audit of Haddock in the Irish Sea (had.27.7.a)

Date: 07/06/2017

Auditor: Andrzej Jaworski

General

ICES provides annual catch advice for this stock based on the MSY approach. A full analytical assessment and forecast were performed in 2017 in accordance with the procedures outlined in the stock annex. The assessment is based on an age-structured model.

For single stock summary sheet advice:

1) **Assessment type:** Update (following the WKIrish3 benchmark assessment). Age-structured assessment. The stock was benchmarked by WKIrish in 2017.
2) **Assessment**: Age-structure assessment. Stock Category 1.
3) **Forecast**: Short-term forecast is presented. Conducted using FLR libraries. The introduction of ASAP has considerably changed the catch advice compared to previous years.
4) **Assessment model**: Age-structured assessment model using Age-Structured Assessment Program (ASAP) with commercial catches and four survey indices.
5) **Consistency**: There is close agreement of the stock trends in the current assessment and the benchmark assessment.
6) **Stock status**: Spawning–stock biomass (SSB) is currently at the highest observed levels in the time-series and above MSY $B_{trigger}$. Fishing mortality (F) has been below F_{MSY} since 2012. The stock is characterized by highly variable recruitment. Recent recruitment has been above the time-series mean.
7) **Man. Plan**: No specific management plan has been agreed or proposed.

General comments

The report was generally well written and the assessment followed the methods detailed in the stock annex.

Technical comments

ASAP analysis was correctly performed. There were some small editorial errors.

Conclusions

The assessment has been performed correctly and provides an appropriate basis for providing catch advice.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice? **Yes**
- Is the assessment according to the stock annex description? **Yes**

- Is general ecosystem information provided and is it used in the individual stock sections. **Yes**
- If a management plan has been agreed, has the plan been evaluated? **No**

For update assessments

- Have the data been used as specified in the stock annex? **Yes**
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? **Yes**
- Is there any **major** reason to deviate from the standard procedure for this stock? **No**
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? **Yes**

12 Haddock in Divisions 7.b,c,e–k

Type of assessment in 2017

Update assessment procedure.

ICES advice applicable to 2017

Last year's full advice is available in the ICES Advice 2016, Book 5. The headline advice was as follows:

"ICES advises that when the MSY approach is applied, catches in 2017 should be no more than 12 444 tonnes. If discard rates do not change from the average of the full time-series (1993–2015), this implies landings of no more than 7751 tonnes."

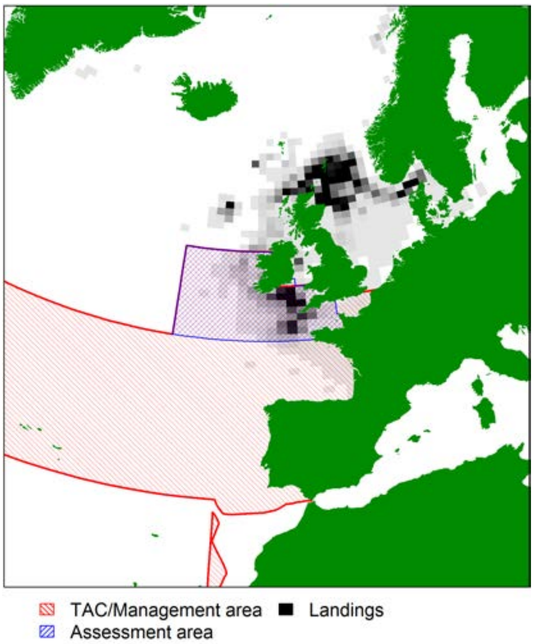
12.1 General

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 2015. 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).



2016 management (Council Regulation (EU) 2016/72)

Species:	Haddock *Melanogrammus aeglefinus*	**Zone:**	VIIb-k, VIII, IX and X; Union waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	81		
France	4 838		
Ireland	1 613		
United Kingdom	726		
Union	7 258		
TAC	7 258		Analytical TAC Article 12(1) of this Regulation applies

2017 management (Council Regulation (EU) 2017/127)

Species:	Haddock *Melanogrammus aeglefinus*	**Zone:**	VIIb-k, VIII, IX and X; Union waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	86		
France	5 168		
Ireland	1 722		
United Kingdom	775		
Union	7 751		
TAC	7 751		Analytical TAC Article 7(2) of this Regulation applies Article 12(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.

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. No revisions to the landings or discard figures for 2015 were provided.

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 2002–2003 and perhaps after (Table 7.4.1a and Figure 7.4.2b). (WGSSDS05 provided some qualitative evidence that misreporting 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.

12.1.1 Information from the industry

The French and Irish fishing industry have reported that the abundance and distribution of haddock has increased a lot in 2016. Due to the restrictive TAC the industry have reported to national scientists that there is increased discarding of haddock.

12.1.2 Data

Numbers-at-length

Discard and retained catch–length distributions for 2015 and 2016 are shown in Figure 7.4.4. Significant numbers of discarded fish were above the MLS, which is likely to be the result of restrictive quota.

Figure 7.4.5a shows the available time-series of catch (discards and retained catch) length distributions. The Irish fleet in 7.b generally catches smaller fish than the other fleets although the retained catches appear similar to the Irish 7.gj fleets. The French fleets tend to catch fewer small fish and discard larger fish than the Irish fleets although this was not the case in 2014. Figure 7.4.5b shows the time-series of discard ogives. Discarding of fish over the minimum landing size of 30 cm has occurred in all years although nearly all fish >35 cm were landed up to 2010. Since then increasing proportions of large fish have been discarded.

Landings and discard numbers-at-age

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. The remaining unsampled catches were minor (Figure 7.4.6). For métiers where discards were not provided, the discards were estimated from the discard rate of métiers that had both landings and discards. The allocation rules were simple and slightly different from those described in the stock annex: any unsampled catches were allocated age compositions from the combined annual landings or discards of all countries using the same gear type (otter trawl, beam trawl, seine, gillnet or miscellaneous). An alternative allocation rule that merged all sampled landings/discards and applied to the unsampled landings/discards resulted in nearly identical estimates.

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 7.4.7 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).

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.

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 7.4.9a and by cohort in Figure 7.4.9b. Figure 7.4.10 shows the scatterplot matrices of the log indices. These plots suggest that the internal consistency of the indices is quite good. The IR-GAD index (Figure 7.4.9.a) shows an increasing trend over time, mainly as a result of the relatively strong 2002 and 2009 cohorts.

12.1.3 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 2.5.20170215 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\Stock\had-7bce–k' on SharePoint.

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 7.4.11 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 observed and predicted catches are shown in Figure 7.4.12. The predicted catches were slightly lower than observed in most recent years while they were generally higher than observed from 2002–2006.

The residuals of the index proportions-at-age are shown in Figure 7.4.13a. The 2009 year class consistently has positive residuals in the survey index while the 2010 year class has negative residuals, indicating that the model does not 'believe' that the 2009 cohort is as strong as the index suggests. However, right-hand panel of the figures shows that the difference between observed and predicted values for this cohort are minor. The observed and predicted index cpue values are shown in Figure 7.4.14. The model closely follows the survey index but in there is a bias in the last few years for the IRL-GAD fleet that shows up in Figures 7.4.14 and 7.4.11 as a strong positive residual on the 2009 year class at ages 4 to 6. There catches of this year class may be underestimated, which could cause the retrospective bias in F (see below).

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).

Figure 7.4.15 shows the retrospective analysis. The predicted catch shows no obvious retrospective pattern, neither does the recruitment estimate. However, the SSB has a tendency to be revised upwards as another year of data was added. F has been overestimated recently and revised downwards with the addition of another year. It is likely that this retrospective bias appears to have been caused by the strong 2009 cohort for which caused a conflict between the catch data and the IRL_GAD index: the index (Figure 7.4.11) shows large negative residuals for the young ages and positive residuals for this cohort at ages five and six.

Comparison with previous assessments

Figure 7.4.16 shows the comparison of the current assessment with previous ASAP and XSA assessments. The 2017 assessment has revised F down for the last couple of years. The plot also shows the intermediate-year assumptions for the short-term forecast (for SSB the assumption is for the intermediate year + 1). These assumptions appear to have been reasonable.

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 and Figure 7.4.17.

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 and SSB appears to have stabilised. Fishing mortality (F) has been above F_{MSY} for the entire time-series but shows a declining trend.

12.1.4 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 2017. The short-term predictions however, are expected to give a reasonably reliable estimate of landings in 2018 (assuming average F 2013–2015), which are largely based on the estimates of the 2014 and 2016 recruitments. In the past, recruitment has generally been accurately estimated.

Short-term projections were performed using FLR libraries. Recruitment for 2017–2019 was estimated at 257 583 (GM 1993–2013; 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.

Estimates of the relative contribution of recent year classes to the 2018 landings and 2019 SSB are shown in Figure 7.4.18. The relatively high recruitment in 2015 accounts for over half of the projected landings in 2018. The GM assumption only accounts for 4% of the landings in 2018. The 2015 cohort also contributes considerably to the estimated SSB in 2018 but much of this estimate results from the 2017 GM assumption. At GM recruitment and *status quo* F, SSB will remain well above $B_{trigger}$.

12.1.5 MSY evaluations and biological reference points

ICES carried out and evaluation of MSY and PA reference points for this stock last year 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 (2016b)
	F_{MSY}	0.40	Median point estimates of EqSim with segmented regression S–R relationship (landings: 0.36 + discards: 0.04).	ICES (2016b)
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 (2016)
	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	SSB_{MGT}	Undefined		
	F_{MGT}	Undefined		

12.1.6 Management plans

No management plan for 7.b,c,e–k haddock has been agreed or proposed.

12.1.7 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 approaches, although the assessment is contingent on the accuracy of the landings statistics.

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

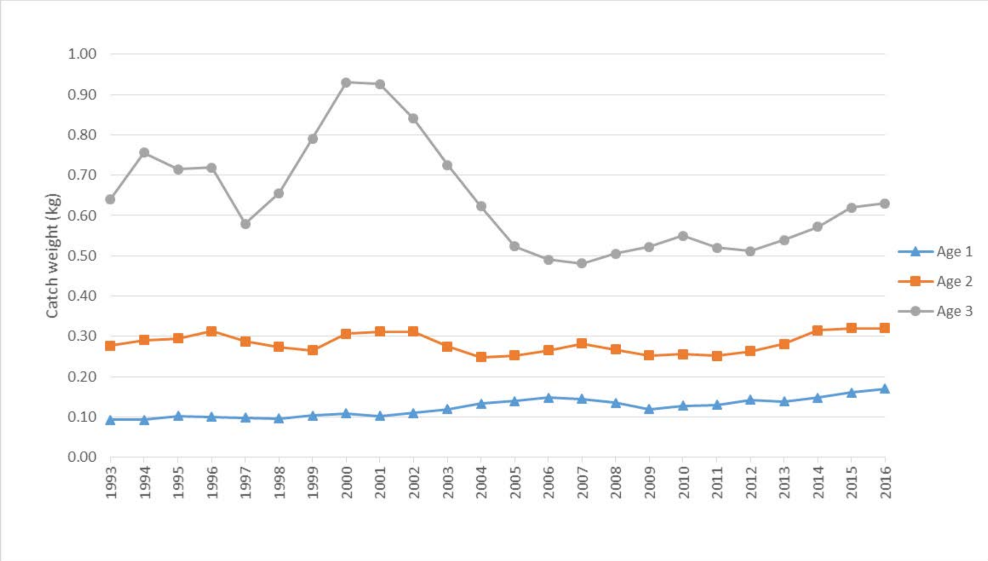
WKROUND (2012) concluded that the ASAP assessment is relatively robust to the uncertainty in the discard estimates.

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 due to the small sample sizes is likely to be high but the cost of increasing discard coverage would be considerable.

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 7.4.11).
- 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 2009 (Figure below). The catch weights of 2-year-olds increased between 2011 and 2014 and has been stable since, 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.

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.

Forecast

The 2015 cohort accounts for over half the projected landings in 2018, with recruitment of this cohort estimated with a CV of 42%, 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 in all divisions covered by the survey and by both the French and Irish component of the survey index.

The 2017 GM recruitment assumption does not contribute much to the forecasted landings in 2018 (4% contribution); however it contributes 54% to the 2018 SSB estimate; this adds considerable uncertainty to the 2018 SSB forecast.

12.1.8 Recommendation for next benchmark

Stock audit

The audit of the 2016 report did not raise any concerns.

Recommendations for future work

WGCSE recommend that cod, haddock and whiting in the Celtic Sea should be benchmarked together in 2018. The focus of the benchmark would be on 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 should also relook at the assessment methods and diagnostics given the potential for changes in selectivity in the commercial fishery. The benchmark should also investigate mixed fisheries and multispecies interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species.

The 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 a lower 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 if there is any worth in retaining the commercial tuning fleet. If this fleet is to be retained it would be useful to apply some sort of standardisation to account for possible changes in the fleet.

12.1.9 Management considerations

The stock size fluctuates strongly over the time. The size of the stock is determined to a large extent by recruitment, which is erratic. 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 very robust to over-fishing. On the other hand, at current levels of F the SSB could quickly fall below B_{loss} if recruitment is low for three or four years (B_{loss} has been proposed as $B_{trigger}$). Current SSB is well above B_{loss}.

The variable recruitment has also resulted in substantial short-term variability in TACs and high discards have occurred when a strong year class occurs. Discarding of undersize as well as marketable fish is a serious problem for this stock: over the last ten years over 77% of the catch numbers and 45% of the catch weight has been discarded. Alternative or complimentary approaches to managing such strong, recruit-driven fluctuations are required, especially with regard to the upcoming discard ban.

The minimum landing size of haddock is 30 cm, which is about 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.

12.1.10 References

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%)	85	4348 (70%)	2188 (106%)	315 (34%)	21	7089	9300
2003	118 (130%)	82	5781 (106%)	1867 (103%)	393 (48%)	0	8241	8185
2004	136 (127%)	143	6130 (96%)	1715 (80%)	313 (33%)	16	8453	9600
2005	167 (130%)	197	4166 (54%)	2037 (80%)	292 (25%)	0	6859	11520
2006	99 (77%)	185	3190 (42%)	1875 (73%)	274 (24%)	24	5647	11520
2007	119 (93%)	49	4142 (54%)	1930 (75%)	386 (34%)	3	6629	11520
2008	108 (84%)	121	3639 (47%)	1800 (70%)	566 (49%)	0	6234	11579
2009	131 (102%)	47	5429 (70%)	2983 (116%)	716 (62%)	1	9307	11579
2010	170 (132%)	127	6240 (81%)	2609 (101%)	852 (74%)	1	9999	11579
2011	211 (143%)	94	8388 (94%)	3322 (112%)	1659 (125%)	35	13709	13316
2012	231 (125%)	105	11793 (106%)	4130 (112%)	1901 (114%)	62	18222	16645
2013	173 (110%)	3	8748 (93%)	2699 (86%)	1455 (103%)	20	13098	14148
2014	99 (94%)	3	6374 (101%)	2092 (99%)	785 (83%)	18	9371	9479
2015	117 (126%)	0	5681 (102%)	1656 (89%)	759 (91%)	4	8217	8342
2016	88 (103%)	0	4487 (87%)	1713 (99%)	692 (91%)	26	7007	7751

*** 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				

*** 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	4.77	150	4.34	78	2.91	21.2
2016	NA	NA	39	2.76	163	6.24	83	3.09	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	60	330	5509	201	94	394	476	45

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

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
24
# 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
# 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
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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 0.197 0.316 0.736 1.1 1.548 1.816 1.433 1.888
# 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 0.138 0.281 0.539 0.848 1.348 1.846 2.166 2.383
0.055 0.148 0.315 0.572 0.824 1.251 1.617 1.922 2.115
0.07 0.16 0.32 0.62 0.87 1.15 1.65 1.82 2
0.08 0.17 0.32 0.63 0.93 1.17 1.63 1.79 1.97
# 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
# 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 22650 4446 12503 281 98 427 787 46 17931
# 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
# 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
# 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 250.4 0.2 38.6 166.8 31.8 12.2 0.7 0.3 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 3.057 0.3 0 0 0 0.378 0.166 0.521 1.902 0.089 0 40
2016 5.142 0.3 0 0 0 4.286 0.125 0.049 0.253 0.429 0 40
# 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
# 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
# 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
# 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
# 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
# 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
2017
# Projection Data by Year
2017 -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	0.396	1.066	1.088	1.088	1.088	1.088	1.088	1.088
1994	0	0.382	1.029	1.051	1.051	1.051	1.051	1.051	1.051
1995	0	0.308	0.830	0.847	0.847	0.847	0.847	0.847	0.847
1996	0	0.302	0.815	0.832	0.832	0.832	0.832	0.832	0.832
1997	0	0.250	0.674	0.688	0.688	0.688	0.688	0.688	0.688
1998	0	0.273	0.736	0.752	0.752	0.752	0.752	0.752	0.752
1999	0	0.189	0.510	0.520	0.520	0.520	0.520	0.520	0.520
2000	0	0.237	0.639	0.652	0.652	0.652	0.652	0.652	0.652
2001	0	0.251	0.675	0.689	0.689	0.689	0.689	0.689	0.689
2002	0	0.454	1.223	1.248	1.248	1.248	1.248	1.248	1.248
2003	0	0.234	0.629	0.643	0.643	0.643	0.643	0.643	0.643
2004	0	0.281	0.758	0.774	0.774	0.774	0.774	0.774	0.774
2005	0	0.293	0.789	0.805	0.805	0.805	0.805	0.805	0.805
2006	0	0.186	0.502	0.513	0.513	0.513	0.513	0.513	0.513
2007	0	0.147	0.396	0.404	0.404	0.404	0.404	0.404	0.404
2008	0	0.263	0.709	0.724	0.724	0.724	0.724	0.724	0.724
2009	0	0.205	0.553	0.565	0.565	0.565	0.565	0.565	0.565
2010	0	0.216	0.582	0.594	0.594	0.594	0.594	0.594	0.594
2011	0	0.165	0.445	0.454	0.454	0.454	0.454	0.454	0.454
2012	0	0.209	0.562	0.574	0.574	0.574	0.574	0.574	0.574
2013	0	0.182	0.489	0.499	0.499	0.499	0.499	0.499	0.499
2014	0	0.193	0.519	0.530	0.530	0.530	0.530	0.530	0.530
2015	0	0.190	0.511	0.521	0.521	0.521	0.521	0.521	0.521
2016	0	0.245	0.660	0.674	0.674	0.674	0.674	0.674	0.674

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	110936	49973	11947	2791	794	252	256	225	75
1994	381728	41221	16376	2258	570	174	57	60	71
1995	528864	141841	13693	3210	479	130	41	14	32
1996	149612	196514	50740	3277	835	134	37	12	14
1997	75711	55592	70690	12328	865	236	39	11	8
1998	158254	28132	21071	19774	3758	283	80	14	7
1999	419100	58803	10420	5538	5657	1153	89	26	7
2000	398204	155728	23690	3435	1997	2187	459	37	14
2001	449757	147963	59807	6865	1086	677	764	165	18
2002	794417	167119	56052	16705	2090	354	228	265	64
2003	216734	295187	51665	9054	2907	390	68	45	66
2004	279581	80533	113749	15110	2888	995	138	25	41
2005	269409	103886	29589	29257	4228	867	308	44	22
2006	199665	100106	37732	7378	7932	1229	260	95	21
2007	703294	74191	40439	12531	2680	3090	493	107	48
2008	367760	261328	31179	14939	5074	1164	1383	228	73
2009	1738552	136651	97773	8421	4394	1601	378	463	102
2010	215775	646006	54164	30850	2903	1625	610	149	225
2011	56642	80177	253350	16609	10329	1042	601	233	146
2012	40546	21047	33084	89097	6396	4266	444	264	169
2013	530150	15066	8315	10349	30444	2344	1611	173	171
2014	119004	196992	6116	2798	3810	12020	954	675	147
2015	450962	44219	79079	1997	999	1459	4742	388	339
2016	44344	167567	17807	26042	719	386	581	1945	304

Table 7.4.8. Haddock in 7.bc–ek. Stock Summary: weights in tonnes; CatchPred is prediced 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	4676	16678	7482	0.211	110936	0.212	1.088	0.246
1994	4131	1886	6017	5346	27835	7969	0.220	381728	0.184	1.051	0.236
1995	4470	2218	6688	6494	45661	7394	0.195	528864	0.160	0.847	0.258
1996	6756	4309	11065	12228	46204	19671	0.183	149612	0.199	0.832	0.257
1997	10827	2883	13710	13365	37264	28560	0.157	75711	0.222	0.688	0.257
1998	7928	934	8862	9941	30943	22386	0.159	158254	0.193	0.752	0.244
1999	4970	586	5556	5984	31852	14060	0.160	419100	0.182	0.520	0.289
2000	7499	2503	10002	10675	45031	17306	0.167	398204	0.207	0.652	0.277
2001	9278	3418	12696	16421	54173	29186	0.167	449757	0.174	0.689	0.303
2002	6488	7073	13561	23560	71247	36181	0.203	794417	0.140	1.248	0.233
2003	8292	9456	17748	17076	65349	25237	0.165	216734	0.156	0.643	0.268
2004	8777	6750	15527	21988	62916	43258	0.141	279581	0.131	0.774	0.242
2005	6787	5191	11978	14593	53833	29425	0.152	269409	0.125	0.805	0.232
2006	5593	2484	8077	10525	46904	23503	0.138	199665	0.139	0.513	0.285
2007	6781	2739	9520	8527	64440	24848	0.131	703294	0.106	0.404	0.267
2008	7455	11187	18642	15314	76782	23850	0.130	367760	0.131	0.724	0.178
2009	9608	9080	18688	15995	135880	36168	0.109	1738552	0.090	0.565	0.187
2010	10262	16547	26809	25468	128894	37358	0.119	215775	0.139	0.594	0.183
2011	12879	14378	27257	27682	98047	85188	0.092	56642	0.193	0.454	0.191
2012	18376	10191	28567	25475	72814	68042	0.101	40546	0.207	0.574	0.160
2013	13424	2085	15509	13364	71354	40647	0.113	530150	0.111	0.499	0.182
2014	9854	3177	13031	12053	60554	24854	0.141	119004	0.196	0.530	0.202
2015	8545	6694	15239	15031	76940	38298	0.118	450962	0.159	0.521	0.218
2016	7594	10337	17931	17323	60285	28251	0.153	44344	0.424	0.674	0.252
2017*	NA	NA	NA	NA	NA	32936	NA	257583	NA	0.575	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.

2017

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	257583	0.99	0	0	0	0.068	0.000	0.000	0.000	0.068
1	16477	0.72	0	0	0	0.159	0.012	0.397	0.197	0.161
2	63842	0.60	1	0	0	0.318	0.188	0.678	0.376	0.304
3	5051	0.50	1	0	0	0.607	0.427	0.885	0.148	0.501
4	8052	0.43	1	0	0	0.875	0.534	1.082	0.041	0.604
5	238	0.40	1	0	0	1.190	0.571	1.344	0.004	0.869
6	132	0.37	1	0	0	1.632	0.572	1.675	0.003	0.769
7	204	0.36	1	0	0	1.844	0.563	1.878	0.012	1.318
8	802	0.34	1	0	0	2.028	0.574	2.313	0.001	1.193

2018

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	257583	0.99	0	0	0	0.068	0.000	0.000	0.000	0.068
1	95712	0.72	0	0	0	0.159	0.012	0.397	0.197	0.161
2	6507	0.60	1	0	0	0.318	0.188	0.678	0.376	0.304
3	19947	0.50	1	0	0	0.607	0.427	0.885	0.148	0.501
4	1724	0.43	1	0	0	0.875	0.534	1.082	0.041	0.604
5	2947	0.40	1	0	0	1.190	0.571	1.344	0.004	0.869
6	90	0.37	1	0	0	1.632	0.572	1.675	0.003	0.769
7	51	0.36	1	0	0	1.844	0.563	1.878	0.012	1.318
8	401	0.34	1	0	0	2.028	0.574	2.313	0.001	1.193

2019

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	257583	0.99	0	0	0	0.068	0.000	0.000	0.000	0.068
1	95712	0.72	0	0	0	0.159	0.012	0.397	0.197	0.161
2	37798	0.60	1	0	0	0.318	0.188	0.678	0.376	0.304
3	2033	0.50	1	0	0	0.607	0.427	0.885	0.148	0.501
4	6807	0.43	1	0	0	0.875	0.534	1.082	0.041	0.604
5	631	0.40	1	0	0	1.190	0.571	1.344	0.004	0.869
6	1112	0.37	1	0	0	1.632	0.572	1.675	0.003	0.769
7	35	0.36	1	0	0	1.844	0.563	1.878	0.012	1.318
8	181	0.34	1	0	0	2.028	0.574	2.313	0.001	1.193

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.

2017

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0.000	0	0	0.000	0	0	257583	17602	0	0
1	0.012	125	50	0.197	2118	340	16477	2625	0	0
2	0.188	7077	4796	0.376	14179	4310	63842	20323	63842	20323
3	0.427	1321	1169	0.148	459	230	5051	3068	5051	3068
4	0.534	2711	2933	0.041	210	127	8052	7043	8052	7043
5	0.571	87	117	0.004	1	1	238	284	238	284
6	0.572	49	82	0.003	0	0	132	215	132	215
7	0.563	75	140	0.012	2	2	204	377	204	377
8	0.574	302	698	0.001	1	1	802	1627	802	1627
Total	0.511	11747	9985	0.065	16970	5011	352381	53164	78321	32937

2018

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0.000	0	0	0.000	0	0	257583	17602	0	0
1	0.012	728	289	0.197	12304	1977	95712	15250	0	0
2	0.188	721	489	0.376	1445	439	6507	2071	6507	2071
3	0.427	5218	4618	0.148	1811	908	19947	12114	19947	12114
4	0.534	580	628	0.041	45	27	1724	1508	1724	1508
5	0.571	1075	1445	0.004	7	7	2947	3508	2947	3508
6	0.572	33	56	0.003	0	0	90	147	90	147
7	0.563	19	35	0.012	0	1	51	94	51	94
8	0.574	151	349	0.001	0	0	401	814	401	814
Total	0.511	8525	7909	0.065	15612	3359	384962	53108	31667	20256

2019

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0.000	0	0	0.000	0	0	257583	17602	0	0
1	0.012	728	289	0.197	12304	1977	95712	15250	0	0
2	0.188	4190	2840	0.376	8395	2552	37798	12032	37798	12032
3	0.427	532	471	0.148	185	93	2033	1235	2033	1235
4	0.534	2292	2479	0.041	178	107	6807	5954	6807	5954
5	0.571	230	309	0.004	2	1	631	751	631	751
6	0.572	411	689	0.003	2	2	1112	1815	1112	1815
7	0.563	13	24	0.012	0	0	35	64	35	64
8	0.574	68	157	0.001	0	0	181	367	181	367
Total	0.511	8464	7258	0.065	21066	4732	401892	55070	48597	22218

Table 7.4.11. Haddock in 7.bc–ek. Management options table. Weights in tonnes.

Fmult	Catch17	Land17	Dis17	Basis	FCatch17	FLand17	FDis17	SSB18	dSSB	dTac
0.0	0	0	0	NA	0.00	NA	NA	32908	62%	-100%
0.1	1372	985	387	NA	0.06	0.05	0	31593	56%	-87%
0.2	2682	1921	761	NA	0.12	0.10	0	30341	50%	-75%
0.3	3933	2810	1123	NA	0.17	0.15	0	29148	44%	-64%
0.4	5128	3654	1474	NA	0.23	0.20	0	28011	38%	-53%
0.5	6269	4456	1813	NA	0.29	0.26	0	26928	33%	-43%
0.6	7360	5218	2142	NA	0.35	0.31	0	25895	28%	-33%
0.7	8403	5943	2460	NA	0.40	0.36	0	24910	23%	-23%
0.8	9400	6631	2769	NA	0.46	0.41	0	23970	18%	-14%
0.9	10354	7286	3068	NA	0.52	0.46	0	23074	14%	-6%
1.0	11267	7908	3359	NA	0.58	0.51	0	22218	10%	2%
1.1	12141	8500	3640	NA	0.63	0.56	0	21402	6%	10%
1.2	12977	9063	3914	NA	0.69	0.61	0	20622	2%	17%
1.3	13778	9599	4179	NA	0.75	0.66	0	19876	-2%	24%
1.4	14546	10109	4437	NA	0.81	0.71	0	19165	-5%	30%
1.5	15282	10594	4688	NA	0.86	0.77	0	18484	-9%	37%
1.6	15987	11056	4931	NA	0.92	0.82	0	17834	-12%	43%
1.7	16664	11496	5168	NA	0.98	0.87	0	17212	-15%	48%
1.8	17313	11916	5398	NA	1.04	0.92	0	16616	-18%	54%
1.9	17936	12315	5621	NA	1.09	0.97	0	16047	-21%	59%
2.0	18534	12695	5839	NA	1.15	1.02	0	15502	-23%	64%

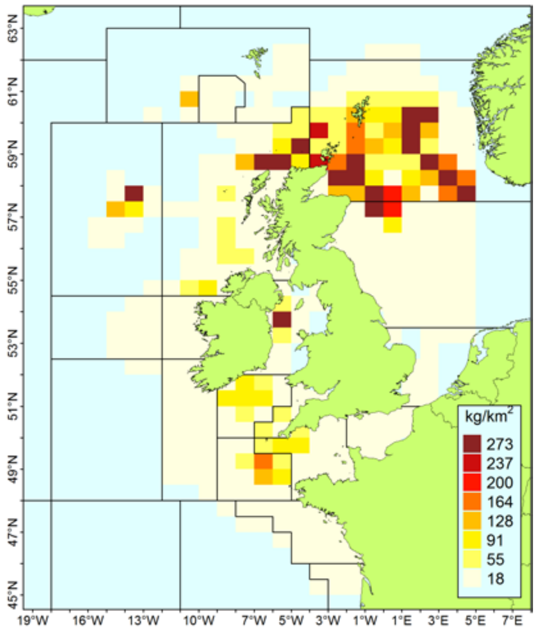


Figure 7.4.1. International haddock landings by ICES rectangle (all gears; 2015; data from https://stecf.jrc.ec.europa.eu/data-dissemination).

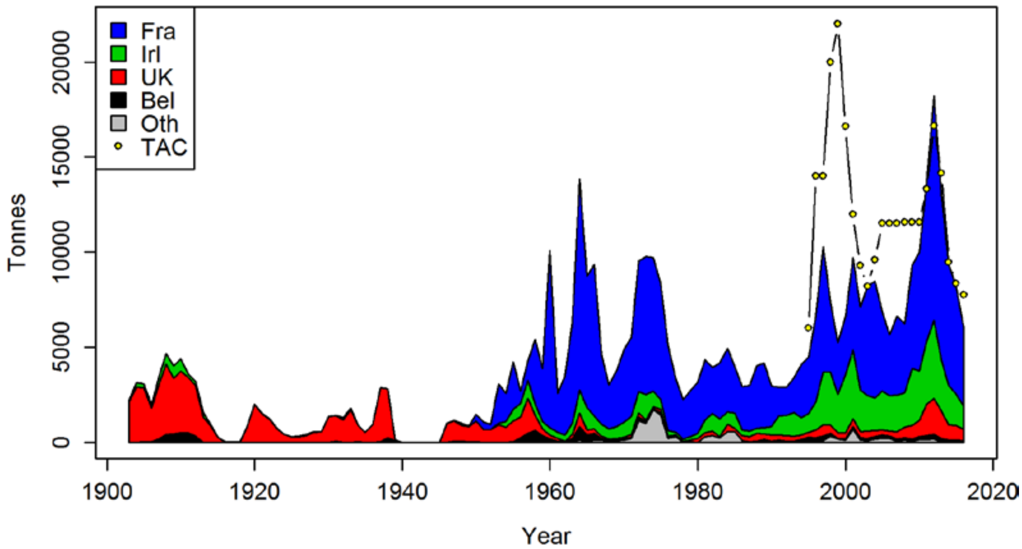


Figure 7.4.2. a) Haddock in 7.bc–ek. Official Ices landings and TAC of haddock in 7.b–k.

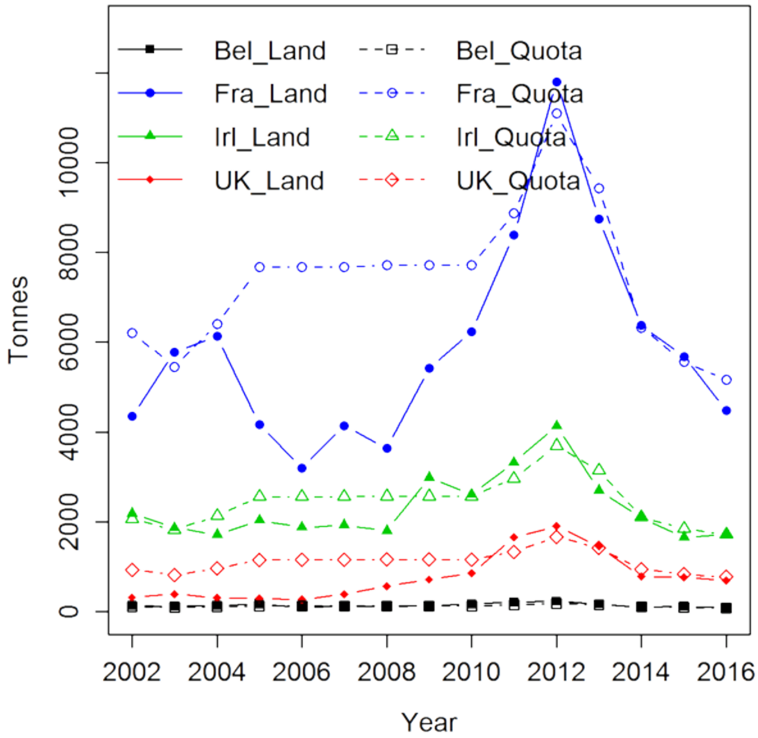


Figure 7.4.2 b) Haddock in 7.bc–ek. Recent working group landings and quota by country.

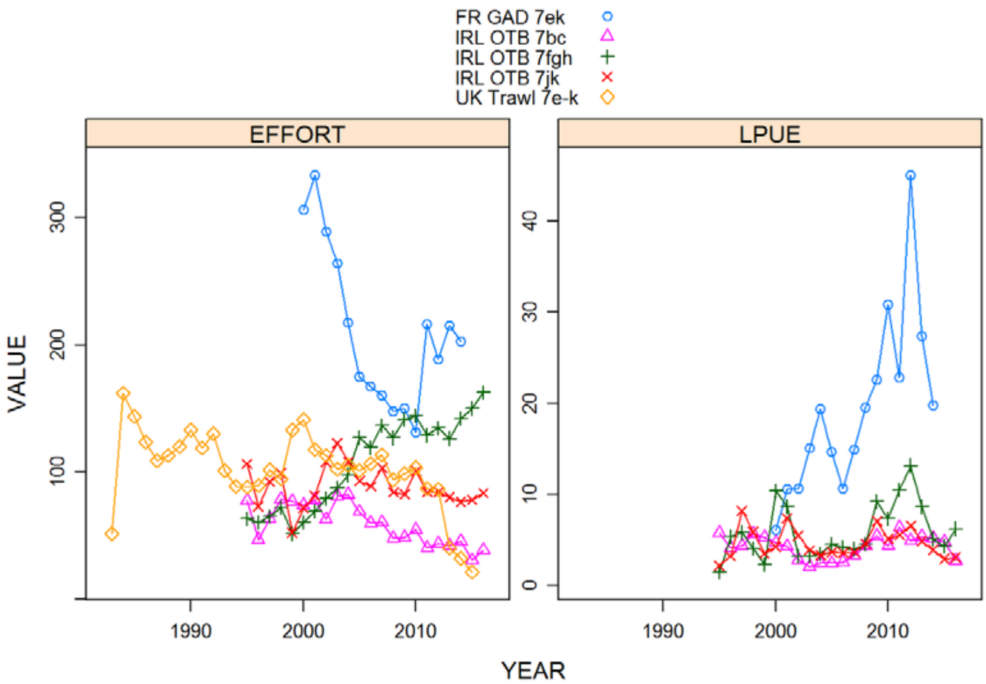


Figure 7.4.3. Haddock in 7.bc–ek. Effort ('1000h) of the Irish Otter trawl fleets, the French demersal otter trawl fleet and for UK trawl fleet (effort in fishing days, rescaled to other fleets) and lpue (kg/h) for the Irish and French fleets.

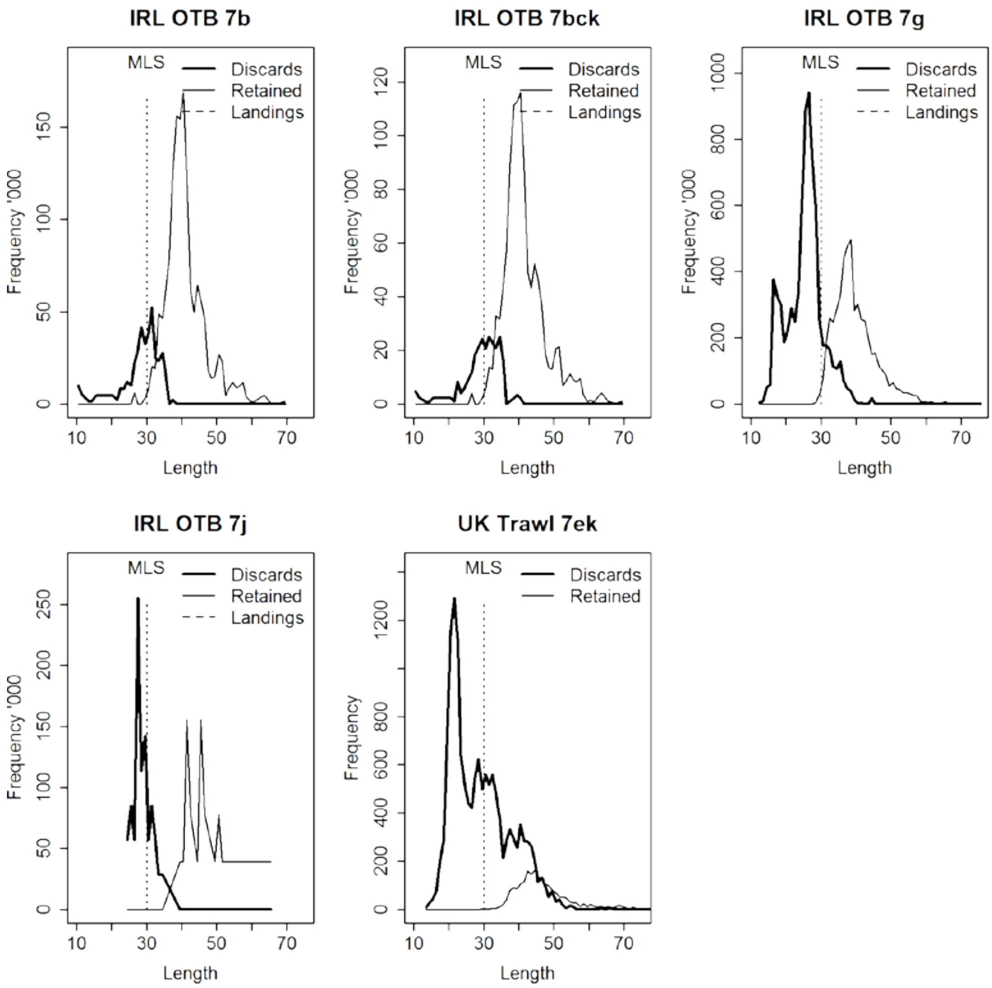


Figure 7.4.4. Haddock in 7.bc–ek. Length distributions of discards and the retained catch of haddock in 7.b–k in 2015. F; IRL OTB is the Irish otter trawl fleet; UK trawl consists of all UK trawls except beam trawls. Irish data were raised to total numbers.

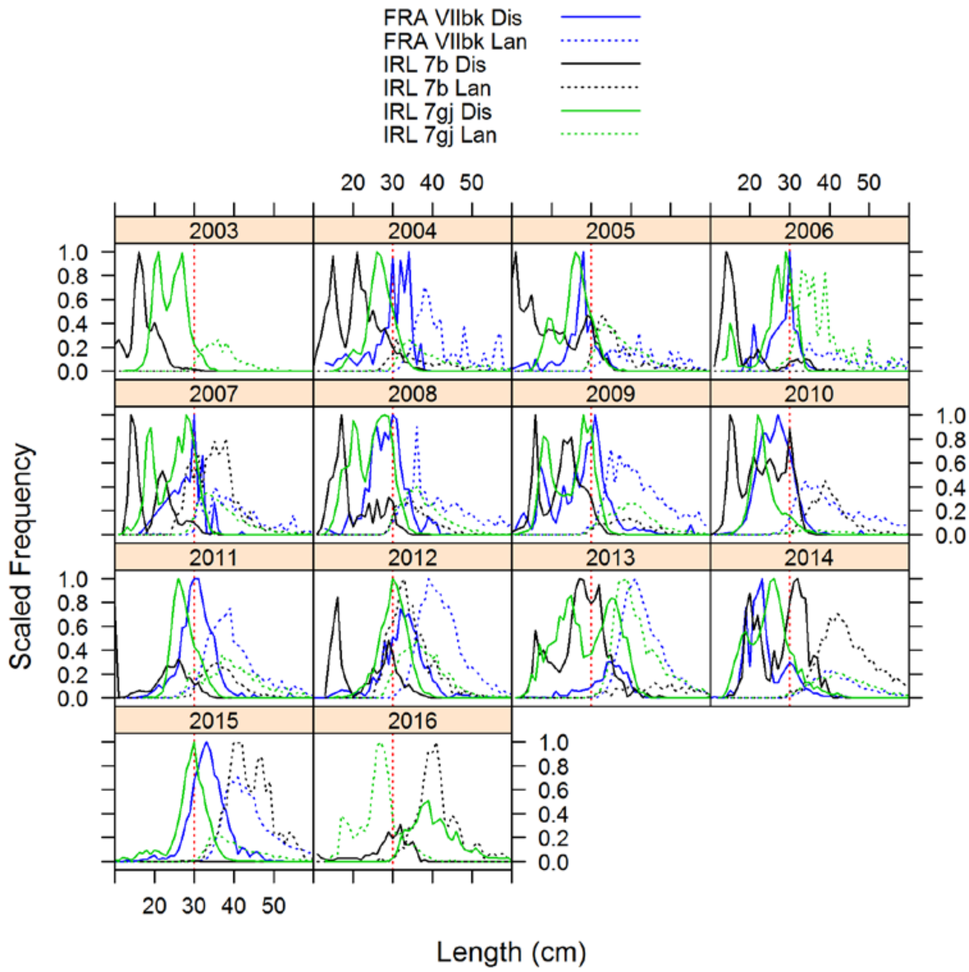


Figure 7.4.5a. Haddock in 7.bc–ek. Time-series of the cumulative scaled length distributions of total catch and the retained catch of haddock in 7.b–k. The minimum landing size (30 cm) is indicated by the dotted red line.

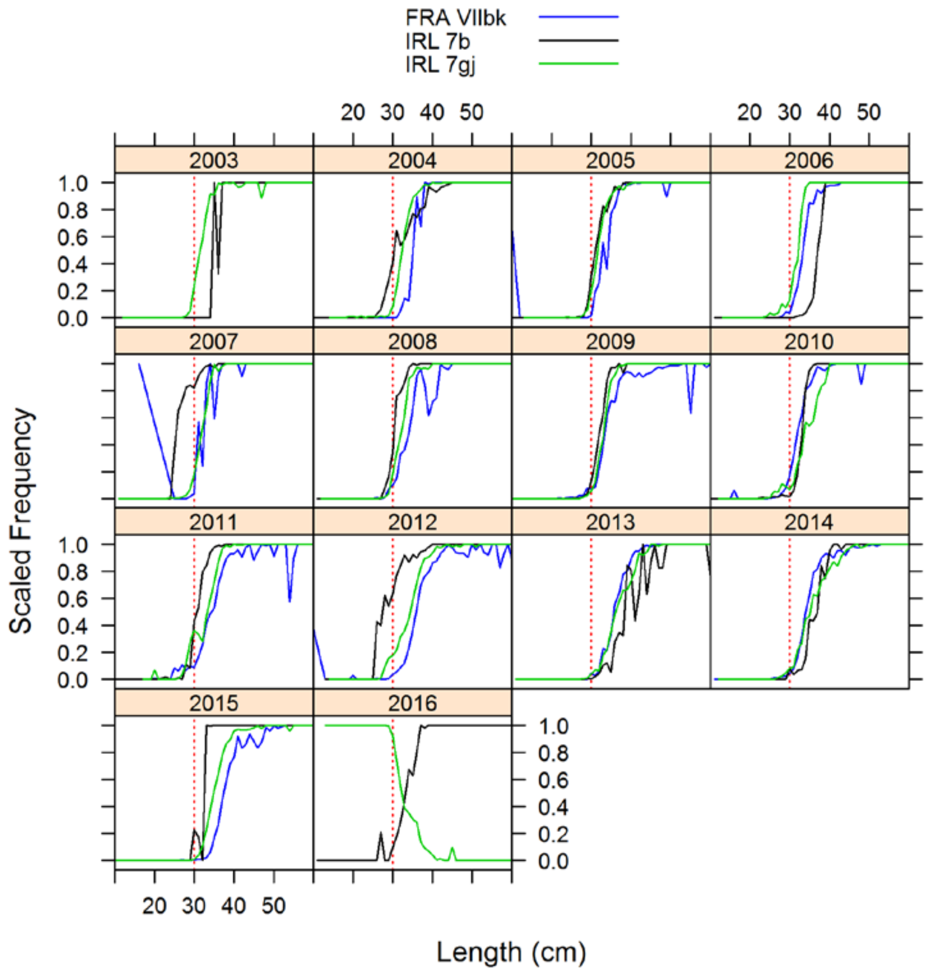


Figure 7.4.5b. Haddock in 7.bc–ek. Time-series of the discard ogives of haddock in 7.bc–ek. The minimum landing size (30 cm) is indicated by the dotted red line.

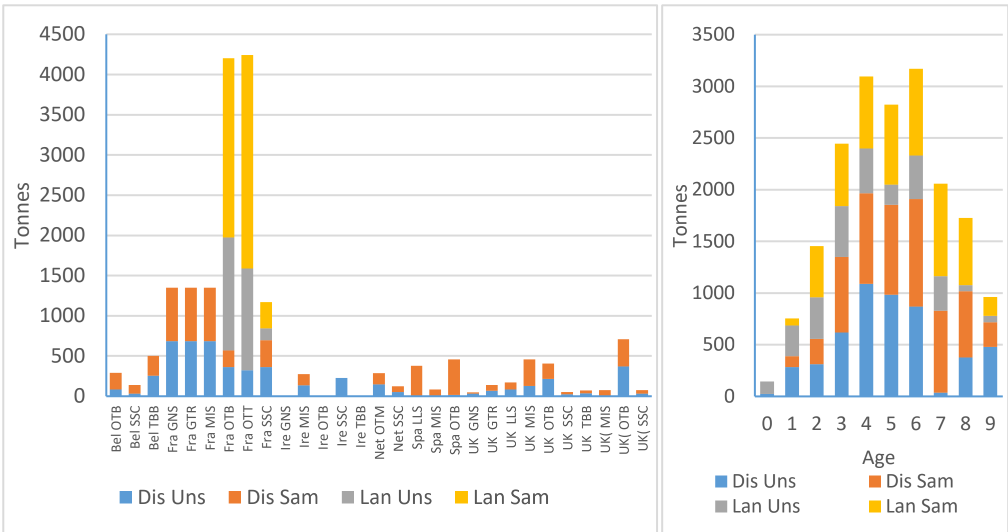


Figure7.4.6. Haddock in 7.bc–ek. Distribution of sampled and unsampled in catches by country and gear (left) and by age (right). Note that both France and Ireland allocated age data to most unsampled strata before uploading to InterCatch.

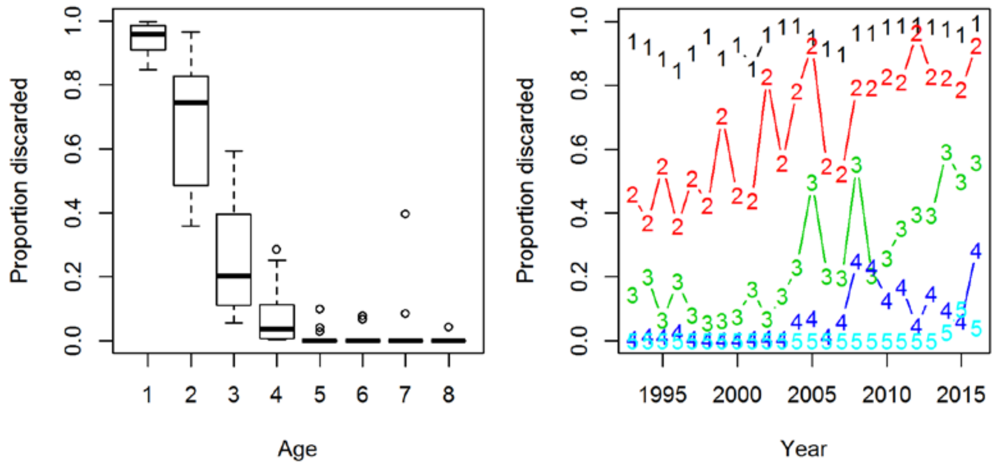


Figure7.4.7. Haddock in 7.bc–ek. Proportion of discards by age (left) and year (right).

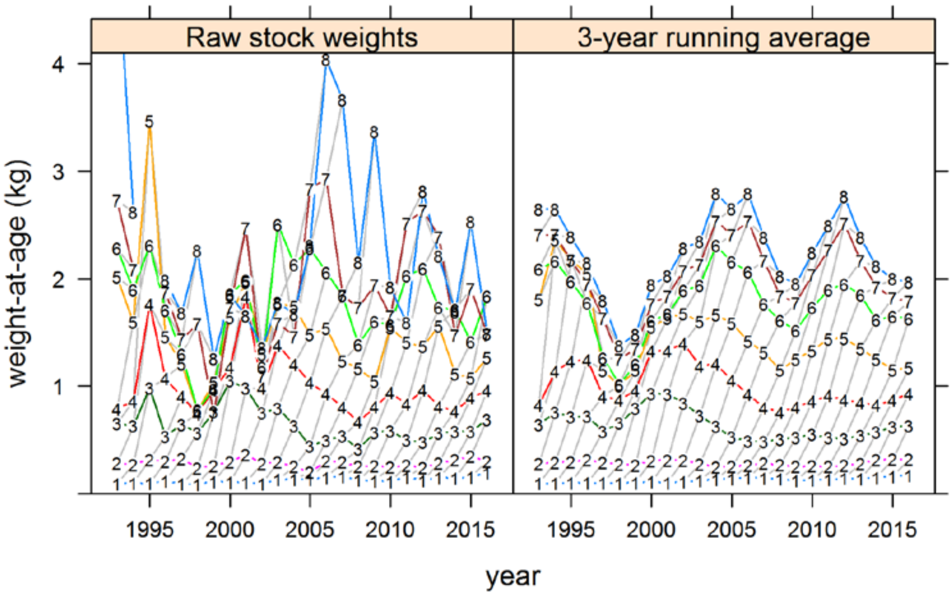


Figure7.4.8. Haddock in 7.bc–ek. Raw stock weights-at-age (left) and the three-year running average stock weights (right).

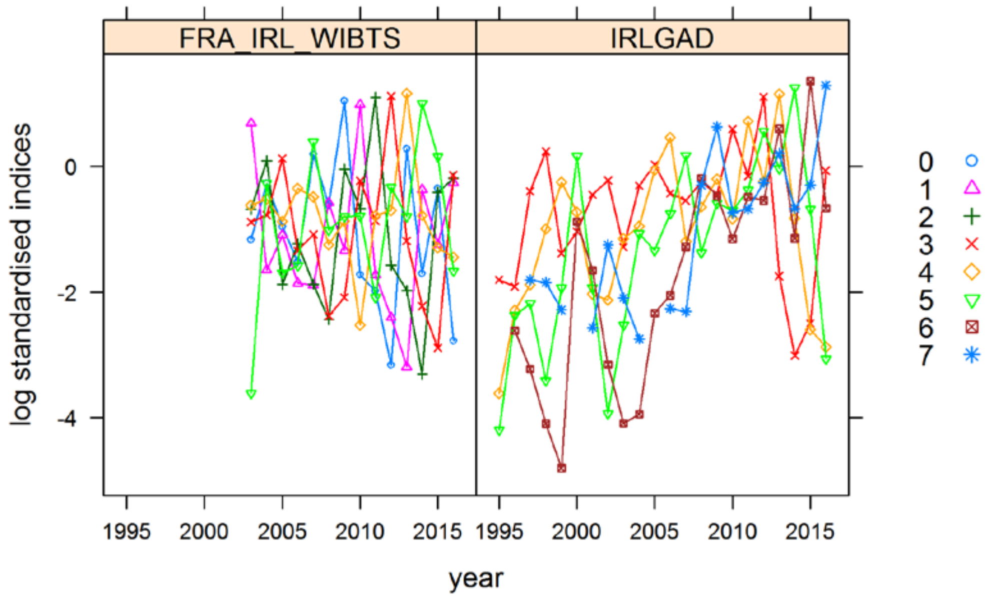


Figure 7.4.9a. Haddock in 7.bc–ek. Log standardised indices of tuning fleets by year. The FRA-IRL-IBTS survey is the combined French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS survey. The IRL-GAD commercial tuning fleet is the Irish gadoid fleet in 7.gj.

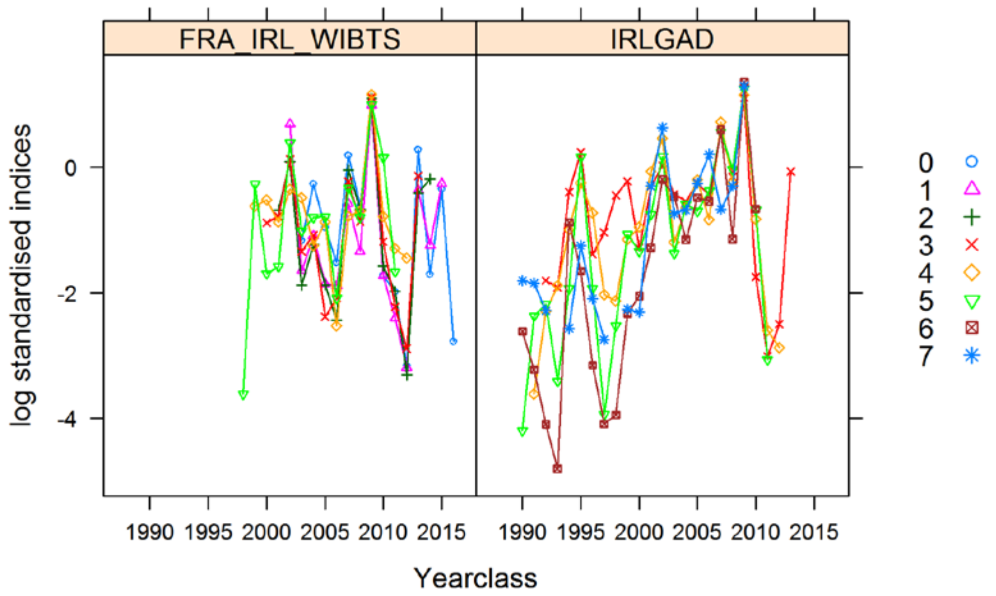


Figure 7.4.9b. Haddock in 7.bc–ek. Log standardised indices of tuning fleets by cohort.

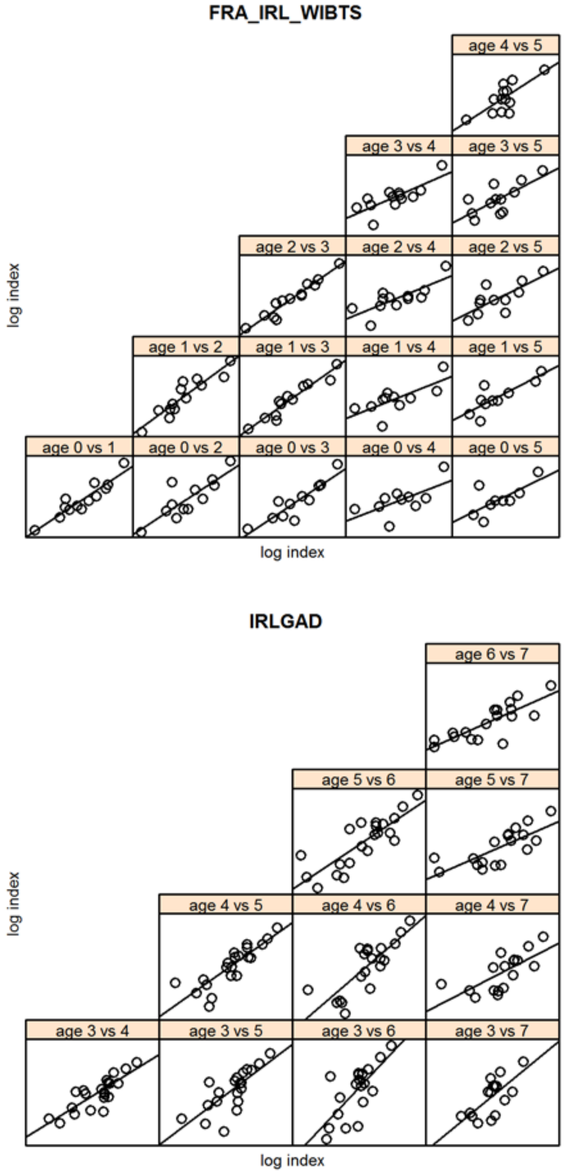


Figure 7.4.10. Haddock in 7.bc–ek. Scatterplot matrix of log indices of cohorts at different ages.

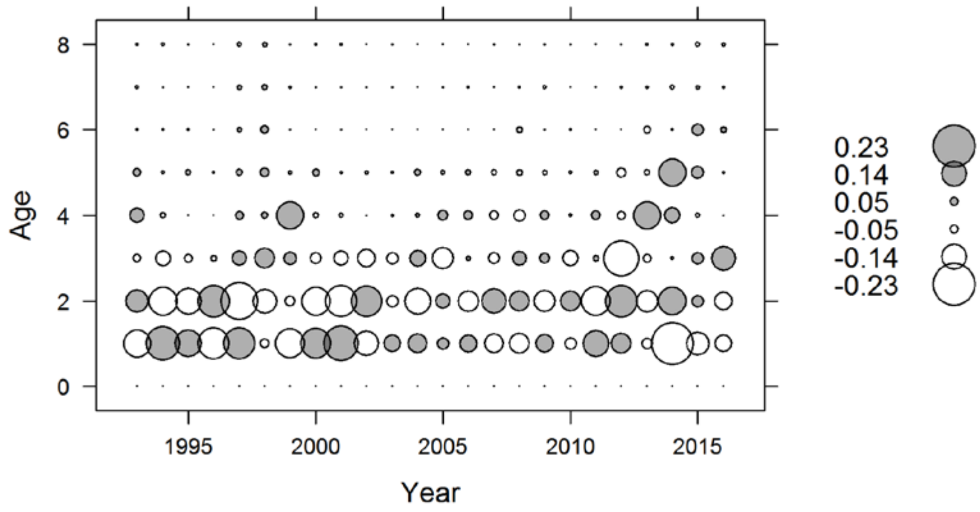


Figure 7.4.11. Haddock in 7.bc–ek. Catch proportions-at-age residuals (observed-predicted).

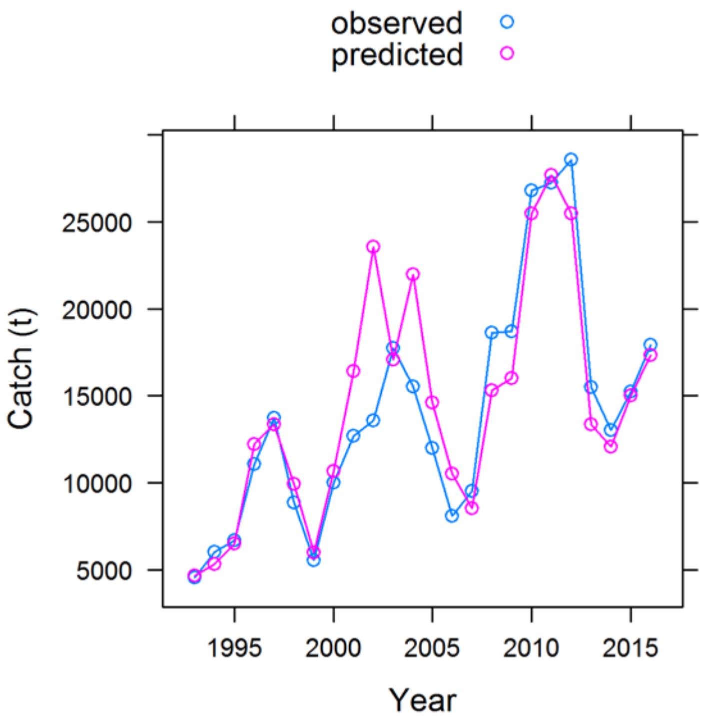


Figure 7.4.12. Haddock in 7.bc–ek. Observed and predicted catches.

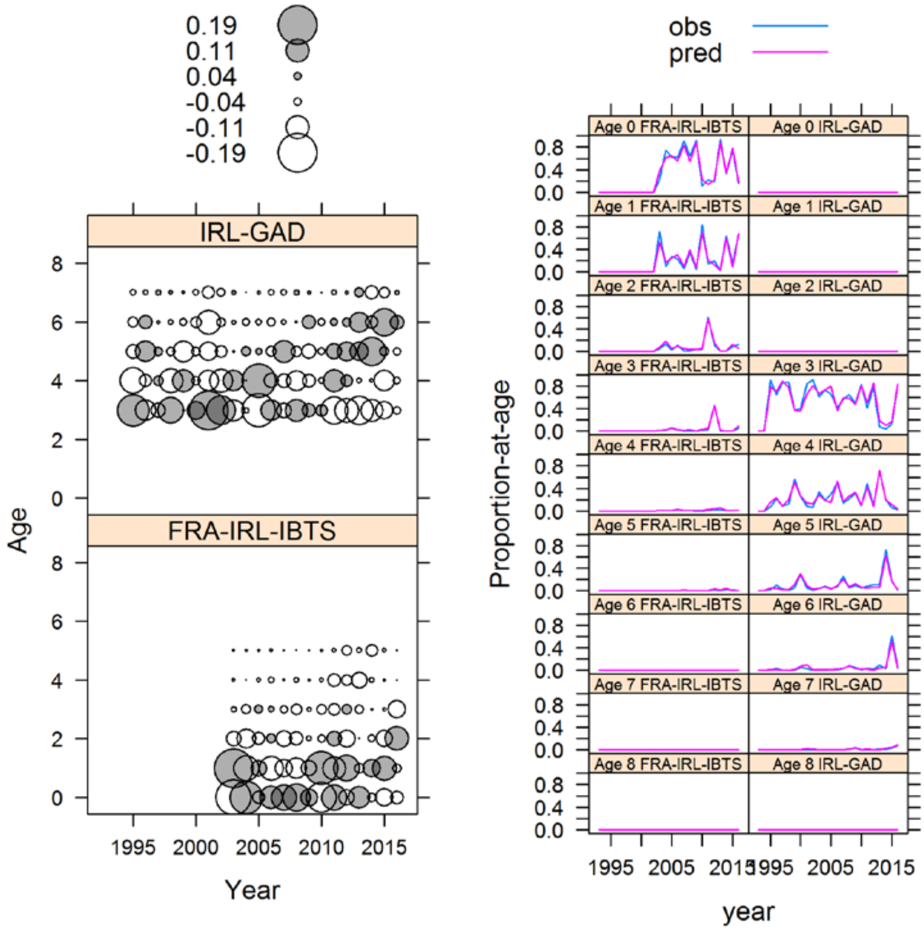


Figure 7.4.13. Haddock in 7.bc–ek. Index proportions-at-age residuals (observed - predicted).

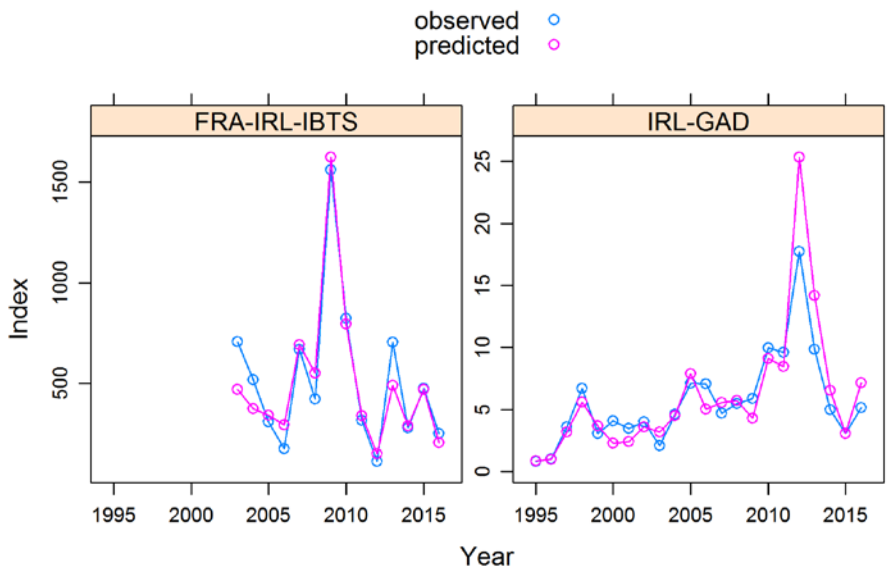


Figure 7.4.14. Haddock in 7.bc–ek. Observed and predicted index cpue.

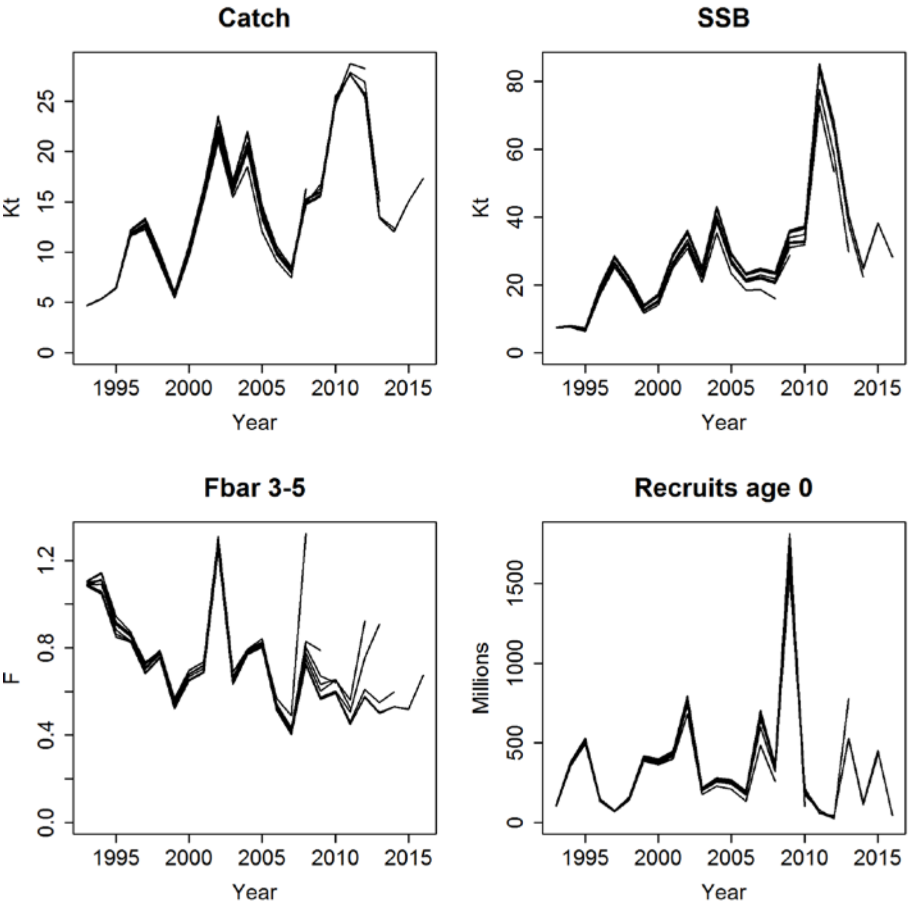
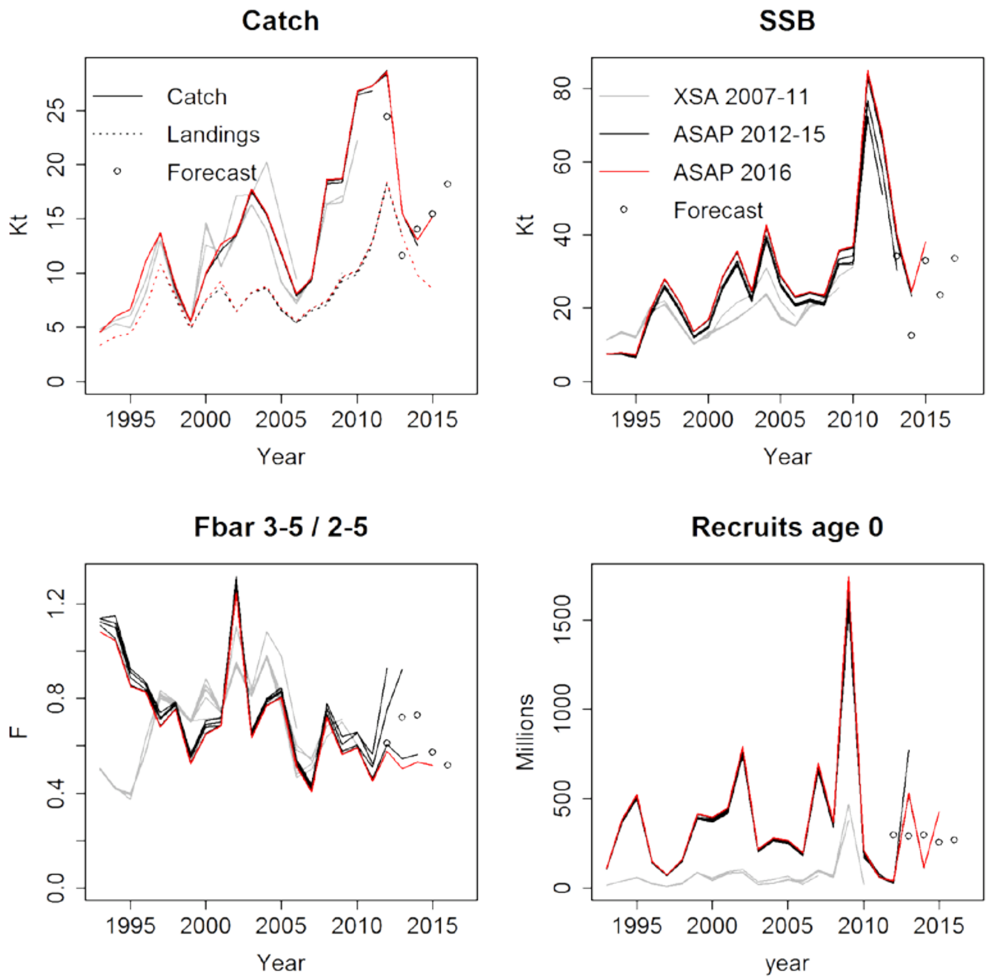


Figure 7.4.15. Haddock in 7.bc–ek. Retrospective analysis of the final ASAP run. Note that the survey index only started in 2003.


Catch
Catch
Landings
Forecast
Kt
Year
SSB
XSA 2007-11
ASAP 2012-15
ASAP 2016
Forecast
Kt
Year
Fbar 3-5 / 2-5
F
Year
Recruits age 0
Millions
year

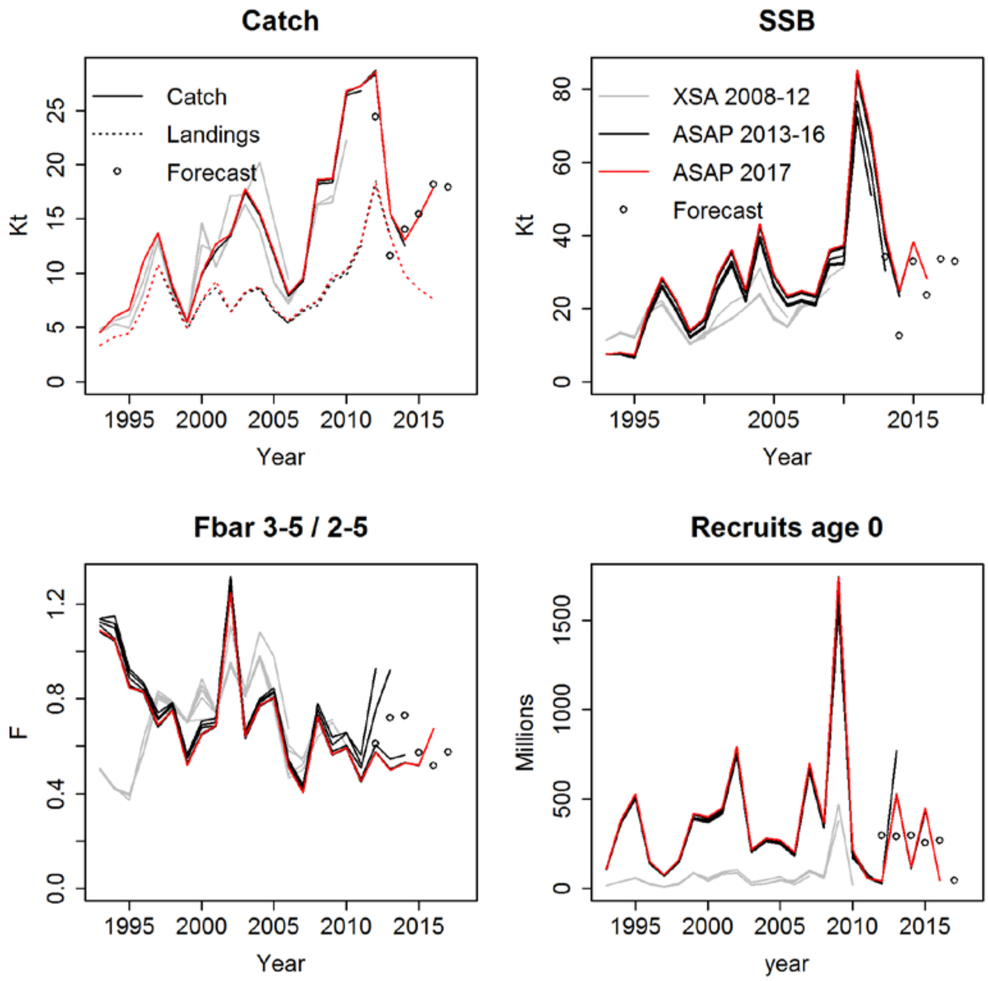


Figure 7.4.16. Haddock in 7.bc–ek. Comparison of the latest ASAP assessment (red) with historic assessments (ASAP in black; XSA in grey). The F_{bar} range was 3–5 for the ASAP assessments and 2–5 for the XSAs. The natural mortality assumption for the ASAP is much higher for young ages than the assumed M for the historic XSAs, resulting in a higher estimate of recruitment. The intermediate-year assumptions for the short-term forecast are also shown (for SSB the assumption is for the intermediate year + 1).

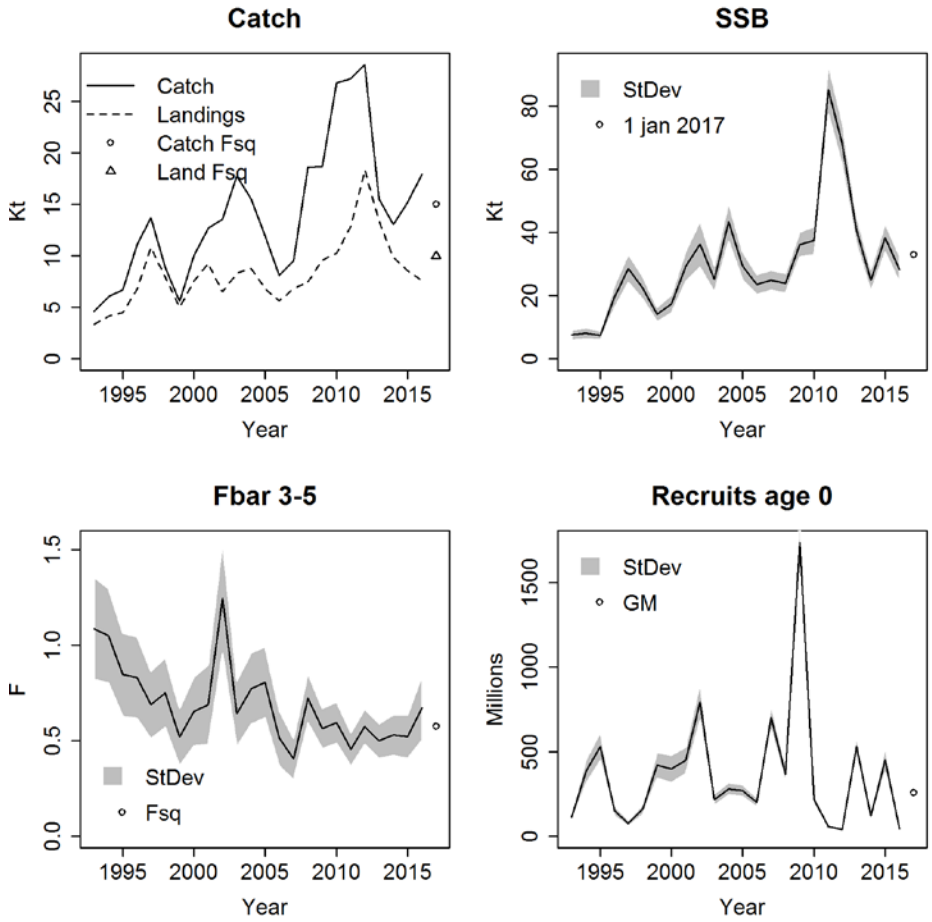


Figure 7.4.17. Haddock in 7.bc–ek. Stock summary plot. The thick black line represents the ASAP assessment standard deviations from ASAP are shaded grey. The forecast/ assumed values are given by open circles. The thick black line in the catch plot represents the predicted catch from ASAP. The dotted line in the SSB, F_{bar} and recruitment plots represents the XSA assessment with the same input data.

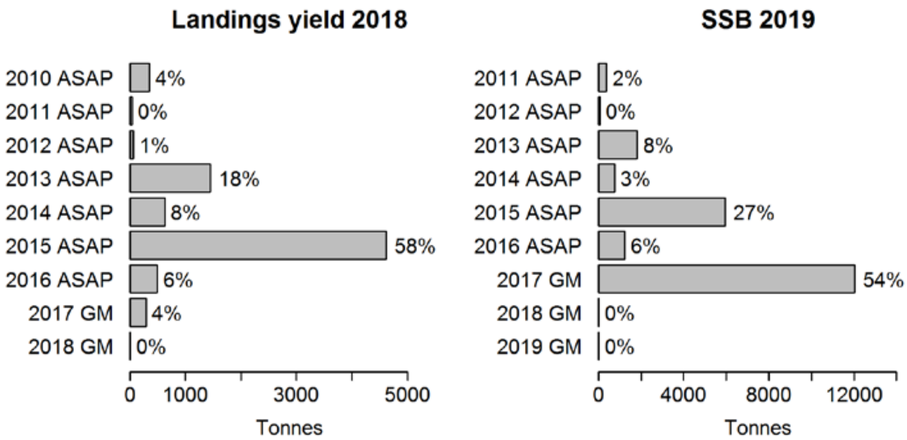


Figure 7.4.18. Haddock in 7.bc–ek. Haddock 7bc–ek. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

13 Megrim in 4.a and 6.a (Northern North Sea and West of Scotland)

Type of assessment in 2017

Update of 2016 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.

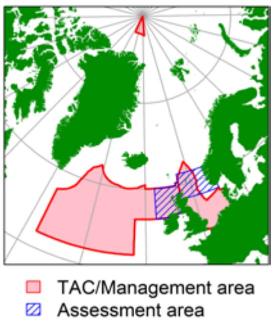
ICES advice applicable to 2016 and 2017

ICES advises that when the MSY approach is applied, catches in each of the years 2016 and 2017 should be no more than 8567 tonnes. If discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 7539 tonnes.

13.1 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 IIa and IV (LEZ/2AC4-C)
Belgium	8	
Denmark	7	
Germany	7	
France	43	
The Netherlands	34	
United Kingdom	2 540	
Union	2 639	
TAC	2 639	Analytical TAC

Species: Megrims *Lepidorhombus* spp.		Zone: Union and international waters of Vb; VI; international waters of XII and XIV (LEZ/56-14)
Spain	592	
France	2 312	
Ireland	675	
United Kingdom	1 635	
Union	5 214	
TAC	5 214	Analytical TAC Article 7(2) of this Regulation applies

2016 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 IIa and IV (LEZ/2AC4-C)
Belgium	8	
Denmark	7	
Germany	7	
France	43	
The Netherlands	34	
United Kingdom	2 540	
Union	2 639	
TAC	2 639	Analytical TAC Article 7(2) of this Regulation applies

Species: Megrims *Lepidorhombus* spp.		Zone: Union and international waters of Vb; VI; international waters of XII and XIV (LEZ/56-14)
Spain	646	
France	2 518	
Ireland	736	
United Kingdom	1 782	
Union	5 682	
TAC	5 682	Analytical TAC Article 7(2) of this Regulation applies

2017 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 2016 TAC for ICES Division 6 and EU waters of 5.b was 28%. Uptake varied considerably between countries. France, which holds much of the quota allocation, utilised only 6% of its allocation.

In ICES Area 4 and 2.a, 88% of the TAC was used in 2016. The majority of available TAC is allocated to the UK.

Fishery in 2016

Landings

Official landings data for each country together with Working Group best estimates of landings from 6.a are shown in Table 13.1 and for 4.a in Table 13.2. 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 2016 and 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 official landings estimate is 3219 tonnes but this includes 6.b. The InterCatch catch estimate is 2791 tonnes, and the ICES catch estimate for 6.a and 4.a was 2959 t. The total ICES landings are way below the TAC.

Discards

Raised discard data were made available by Scotland and France (6.a and 4.a) and Ireland (6.a). Scottish data give a discard rate of 6.6%, Irish discards were 2.4% and French discards were 7.8% by weight. Total discards were estimated to be 167 t or 5.3% by weight for the stock area in 2016. We assume no discards for Denmark, Spain, Netherlands and Norway.

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.

Catch

A break for of 2016 catch by main gear type in InterCatch is given below:

CATCH	LANDINGS			DISCARDS		
2959 tonnes	*Nephrops* trawls	Other Gears	Fin fish trawls	*Nephrops* trawls	Other Gears	Fin fish trawls
	0.65%	0.43%	98.92%	33.43%	0.02%	66.56%
	2792 tonnes			167 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	1987–2015	<400 m
2	Sco-IBTS-Q1	Scotland	4.a	1987–2015	<400 m
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	2005–2015	50–1050
6	IAMISS-Q2	Ireland	6.a	2005–2015	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.

13.2 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. This generates a slightly different cpue index Figure 13.6. The truncated series was used in the 2017 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. 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.

13.3 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.

2017 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 year's 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 2017 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.

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 and increasing trend since 2005. The stock in 2016 is estimated 1.7 times B_{MSY}. The fishing mortality in 2016 is estimated to 35% of F_{MSY}.

13.4 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 2018 is projected to result in total catches of 7800 t (landing of 7217 t and discards of 583 t) and an SSB of 1.4 times B_{msy} in 2019.

13.5 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 *Blim is*:

$Plim=rBlim(1-Blim/K)$

The corresponding *F* is:

$Flim=rBlim(1-Blim/K)/Blim = r(1-Blim/K)$

$Blim=0.3Bmsy = 0.3K/2$

$Flim = r(1-0.3K/(2K)) = r(1-0.3/2) =0.85r$

$Fmsy=r/2$, let x denote the proportionality between *Fmsy* and *Flim*

$xFmsy=Flim$

$x(r/2)=0.85r$

$x=2*0.85$

$x=1.7$

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 Flower[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)]	0.25 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 SSB and F have large uncertainty, despite this there is a low probability that SSB is below B_{MSY} and a high probability that F is below F_{MSY}. Estimated stock trends are fairly consistent with previous assessments. The positive catchability residuals for the North Sea surveys indicate that the assessment model is having problems reconciling the increases in cpue seen in those surveys with other data.

The quality of the available landings data (unknown area misreporting) has been a concern in the past. Landings data after 2006 is thought to be more accurate. The discard information in the past has also been a concern. The approach used to extrapolate the discards for the historic period is an assumption, although sensitivity explorations, have shown that the assessment is not overly sensitive to this approach.

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.

13.6 References

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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

*** 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	14 37	0		0	0	8	0	0					1175	1217	1230
2016*	0	46	13	2		0	2	21	0	0					1278	1362	1361

*** 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	1.243696	NA	NA	NA
1987	1.370928	NA	1.373089	NA	NA	NA
1988	2.008519	NA	1.664841	NA	NA	NA
1989	1.161744	NA	1.351147	NA	NA	NA
1990	1.072564	1.589121	0.722978	NA	NA	NA
1991	0.79324	1.273655	0.489221	0.331577	NA	NA
1992	0.958432	1.885181	0.664802	0.318708	NA	NA
1993	1.013121	2.058297	1.114901	0.306721	NA	NA
1994	1.589026	3.246435	0.24658	0.385281	NA	NA
1995	1.555855	1.862839	0	0.386659	NA	NA
1996	1.939844	1.94602	0.50344	0.617603	NA	NA
1997	1.100464	1.081142	0.448168	0.431751	NA	NA
1998	1.094432	1.892789	0.793617	0.24316	NA	NA
1999	1.322173	1.360191	1.006661	0.243381	NA	NA
2000	1.140297	1.18569	0.851155	0.266202	NA	NA
2001	0.997603	0.967749	0.282395	0.08844	NA	NA
2002	0.760004	1.857327	1.188347	0.345849	NA	NA
2003	1.271763	1.204998	0.52257	0.328697	NA	NA
2004	1.244469	1.063918	0.267764	0.475044	NA	NA
2005	0.690391	1.012593	0.58873	0.847381	1660.379	4753.223
2006	0.916576	1.120885	0.792035	0.992315	2688.942	3344.997
2007	0.90675	1.198995	0.870869	1.412133	3380.351	6347.544
2008	1.253294	0.956626	1.571166	1.204822	2467.076	7754.143
2009	1.572727	1.396689	1.944109	1.082862	3830.668	5946.946
2010	1.170501	NA	1.720945	1.721224	3312.129	5394.946
2011	NA	NA	1.931612	1.591917	2501.99	4683.594
2012	NA	NA	2.577931	1.521725	3450.807	4839.468
2013	NA	NA	2.705826	1.436143	6174.864	6460.015
2014	NA	NA	2.197141	1.290251	3033.072	11970.3
2015	NA	NA	3.030244	1.344515	2563.105	4986.899
2016	NA	NA	1.477813	1.288101	3027.648	8207.787

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	$\text{Uniform}(\ln(\max(C)), \ln\left(10 \times \sum_{t=1985}^{2010} C_t\right)$	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
r.hat	0.67	0.55	0.51	0.51	0.507507
K.hat	39346	43134	47216	46840	42681
MSY	6037	5660	5612	5362	5072
FMSY	0.33	0.28	0.26	0.26	0.253753
BMSY	19673	21567	23608	23420	21340
B	3624	4109	42416	42356	37610
F	0.09	0.08	0.07	0.07	0.07291
Blim	5902	6470	7082	7026	6402
Btrig	9837	10783	11804	11710	10670

Table 13.7. Time-series of B/BMSY and F/FMSY estimates and landings and discards in tonnes for the final assessment.

Year	B/Bmsy	B/Bmsy High	B/Bmsy Low	Landings	Discards*	F/Fmsy	F/Fmsy High	F/Fmsy Low
1985	2.444963	3.701667	1.122219	4499	1928	0.645	1.242	0.361
1986	1.688691	2.346281	1.020236	2858	1193	0.514	0.862	0.303
1987	1.581257	2.125824	0.987249	4614	1874	0.905	1.491	0.534
1988	1.496522	2.167995	0.944323	5212	2061	1.1	1.763	0.573
1989	1.208168	1.719227	0.763424	3451	1327	0.837	1.323	0.466
1990	1.107711	1.540362	0.70292	3047	1140	0.785	1.262	0.424
1991	1.0399	1.414802	0.658489	3310	1204	0.905	1.468	0.507
1992	1.103135	1.515213	0.711523	3574	1263	0.923	1.486	0.512
1993	1.19408	1.654681	0.752711	3802	1305	0.91	1.463	0.495
1994	1.309798	1.943307	0.804679	3900	1300	0.859	1.366	0.44
1995	1.338153	1.924982	0.83885	4670	1511	1.019	1.621	0.53
1996	1.301273	1.934497	0.783938	5253	1649	1.199	1.896	0.577
1997	1.076817	1.518638	0.683062	4856	1478	1.295	2.043	0.67
1998	1.033464	1.480897	0.630663	4253	1254	1.159	1.847	0.583
1999	1.007944	1.52943	0.596785	3759	1074	1.033	1.662	0.508
2000	0.942671	1.383785	0.578919	3494	966	1.004	1.665	0.508
2001	0.87006	1.241912	0.524869	3571	956	1.103	1.847	0.567
2002	0.890155	1.280771	0.518201	2803	725	0.82	1.388	0.43
2003	0.926241	1.403114	0.556647	2369	592	0.654	1.094	0.312
2004	0.928553	1.319734	0.54233	2067	499	0.555	0.927	0.283
2005	0.911451	1.213525	0.581301	1527	356	0.401	0.65	0.229
2006	1.035287	1.36525	0.682261	2054	461	0.482	0.786	0.272
2007	1.178993	1.577439	0.771881	2348	508	0.489	0.78	0.275
2008	1.292592	1.731072	0.83734	2894	602	0.557	0.899	0.318
2009	1.426634	1.937708	0.922441	2871	574	0.503	0.803	0.284
2010	1.434479	1.942705	0.897922	3197	614	0.555	0.911	0.323
2011	1.470864	1.96107	0.989243	3257	600	0.548	0.857	0.325
2012	1.590851	2.158184	1.030687	2545	449	0.419	0.656	0.254
2013	1.818045	2.610614	1.158734	2737	327	0.322	0.494	0.183
2014	1.776714	2.474693	1.179362	2500	309	0.296	0.459	0.171
2015	1.628622	2.145848	1.088416	2471	152	0.313	0.482	0.191
2016	1.667665	2.249389	1.144661	2792	167	0.348	0.54	0.206

*** The shaded 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 (2017)/F_{MSY}	0.3305456	ICES (2017a)	F (average 2014–2016)
B (UPDATE)/B_{MSY}	1.663618	ICES (2017a)	Short-term forecast
Catch (2017)	2772	ICES (2017a)	Short-term forecast
Landings (2017)	2565	ICES (2017a)	Assuming discard rate of 7.480%in total weight of catch (average 2014–2016)
Discards (2017)	207	ICES (2017a)	Assuming discard rate of 7.480%in total weight of catch (average 2014–2016)

Table 13.9. The management option table.

Basis	Total catch (2018)	Wanted catch* (2018)	Unwanted catch* (2018)	Fishing mortality (F_{2018}/F_{MSY})	Stock size (B_{2019}/B_{MSY})	Probability** of $Biomass_{2019}$ falling below MSY $B_{trigger}$	Probability** of $Biomass_{2019}$ falling below B_{lim}	% SSB change **	% TAC change ***
ICES advice basis									
MSY approach: F_{MSY}	7800	7217	583	1.00	1.40	0.07	0	-16%	-6%
Other options									
F = 0	0	0	0	0.00	0.02	0.00	1.79	108%	0%
SSB (2019) = B_{lim}	30000	27756	2244	3.83	0.30	0.98	0.53	-82%	261%
SSB (2019) = B_{pa}	25450	23546	1904	3.26	0.50	0.94	0.28	-70%	206%
SSB (2019) = MSY $B_{trigger}$	15350	14202	1148	1.96	1.00	0.51	0.01	-40%	84%
F = F_{2017}	2772	2565	207	0.33	1.66	0.00	0.00	0%	-67%
F = $F_{MSY\ Upper}$	6150	5690	460	0.78	1.48	0.04	0.00	-11%	-26%
F = $F_{MSY\ lower}$	9500	8789	711	1.22	1.28	0.13	0.00	-23%	14%
Long-term MSY	5158	4772	386	0.66	1.51	0.04	0.00	-9%	-38%

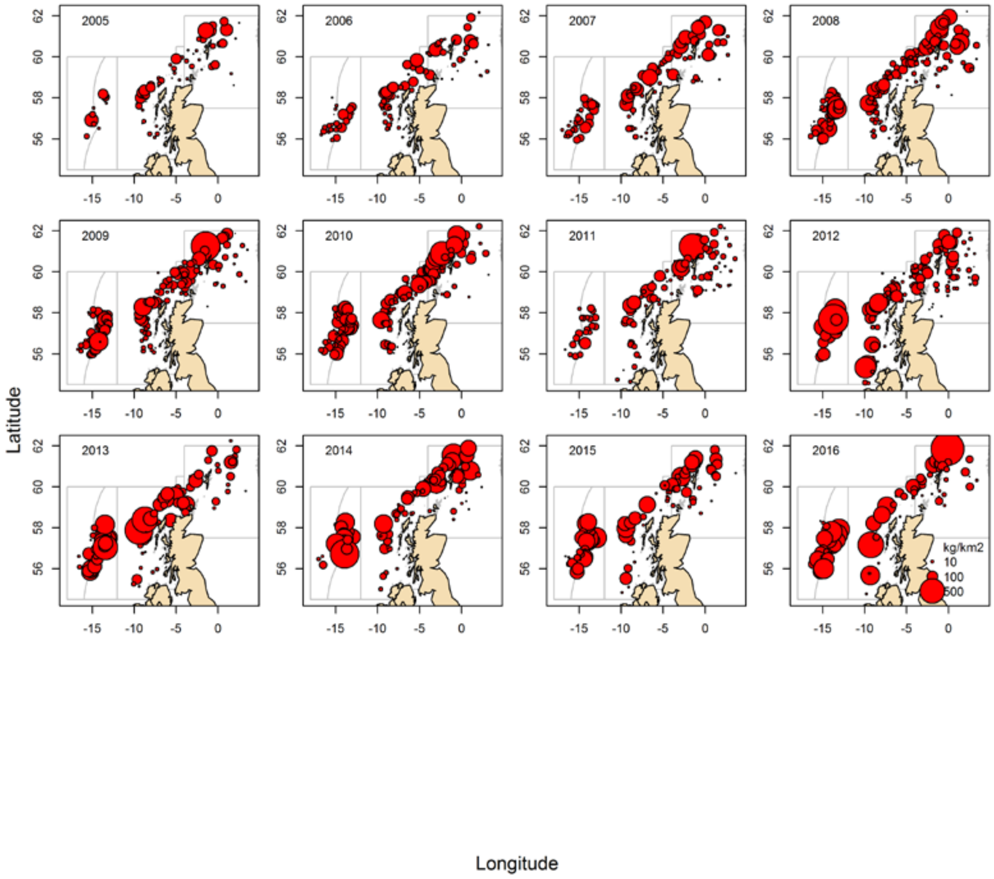


Figure 13.1. Maps of the northern continental shelf around the British Isles showing the biomass of megrim during the anglerfish surveys (SAMISS and IAMISS) 2005–2016.

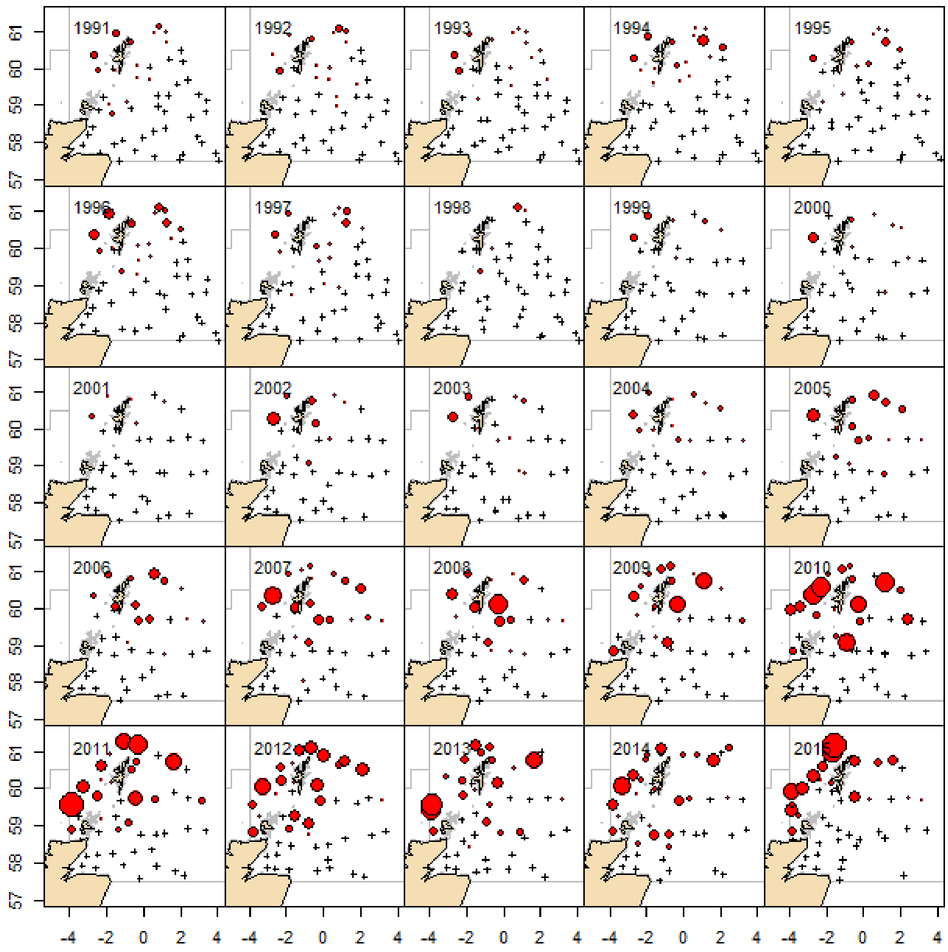


Figure 13.2. Scottish IBTS Q3 4.a megrim biomass maps.

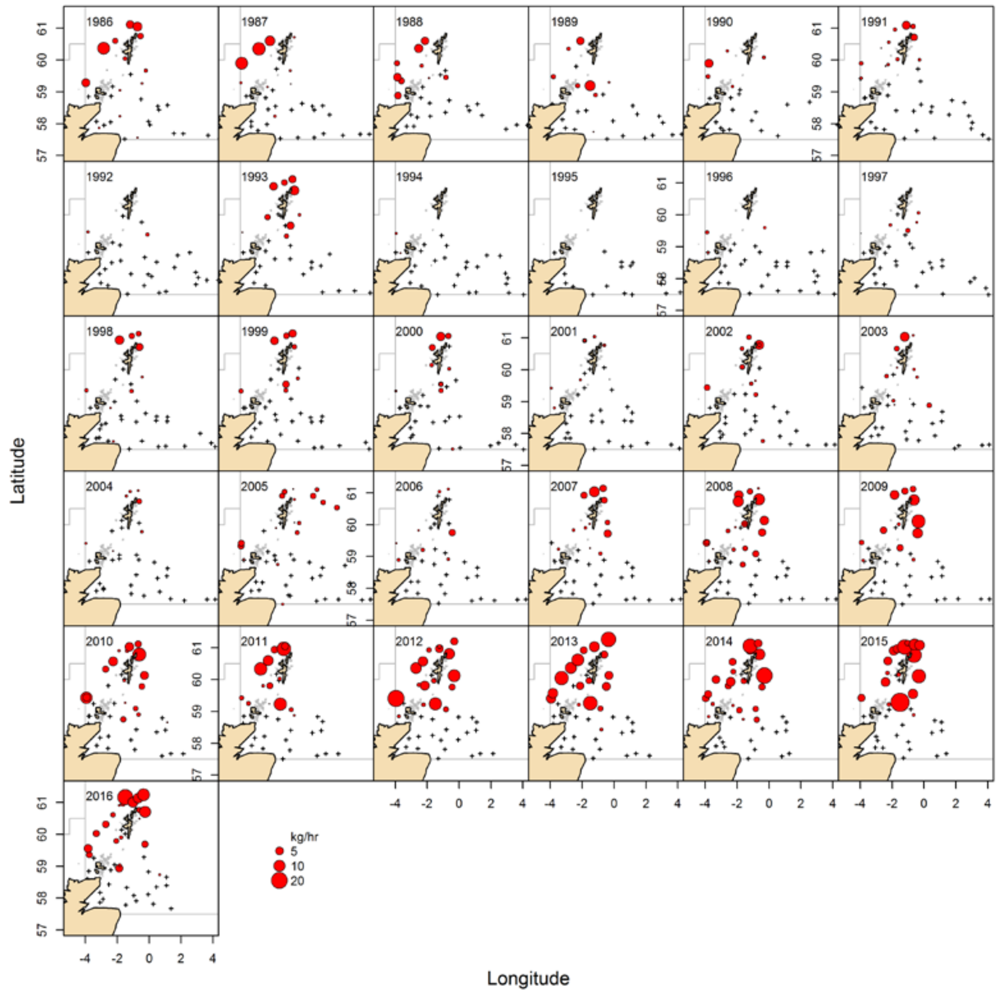


Figure 13.3. Scottish IBTS Q1 4.a megrim biomass maps.

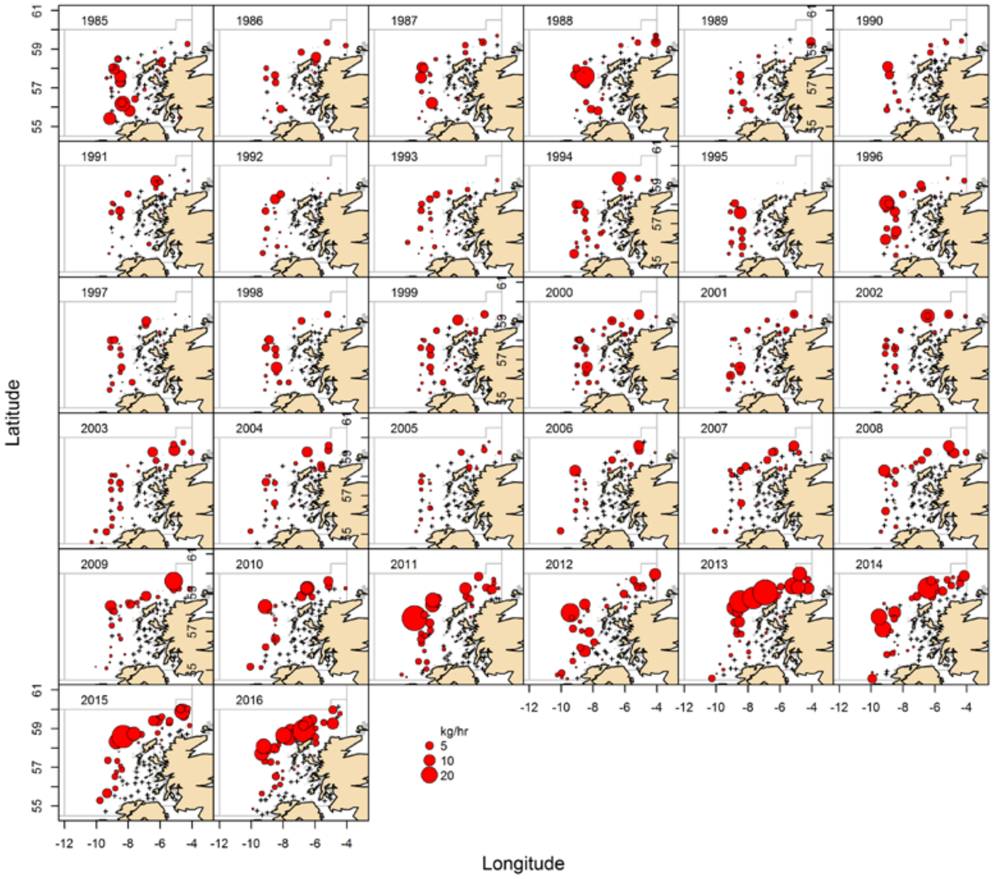


Figure 13.4 Scottish IBTS Q1 4.a megrim biomass maps.

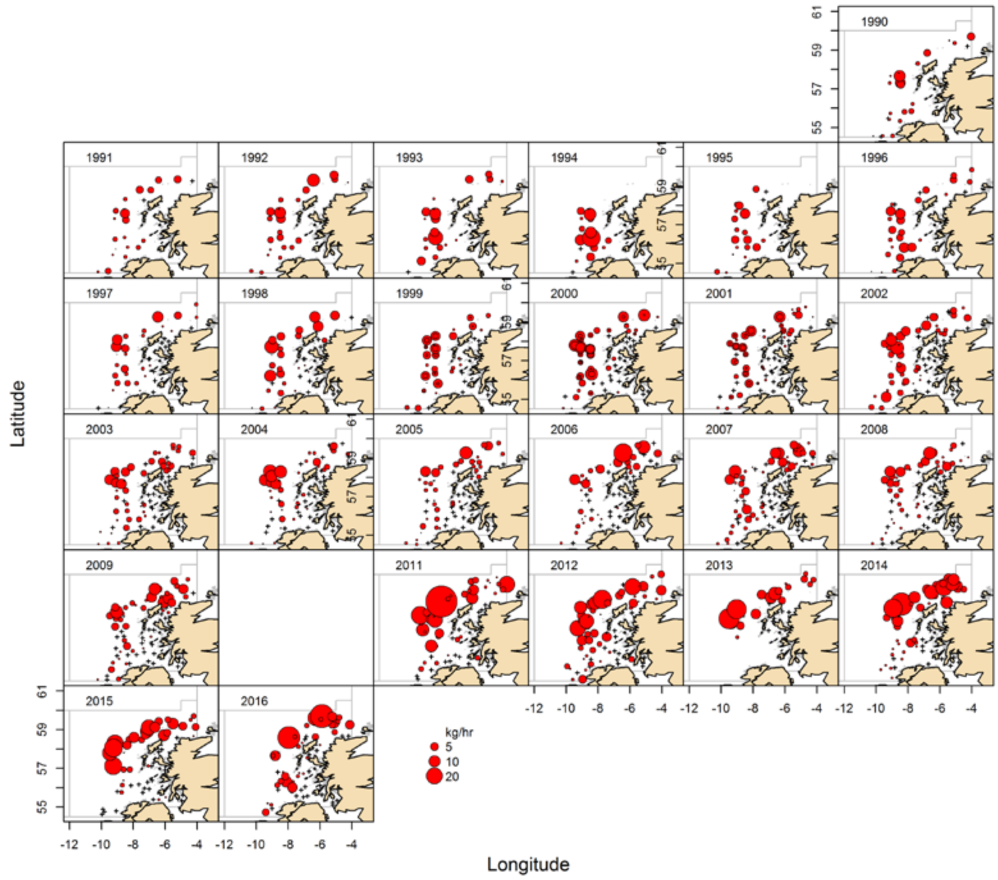


Figure 13.5. Scottish IBTS Q4 6.a megrim biomass maps.

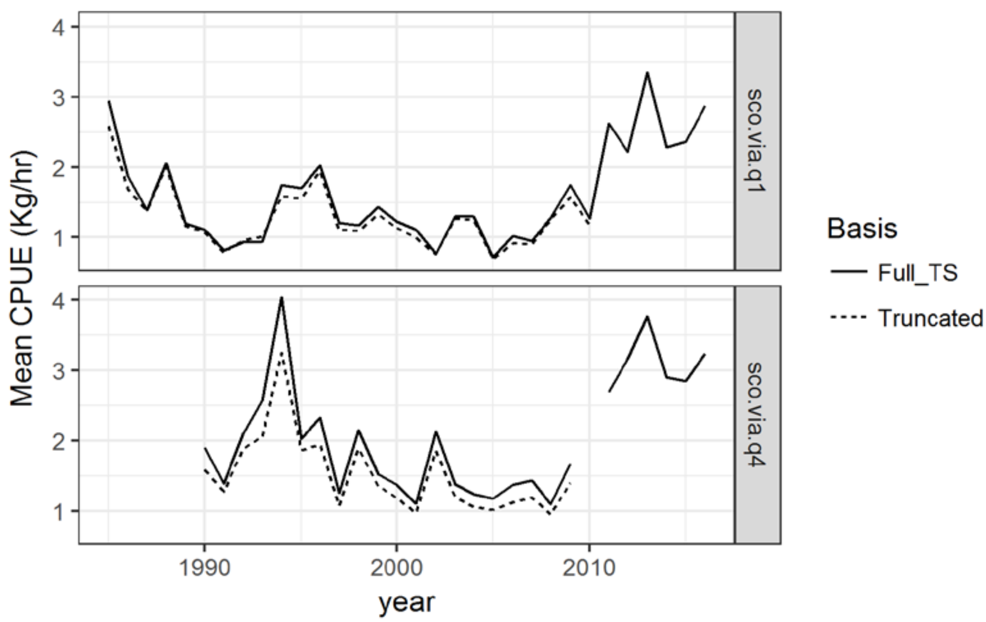


Figure 13.6. Comparison of the delta-gamma cpue estimates for the two 6.a Scottish IBTS surveys using the full time-series or truncating the series to 2010 after which the survey design and ground gear was changed.

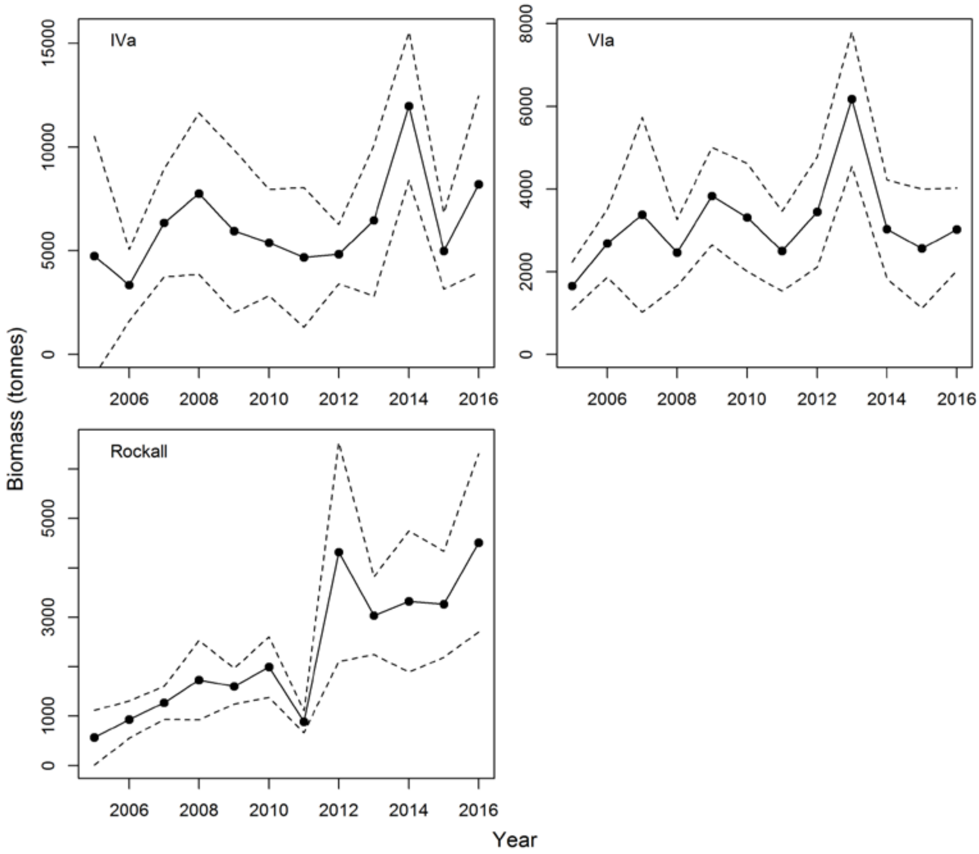


Figure 13.7. Megrim biomass estimates in ICES Division 4, 6.a and 6.b from the anglerfish (AMISS) survey.

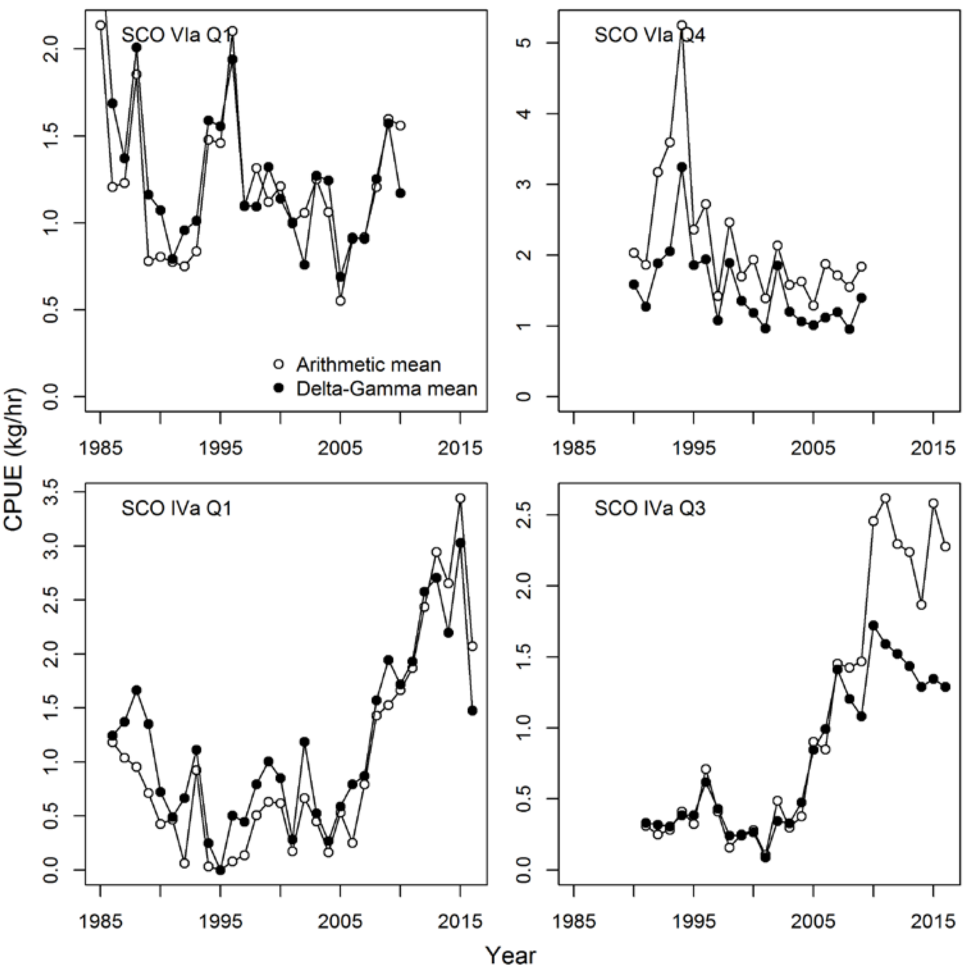


Figure 13.8. Megrim cpue estimates in ICES Division 6.a Q1 top left panel and 6.a Q4.

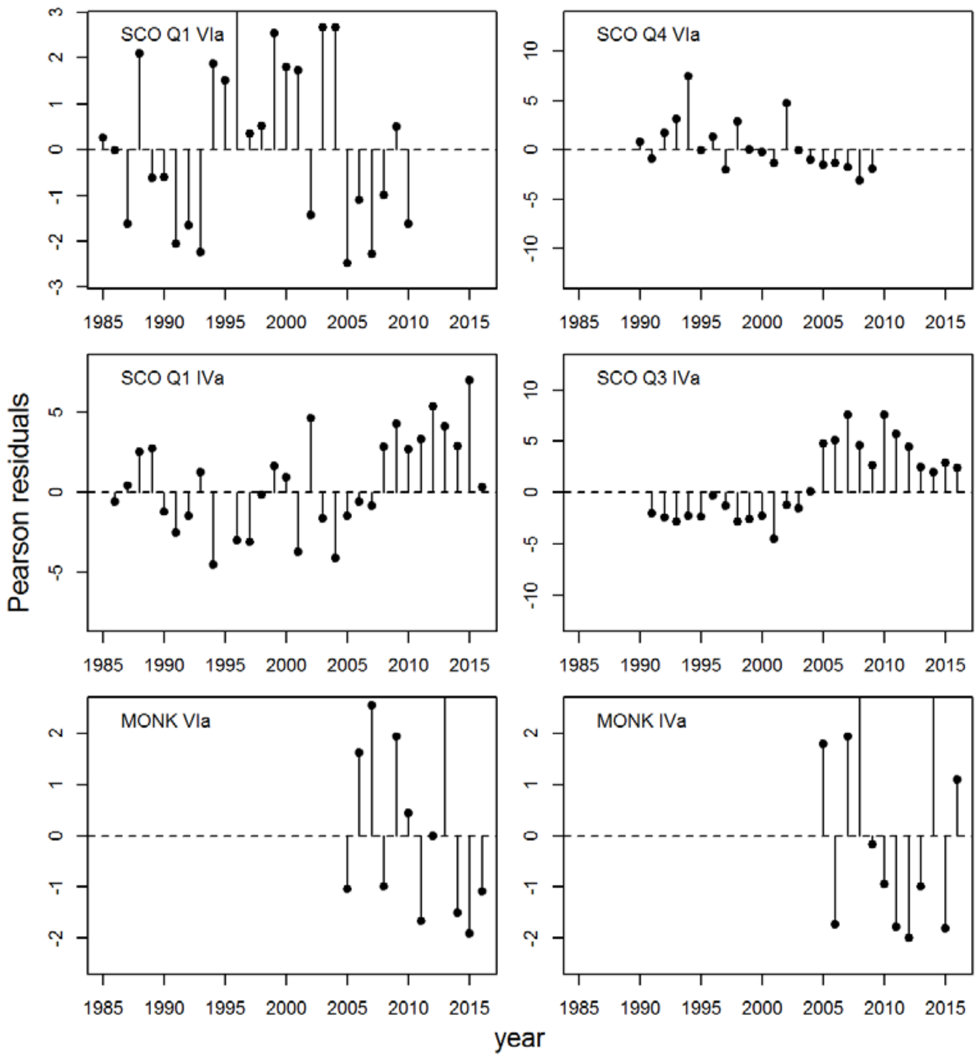


Figure 13.9. Pearson residuals for the six survey indices.

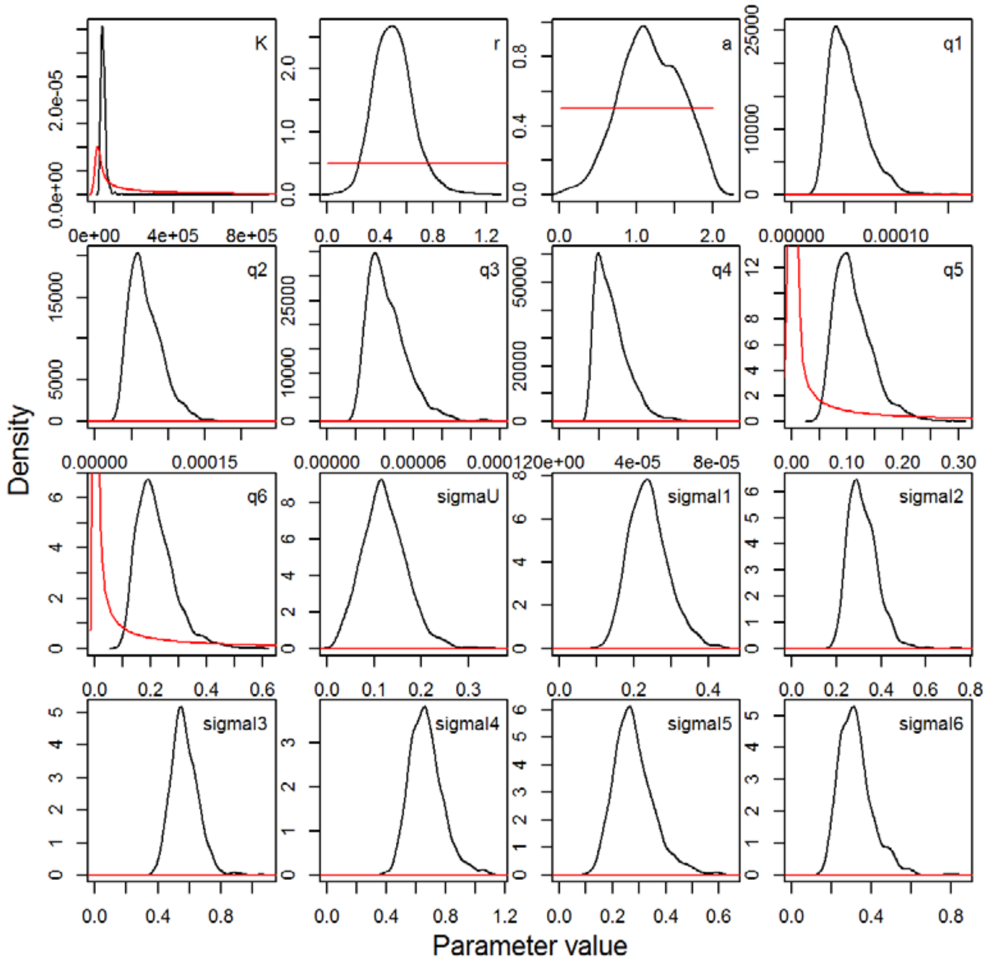


Figure 13.10 Prior (red line) and posterior distributions (black line) for the parameters in the model.

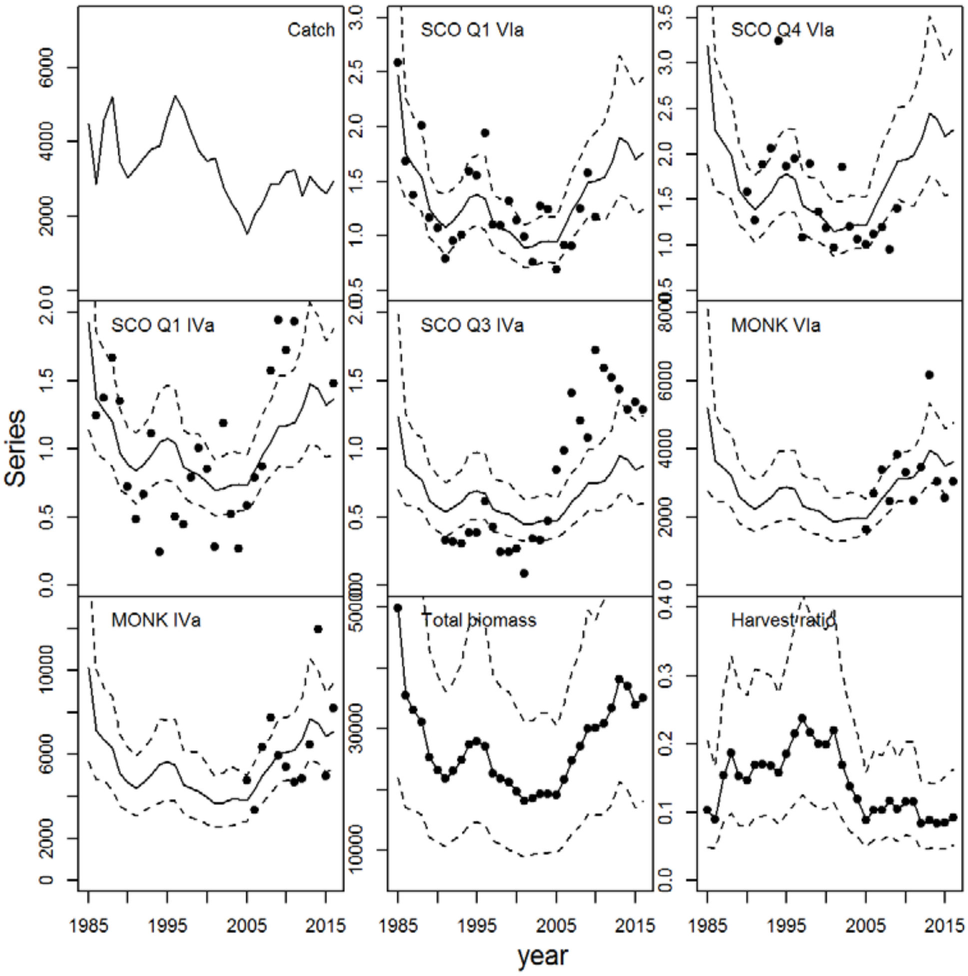


Figure 13. 11. Time-series of catch and model estimates of total biomass and exploitation rate (median values are shown as solid lines and 95% confidence intervals shown as broken lines). The model fits to the various cpue series is also shown (observations dots, median fit solid line and 95% confidence intervals shown as broken lines).

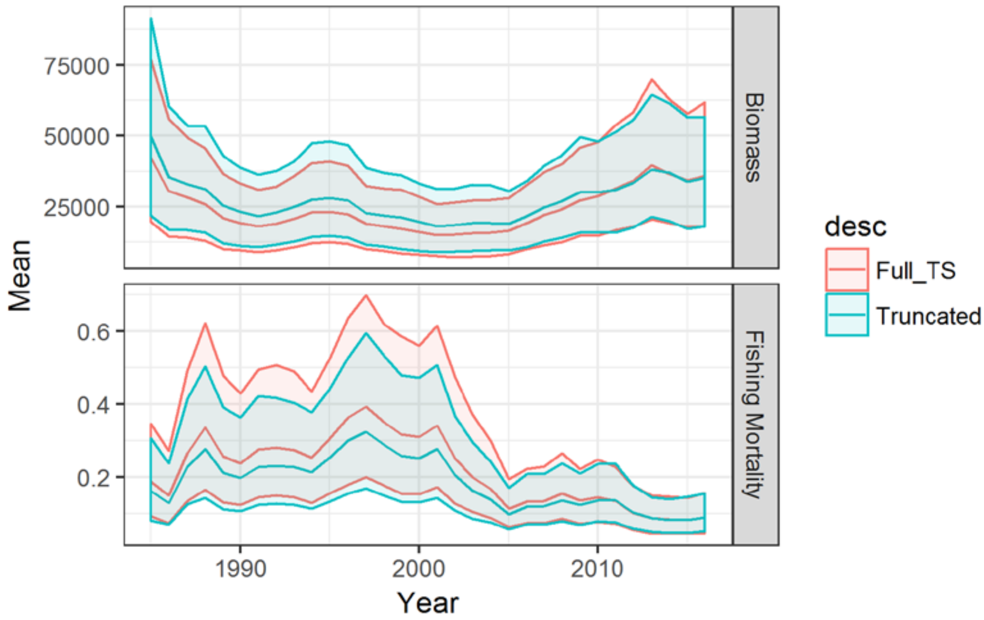


Figure 13.12. Comparison of assessment results models fitted to a cpue generated using the full time-series of the 6.a (red) and a truncated time-series (blue).

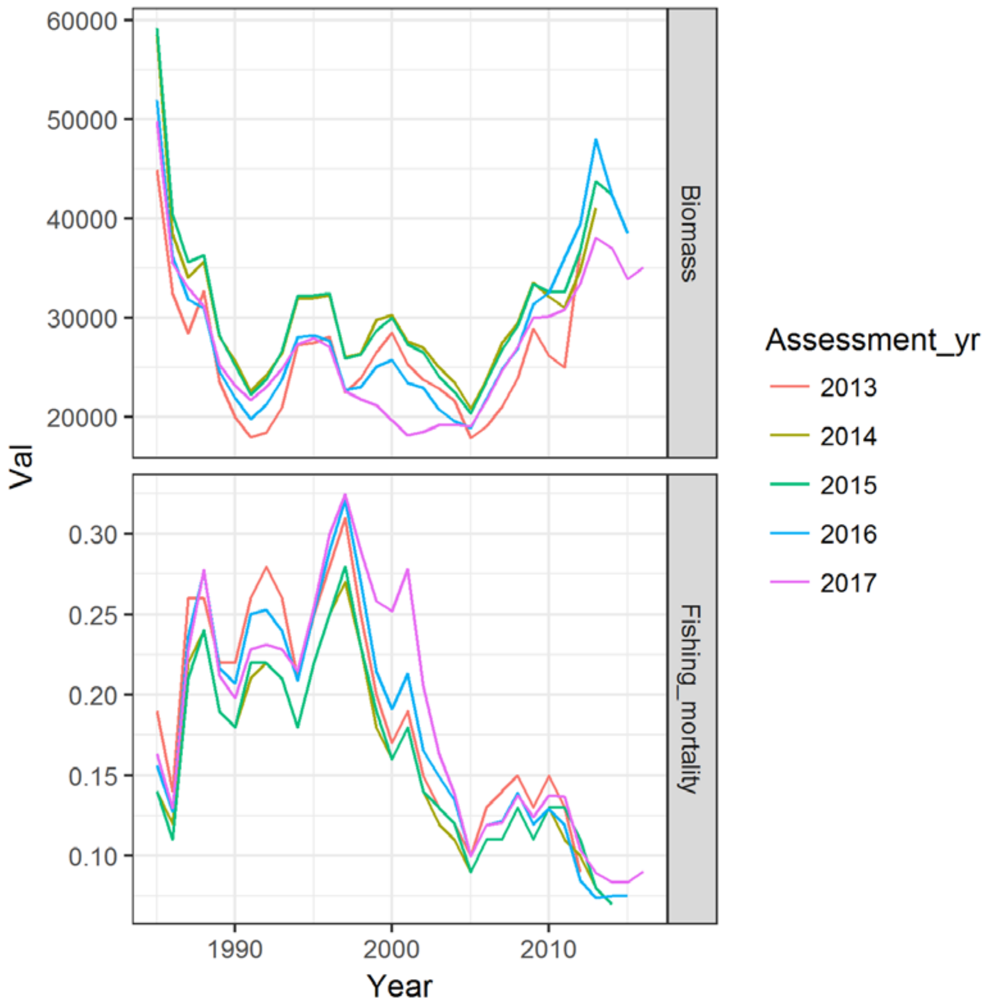


Figure 13.13. Comparison with previous assessments.

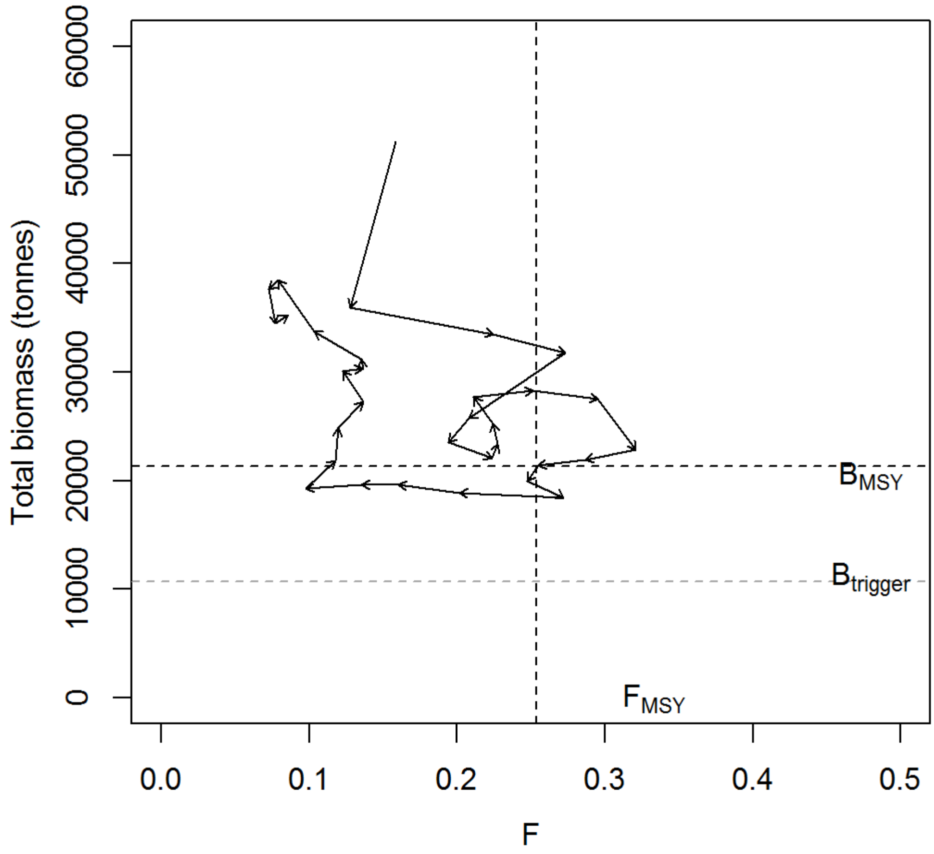


Figure 13.14. Kobe plot of stock status.

14 Megrim (*Lepidorhombus* ssp.) in Division 6.b (Rockall)

Type of assessment in 2017

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 2016

Based on ICES approach to data-limited stocks, ICES advises that landings and catches should be no more than 343 t and 380 t respectively in 2016.

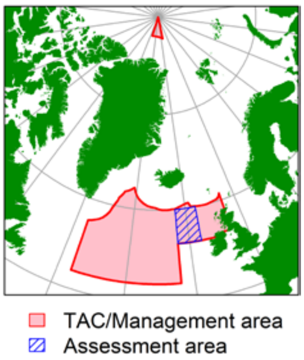
ICES advice applicable to 2017

ICES advises that when the precautionary approach is applied, catches in 2017 should be no more than 379 tonnes. If discard rates do not change from the average of the last three years (2013–2015), this implies landings of no more than 342 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 2016

Ireland had the highest catches in 2016 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%	0.12%	99.88%	0.00%	0.01%	99.99%

Data

As part of the 2011 benchmark, landings-at-age data were compiled from 1990 to 2010. However, there are very sparse age data available from 6.b and prior to 2002, a common Subarea 6 ALK was applied to megrim from 6.a and 6.b. Commencing in 2012, area-specific age data will be gathered during the anglerfish survey.

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 were available from Ireland and Scotland in 2015 and 2016 in InterCatch. The discard estimates for Scotland increased in 2016. 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 2005–2013. 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 2005–2010).

Surveys

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish. Eleven 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 is 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. There is an increasing trend in both abundance and biomass in 6.b since 2005. Both abundance and biomass decline in 2017. The area-stratified survey provides a minimum estimate of absolute biomass as the survey catches are raised based on swept area raised 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 providing a minimum estimate of stock biomass. However, the biomass dynamic model used for 6.a/4.a megrim assessment, provides megrim catchability estimates for SAIMISS-Q2/IAMISS-Q2 6.a and 4.a surveys. These are estimated to be in the region of 0.2–0.3. Using the upper q estimate of

0.3 in combination to scale the survey biomass estimate to provide an absolute biomass estimate, and catch estimate have been used to provide a broad estimate of the relative harvest ratio of megrim in 6.b (Table 5.3.1.9). This shows that the harvest ratio for megrim to be in the range 2 to 25% over the time-series and this has been very low in recent years typically less than 6%.

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 14.3. 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_{MSYS}	3178	1109	9108	8.1
F_{MSYS}	0.218	0.104	0.458	-1.5
MSY_S	695	397	1215	6.6

The general conclusion of WKProxy and WGCSE last year is still valid; that the stock is currently exploited well below F_{MSY} proxy reference points and SSB is well 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.

14.1 Uncertainties and bias in assessment and forecast

There is no accepted analytical assessment for this stock.

14.2 Recommendation for next Benchmark

This stock was recently subject to benchmark in 2011. This stock should be benchmarked as soon as practical. WGCSE next year should review the available data, discuss assessment options and schedule a benchmark.

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.

14.3 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 Subarea 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 Megrim Rockall, as officially reported to ICES and WG best estimates of landings.

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

Table14.2. Estimates of 6.b (Rockall) megrim biomass and harvest ratio from SAMISS surveys.

Year	Survey Biomass	Survey q	Raised Biomass	Landings	Discards	Catch	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	14401	224	21	245	0.02
2013	3030	0.3	10101	278	15	293	0.03
2014	3318	0.3	11060	343	15	358	0.03
2015	3262	0.3	10872	453	85	538	0.05
2016	4507	0.3	15024	405	145	550	0.04
2017	3020	0.3	10067				

Table14.3. SPICT results for 6.b (Rockall) megrim.

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 32.8975298
Euler time step (years):  1/16 or 0.0625
Nobs C: 26,  Nobs I1: 13

Priors
    logn  ~  dnorm[log(2), 2^2]
 logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]

Fixed parameters
    fixed.value
 phi          NA

Model parameter estimates w 95% CI
           estimate        cilow        ciupp    log.est
 alpha     6.0891464    0.6165611 6.013630e+01  1.8065079
 beta      0.6440206    0.2214100 1.873278e+00 -0.4400246
 r         0.3781869    0.0252818 5.657245e+00 -0.9723669
 rc        0.4385207    0.2114772 9.093198e-01 -0.8243482
 rold      0.5217594    0.0041890 6.498749e+01 -0.6505488
 m       700.2861751  395.4671377 1.240054e+03  6.5514891
 K      6775.4574931 3778.3440376 1.214999e+04  8.8210622
 q         0.7380516    0.3270360 1.665627e+00 -0.3037416
 n         1.7248300    0.0756037 3.935043e+01  0.5451285
 sdb       0.0591119    0.0064474 5.419603e-01 -2.8283232
 sdf       0.3326490    0.1632896 6.776630e-01 -1.1006675
 sdi       0.3599410    0.2343294 5.528863e-01 -1.0218153
 sdc       0.2142328    0.1260990 3.639655e-01 -1.5406920

Deterministic reference points (Drp)
          estimate        cilow        ciupp   log.est
 Bmsyd 3193.8566854 1118.5759865 9119.3809358  8.068984
 Fmsyd    0.2192604    0.1057386    0.4546599 -1.517495
 MSYd   700.2861751  395.4671377 1240.0543060  6.551489
Stochastic reference points (Srp)
          estimate        cilow        ciupp   log.est rel.diff.Drp
 Bmsys 3178.2898210 1109.0871655 9107.9641894  8.064099 -0.004897874
 Fmsys    0.2186368    0.1042506    0.4585301 -1.520343 -0.002852048
 MSYs   694.8813578  397.3857540 1215.0916244  6.543741 -0.007778043

States w 95% CI (inp$msytype: s)
                   estimate        cilow        ciupp    log.est
 B_2017.00      4653.4544063 2409.5411777 8987.0379109  8.4453651
 F_2017.00         0.1171897    0.0487911    0.2814736 -2.1439616
 B_2017.00/Bmsy    1.4641378    0.6123511    3.5007688  0.3812666
 F_2017.00/Fmsy    0.5360016    0.1868626    1.5374808 -0.6236181

Predictions w 95% CI (inp$msytype: s)
                 prediction        cilow        ciupp    log.est
 B_2017.00      4653.4544063 2409.5411777 8987.0379109  8.4453651
 F_2017.00         0.1171897    0.0487911    0.2814736 -2.1439616
 B_2017.00/Bmsy    1.4641378    0.6123511    3.5007688  0.3812666
 F_2017.00/Fmsy    0.5360016    0.1868626    1.5374808 -0.6236181
 Catch_2017.00   546.6202834  290.0562679 1030.1233496  6.3037544
 E(B_inf)       4715.4471120           NA           NA  8.4585990
```

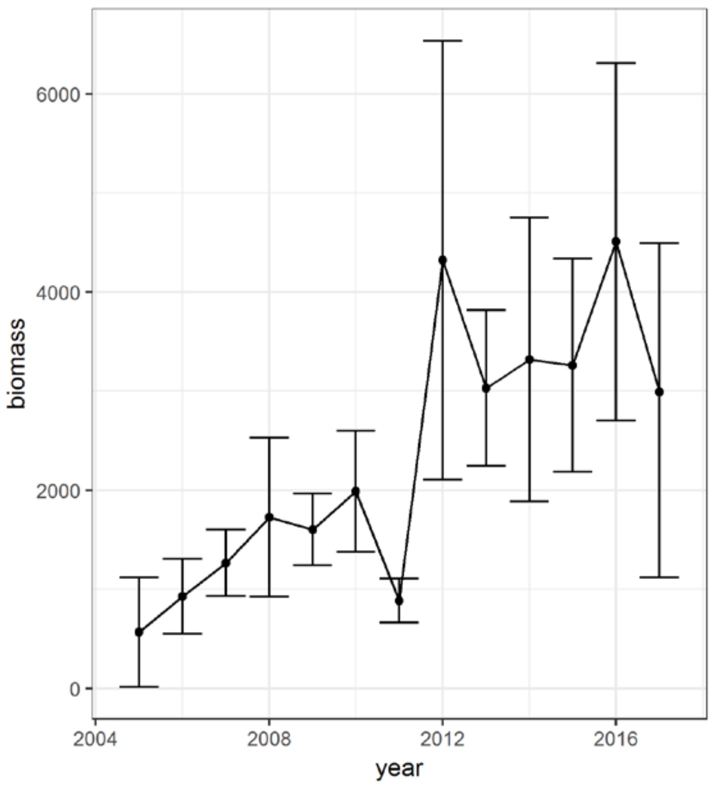


Figure 14.1. Meg-rock estimate biomass time-series.

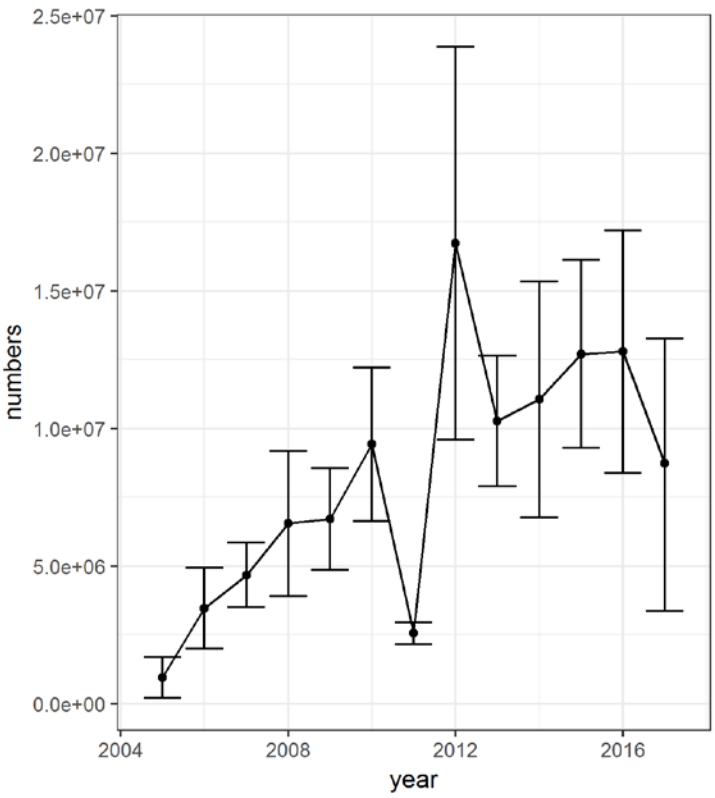


Figure 14.2. Meg-rock estimate abundance time-series.

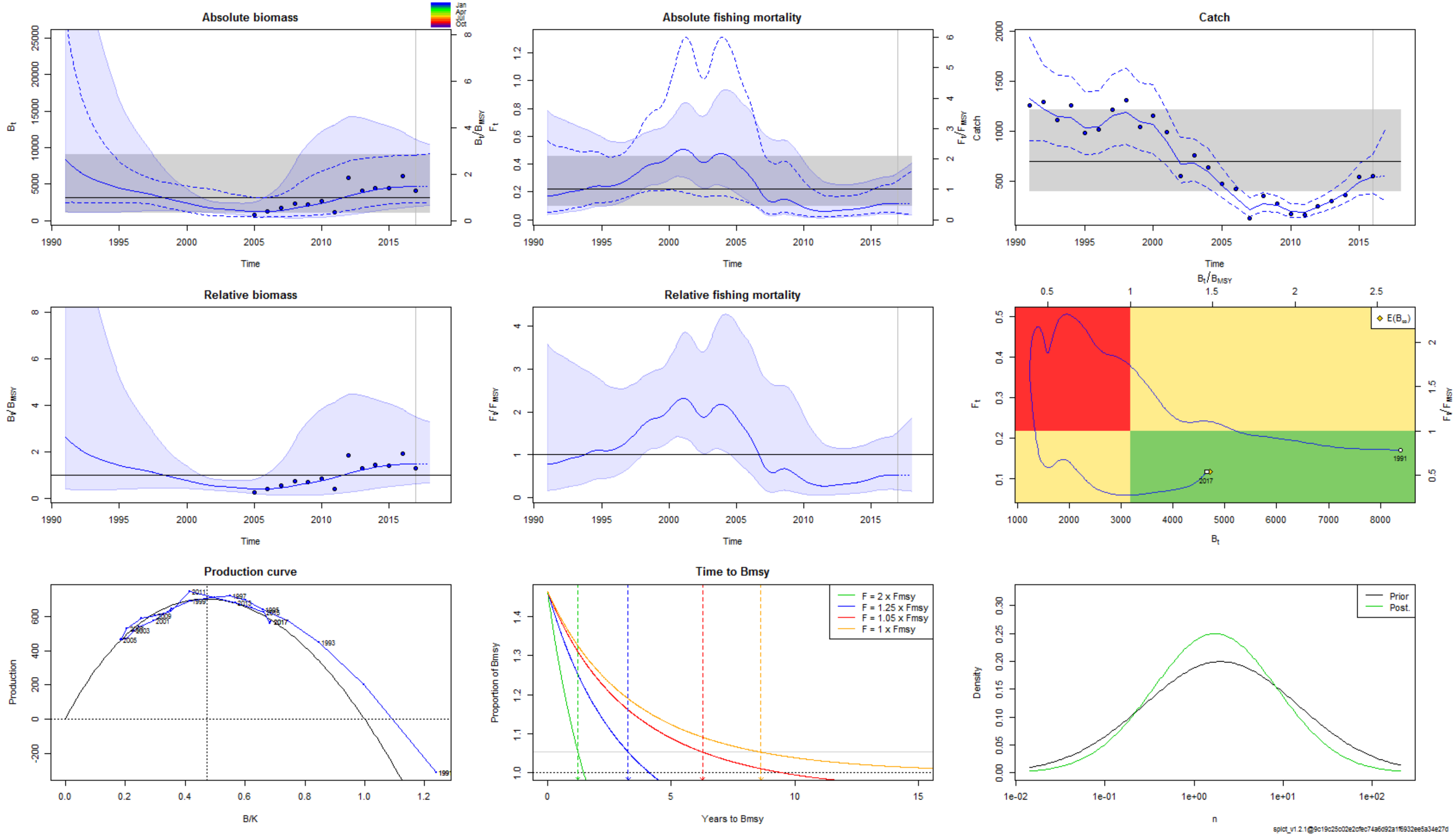


Figure 14.3. Meg-rock SPiCT model output. Top right: observed and fitted catch with 95 ci. Centre left: Biomass relative to B_{MSY}. Centre: F relative to F_{MSY}. Corresponding MSY quantities are shown in each plot as horizontal lines (0.5 B_{MSY} in the case of the relative biomass plot). Centre right Kobe plot of stock trajectory.

15 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 15.1 and illustrated in Figure 15.1. 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 2017

The assessment of North Minch *Nephrops* in 2017 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 2016

'ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 3770 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 3677 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 2017

'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 2013–2015, catches in 2017 should be no more than 3814 tonnes. This implies landings of no more than 3610 tonnes.

To ensure that the stock in functional unit (FU) 11 is exploited sustainably, management should be implemented at the functional unit level.'

15.1 General

Nominal landings as reported to ICES for Divisions 6.a and 6.b are presented in Table 15.1.1. Total official landings from Division 6.a were 14707 tonnes in 2016, mostly reported by the UK with only 107 tonnes reported from Ireland. Minor updates were available for 2013 Irish landings. Table 15.1.2 and Figure 15.1.1 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 2016, 236 tonnes of landings were reported from outside the FUs which is lower than the long-term average (Table 15.1.2). 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. In 2016, less than a tonne of *Nephrops* were landed from this division and is rounded to zero in Table 15.1.1(b).

Stock description and management units

The North Minch (FU11) is located at the northern end of the west coast of Scotland (Figure 15.1). 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 2016 and 2017

The management unit is Subarea 6 and EU and international waters of 5.b. The TAC for this area is 16 407 tonnes in 2017, down from 16 524 tonnes in 2016.

Since 2016, fisheries catching *Nephrops* in Division 6.a have been covered by the EU landing obligation (EU, 2015a). Creel fisheries are exempted from the landing obligation due to high survivability of discards, while there is a *de minimis* exemption consisting of a 7% discard rate by weight for the trawl fishery in 2016 and 2017.

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 fishery officers.

Overall fishing was reported to be fairly good throughout 2016, although similarly to 2015, poor weather caused the fleet to tie up at times. Trawlers targeted *Nephrops* year round whereas some creelers targeted *Nephrops* in the winter and shifted to lobster and crab over the summer months. Fourteen creelers also targeted wrasse between May and October, supposedly easing pressure on shellfish stocks. Non-local vessels were reported to arrive in the spring and early summer. However an influx of east coast vessels, as occurred in 2015, was not reported. The price was described as good, increasing in 2016 from 2015, as it had from 2014 to 2015. Profitability was further benefited by the weak pound and low fuel prices.

No information on Barra, Lochiver, Ullapool or Gairloch was received in 2016. The largest part of the North Minch fleet is still assumed to be based at Stornoway, numbering 209 vessels in 2016. The majority of the Stornoway vessels, 165, are below 10 m in length. In 2015 the Barra vessels were generally bigger than the Stornoway fleet, all being greater than 15 m in length. The Bara fleet was more nomadic due to fishing exposed grounds, forcing the vessels to find shelter on the east side of the North Minch. The Stornoway fleet in 2016 targeted the usual local grounds from Stornoway to Northbay with trip lengths of one to two days, the same length as those reported from Barra in 2015.

No major changes in gear use were reported in 2016 on the previous year. 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.

The implementation of management measures for Marine Protected Areas (MPAs) did influence the fishery. Specifically, the closure of the East Mingualy Special Area of Conservation (SAC) to creeling caused one creeler to tie up (this SAC is located in the South Minch). In addition certain areas of the Wester Ross Nature Conservation MPA (NCMPA) were closed to demersal trawls; this area tended to be fished during periods of poor weather.

Further general information on the fishery can be found in the stock annex.

15.2 Data available

InterCatch

Data for 2016 were successfully uploaded into InterCatch prior to the 2017 WG meeting according with the deadline proposed. Uploaded data were worked up in InterCatch to generate 2016 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 15.2.1. Landings from this fishery are usually only reported from Scotland but in 2012–2014, 2 tonnes of *Nephrops* were reported by Ireland. Total reported Scottish landings in 2016 were 3529 tonnes, consisting of 3039 tonnes landed by trawlers targeting *Nephrops* (~86.1%), 475 tonnes landed by creel vessels (~13.5%) and 15 tonnes by other trawlers. In addition, 0.4 tonnes of *Nephrops* were 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 Targetting Crustaceans) has shown a decreasing trend since 2000 (Figure 15.2.1) 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 was relatively stable between 2015 and 2016. Note that the year range in effort time-series (2000–2016) 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 15.2.2. 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. Sampling for this FU was considered to be adequate in 2016. Ahead of the 2017 WG, additional market samples for 2015 became available and the catch estimation was updated resulting in minor changes to landings length–frequency distributions for that year.

Length compositions

Figure 15.2.2 shows a series of annual length–frequency distributions for the period 2000 to 2016. 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 2016 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 seem to vary between years (Figure 15.2.3(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.* This occurs because males are available throughout the year and the fishery is prosecuted in all quarters (although effort is reduced during the winter months when the weather is poor). 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 15.2.3(b) where males dominate in quarters one and four but the ratio is more even (or often female dominated) in quarters two and three.

Mean weights

The mean weight in the landings (trawls and creels combined) shows substantial interannual variation (Figure 15.2.4 and Table 15.2.3) decreasing between 2010 and 2012, followed by an increase in 2013–2015 and a decrease again in 2016. 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 15.2.2) in particular are due to a higher proportion of creel landings. Figure 15.2.5 shows the mean weight by sample and gear type over the period 2009–2016. 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 data. A slight decrease in the mean weight of creel caught males noted in 2016 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 2016 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 ~11% by number in the last three years (Table 15.2.4). In 2016 the discard rate increased to 14.0% by number (from 12.6% in 2015).

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 2018 is 8.5% based on a three year average of 2014–2016.

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 2016, 39 valid stations were used in the survey final analysis (Table 15.2.5).

Table 15.2.6 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 10.2%, lower than the precision level agreed (Table 15.2.6).

Figure 15.2.6 shows the distribution of stations in recent TV surveys (2010–2016), with the size of the symbols reflecting the *Nephrops* burrow density. Table 15.2.5 and Figure 15.2.7 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%.

15.3 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 major issues were highlighted by the audit conducted last year.

State of the stock

The assessment summary is provided in Table 15.2.4. 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 2016 was 1422 million individuals, a 1.6% decrease from the 2015 estimate. However, this decrease was not statistically significant (95% confidence intervals for 2015 and 2016 overlapped) and 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 15.2.7).

The calculated harvest rate in 2016 (dead removals/TV abundance = 10.7%) is close to the F_{MSY} proxy for this stock (the value associated with high long-term yield and low risk depletion) of 10.8%. This is due to the relative increase in catches in 2016 against the survey abundance.

Note that there have been minor amendments to the 2015 estimates of total removals and resulting harvest rate compared to last year. This is due to additional sampling data being included in the catch estimation process.

15.4 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 2017 UWTV survey conducted in June and presented in October 2017 for the provision of advice.

The table below shows the agreed inputs to the catch options table.

INPUT	DATA	2017 ASSESSMENT
Survey abundance (millions)	UWTV 2017	Not yet known
Mean weight in landings (g)	1999–2016	25.82
Mean weight in discards (g)	1999–2016	10.88
Dead discard rate	average 2014–2016	8.50%

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 2016 for producing the catch options.

15.5 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 15.2.4 and Figure 15.5.1 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, remaining below the F_{MSY} proxy for 2013 to 2015. In 2016 the harvest rate has increased to 10.7%, just below the F_{MSY} proxy.

It is likely that prior to 2006, the estimated harvest rates may not be representative due to underreporting of landings.

15.6 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 15.6.1.

15.7 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, reaching 13.5% in 2016. 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 (2014–2016) 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.

15.8 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.

15.9 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.

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Table 15.1. *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 15.1.1(a). Nominal landings (tonnes) of *Nephrops* in Division 6.a, 1980–2016, 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
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

*** Landings for 2015 and 2016 are preliminary.**

Table 15.1.1(b). Nominal landings (tonnes) of *Nephrops* in Division 6.b, 1981–2016, 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
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
2007	-	-	-	2	3	-	5
2008	-	-	-	-	-	-	0
2009	-	-	-	-	-	-	0
2010	-	-	-	-	-	-	0
2011	-	-	-	-	-	-	0
2012	-	-	-	-	-	-	0
2013	-	-	-	-	-	-	0
2014	-	-	-	-	-	-	0
2015*	-	-	-	-	-	-	0
2016*	-	-	-	-	-	0	0

***Landings for 2015 and 2016 are preliminary.**

Table 15.1.2. ***Nephrops*****, Total** ***Nephrops*** **landings (tonnes) by Functional Unit plus Other rectangles, 1981–2016.**

YEAR	NORTH MINCH (FU11)	SOUTH MINCH (FU12)	CLYDE (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
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*	4402	6447	236	14614*

***Includes below minimum size landed discards of 0.4 t.**

Table 15.2.1. Nephrops, North Minch (FU11), Nominal Landings of *Nephrops*, 1981–2016.

UK SCOTLAND						OTHER UK & IRELAND	TOTAL
Year	*Nephrops* trawl	Other	Creel	Below Minimum Size	Sub Total		
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
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	0	3529

***Below minimum size landings not rounded to show it was reported.**

Table 15.2.2. ***Nephrops*** **Scottish sampling levels all FUs in 6.a (including N. Irish for Clyde).**

		2014		2015		2016	
FU		**N TRIPS***	**N MEASURED**	**N TRIPS***	**N MEASURED**	**N TRIPS***	**N MEASURED**
North Minch (FU11)	**Landings**	40	28 859	46	26113	44	32 483
	Discards	24	3806	14	2382	23	4402
South Minch (FU12)	**Landings**	44	28 378	52	30546	37	20 439
	Discards	21	3503	24	3074	8	1274
Clyde (FU13)	**Landings**	32	20 968	40	27465	22	19 069
	N.Irish Landings	12	7283	4	2206	28	18218
	Discards	19	2977	21	3467	21	3337

***Number of trips expressed as number of hauls for discards.**

Table 15.2.3. *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
Average**	25.82	26.71	20.23

***From 1999 onwards mean weights are shown for trawl and creels combined.**

**** Average for FU11 and FU12 (1999–2016); FU13 (2014–2016).**

Table 15.2.4. ***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
Average****									8.50	25.82	10.88

*** 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: 2014–2016; Mean weight in landings and discards average: 1999–2016.**

Table 15.2.5. ***Nephrops*, North Minch (FU11): Results of the 1994–2016 TV surveys (values adjusted for bias).**

YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS/m ²)	ABUNDANCE (VMS; MILLIONS)	95% CONFIDENCE INTERVAL (VMS; MILLIONS)
1994	41	0.29	820	122
1995		No Survey		
1996	38	0.19	541	76
1997		No Survey		
1998	38	0.31	898	127
1999	36	0.27	794	147
2000	39	0.40	1166	134
2001	56	0.38	1092	133
2002	37	0.46	1337	149
2003	41	0.60	1751	211
2004	38	0.60	1751	175
2005	41	0.53	1540	164
2006	30	0.61	1762	165
2007	36	0.41	1206	150
2008	41	0.36	1047	157
2009	26	0.41	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

Table 15.2.6. *Nephrops*, North Minch (FU11): Results of the 2016 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)
2016 TV survey								
VMS	2908	39	0.489	0.097	1421.8	20967	1	
Total	2908	39			1421.8	20967	1	0.102

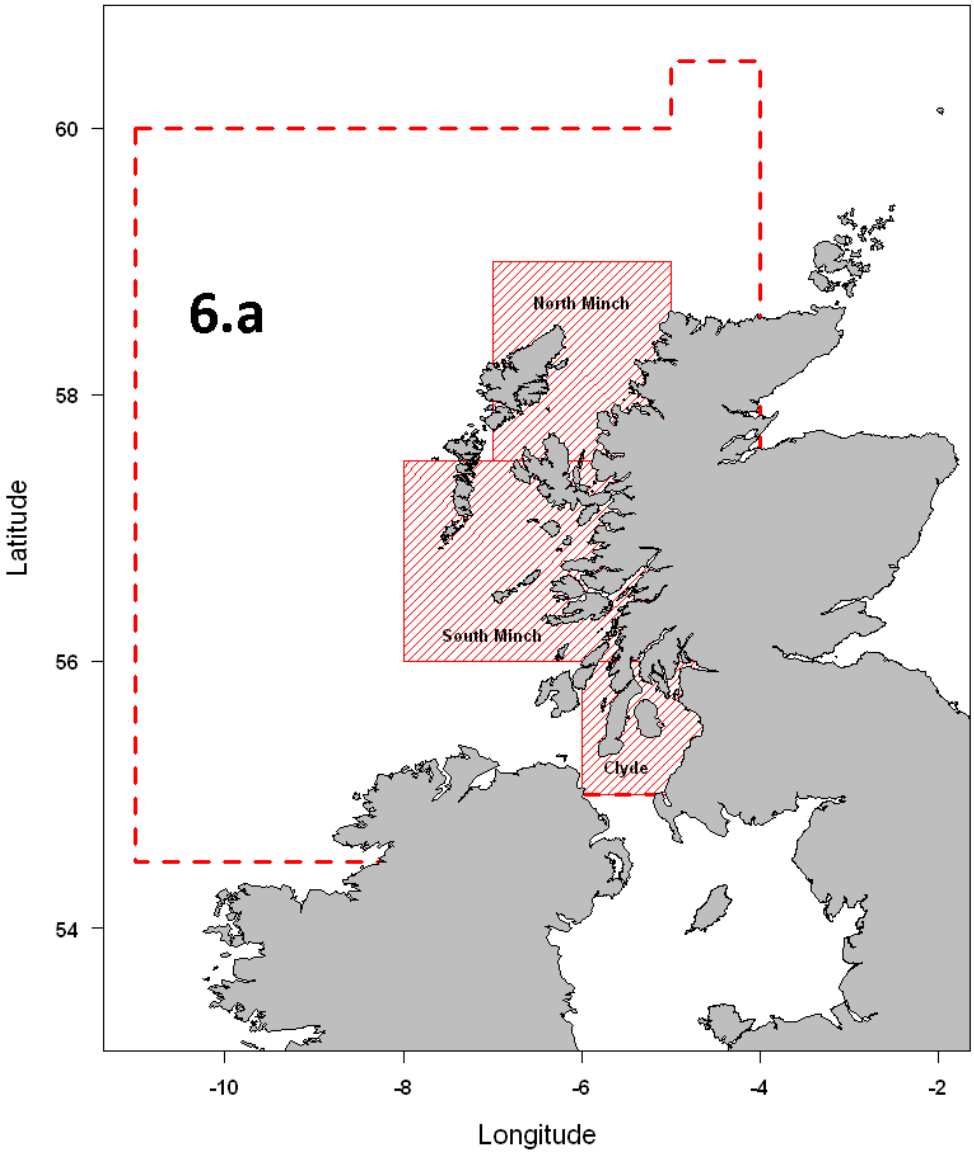


Figure 15.1. ***Nephrops*** **Functional Units in 6.a. North Minch (FU11), South Minch (FU12), Clyde (FU13).**

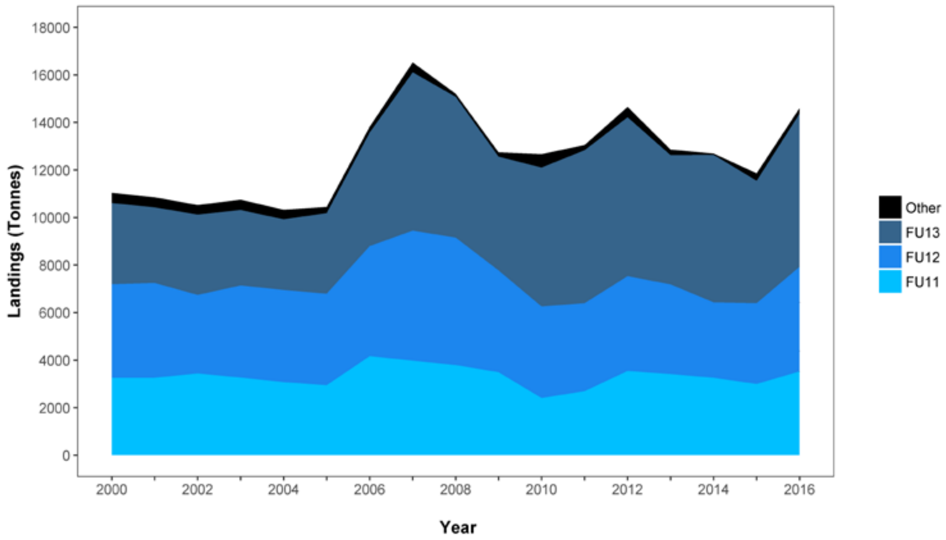
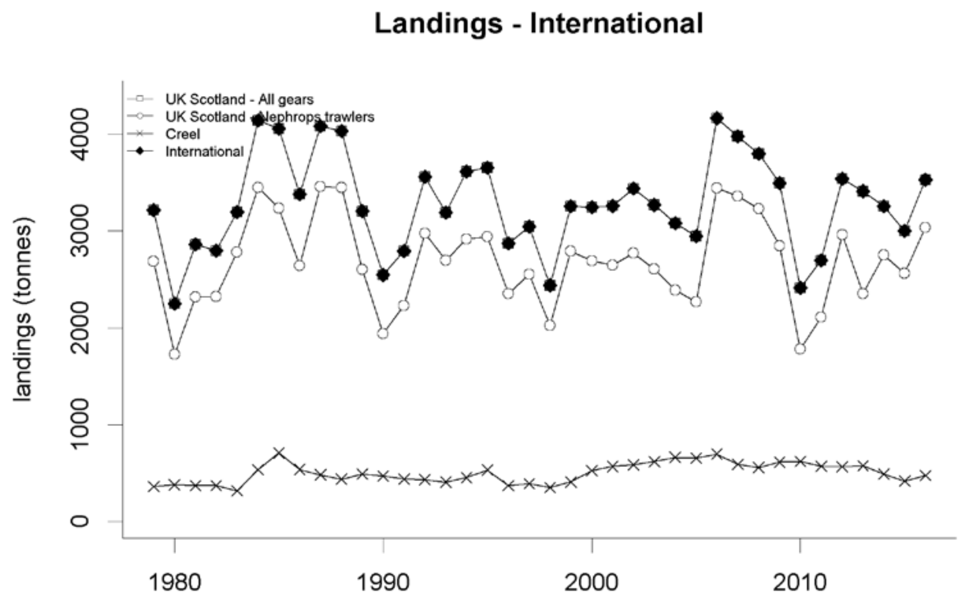


Figure 15.1.1. ***Nephrops*** **in Division 6.a. Landings (tonnes) by functional unit (FU11 to 13) and from rectangles outside the functional units (Other).**



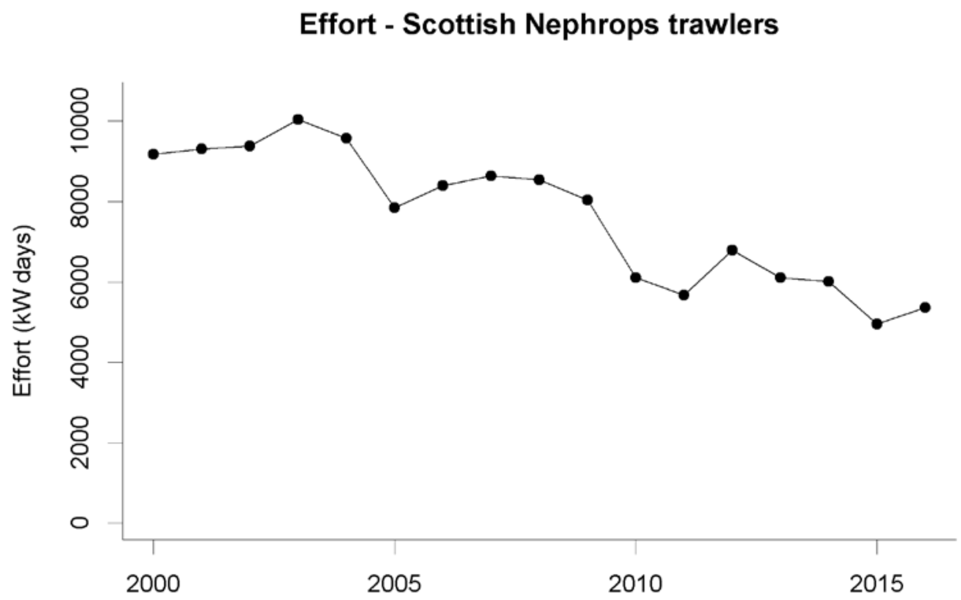


Figure 15.2.1. ***Nephrops*****, North Minch (FU11). Long-term landings and effort.**

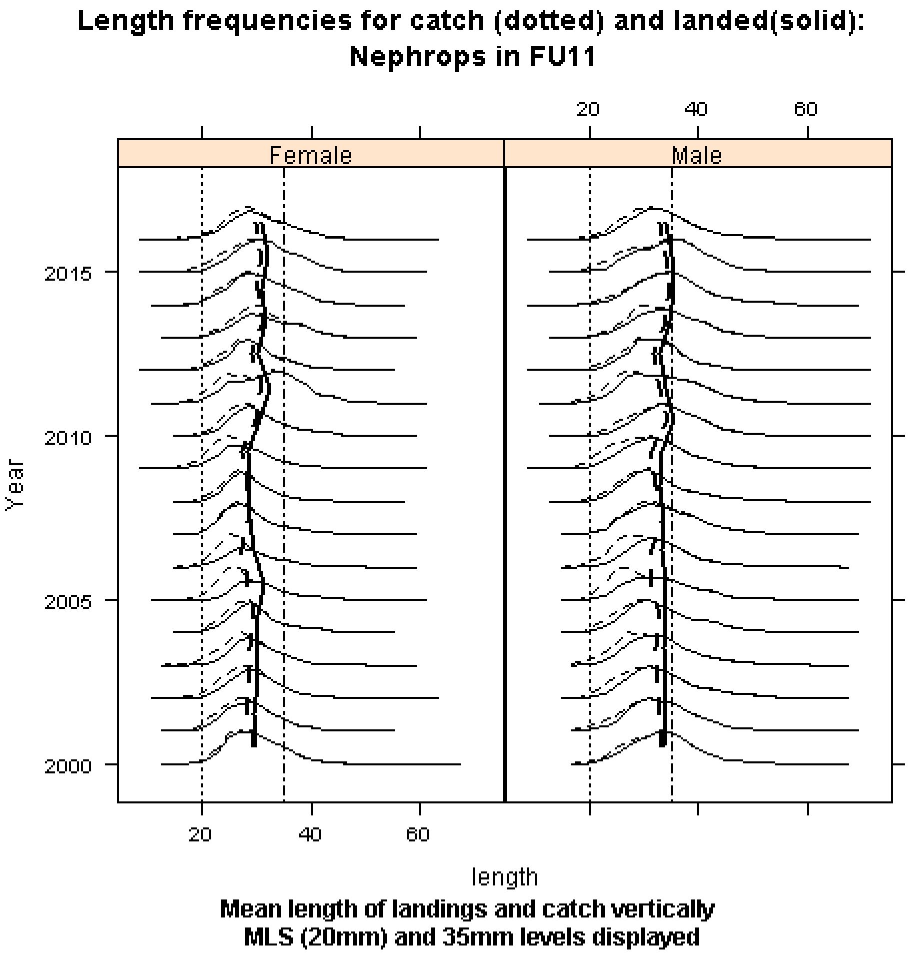
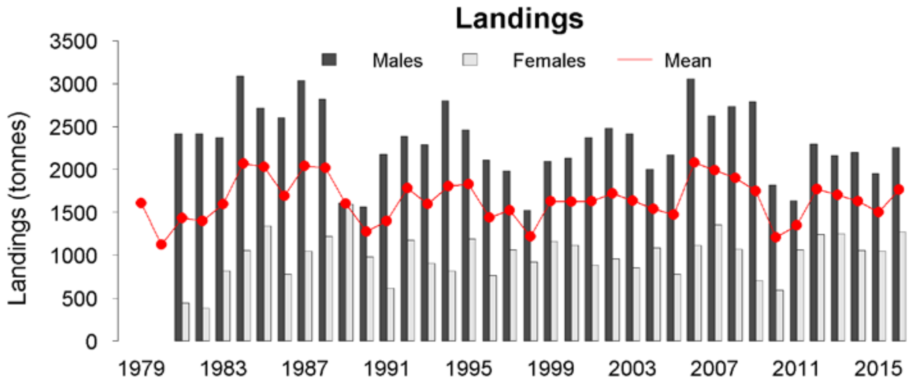


Figure 15.2.2. ***Nephrops*****, North Minch (FU11), Catch length–frequency distribution and mean sizes (red line) for** ***Nephrops*** **in the North Minch, 2000–2016.**



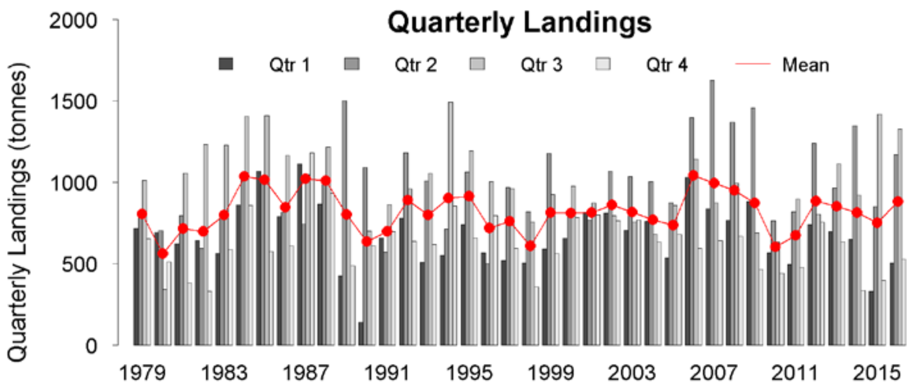


Figure 15.2.3 (a). ***Nephrops*****, North Minch (FU11), Landings by quarter and sex from Scottish trawlers.**

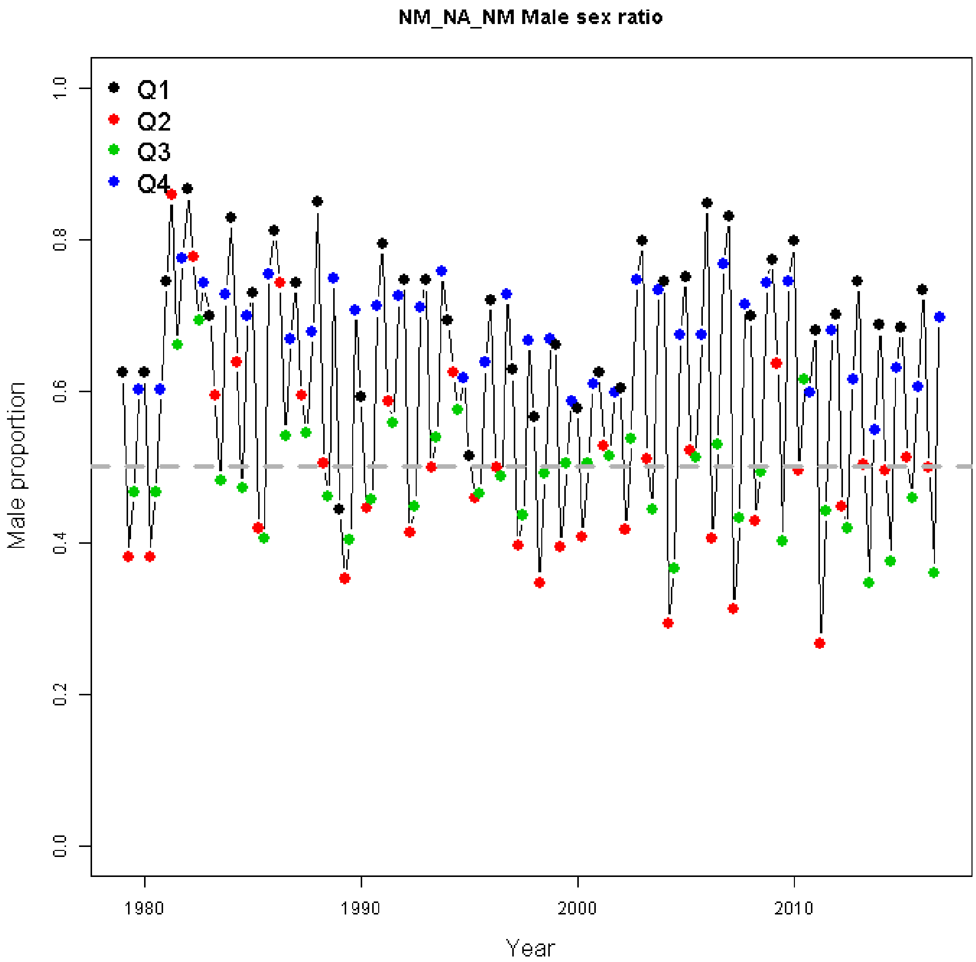


Figure 15.2.3 (b). ***Nephrops*, North Minch (FU11), Proportion of males by quarter (1980–2016).**

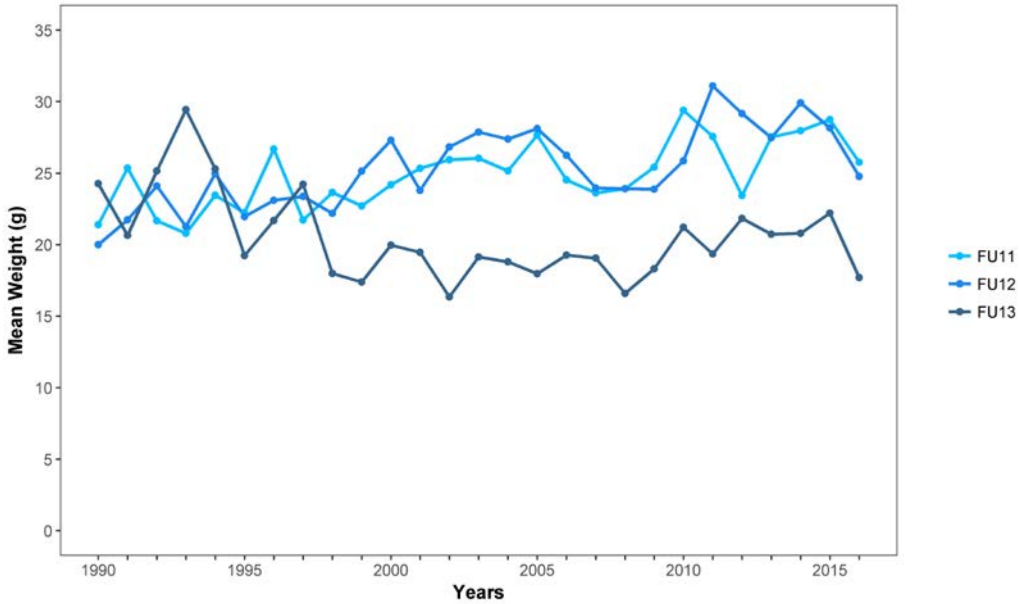


Figure 15.2.4. ***Nephrops*, (FU11 North Minch, FU12 South Minch and FU13 Clyde), mean weight in the landings from 1990–2016 (from Scottish market sampling data).**

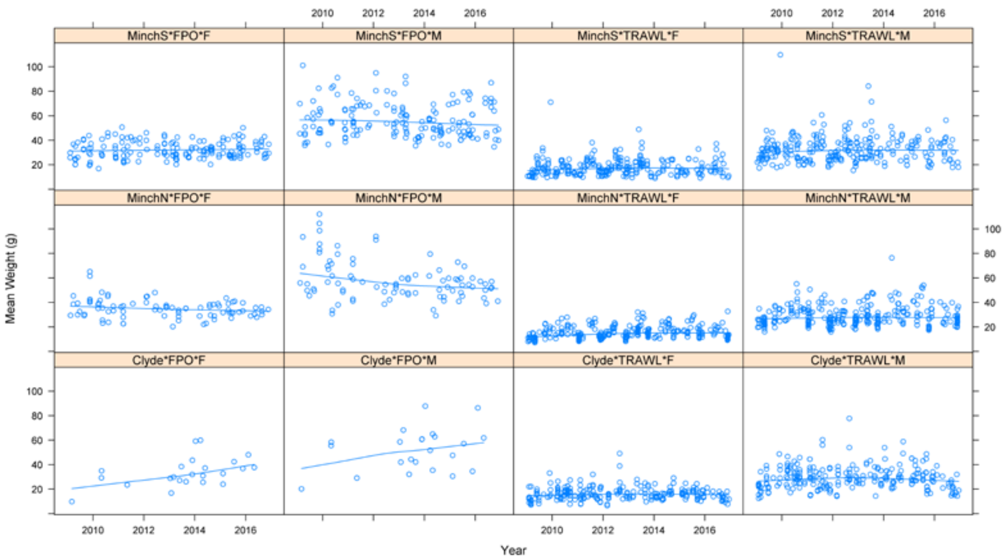


Figure 15.2.5. ***Nephrops*, (FU11 North Minch, FU12 South Minch, FU13 Clyde), mean weight in landings 2009–2016 by sample date, sex, métier and functional unit.**

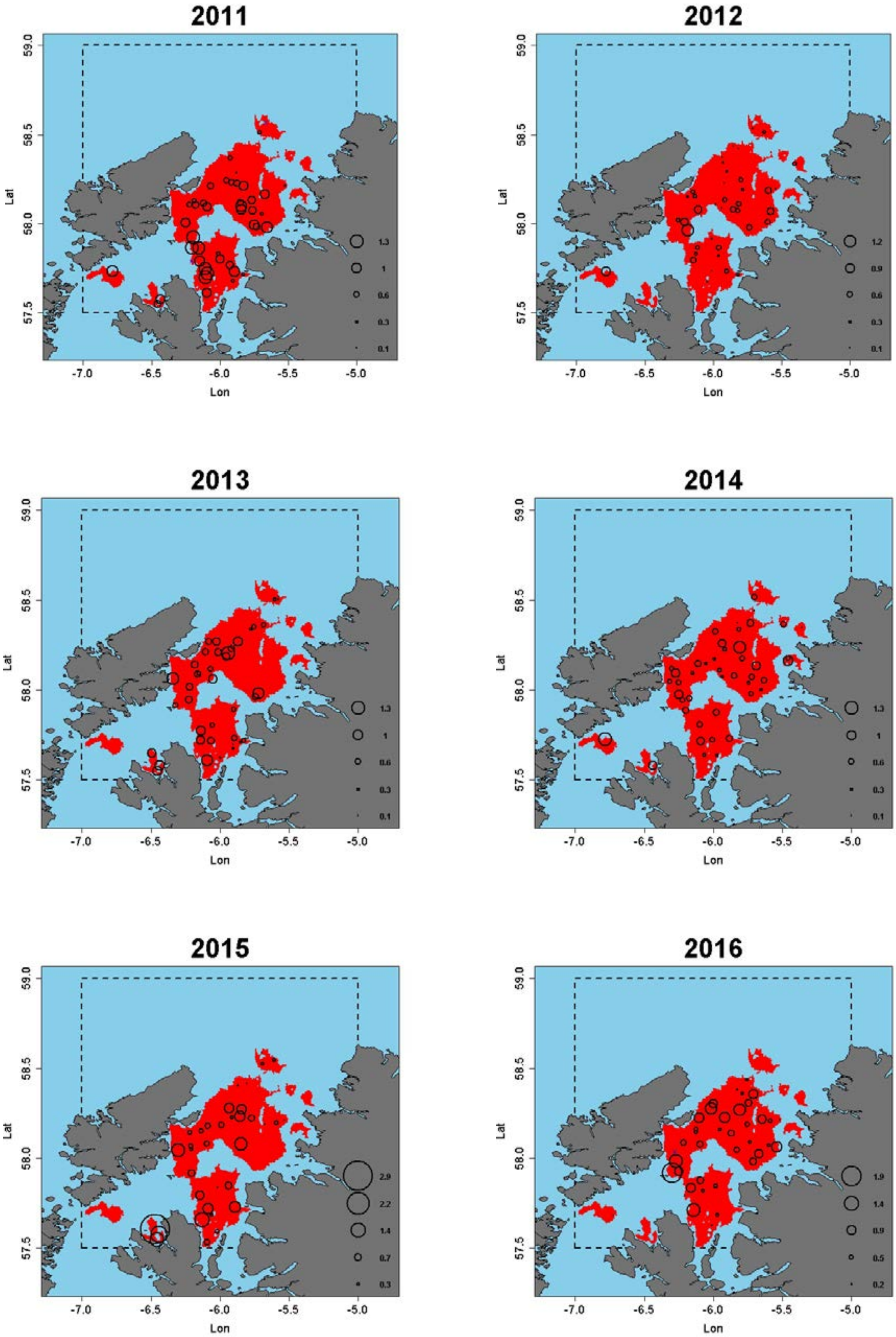


Figure 15.2.6. ***Nephrops*, North Minch (FU11), TV survey station distribution and relative density (burrows/m²), 2010–2016. Bubbles in these figures are all scaled the same. Crosses represent zero observations.**

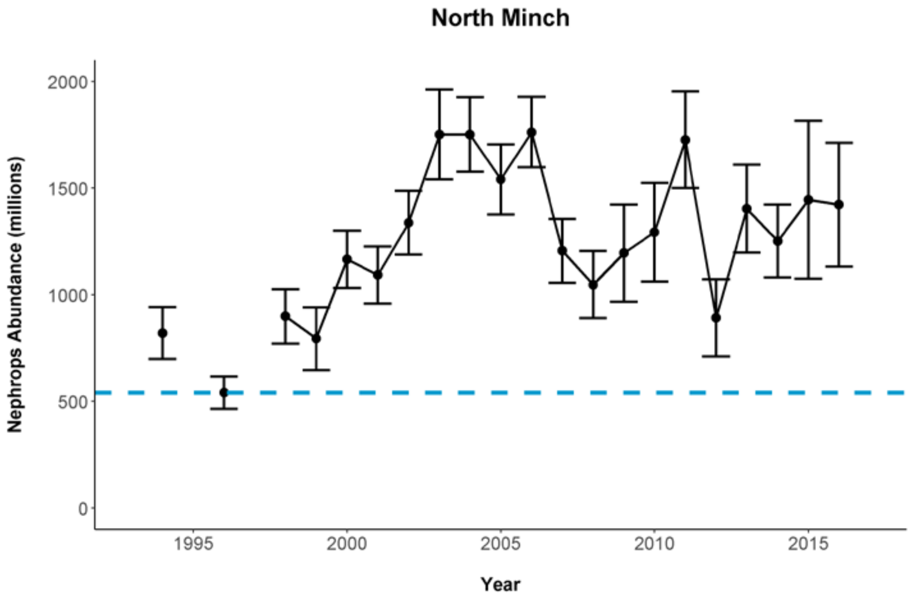


Figure 15.2.7. ***Nephrops*, North Minch (FU11), time-series of revised TV survey abundance estimates (adjusted for bias), with 95% confidence intervals, 1994–2016 (no survey in 1995 and 1997). The dashed blue line is the rounded $B_{trigger}$ value of 540 million individuals.**

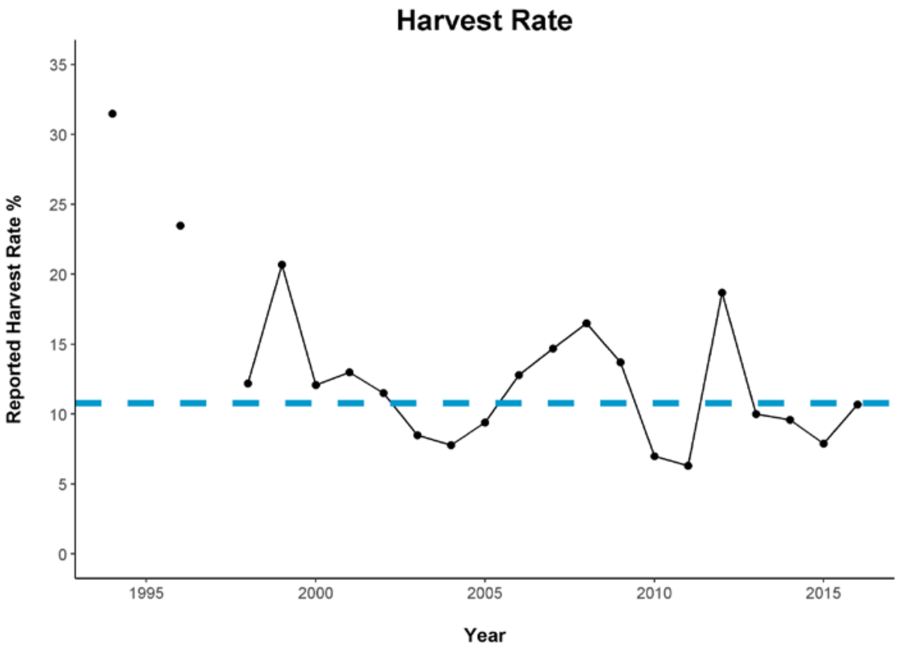


Figure 15.5.1. ***Nephrops*, North Minch (FU11), harvest rate, 1995–2016 (no survey data in 1995 and 1997). The blue dashed and solid lines are the F_{MSY} proxy harvest rate (10.8%) and the harvest rate respectively. Harvest rates prior to 2006 are unreliable.**

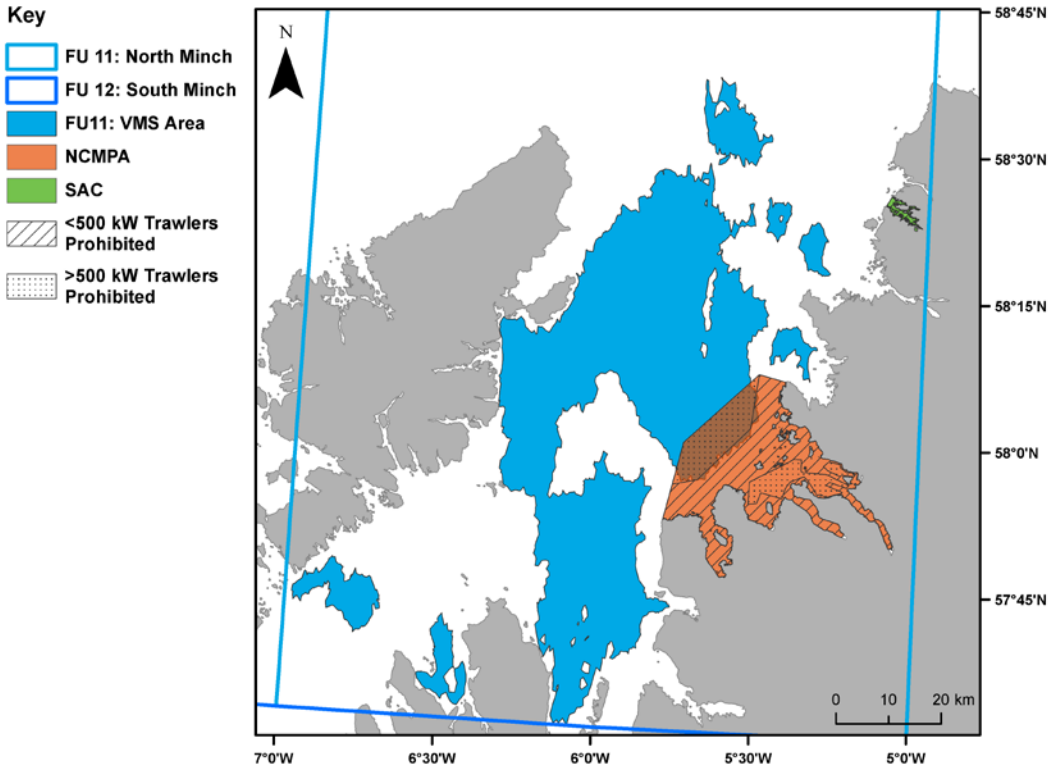


Figure 15.6.1. The area of *Nephrops* habitat (estimated from VMS data) within the North Minch (FU11) relative to the areas of the Nature Conservation MPA (NCMPA) and Special Area of Conservation (SAC) showing areas within these where demersal trawling is banned (hatched) and where it is permitted for 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).

16 Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 12 (West of Scotland, South Minch)

Type of assessment in 2017

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 2016

'ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 6163 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 6073 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 2017

'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 2013–2015, catches in 2017 should be no more than 6419 tonnes. This implies landings of no more than 6196 tonnes.

To ensure that the stock in functional unit (FU) 12 is exploited sustainably, management should be implemented at the functional unit level.'

16.1 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 2016 and 2017

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 staff, specifically fishery officers.

In 2016, the fishery was described as more active during winter months compared to the previous year due to good weather. Usually during winter, fishing activity is reduced in the South Minch and small boats are often restricted to trawling in the sheltered sea-lochs. Boats operating out of Oban and Portree continued to operate over similar areas to previous years. Boats operating out of Oban fished locally during the spring and summer while two larger vessels fished grounds from the east coast of North England from late autumn and through winter. No influx of east coast vessels were reported as in previous years. In Oban the few visiting vessels were English or from other west coast harbours, in Portree the few visiting boats were less than 12 m, probably local west coast vessels. Most of the 45 and 115 vessels fishing out of Oban and Portree, respectively, are creelers.

It is still presumed two distinct fleets operate in the South Minch and the main ports are Oban and Mallaig, as no information was received from Mallaig. Inshore a fleet of smaller vessels includes creel boats operated throughout the year in 2015, while some larger twin riggers fished further offshore. The local Mallaig fleet tended to fish closer to shore on harder ground and land better quality *Nephrops* than visitor boats. Most boats landed once or twice per week and only a few vessels (2–3) landed on a daily basis. Given that vessels were still fishing their usual grounds in 2016 it is likely this pattern persisted. In terms of the impact of Marine Protected Area (MPA) management measures, little impact was felt in Portree as the closest MPA was already covered by a seasonal closure. In Oban smaller vessels trawling for prawns were most affected with one vessel switching to creels.

There is increasing overlap of the areas exploited by trawl and creel fishing and this has led to some gear conflict issues, although this was not reported in 2016. 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 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 prawns of better average size and quality.

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 6a are now covered by the landings obligation in area. From 2016, vessels with total landings that contained 10% or more of any combination of cod, haddock, whiting or saithe in 2013 and 2014 had to land haddock (EU, 2015). This may include some vessels fishing for *Nephrops*.

Further general information on the fishery can be found in the stock annex.

16.2 Data available

InterCatch

Data for 2016 were successfully uploaded into InterCatch prior to the 2017 WG meeting according to the deadline. Uploaded data were worked up in InterCatch to generate 2016 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 2016 were 4310 tonnes (plus 33 tonnes from other UK vessels and 59 tonnes from Ireland), consisting of 3450 tonnes (80.0%) landed by Scottish *Nephrops* trawlers and 838 tonnes (19.4%) landed by Scottish creel vessels. The proportion of creel caught landings has remained relatively stable over the last five years.

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). Since 2013 effort has been stable at a level comparable to 2011. Note that the effort time-series range (2000–2016) 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 fell in 2016 compared to 2015, with only 8 discard samples available for 2016. This may have been due to a combination of potential factors; including recent changes to the sampling design, inadequate training of Scottish Fishermen's Federation observers and industry pelagic surveys taking priority over discard trips. 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. 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 declined slightly in 2016 compared to 2015 and this decrease was also reported by the industry. In both sexes there are peaks towards the lower size ranges, particularly for males which show a bimodal distribution. This may be indicative of elevated recruitment which would reduce the mean size. Moreover 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 2016. This supports the perception that the decline is due to elevated recruitment rather than exploitation, which would be consistent with the stock being exploited below F_{MSY} (see Section 16.3).

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 2016 weather during the winter was relatively settled, with increased landings in quarter one in comparison to 2015 when females are available to the fishery (Figure 16.2.3 (a)). Although the proportion of males in landings was only marginally higher in 2016 than it was in 2014 when weather was poor. Figure 16.2.3 (b) illustrates the sex ratio by season. There are no particularly anomalous values evident in 2016.

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. Although no obvious trends between years are present (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 an 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 2016 the discarding rate was 14.9%, higher than in 2015 (7.7%) and comparable to 2014 (15.6%) (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 2014–2016 and amounts to 9.87%.

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 2016, 37 valid stations were used in the survey final analysis (Table 16.2.3).

TV survey abundance estimates from 1999–2016 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 2016 abundance represents a 5.7% increase in relation to 2015. Although this increase is not statistically significant given the overlap of the two years 95% confidence intervals.

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 slightly in 2016, in comparison to the 2015 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 (2016; 15.4%). 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). 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%.

16.3 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 2016 survey are shown in Table 16.2.4 and compared with the 2014 and 2015 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 2016 was 2118 million individuals, substantially 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 2016 (dead removals/TV abundance = 9.5%) was below the F_{MSY} proxy for this stock (the value associated with high long-term yield and low risk depletion) of 11.7%.

16.4 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 2017 UWTV survey conducted in June. These will be presented in October 2017 for the provision of advice.

Catch option 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 options 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 2017.

The table below shows the agreed inputs to the catch options table.

Input	Data	2017 assessment
Survey abundance (millions)	UWTV 2017	Not yet known
Mean weight in landings (g)	1999–2016	26.71
Mean weight in discards (g)	1999–2016	10.03
Average dead discard rate	2014–2016	9.87%

16.5 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. 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.

It is likely that prior to 2006, the harvest rates are underestimates due to under-reported landings.

16.6 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 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). However, this could not have influenced the fishery in 2016. 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.

16.7 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 2016 than previous years (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 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 UWTV-FU12 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.

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 (2014–2016) 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.

16.8 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.

16.9 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 are made 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 which were introduced as part of the previous Scottish Conservation Credits scheme.

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Table 16.2.1. ***Nephrops*, South Minch (FU12), ICES estimates of landings of *Nephrops*, 1981–2016.**

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
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

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
Average***									9.87	26.71	10.03

***Harvest rates previous to 2006 are unreliable.**

****Removals numbers take the dead discard rate into account.**

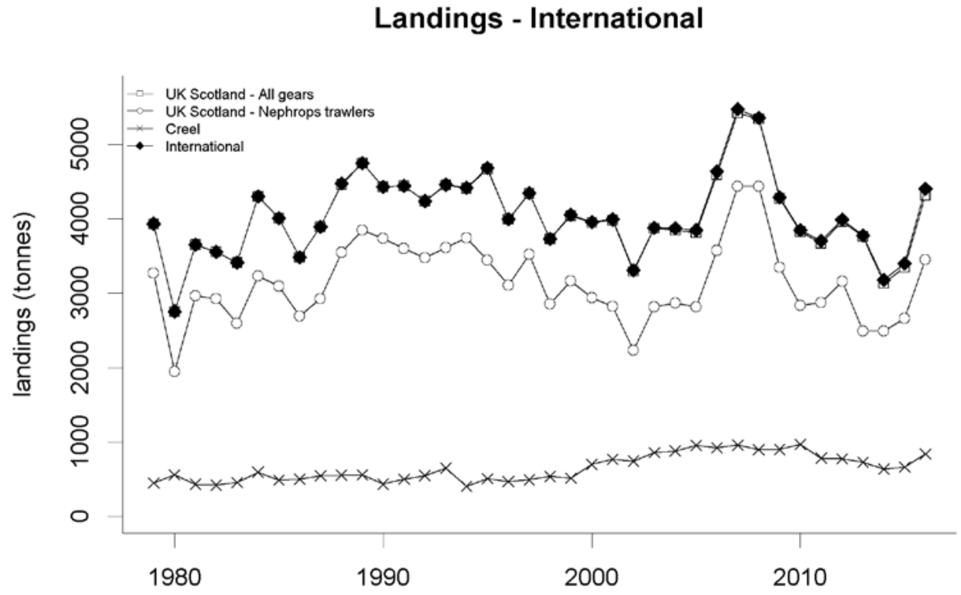
*****Dead discard average: 2014–2016; Mean weight in landings and discards average: 1999–2016.**

Table 16.2.3. *Nephrops*, South Minch (FU12): Results of the 1995–2016 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

Table 16.2.4. ***Nephrops*** **South Minch (FU12). Results by stratum of the 2014–2016 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 STA-TIONS	MEAN BURROW DENSITY (NO./M^2)	OBSERVED VARIANCE	ABUNDANCE (MILLIONS)	STRATUM VARIANCE	PROPORTION OF TOTAL VARIANCE	SURVE PRECI LEVEL (RSE)
2014 TV Survey								
M	303	4	0.212	0.001	64.3	32	0	
SM	2741	16	0.52	0.115	1424.8	53930	0.769	
MS	2028	16	0.288	0.063	583.7	16174	0.231	
Total	5072	36			2072.8	70135	1	0.12
2015 TV Survey								
M	303	4	0.509	0.141	154.4	3236	0.049	
SM	2741	16	0.486	0.114	1330.1	53565	0.811	
MS	2028	15	0.253	0.034	513	9215	0.14	
Total	5072	35			1997.5	66016	1	0.12
2016 TV Survey								
M	303	2	0.402	0.004	121.7	190	0.004	
SM	2741	19	0.467	0.082	1281.8	32355	0.668	
MS	2028	16	0.352	0.062	714.2	15905	0.328	
Total	5071	37			2117.7	48450	1	0.15



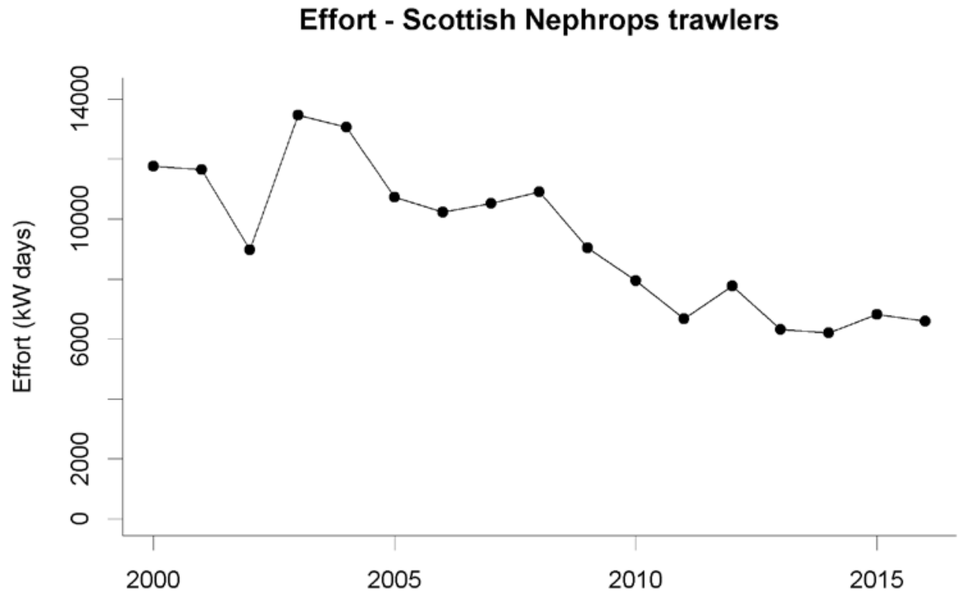


Figure 16.2.1. ***Nephrops*****, South Minch (FU12). Long-term landings and effort.**

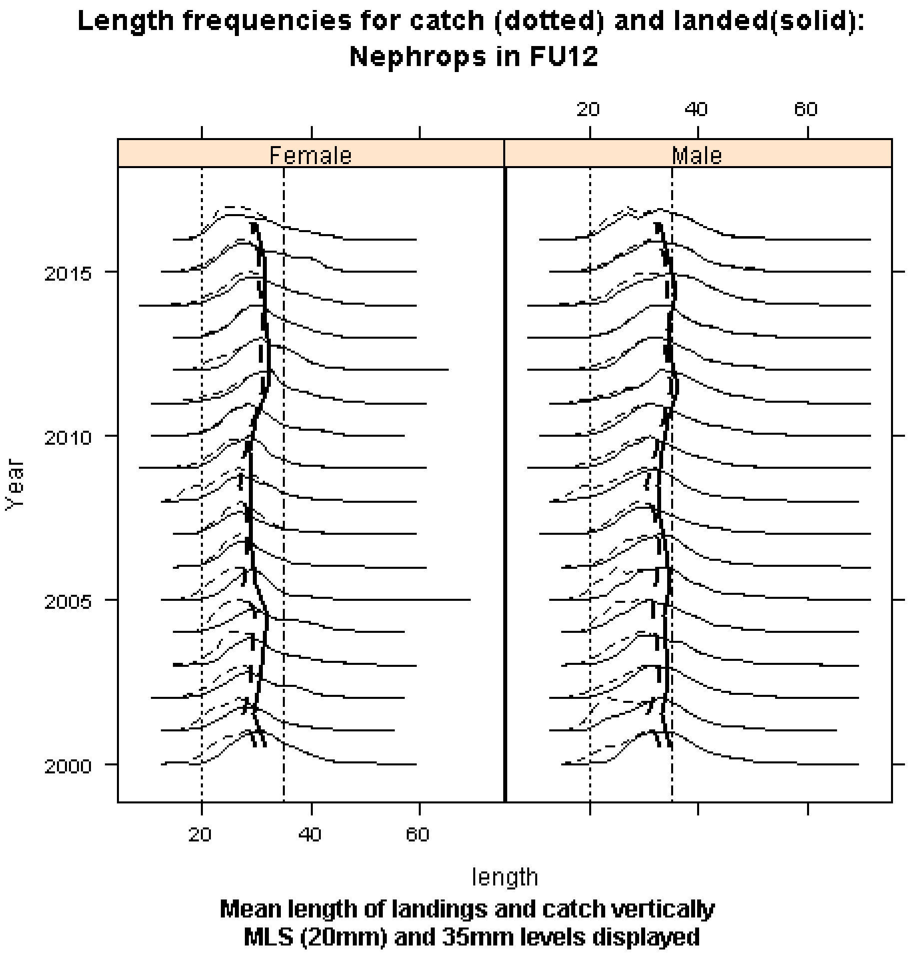
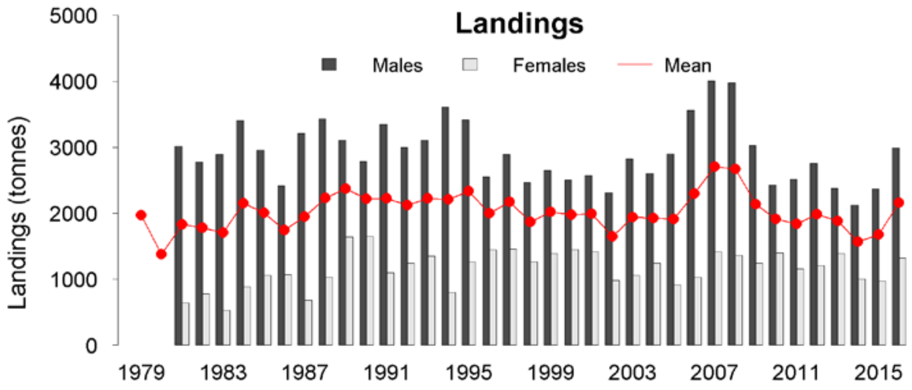


Figure 16.2.2. ***Nephrops*****. South Minch (FU12). Catch length–frequency distribution and mean sizes (solid black line) for *****Nephrops***** in the South Minch, 2000–2016.**



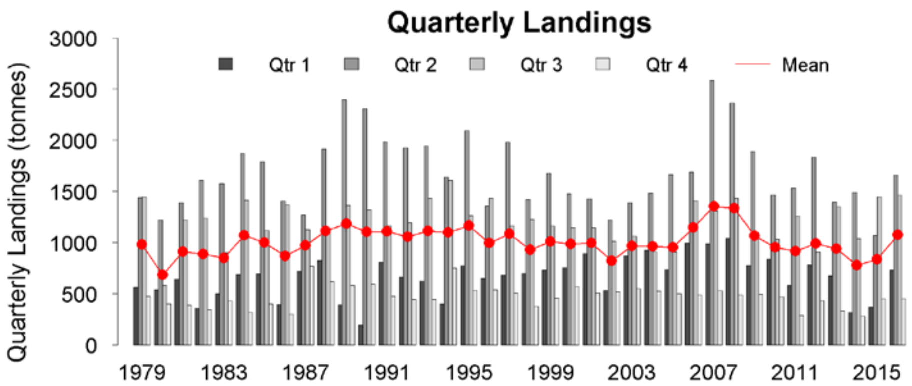


Figure 16.2.3. (a) ***Nephrops*, South Minch (FU12). Landings by sex and quarter from Scottish trawlers.**

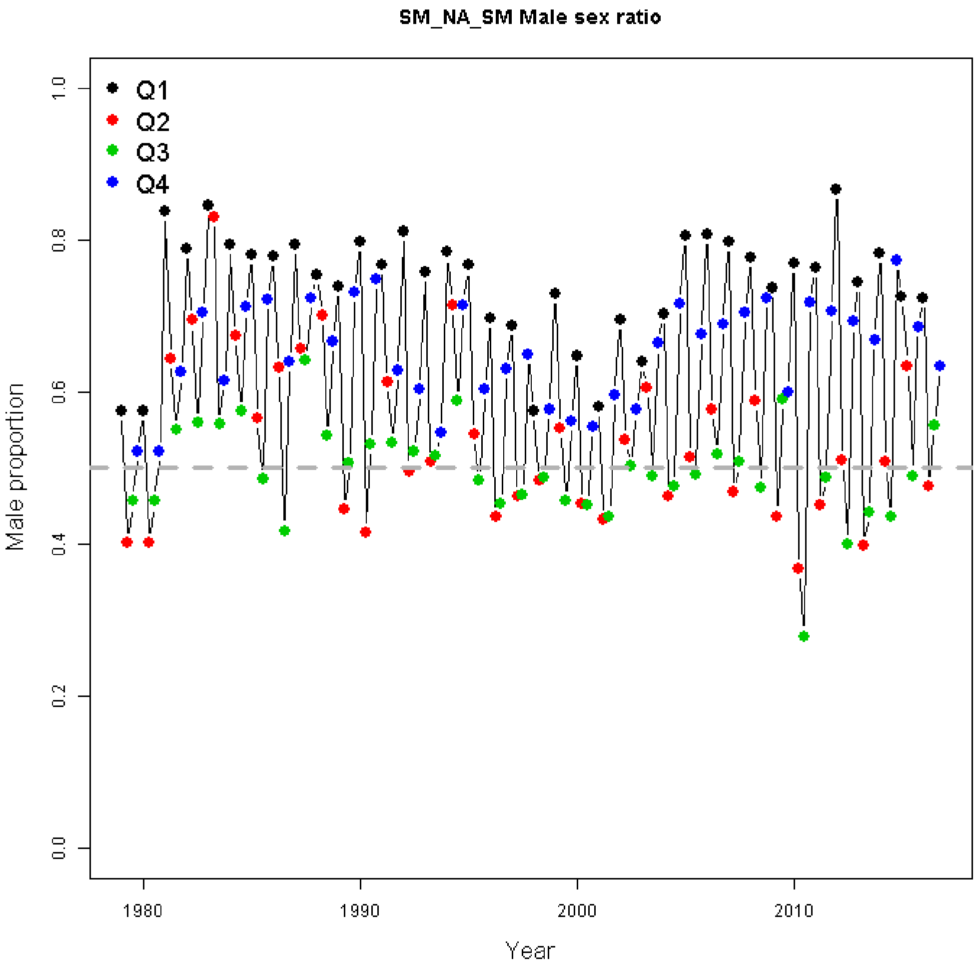


Figure 16.2.3 (b) ***Nephrops*****, South Minch (FU12), Proportion of males by quarter (1980–2016).**

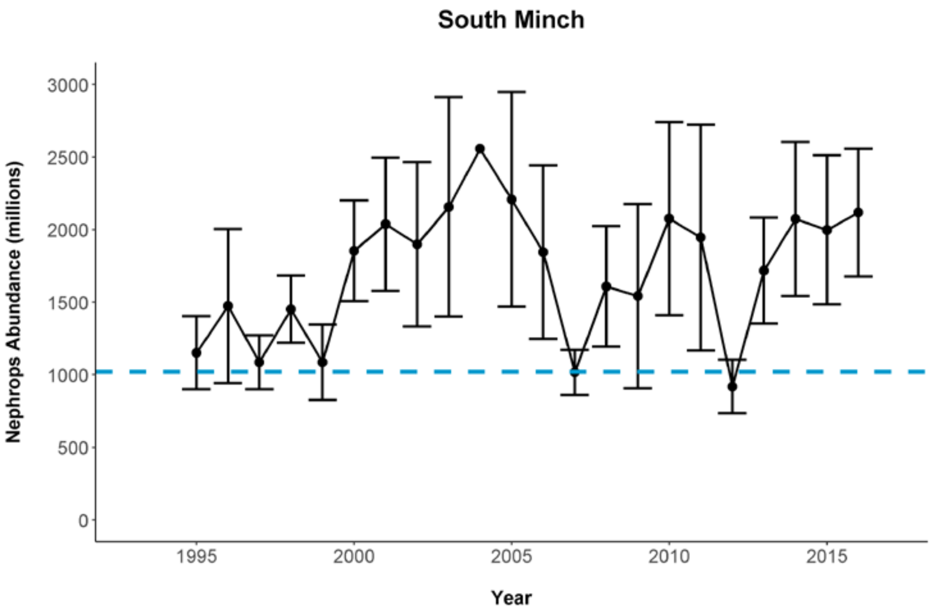


Figure 16.2.4. ***Nephrops*, South Minch (FU12), Time-series of TV survey abundance estimate (adjusted for bias), with 95% confidence intervals, 1995–2016. The dashed blue line is the rounded $B_{trigger}$ value of 1020 million individuals.**

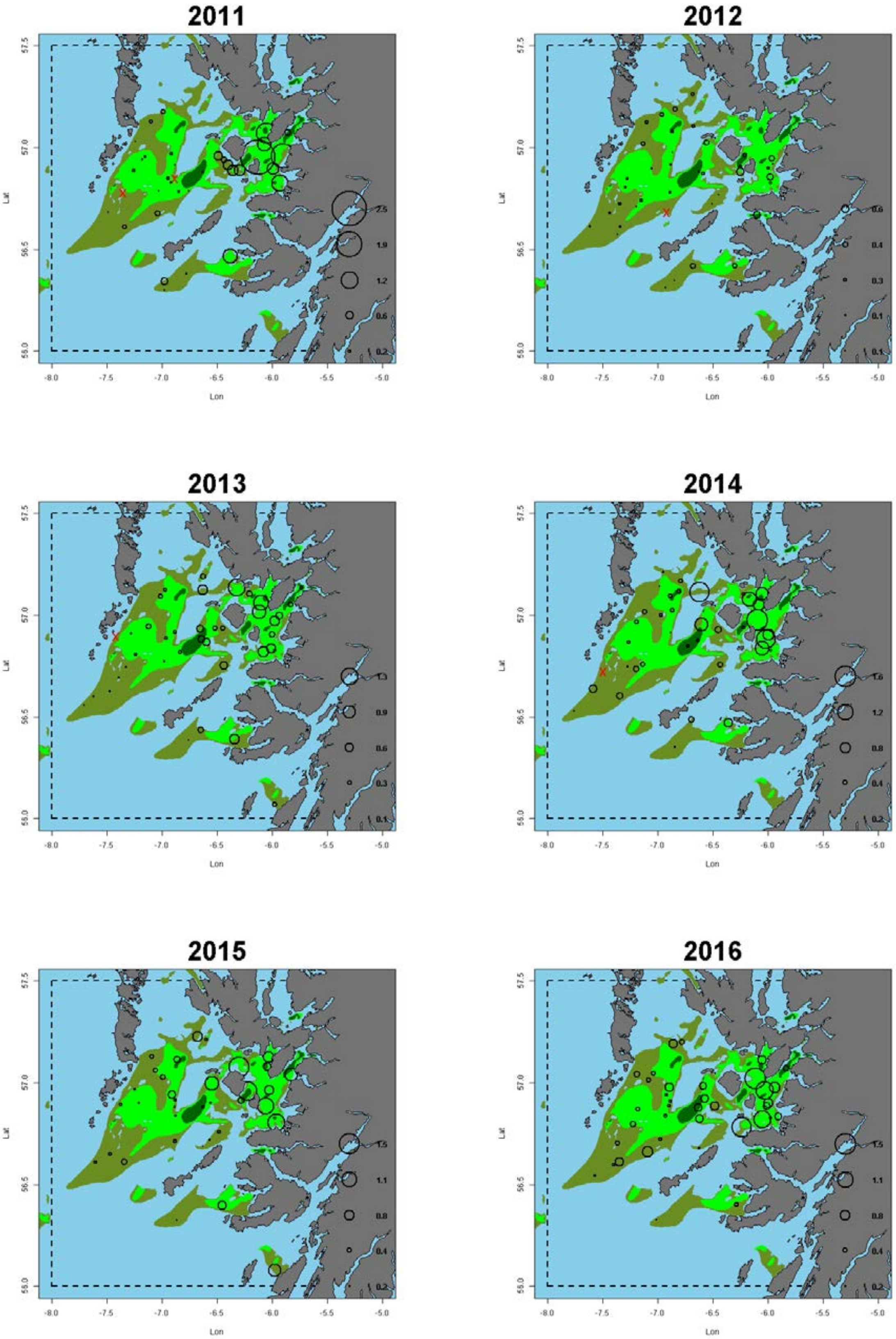


Figure 16.2.5. ***Nephrops*****, South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2011–2016. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles in this figure are all scaled the same. Red crosses represent zero observations.**

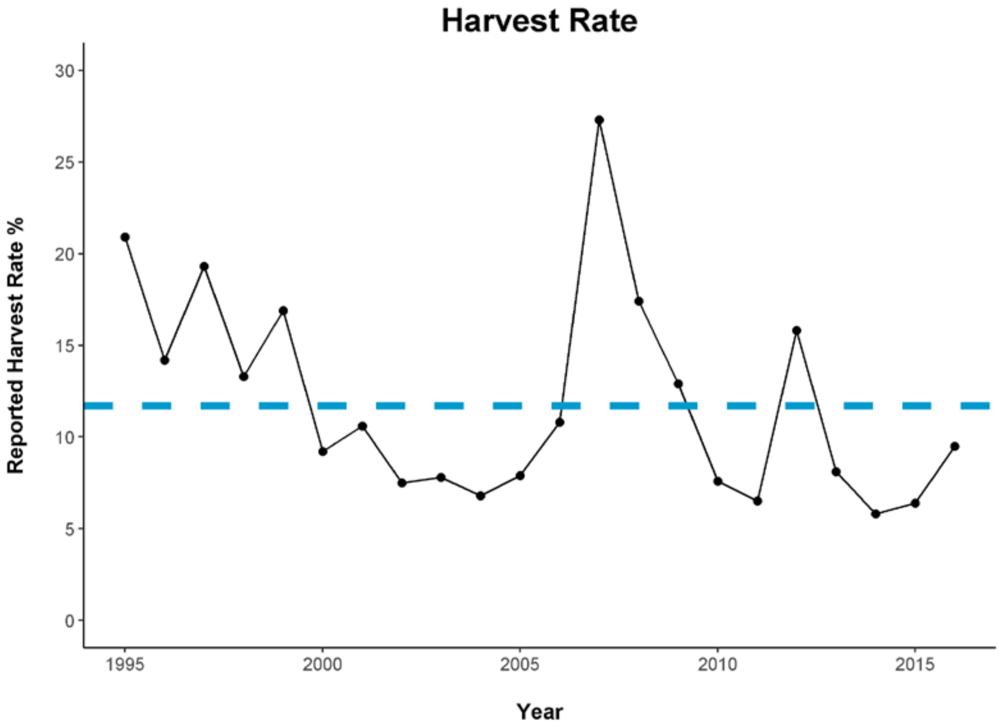


Figure 16.5.1. *Nephrops*, South Minch (FU12), harvest rate, 1995–2016. The dashed and solid lines are the F_{MSY} proxy harvest rate (11.7%) and the harvest rate respectively. Harvest rates prior to 2006 are unreliable.

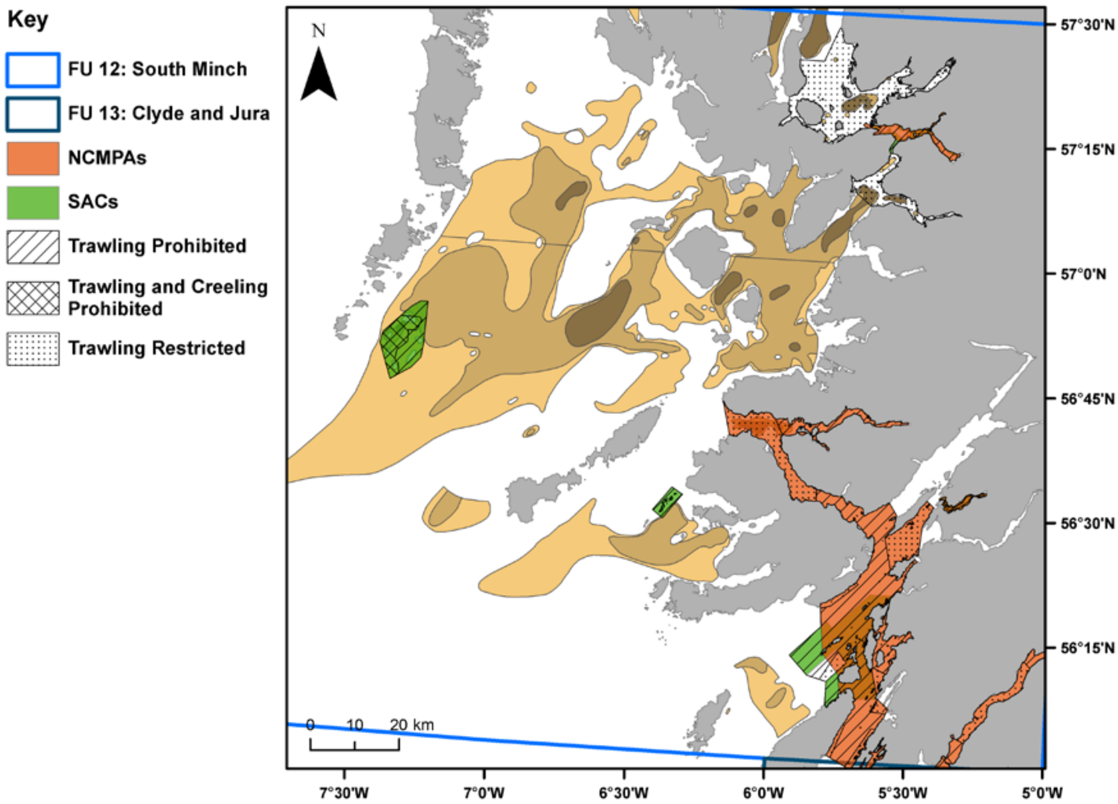


Figure 16.6.1. The area of *Nephrops* habitat (Mud, Muddy Sand and Sandy Mud) within the South Minch (FU12) relative to the areas of the Nature Conservation MPAs (NCMPAs) and Special Area of Conservations (SACs) with fisheries management measures. Areas where demersal trawling is prohibited, restricted (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).

16.11 Audit of nep.fu.12

General

For single stock summary sheet advice

- **Assessment type:** Update with one additional year of survey and catch data (benchmarked at WKNEPH2009, stock annex updated at WGCSE 2016).
- **Assessment**: Analytical (UWTV survey-based abundance assessment combined with commercial fishery data, follows the process defined by the benchmark WG ((WKNEPH2009 and stock annex).
- **Forecast**: A short-term projection was completed to produce a catch option table.
- Assessment model: UWTV based approach.
- Data issues: None though the following points to note:

  Sampling levels slightly lower than previous year.

- Consistency:

  The 2017 assessment is consistent with the 2016 assessment and with the assessment methods described at the 2013 benchmark.

  Stock annex was updated for FMSYRef4 report and the assessment process is consistence with the stock annex. Check the $B_{trigger}$ value as this differs in report and annex compared to FMSYRef4 report (1016 versus 1020 million).

  Given the fluctuations observed in mean weights for landings and discards an average from 1999 to 2016 is used in the calculation of catch options as set out in the stock annex.

- Stock status:

  UWTV abundance estimates suggest that the stock size has fluctuated with a recent stable trend.

  TV survey estimated stock abundance in 2016 was 2118 million individuals, substantially above the $MSYB_{trigger}$ value of 1016 million.

  Recent harvest ratios which have been below the F_{MSY} proxy for the last three years.

  The F_{MSY} proxy was revised by WKMSYRef4. Rationale: $F_{35\%SPR}$ combined sexes =11.7%).

  The 2016 harvest ratio for the North Minch (9.5%; dead removals/TV abundance) is below the F_{MSY} proxy harvest rate. Increase due to increase in TV abundance

- Management Plan:

  No specific management plan exists for this stock.

  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 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.

ICES advices that to ensure that the stock in functional unit (FU) 12 is exploited sustainably, management should be implemented at the functional unit level.

General comments

- The assessment was well-written and explanations were thorough. Report is brief and clear.
- The assessment is in accordance with the Stock Annex. Methods to derive F_{MSY} and landings predictions did not deviate from the benchmark process/stock annex.
- Clear description on how the InterCatch was used in the 2017 assessment. Data were available in InterCatch and used to generate 2016 raised international length–frequency distributions.
- This stock has not been benchmarked but the full UWTV survey approach has been.

Technical comments

- Have made comments using track changes on report document in SharePoint. Main point is to check table and figure numbering and suggest swapping tables/figures to be consistent.
- Check syntax for all *Nephrops* stocks: is it Harvest rate or Harvest ratio in report; we should all be consistent and probably follow that from the advice sheet.

Conclusions

- The assessment has been performed correctly for the basis of management advice. The stock appears to be stable in recent years and is above $B_{trigger}$ and recent Harvest ratios below F_{MSY} (11.7%).

Checklist for audit process

General aspects

- Has the EG answered those ToRs relevant to providing advice? YES
- Is the assessment according to the stock annex description? YES
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? N/A
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes, where appropriate
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

17 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 2017

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 2016

'ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 6568 tonnes (5554 tonnes for the Firth of Clyde and 1014 tonnes for the Sound of Jura). If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 6206 tonnes (5247 tonnes for the Firth of Clyde and 959 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 2017

'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 2013–2015, catches in 2017 should be no more than 6747 tonnes (5755 tonnes for the Firth of Clyde and 992 tonnes for the Sound of Jura). This implies landings of no more than 6185 tonnes (5276 tonnes for the Firth of Clyde and 909 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 should be implemented to ensure landings taken in each subarea (Firth of Clyde and Sound of Jura) are in line with the advice.'

17.1 General

Stock description

The Clyde functional unit (FU13) is located in the southern waters off the west coast of Scotland (North Minch report, Section 15, 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 2016 and 2017

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 staff, specifically fishery officers.

The *Nephrops* fishery in 2016 was described as "still fairly strong" in the Campbeltown district and it was noted that some vessels from Ayr were targeting both the Clyde and the Sound of Jura. The activity of Northern Irish vessels was not perceived to be high in 2016 compared to 2015 near Campbeltown and around Ayr was perceived to be normal. However, this is not supported by landings data which shows Northern Irish landings were at their highest level ever from this functional unit (other UK landings in Table 17.1.1). Prices and market conditions were reported to be good in 2016, partly due to the reduced value of the pound and the strength of European markets. In Campbeltown lower fuel prices also benefited the fleet whereas in Ayr good prices helped balance out high fuel and running costs.

There are 70 resident vessels based in the Campbeltown district, 44 vessels over 10 m and 26 under 10 m. Of the over 10 m vessels six are creelers, whereas there are 19 creelers under 10 m. 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.

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. The small area of the Upper Loch Fyne NCMPA closed to trawlers was reported to have had little impact.

Further general information on the fishery can be found in the stock annex.

17.2 Data available

InterCatch

Data for 2016 were successfully uploaded into InterCatch prior to the 2017 WG meeting according with the deadline proposed. Uploaded data were worked up in InterCatch to generate 2016 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 15). These relate to the whole of area 6.a of which the Clyde FU 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 1248 tonnes in 2016. Total reported Scottish landings in 2016 were 5195 tonnes (plus 1248 tonnes from other UK vessels i.e. Northern Ireland), consisting of 4922 tonnes landed by trawlers (94.8%) and 267 tonnes (5.1%) landed by Scottish creel vessels. Creel landings have generally increased in the most recent years, and have been in the range of 4.3–5.1 % of total landings from 2013 to 2016, which is low compared to the other FUs to 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. Note that the effort time-series range (2000–2016) 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 15). 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. Sampling for FU13 is considered acceptable and although Scottish landings sampling fell substantially in 2016, sampling of Northern Irish landings increased the net sampling effort by six trips. The fall in the sampling effort for Scottish landings may be due to changes in the sampling design, which has reduced flexibility as to when samples can be taken, however other factors are likely to have contributed. Sampling of discards was at the same level in 2016 as in 2015. 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. 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 2016. Catch (removals) length compositions are shown for each sex along with the mean size for both. In both sexes the mean size has declined in 2016 particularly for males. The industry also reported that prawn size in the northern areas of the Clyde had declined. 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. Both these parameters suggest that exploitation of the stock has increased.

Sex ratio

Sex ratio in the Clyde shows some variation but males generally make the largest contribution to the annual landings shown in 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 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 2014 and 2015 males were dominant in quarters one, two and four. In 2016 the males dominated in all quarters, but this was within the normal range of variation which is seen for this stock over the time-series.

Mean weights

The mean weights in the landings have fluctuated in this FU over the time-series, although not as much compared to FU11-12. The mean weight declined in 2016 as observed in FU11 and 12. 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, observable for both sexes, but particularly for males. However, sampling levels are low, particularly for the early years of the time-series and given the seasonal variation present in other FUs it is not possible to say with any certainty that this trend is real (Figures 15.2.4 and 15.2.5; see FU11 North Minch report, Section 15).

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 28.2% by number in this FU since 1999. Since 2010, discard rates have been estimated to be substantially lower (19%) than the average and there was a further decrease in 2016 to 15.9% (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 14.60% (taking a three year average from 2014 to 2016).

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 2016, 37 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). This was the same level of sampling effort as in 2015. 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. 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 (2010–2016) 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 south part of the Clyde In 2016 this appeared to still be the case, although the relative difference appeared less distinct.

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 declined and fluctuated around the values previously observed in the early 2000s. In 2016 the abundance was at a comparable level to the abundances seen in the early 2000s (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 has increased in subsequent years and in 2016 it was above the level seen in 2013 and 2014, this difference was statistically significant (i.e. 95% confidence intervals did not overlap, Figure 17.2.6).

17.3 Assessment

Comparison with previous assessments

The assessment in 2017 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 2017 follows that of 2016 and 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 2016 was 1946 million individuals, a 6.9% increase from the 2015 estimate (although this was not statistically significant) and 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 2016 was 422 million individuals, a 12.2% increase on the 2015 estimate (although 95% CI intervals overlapped) 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 2016 (dead removals for both subareas/ Firth of Clyde and Sound of Jura TV abundance = 17.6%) was above 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).

17.4 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 2017 UWTV survey conducted in June. These will be presented in October 2017 for the provision of advice.

Catch option 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 options table.

INPUT	DATA	2017 ASSESSMENT
Survey abundance (millions)	UWTV 2017	Not yet known
Mean weight in landings (g)	2014–2016	20.23g
Mean weight in discards (g)	2014–2016	8.52g
Average dead discard rate	2014–2016	14.60%

17.5 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.

An 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 rose from 12.4% in 2015 (below F_{MSY}) to 17.6% in 2016 (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.

17.6 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.

17.7 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.

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 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 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 (2014–2016) of discard rate (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 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.

17.8 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.

17.9 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 are made 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.

17.10 References

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Table 17.1.1. ***Nephrops*, Clyde and Sound of Jura (FU13), ICES estimates of landings of *Nephrops*, 1981–2016.**

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
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

**** Total also includes Republic of Ireland.**

Table 17.2.1. *Nephrops*, Clyde (FU13), ICES estimated landings of *Nephrops*, in each of the subareas (Firth of Clyde and Sound of Jura 1981–2016).

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
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

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
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
Average***											14.60	20.23	8.52

*** Harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Dead discard average: 2014–2016; Mean weight in landings and discard average: 2014–2016.**

Table 17.2.3. ***Nephrops*****, Clyde (FU13): Firth of Clyde subarea. Results of the 1995–2016 TV surveys (values adjusted for bias).**

YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS / m²)	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

Table 17.2.4. *Nephrops*, Clyde (FU13): Sound of Jura subarea. Results of the 1995–2016 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

Table 17.2.5. *Nephrops,* Clyde (FU13): Firth of Clyde subarea. Results by stratum of the 2014–2016 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)
2014 TV survey								
M	717	11	0.545	0.03	391	1397	0.099	
SM	699	11	0.842	0.18	588.2	7990	0.567	
MS	665	13	0.525	0.138	349.2	4713	0.334	
Total	2081	35			1328.4	14099	1	0.09
2015 TV survey								
M	717	13	0.917	0.213	657.1	8407	0.273	
SM	699	14	0.963	0.328	673	11422	0.37	
MS	665	10	0.737	0.249	489.8	11006	0.357	
Total	2081	37			1819.9	30835	1	0.09
2016 TV survey								
M	717	14	1.006	0.104	721.1	3799	0.245	
SM	699	13	0.932	0.047	651.2	1773	0.114	
MS	665	10	0.863	0.225	573.5	9936	0.641	
Total	2081	37			1945.8	15508	1	0.06

Table 17.2.6. ***Nephrops,*** **Clyde (FU13): Sound of Jura subarea. Results by stratum of the 2014–2016 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)
2014 TV survey								
M	90	3	0.619	0.202	55.7	545	0.269	
SM	150	2	0.702	0.099	105.2	1116	0.552	
MS	142	4	0.496	0.072	70.4	362	0.179	
Total	382	9			231.3	2023	1	0.199
2015 TV survey								
M	90	2	1.328	0.326	119.5	1318	0.327	
SM	150	5	1.103	0.18	165.4	810	0.201	
MS	142	5	0.642	0.47	91.2	1897	0.471	
Total	382	12			376.1	4024	0.999	0.177
2016 TV survey								
MUD	90	2	0.828	0.003	74.5	11	0.026	
SM	150	6	0.872	0.069	130.9	260	0.578	
MS	142	4	1.527	0.035	216.9	179	0.396	
Total	382	12			422.4	450	1	0.058

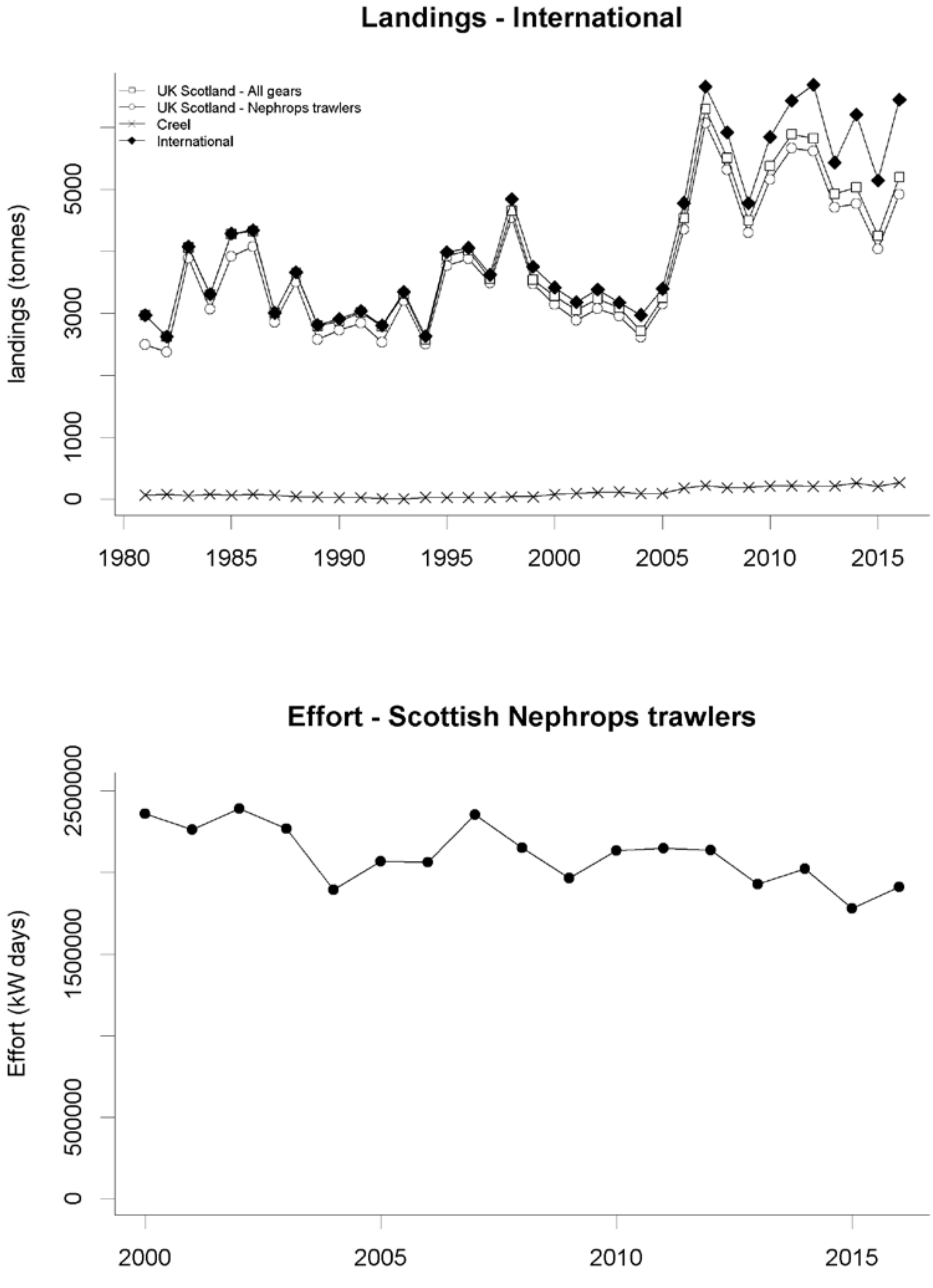


Figure 17.2.1. ***Nephrops*, Clyde (FU13). Long-term landings and effort.**

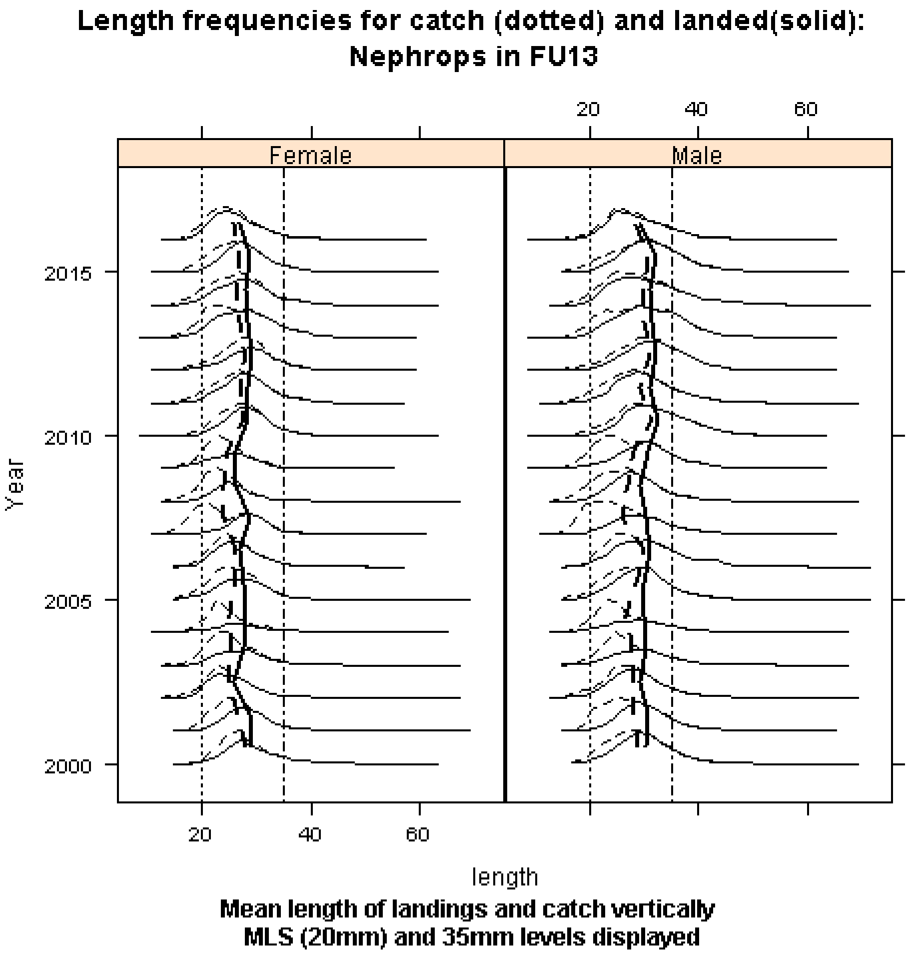


Figure 17.2.2. ***Nephrops*****, Clyde (FU13). Catch length–frequency distribution and mean sizes (red line) for** ***Nephrops*****, 2000–2016.**

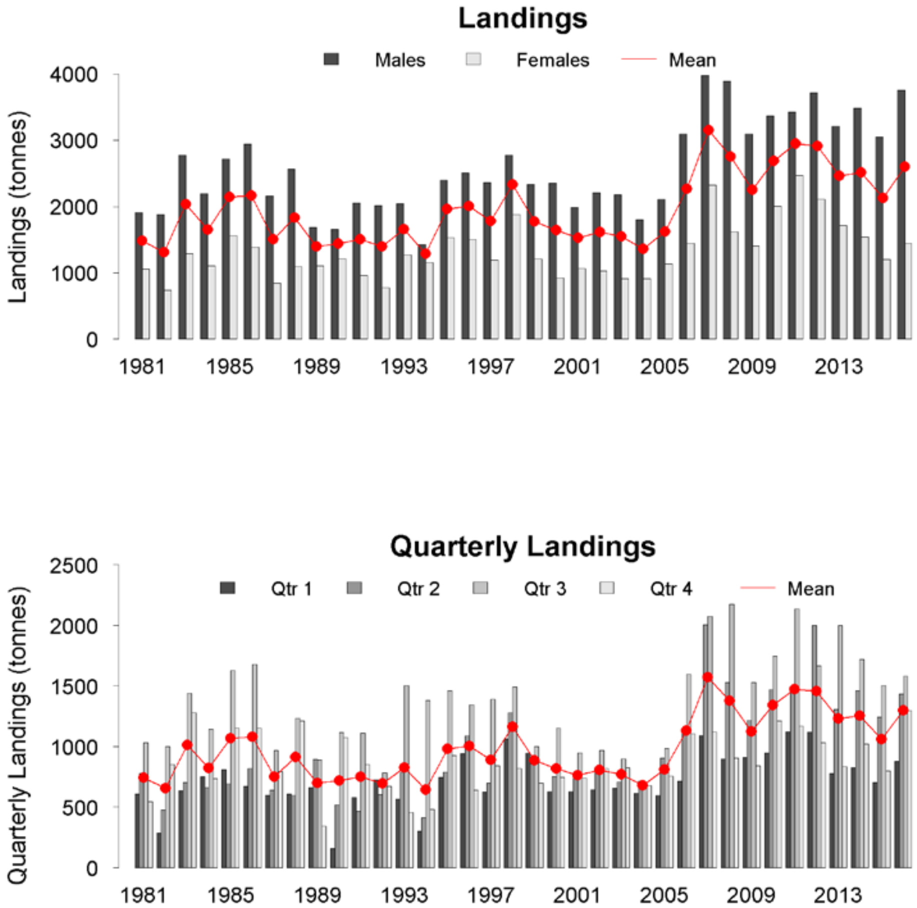


Figure 17.2.3.(a) ***Nephrops*, Clyde (FU13). Landings by quarter and sex from Scottish trawlers.**

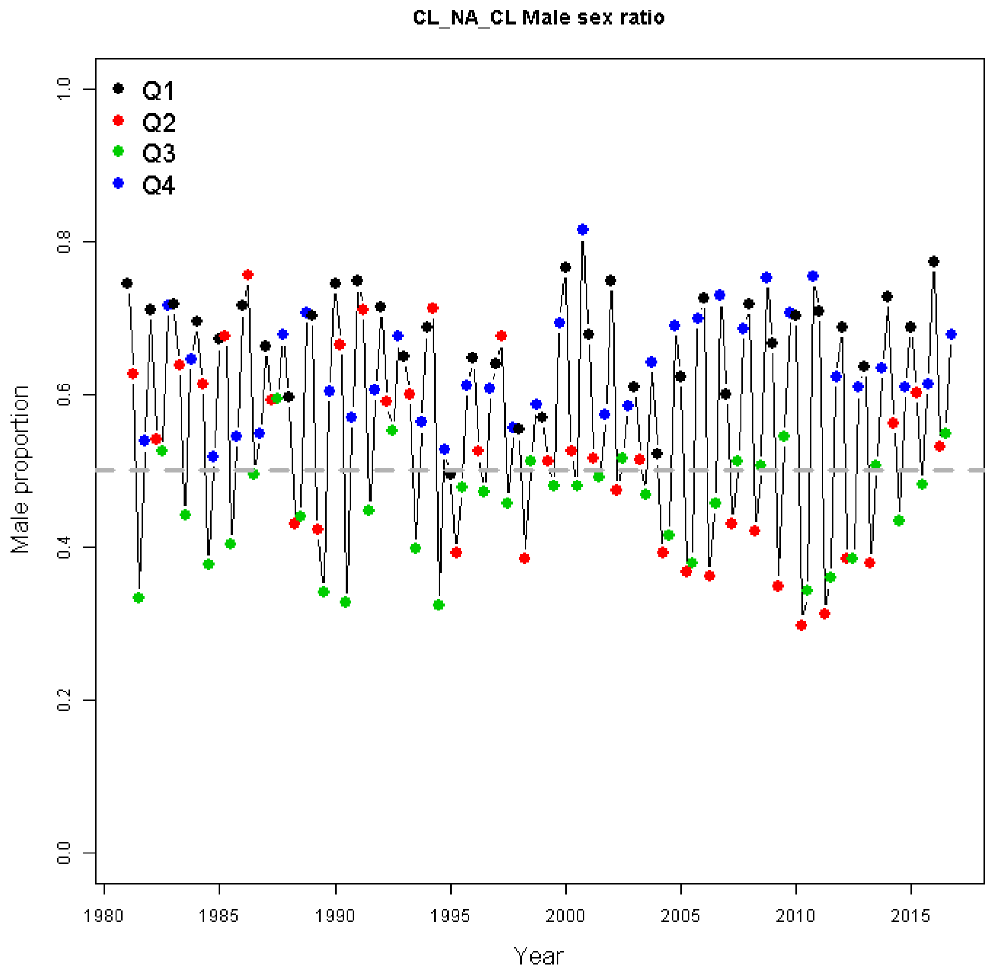


Figure 17.2.3. (b) ***Nephrops*****, Clyde (FU13), Proportion of males by quarter (1980–2016).**

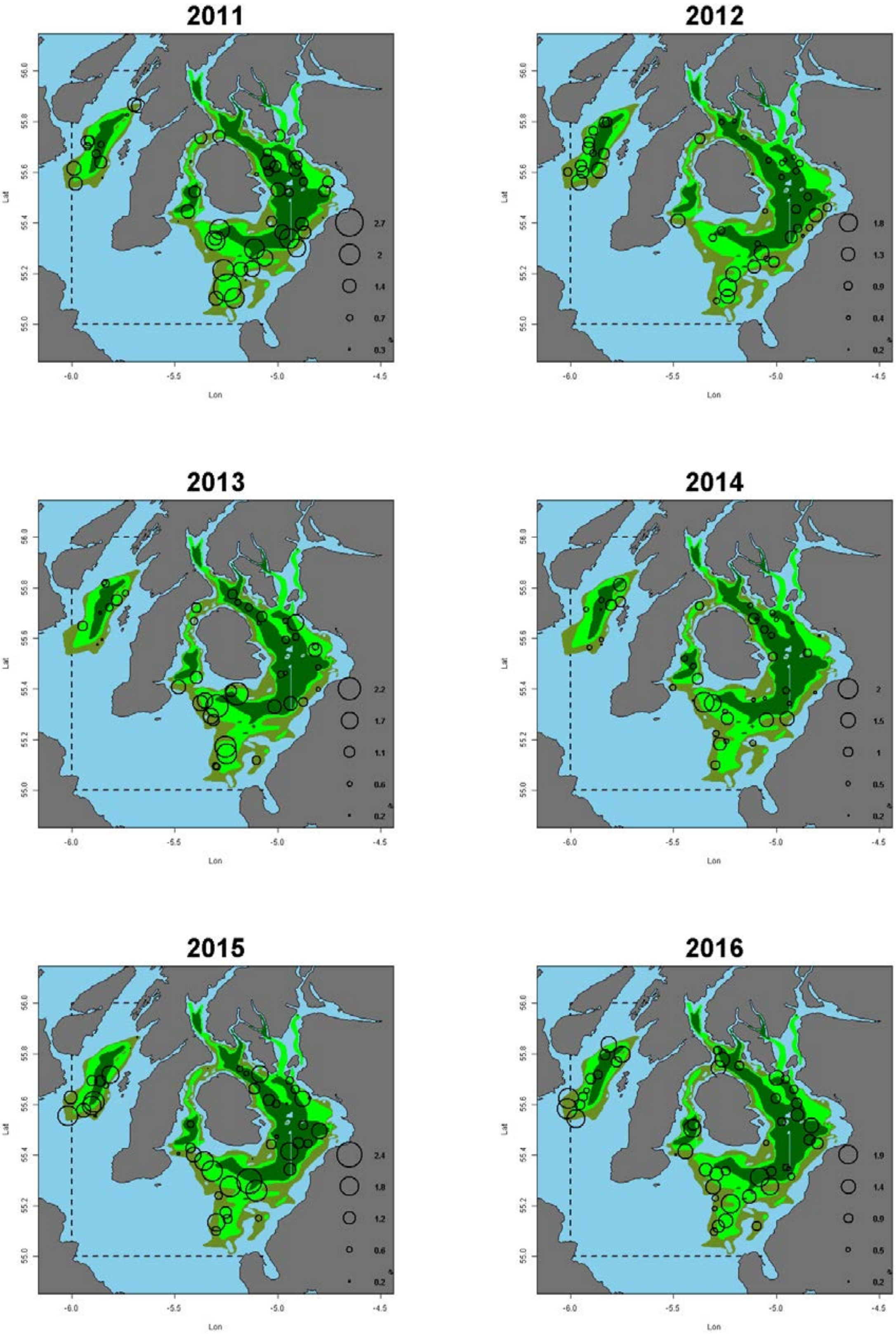


Figure 17.2.4. ***Nephrops*, Clyde (FU13), TV survey station distribution and relative density (burrows/m^2) for Firth of Clyde and Sound of Jura subareas, 2010–2016. Sound of Jura located to the east. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles scaled the same. Red crosses represent zero observations.**

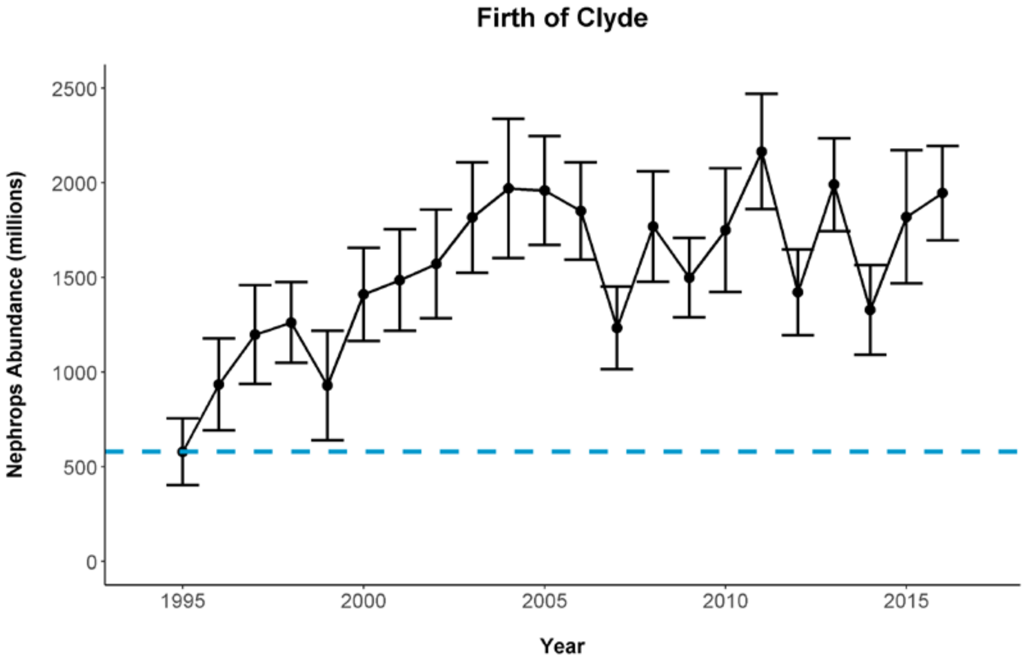


Figure 17.2.5. ***Nephrops*, Clyde (FU13): Firth of Clyde subarea. Time-series of revised TV survey abundance estimates (adjusted for bias), with 95% confidence intervals, 1995–2016. The dashed blue line is the rounded $B_{trigger}$ value of 580 million individuals.**

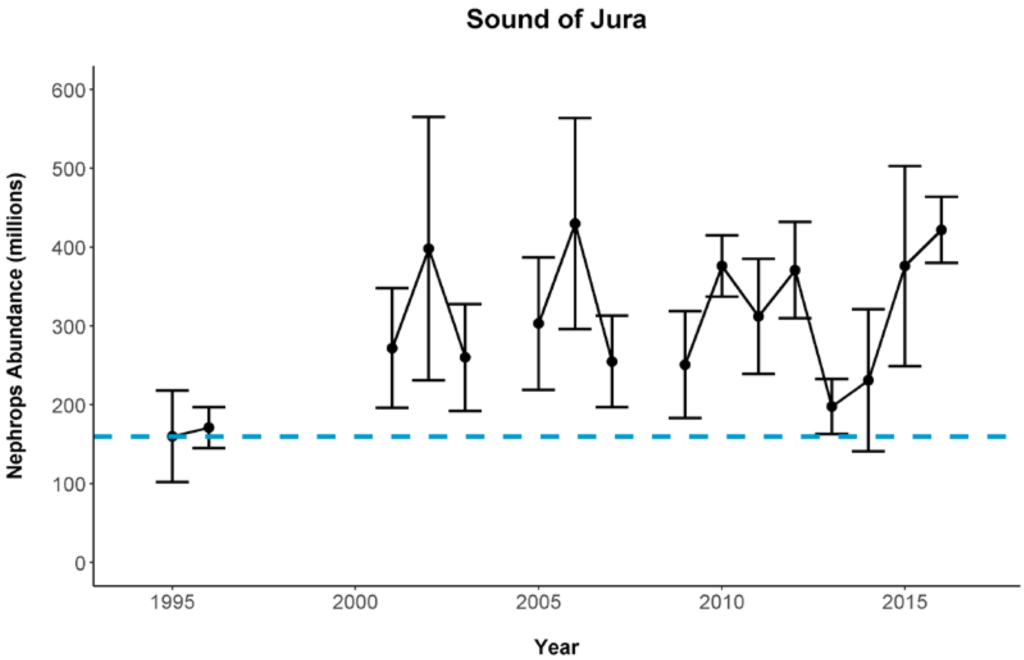


Figure 17.2.6. ***Nephrops*, Clyde (FU13): Sound of Jura subarea. Time-series of TV survey abundance estimates (adjusted for bias) with 95% confidence intervals, 1995–2016. The dashed blue line is the rounded $B_{trigger}$ value of 160 million individuals.**

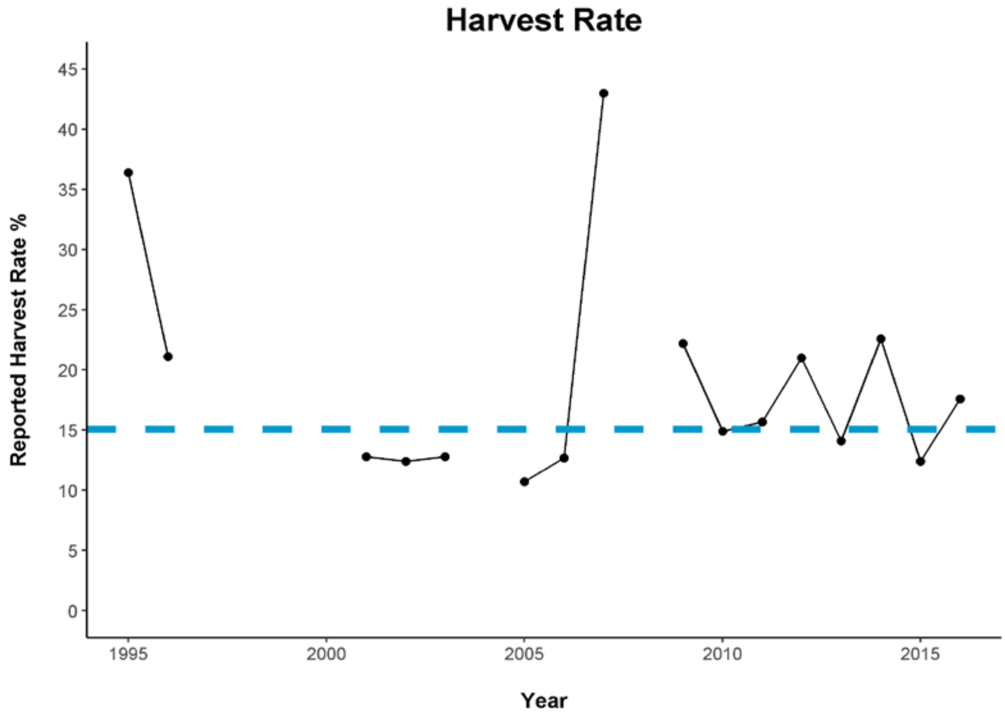


Figure 17.4.1. Clyde (FU13) *Nephrops* harvest rate, 1995–2016. The harvest rate is calculated by dead removals (both subareas combined)/TV abundances (both sub-areas combined). The dashed and solid lines are the F_{MSY} proxy harvest rate (for the Firth of Clyde 15.1%) and the harvest rate respectively. Harvest rates prior to 2006 are unreliable.

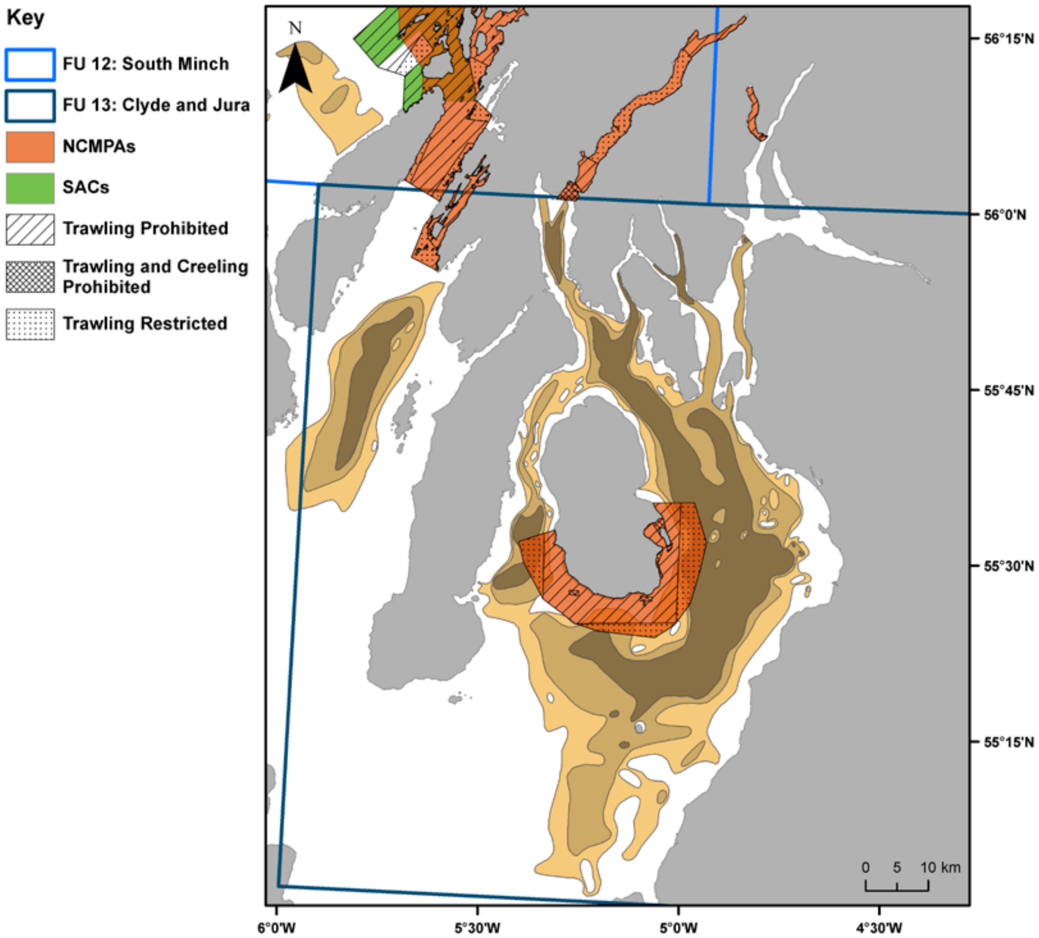


Figure 17.6.1. The area of *Nephrops* habitat (Mud, Muddy Sand and Sandy Mud) within the Clyde functional unit (FU13) relative to the areas of the Nature Conservation MPAs (NCMPAs) which fisheries management measures. Areas where demersal trawling is prohibited, restricted (i.e. vessel size restrictions 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).

17.11 Audit of nep.fu.13

General

For single stock summary sheet advice

- **Assessment type:** Update with one additional year of survey and catch data (benchmarked at WKNEPH2009, stock annex updated at WGCSE 2016).
- **Assessment**: Analytical (UWTV survey-based abundance assessment combined with commercial fishery data, follows the process defined by the benchmark WG ((WKNEPH2009 and stock annex).
- **Forecast**: A short-term projection was completed to produce a catch option table.
- **Assessment model**: UWTV based approach.
- **Data issues:** Sampling for FU13 is considered acceptable and although Scottish landings sampling fell substantially in 2016, sampling of Northern Irish landings increased the net sampling effort by six trips.
- **Consistency**: The 2017 assessment is consistent with the 2016 assessment and with the assessment methods described at the 2013/2009 benchmark.

  Stock annex was updated for FMSYRef4 report and the assessment process is consistence with the stock annex. Check the $B_{trigger}$ value as this differs in report and annex compared to FMSYRef4 report - rounding.

  Given the fluctuations observed in mean weights for landings and discards an average from 2014 to 2016 is used in the calculation of catch options as set out in the stock annex.

- **Stock status**: UWTV abundance estimates suggest that the stock size has fluctuated for both Clyde and Jura with an increasing trend in recent years.

  TV survey estimated stock abundance for the Firth of Clyde in 2016 was 1946 million individuals, a 7% increase from the 2015 estimate and well above the $B_{-trigger}$ value of 579 million.

  TV survey estimated stock abundance for the Sound of Jura in 2016 was 422 million individuals, a 12% increase on the 2015 estimate and above the $B_{-trigger}$ value of 200 million. In FMSYRef4 $B_{trigger}$ Jura = 160 million.

  Recent harvest ratios which have been close to the F_{MSY} proxy for the last three years.

  The F_{MSY} proxy was revised by WKMSYRef4. Rationale: $F_{35\%SPR}$ combined sexes =15.1%).

  The combined calculated harvest ratio for the FU13 in 2016 (dead removals for both subareas/Firth of Clyde TV abundance = 17.6%) was above the MSY proxy for this stock (the value associated with high long-term yield and low risk depletion) of 15.1%.

- Management Plan:

  No specific management plan exists for this stock.

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).

General comments

- The assessment was well-written and explanations were thorough. Report is brief and clear.
- The assessment is in accordance with the Stock Annex. Methods to derive F_{MSY} and landings predictions did not deviate from the benchmark process/stock annex.

- Clear description on how the InterCatch was used in the 2017 assessment. Data were available in InterCatch and used to generate 2016 raised international length–frequency distributions.

Technical comments

- Have made comments using track changes on report document in SharePoint. Main point is to check table and figure numbering and suggest swapping tables/figures to be consistent.
    - Check syntax for all *Nephrops* stocks: is it Harvest rate or Harvest ratio in report: we should be all consistent for *Nephrops* stocks and probably follow that from the advice sheet.

Conclusions

The assessment has been performed correctly.

- The assessment has been performed correctly for the basis of management advice. Both Clyde and Sound of Jura patch appears to be stable in recent years and is above $B_{trigger}$. The combined harvest rate is just above F_{MSY} (15.1%).

Checklist for audit process

Checklist for audit process

General aspects

- Has the EG answered those ToRs relevant to providing advice? YES
- Is the assessment according to the stock annex description? YES
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? N/A
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes, where appropriate
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

18 Norway lobster (*Nephrops norvegicus*) in Division 7.a, Functional Unit 14 (Irish Sea, East)

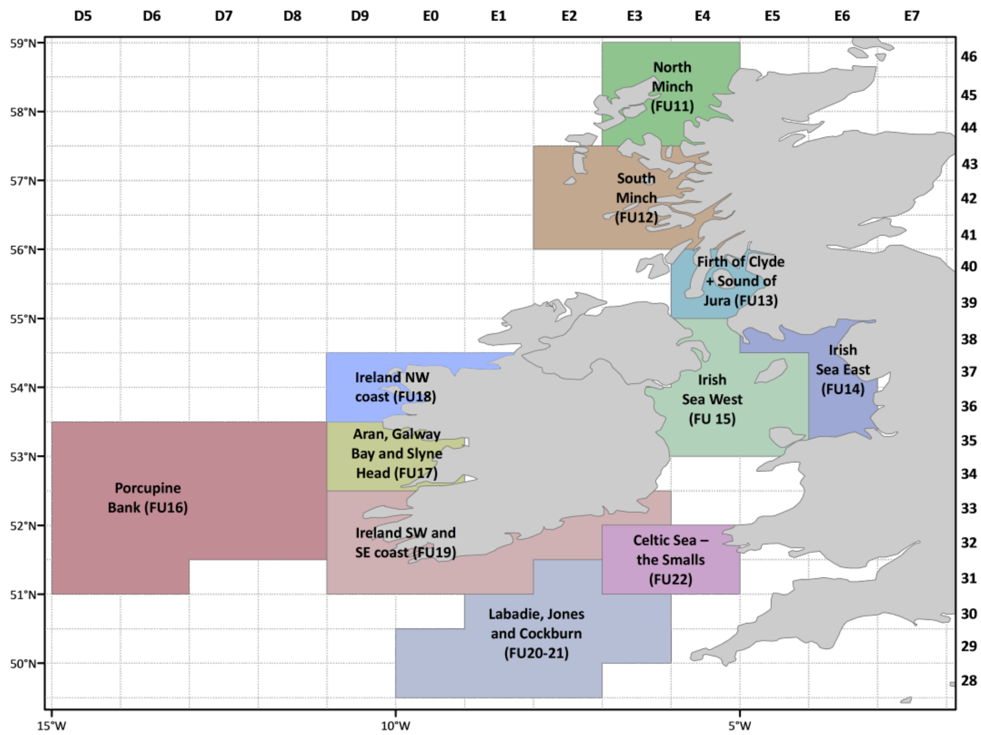
18.1 *Nephrops* Subarea 7 general section

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

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 2016, vessels where 30% or more of their landings in 2013 and 2014 were *Nephrops* had to land all *Nephrops*. In 2017, vessels where 20% or more of their landings in 2014 and 2015 were *Nephrops* will have to land all *Nephrops*.

Minimum conservation reference size (minimum landing size)

Under the Landing Obligation, minimum landings sizes are being abolished. Instead a Minimum Conservation Reference Size (MCRS) for each species will be 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) in the North Sea (4, FUs 5–10), around Ireland (FUs 16–22) and the Norwegian Deep (FU 32); the MCRS is 20 mm CL (>70 mm TL) on the West coast (6.a, FUs 11–13), the Irish Sea (7a, FUs 14–15) and the Bay of Biscay (7I), and the Iberian Peninsula (9). The MCRS for all EU States from Skagerrak and Kattegat (FUs 3 and 4) is now 32 mm CL (>105 mm TL); Norway still uses the previous MCRS of 40 mm (>130 mm TL).

The MCRS implemented for the Irish Sea is 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.

Exemptions

De minimis exemptions apply to *Nephrops* vessels, allowing them to discard *Nephrops* under the MCRS, as long as they make up no more than 6% of total catch in the North

Sea, Skagerrak and Kattegat or 7% of the total catch in western waters. A survivability exemption exists in all areas allowing any level of discarding from creels and pots and in the Skagerrak and Kattegat for >70 mm mesh size trawlers fitted with designated selectivity devices.

Management applicable in 2016 and 2017

The TAC is currently set for the whole Area 7. The TAC for 2017 was 25 356 t, this represented an increase of 8% in relation to 2016 with 23 348 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) 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

COUNCIL REGULATION (EU) 2016/72 of 22 January 2016 fixing for 2016 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) 2015/104.

TAC in 2016

Species:	**Norway lobster** *Nephrops norvegicus*	**Zone:**	**VII** **(NEP/07.)**
Spain	1 401		
France	5 678		
Ireland	8 610		
United Kingdom	7 659		
Union	23 348		Analytical TAC
TAC	23 348		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 VII (NEP/*07U16):
Spain	558
France	349
Ireland	671
United Kingdom	272
Union	1 850

Landings area 7

Text 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 North West Coast	FU 19 – Ireland South West and South East 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	10,730	
1979	900	8,948	2,269	452						237	12,807	
1980	730	4,578	2,925	442						205	8,880	
1981	829	7,249	3,381	414						382	12,255	
1982	869	9,315	4,289	210						234	14,917	
1983	763	9,448	3,426	131					3,667	174	17,609	
1984	602	7,760	3,571	324					3,653	187	16,097	
1985	498	6,901	3,919	207					3,599	194	15,317	
1986	671	9,978	2,591	147					2,638	113	16,138	
1987	449	9,753	2,499	62					3,409	107	16,279	24,700
1988	462	8,586	2,375	828					3,165	140	15,557	24,700
1989	401	8,128	2,115	344		899			4,005	134	16,026	26,000
1990	563	8,300	1,895	519		754			4,290	102	16,423	26,000
1991	747	9,554	1,640	410		1,077			3,295	169	16,892	26,000
1992	427	7,541	2,015	372		888			4,165	409	15,816	20,000

Year	FU 14 – Irish Sea East	FU 15 – Irish Sea West	FU 16 – Porcupine Bank	FU 17 – Aran Grounds	FU 18 – Ireland North West Coast	FU 19 – Ireland South West and South East 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 Sub-area 7	TAC for 7
1993	515	8,102	1,857	372	10	905			4,648	455	16,863	20,000
1994	447	7,606	2,512	729	126	390			5,143	570	17,523	20,000
1995	584	7,796	2,936	866	26	695			5,505	397	18,805	23,000
1996	475	7,247	2,230	525	46	888			4,828	623	16,862	23,000
1997	566	9,971	2,409	841	15	756			4,240	340	19,138	23,000
1998	388	9,128	2,155	1,410	78	827			3,925	514	18,426	23,000
1999	624	10,786	2,289	1,140	16	579	1,152	1,788		322	18,699	23,000
2000	567	8,370	911	880	9	696	1,778	2,907		243	16,365	21,000
2001	532	7,441	1,222	913	2	815	1,833	2,935		368	16,064	18,900
2002	577	6,793	1,327	1,154	14	1,318	2,674	1,990		243	16,099	17,790
2003	376	7,052	907	933	16	1,239	2,953	2,050		186	15,712	17,790
2004	472	7,266	1,525	525	22	1,074	2,443	1,827		161	15,314	17,450
2005	570	6,529	2,312	778	15	711	2,469	2,425		180	16,042	19,544
2006	628	7,535	2,120	637	14	741	2,523	1,752		270	16,210	21,498
2007	959	8,424	2,186	1,096	3	957	2,419	2,881		206	19,130	25,153
2008	726	10,482	1,000	1,057	1	841	2,980	3,114		111	20,430	25,153
2009	693	9,166	825	625	10	833	3,145	2,245		81	17,619	24,650
2010	583	8,929	917	1,000	7	722	1,793	2,708		50	16,710	22,432

Year	FU 14 – Irish Sea East	FU 15 – Irish Sea West	FU 16 – Porcupine Bank	FU 17 – Aran Grounds	FU 18 – Ireland North West Coast	FU 19 – Ireland South West and South East 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 Sub-area 7	TAC for 7
2011	561	10,159	1,187	600	13	608	1,237	1,617		109	16,092	21,759
2012	531	10,527	1,260	1,135	28	770	1,189	2,633		289	18,360	21,759
2013	495	8,672	1,142	1,295	-	781	1,387	2,255		49	16,076	23,605
2014	679	8,613	1,189	766	-	468	1,840	2,614		119	16,288	20,989
2015	378	8,632	1,394	370	-	507	2,116	2,368		65	15,830	21,619
2016	237	7327	2154	641	-	591	2453	3276		118	16979	23, 348
Average	591	8356	2067	657	20	798	2,132	2,410	4,011	233	21,252	

Nephrops FU14 section

Type of assessment in 2017

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 follow the process defined by the inter-benchmark process and described in the stock annex (updated at WGCSE 2017). The UWTV survey done in the summer 2016 will form the basis of advice for this stock in the autumn 2017.

ICES advice applicable to 2017

"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 2013–2015, catches in 2017 should be no more than 995 tonnes. This implies landings of no more than 941 tonnes.

To ensure that the stock in functional unit (FU) 14 is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2016

"ICES advises that when the MSY approach is applied, catches in 2016 (assuming a landing obligation applies) should be no more than 1272 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average (2013–2014), this implies landings of no more than 1213 tonnes.

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level."

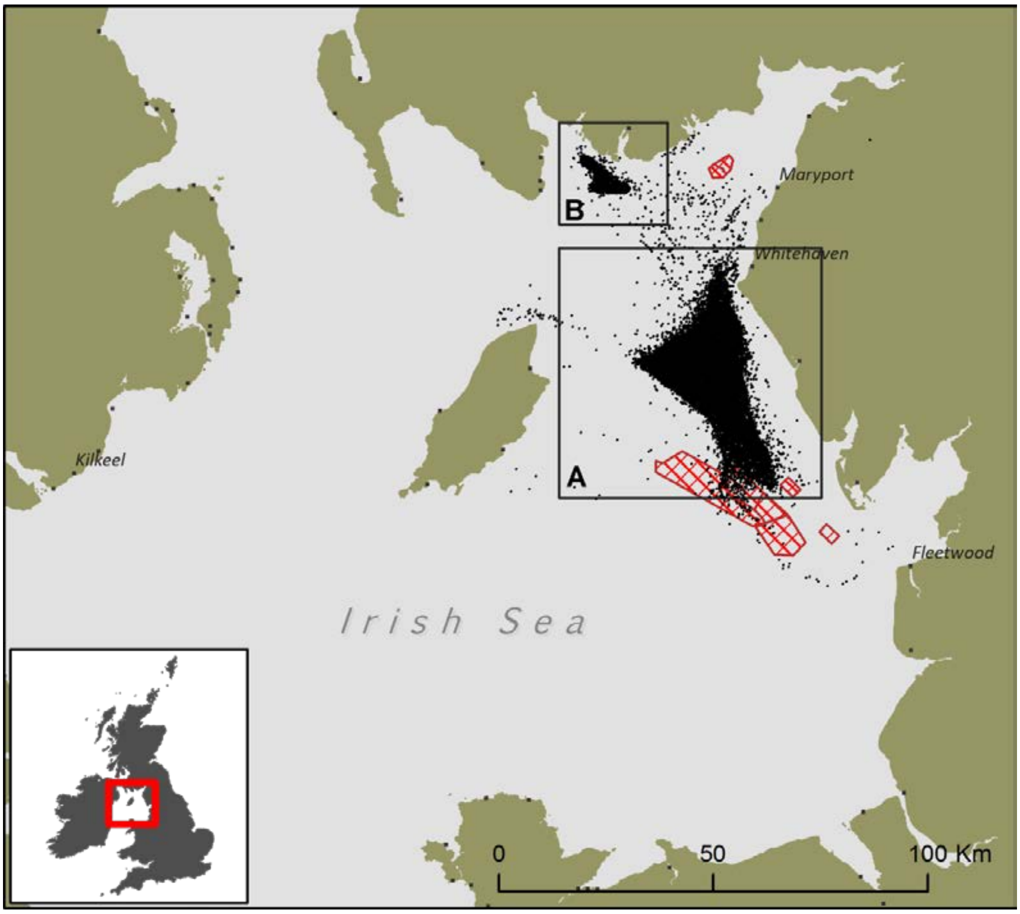
18.1.1 General

Stock description and management units

The Irish Sea East *Nephrops* stock (FU14) is in ICES Subarea 7, more specifically in area 7a which also includes the Irish Sea West (FU15) stock.

FU14 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. Main landing ports: Whitehaven, Fleetwood, Maryport and Kilkeel.

Fishery in 2017

The Eastern Irish Sea *Nephrops* fishery is an UK lead fishery, representing on average 93% of the reported annual international landings (2007–2016) and is considered to be a relative small fishery within Area 7.a where with landings showing a generally downward trend over the past ten years (Table 3.8.2), from a high of 959 tonnes in 2007 down to a low of 237 tonnes in 2016. 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 2016, the UK fleet accounts for the highest proportion of landings in tonnes. Of this the majority is from English vessels, however there has been an increase this year in the proportion landed from Northern Irish vessels (Figure 3.8.1).

A more detailed historical fishery description is provided in the stock annex.

Information from stakeholders

No information provided.

18.1.2 Data

InterCatch

Data for 2016 were successfully uploaded into InterCatch prior the 2017 WG meeting. Uploaded data were worked-up in InterCatch to generate 2016 raised international length–frequency distributions and to derive catch and discard length frequencies for 2016.

Landings

Official landings as reported to ICES from FU14 are presented in Table 3.8.1 and were updated for 2016 data.

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. Landings in 2016 (237 t) decreased 38% in relation to 2015 following a comparable decrease in between 2015 and 2014 (44%). 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 last ten years (2007–2016), UK vessels have landed, on average, ~92% of the reported annual international landings. Irish vessels increased their share of the landings to 35% in 2002, declining since then to values generally <10% of the international landings (2007–2014). In 2015 the Republic of Ireland fleet landings increased significantly, accounting for 23% of the total landings, however the proportion dropped back down to 9% in 2016 (Table 3.8.2).

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 was a significant decline in effort in 2016 which is due to decrease of Northern Ireland vessels on the ground.

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by IBPNeph 2015 and are documented in the stock annex. Recent sampling levels have fluctuated, but for 2016 were higher than in 2015 and comparable with 2013–2014 levels. Sampling has typically only been from the UK (E&W) fleet however for 2016 also included samples the UK (NI) fleet.

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 2016, the mean size of the landings was in the lowest recorded (since 1999) and mean landed sizes from UK (NI) landings samples were much lower than those for UK (E&W). Mean size of the discards is slightly higher in 2016, but consistent with earlier years.

Length composition

Since 2009 sampling was considered insufficient to derive catch and discard length frequencies. As a result none of the length derived metrics have been updated for 2010, 2011 and 2012. However, due to increase in number of samples 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 in 2015 were conducted according to benchmark procedures (ICES, 2005) and referred 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. Final discard selection 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. This shows some fluctuations over time, but showing for the last three year a proportion of around 50%. Between 2010 and 2012 due to poor sampling levels estimates of sex ratio are not reliable.

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. The mean weight for 2016 landings decreased markedly from its value in previous years and is the lowest on record. Mean weight of females was considerably lower in the UK (NI) fleet at Mean weight for discards increased from 2015, but is comparable with recent years.

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. The discard ogive was not updated using 2015 and 2016 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 updated form 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 FU 15 where fishing practices are similar and both are largely spring/summer fisheries and animals discarded are exposed to warmer temperatures before returned to sea.

Abundance indices from UWTV surveys

In August of 2007–2016 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 2016 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 2011–2016	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, year where the effect of effort displacement is clearly visible due to the wind farm construction. Final updated abundance burrow density estimates are presented 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%.

Abundance estimate for 2016 (432.9 million) decreased compared to 2015 figure of 590.5 million (Figure 3.8.10), but showing a similar abundance estimation of 2013 and 2014. The surveys show a clear spatial distribution pattern, with highest densities in the central north of the patch and 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).

Year	No valid stations	Mean Krigged density (no./m^2)	Abundance (millions) including Wigtown Bay (1.9% 2008–2010)	Abundance (millions) including Wigtown Bay (6.6% 2011–2015)	95% CI	CV
2007			Ureliable data			
2008	32	0.38	407.6		63	
2009	32	0.33	350		76	
2010	26	0.4	422		103	
2011	26	0.41		449.2	98.8	11.80%
2012	26	0.64		693.8	99	7.80%
2013	31	0.45		487	81.6	9.10%
2014	34	0.41		449.1	91.8	10.70%
2015	42	0.54	590.5		86	7.90%
2016	48	0.40	430.0		106.3	12.60%

As described in previous reports, the limited number of stations available on the 2007 survey and the poor quality of the data processed preclude its use in formal assessment. The subsequent surveys were far more successful. A new camera and sledge improved the resolution of the footage captured and the sea conditions were far better so the quality of the video data collected was much improved, thus the valid surveys dataseries started in 2008.

Changes to number of UWTV stations:

- Due to the construction of the Walney Offshore wind farm in the southern part of the ground, in 2010 and 2011 some stations were abandoned.
- In 2011 three new exploratory stations were added due to some VMS activity in that part of the ground. Although, those stations were very close to zero burrows counts and were not included in the calculations of the main area abundance.
- In 2012 another station was added in the eastern part of the ground, but no *Nephrops* burrows were observed in this station.
- In 2013 three stations were moved slightly due to the proximity of new windfarm.
- In 2015 new exploratory stations (14-AS, 14-AT, 14-AU, 14-AV and 14-AW) were added to support the benchmark process to review of the ground boundaries for this stock.
- In 2016, following the benchmark recommendations, new stations were added in Wigtown Bay area (14-BA, 14-AY, 14-AZ).

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.

18.1.3 Assessment

Comparison with previous assessments

The WGCSE 2017 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).

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated between abundance values of 350 and 694 million *Nephrops*. The 2017 estimate (580 million) increased in relation to 2016 and is broadly in line with some historical figures and is above the MSY $B_{trigger}$ (350 million).

The 2017 abundance is below the average of the series 2008–2016 (geo-mean: 477 million). Table 3.8.5 and Figure 3.8.11 summarize the abundance estimated including the confidence intervals and the harvest ratios (% dead removed / UWTV abundance) which have been above the F_{MSY} proxy.

18.1.4 Catch option table

Catch option 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	580 million	UWTV Survey 2017
Mean weight in landings	21.32 g	Average 2014–2016
Mean weight in discards	8.63g	Average 2014–2016
Discard rate	11.56%	Average (proportion by number) 2014–2016. Calculated as discards/(landings + discards).
Discard survival rate	10%	Only applies in scenarios where discarding is allowed.
Dead discard rate	10.52%	Average 2014–2016 (proportion by number). Calculated as dead discards divided by dead removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

18.1.5 Reference points

New 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 4.7% (Fsq_2014–2016 = 4.7%; F2016 = 3.7%), 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)

18.1.6 Management strategies

There are no explicit management strategies for this stock.

18.1.7 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 2008–2013.

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.

18.1.8 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 $B_{trigger}$ 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?

18.1.9 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 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.

18.1.10 References

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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. 2015* 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

Table 3.8.2. Irish Sea East (FU14): Landings (tonnes) by country, 2000–2016.

YEAR	REP. OF IRELAND	UK	OTHER COUNTRIES	TOTAL
2000	114	451	2	567
2001	26	506	0	532
2002	203	373	1	577
2003	69	306	1	376
2004	62	409	1	472
2005	34	536	0	570
2006	34	594	0	628
2007	86	873	0	959
2008	29	652	0	681
2009	16	692	0	708
2010	45	538	0	583
2011	31	530	0	561
2012	53	478	0	531
2013	35	460	0	495
2014	31	648	0	679
2015	88	290	0	378
2016	21	216	0	237

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/KWDAYS	EFFORT (KW DAYS)	LANDINGS (TONNES)	LPUE/KWDAYS
2000	145 794	393	6.8	47 958	109	2.3
2001	141 686	417	6.9	8691	21	2.4
2002	97 368	285	6.8	72 588	201	2.8
2003	114 096	226	4.5	23 269	41	1.8
2004	107 570	323	6.9	26 345	55	2.1
2005	124 349	395	6.6	17 504	34	1.9
2006	249 846	408	4.3	6932	18	2.7
2007	345 818	668	6.7	25 309	79	3.1
2008	308 427	508	4.3	8136	15	1.8
2009	262 030	499	5.1	5516	13	2.4
2010	217 937	356	4.8	13 496	45	3.3
2011	188 876	356	5.5	8955	31	3.4
2012	163 110	301	5.3	21 224	53	2.5
2013	170 799	339	5.6	11 304	35	3.1
2014	179 356	404	6.1	10 259	29	2.8
2015	79 960	155	5.0	27 128	84	3.1
2016	59 970	101	4.4	9 496	21	2.2

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 discarded
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	27.69	23.21	16.39	8.47	0.1

*** Values for 2010, 2011 and 2012 are not reliable due to poor sampling.**

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	29.7	10.7	40.4	24.4	26.4				566.6	80.2	19.0	7.5
2001	25.5	5.2	30.7	15.5	17.0				532.3	41.6	20.9	8.0
2002	25.8	4.7	30.4	14.1	15.4				577.3	42.1	22.4	9.0
2003	12.9	1.4	14.3	9.0	9.9				376.0	10.8	29.1	7.6
2004	21.5	3.7	25.3	13.5	14.8				472.2	28.2	21.9	7.6
2005	26.5	4.0	30.5	11.8	13.0				569.7	33.4	21.5	8.4
2006	25.1	2.8	27.9	9.2	10.1				628.4	22.4	25.1	8.0
2007	40.1	6.4	46.5	12.5	13.8				959.0	46.8	23.9	7.3
2008	29.5	4.3	33.9	11.6	12.7	407.6	63.0	8.2	676.0	36.6	22.9	8.5
2009	19.4	0.7	20.1	3.3	3.7	350.0	76.0	5.7	707.0	6.3	36.5	8.6
2010						422.0	103.0		582.3			
2011						449.2	98.8		561.0			
2012						693.8	99.0		531.0			
2013	24.9	4.9	29.7	15.0	16.4	487.0	81.6	6.0	495.4	39.3	19.9	7.9
2014	30.3	3.7	34.0	9.8	10.8	449.1	91.8	7.5	678.5	32.4	22.4	9.6
2015	15.0	2.2	17.2	11.9	13.0	590.5	86.0	2.9	377.7	17.6	25.2	7.8
2016	14.3	1.7	16.1	9.9	10.9	430.0	106.3	3.7	237.1	14.8	16.4	8.5

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% 2011–2016). Due to poor sampling no estimates for 2010–2012.

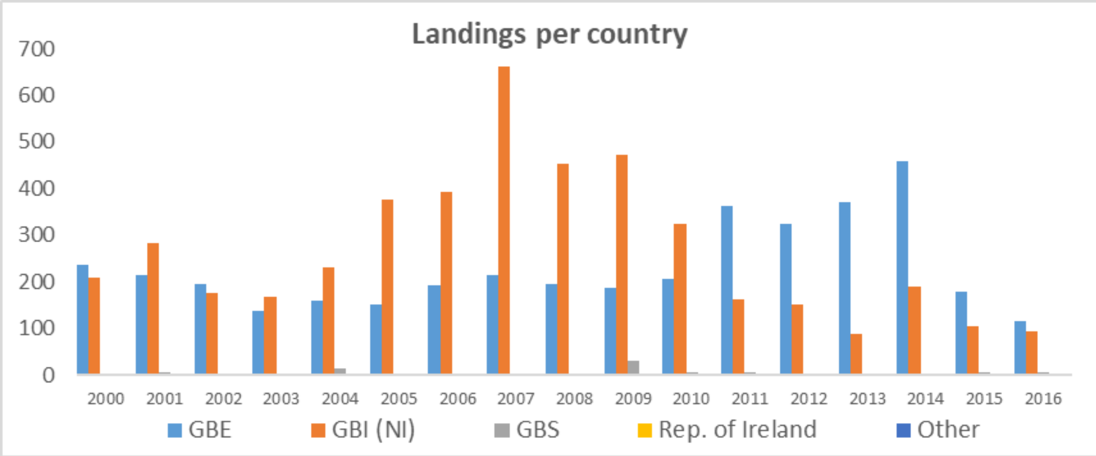


Figure 3.8.1. Irish Sea East (FU14): Landings in tonnes by country. GBE=England; GBN=Northern Ireland; GBS=Scotland; Rep. of Ireland=Republic of Ireland.

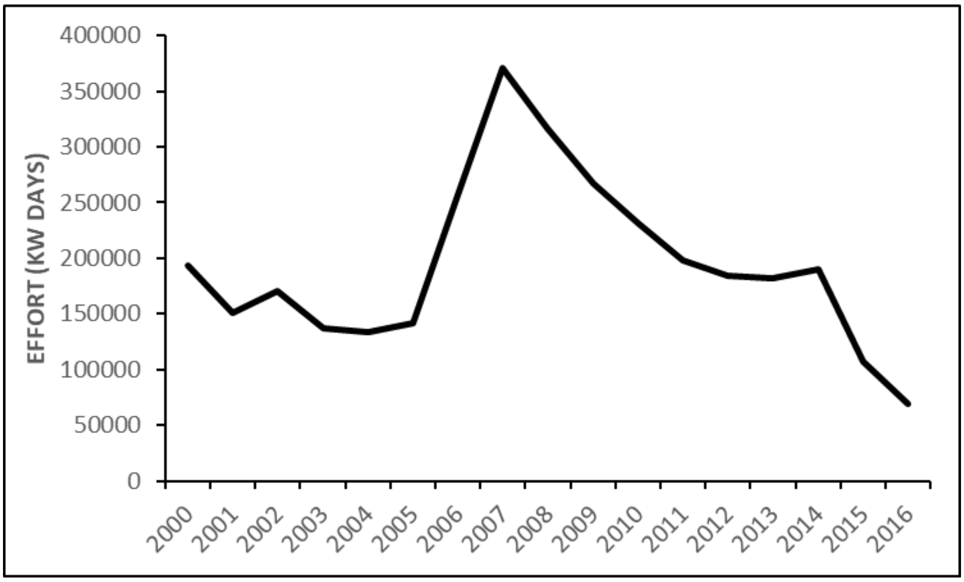


Figure 3.8.2. Irish Sea East (FU14): Effort data (KW days) for UK directed *Nephrops* fleet.

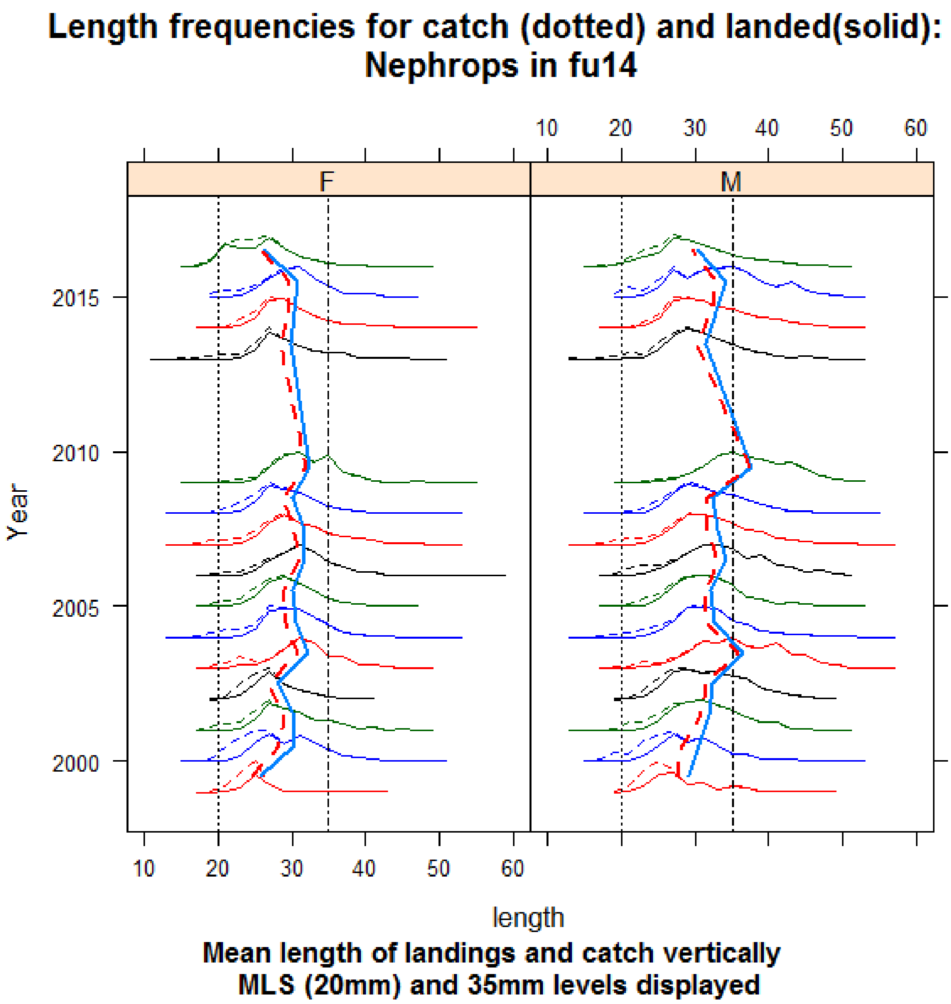


Figure 3.8.3. Irish Sea East (FU14): Length distribution of landings (solid lines) and catch (dotted lines), 2000–2016. Length frequencies for 2010–2012 are based in very poor sampling so not reliable. Figure shows a vertical display of MLS (20 mm CL) and 35 mm CL levels.

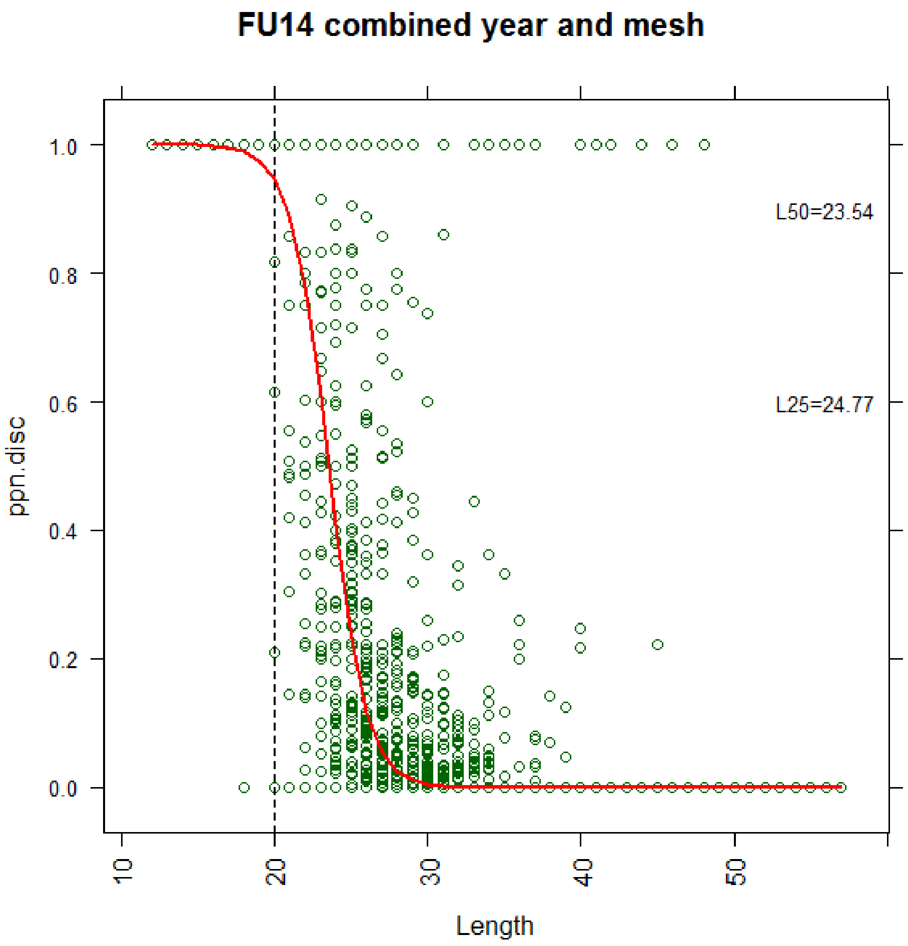


Figure 3.8.4. Irish Sea East (FU14): Final discard ogive pooled for all years (2003–2014) and mesh sizes. L50=23.54 and L25=24.77.

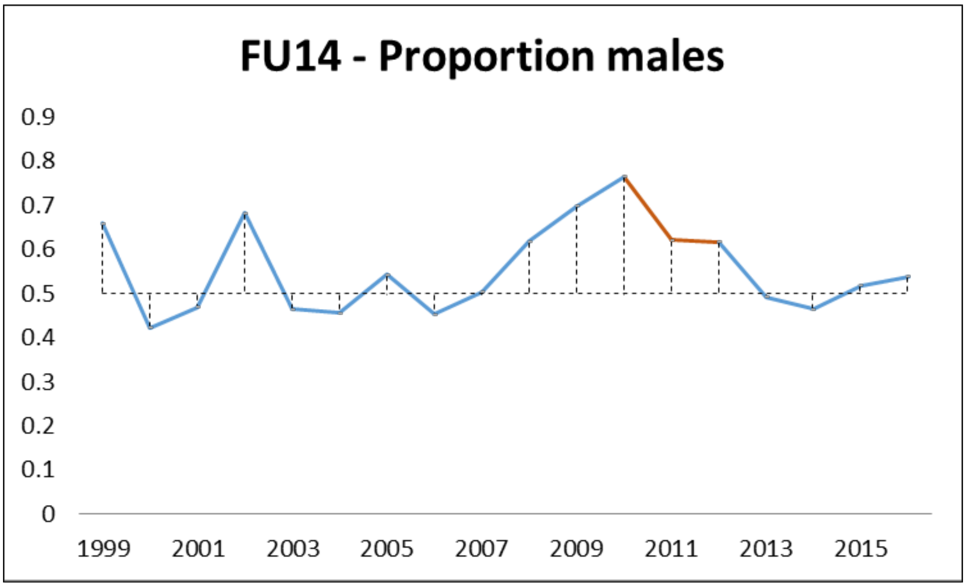


Figure 3.8.5. Irish Sea East (FU14): Proportion of males in catch since 1999. Between 2010 and 2012 due to poor sampling levels estimates of sex ratio are not reliable.

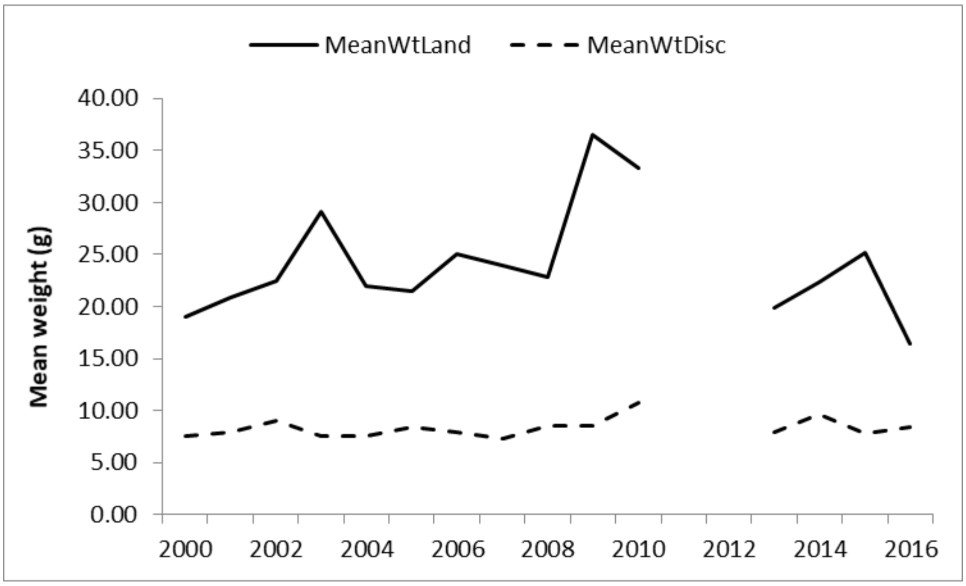


Figure 3.8.6. Irish Sea East (FU14): Mean weight (g) combined by sex for total annual landings and discards. Values for 2010, 2011 and 2012 are not reliable due to poor sampling.

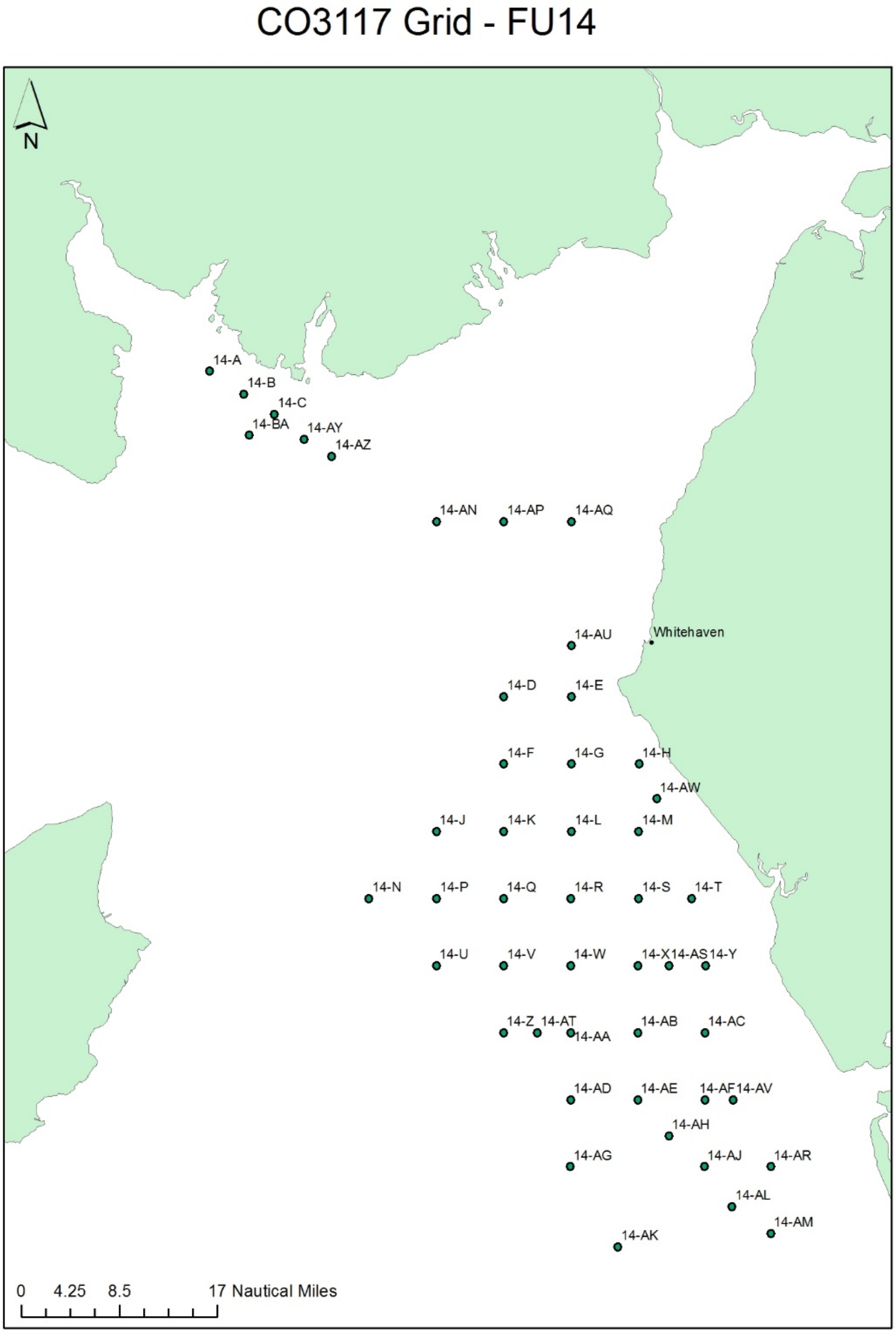


Figure 3.8.7. Irish Sea East (FU14): UWTV Survey stations for 2017.

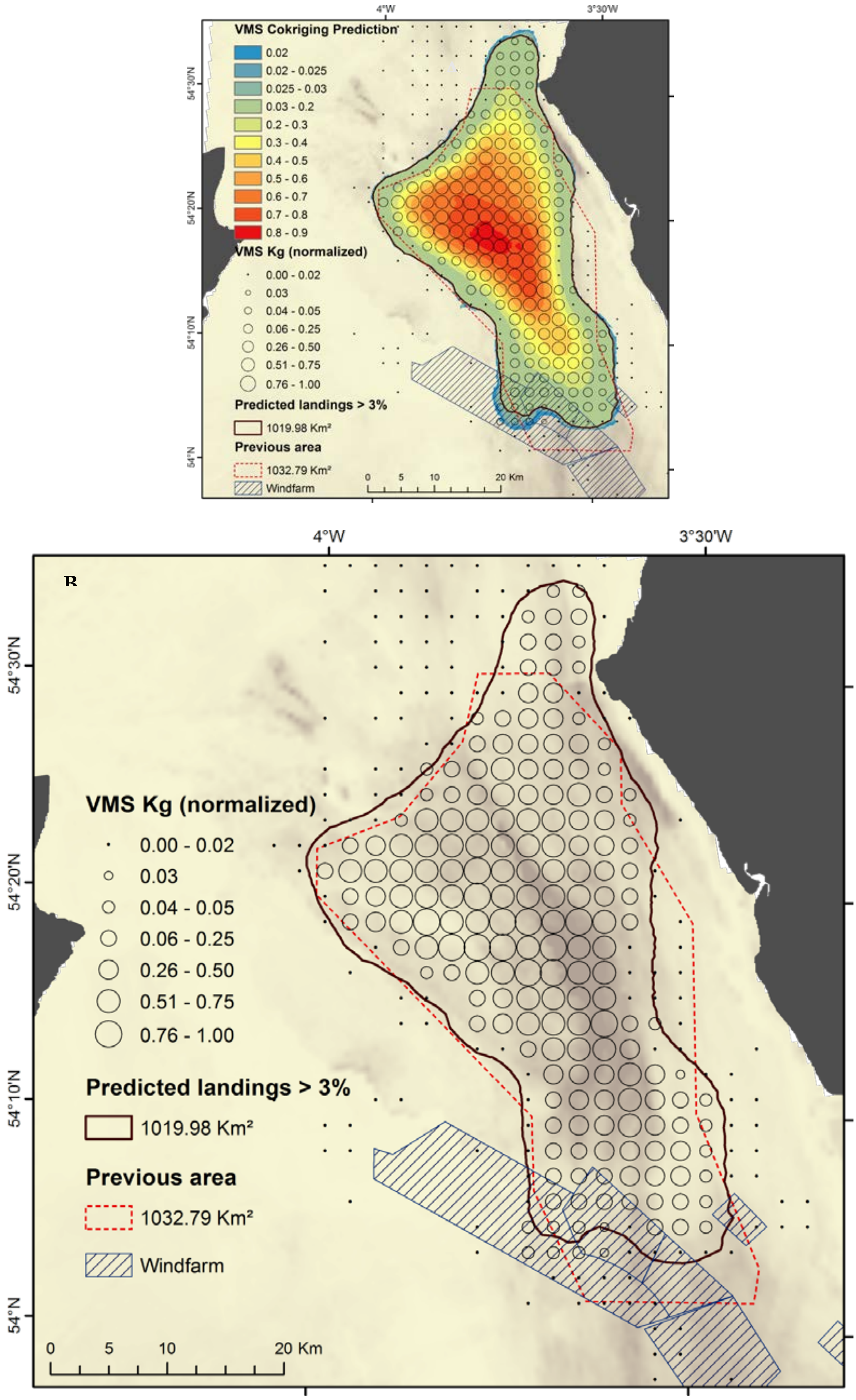
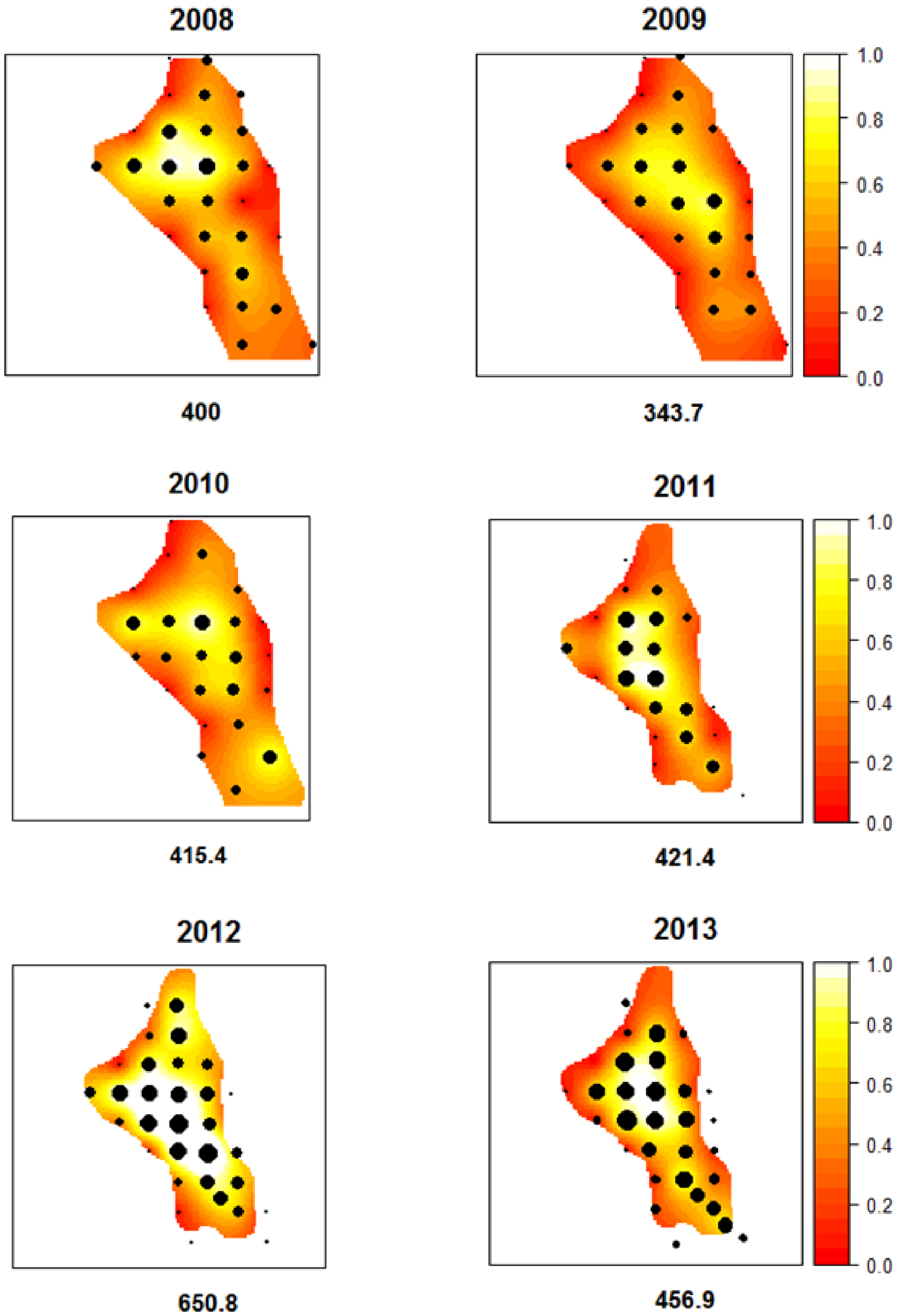


Figure 3.8.8. Irish Sea East (FU14): Co-kriging approach. Interpolation result of VMS (cut off 3%), survey density (2013–2015) data and mud distribution. A – model output; B – final polygon.


2008
400
2009
343.7
1.0
0.8
0.6
0.4
0.2
0.0
2010
415.4
2011
421.4
2012
650.8
2013
456.9

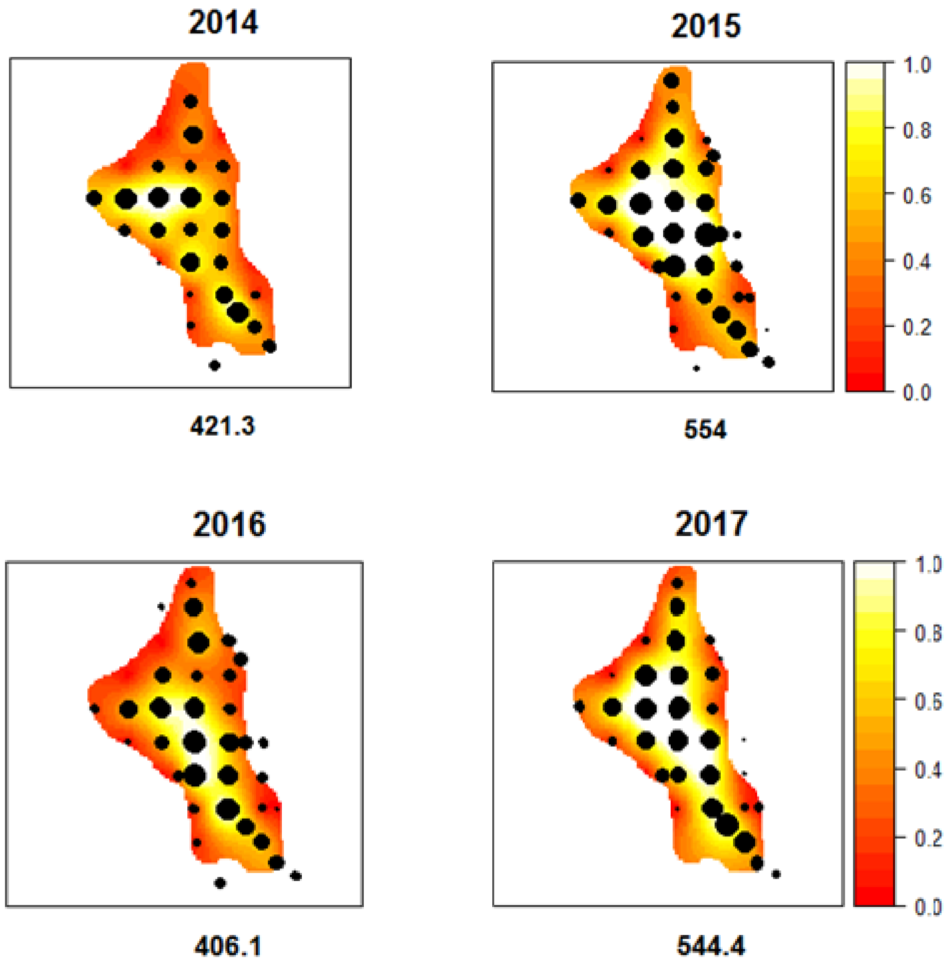


Figure 3.8.9. Irish Sea East (FU14): Burrow density estimates from the UWTV Survey 2008–2016 (individuals / m². Abundance estimates (millions) given at the bottom of each plot are adjusted with the cumulative absolute conversion factor (but does not contain the additional area for Wigtown Bay). Area of ground = 1032.75 Km² for 2008–2010 and 1019.79 Km² for 2011–2016.

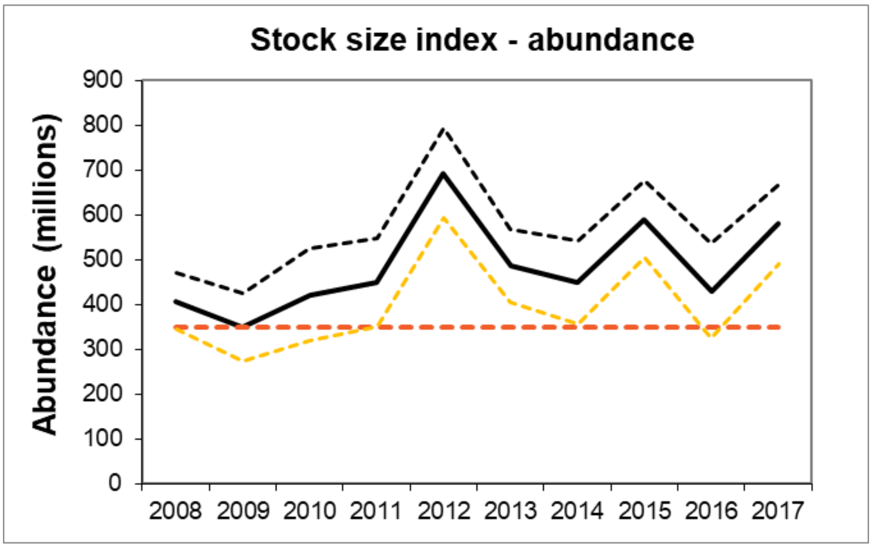


Figure 3.8.10. Irish Sea East (FU14): Burrow density estimates from the UWTV Survey 2008–2017. $B_{trigger}$ set as 350 million (orange dashed line).

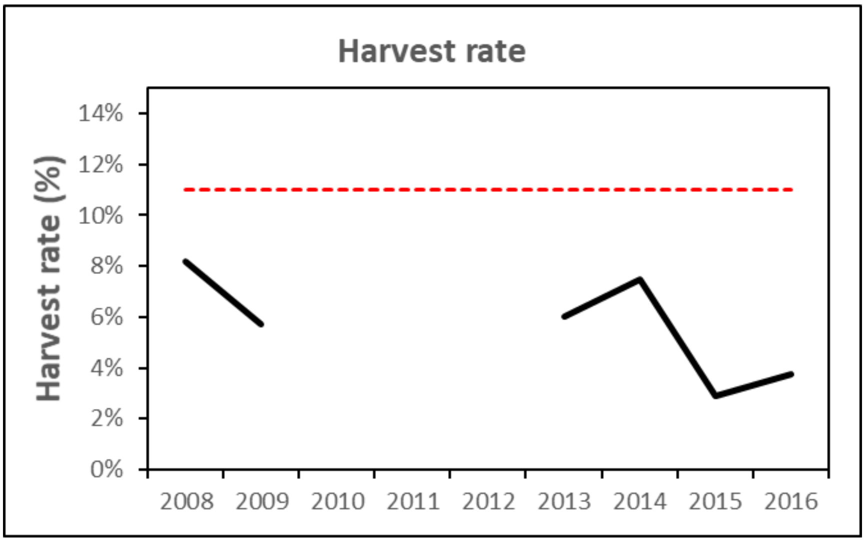


Figure 3.8.11. Irish Sea East (FU14): Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy (11%) and the harvest rate respectively. Between 2010 and 2012 due to poor sampling levels harvest rate estimates are not reliable.

18.2 Audit of *Nephrops* in Division 7.a (Irish Sea East, FU14)

General

For single-stock summary sheet advice

1) **Assessment type:** Update with one additional year of catch and survey data (benchmarked at IBPNeph 2015, stock annex updated at WGCSE 2016).
2) **Assessment**: Analytical. A combination of UWTV survey-based abundance assessment and commercial fishery data, following the process defined by the benchmark working group (IBPNeph 2015 and stock annex).
3) **Forecast**: Short-term projection to produce a catch options table.

4) **Assessment model**: UWTV based approach.

5) **Data issues**:

5.1) The levels of biological sampling was not stated for 2016. It would be useful to state this for the last three years.

5.2) The number of valid stations used in the assessment was not stated.

6) Consistency:

6.1) The assessment process is consistent with the stock annex and the previous year's assessment.

6.2) Fluctuations are observed in the mean weight in sampled landings and discards and hence three year averages are given from 2014 to 2016.

7) Stock status:

7.1) UWTV abundance estimates suggest stock size has fluctuated generally above the $B_{trigger}$.

7.2) In 2016 stock abundance was 432.9 million individuals for FU14, a decrease on 2015 (590.5 million), but still well above the $B_{trigger}$ value of 350 million.

7.3) Harvest ratios have been below the F_{MSY} proxy (11%; estimated by IBTNeph 2015, based on $F_{0.1}$ for combined sexes) from 2013 to 2016.

8) Management Plan:

8.1) There are no explicit management strategies for this stock.

8.2) Management should be carried out at a smaller scale than the ICES division level.

General comments

- The audit was undertaken with a draft of the document, prior to a second opinion given internally by another member of staff at Cefas, therefore some of the comments may not apply to the final document on SharePoint.
- The report did contain some misplotting in graphs (detailed in Technical comments) but was generally clearly written.
- The assessment is in line with the Stock Annex with the methods used to derive the F_{MSY} and landings predictions not deviating from the stock annex.
- The basis for the catch options (discard rates, survival, etc.) are clearly presented under Section 6.4.3.
- Most comments made in the 2016 stock audit appeared to have been taken on board i.e. stating survey CVs in the report, etc.

Technical comments

- Comments were made on a draft of the report which was available on SharePoint and submitted to the report writer.
- The two main errors in the report draft:
- Landings from the Republic of Ireland in Figure 3.8.1 were not plotted.
- The most recent harvest ratio (for 2016) was not plotted in Figure 3.8.11 although is present in the table.

Conclusions

The assessment was performed correctly and provides a valid basis for the management advice. The stock has declined in abundance from 2015 to 2016 but is still stable and above $B_{trigger}$. Although harvest ratios are still greatly below F_{MSY} (11%).

Checklist for audit process

General aspects

- Has the EG answered those ToRs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? N/A
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

19 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 2017 and the new survey will form the basis of advice for this stock in the autumn.

ICES advice applicable to 2016

ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 8682 tonnes. If instead discards rates continue at recent values (average 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 7577 tonnes.

To ensure that the stock in functional unit (FU) 15 is exploited sustainably, management should be implemented at the functional unit level.

ICES advice applicable to 2017

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 2013–2015, catches in 2017 should be no more than 11 248 tonnes. This implies landings of no more than 9376 tonnes.

To ensure that the stock in functional unit (FU) 15 is exploited sustainably, management should be implemented at the functional unit level.

19.1 General

Stock description and management units

The Irish Sea West (FU15) is comprised of ICES rectangles 35E3–E5, 36E3–E5, 37E3–E5 & 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 (Figure xx). The TAC for Area 7 is shown in Table xx.

Fishery description

The FU 15 *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 2016

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 19.1 and Figure 19.1. Total declared international *Nephrops* landings reported from FU15 in 2015 was 7327 t, which are the lowest observed landings since 2005. 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.

Further general information on the fishery can be found in the stock annex.

Information from stakeholders

No information from stakeholders.

19.2 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 19.1 and Figure 19.1. Total declared international *Nephrops* landings reported from FU15 in 2016 was 7327 t, which are the lowest observed landings since 2005. Ireland's landings were 1609 t, a decrease of 58% from the recent 2012 peak. UK vessels landed 5715 t in 2016, a decrease of 11% from last year, with landing 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 reduction in effort and lpuelpue time-series for Ireland (Table 19.3) compared to 2015, to the lowest reported value in the series. In previous years these inter annual 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 lpuelpue. The decrease in landings and lpuelpue in 2015 is most likely associated with better fishing opportunity elsewhere in the TAC area. 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 2016 are similar 2.68 kg/kWd c.f. 2.75 kg/kWd respectively.

Sampling levels

Sampling catches by means of the fisher self-sampling scheme for Northern Irish vessels has continued at sustained high levels with 94 samples collected from the reference fleet, with 31, 20, 18 and 25 samples in quarters 1–4 respectively. The number of discard and catch samples collected from the Irish fleet was 38 with eight, eight,16 and six samples collected in quarters 1–4 respectively. These rates correspond to one sample per 58 t landed by the Northern Irish fleet and one sample for every 42 t landed by the Irish fleet. Sampling levels of commercial catches in 2016 remained at a level similar to those in previous years.

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 19.1). 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 19.2).

Sex ratio

The sex ratio by year is shown in Figure 19.3. This shows some fluctuations over time. In general the sex ratio in landings and catches are biased toward males, with a geomean of 55.8% males in landings (1986–2016) and 52.1% in catches (1986–2016). A small bias toward males in catches was observed in 2016, the catch comprises 51.8% and 55.3% in landings compared to 49.2% in the catch and 52.3% in landings in 2015. 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 19.4). This corresponds with the emergence of mature females from the burrows to mate in summer. Over time there has been a trend toward decreasing mean weights (Figure 19.5). The trend has decreased in strength in later years. The mean weights in landings (2014–2016) and mean weights in discards (2014–2016) 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 derived, 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 to 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 30% of the catch by number in 2016 (Table 19.6). 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 19.7. Details of the survey methodology are available in WGNEPS (ICES, 2016). Figure 19.6 shows the distribution of stations sampled in 2016. 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 19.7 and 19.8 are contour plot of the krigged-density estimates for FU15 over the period 2003–2016. The survey abundance estimate in 2016 is approximately 6% higher than 2015 estimate (Table 19.7). A violin plot of the burrow densities observed in the survey (2003–2016) is shown in Figure 19.9. 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 reminded. Mean carapace length-by-sex (from the trawl survey) shows inter-annual variation fluctuating around mean with no apparent trend over time (Figure 19.10).

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 break-down, no data are available for the 2013 summer survey. The summer trawl survey catch rates correlate somewhat with UWTV survey abundance estimates (Figure 19.11), 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.

19.3 Assessment

Comparison with previous assessments

The assessment approach used by WGCSE 2017 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 small increase, but with the limits previously observed for the stock. The harvest ratio has increased slightly in 2016 is below F_{MSY} (Figure 19.12). This stock has sustained landings at around 9000 t for many years. The stock increased until 2003. Since then, the stock has decreased but is still at high levels. The most recent UWTV abundance estimate of 5.1 billow in 2016 follows a period (2013–2015) of below average size (geometric mean of current series: 4.9 billion). Figure 19.12 is the stock summary plot for FU15. Recent harvest rates have fluctuated around F_{MSY}, estimated as 15.3 in 2016, having decreased from 19.9 in 2015 (Table 19.6). The stock is estimated to be well above $B_{trigger}$ (3000 million).

19.4 Catch option table

Catch option table inputs are presented in Table 19.6 and summarised below. A three year average (2014–2016) of mean weight in the landings and proportion of removals retained was used.

A landings prediction for 2017 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 2017 UWTV survey. This will be presented in October 2017 for the provision of advice.

The basis for the catch options.

Variable	Value	Notes
Stock abundance	Available in October 2017	UWTV survey 2017.
Mean weight in landings	13.47 g	Average 2014–2016.
Mean weight in discards	7.68 g	Average 2014–2016.
Discard rate	28.4%	Average 2014–2016 (by number).Calculated as discards divided by landings + discards.
Discard survival rate	10%	Only applies in scenarios where discarding is allowed.
Dead discard rate	26.3%	Average 2014–2016 (by number). Calculated as dead discards divided by dead removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

19.5 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 19.8), this is still accepted as an appropriate $B_{trigger}$ for FU15.

Stock code	MSY Flower	Fmsy	MSY Fupper with AR	MSY Btrigger	MSY Fupper with no AR
nep-15	12.4	18.2	18.2	3000*	18.2

***Abundance in millions.**

19.6 Management strategy

As yet there are no explicit management strategies for this stock.

19.7 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.

19.8 Recommendations for next benchmark

WGCSE will keep the stock under close review and recommend future benchmark as required.

19.9 Management considerations

The FU15 *Nephrops* fishery first developed in the late 1950s. Since then it has sustained landings of around 9000 t for more than 35 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 a level 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.

19.10 References

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Table 19.1. Irish Sea West (FU15): Landings (tonnes) by country, 2000–2016.

Year	Ireland	Isle of Man	UK	Other countries	Total
2000	3,433	0	4937	0	8370
2001	2,689	3	4749	0	7441
2002	2,291	1	4501	0	6793
2003	2,709	4	4352	0	7065
2004	2,786	13	4470	1	7270
2005	2,133	0	4420	0	6554
2006	2,051	1	5508	1	7561
2007	2,767	0	5724	0	8491
2008	3,132	50	7323	2	10508
2009	2,343	1	6855	0	9198
2010	2,578	0	6384	0	8963
2011	3,575	2	6584	0	10162
2012	3,794	3	6732	0.2	10529
2013	2,465	31	6175	0.2	8672
2014	2,938	0**	5676	0.0	8613
2015	2,199	0**	6433	0.3	8632
2016*	1,609	0**	5715	3	7327

*** provisional. **included in UK landings.**

Table 19.2. 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 2016.

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

Table 19.3. Irish Sea West (FU15): Landings (tonnes), effort ('000 hours trawling), lpuelpue (kg/hour trawling), effort ('000 kW days) and lpue (kg/kWd) of Northern Ireland *Nephrops* trawlers, 2000–2016.

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

*** provisional.**

cpuelpue

Table 19.4. Irish Sea West (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Northern Ireland catches, landings and discards, 2000–2016.

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

* provisional na = not available

Table 19.5. Irish Sea West (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Republic of Ireland catches, landings and discards, 2000–2016.

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

na = not available

Table 19.6. 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	7.7	30%	28%
Average 2014–2016							13.5	7.7	28.4%	26.3%

Table 19.7. Irish Sea West (FU15): Results from NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003–2016.

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%

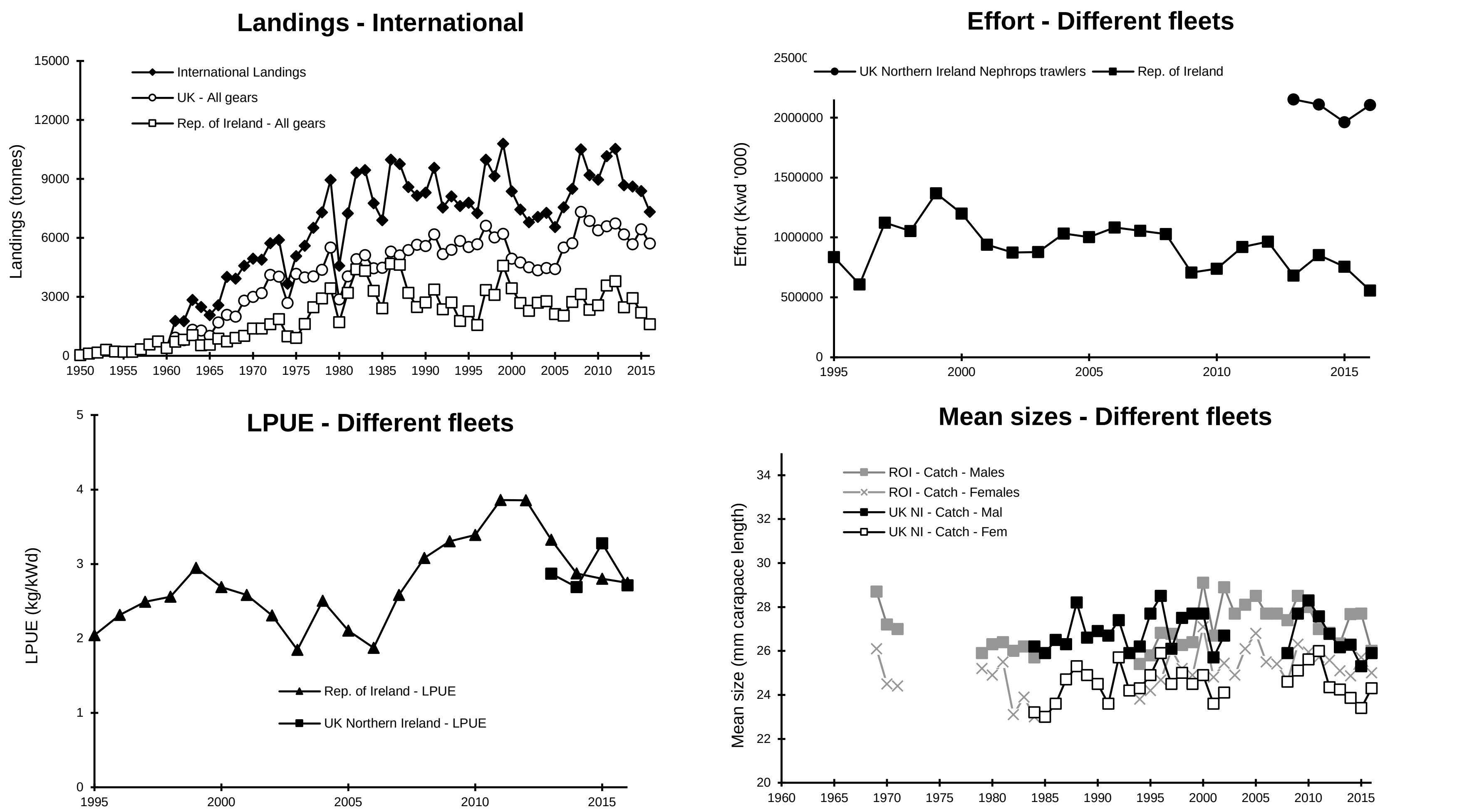


Figure 19.1. Irish Sea West (FU15): Long-term trends in landings, effort, lpue, and mean sizes of *Nephrops*. [The quality of landings data has improved since 2007 with the implementation of sales notes and buyers and sellers legislation, which result in misleading lpuelpue trend plots pre and post 2007].

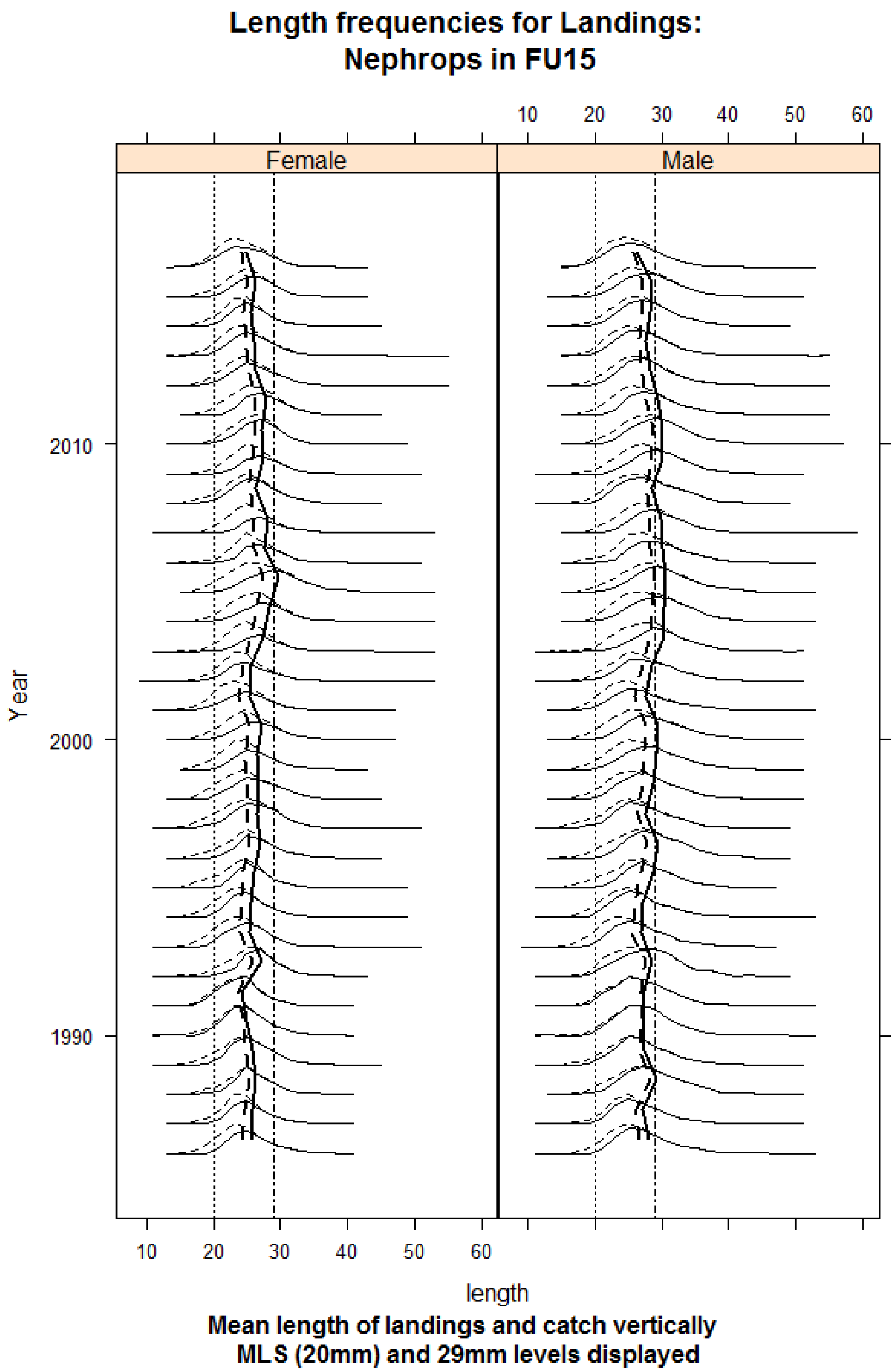


Figure 19.2. Irish Sea West (FU15): Length distributions in the landings (solid) and catches (dotted) 1986–2016 females (left) and females (right).

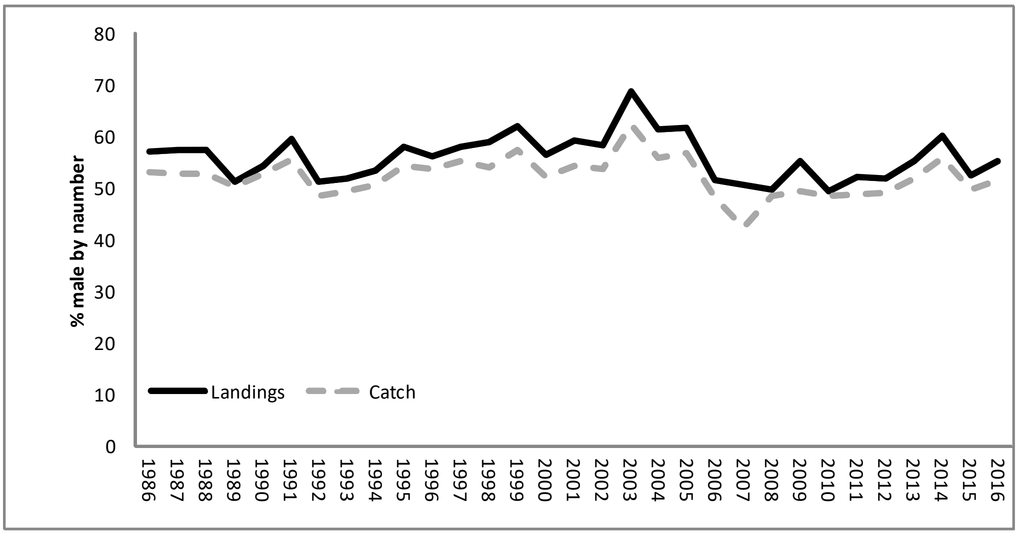


Figure 19.3 ***Nephrops*** **in FU15 (Irish Sea West). Sex ratio of landings (1986–2016) and catch (1986–2016).**

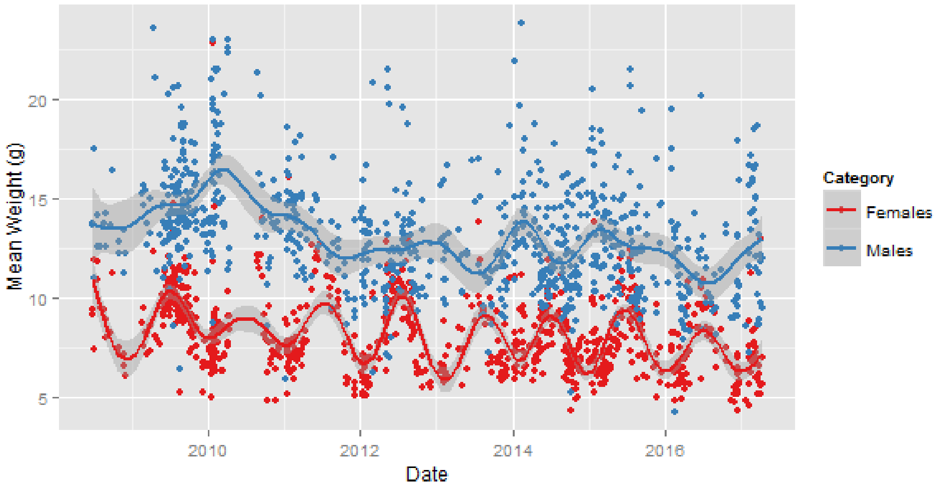


Figure 19.4 ***Nephrops*** **in FU15 (Irish Sea West).Mean weight in catch samples by sex with GAM loess smoother (k=20).**

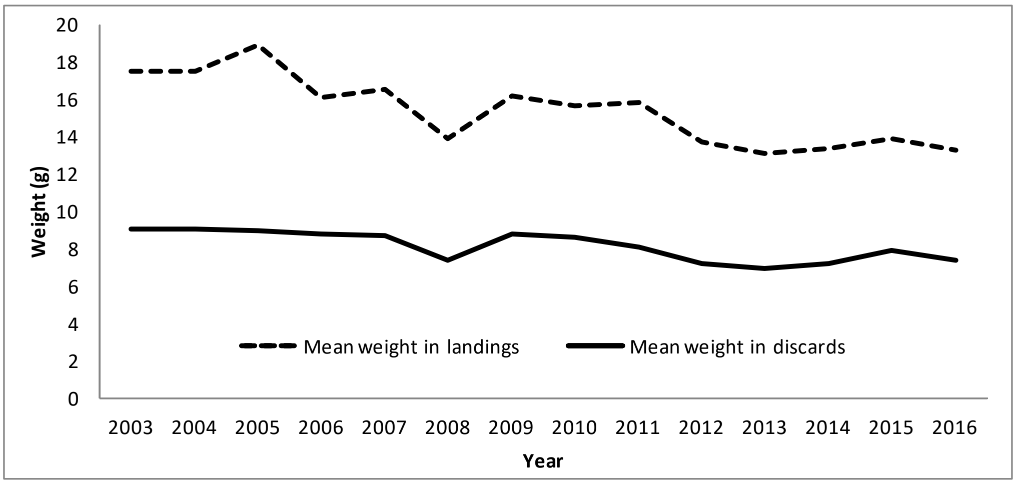


Figure 19.5 ***Nephrops*** **in FU15 (Irish Sea West). Mean weight in landings and discards.**

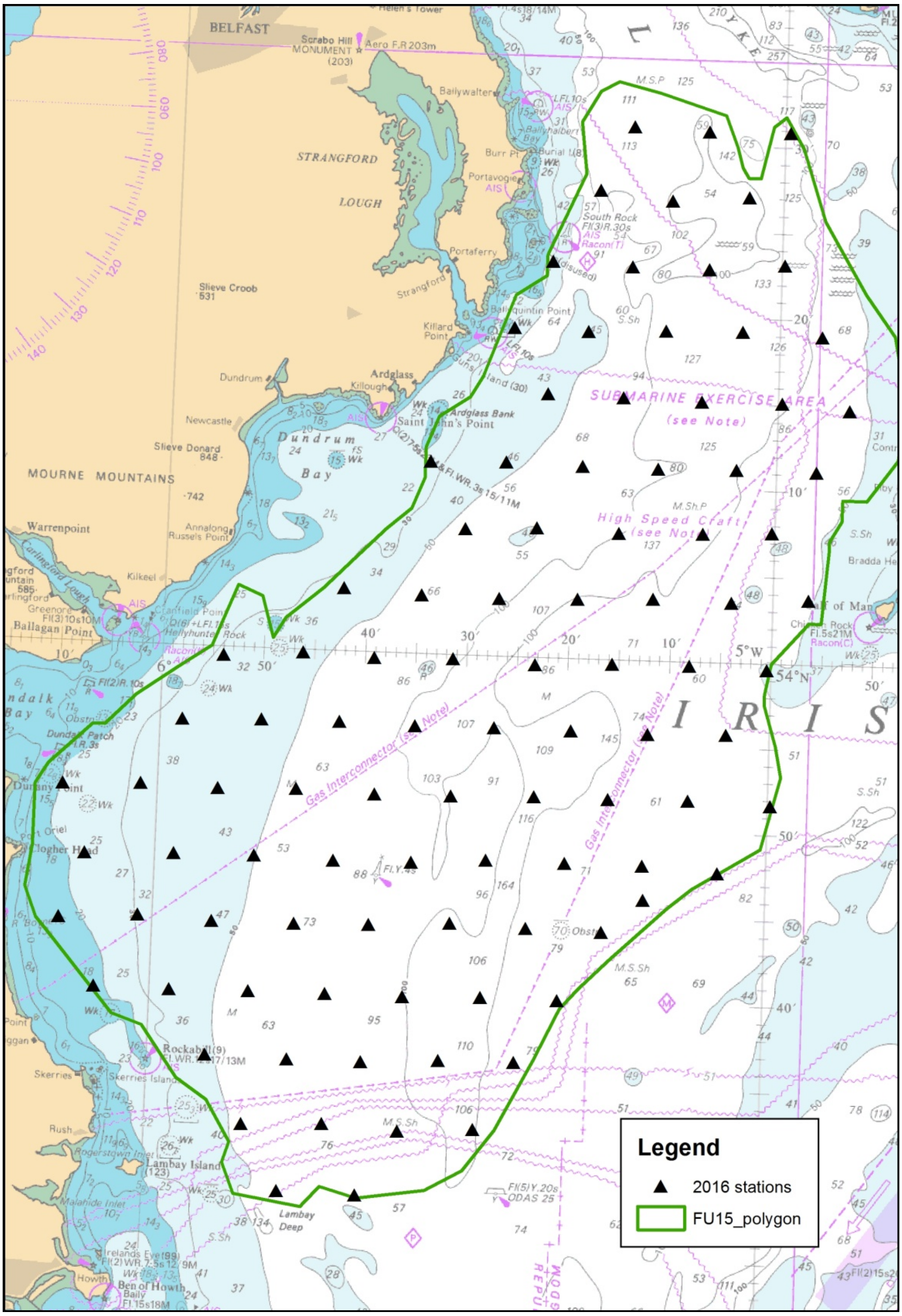


Figure 19.6. Irish Sea West (FU15): 2016 UWTV survey stations.

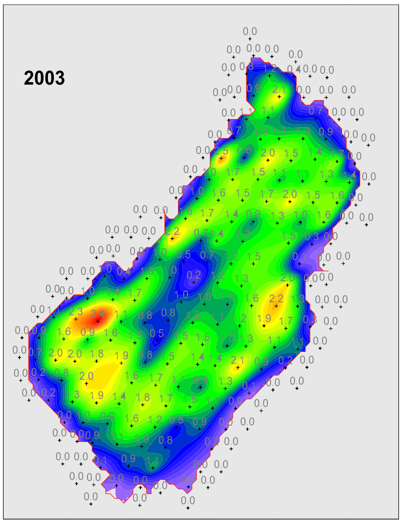


Figure 19.7. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2003–2008.

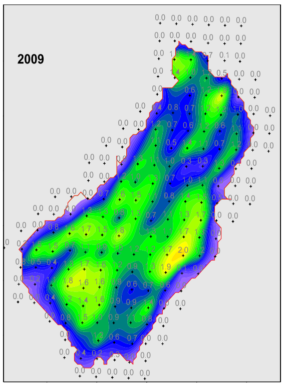


Figure 19.8. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2009–2016.

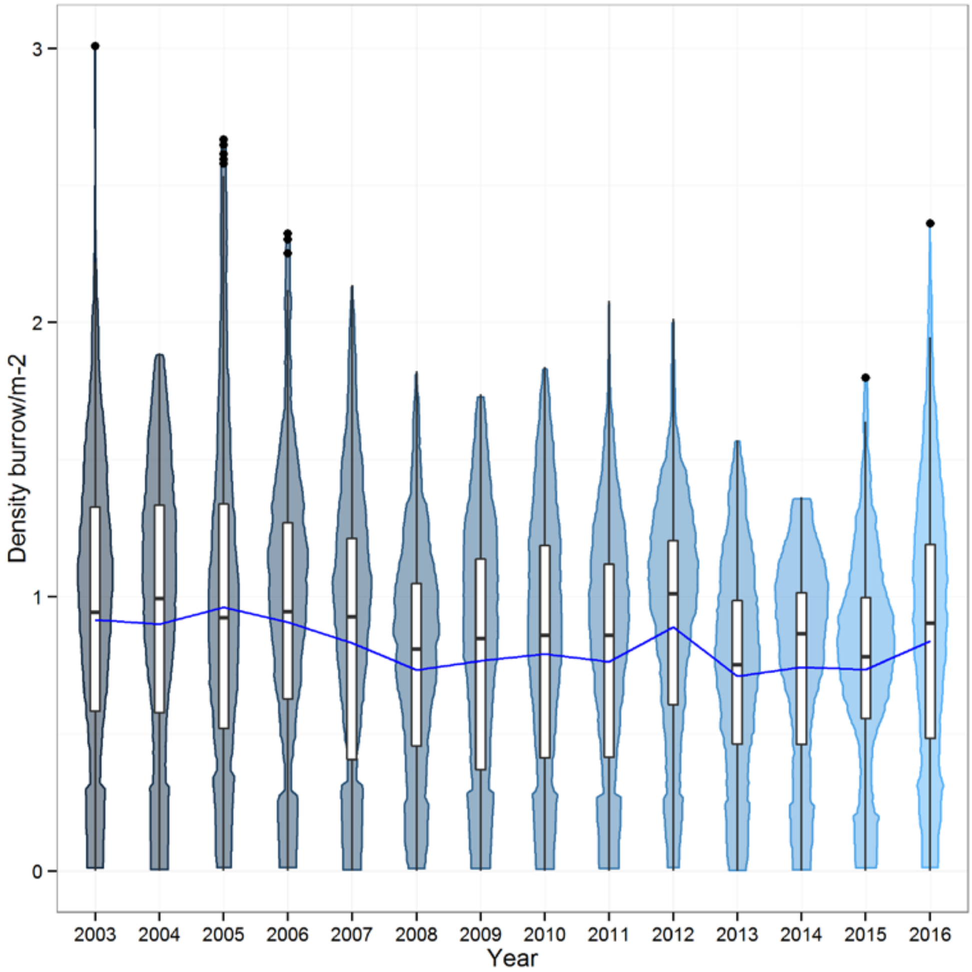


Figure 19.9. Irish Sea West (FU15): Box and kite plot of burrow density observed during UWTV survey 2003–2016.

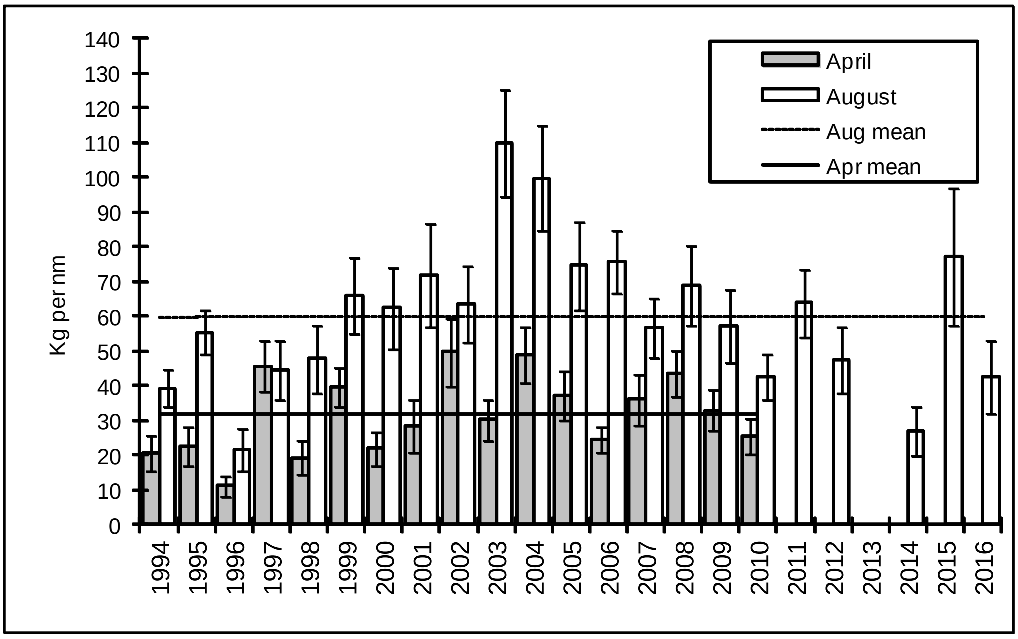


Figure 19.10. Irish Sea West (FU15): *Nephrops* catches (kg per nm) from NI trawl surveys. No data available in 2013 due to major ship breakdown.

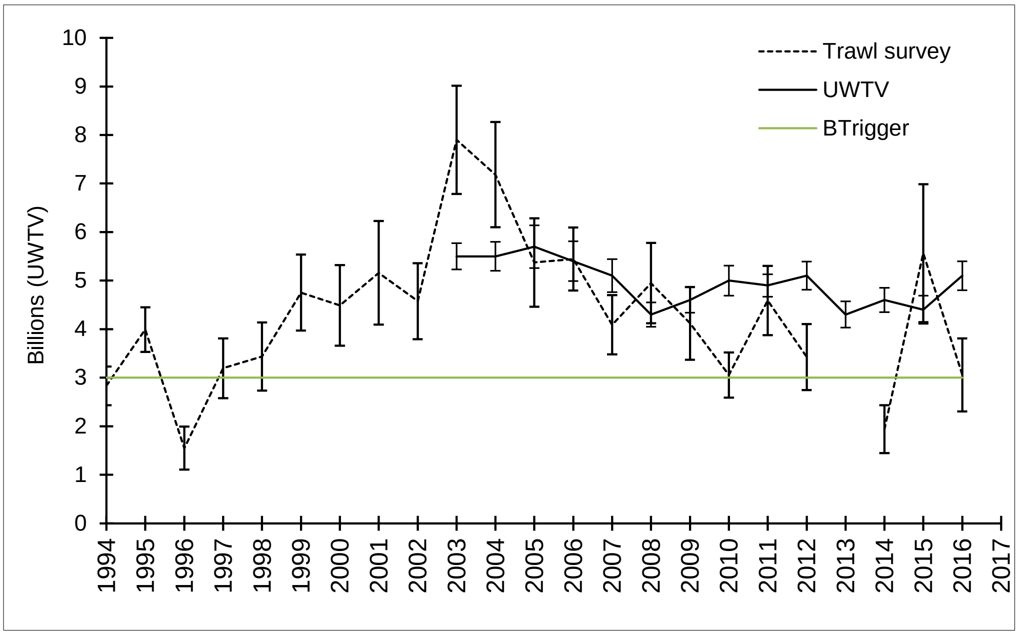


Figure 19.11. Irish Sea West (FU15): Revised UWTV index and scaled trawl survey. Cpue along with $B_{trigger}$ based upon mean of five lowest trawl survey values. Abundance figures have not been bias corrected.

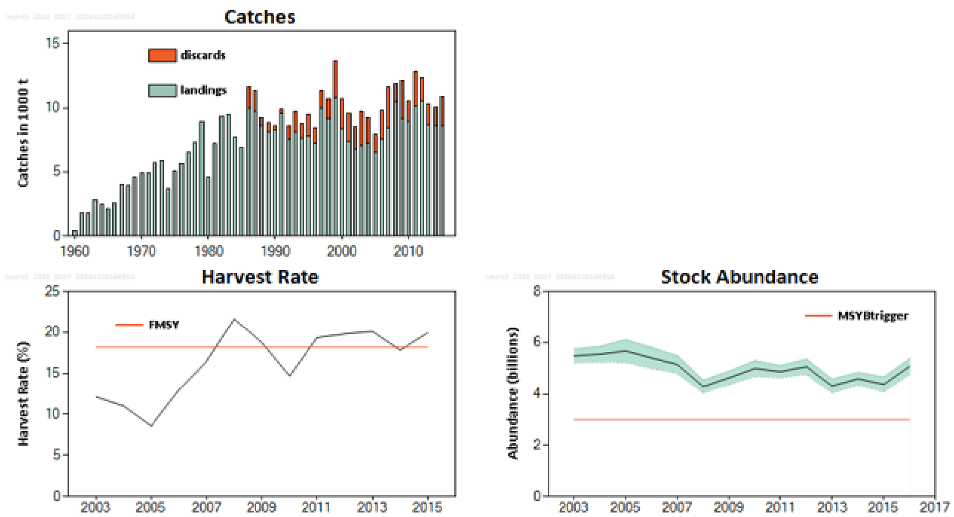


Figure 19.12. Irish Sea West (FU15): Stock summary plot of landings (tonnes), UWTV abundance and harvest rate (ratio).

19.11 Audit of nep.fu.15

General

For single stock summary sheet advice

- **Assessment type:** Update with one additional year of survey and catch data (benchmarked at WKNEPH2009, stock annex updated at WK*NEPH*2009).
- **Assessment**: Analytical (UWTV survey-based abundance assessment combined with commercial fishery data, follows the process defined by the benchmark WG ((WKNEPH2009 and stock annex).
- **Forecast**: A short-term projection was completed to produce a catch option table.
- **Assessment model**: UWTV based approach.
- **Data issues:** None though the following points to note:

  Data weren't available to check on SharePoint - had to go through presentation.

- **Consistency**:

  The 2017 assessment is consistent with the 2016 assessment and with the assessment methods described at the 2009 benchmark.

  Stock annex needs to be updated with WKFMSYRef4 report. The assessment process is consistence with the stock annex. Check the $B_{trigger}$ value as this differs in report and annex compared to WKFMSYRef4 report (6000 billion versus 3000 billion).

- Stock status:

  UWTV abundance estimates suggest that the stock size has fluctuated with a recent stable trend.

  TV survey estimated stock abundance in 2016 was 5.1 billion individuals, substantially above the MSY $B_{trigger}$ value of 3000 billion.

  2016 Recent harvest ratios which have been hovering around the F_{MSY} proxy for the last three years.

  The F_{MSY} proxy was revised by WKMSYRef4. Rationale: F35%SPR combined sexes =18.2%).

  The 2016 harvest ratio for the North Minch (15.4%; dead removals/TV abundance) is below the F_{MSY} proxy harvest rate.

- Management Plan:

  No specific management plan exists for this stock.

  ICES advices that to ensure that the stock in functional unit (FU) 15 is exploited sustainably, management should be implemented at the functional unit level.

General comments

- The assessment was well-written and explanations were thorough. Report is brief and clear.

- The assessment is in accordance with the Stock Annex. Methods to derive F_{MSY} and landings predictions did not deviate from the benchmark process/stock annex.
- Clear description on how the InterCatch was used in the 2017 assessment. Data were available in InterCatch and used to generate 2016 raised international length–frequency distributions.
- This stock has not been benchmarked but the full UWTV survey approach has been.

Technical comments

- Have made comments using track changes on report document in SharePoint. Main point is to check table and figure numbering. And years reference in the report.
- *Nephrops* effort in Kw Days not presented - would also be useful to have numbers of vessels in the fishery over time and have this in stock annex.
- Check syntax for all *Nephrops* stocks is it Harvest rate or Harvest ratio in report; we should all be consistent and probably follow that from the advice sheet.
- Catch options table needs to be in report.
- Are the *Nephrops* trawl data useful in report - these could be moved to the stock annex with a reference to the how the $B_{trigger}$ was derived.
- Stock annex could do with a review.

Conclusions

- The assessment has been performed correctly for the basis of management advice. The stock appears to be stable in recent years and is above $B_{trigger}$ and 2016. Harvest ratios around F_{MSY} (18.2%).

Checklist for audit process

General aspects

- Has the EG answered those ToRs relevant to providing advice? YES
- Is the assessment according to the stock annex description? YES
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? N/A
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes, where appropriate
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

20 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 2017

Available data on the fishery for 2016 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 2016

ICES advises on the basis of the MSY approach that catches from FU 16 in 2016 should be no more than 1850 tonnes. All catches are assumed to be landed.

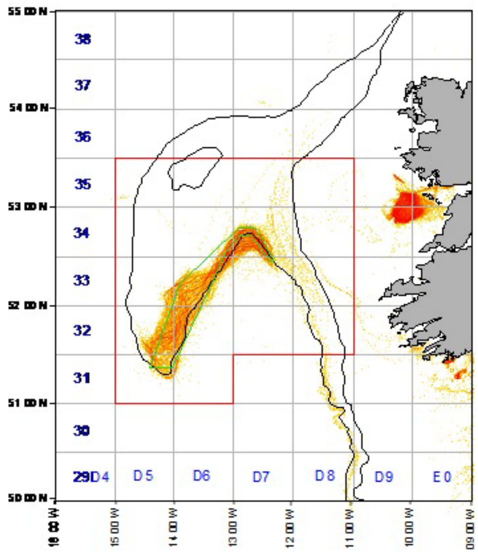
ICES advice applicable to 2017

ICES advises on the basis of the MSY approach that catches from FU 16 in 2017 should be no more than 3100 tonnes. All catches are assumed to be landed.

20.1 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 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 2016 and 2017

TAC in 2016

COUNCIL REGULATION (EU) 2016/72 of 22 January 2016 fixing for 2016 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) 2015/104.

Species:	Norway lobster *Nephrops norvegicus*	**Zone:**	VII (NEP/07.)
Spain	1 401		
France	5 678		
Ireland	8 610		
United Kingdom	7 659		
Union	23 348		
TAC	23 348		Analytical TAC 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 VII (NEP/*07U16):
Spain	558
France	349
Ireland	671
United Kingdom	272
Union	1 850

TAC in 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.

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		
TAC	25 356		Analytical TAC 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 VII (NEP/*07U16):
Spain	935
France	586
Ireland	1 124
United Kingdom	455
Union	3 100

20.2 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 table below:

(c) Fisheries with TAC covering ICES subarea VII for Norway lobster

Fishery	Gear Code	Fishing gear description	Mesh Size	Landing Obligation
Norway lobster (*Nephrops norvegicus*)	OTB SSC, OTT, PTB, SDN, SPR, FPO, TBN, TB, TBS, SX, SV, FIX, OT, PT, TX	Trawls, Seines, Pots, Traps & Creels	All	Where the total landings per vessel of all species in 2013 and 2014 consist of more than 30 % of Norway lobster, the landing obligation shall apply to Norway lobster.

The landing obligation also applied in 2017 to additional vessels that meet the criteria set out below:

c) Fisheries with TAC covering ICES subarea VII for Norway lobster

Fishery	Gear Code	Fishing gear description	Mesh Size	Species to be landed
Norway lobster (*Nephrops norvegicus*)	OTB SSC, OTT, PTB, SDN, SPR, FPO, TBN, TB, TBS, OTM, PTM, SX, SV, FIX, OT, PT, TX	Trawls, Seines, Pots, Traps & Creels	All	All catches of Norway lobster where the total landings per vessel of all species in 2014 and 2015 (*) consisted of more than 20 % of Norway lobster

(*) Vessels listed as subject to the landing obligation in this fishery in accordance with Delegated Regulation (EU) 2015/2438 remain on the list indicated in Article 4 of this Regulation despite the change in the reference period and continue being subject to the landing obligation in this fishery.

In addition: The exemption from the landing obligation provided for in Article 15(4)(b) of Regulation (EU) No 1380/2013 for species for which scientific evidence demonstrates high survival rates shall apply to Norway lobster (*Nephrops norvegicus*) caught in pots, traps or creels (Gear codes (1) FPO and FIX) in ICES Division 6.a and Subarea 7.

Currently there are no pot fisheries for *Nephrops* on the Porcupine Bank.

20.3 Fishery in 2016

WGCSE reviewed effort trends for Irish vessels that accounted for 88% of the total landings in 2016. The fishery in 2016 took place throughout the year with the highest effort in June and July. Effort in all months in 2016 was significantly higher than usual. The industry reported very good catch on *Nephrops* but commented that the mean size had declined significantly.

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. The implementation of the quota in Ireland has had the perverse consequence of increasing effort and participation in the fishery as vessels try to establish 'track record' in the fishery.

Previously WGCSE have carried out an analysis of VMS effort data by month which illustrated that the spatio-temporal closed area has been respected by the fleet but effort was displaced to the parts of the *Nephrops* ground not fully covered by the closure.

Information from stakeholders

The provision of grade information by individual fishers and co-ops remains a highly important assessment input. In 2016 the percentage of landings where grade data were provided increased.

Year	% of Irish landings where grade data were provided
2011	60%
2012	45%
2013	57%
2014	33%
2015	44%
2016	49%

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.

20.4 Data

InterCatch

Data were available in InterCatch and used on a trial basis.

Landings

Total international landings increased by ~54% in 2016 to 2154 t (Figure 20.1 and Table 20.2). The total landings include the WGCSE best estimate of "unallocated landings" for the area ~849 t. The "unallocated" landings includes an estimate of area-misreported catches for Irish vessels. This was derived in the following way: If a vessel had catch in rectangles outside the defined FUs this was assumed to be take in FU16 or if the vessel had a daily lpue outside FU16 on trips which also fished in FU16 that was beyond the 90th percentile of the lpue distribution for that other FU then the daily catch was estimated using daily effort * average annual lpue for that FU. Any residual catch

[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.

was assumed to be taken in FU16. The "unallocated" landings prior to 2013 included a component derived for differences between Spanish "official" landings and IEO estimates for FU16.

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 12% 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 2016 is relatively broad but to the left of the historical time-series. 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 between 2007 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 a range of 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.

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 the 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).

A detailed examination of discard estimates was provided in Spain in 2014. No estimate of was provided in InterCatch by Spain in 2015 or 2016.

Abundance indices from UWTV surveys

The latest survey report is available at http://oar.marine.ie/handle/10793/59 (Doyle *et al*., 2016). 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 available at http://oar.marine.ie/handle/10793/59.

Trawl surveys

The longest time-series of fishery-independent source of data is from the Spanish Porcupine trawl survey 2001–2016 (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 2016 is shown in Figure 20.5. 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 in 2010 (Figure 20.6).

The size structure of the catches in the survey shows two things: a much 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). There appears to be increased recruitment in the last few years with increased catches of individuals <21 mm (Figure 20.7).

An Irish Fisheries Science Research Partnership (IFSRP) survey was developed in collaboration 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 2010-12 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, 2013a). WGCES 2016 recommended presenting the effort in KWDays and lpue in tonnes/ KWDays. This has been done for Ireland this year. 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 20.7.

20.5 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). No survey was possible in 2015 so this year's assessment has been updated based on the results of the June 2017 UWTV survey.

State of the stock

The UWTV results are shown in Table 20.6. These indicate that recent harvest ratios have been below the F_{MSY} proxy but F has increased significantly in 2016 (Figure 20.8). Total abundance has declined by 11% in 2017 but remains above the average of the time-series.

Catch options table

The inputs to the catch options are given below. WGCSE concluded that the mean weights for the full time-series should be used for the catch options because recent mean weights in the landings have fluctuated considerably. 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 in 2016.

Variable	Value	Source	Notes
Stock abundance	850	ICES (2016a)	UWTV survey 2017.
Mean weight in landings	51.9	ICES (2016a)	Average 1986–2016.
Mean weight in discards		ICES (2016a)	Not relevant.
Discard proportion		ICES (2016a)	Discarding is negligible.
Discard survival rate		ICES (2016a)	Not relevant.
Dead discard rate		ICES (2016a)	Discarding is negligible.

20.6 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).**

20.7 Management strategies

There is no management plan for this stock.

20.8 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. A long-term mean weight has been used in the calculation of catch options. There is some evidence from surveys and length structure that recruitment has improved and this has resulted in a reduction in mean weight in the stock in 2016. The mean weight in 2017 and 2018 may well increase again as the strong cohort grows. Currently there is no methodology to take this into account in the calculation of catch options. In 2015 and 2016 the amount of discards observed on catch sampling trips have increased. This may be temporary linked to the incoming recruitment. It will result is a small underestimate of recent harvest rates of similar magnitude to the numbers which will not change the status evaluation.

The UWTV survey provides abundance since 2012 (except 2015) with high precision, but the time-series is short and an abundance $MSY_{trigger}$ hast yet to be defined. The landings are considered fairly well estimated (an unallocated component related to area misreporting has been included since 2011).

20.9 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.

20.10 Management considerations

The introduction of the "of which limit" with the TAC regulations since 2011 has increased the risk of highgrading and area misreporting in this fishery.

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 evaluation of the impact of this closure and whether it provides a conservation benefit over and above 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.

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).

20.11 References

Doyle, J., Lordan, C., Fitzgerald, R., O'Brien, S., Allsop, C., Kelly C., and McArdle J. 2016. Porcupine Bank *Nephrops* Grounds (FU16) 2016 UWTV Survey Report and catch options for 2017. Marine Institute UWTV Survey report.

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.

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.

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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.

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

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
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

Year	France	Ireland	Spain	UK E& W	UK Scotland	Unallocated	Total
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

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
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 1981–2016.

	Spain		Ireland		France		Porcupine Survey	
Year	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
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

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	46.40
1990	38.9	1895	48.67
1991	37.3	1640	43.98
1992	47.0	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	32.0	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	25.0	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
Average 1986–2016			**51.85**

Table 20.6. *Nephrops* Porcupine Bank (FU16): Assessment summary.

Year	Landings in number	Total discards in number *	Removals in number	UWTV abundance estimates	95% conf. intervals	Harvest rate	Mean weight in landings	Mean weight in discards	Discard rate	Dead discard rate
	millions	millions	millions	millions	millions	%	grammes	grammes	%	%
2012	25.0	0	25.0	787	78.7	3.2	50.4	NA	0	0
2013	19.8	0	19.8	768	61.4	2.6	57.5	NA	0	0
2014	17.4	0	17.4	722	35.4	2.4	68.4	NA	0	0
2015	27.4	0	27.4	840	NA	3.3**	50.9	NA	0	0
2016	53.5	0	53.5	958	68.1	5.6	40.3	NA	0	0
2017				850	89.7					

***Discards are considered negligible and are not included in the assessment.**

**** The harvest rate is estimated based on a linear extrapolation of abundance for 2016 when no survey was carried out.**

Table 20.7. ***Nephrops*** **Porcupine Bank (FU16): Effort and lpue for the various different fleets exploiting the stock 1971–2016.**

Year	Spain[1]		France2		Ireland3	
	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	1.40
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	278.0	1.29
2000	47	5	23	14	92.8	1.25

Year	Spain[1]		France2		Ireland3	
	EFFORT ('000'S HRS)	LPUE (KG/HR)	EFFORT[2] ('000'S HRS)	LPUE (>10%) (KG/HR)	EFFORT[3] ('000'S KWDAYS)	LPUE (T/KWDAYS)
2001	44	6	24	15	230.2	1.12
2002	54	5	18	18	339.8	1.30
2003	66	5	7	19	294.7	0.80
2004	59	10	9	25	569.2	0.68
2005	60	13	15	26	756.2	0.83
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			1330.7	1.45

[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*.

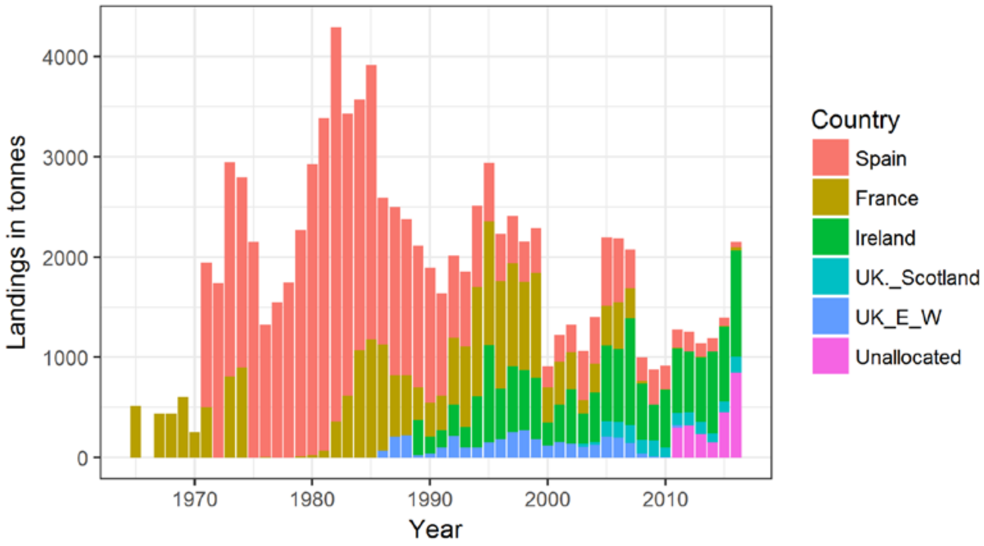


Figure 20.1. ***Nephrops*** **in FU16 (Porcupine Bank). WGs best estimates of landings in tonnes by country.**

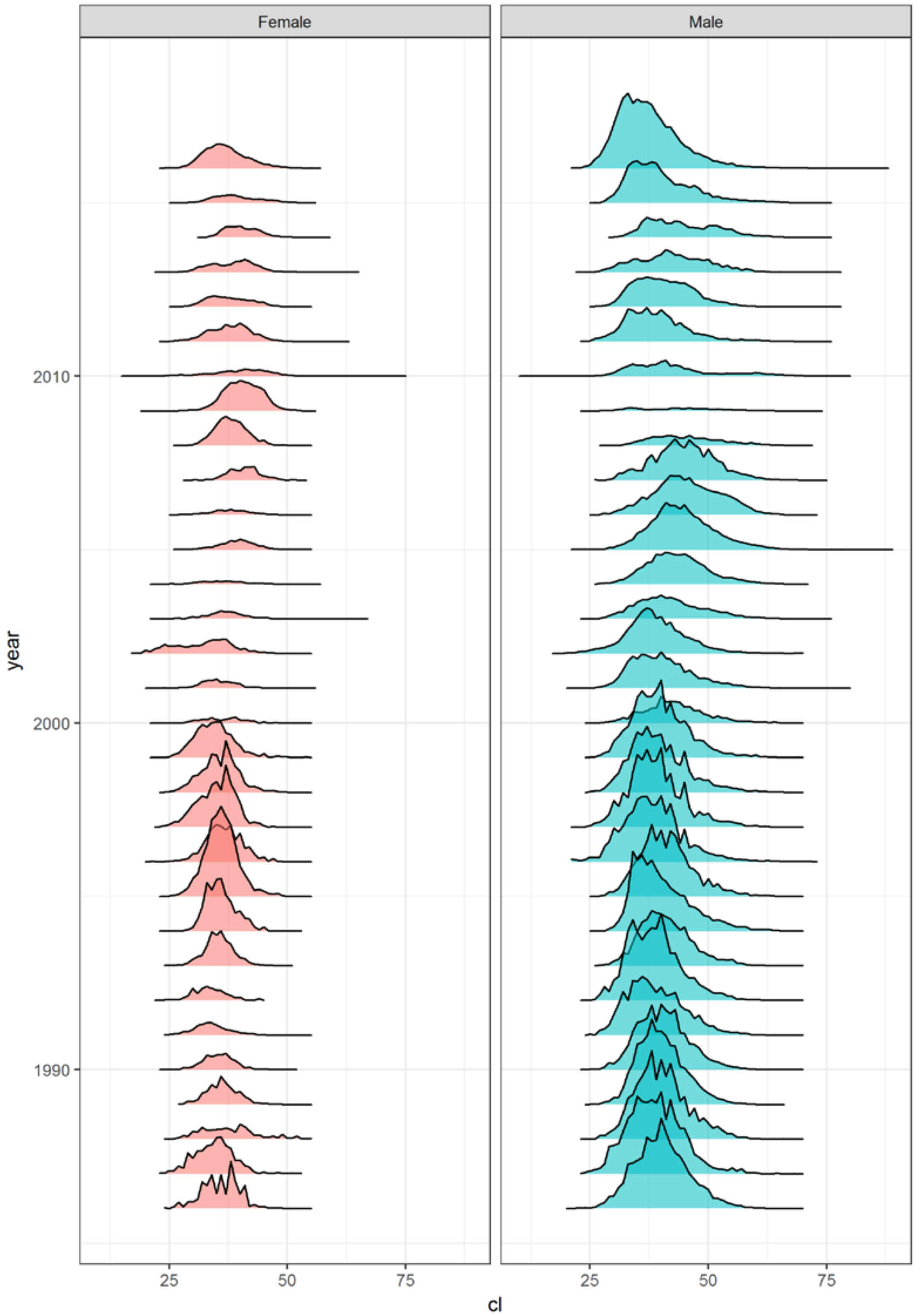


Figure 20.2. *Nephrops* in FU16 (Porcupine Bank). Female and male length distributions of raised international landings.

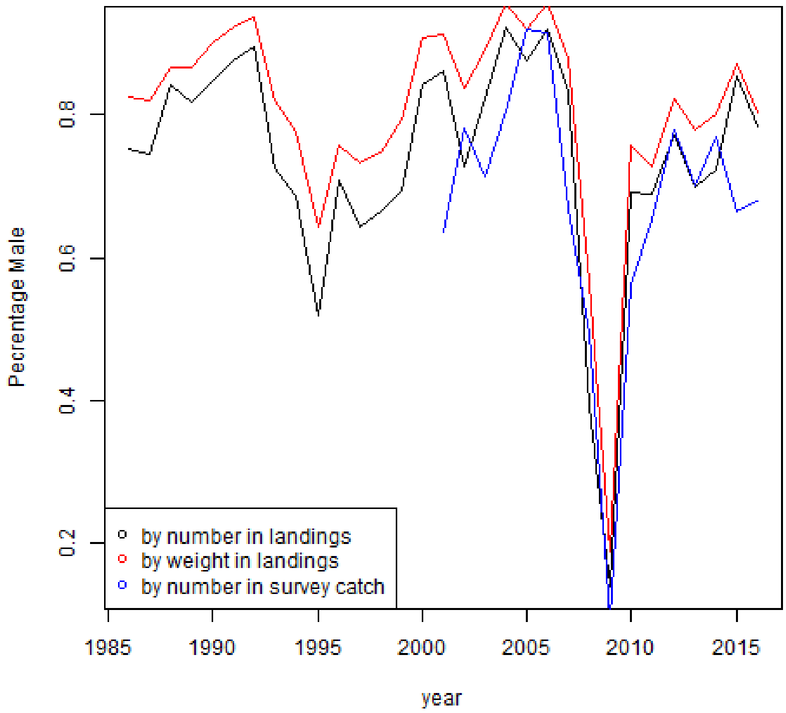


Figure 20.3. ***Nephrops*** **in FU16 (Porcupine Bank). The percentage males in the landings and survey over time.**

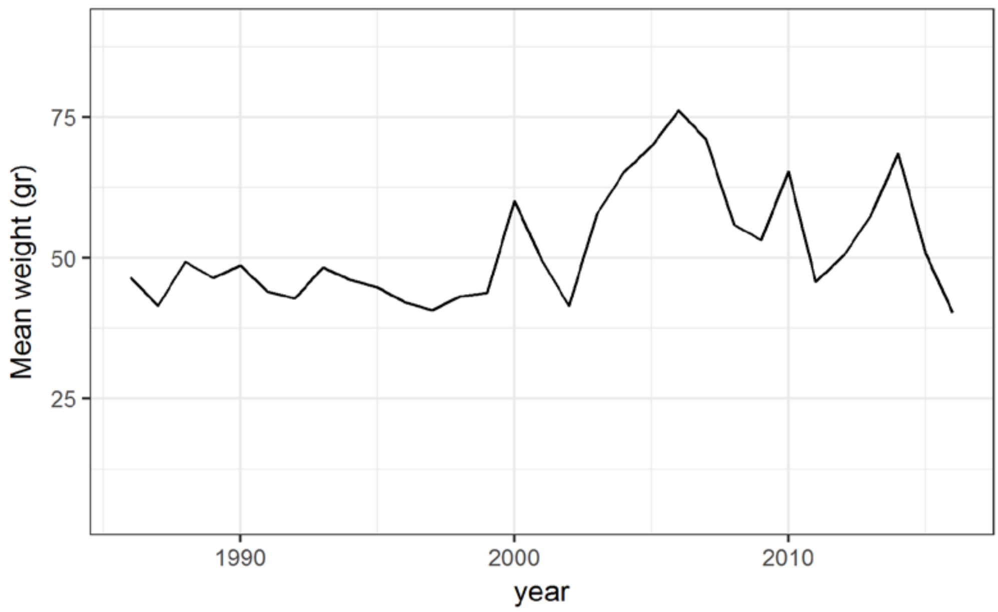


Figure 20.4. ***Nephrops*** **in FU16 (Porcupine Bank). Mean weight in the commercial landings.**

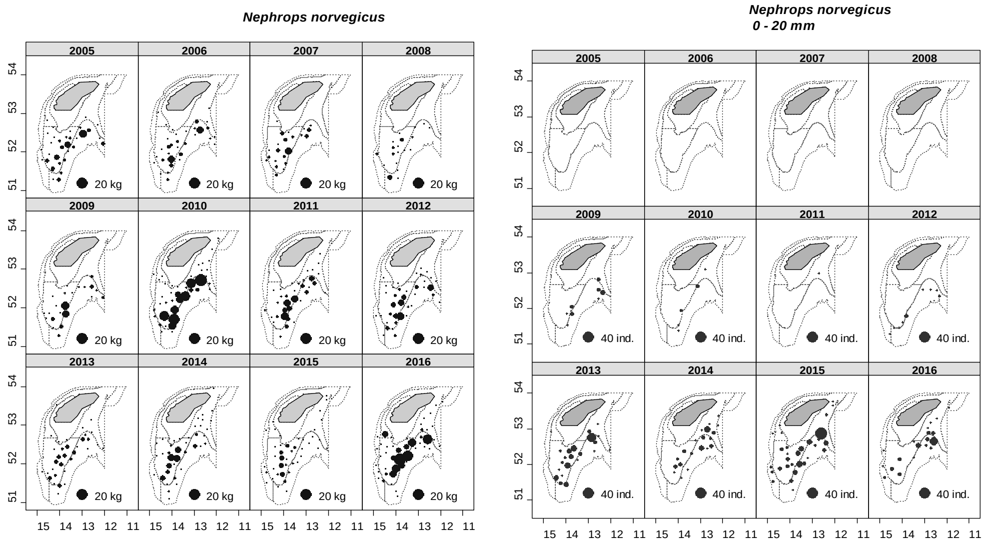


Figure 20.5. ***Nephrops*** **in FU16 (Porcupine Bank). Distribution of** ***Nephrops norvegicus*** **in Porcupine surveys left biomass, right No. juveniles (<20 mm carapace length.)**

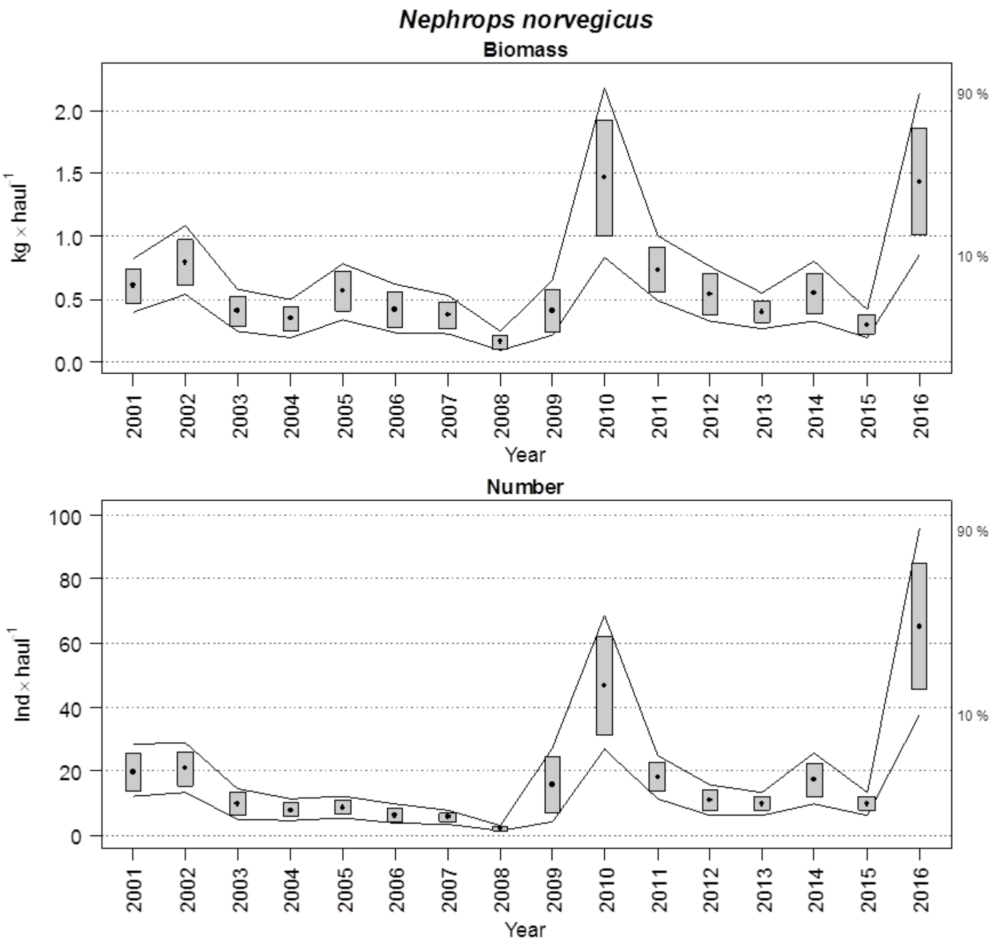


Figure 20.6. ***Nephrops*** **in FU16 (Porcupine Bank). Changes in** ***Nephrops norvegicus*** **biomass and number stratified indices during Porcupine Survey time-series (2001–2016). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α=0.80, bootstrap iterations=1000).**

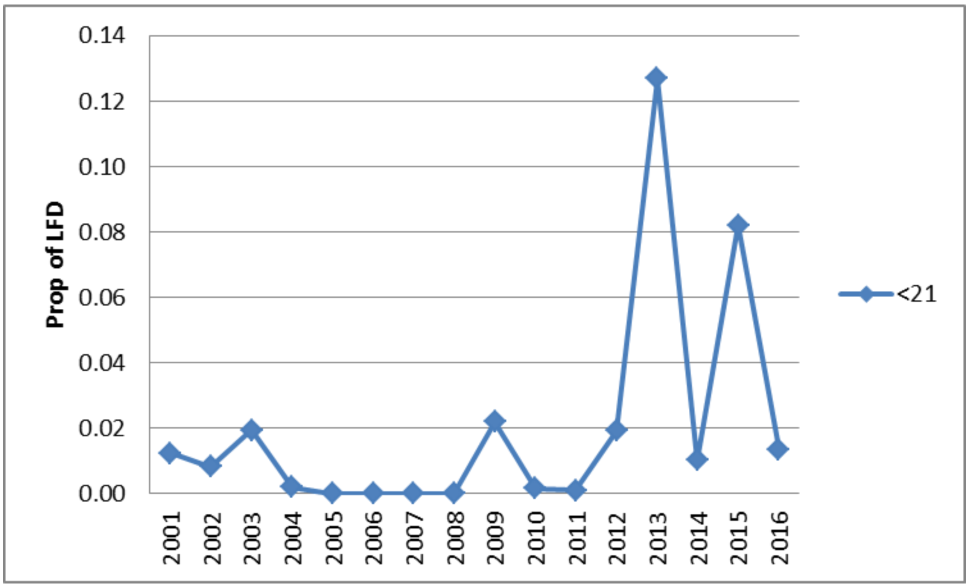


Figure 20.7. Proportion of individuals caught below 21 mm Carapace Length on the Porcupine Survey.

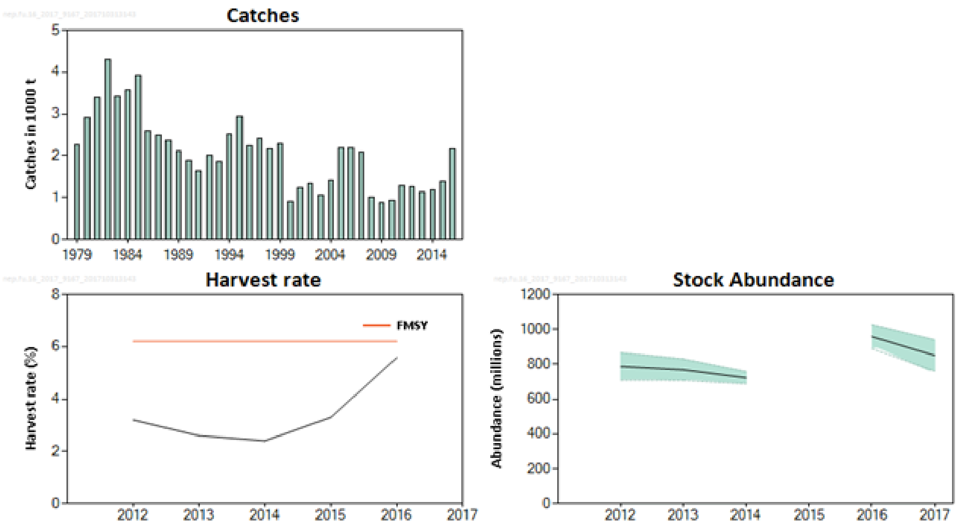


Figure 20.8. Summary of stock status for Porcupine *Nephrops*.

21 Norway lobster (*Nephrops norvegicus*) in Division 7.b, Functional Unit 17 (west of Ireland, Aran grounds)

Type of assessment in 2017

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 2016

"ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 991 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 948 tonnes.

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2017

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 2013–2015, catches in 2017 should be no more than 489 tonnes. This implies landings of no more than 456 tonnes.

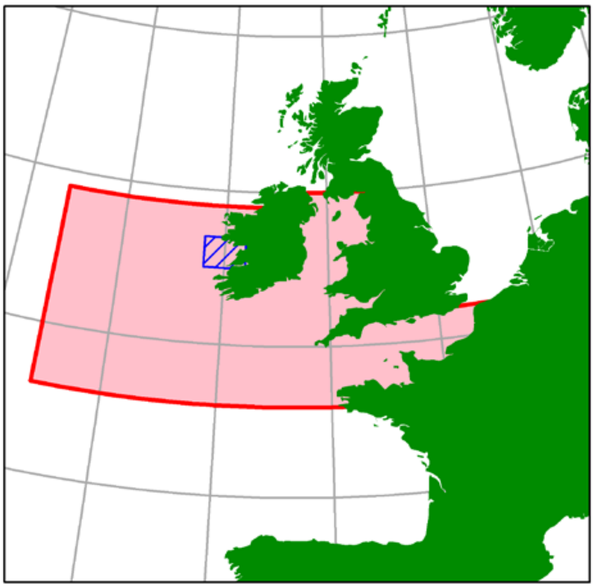
To ensure that the stock in functional unit (FU) 17 is exploited sustainably, management should be implemented at the functional unit level.

21.1 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, 2015).

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 2016

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).

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.

21.2 Data

InterCatch

Data were available in InterCatch and used on a trial basis.

Landings

The reported landings time-series is shown in Figure 21.2.1 and Table 21.2.1. The 2016 landings increased by about 60% from those made in 2015 and amounted to 641 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 which is due to the local management efforts put in place in April and May. In 2016 effort increased to levels observed previously.

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 2016 were good and are comparable to 2015 levels.

Commercial length–frequency distributions

The raised catch length distributions are shown in Figure 21.2.4. The mean size for both sexes from 2008 fluctuate considerably.

Sex ratio

The sex ratio by year is shown in Figure 21.2.5. This shows some fluctuations over time. The sex ratio has a distinct seasonal pattern (Figure 21.2.6) 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 (Figure 21.2.6). This corresponds with the emergence of mature females from the burrows to mate in summer. The annual mean weight estimate for landings and discards is shown in Figure 21.2.7. The mean weight estimates from 2008 fluctuate considerably.

Discarding

Table 21.2.4 gives weights, numbers and mean weights of the landings and discard raised internationally according to the stock annex. 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 (see stock annex).

Abundance indices from UWTV surveys

The spatial extent of the *Nephrops* grounds in FU17 has been re-defined by IBPNeph 2015 and the total abundance estimates have been revised using a new procedure (ICES, 2015). 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 2016 UWTV survey are available (Doyle *et al.*, 2016).

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 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 2016 was mainly towards the middle of the ground.

On average the Aran Grounds account for ~88% of the total estimated burrow abundance from FU17. Galway Bay and Slyne Head account for ~8% and ~2% respectively. The Galway Bay estimates fluctuate widely but appear to be highly correlated with the Aran ground (except 2004). Estimates for the Slyne Head ground also fluctuate considerably but show no significant correlation with the other areas (Figure 21.2.9).

Table 20.2.5 shows the Aran ground abundance estimates and CV (or relative standard error) which is well below (<6%) the recommendation of 20% by SGNEPS (ICES, 2012). The CVs on the abundance estimates for Galway Bay and Slyne Head are also well within the recommendation showing the surveys are precise (Table 21.2.6). Figure 21.2.10 and Table 21.2.7 shows the total abundance estimate for FU17 with the IBPNeph proposed MSY $B_{trigger.}$ The 2016 combined abundance estimate was 32%lower than in 2015 and at 379 million and is 30% below the MSY $B_{trigger}$ (540 million).

21.3 Assessment

Comparison with previous assessments

The WGCSE 2017 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).

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated widely with an overall declining trend. The 2016 estimate is the lowest observed in the time-series and is 30% below the MSY $B_{trigger}$. The 2016 abundance remains below the average of the series (geomean: 696 million). Harvest rate is calculated as (landings + dead discards/abundance estimate). Table 21.3.1.and Figure 21.3.1 summarize recent harvest ratios which have been above the $F_{MSYproxy}$ for the last three years.

21.4 Catch option table

Catch option 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 options.

Variable	Value	Notes
Stock abundance	Available October 2017	UWTV Survey 2017
Mean weight in landings	22.2 g	Average 2008–2016.
Mean weight in discards	11.2 g	Average 2008–2016.
Discard rate	12.9%	Average (proportion by number) 2014–2016. Calculated as discards/(landings + discards).
Discard survival rate	25%	Only applies in scenarios where discarding is allowed.
Dead discard rate	10.0%	Average 2014–2016 (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).

21.5 Reference points

New reference points were defined for this stock at the IBPNeph (ICES, 2015) and no new proposals were made by WKMSYRef4 (ICES, 2016XX; ICESYY). 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 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 should improved data become available.

21.6 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.

21.7 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. Fisheries catching *Nephrops* in Subarea 7 will be covered by the EU landing obligation from 2016 (EC, 2015). *Nephrops* creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 7% discard rate by weight for the trawl fishery in 2016 and 2017. The average discard rate by weight for FU17 over the last three years is 6%. Two different catch options at F_{MSY} have been provided to give some information on the impact of different LO scenarios on catches.

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 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 18).

21.8 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.

21.9 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. 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.

21.10 References

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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
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	0

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

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
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

Table 21.2.4. *Nephrops* in FU17 (Aran Grounds). Raised landings and discard weight and numbers by year.

Year	Landings (t)	Discards (t)	Discards by weight (%)	Landings in number ('000s)	Discards in number ('000s)	Discards by number (%)
2008	1057	248	19%	48,162	22,074	31%
2009	626	129	17%	24,935	9,487	28%
2010	939	224	19%	37,341	15,246	29%
2011	659	92	12%	31,950	8,542	21%
2012	1246	86	6%	61,076	8,292	12%
2013	1295	129	9%	60,016	12,034	17%
2014	766	48	6%	33,882	5,038	13%
2015	370	15	4%	17,693	1,622	8%
2016	641	69	10%	30,231	6,375	17%

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*	0.4	1197	480	4%
	2016	34*	0.29	1197	343	3%

***reduced isometric grid.**

Table 21.2.6. *Nephrops* in FU17 (Galway Bay and Slyne Head). Results summary table for analysis of UWTV survey.

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%
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%
	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	0.3	39.1	10.8	3%

***random stratified estimates are given for the Slyne Head and Galway Bay grounds.**

****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	1069.796	1139.209	1000.383
2003	1246.37	1432.821	1059.92
2004	1409.782	1523.114	1296.45
2005	1091.971	1148.121	1035.822
2006	626.7601	686.7448	566.7755
2007	919.7013	972.1887	867.214
2008	541.1782	572.2073	510.1491
2009	695.6454	724.5324	666.7583
2010	878.5592	916.5185	840.5999
2011	672.1959	710.8391	633.5526
2012	468.2692	504.6183	431.92
2013	441.0297	486.5642	395.4952
2014	383.0244	419.5843	346.4646
2015	555.5154	605.8891	505.1418
2016	379.1418	407.5817	350.7018

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	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
2001	48.7	25.4	67.8	28.2	34.3				912			
2002	54.5	17.7	67.8	19.6	24.5	1070	69	6.30	1152	192	21.2	10.8
2003	44.1	18.3	57.8	23.7	29.3	1246	186	4.60	933	183	21.2	10
2004	29	11.4	37.6	22.9	28.2	1410	113	2.70	525	112	18.1	9.9
2005	42.4	19.7	57.2	25.9	31.7	1092	56	5.20	778	182	18.4	9.2
2006	na	na	49.5*	na	na	627	60	7.90	636	na	na	na
2007	na	na	57.3*	na	na	920	52	6.20	913	na	na	na
2008	48.2	22.1	64.7	25.6	31.4	541	31	12.00	1057	248	21.9	11.2
2009	24.9	9.5	32	22.2	27.6	696	29	4.60	626	129	25.1	13.6
2010	37.3	15.2	48.8	23.4	29.0	879	38	5.60	939	224	25.2	14.7
2011	31.9	8.5	38.4	16.7	21.1	672	39	5.70	659	92	20.6	10.8
2012	61.1	8.3	67.3	9.2	12.0	468	36	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	46	15.70	1295	129	21.6	10.7
2014	33.9	5	37.7	10.0	12.9	383	37	9.80	766	48	22.6	9.6
2015	17.7	1.6	18.9	6.4	8.4	556	50	3.40	370	15	20.9	9.1
2016	30.2	6.4	35.0	13.7	17.4	379	28	9.20	641	69	21.2	10.9
			Average 14–16	**10.0**	**12.9**					**Average 08–16**	**22.2**	**11.2**

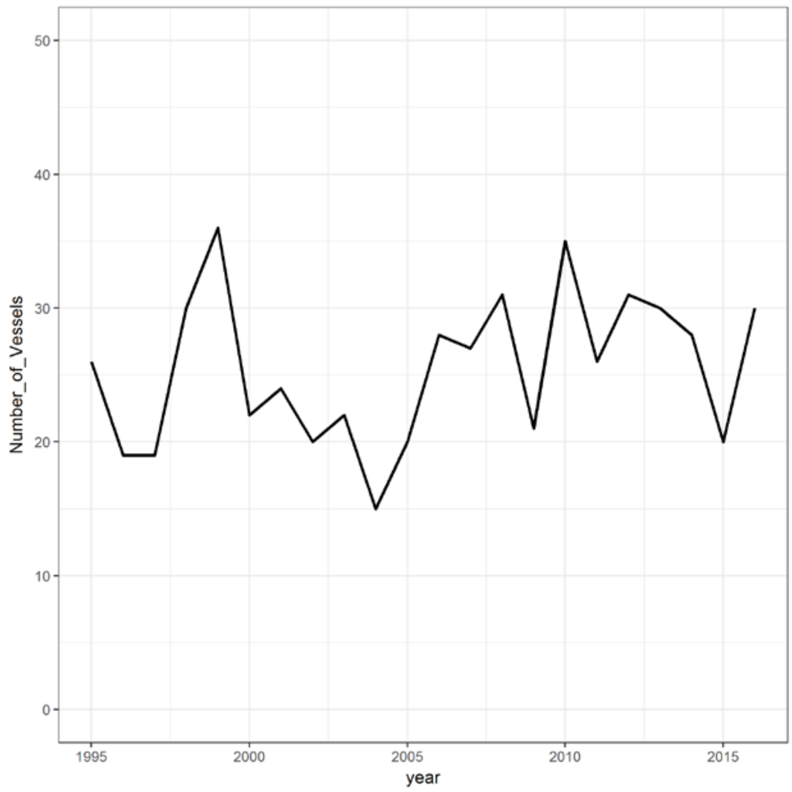


Figure 21.1.1. ***Nephrops*** **in FU17 (Aran Grounds). Time-series of the number of Irish vessels reporting landings of** ***Nephrops*** **from FU17 with a >10 t threshold.**

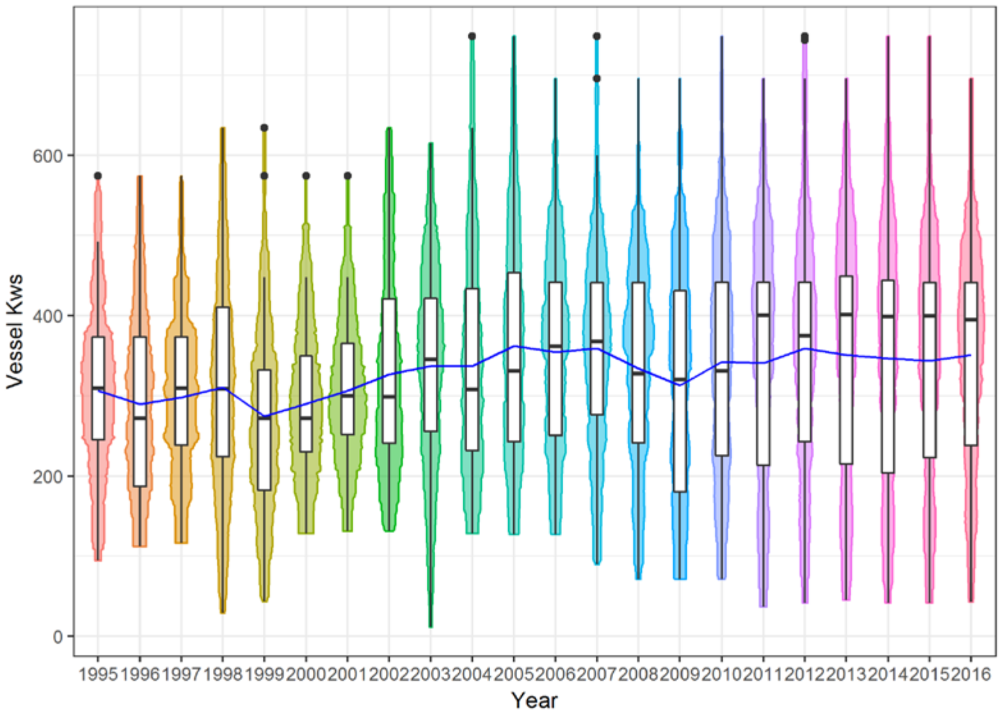


Figure 21.1.2. ***Nephrops*** **in FU17 (Aran Grounds). Combined box and kite plot of vessel power on the Aran Grounds by year. The blue line indicates the mean.**

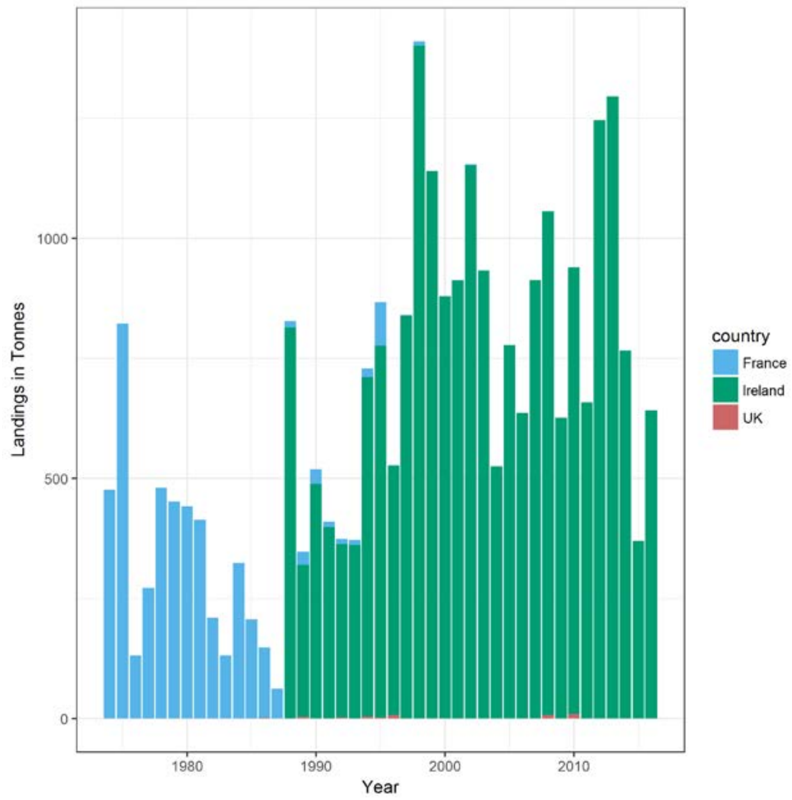


Figure 21.2.1. ***Nephrops*** **in FU17 (Aran Grounds). Landings in tonnes by country.**

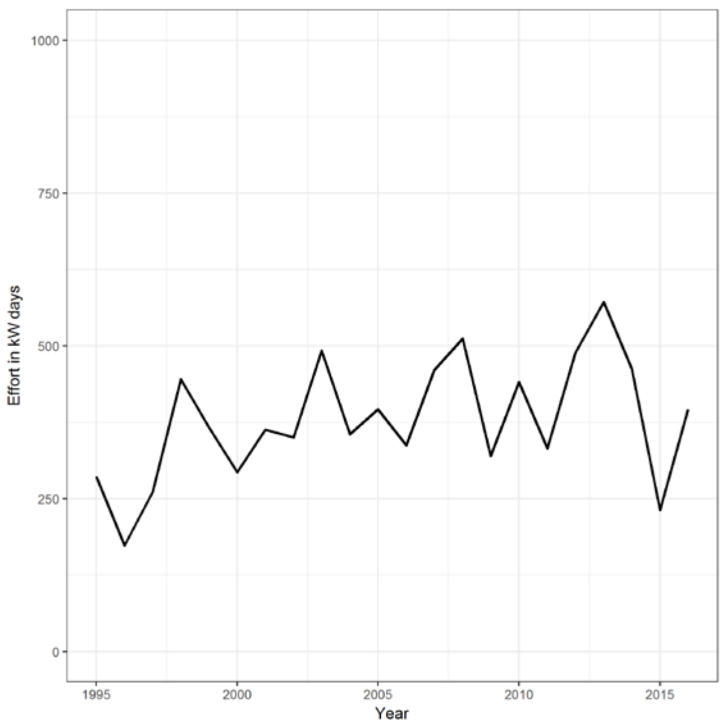


Figure 21.2.2. ***Nephrops*** **in FU17 (Aran Grounds). Effort data (KW days) for Irish directed** ***Nephrops*** **fleet.**

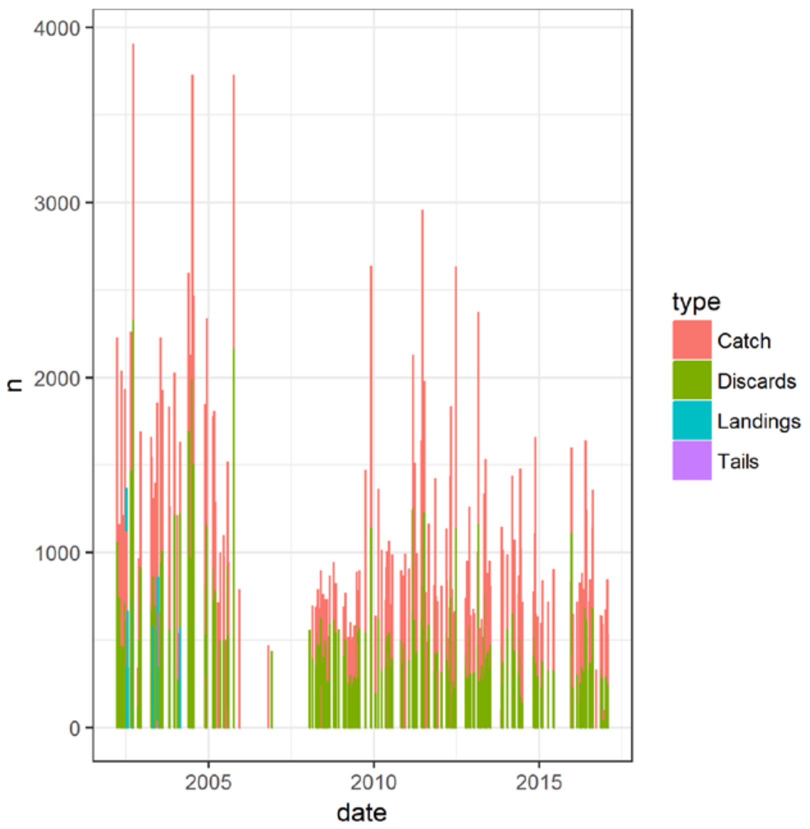


Figure 21.2.3. ***Nephrops*** **FU17 (Aran Grounds).Sampling levels for the Aran grounds.**

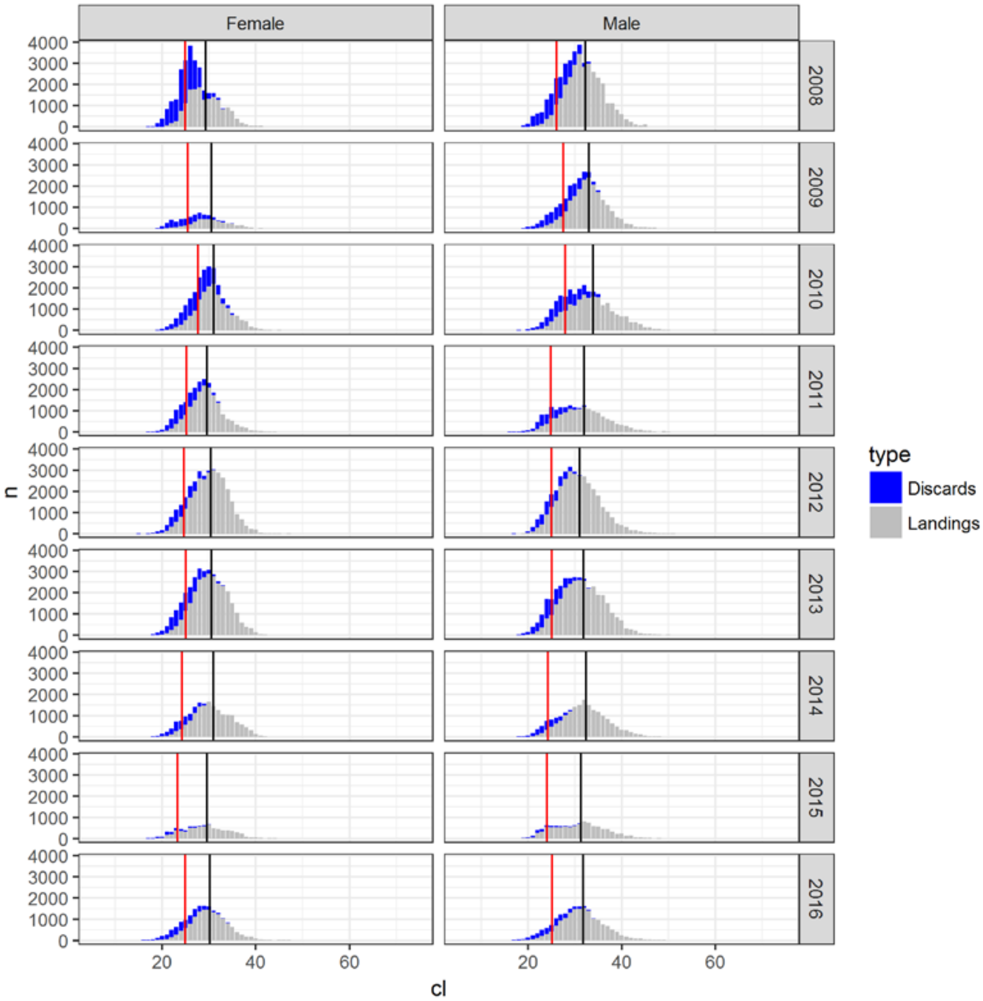


Figure 21.2.4. *Nephrops* FU17 Aran Grounds. Annual length composition of landings (grey) and discards (blue) for males (right) and females (left) from 2008 (top) to 2016 (bottom). Mean sizes of landings (black vertical line) and discards (red vertical line) are also shown.

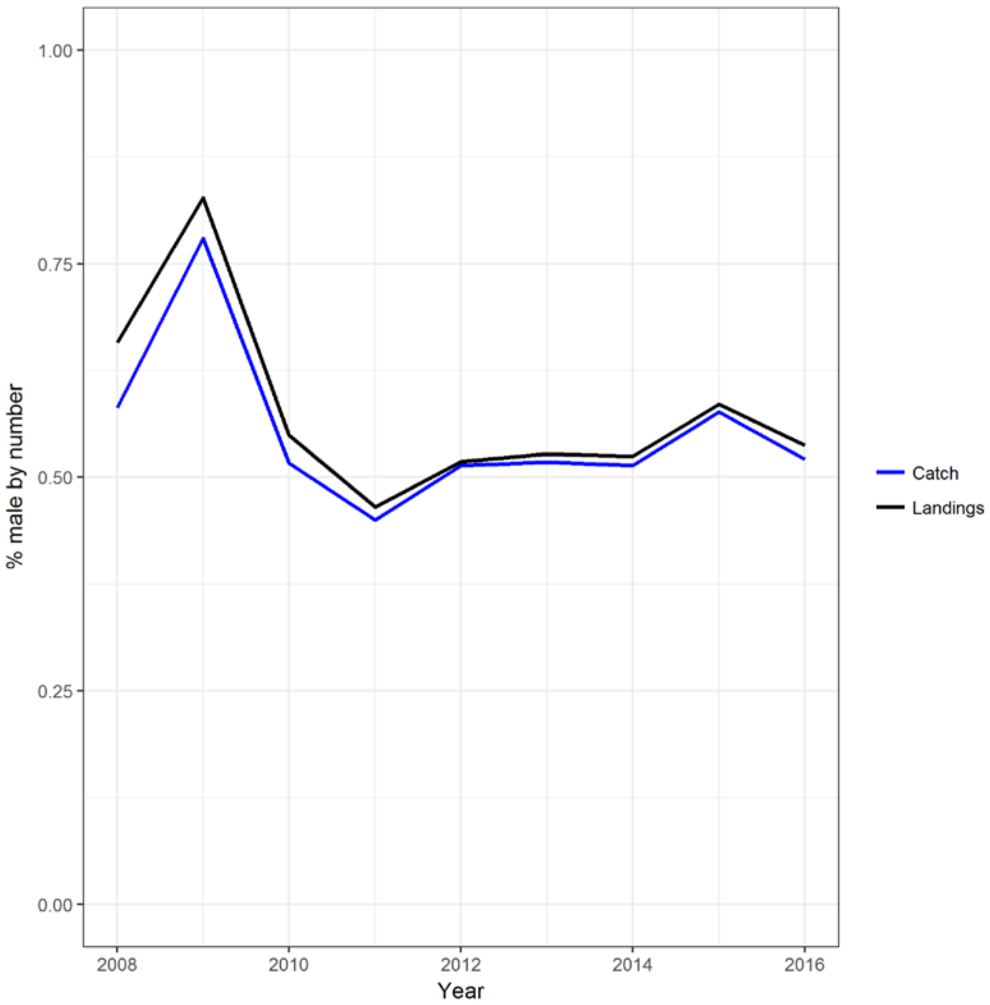


Figure 21.2.5. ***Nephrops*** **FU17 (Aran Grounds). Annual sex ratio of landings (2008–2016) and catch (2008–2016).**

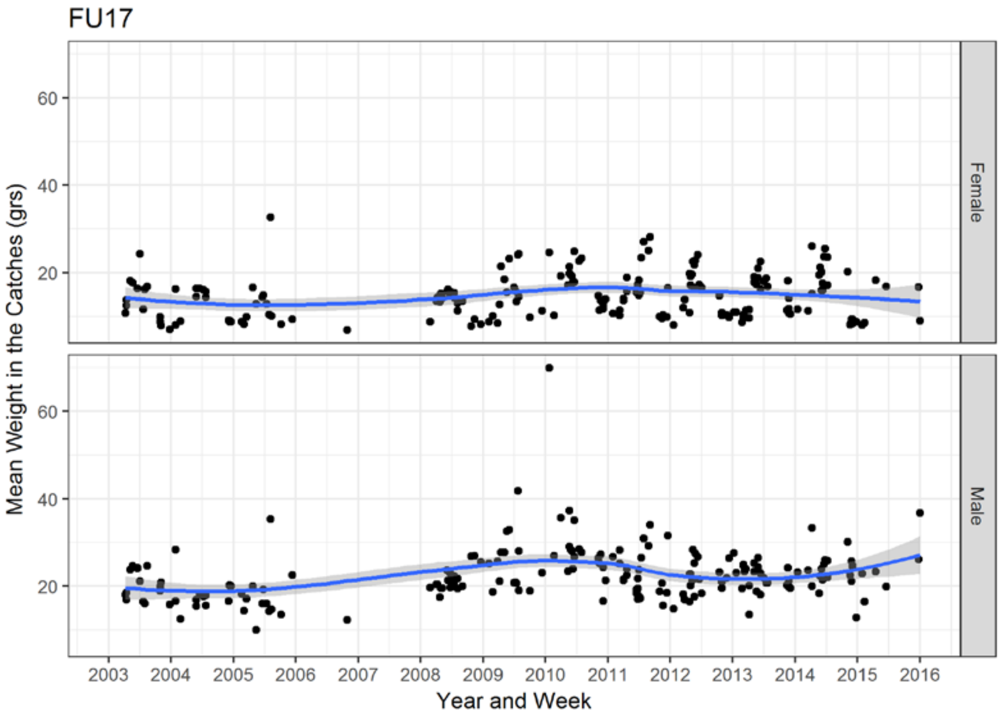


Figure 21.2.6. ***Nephrops*** **FU17 (Aran Grounds). Mean weight in catch samples by sex showing cyclical trends.**

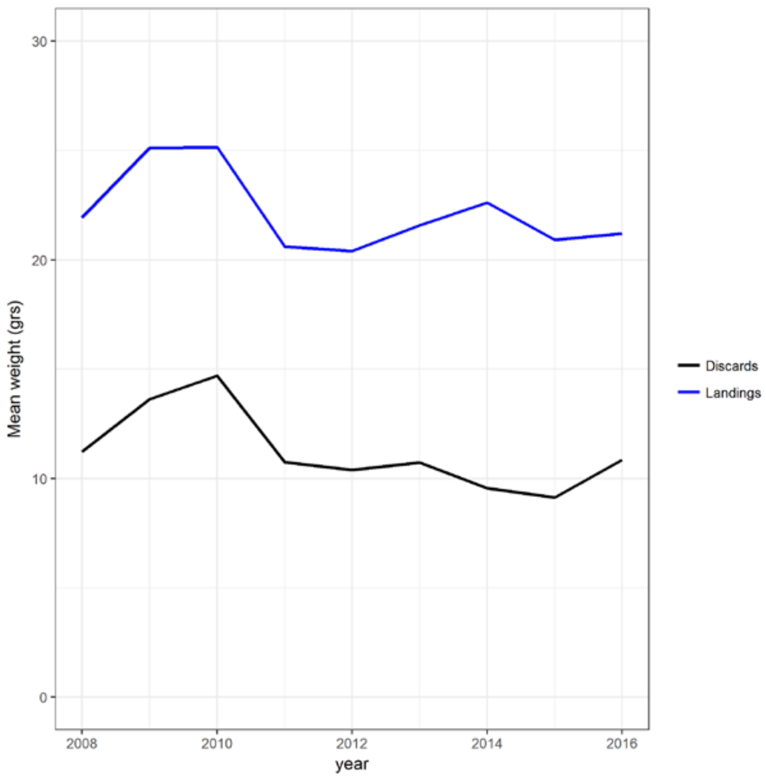


Figure 21.2.7. ***Nephrops*** **FU17 (Aran Grounds). Annual mean weight (gr) estimates of landings and discards.**

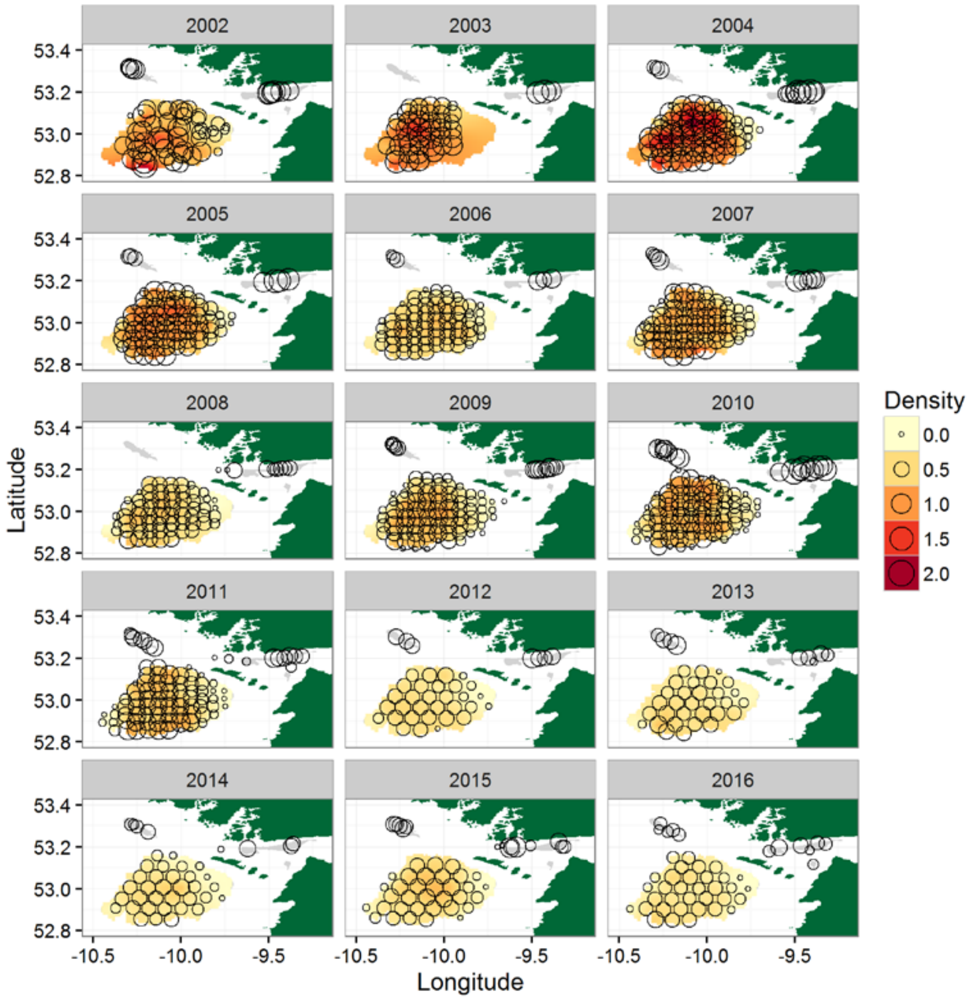


Figure 21.2.8. ***Nephrops*** **in FU17 (Aran Grounds). Contour plots of the krigged density estimates for the Aran Ground UWTV surveys from 2002 (top left) to 2016 (bottom right).**

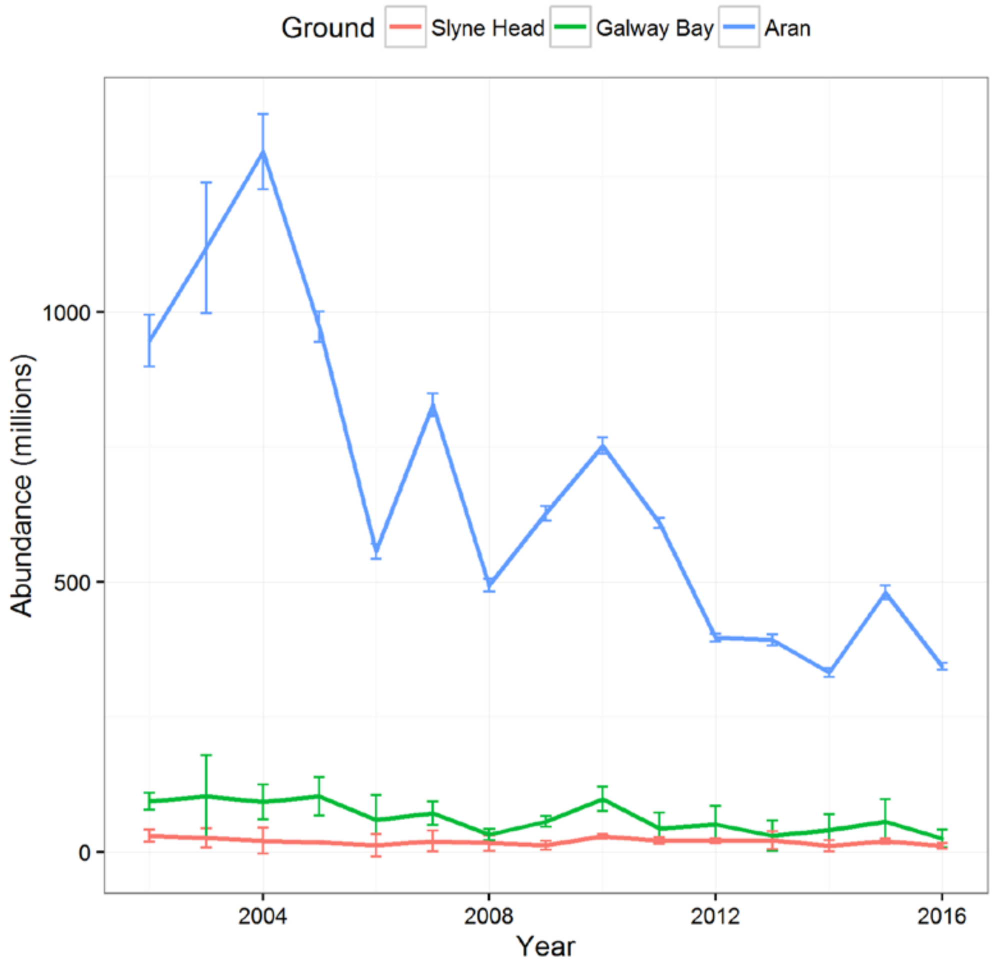


Figure 21.2.9. ***Nephrops*** **FU17 Aran Grounds.** ***Nephrops*** **burrow estimates in FU17 Aran, Galway Bay and Slyne Head grounds 2002–2016.**

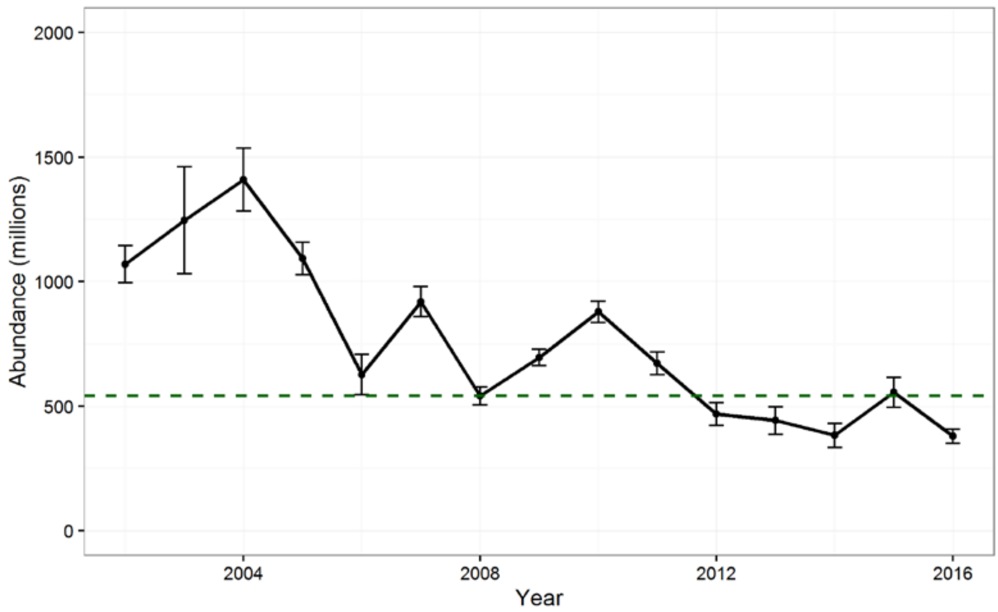


Figure 21.2.10. Time-series of total abundance estimates for FU17 (error bars indicate 95% confidence intervals) and $B_{trigger}$ is dashed green line.

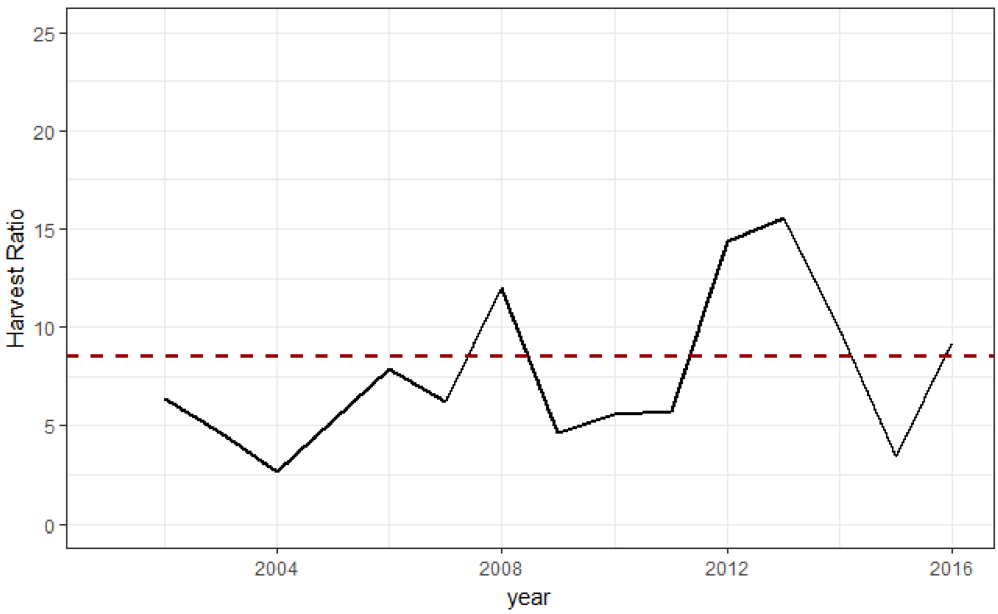


Figure 21.3.1. *Nephrops* FU17 Aran Grounds. Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.

22 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 2017

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 2016

"ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 793 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 618 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 2017

"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 2013–2015, catches in 2017 should be no more than 838 tonnes. This implies landings of no more than 599 tonnes.

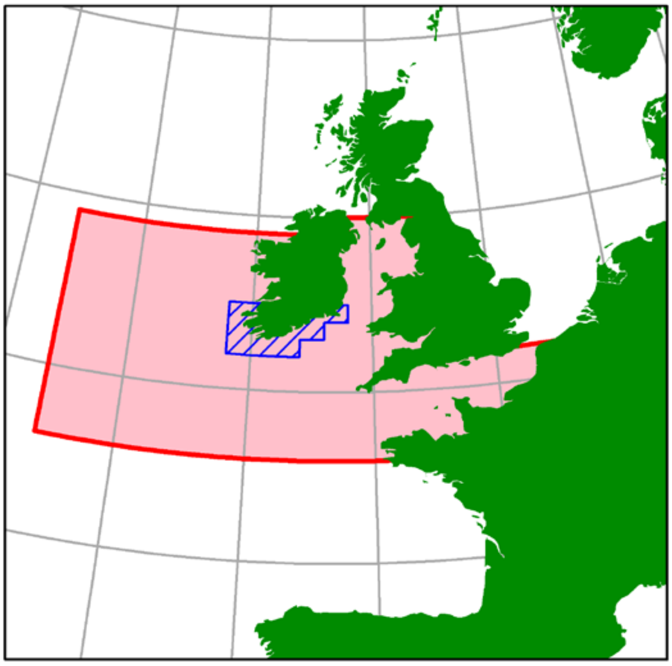
To ensure that the stock in functional unit (FU) 19 is exploited sustainably, management should be implemented at the functional unit level."

22.1 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 21.1.1). 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 21.1.2. 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 22.1.3.

Fishery in 2016

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 2016.

Information from stakeholders

None available.

22.2 Data

InterCatch

All data were available in InterCatch and used on a trial basis.

Landings

Landings data for FU19 are summarized in Table 22.2.1. The Republic of Ireland, France and the UK report landings for FU19. 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 2016 landings increased by approximately 14% 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. 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 2016. Landings from the UK are minor at 3 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 1995–2016 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 2015 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 2016 were good and are comparable to 2015 levels.

Commercial length-frequency distributions

Length–frequency data of the landings were collected on a regular basis 2002 to 2016. 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 has 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 2016 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 mean weight estimates show a slight increase.

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 was not revised as was considered to be not of good enough quality. The 2016 catch data were split using this selection ogive.

Discard rates range between 25–86% of total catch by weight and 41–80% 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 practiced 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.

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 and are documented by WKNEPHTV (ICES, 2007), WKNEPHBID (ICES, 2008), SGNEPS (ICES, 2009; 2010; 2012) and WGNEPS (ICES, 2013; 2014; 2015, 2016). 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 2016 an average of 38 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. In 2015 and 2016 a new patch Kenmare Bay was surveyed. Operational details of the 2016 UWTV survey are available (WGNEPS, 2016).

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 2016 all discrete grounds were covered by the TV survey and also two stations on a new patch Kenmare Bay (Lordan *et al.*, 2015). The 2016 mean density estimates adjusted vary between patches from 0.07 (no./m²) observed at Helvick 2 to 0.53 (no./m²) at Galley ground 2 (Table 22.2.6, Figure 22.2.9) whereas in 2015 the lowest density was also observed at Cork Channels (0.08 no./m²) and the highest at Galley ground 2 (0.53 no./m²). The overall mean density for FU19 in 2016 is 0.20 (no./m²) (Table 22.2.7) which is the lowest observed in the time-series.

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 2016 abundance estimate was 18% lower than in 2015 and at 399 million and is below the MSY $B_{trigger}$ (430 million) with a RSE of 13% 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 2003–2016 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.

22.3 Assessment

Comparison with previous assessments

The WGCSE 2017 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 2016 estimate is the lowest observed and is below the MSY $B_{trigger}$. The 2016 abundance remains below the average of the series (geomean: [2011–2016]: 568 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.

22.4 Catch option table

Catch option 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	Available October 2017	UWTV survey 2017
Mean weight in landings	29.4 g	Average 2014–2016
Mean weight in discards	14.0 g	Average 2014–2016
Discard rate	41.6%	Average 2014–2016 (by number). Calculated as discards divided by landings + discards.
Discard survival rate	25%	Only applies in scenarios where discarding is allowed.
Dead discard rate	34.9%	Average 2014–2016 (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 2017 UWTV survey. This will be presented in October 2017 for the provision of advice.

22.5 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.**

22.6 Management strategies

No specific management plan exists for this stock.

22.7 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 2014–2016 are used although there is some variability of these over time.

Fisheries catching *Nephrops* in Subarea 7 will be covered by the EU landing obligation from 2016 (EC, 2015). *Nephrops* creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 7% discard rate by weight for the trawl fishery in 2016 and 2017. The average discard rate by weight for FU19 over the last three years is 25%. Two different catch options at F_{MSY} have been provided to give some information on the impact of different LO scenarios on catches.

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 2016 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 13% 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).

22.8 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.

22.9 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. A new survey point should be available by September 2017 which will provide a more up to date prognosis of stock status. This up to date survey information will be used to generate catch options and the provision of advice in October 2017.

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).

22.10 References

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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	805	15	866
2009	55	764	15	833
2010	14	694	13	722
2011	23	585	1	608
2012	11	758	1	770
2013	4	771	6	781
2014	6	459	3	468
2015	5	502	0	507
2016	4	583	3	590

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	
	Effort Kw Days	Landings Tonnes	Effort Kw Days	Landings Tonnes
1995	221,983	380	80,747	121
1996	178,640	355	55,593	86
1997	160,996	306	53,874	101
1998	329,624	498	144,552	189
1999	182,895	236	42,316	47
2000	141,987	217	56,157	86
2001	193,345	397	89,138	139
2002	506,728	883	323,726	446
2003	555,871	693	318,793	364
2004	488,143	558	303,025	311
2005	404,965	471	220,589	219
2006	424,189	478	208,822	186
2007	558,838	713	287,410	262
2008	534,101	643	288,083	319
2009	471,984	613	224,503	243
2010	382,164	494	103,654	114
2011	337,328	449	142,898	167
2012	355,468	541	91,897	126
2013	336,133	571	88,553	133
2014	213,561	332	52,124	74
2015	244,554	393	85,536	118
2016	287,307	558	111,207	233

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 22.2.4. ***Nephrops*** **in FU19 (SW and SE Ireland). Landings and discard weight and numbers by year and sex.**

	Female		Male		Both sexes
Year	Landings (t)	Discards (t)	Landings (t)	Discards (t)	% Discard
2008	99	29	691	68	86%
2009	117	106	681	141	79%
2010	138	98	522	148	74%
2011	155	135	425	235	69%
2012	180	183	579	232	69%
2013	272	203	500	197	59%
2014	106	71	354	86	26%
2015	78	69	424	107	26%
2016	154	91	429	100	25%
	Female Numbers '000s		Male Numbers '000s		Both sexes
Year	Landings	Discards	Landings	Discards	% Discard
2008	3892	1777	19 520	3254	80%
2009	5816	8248	20 324	8793	39%
2010	6271	8144	15 996	10 116	45%
2011	7273	12 161	15 935	17 167	56%
2012	8670	15 869	20 129	16 654	53%
2013	12 087	17 833	16 118	15 191	54%
2014	4,862	5,647	11,183	5,572	41%
2015	3,697	5,738	13,187	7,012	43%
2016	6,877	6,761	12,610	6,668	41%

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	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

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	No Survey Data						
2008							
2009							
2010							
2011	35	0.34	0.26	665	842	488	13%
2012	40	0.30	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	0.20	482	612	352	13%
2016	42	0.20	0.17	399	501	296	13%

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	9	7	na	na	na	741	37	28.3	14.4
2007	30.8	1.5	31.9	5	4	na	na	na	957	26	31.1	17
2008	25.7	5.5	29.8	18	14	na	na	na	866	107	33.7	19.3
2009	27.3	17.8	40.6	39	33	na	na	na	833	258	30.5	14.5
2010	24.4	20	39.3	45	38	na	na	na	722	269	29.6	13.5
2011	24.3	30.7	47.3	56	49	665	171	7.10	608	387	25	12.6
2012	29.2	33	54	53	46	594	111	9.10	770	420	26.4	12.7
2013	28.5	33.4	53.6	54	47	487	161	11.00	781	404	27.4	12.1
2014	16.4	11.4	24.9	41	34	636	188	3.90	468	161	28.6	14.1
2015	17	12.9	26.7	43	36	482	126	5.50	507	177	29.8	13.8
2016	19.7	13.6	30	41	34	399	100	7.50	591	194	29.9	14.2
			Average 14–16	**41.6**	**34.9**					Average 14–16	**29.4**	**14.0**

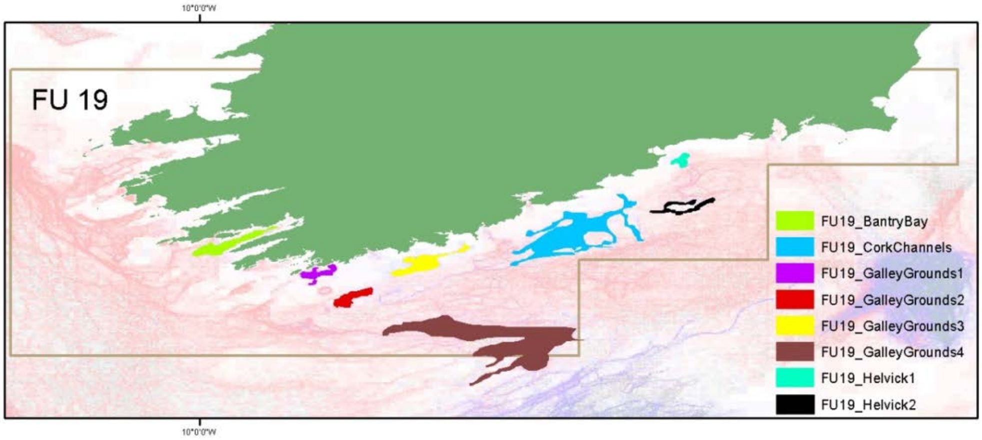


Figure 22.1.1. *Nephrops* in FU19 (Ireland SW and SE Coast). Revised discrete patches overlaid on overlaid on proportion of *Nephrops* in the Irish landings overlaid on international OTB effort (red=0% *Nephrops*; blue=50–60% *Nephrops*; grey=unknown (no Irish landings).

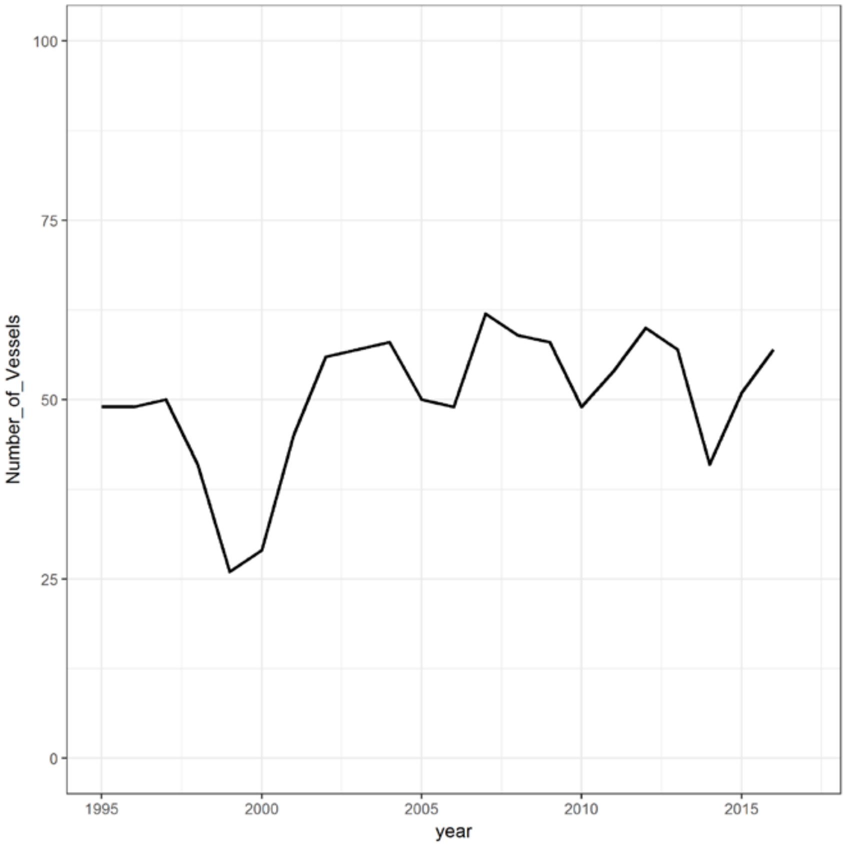


Figure 22.1.2. *Nephrops* in FU19 (Ireland SW and SE Coast). Time-series of the number of Irish vessels reporting landings of *Nephrops* from FU19 with a >10 t threshold.

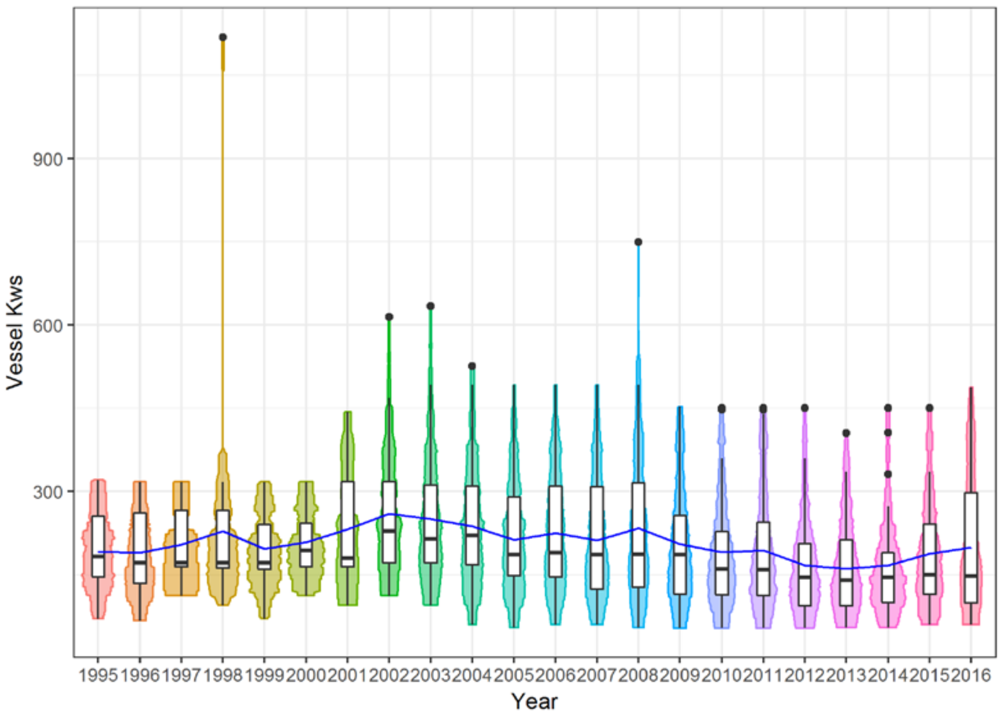


Figure 22.1.3. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Combined box and kite plot of vessel power by year. The blue line indicates the mean.**

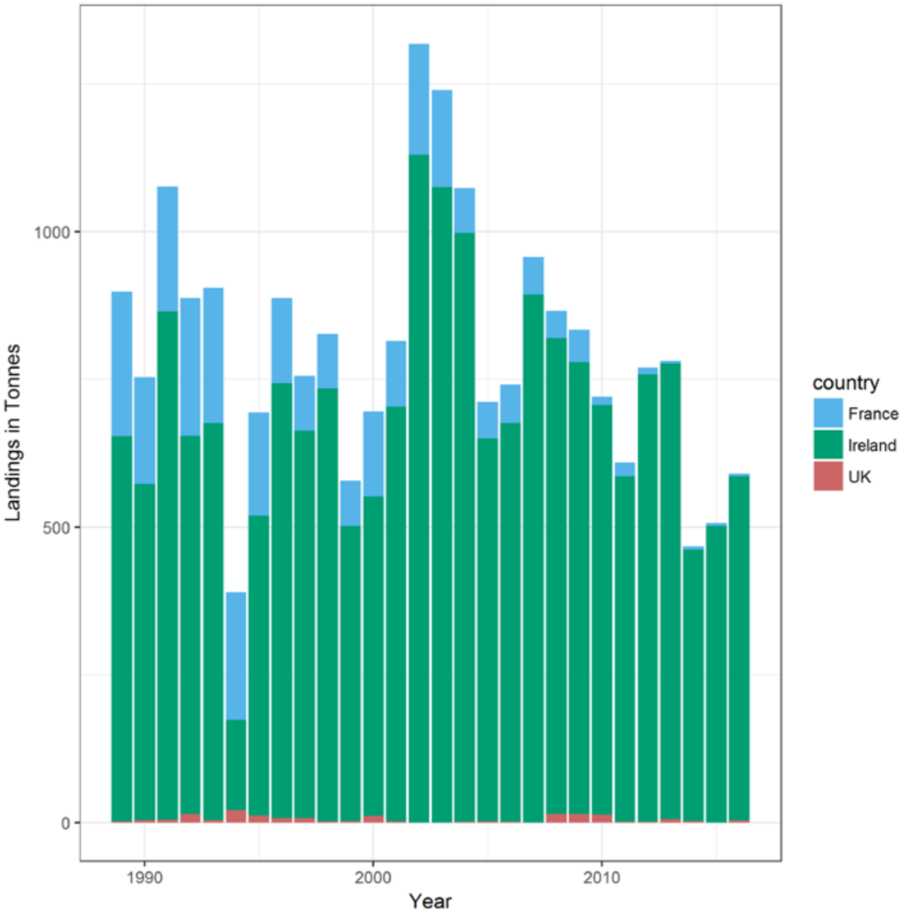


Figure 22.2.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Landings in tonnes by country.**

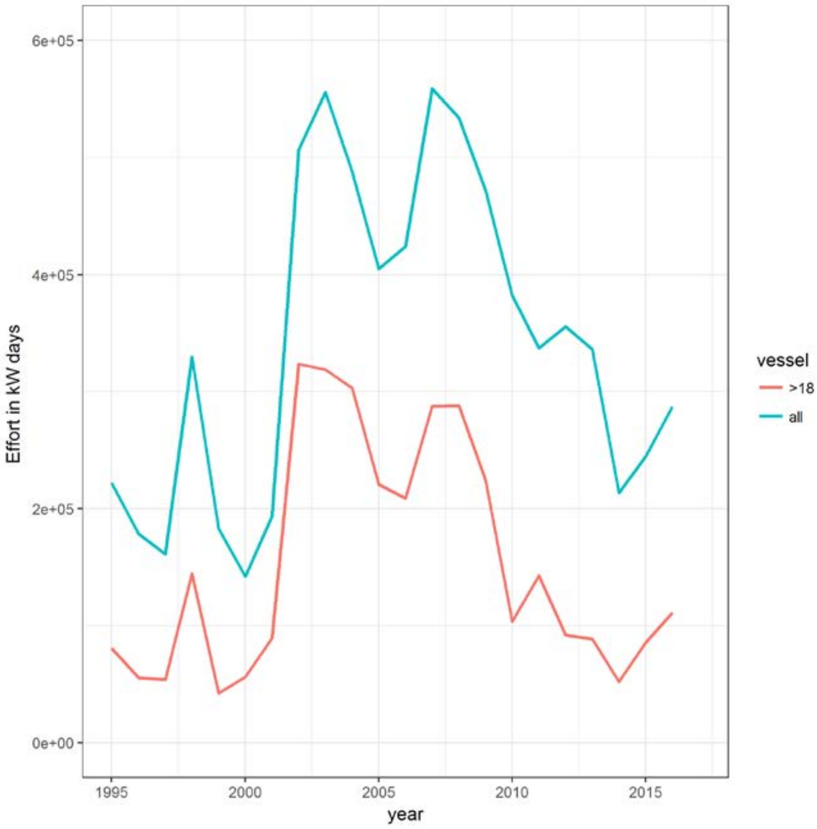


Figure 22.2.2. *Nephrops* in FU19 (Ireland SW and SE Coast). Trawl effort for Irish OTB vessels where >30% of landed weight was *Nephrops*.

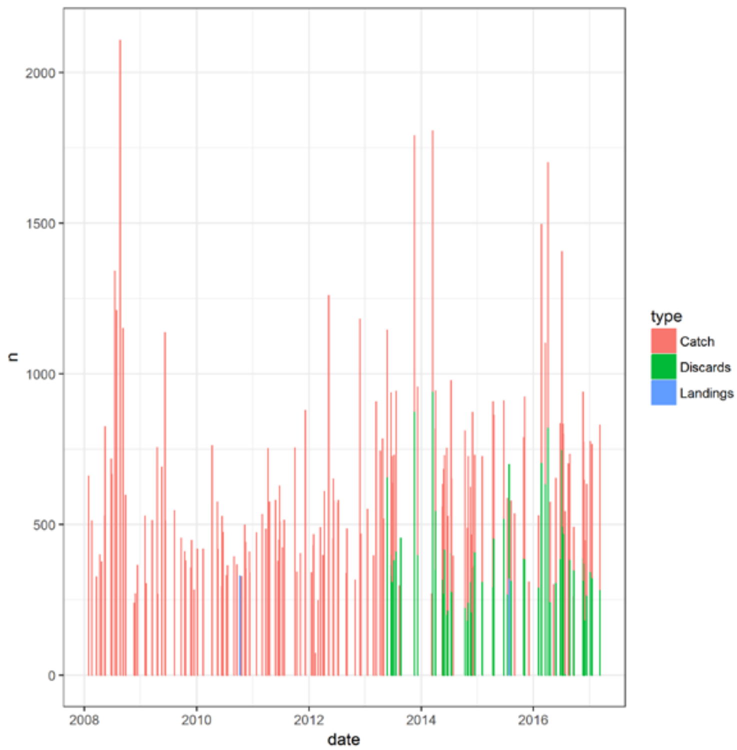


Figure 22.2.3. *Nephrops* in FU19 (Ireland SW and SE Coast). Sampling levels for FU19.

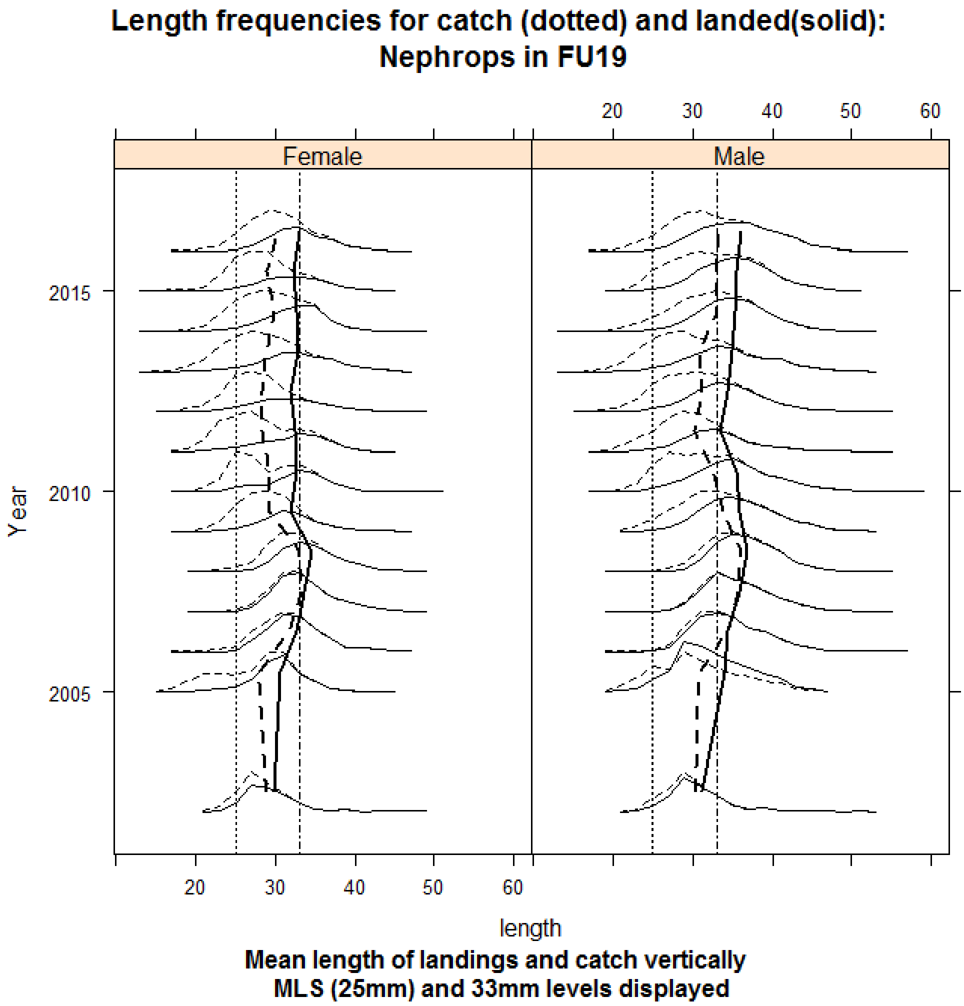


Figure 22.2.4. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches and whole landings by sex 2002–2016.**

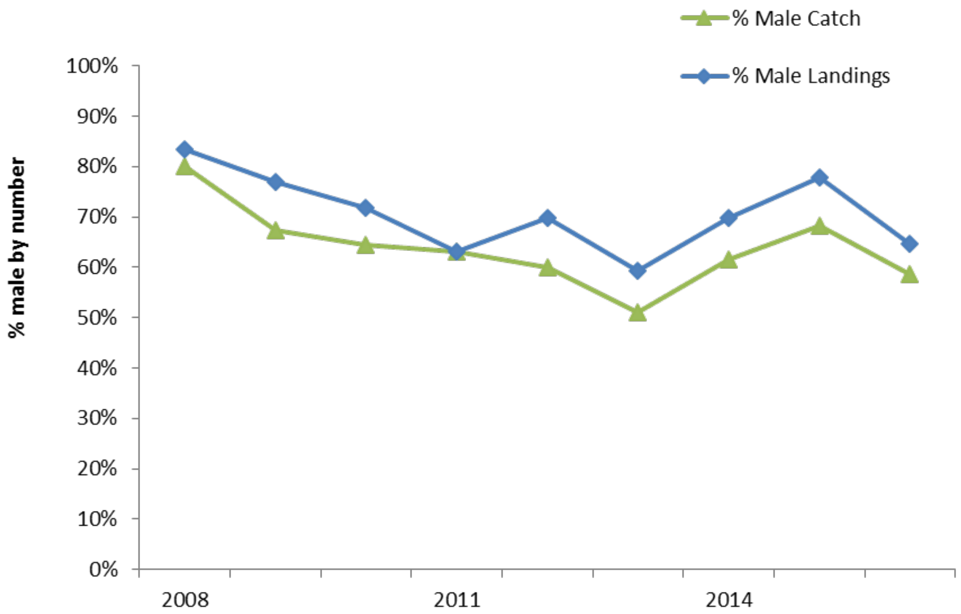


Figure 22.2.5. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Annual sex ratio of landings (2008–2016) and catch (2008–2016).**

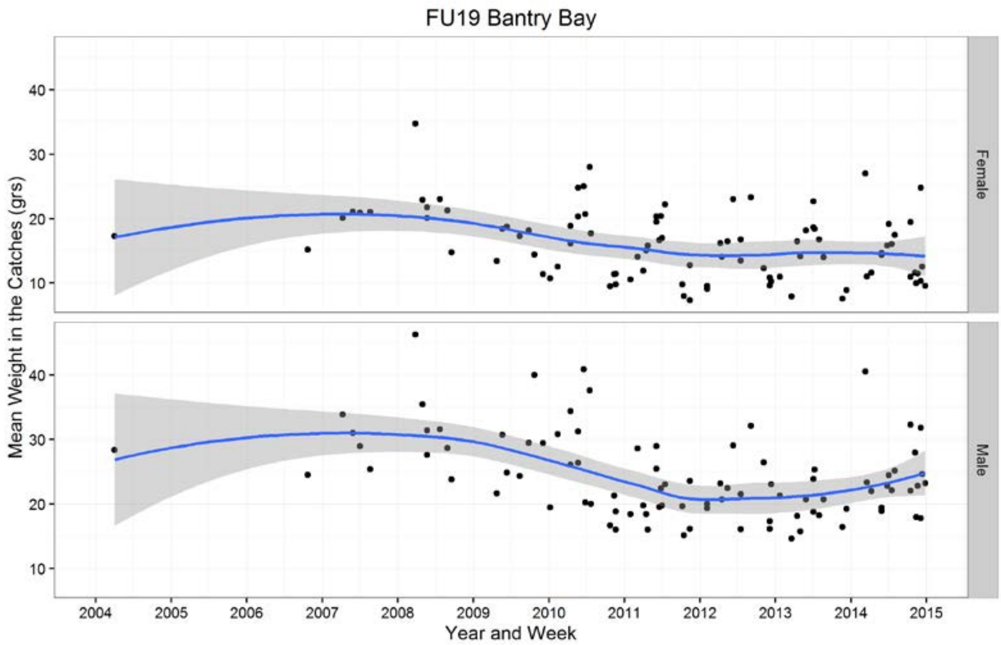


Figure 22.2.6. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean weight in Bantry Bay catch samples by sex with loess smoother and showing cyclical trends.**

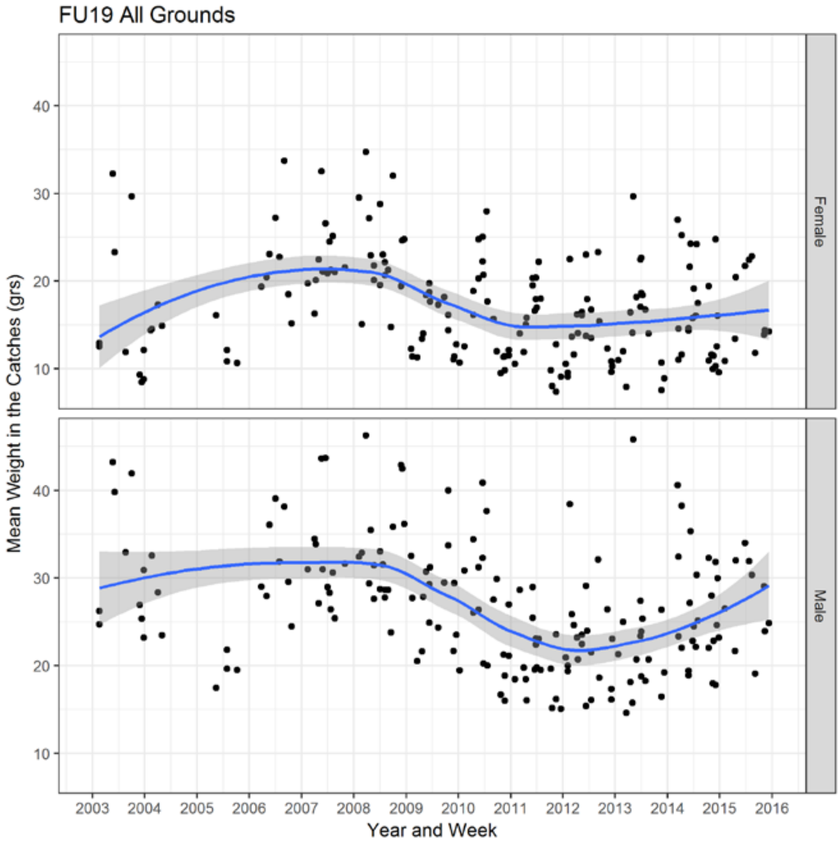


Figure 22.2.7. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean weight in catch data for all grounds in FU19 by sex with loess smoother and showing cyclical trends.**

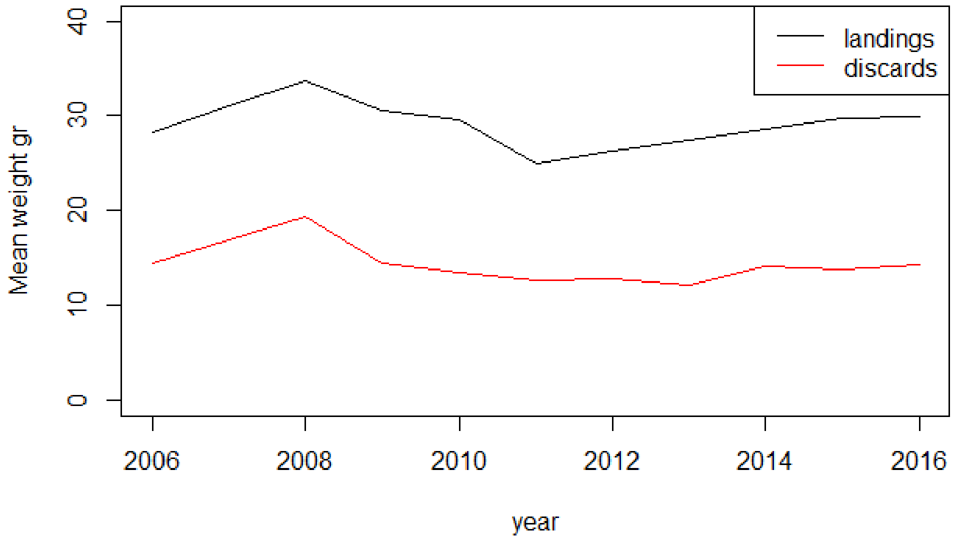


Figure 22.2.8. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Annual mean weights (gr) in the landings and discards.**

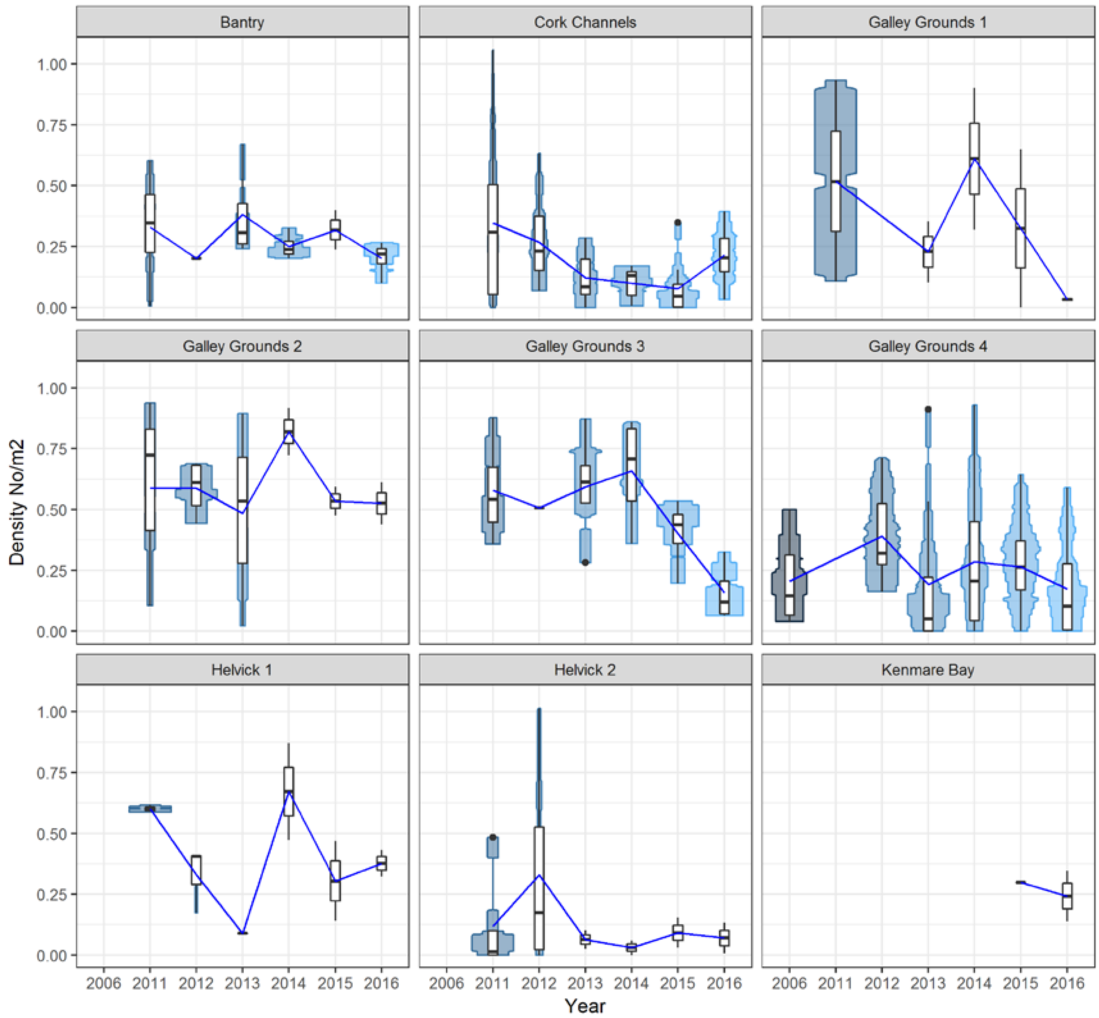


Figure 22.2.9. *Nephrops* in FU19 (Ireland SW and SE Coast). Violin and box plot a of adjusted burrow density (burrow/m²) distributions by year from 2006–2016. The blue line indicates the mean density over time. The horizontal black line represents the median, white box is the inter quartile range, the black vertical line is the range and the black dots are outliers. No estimate available for Galley Ground 4 in 2011, Galley Ground 1 in 2012. No TV survey from 2007 to 2010.

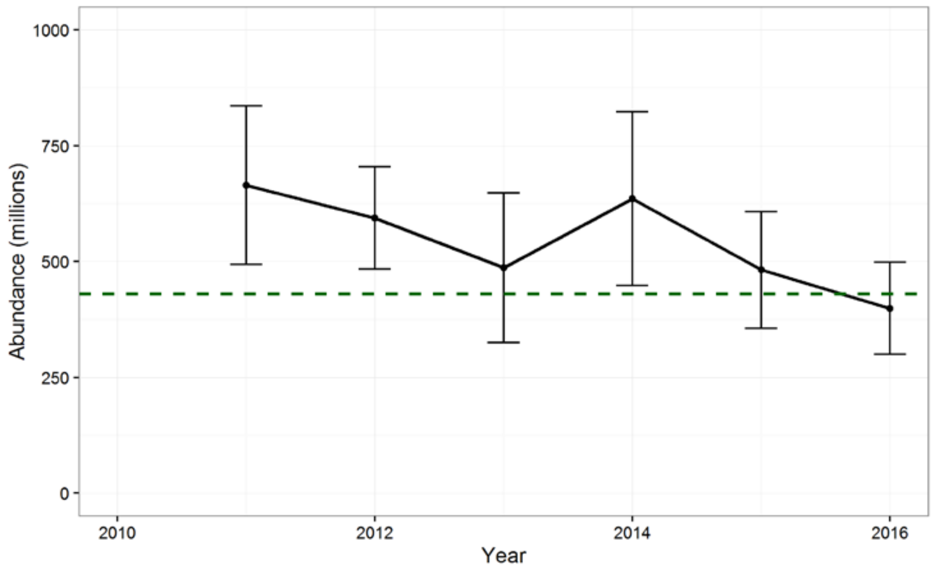


Figure 22.2.10. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Time-series of total abundance estimates for FU17 (error bars indicate 95% confidence intervals) and $B_{trigger}$ is dashed green line.**

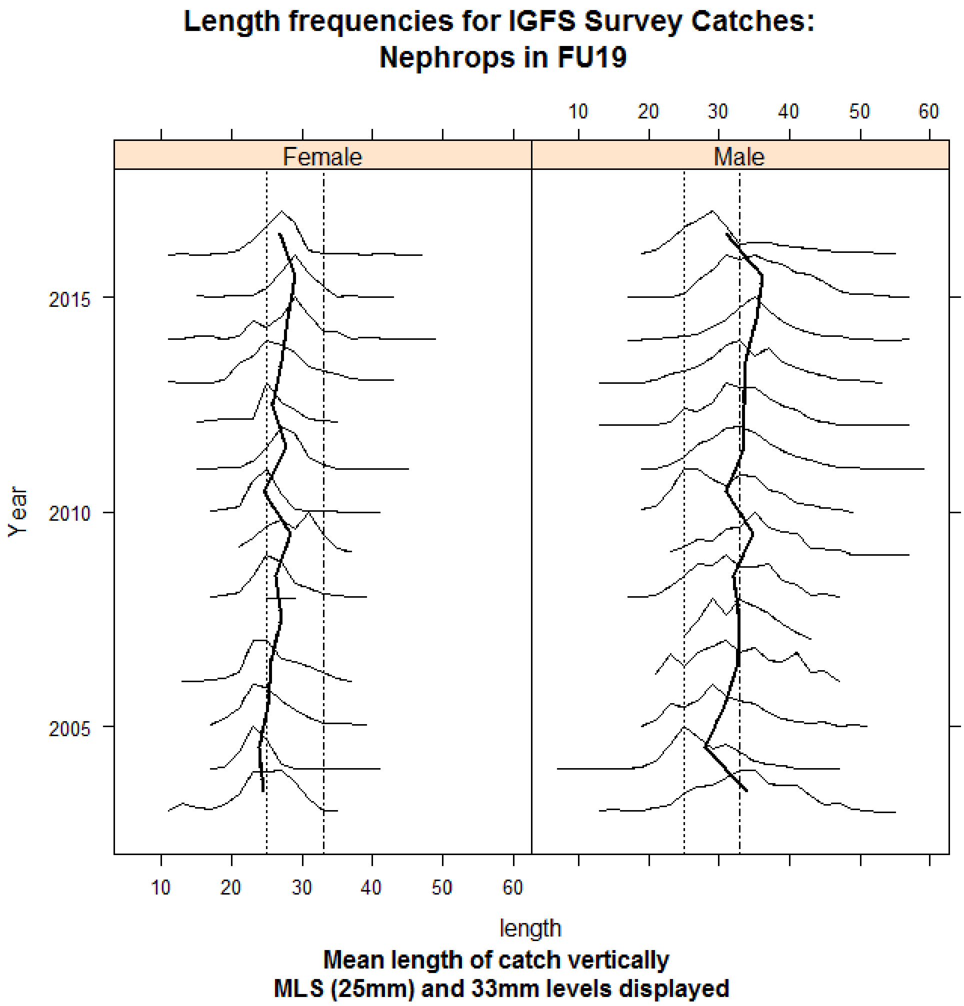


Figure 22.2.11. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches by sex from Irish Groundfish Survey 2003–2016.**

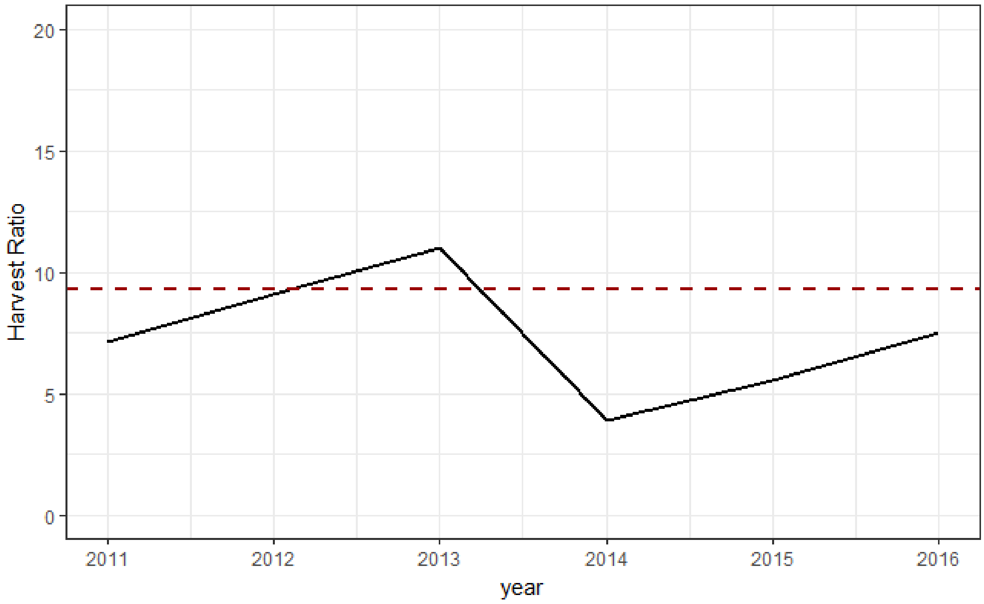


Figure 22.3.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

23 Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h, functional units 20 and 21 (Celtic Sea)

Type of assessment in 2016

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 2016

"ICES advises that when the precautionary approach is applied, catches in 2016 (assuming zero discards) should be no more than 3045 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 2500 tonnes.

To ensure that the stock in functional units (FUs) 20 and 21 is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2017

"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 2013–2015, catches in 2017 should be no more than 3552 tonnes. This implies landings of no more than 2727 tonnes.

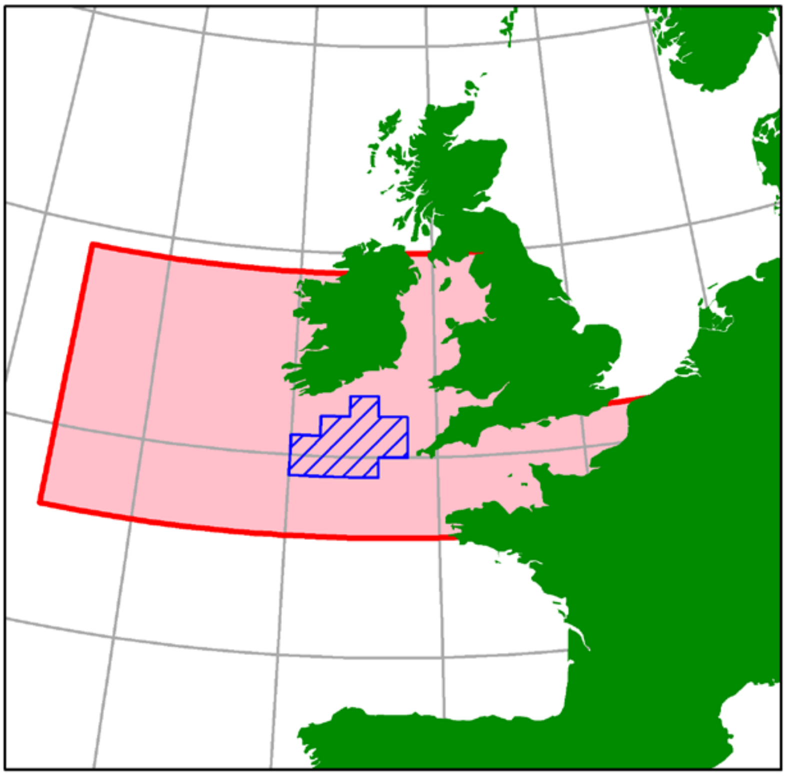
To ensure that the stock in functional units (FUs) 20 and 21 is exploited sustainably, management should be implemented at the functional unit level."

23.1 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 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 over 70% 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 have been higher then 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 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 6% of the landings from this FU in recent times (2011–2016).

Fishery in 2016

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 2016 56 reported landings in excess of 10 t accounting for 92% of total Irish landings.

France

In 2016 45 French vessels reported landings from FU20–21 where many of these switch between FU20–21 and FU22 within a trip.

UK

26 UK(E&W) vessels reported landings for FU20–21, seven vessels from Scotland and three vessels from Northern Ireland.

Information from stakeholders

None presented.

23.2 Data

InterCatch

Data were available in InterCatch and used on a trial basis. French data provided directly by national expert.

Landings

The reported landings time-series is shown in Figure 23.2.1 and Table 23.2.1.

The reported Irish landings from FU2021 have increased since the mid-2000s to the second highest in the Irish time-series in 2016 (1531 t). French landings have gradually decreased since the early 2000s to the present (477 t). Reported landings from the UK have fluctuated with an increasing trend in 2016. UK England & Wales had the highest landings at 389 t followed by Scotland (33 t), Northern Ireland reporting 22 t, and minor landings from Belgium less than 0.2 t. In 2016 most of the UK E& W landings were from Scottish vessels (based at Fraserburgh).

The overall fishing profile remains typically seasonal with the majority of Irish and French landings coming from the 2nd and 3rd quarters (see stock annex).

Effort

Effort data are available for the Irish *Nephrops* directed fleet in FU2021 from 1995–2016. 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 2016 this fleet accounted for ~95% of the landings compared with an average of 70% over the time period. Effort shows an increasing trend since the mid-2000s (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.

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 (see stock annex for details).

Length–frequency distributions of landings and discards for both countries from 2012 to 2016 are presented in Figure 23.2.3 along with the European (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 45% 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 2016 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 revised 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, 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 but at present it is the best available.

Estimated discard rates range between 28–41% of total catch by number and 13–27% 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 38–52% of total catch by number and 17–31% 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).

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) and WGNEPS (ICES, 2013; 2014; 2015; 2016). 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. 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 2013–2016 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 2016 full survey coverage was achieved. The geo-statistical analysis for years 2013 to 2016 follows the steps documented in Doyle *et al*., 2016 in press.

The 2016 mean burrow density was 0.18 burrows/m^2 compared with 0.20 burrows/m^2 in 2015. The 2016 geostatistical abundance estimate was 1.9±0.02 billion a 2% decrease on the abundance for 2014 with a CV of 5% which is well below the upper limit of 20% recommended by SGNEPS 2012. Highest densities were general observed towards the north and southwest of the ground, and there were also high densities observed close to boundaries. 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%).

Groundfish survey data

There are two IBTS- GFS catching *Nephrops* in FU2021: 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 FU2021 (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).

23.3 Assessment

Comparison with previous assessments

Previously a *Nephrops* data-limited exploration was carried out by working groups; see stock annex on historical overview of previous methods (ICES, 2015). This approach estimated harvest rates of 4.4% which is very low relative to most other developed *Nephrops* fisheries and similar to the harvest rate in place for the Porcupine Bank (FU16).

In 2016 stock-specific reference points were estimated by this 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).

The WGCSE 2017 carried out a full UWTV based assessment for this stock.

State of the stock

UWTV abundance estimates suggest that the stock size is relatively stable over the short time-series. The 2016 estimate is a slight decrease from 2015 estimate by 6%.

No MSY $B_{trigger}$ has been proposed as the time-series is too short (three 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.

23.4 Catch options table

Catch option 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 (2014–2016) of mean weights is used to account for this variability. Three year average (2014–2016) of proportion of removals retained was used as is standard for other *Nephrops* stocks.

The basis for the catch options.

Variable	Value	Notes
Stock abundance	Available October 2017	UWTV survey 2017
Mean weight in landings	37.6 g	Average 2014–2016
Mean weight in discards	17.4 g	Average 2014–2016
Discard rate	41.00%	Average 2014–2016 (by number). Calculated as discards divided by landings + discards.
Discard survival rate	25%	Only applies in scenarios where discarding is allowed.
Dead discard rate	34.40%	Average 2014–2016 (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 FU2021 using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the stock annex will be made on the basis of the 2017 UWTV survey. This will be presented in October 2017 for the provision of advice.

23.5 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	6.0%	6.0%	6.0%	Not defined	6.0%

*** Harvest rate (HR).**

No proposal has been made for MSY Btrigger as the time-series is too short.

23.6 Management plans

There is no specific management plan for the FU20–21 *Nephrops*.

23.7 Quality of assessment and forecast

Since the benchmark 2014 UWTV and sampling coverage has been improving in this area. There are now three years of full UWTV survey coverage (2014–2016).

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*, 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.

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).

23.8 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.

23.9 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.

Fisheries catching *Nephrops* in Subarea 7 will be covered by the EU landing obligation from 2016 (EC, 2015). *Nephrops* creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 7% discard rate by weight for the trawl fishery in 2016 and 2017. The average discard rate by weight for FU20–21 over the last three years is 24%. Two different catch options at F_{MSY} have been provided to give some information on the impact of different LO scenarios on catches.

UWTV survey coverage has improved. A new survey point will be available by autumn 2017 providing a more up to date estimate of density and abundance. The use of the most up to date survey information should be 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.

23.10 References

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Table 23.2.1. ***Nephrops*** **FU 20–21. Landings in tonnes by country.**

FU 20–21 Landings (t)				
Year	France	Rep. of Ireland	UK	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	440	2453

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

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

Table 23.2.4. ***Nephrops*** **FU 20–21. Sampling levels by country.**

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	2,024	1,747
2013	1	1	1		319	423	
2013	2	9	7	1	2514	2,038	2,187
2014	2	2	2		718	782	
2015	1			1			1,724
2015	2	6	6	2	2714	3,997	3,204
2015	3			4			4,750
2015	4	2	2		650	419	
2016	2	8	5	1	2,859	1,485	384
2016	4	3	2	4	767	1,678	1,743

France		Number of samples			Numbers measured		
Year	**Quarter**	**Catch**	**Discards**	**Landings**	**Catch**	**Discards**	**Landings**
2012	1		31	9		391	1,431
2012	2		13	8		198	1,202
2012	3		47	8		667	1,155
2012	4		6	6		16	860
2013	1		0	12		0	1,362
2013	2		68	72		1,120	3,151
2013	3		16	68		131	1,917
2013	4		2	14		12	1,303
2014	1		0	10		0	1,221
2014	2		40	47		1,127	3,536
2014	3		20	33		458	1,934
2014	4		0	9		0	1,360
2015	1		2	14		60	1,508
2015	2		24	44		520	3,249
2015	3		1	9		1	1,366
2015	4		0	9		0	1,357
2016	1		35	46		464	3,164
2016	2		24	27		519	1,263
2016	3		18	26		217	1,971
2016	4		8	20		5	1,935

Table 23.2.5. *Nephrops* FU 20–21. Sex ratio in the landings by country based on available sampling.

Year	Females (‘000s)	Males (‘000s)	% Males in Landings
Ireland			
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	15807	23835	60%
France			
Year	**Females (‘000s)**	**Males (‘000s)**	**% Males in Landings**
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	8815	91%

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 (as reported to WGCSE 2016)										
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	11.5	18.8	25.5	55	62	43	453	344	39.5	18.4
2013	10.1	10.9	18.3	45	52	29	486	195	48.1	17.9
2014	11.4	39.9	41.3	72	78	58	465	639	40.8	16.0
2015	7.9	8.3	14.1	44	51	33	355	174	44.8	21.0

France Revised										
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	62	42	453	322	41.7	18.1
2013	9.3	10.0	16.9	45	52	27	486	176	52.2	17.6
2014	10.6	37.0	38.4	72	78	56	465	588	43.8	15.9
2015	7.4	7.7	13.2	44	51	32	355	165	48.1	21.4
2016	9.6	3.2	12.0	20	25	16	477	92	49.5	29.1

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.**

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	40	23	708	207	26.7	11.9
2013	24.2	8.3	30.5	21	26	14	844	137	34.9	16.4
2014	39.1	17.6	52.3	25	31	15	1,342	233	34.3	13.3
2015	47.9	18.6	61.9	23	28	13	1,620	248	33.8	13.4
2016	39.6	27.5	60.3	34	41	27	1,531	564	38.6	20.5

***25% discards survival.**

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 and scaled to international landings based on available sampling.**

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	49	31	1,189	542	31.1	15.0
2013	34.8	19.2	49.2	29	36	19	1,387	327	39.9	17.0
2014	50.6	55.5	92.2	45	52	31	1,836	834	36.3	15.0
2015	59.4	28.1	80.5	26	32	17	2,116	442	35.7	15.7
2016	60.2	37.5	88.3	32	38	25	2,453	801	40.7	21.4

***25% discards survival.**

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%

*** 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.**

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**
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	125	4.0	2116	442	35.7	15.7
2016	60.2	37.5	88.3	38.4	31.8	1879	175	4.7	2453	801	40.7	21.4
			Average 14–16	34.4	41.0					**Average 14–16**	37.6	17.4

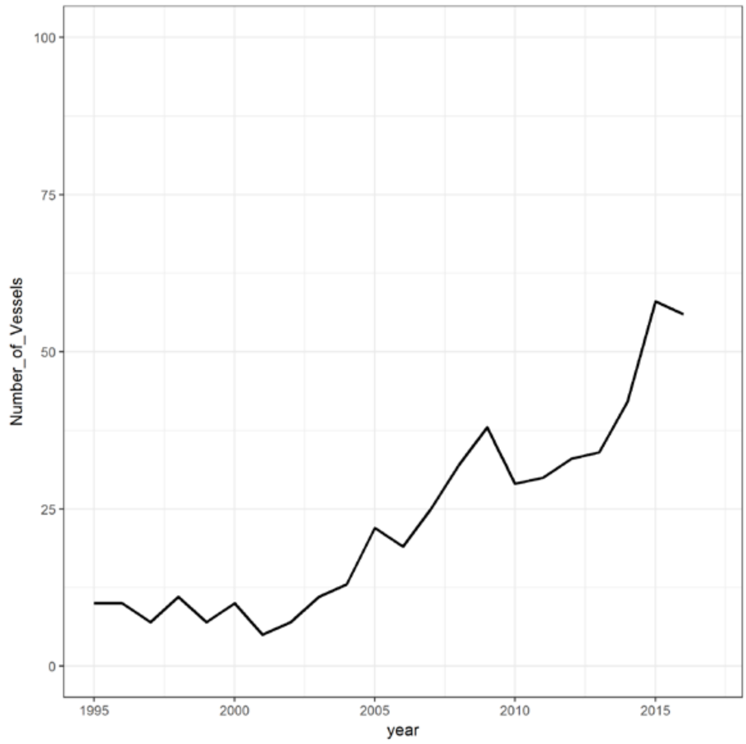


Figure 23.1.1. ***Nephrops*** **FU 20–21. Number of Irish vessels reporting landings >10 t.**

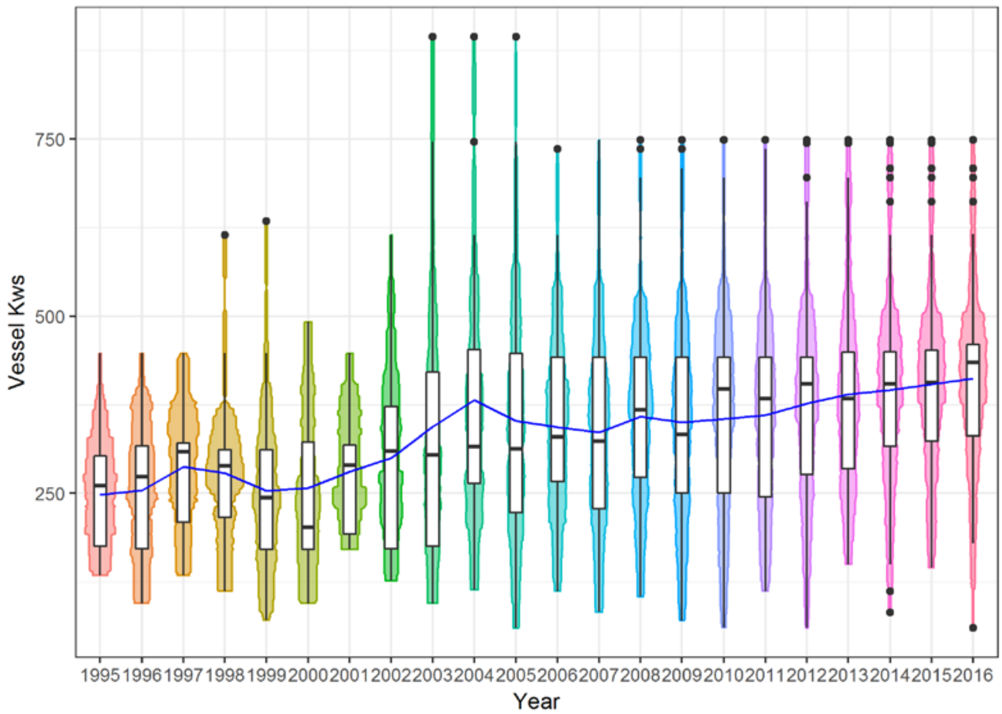


Figure 23.1.2. ***Nephrops*** **FU 20–21. Combined box and kite plot of vessel power on the FU20–21 grounds by year. The blue line indicates the mean.**

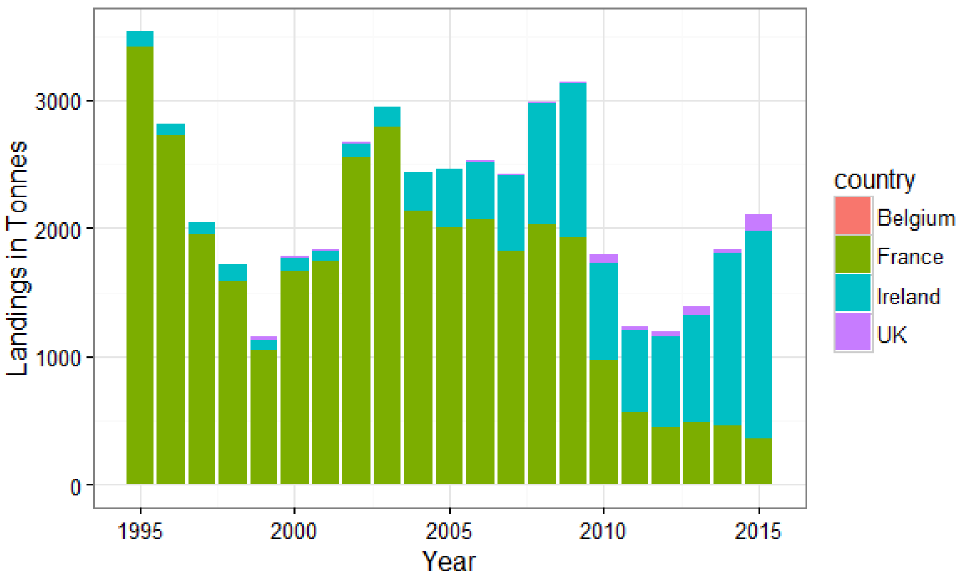


Figure 23.2.1. ***Nephrops*** **FU 20–21. Landings in tonnes by country.**

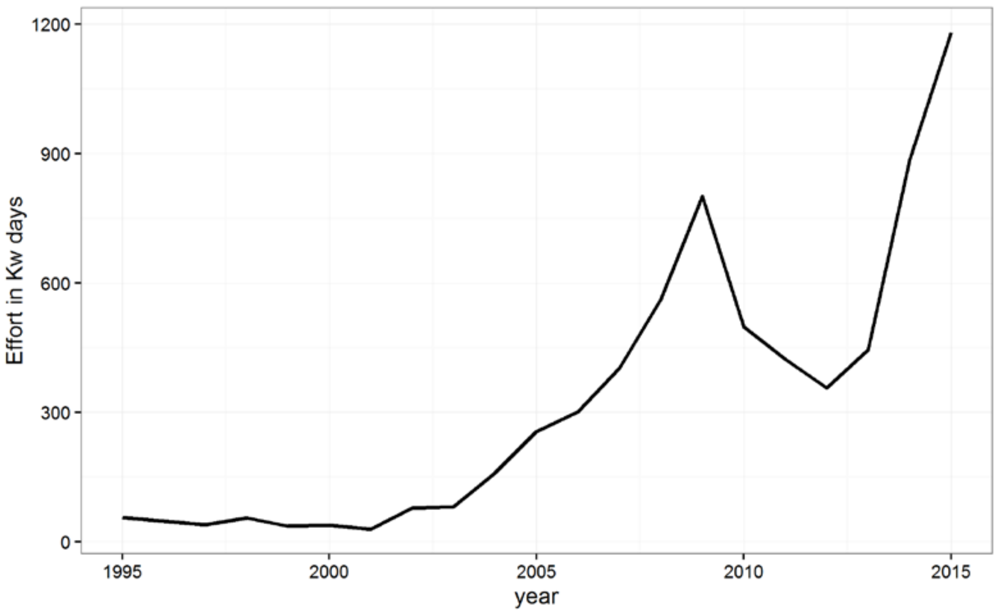


Figure 23.2.2. *Nephrops* FU 20–21. Effort data (Kw days) for the Irish otter trawl *Nephrops* directed fleet.

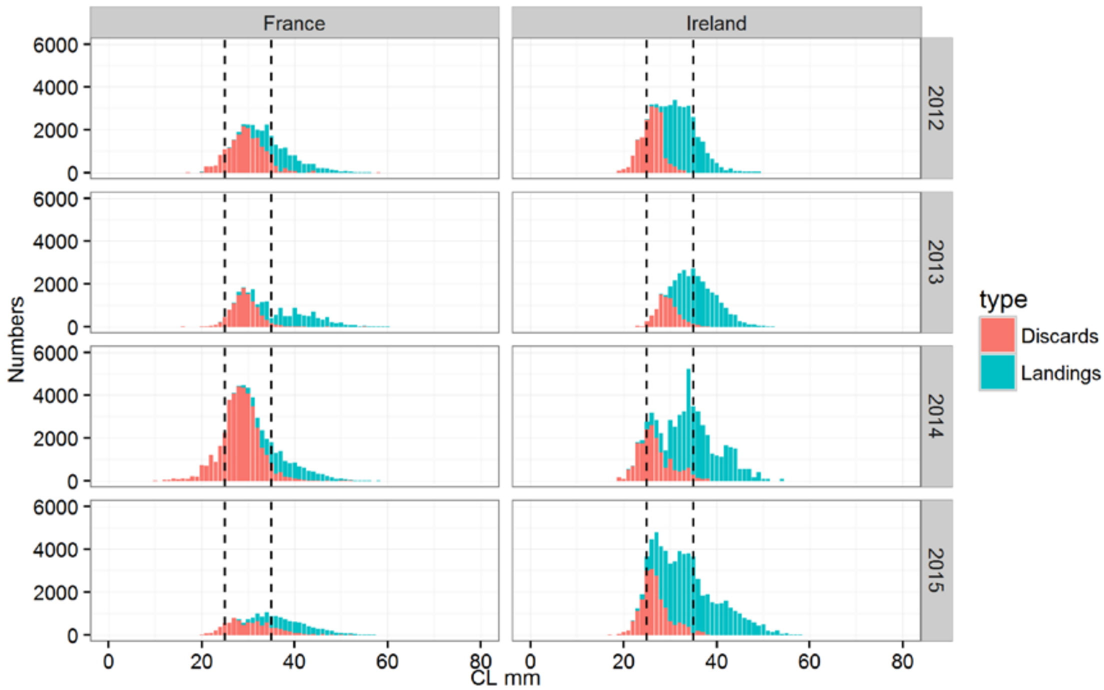


Figure 23.2.3. *Nephrops* FU 20–21. Commercial length frequency distribution by country. Minimum landing size of 25 mm (European MLS) and 35 mm (French MLS) displayed.

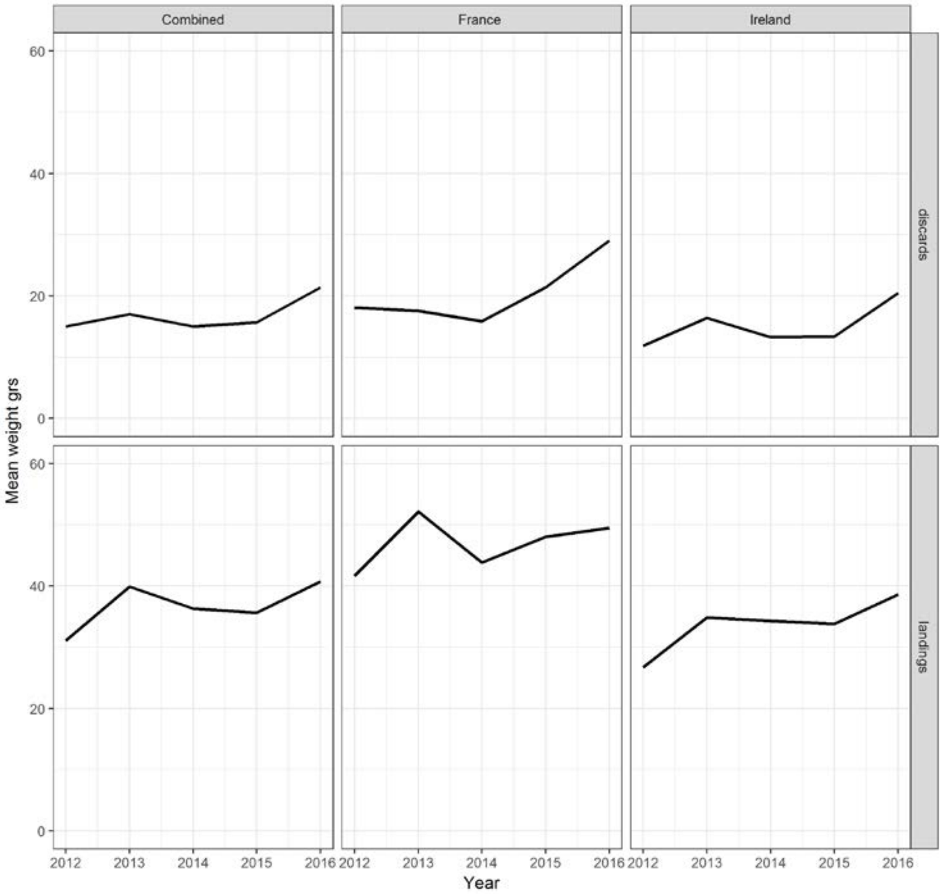


Figure 23.2.4. ***Nephrops*** **FU 20–21. Annual mean weights (gr) in the landings and discards by country and combined scaled to international landings.**

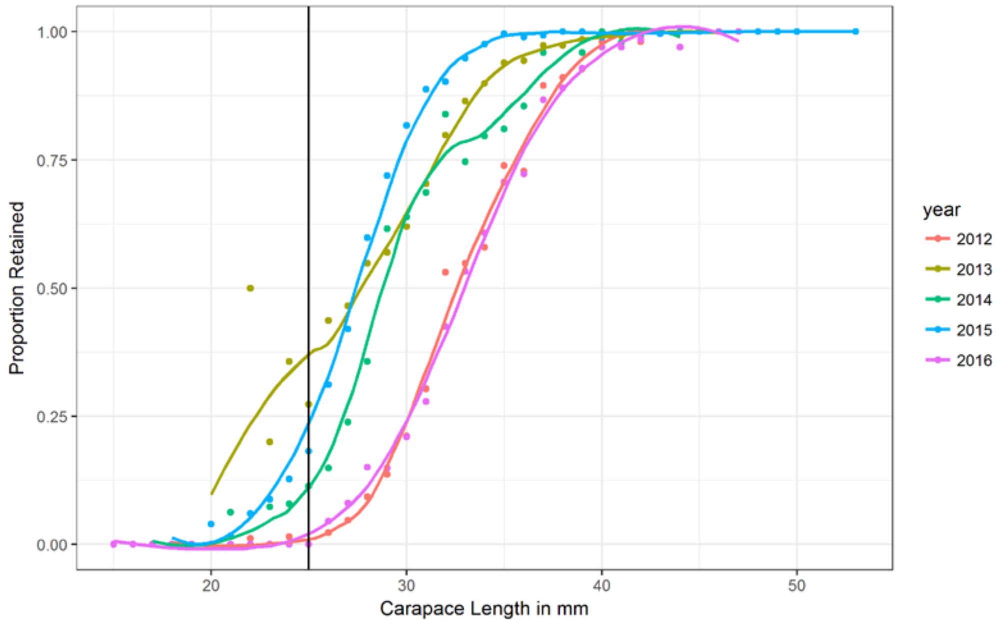


Figure 23.2.5. ***Nephrops*** **FU 20–21. Annual discard ogive derived from Irish sampling. Minimum landing size of 25 mm (European MLS) as black line.**

Figure 23.2.6. ***Nephrops*** **FU 20–21. Contour plots of krigged density estimates for the UWTV surveys from 2013 to 2016.**

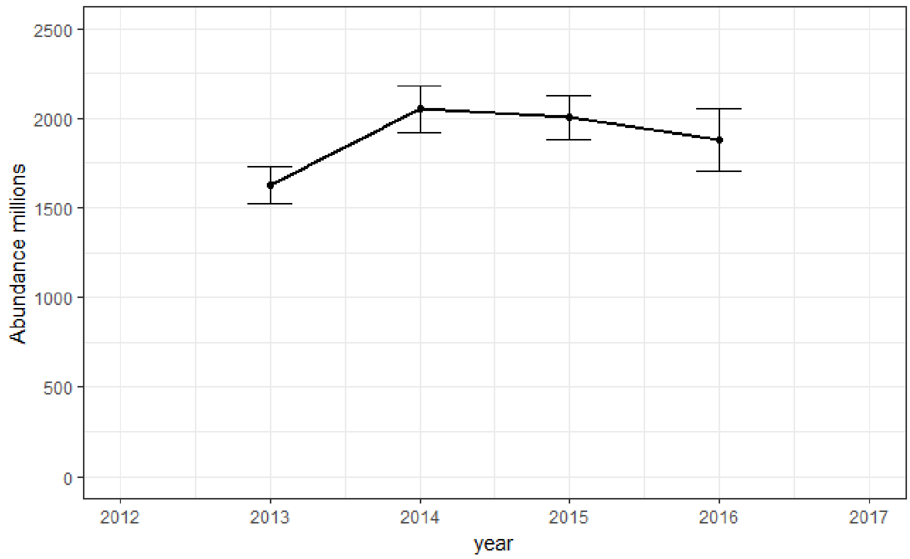


Figure 23.2.7. *Nephrops* FU 20–21. Time-series of abundance estimates for FU20–21 (error bars indicate 95% confidence intervals).

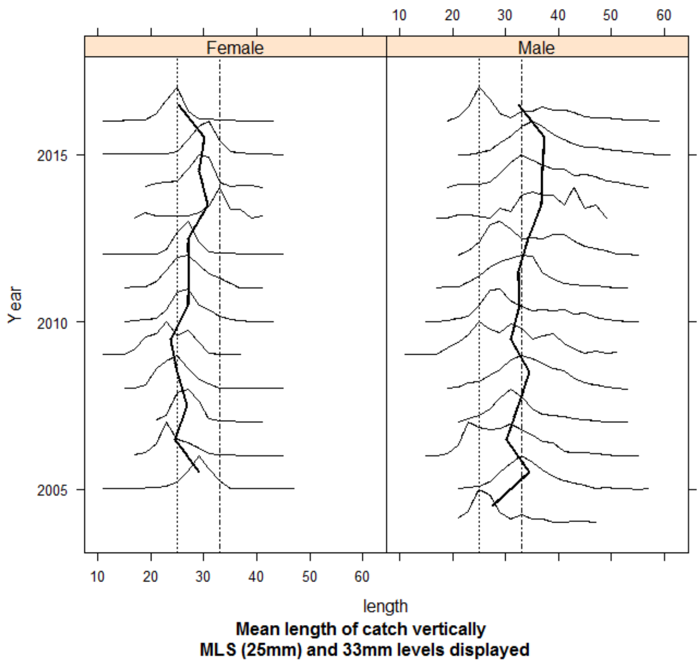


Figure 23.2.8. *Nephrops* FU 20–21. Mean size trends for catches by sex from the IBTS-IGFS Irish survey in the Celtic Sea.

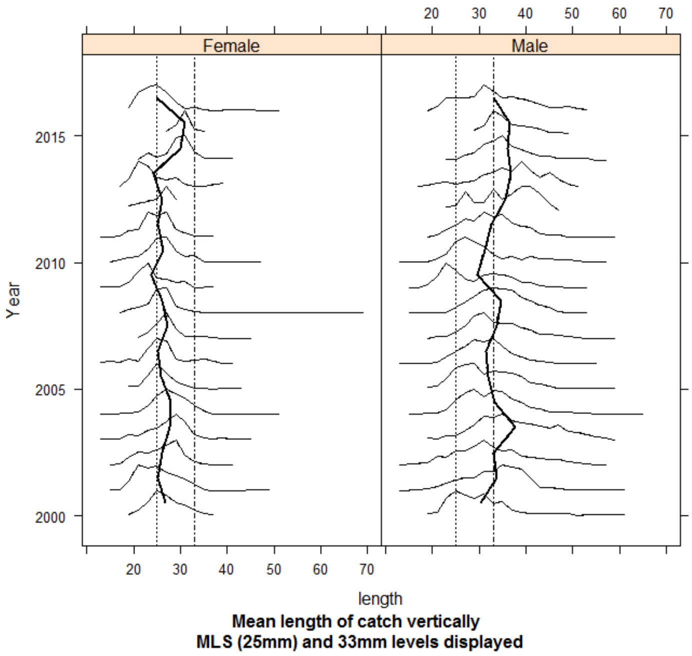


Figure 23.2.9. ***Nephrops*** **FU 20–21. Mean size trends for catches by sex from the IBTS-EVHOE French survey in the Celtic Sea.**

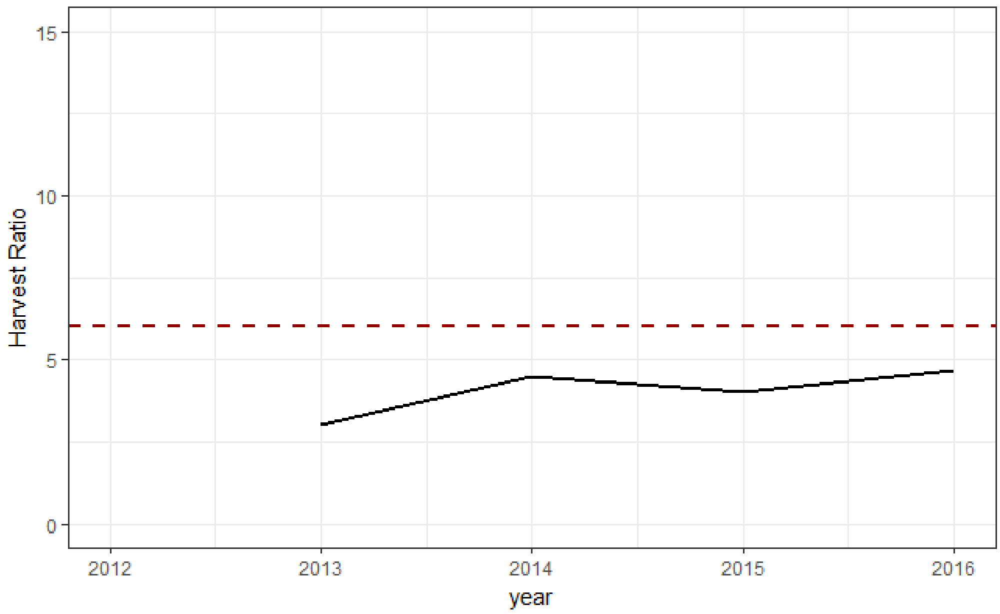


Figure 23.3.1. ***Nephrops*** **FU 20–21. Harvest ratio (% dead removed / UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

24 Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.f, Functional Unit 22 (Celtic Sea, Bristol Channel)

Type of assessment in 2016

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 2017 and the new survey will form the basis of advice for this stock in the autumn.

ICES advice applicable to 2016

"ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 3027 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 2778 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 2017

"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 2013–2015, catches in 2017 should be no more than 2063 tonnes. This implies landings of no more than 1807 tonnes.

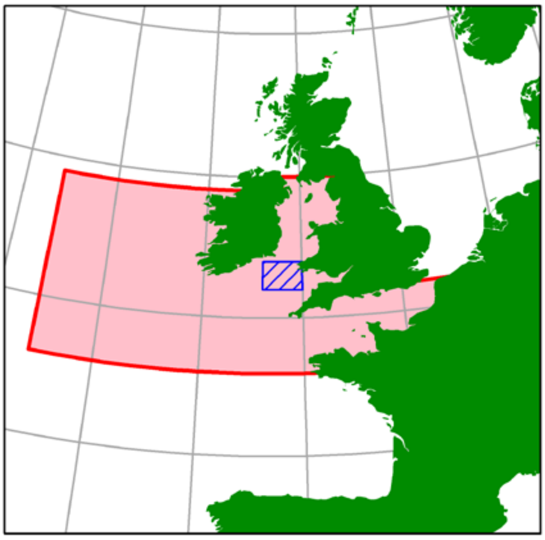
To ensure that the stock in functional unit (FU) 22 is exploited sustainably, management should be implemented at the functional unit level."

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. A description of the 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 increasing in recent years. 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 is mainly UK-Northern Irish vessels in this fishery where in recent years the UK fleet had on average ~10% of the landings.

Fishery in 2016

In 2016, 81 Irish vessels reported landings from FU22. Of these, 67 vessels reported landings in excess of 10 t. Vessels >18 m account for 90% of the landings in 2016. 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 2016, 15 French trawlers reported landings for FU22. French vessels switch between FU20–21 and FU22. In 2016, fourteen Northern Ireland and six UK(E&W) 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 on a trial basis.

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 to the present highest level observed in 2016 of approximately 3000 t. French landings have gradually decreased since the early 2000s to the present to the lowest level (7 t). Reported landings from the UK have fluctuated with no obvious trend. Northern Ireland had the highest landings at 271 t followed by England and Wales reporting 24 t and 18 t from Scotland. In 2016 Belgium reported 3 t from this FU due to quota swap.

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. Effort data are available for the Irish *Nephrops* directed fleet in FU22 from 1995–2016. 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).

Sampling levels

A dedicated sampling of landings and discards began in 2003 by Ireland. Sampling levels in 2016 were good and comparable to levels in 2015 (Figure 24.2.3) Sampling levels, data aggregating and raising procedures are documented in stock annex.

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 24.2.4) with a slight increase observed in 2016. There is an increase 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 UWTV and Irish groundfish survey.

Sex ratio

The sex ratio by year is shown in Figure 24.2.5. This shows some fluctuations over time. The sex ratio has a distinct seasonal pattern (Figure 24.2.6) 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 24.2.6). This corresponds with the emergence of mature females from the burrows to mate in summer. There is an increase in mean weight in 2007 to 2009 for both sexes which is linked to the recruitment signal picked up by both the UWTV and Irish groundfish survey (Figure 24.2.10). The annual mean weight estimate for landings and discards is shown in Figure 24.2.7. The mean weight estimates show a slight increase.

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 quarterly 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 in recent years has been good.

Discard rates range between 6–34% of total catch by weight and 10–48% 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.

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) and WGNEPS (ICES, 2013; 2014; 2015; 2016). 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 41 on the Smalls grounds in 2016 which allowed survey coverage of other FUs. A randomised isometric grid design was employed with UWTV stations at 5.5 nmi intervals, whereas previously a 3.0 nmi square grid was used. Operational details of the 2016 UWTV survey are available (ICES, 2016).

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. Seven stations in FU22 were not surveyed successfully in 2015 due to very poor visibility conditions encountered as a result of strong tides. WGCSE 2015 recommended 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 24.2.8. 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 which was the highest in the series. The mean density in 2016 is approximately 36% decrease on 2015 and is the lowest observed in the series. The summary statistics from this geostatistical analysis are given in Table 24.2.5 and plotted in Figure 24.2.9. The statistical analysis follows these steps documented in Lordan *et al.*, 2016 in press): annual variograms were used to create krigged grid files and the resulting cross-validation data were plotted. If the results looked reasonable then surface plots of the grids were made using a standardised scale. The final part of the process was to limit the calculation to a fixed ground boundary using a blanking file. The resulting blanked grid was used to estimate the mean, variance, standard deviation, coefficient of variation, domain area and total burrow abundance estimate.

The 2016 estimate of 866 million burrows is the lowest observed, although estimates have remained fairly stable since the survey commenced. The estimation variance of the survey as calculated by EVA is very low (CVs in the order <8%).

Groundfish survey data

The Irish groundfish survey (IGFS-WIBTS-Q4) has been carried out since 2003 (Stokes *et al.*, 2014; ICES, 2015). 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 24.2.10). This signal of recruitment was also picked up during the 2006 UWTV survey (Doyle *et al.*, 2012). The groundfish survey provides a useful indicator of recruitment in this FU.

24.3 Assessment

Comparison with previous assessments

The WGCSE 2017 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 areas 6 and 7 by WGCSE.

State of the stock

UWTV abundance estimates suggest that the stock size is stable with a recent decline in 2016. The 2016 estimate is the lowest observed in the time-series and is below the MSY $B_{trigger}$. The2016 estimate (866 million) is above the average of the series (geomean [2006–2016]: 1240 million).

Harvest rate is calculated as (landings + dead discards)/(abundance estimate). Table 24.3.1 and Figure 24.3.1 summarize recent harvest rates. Recent harvest rates have fluctuated due to recruitment pulses into the fishery in 2006 and 2010.

24.4 Catch options table

Catch option 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 18–26 gr (Figure 24.2.7). In line with previous practice an average (2003–2016) of mean weights is used to account for this variability. Three year average (2014–2016) of proportion of removals retained was used as is standard for other *Nephrops* stocks. The estimate harvest ratio has also varied a lot, 5–24% 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 options.

Variable	Value	Notes
Stock abundance	Available October 2017	UWTV survey 2017
Mean weight in landings	22.1 g	Average 2003–2016
Mean weight in discards	12.0 g	Average 2003–2016
Discard rate	20.7%	Average 2014–2016 (by number). Calculated as discards divided by landings + discards.
Discard survival rate	25%	Only applies in scenarios where discarding is allowed.
Dead discard rate	16.3%	Average 2014–2016 (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 2017 UWTV survey. This will be presented in October 2017 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}*	FMSY*	MSY Fupper* with AR	MSY Btrigger	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

No management strategies exist for this stock.

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). 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 2–8%) 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.

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 FU22 deterministic estimates of the mean weight in the landings and discard rates for 2003–2016 are used 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.

Fisheries catching *Nephrops* in Subarea 7 will be covered by the EU landing obligation from 2016 (EC, 2015). *Nephrops* creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 7% discard rate by weight for the trawl fishery in 2016 and 2017. The average discard rate by weight for FU22 over the last three years is 25%. Two different catch options at F_{MSY} have been provided to give some information on the impact of different LO scenarios on catches.

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 methodology for aggregating length–distributions and calculating landings and discard LFDs and mean weights should be thoroughly investigated.
- 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 although it is stable over the time-series. There are fluctuations in the harvest rates which are related to the signals of recruitment into the fishery in 2006 and 2007 picked up by the UWTV and IGFS-WIBTS-Q4. Recent harvest rates for the FU22 Smalls suggest the stock is exploited below F_{MSY}.

A new survey point should be available in September 2017 which will provide a more up to date prognosis of stock status. This up to date survey information will be used to generate catch options and the provision of advice in October 2017.

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

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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	1,027	741	20		1,788
2000	1,186	1,687	34		2,907
2001	876	2,054	5		2,935
2002	595	1,392	3		1,990
2003	799	1,241	10		2,050
2004	465	1,330	33		1,827
2005	494	1,931	0		2,425
2006	302	1,398	52		1,752
2007	218	2,614	48		2,881
2008	312	2,474	328		3,114
2009	235	1,642	368		2,245
2010	136	2,220	351		2,708
2011	54	1,548	15		1,617
2012	65	2,509	59		2,633
2013	83	2,079	86	7	2,633
2014	29	2,443	134	8	2,615
2015	9	2258	97	5	2,368
2016	7	2952	314	3	2016

Table 24.2.2. ***Nephrops*** **in FU22 (Smalls Grounds). Effort data for the Irish otter trawl** ***Nephrops*** **directed fleet.**

YEAR	EFFORT (KW DAYS)	LANDINGS (TONNES)
1995	551,930	1,226
1996	411,724	1,010
1997	473,822	1,096
1998	524,420	1,353
1999	292,419	620
2000	585,809	1,335
2001	788,999	1,964
2002	614,958	1,298
2003	638,990	1,000
2004	619,862	981
2005	986,292	1,882
2006	855,110	1,374
2007	1,130,765	2,677
2008	1,047,430	2,501
2009	702,412	1,605
2010	962,427	2,198
2011	723,924	1,497
2012	970,255	2,260
2013	902,073	1,849
2014	915,180	2,182
2015	970,561	2,076
2016	1,269,573	2,761

Table 24.2.4. *Nephrops* in FU22 (Smalls Grounds). Landings and discards weight and numbers by year and sex.

	Female		Male		Both sexes
Year	Landings (t)	Discards (t)	Landings (t)	Discards (t)	% Discard
2003	504	193	886	170	21%
2004	803	60	796	44	6%
2005	1,075	692	1,289	428	32%
2006	758	307	1,080	300	25%
2007	1,041	903	2,137	738	34%
2008	976	448	2,408	358	19%
2009	645	200	2,181	249	14%
2010	1,066	245	2,015	191	12%
2011	402	34	1,129	78	7%
2012	645	114	1,864	130	9%
2013	567	160	1,514	174	14%
2014	951	219	1,493	169	14%
2015	737	94	1,522	77	7%
2016	730	166	2221	299	14%

	Female Numbers '000s		Male Numbers '000s		Both sexes
Year	Landings	Discards	Landings	Discards	% Discard
2003	29,116	20,427	35,772	16,335	36%
2004	35,081	4,417	27,612	3,047	11%
2005	56,023	55,037	55,817	33,507	44%
2006	48,589	30,199	53,375	27,165	36%
2007	74,047	98,994	107,834	66,434	48%
2008	54,518	39,354	88,841	26,430	31%
2009	38,239	19,316	78,474	19,796	25%
2010	60,796	17,201	79,957	13,571	18%
2011	19,377	2,003	38,878	4,288	10%
2012	38,211	11,779	79,779	11,088	16%
2013	30,197	14,471	58,890	13,813	24%
2014	45,619	16,564	52,032	11,809	23%
2015	47,225	11,207	69,748	8,139	14%
2016	43,158	19,881	99,039	28,247	25%

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	4.69	3064	2,897	1363	7%
	2016*	41	0.31	6.4	3063	2,457	866	7%

*** 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 option calculations).**

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
2003	95.7	54.2	136.4	29.8	36.2	Na			2,050	536	21.4	9.9
2004	71.7	8.5	78.1	8.2	10.6	Na			1,828	119	25.5	13.9
2005	114.7	90.8	182.8	37.3	44.2	Na			2,425	1149	21.1	12.7
2006	97.2	54.7	138.2	29.7	36.0	1503	70	9.2	1,752	579	18	10.6
2007	164.8	149.9	277.2	40.6	47.6	1136	126	24.4	2,880	1487	17.5	9.9
2008	131.9	60.5	177.3	25.6	31.5	1114	123	15.9	3,114	742	23.6	12.3
2009	92.8	31.1	116.1	20.1	25.1	1093	108	10.6	2,245	357	24.2	11.5
2010	123.7	27	143.9	14.1	17.9	1141	88	12.6	2,708	383	21.9	14.2
2011	61.6	6.7	66.5	7.5	9.8	1256	72	5.3	1,617	118	26.3	17.8
2012	123.8	24	141.8	12.7	16.2	1498	239	9.5	2,633	256	21.3	10.7
2013	96.6	30.7	119.6	19.2	24.1	1254	177	9.5	2,255	362	23.3	11.8
2014	104.5	30.4	127.3	17.9	22.5	1622	268	7.8	2,615	415	25	13.7

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	122.6	20.3	137.8	11.0	14.2	1363	179	10.1	2,368	179	19.3	8.8
2016	157.8	53.4	197.9	20.2	25.3	866	112	22.8	3,276	516	20.8	9.7
			Average 14–16	**16.4**	**20.7**					**Average 03–16**	**22.1**	**12.0**

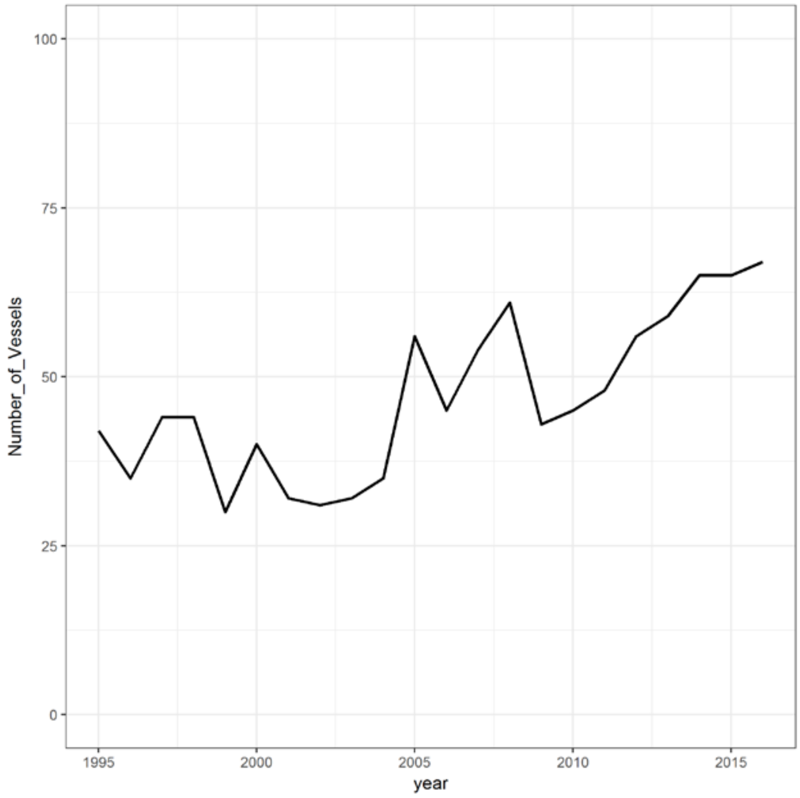

Figure 24.1.1. ***Nephrops*** **in FU22 (Smalls Grounds). Time-series of the number of Irish vessels reporting landings of** ***Nephrops*** **from FU22 with a >10 t threshold.**

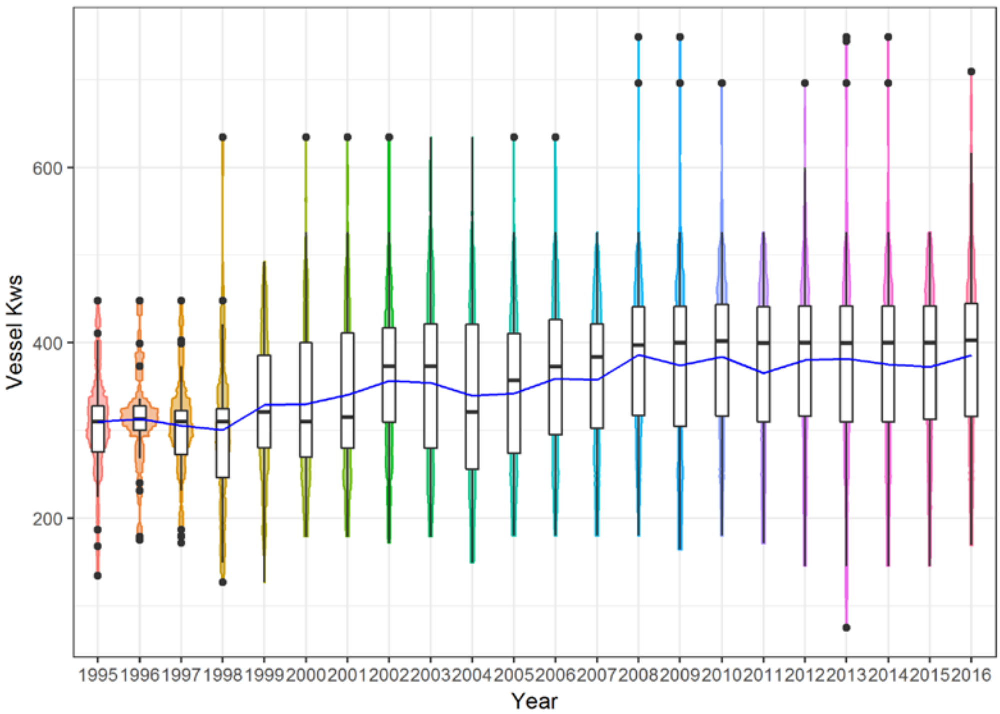

Figure 24.1.2. ***Nephrops*** **in FU22 (Smalls Grounds). Combined box and kite plot of vessel power on the Smalls Grounds by year. The blue line indicates the mean.**

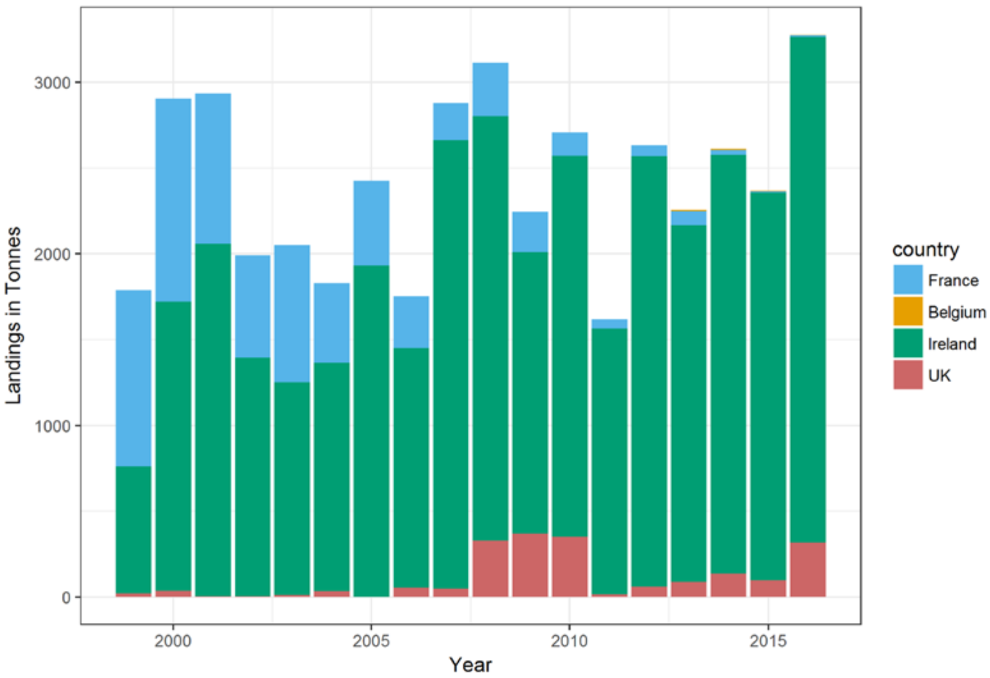

Figure 24.2.1. ***Nephrops*** **in FU22 (Smalls Grounds). Landings in tonnes by country.**

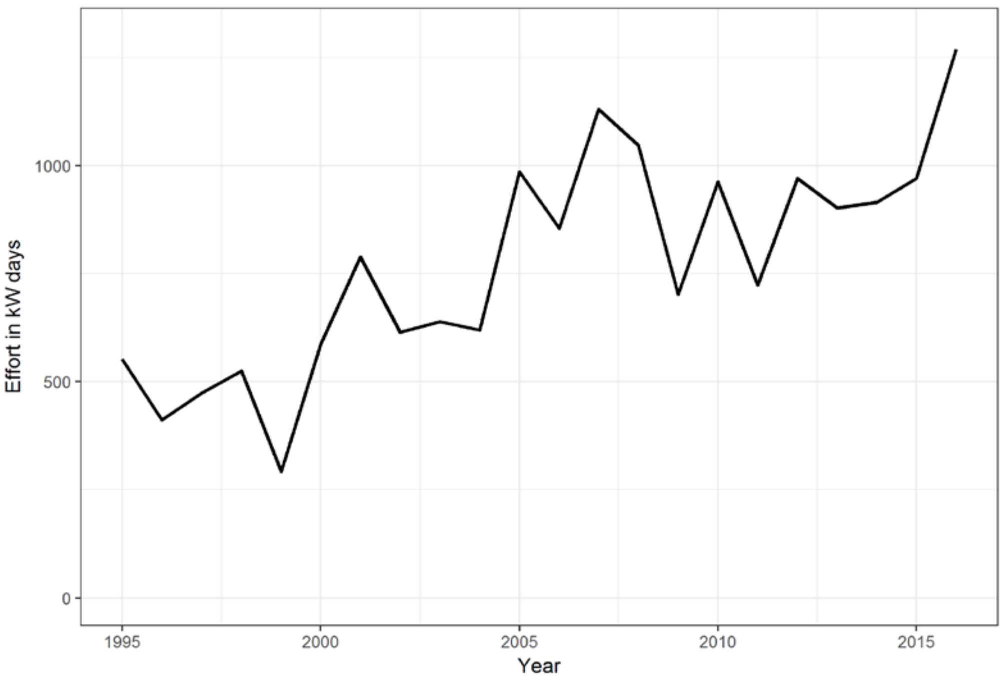

Figure 24.2.2. ***Nephrops*** **in FU22 (Smalls Grounds). Fishing effort Kw days for the Irish otter trawl** ***Nephrops*** **directed fleet (30% of** ***Nephrops*** **weight in total landings).**

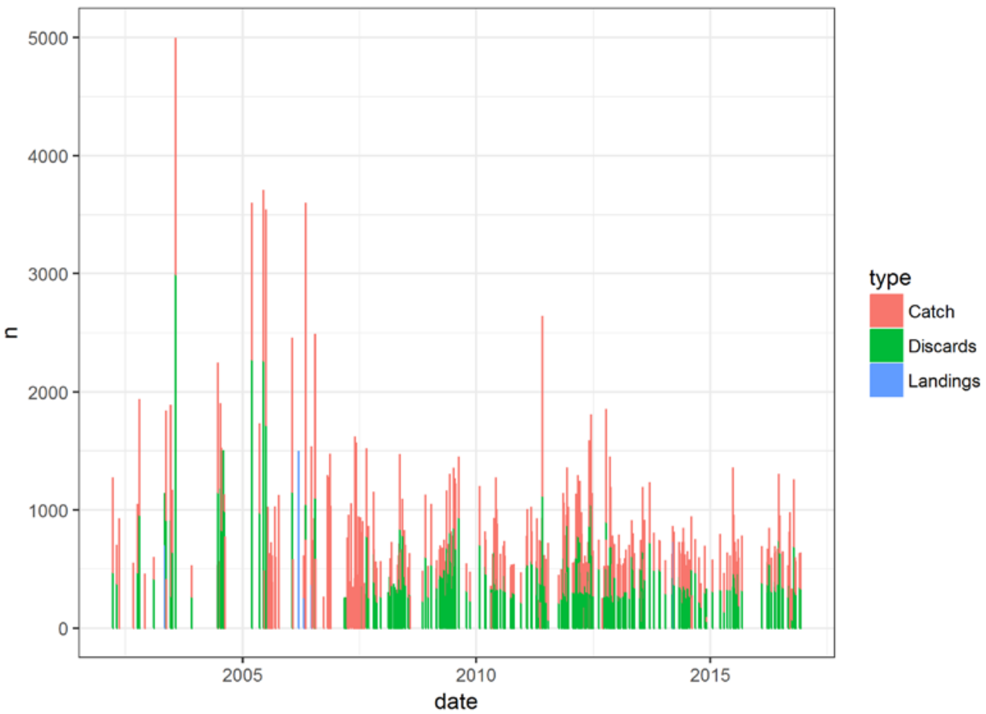

Figure 24.2.3. ***Nephrops*** **in FU22 (Smalls Grounds). Sampling levels.**

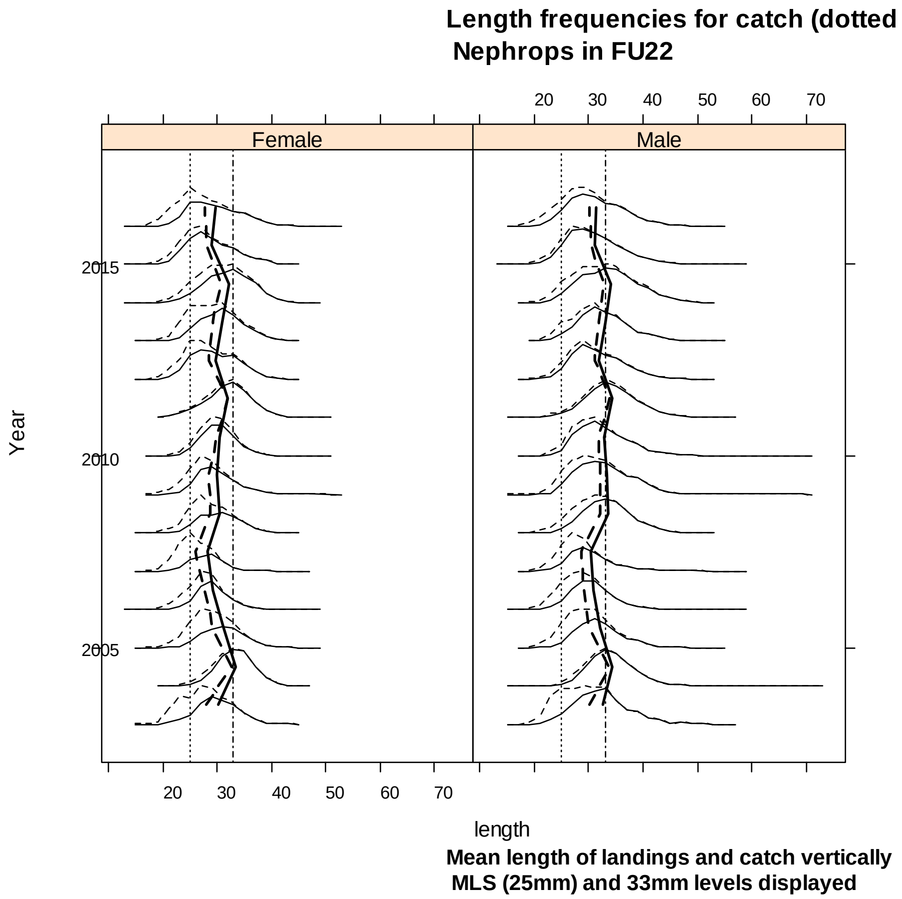

Figure 24.2.4 ***Nephrops*** **in FU22 (Smalls Grounds). Mean size trends for catches and whole landings by sex 2003–2016.**

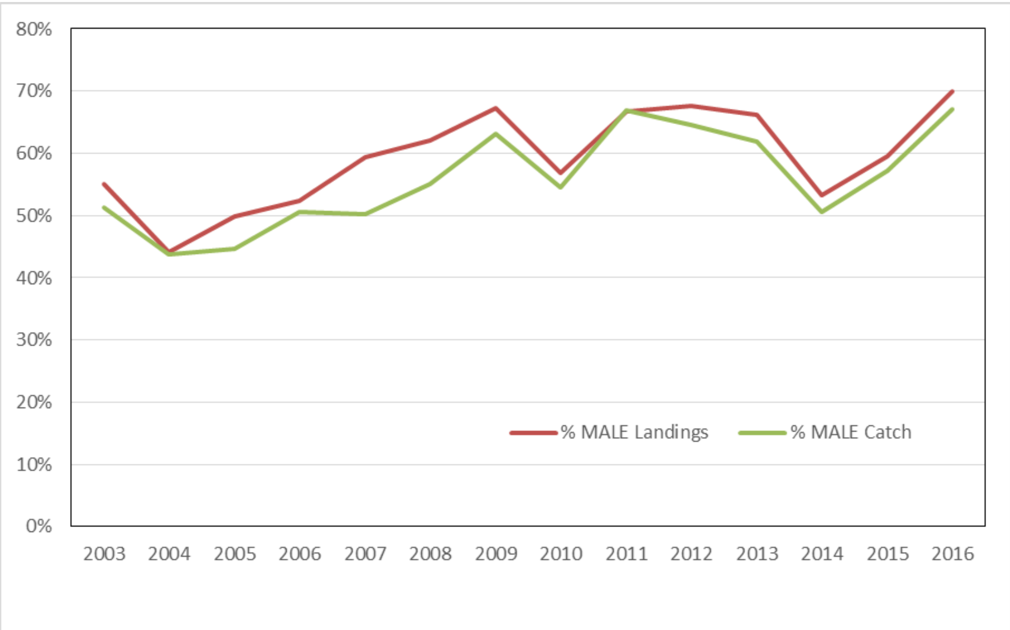

Figure 24.2.5. ***Nephrops*** **in FU22 (Smalls Grounds). Annual sex ratio of landings (2003–2016) and catch (2003–2016).**

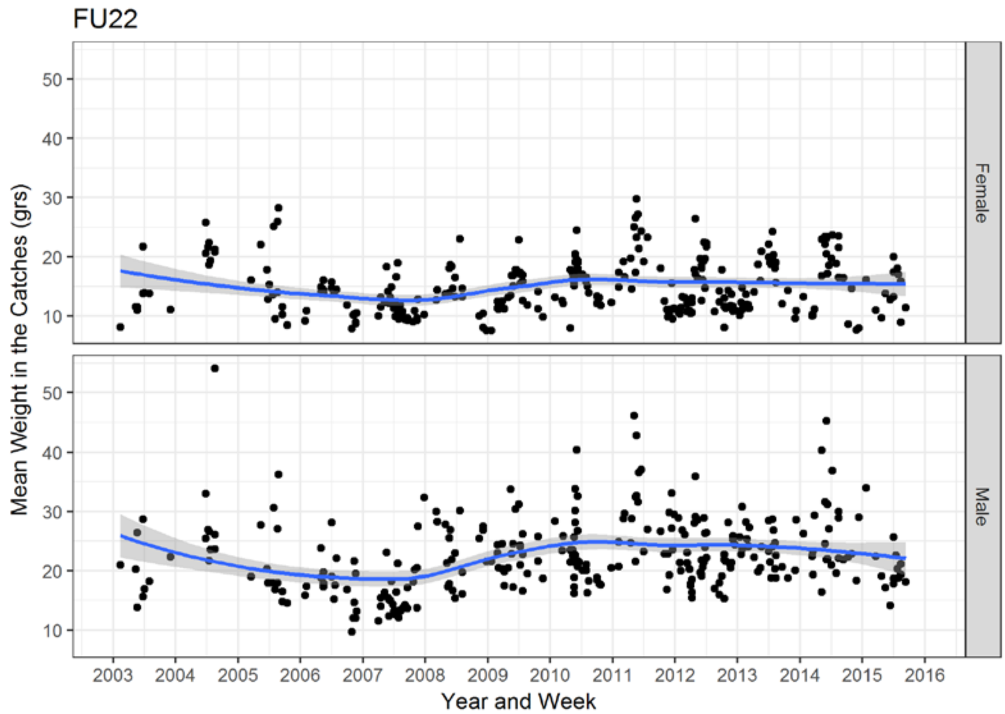

Figure 24.2.6. ***Nephrops*** **in FU22 (Smalls Grounds). Mean weight in catch samples by sex with loess smoother and showing cyclical trends.**

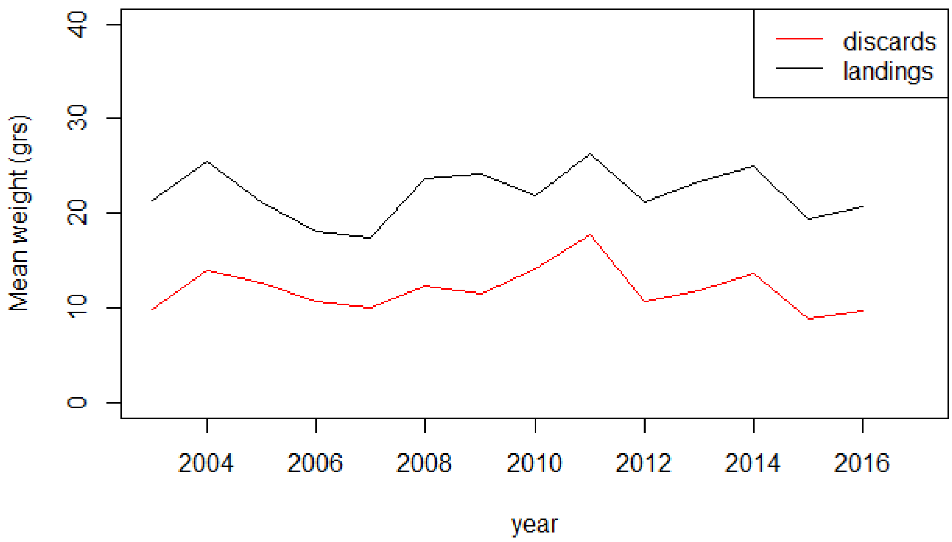

Figure 24.2.7. ***Nephrops*** **in FU22 (Smalls Grounds). Annual mean weights (gr) in the landings and discards.**

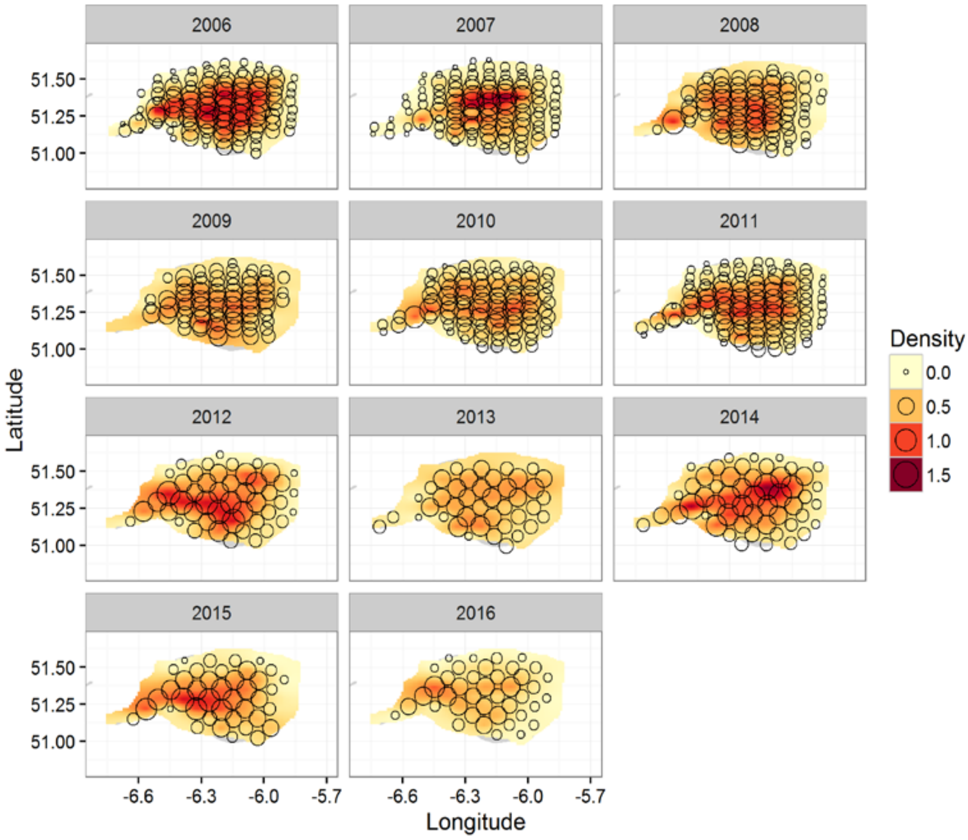

Figure 24.2.8. ***Nephrops*** **in FU22 (Smalls Grounds). Contour plots of the krigged density estimates for the UWTV surveys from 2006–2016.**

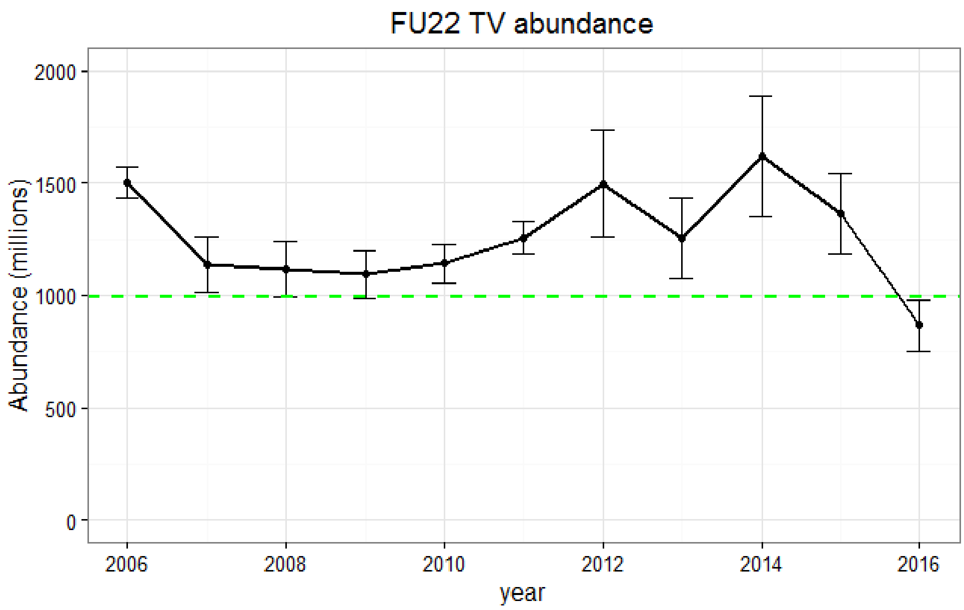

Figure 24.2.9. ***Nephrops*** **in FU22 (Smalls Grounds). Time-series of abundance estimates for FU22 (error bars indicate 95% confidence intervals) and $B_{trigger}$ is dashed green line.**

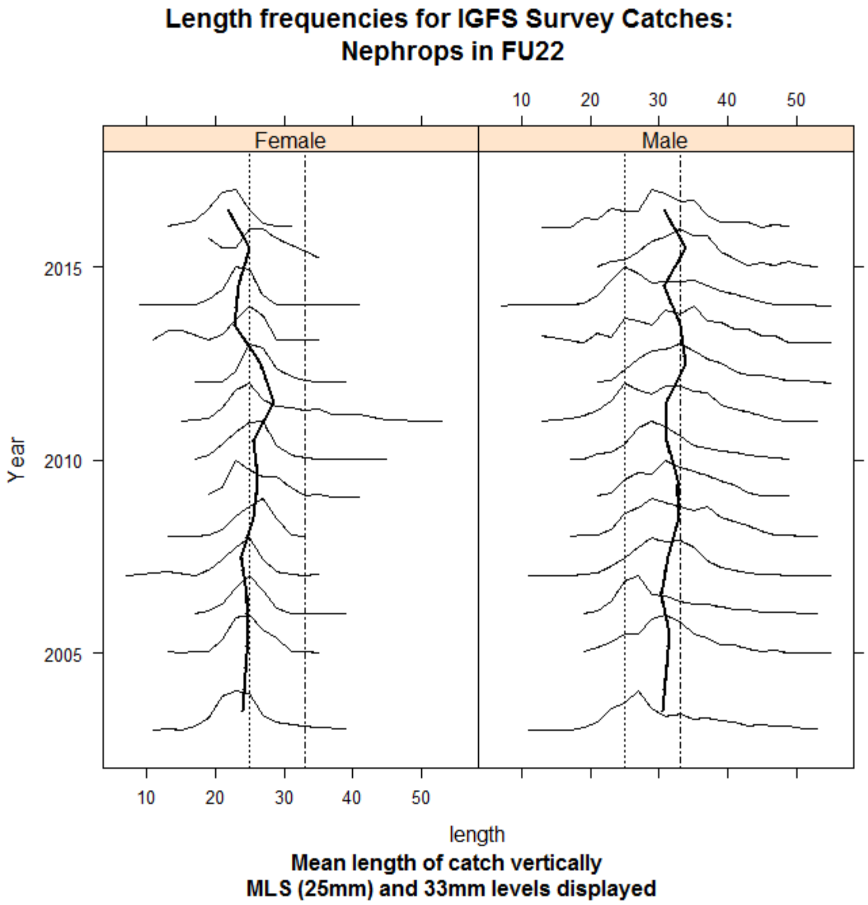

Figure 24.2.10. ***Nephrops*** **in FU22 (Smalls Grounds). Mean size trends for catches by sex from Irish Groundfish Survey 2003–2016.**

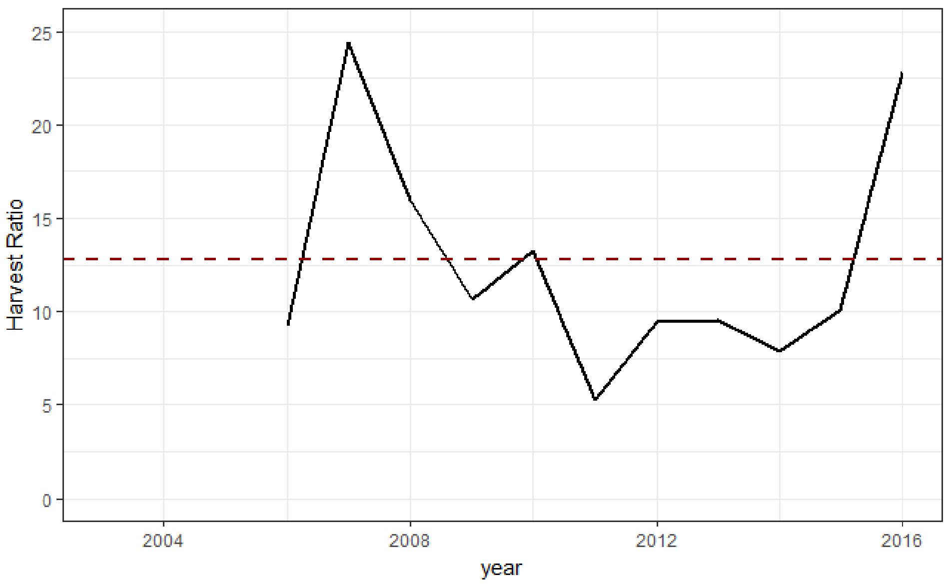

Figure 24.4.1. ***Nephrops*** **in FU22 (Smalls Grounds). Harvest Ratio (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

24.11 Audit of *Nephrops* FU22 (Smalls Grounds)

There is no audit available.

25 Plaice in Division 27.7.a (Irish Sea)

Type of assessment in 2017

ICES WKIRISH (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 discard scenario (ICES, WKIRISH 2017, Annex 4).

ICES advice applicable to 2016

ICES advice applicable to 2016 ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 1244 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 343 tonnes.

ICES advice applicable to 2017

ICES advises that when the precautionary approach is applied, catches in 2017 should be no more than 1493 tonnes. If this stock is not under the EU landing obligation in 2017 and discard rates do not change from the average of the last three years (2013–2015), this implies landings of no more than 436 tonnes.

Last year's advice is available at:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/ple-iris.pdf

25.1 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 2016 and 2017

Management of plaice in Division 27.7.a is by TAC and there is a minimum landing size (MLS) of 27 cm in force. The agreed TACs and associated implications for plaice in Division 27.7.a are detailed in the tables below.

2016

Species:	Plaice *Pleuronectes platessa*	Zone:	VIIa (PLE/07A.)
Belgium	28		
France	12		
Ireland	768		
The Netherlands	9		
United Kingdom	281		
Union	1 098		
TAC	1 098		Analytical TAC

(Source: Council Regulation (EU) 2016/72, ANNEX IA)

2017

Species:	Plaice *Pleuronectes platessa*	Zone:	VIIa (PLE/07A.)
Belgium	28		
France	12		
Ireland	768		
The Netherlands	9		
United Kingdom	281		
Union	1 098		
TAC	1 098	Precautionary TAC Article 7(2) of this Regulation applies	

(Source: Council Regulation (EU) 2017/127, ANNEX IA)

The fishery in 2016

National landings data reported to ICES and Working Group estimates of total landings are given in Table 25.2.1. A summary by gear is given below.

Catch (2016)	Landings			Discards		
1119 t	Beam trawl	Otter trawl	Other gear types	Beam trawl	Otter trawl	Other gear types
	49%	30%	21%	39%	44%	17%
	682 t			437 t		

The TAC in 2016 was 1098 tonnes and the working group estimate of landings in 2016 was 682 tonnes, which is a 55% increase in landings comparable to 2015 and represents 62% of the 2016TAC. This shortfall in estimated landings relative to the TAC has occurred in previous years, previously 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 MLS 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 Belgian, UK (E&W), NI, Netherland and Irish fleets comprised approximately 12%, 5%, 3%, 1% and 79% respectively of total landings in 2016. The landings of plaice are mainly split between beam trawlers (49%; primarily Belgian vessels then Irish vessels) targeting sole, and otter trawlers (30%; 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 25.2.1). 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 25.2.4 to 25.2.6).

A general description of the fishery can be found in the stock annex (Annex 25) 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.

25.2 Data

Landings

National landings data reported to ICES and Working Group estimates of total landings are given in Table 25.2.1. 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 25.2.2a).

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 are presented for all UK(E&W) gears in Figure 25.2.4, for Irish otter trawls in Figure 25.2.5 and Belgian beam trawl fleets in Figure 25.2.6. For all of the fleets illustrated the discarding pattern is dominated by discarding of small fish, below the MLS of 27 cm.

WKFLAT 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 25.2.1, Figure 25.2.2b) 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 (62% average discard 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 ICES WKIRISH (2017) report.

Biological

Landings numbers-at-age are given in Table 25.2.5 and plotted in Figure 25.2.2a. Weights-at-age in the landings and stock are given in Table 25.2.6. Discard weights-at-age are given in Table 25.2.7 and weights-at-age in the stock in Table 25.2.8. 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 MLS (see stock annex, Figure A2).

Surveys

All available tuning data are shown in Tables 25.2.2, 25.2.3 (a and b) and 25.2.4. 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 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 has been conducted this year to correct for some inconsistency in the index calculation (Cambiè and Earl, 2017). This revision does not substantially change the trend of the biomass index.

Previous 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 age 1–4 fish calculated from the UK(E&W)-BTS-Q3 (Table 25.2.4) indicates an upwards trend between 1993 and 2003 with stability at a high level subsequently. The trends are mainly driven by increases in the biomass in the eastern Irish Sea (Figure 25.2.8). The NIGFS-WIBTS surveys show similar increases in biomass between 1993 and 2003/4 and then a further increase subsequently.

The NIGFS-WIBTS survey strata can be disaggregated into eastern (Strata 4–7) and western (Strata 1–3) subareas, where the subareas are divided by the deep trench that runs roughly north–south to the west of the Isle of Man (Figure 25.2.7, Table 25.2.3). The notable difference in mean biomass between spring and autumn in the western area (Strata 1–3) suggests either that spawning fish migrate into the area during spring or that catchability of plaice increases during spawning.

The SSB of plaice in the Irish Sea is also independently estimated using the Annual Egg Production Method (AEPM, Figure 25.2.2):

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 25.2.8) 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-Q3 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 25.2.9).

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 25.2.2 and Figure 25.2.1 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 1978 respectively. Effort by UK *Nephrops* trawlers has greatly increased in the years 2006–2014 but has decreased in the last two 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 and 2016 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.

25.3 Historical stock development

Model: Age-based analytical assessment (SAM) that uses landings and discards (Nielsen and Berg, 2014).

Software: R version 3.3.2 with additional packages (version in parenthesis):

stockassessment (0.2.0); FLCore (2.6.0); reshape (0.8.6); ggplot2 (2.2.1); Cairo (1.5–9); doParallel (1.0.10); TMB (1.7.9). (additional packages ellipse, MASS)

Model options chosen

The Aarts and Poos model was replaced by the state–space assessment model (SAM). WGCSE 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) have been provided in the WKIRISH 2017 (Annex 4). The SAM model incorporates the estimated historic discards and is now used to run the assessment.

The model runs were performed using the R package 'stockassessment' (Nielsen *et al.*, 2016). Settings for this update stock assessment are given in the table below. The update assessment follows the same procedure as in the WKIRISH 2017 benchmark assessment. A baseline run of the model was performed using discards since 1981 reconstructed according to the medium discard scenario (ICES, WKIRISH 2017, Annex 4). 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 (ICES, WKIRISH 2017). 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.

Data screening

Data was screened as described in the stock annex.

Final update assessment

ICES, WKIRISH (2017) 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		2014	2015	2016	2017
Assessment model		AP	AP	AP	SAM
Tuning fleets	UK (E&W)-BTS-Q3	Series omitted	Series omitted	Series omitted	Series omitted
	Extended UK (E&W)-BTS-Q3	1993–2013, ages 1–6	1993–2014, ages 1–6	1993–2015, ages 1–6	1993–2016, ages 1–6
	UK(E&W) BTS Mar	Survey omitted	Survey omitted	Survey omitted	Survey omitted
	UK(E&W) OTB	Series omitted	Series omitted	Series omitted	Series omitted
	UK(E&W) BT	Series omitted	Series omitted	Series omitted	Series omitted
	IR-OTB	Series omitted	Series omitted	Series omitted	Series omitted
	NIGFS-WIBTS-Q1*	1993–2013	1993–2014	1993–2015	1993–2016
	NIGFS-WIBTS-Q4	1993–2013	1993–2014	1993–2015	1993–2016
Selectivity model		Linear Time Varying Spline at age (TVS)	Linear Time Varying Spline at age (TVS)	Linear Time Varying Spline at age (TVS)	Correlated random walk
Discard fraction		Polynomial Time Varying Spline at age (PTVS)	Polynomial Time Varying Spline at age (PTVS)	Polynomial Time Varying Spline at age (PTVS)	Estimated by WKIRISH
Landings num at age, range:		1–9+	1–9+	1–9+	1–8+
Discards N at age, yrs, ages:		2004–2012, ages 1–5	2004–2013, ages 1–5	2004–2014, ages 1–5	1981–2016, ages 1–8+

The estimated selectivity patterns, split into the landed and discarded components are shown in Figure 25.2.9. Until early 1990s the landings selectivity had the highest values for fish aged 4 (indicating that 4 years age fish were selected). This selectivity shifted to age 5 in late 1990s and early 2000s, due to the increase of the MLS 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 (Figure 25.2.9).

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 25.2.10).

Diagnostic output from the SAM model is shown in Figure 25.2.11. 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. In the catch residuals, negative values are apparent in ages 8+ from 1998.

Recruitment is fluctuating without an overall trend. 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 25.2.12).

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. The SSB trend is largely in agreement with independent SSB estimates from the Annual Egg Production Method (AEPM, Figure 25.2.13), 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 25.2.13).

Estimates of numbers-at-age in the landings, discards and population, and fishing mortality numbers-at-age are given in Tables 25.3.1–25.3.4. A summary plot for the SAM assessment is shown in Figure 25.2.14 and the time-series estimates for F, SSB and recruitment are given in Table 25.3.6.

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 (Figures 25.2.15 and 25.2.16). The ten assessment model configurations compared in WKIRISH 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 (prior to 2004, discards estimates are reconstructed values based on size-varying discard rates).

State of the stock

Trends in F_{BAR}, SSB, recruitment and catch, for the full time-series, are shown in Table 25.3.6 and Figure 25.2.14. 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. Estimated recruitments are highly variable but an increasing trend is present (Figure 25.2.14). Catch has decreased to low levels and, since 2004, the majority of the catch has been discarded (62% average discard since 2004).

25.4 Short-term projections

Model used: FLR projection

Software used*:* FLR projection

Initial stock size: Taken from last year of assessment

Maturity: The constant maturity ogive used in the assessment

F and M before spawning: 0

Weight-at-age in the stock: Average of the last three years' catch weights-at-age (2014–2016)

Weight-at-age in the catch: Average of the last three years' catch weights-at-age (2014–2016)

Exploitation pattern: Average of the last three years' selectivity (2014–2016)

Intermediate year assumptions: average F from last three years (2014–2016)

Stock–recruitment model used: Geometric mean recruitment (1981–2016)

Procedures used for splitting projected catches: Split according to average landings fractions at age from last ten years. 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.

Raised InterCatch data in 2016 were 1.96% above the precautionary TAC (1098 t). F estimates 2014–2016 is progressively decreasing from 0.09 (2014) to 0.06 (2015) and 0.05 (2016), although this decrease cannot be considered a trend, being consistent only over the last three years. Therefore, F in 2017 has been estimated by averaging the F 2014–2016. This option has been considered more conservative than the use of F in 2016 (F *status quo*, Fsq), which caused a decrease in the catch projections.

Biological and selectivity parameters were also averaged over the last three years (2014–2016). Recruitment was forecast using a long-term geometric mean (1981–2016) due to temporal variability in the time-series.

Complete input data for the short-term forecast are shown in Table 25.3.7.

A full management options table is provided. Implementing the management plan for this stock with F_{MSY}=0.165 leads to a total catch of 3254 t (1749 t of landings and 1505 t of discards) in 2018 and an SSB of 23 013 t in 2019.

25.5 Medium-term projections

There are no medium-term projections for this stock.

25.6 MSY explorations

The most recent reference points for this stock were developed by WKIRISH3 in 2017 (ICES, 2017) and are presented in the table below.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	10 392	Lower 5%ile of current biomass	ICES. 2017
	F_{MSY}	0.1645646	Stochastic simulations with segmented regression from entire time-series (1981–2015)	ICES. 2017
Precautionary approach	B_{lim}	4250	Median breakpoint of stochastic fitting of segmented regression stock–recruit function	ICES. 2017
	B_{pa}	5825	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.192$	ICES. 2017
	F_{lim}	0.4805195	F with 50% probability of SSB < B_{lim}	ICES. 2017
	F_{pa}	0.3472183	F_{lim} combined with the assessment error; $F_{lim} \times \exp(-1.645 \times \sigma)$; $\sigma = 0.198$	ICES. 2017
Management plan	SSB_{mgt}			
	F_{mgt}			

Yield per Recruit analysis

There are no yield per recruit analyses for this stock.

25.7 Management plans

There are no management plans for this stock.

25.8 Uncertainties and bias in assessment and forecast

The assessment was benchmarked in 2017 (WKIRISH 2017), 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.

25.9 Recommendations for next benchmark

There is evidence of substantial substock structure and incorporating information about the differences in growth and maturity between the eastern and western 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.

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
2017	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 between the eastern and western sides of the Irish Sea, and by sex. - Creating age based indices for the NI groundfish surveys	20XX (TBD)	Expert group members

25.10 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).

25.11 Sources

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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, G. and Earl, T. 2017. Review of the UK(E&W)-BTS-Q3 abundance index for Irish Sea plaice (ple-iris, plaice 7a). Working document submitted to ICES 2017.

ICES. 2011. Report of the Benchmark Workshop on Flatfish (WKFLAT), 1–8 February 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:39.

Table 25.2.1. Nominal landings (tonnes) of Plaice in Division 27.7.a as officially reported to ICES.

Year	Belgium	France	Ireland	Netherlands	UK (Eng.&Wales)**	UK (Isle of Man)	UK (Scotland)	Total official landings	Discards
1994	332	13	547	-	1 082	14	63	2051	-
1995	327	10	557	-	1 050	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	628
2005	566	9	272	-	422	0	1	1270	1210
2006	343	2	179	-	413	0	0	937	1254
2007	194	2	194	-	412	0	0	802	1743
2008	157	2	102	-	300	1	1	562	1270
2009	197	0.4	73	-	185	…	2	457	1131
2010	138	0.2	89	-	148	0.5	3	379	2560
2011	332	0.28	118	-	145	0.25	0	594	604
2012	236	0.08	106	-	154	0.11	0	496	981
2013	144	0.29	67	-	91	0.05	0	303	718
2014	100	0.03	123	-	59	0.08	0	282	1196
2015	115	0.01	244	-	80	0	0	439*	565
2016	82	0.01	605	-	56	0	0	742*	437

*** Provisional.**

**** Northern Ireland included with England and Wales.**

Table 25.2.2. 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 ('000hrs)					
	UK(E&W) Beam trawl survey[4]			English[1]		Belgian[5]	Irish[7]		English			Belgian[5]	Irish	
	March	September Prime only	September Extended	Otter Trawl	Beam Trawl	Beam Trawl	Otter Trawl	Beam Trawl	Otter[2] Trawl	Beam[2] Trawl	Nephrops 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	3.08	7.8			88.1	2.8		18.5		
1984				7.77	6.98	6.8			103.1	4.1		13.6		
1985				9.97	25.70	8.8			102.9	7.4		21.9		
1986				9.27	4.21	8.7			90.3	17.0		38.3		
1987				7.20	3.57	8.2			130.6	22.0		43.2		
1988		392		5.02	3.05	6.3			132.0	18.6		32.7		
1989		253		5.51	13.59	6.2			139.5	25.3		36.7		
1990		239		5.93	12.02	7.2			117.1	31.0		38.3		
1991		157		4.79	10.56	7.5			107.3	25.8		15.4		
1992		188		4.20	9.99	11.9			96.8	23.4		23.0		
1993	91	235	149	3.97	9.50	5.0			78.9	21.5		24.4		
1994	128	225	132	4.90	7.79	9.2			43.0	20.1	0.0	31.6		
1995	134	169	109	5.08	7.69	9.5	3.2	17.0	43.1	20.9	0.0	27.1	80.3	8.6
1996	-[6]	210	111	5.37	12.96	11.8	4.1	18.9	42.2	13.3	0.0	22.2	64.8	6.3
1997	147	262	148	5.25	7.66	13.9	3.1	13.7	39.9	10.8	0.0	29.3	92.2	9.0
1998	113	249	146	5.00	5.66	12.3	3.7	22.2	36.9	10.4	0.0	23.8	93.5	11.6
1999	-[6]	264	151	5.38	7.76	7.1	2.3	23.2	22.9	11.0	0.0	37.2	110.3	14.7
2000	-[6]	357	169	5.02	13.04	7.8	2.0	13.8	27.0	6.3	0.0	27.0	82.7	11.4
2001		281	147	3.35	8.33	9.2	2.5	10.8	33.0	12.5	0.0	41.9	77.5	13.1
2002		340	200	5.66	5.46	7.4	2.8	7.9	24.8	8.0	0.0	52.5	77.9	17.7
2003		503	247	2.60	3.76	7.5	4.1	9.5	23.9	14.0	0.0	48.7	73.8	18.7
2004		540	249	3.17	4.20	11.2	2.1	8.6	23.5	7.4	0.0	36.1	72.5	14.2
2005		367	177	4.85	4.67	12.8	2.0	8.0	16.7	11.6	1.0	42.1	68.3	14.7
2006		356	166	6.50	2.19	10.8	1.37	6.3	5.2	4.6	10.9	28.9	64.9	11.9
2007		432	190	17.94	4.22	6.9	1.20	6.1	4.4	3.2	12.6	23.8	73.2	14.0
2008		416	189	9.03	4.47	9.5	0.90	5.2	2.7	1.3	11.5	12.4	58.8	9.5
2009		467	199	6.46	1.21	10.1	1.0	3.8	1.5	0.5	10.0	14.7	41.5	7.6
2010		400	166	11.55	14.39	7.9	1.0	4.5	1.4	0.2	9.2	15.2	45.8	9.4
2011		417	155	4.35	11.95	18.7	1.2	5.5	0.7	1.6	11.7	16.4	54.5	8.1
2012		460	190	0.74	7.25	14.9	1.0	4.9	0.4	0.9	12.1	14.5	58.2	7.2
2013		550	211	7.41	-[8]	14.0	1.6	5.4	0.3	-[8]	10.6	8.9	42.7	5.0
2014		592	270	-	-[8]	13.9	1.5	8.3	0.0	-[8]	8.3	5.1	47.8	6.0
2015		564	235	-	-[8]	20.4	3.3	8.6	0.0	-[8]	4.5	4.6	41.0	8.3
2016		582	220	0	0	26.4	4.6	32.8	0.0	0.0	2.5	2.5	33.4	7.9

1 Whole weight (kg) per corrected hour fished, weighted by area
2 Corrected for fishing power (GRT)
3 Kg/hr
4 Kg/100km. Sept Prime: ISS/ISN Traditional Prime Stations Only. Sept Extended: ISS/ISN/ISW/SGC All Stations.
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

Fishing power corrections are detailed in Appendix 2 of the 2000 working group report

Table 25.2.3a. Irish Sea plaice: NIGFS-WIBTS-Q1 and Q4 indices of relative biomass trends by region in spring.

NIGFS-WIBTS-Q1	Estimated mean abundance			Estimated standard error		
Mar (Spring)	Combined	West	East	Combined	West	East
Year	Str1–7	Str1–3	Str4–7	Str1–7	Str1–3	Str4–7
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	2.99	3.90	3.70

Table 25.2.3b. Irish Sea plaice: NIGFS-WIBTS-Q1 and Q4 indices of relative biomass trends by region in autumn.

NIGFS-WIBTS-Q4	Estimated mean abundance			Estimated standard error		
Oct (Autumn)	Combined	West	East	Combined	West	East
Year	Str1–7	Str1–3	Str4–7	Str1–7	Str1–3	Str4–7
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

Table 25.2.4. Irish Sea plaice: UK (E&W)-BTS-Q3 biomass index (extended area). Ages in bold are those used in the assessment.

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

Table 25.2.5. Irish Sea plaice: Landings number-at-age 1 to 8+ (thousands), where rows are years 1981–2016 and columns are ages 1 to 8+.

IRISH SEA PLAICE
1 2
1981 2016
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

Table 25.2.6. Irish Sea plaice: Landings weight-at-age 1 to 8+ (kg), where rows are years 1981–2016 and columns are ages 1 to 8+

IRISH SEA PLAICE
1 3
1981 2016
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

Table 25.2.7. Irish Sea plaice: Discards weight-at-age 1 to 8+ (kg), where rows are years 1981–2016 and columns are ages 1 to 8+.

IRISH SEA PLAICE
1 23
1981 2016
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
0.057	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

Table 25.2.8. Irish Sea plaice: New stock weights-at-age modified to include discard element (kg).

IRISH SEA PLAICE
1 4
1981 2016
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

Table 25.3.1. Irish Sea plaice: Estimated landed numbers-at-age (thousands).

year\age	1	2	3	4	5	6	7	8+	total
1981	24	1704	4592	3156	828	247	108	250	10908
1982	23	857	3747	3330	1332	360	130	215	9994
1983	50	2696	2712	2958	1454	649	205	230	10956
1984	45	2716	4940	1410	1089	531	293	230	11253
1985	5	2449	5207	3099	608	509	268	309	12454
1986	35	1835	5332	3090	1449	296	292	344	12673
1987	59	3216	4890	3784	1487	801	158	409	14804
1988	56	2673	4995	2587	1398	614	350	319	12991
1989	33	1690	4892	2588	911	500	231	308	11153
1990	12	1140	2966	3134	1135	411	236	269	9304
1991	150	1599	1721	1909	1490	522	193	263	7847
1992	145	2071	3200	1189	1060	919	319	300	9202
1993	32	1232	2092	1724	391	376	413	279	6540
1994	97	1187	2981	1461	721	211	171	330	7160
1995	26	991	1771	2116	624	297	99	224	6147
1996	24	970	1381	1232	1030	315	127	169	5249
1997	25	664	1880	1335	749	591	208	201	5653
1998	6	718	1195	1122	685	395	315	263	4699
1999	58	748	1351	1242	636	321	189	258	4801
2000	372	393	1001	1563	788	292	177	227	4812
2001	14	454	890	1096	1102	367	144	222	4288
2002	1	227	1132	1038	835	640	195	209	4277
2003	207	280	1009	1240	643	427	285	223	4314
2004	18	251	787	900	724	241	155	224	3301
2005	9	220	733	1340	633	522	151	280	3889
2006	2	174	789	563	776	428	242	286	3260
2007	0	57	298	685	490	332	194	244	2299
2008	0	91	407	475	487	252	143	135	1988
2009	0	9	180	379	320	315	98	187	1489
2010	0	6	75	311	190	221	102	151	1055
2011	1	80	320	406	565	306	167	262	2107
2012	0	5	125	263	268	327	137	274	1400
2013	1	17	77	176	229	188	143	287	1118
2014	1	6	61	181	158	141	64	262	874
2015	0	1	40	98	166	117	111	370	902
2016	8	25	89	182	263	271	162	388	1388

Table 25.3.2. Irish Sea plaice: Estimated discarded numbers-at-age (thousands).

year\age	1	2	3	4	5	6	7	8+	total
1981	483	4490	5886	399	7	0	0	0	11265
1982	653	3080	3490	405	14	0	0	0	7643
1983	707	3478	1584	319	17	1	0	0	6106
1984	581	2767	1879	122	12	1	0	0	5361
1985	578	2672	1507	218	5	1	0	0	4981
1986	565	3008	1588	239	13	0	0	0	5414
1987	635	2562	1763	321	16	2	0	0	5300
1988	440	3569	2063	253	21	1	0	0	6347
1989	330	1936	2230	281	18	2	0	0	4796
1990	498	1430	1527	431	34	2	0	0	3922
1991	304	2678	1120	344	62	4	0	0	4513
1992	506	2246	2653	283	59	10	1	0	5757
1993	524	4316	2190	455	24	4	1	0	7514
1994	406	2951	3576	395	51	3	0	0	7381
1995	617	2581	2520	614	48	4	0	0	6384
1996	786	3497	2391	430	102	6	0	0	7212
1997	838	5929	3642	546	86	13	1	0	11055
1998	749	6893	6639	1494	241	25	4	0	16047
1999	493	4153	6687	1665	226	20	3	0	13247
2000	0	3288	4194	1897	222	14	2	0	9617
2001	515	3561	3188	1215	268	15	1	0	8763
2002	471	3748	3817	1091	186	24	1	0	9339
2003	0	3211	3607	1531	186	20	1	0	8556
2004	208	1746	2904	1369	333	18	1	0	6580
2005	278	2742	2888	1248	991	88	10	34	8280
2006	460	2682	3771	2012	543	210	13	3	9695
2007	643	4142	4165	2840	916	315	134	188	13345
2008	412	4049	3364	1654	995	201	27	315	11017
2009	228	2135	3809	1337	617	291	60	94	8570
2010	505	3090	4156	3735	1770	729	532	471	14988
2011	367	2012	1821	1009	689	246	68	207	6419
2012	330	3164	2902	1583	711	506	207	333	9736
2013	218	1660	2702	1416	621	206	121	86	7029
2014	280	1861	2531	2017	1132	581	251	361	9015
2015	90	1207	1521	1169	804	553	127	99	5569
2016	57	563	1328	934	506	285	133	152	3959

Table 25.3.3. Irish Sea plaice: Estimated population numbers-at-age (thousands).

year\age	1	2	3	4	5	6	7	8+	total
1981	16551	19743	17922	7215	2013	690	327	758	65220
1982	22504	12455	13178	7697	3267	1005	394	651	61152
1983	23987	20612	7809	6371	3314	1662	569	637	64962
1984	22914	21373	14352	3298	2721	1480	881	691	67710
1985	21131	20371	14774	7273	1525	1412	803	924	68214
1986	21740	17772	14857	7051	3490	775	830	974	67488
1987	21188	19734	12378	7647	3136	1827	393	1014	67317
1988	15564	20293	13203	5329	2955	1387	853	777	60361
1989	12469	13430	14672	5962	2149	1260	625	833	51400
1990	16109	9271	9210	7447	2735	1057	653	741	47221
1991	16474	14538	5648	4648	3635	1363	542	737	47584
1992	17953	12976	9754	2564	2200	2021	753	706	48926
1993	15901	16559	7770	4189	894	903	1066	720	48002
1994	15076	12586	11717	3613	1692	520	452	869	46524
1995	17779	11101	7803	5625	1595	809	291	658	45660
1996	22407	13795	6994	3611	2933	967	423	560	51688
1997	23010	18487	9948	4017	2166	1847	702	679	60857
1998	19856	21310	12663	4915	2286	1293	1106	917	64346
1999	19079	17432	15817	6639	2640	1342	873	1181	65003
2000	24304	15222	12200	9435	3764	1471	1018	1300	68714
2001	24550	19280	11047	7154	5809	2104	976	1496	72416
2002	25270	21444	15537	7519	4931	4238	1581	1682	82201
2003	22396	23095	17290	11465	4701	3483	2963	2311	87705
2004	20835	18245	18379	12180	7680	2726	2307	3309	85659
2005	17936	19009	13570	11348	7836	4856	1879	3580	80013
2006	23208	15609	15197	8945	6651	4512	2982	3426	80529
2007	27272	19361	12490	10999	5739	3897	3095	4019	86873
2008	21940	24188	13737	8655	7647	3540	2296	4662	86665
2009	17347	17392	19262	9491	6507	6156	2553	4647	83353
2010	23865	16309	13419	13641	7719	5311	5183	5336	90782
2011	28083	18255	11769	8529	9404	5574	3906	7259	92778
2012	24327	26163	14914	9722	6269	7108	4526	8183	101212
2013	24507	21361	20716	12553	8287	5277	5663	8859	107222
2014	30255	23063	18582	16072	10548	7326	4959	11046	121851
2015	17550	26217	18745	14636	12183	9428	5908	13525	118193
2016	16169	15934	21177	16255	12506	10654	8603	17013	118313

Table 25.3.4. Irish Sea plaice: Estimated fishing mortality-at-age.

year\age	1	2	3	4	5	6	7	8+	Fbar (3-6)
1981	0.020	0.270	0.652	0.686	0.573	0.474	0.425	0.425	0.596
1982	0.020	0.262	0.632	0.673	0.567	0.474	0.426	0.426	0.586

1983	0.021	0.283	0.684	0.736	0.627	0.530	0.477	0.477	0.644
1984	0.019	0.245	0.592	0.643	0.553	0.476	0.431	0.431	0.566
1985	0.018	0.238	0.575	0.632	0.548	0.478	0.433	0.433	0.559
1986	0.019	0.245	0.593	0.661	0.580	0.514	0.463	0.463	0.587
1987	0.022	0.295	0.708	0.794	0.698	0.620	0.550	0.550	0.705
1988	0.022	0.290	0.690	0.780	0.698	0.628	0.563	0.563	0.699
1989	0.020	0.256	0.596	0.669	0.602	0.543	0.492	0.492	0.602
1990	0.021	0.260	0.590	0.655	0.589	0.530	0.479	0.479	0.591
1991	0.022	0.267	0.594	0.654	0.585	0.521	0.470	0.470	0.588
1992	0.027	0.328	0.731	0.817	0.742	0.656	0.590	0.590	0.737
1993	0.024	0.281	0.622	0.698	0.650	0.582	0.524	0.524	0.638
1994	0.024	0.287	0.621	0.684	0.632	0.563	0.509	0.509	0.625
1995	0.024	0.278	0.588	0.628	0.565	0.494	0.443	0.443	0.569
1996	0.024	0.270	0.555	0.572	0.499	0.427	0.381	0.381	0.513
1997	0.025	0.278	0.566	0.575	0.494	0.418	0.373	0.373	0.513
1998	0.025	0.277	0.566	0.569	0.483	0.407	0.360	0.360	0.506
1999	0.020	0.220	0.445	0.441	0.369	0.304	0.261	0.261	0.390
2000	0.017	0.181	0.364	0.361	0.300	0.243	0.203	0.203	0.317
2001	0.014	0.154	0.313	0.315	0.261	0.209	0.170	0.170	0.275
2002	0.012	0.131	0.266	0.272	0.227	0.178	0.140	0.140	0.236
2003	0.010	0.107	0.217	0.222	0.186	0.143	0.107	0.107	0.192
2004	0.007	0.079	0.158	0.162	0.136	0.103	0.074	0.074	0.140
2005	0.011	0.110	0.214	0.217	0.181	0.134	0.093	0.093	0.187
2006	0.013	0.130	0.240	0.235	0.193	0.139	0.093	0.093	0.202
2007	0.015	0.150	0.271	0.261	0.213	0.152	0.098	0.098	0.224
2008	0.012	0.118	0.207	0.198	0.163	0.118	0.076	0.076	0.171
2009	0.008	0.082	0.146	0.142	0.119	0.088	0.057	0.057	0.124
2010	0.014	0.129	0.227	0.221	0.188	0.140	0.090	0.090	0.194
2011	0.008	0.078	0.136	0.134	0.117	0.090	0.058	0.058	0.119
2012	0.009	0.081	0.143	0.142	0.125	0.099	0.063	0.063	0.127
2013	0.006	0.052	0.091	0.091	0.080	0.065	0.041	0.041	0.082
2014	0.006	0.053	0.095	0.096	0.088	0.073	0.047	0.047	0.088
2015	0.003	0.030	0.055	0.060	0.058	0.052	0.034	0.034	0.056
2016	0.003	0.025	0.046	0.050	0.049	0.045	0.030	0.030	0.047

Table 25.3.5. Irish Sea plaice: SAM stock assessment summary (± 2 standard deviation uncertainty). Recruitment (000s), spawning–stock biomass (SSB, tonnes), mean fishing mortality (F_{bar}) for ages 3–6, total spawning biomass (TBS, tonnes), landings and discards tonnage.

	Recruitment (thousands)			SSB (t)			Fbar (3-6)			TSB (t)			Landings (t)			Discards (t)		
year	Low	Mid	Hight	Low	Mid	Hight	Low	Mid	Hight	Low	Mid	Hight	Low	Mid	Hight	Low	Mid	Hight
1981	11260	16551	24329	5793	7076	8644	0.46	0.60	0.77	10666	12830	15435	2938	3903	5185	707	940	1249
1982	16116	22504	31425	5595	6755	8154	0.46	0.59	0.74	10484	12424	14722	2538	3238	4130	373	476	607
1983	17293	23987	33274	5103	6074	7230	0.51	0.64	0.81	10918	12986	15447	2904	3637	4555	337	422	528
1984	16617	22914	31597	6429	7682	9180	0.45	0.57	0.71	13328	15916	19005	3388	4278	5400	312	394	497
1985	15360	21131	29070	7094	8485	10151	0.44	0.56	0.7	13975	16661	19863	4014	5085	6443	275	349	442
1986	15781	21740	29948	7594	9074	10844	0.47	0.59	0.74	14202	16795	19862	3856	4867	6142	270	340	430
1987	15259	21188	29421	7173	8510	10095	0.57	0.70	0.88	14062	16613	19627	4979	6244	7830	329	413	518
1988	11312	15564	21416	6656	7909	9398	0.56	0.70	0.87	12468	14705	17344	4005	5002	6247	361	451	563
1989	8785	12469	17699	5886	7040	8420	0.48	0.60	0.76	10815	12848	15263	3441	4362	5528	297	377	478
1990	11763	16109	22059	5341	6394	7655	0.47	0.59	0.74	9396	11080	13066	2597	3272	4122	208	262	329
1991	12104	16474	22420	4309	5121	6086	0.47	0.59	0.74	9221	10878	12833	2059	2557	3176	277	344	427
1992	13309	17953	24218	4355	5176	6152	0.59	0.74	0.91	8627	10146	11932	2630	3260	4042	330	409	507
1993	12136	15901	20833	3618	4323	5165	0.51	0.64	0.8	7683	9073	10715	1613	2000	2479	319	395	490
1994	11455	15076	19842	3769	4558	5513	0.5	0.63	0.79	7557	8964	10633	1666	2067	2565	355	441	547
1995	13565	17779	23302	3289	3991	4843	0.45	0.57	0.72	6823	8094	9602	1511	1874	2326	347	430	534
1996	17052	22407	29444	3520	4308	5273	0.4	0.51	0.65	7423	8842	10533	1388	1706	2096	396	487	598
1997	17548	23010	30173	3743	4575	5592	0.41	0.51	0.65	8025	9565	11402	1523	1873	2303	670	824	1013
1998	15143	19856	26036	4034	4968	6119	0.39	0.51	0.65	8294	9933	11896	1431	1765	2178	1101	1358	1675
1999	14444	19079	25202	4595	5740	7170	0.3	0.39	0.51	9191	11117	13447	1295	1600	1978	872	1078	1332

	Recruitment (thousands)			SSB (t)			Fbar (3-6)			TSB (t)			Landings (t)			Discards (t)		
2000	18125	24304	32588	4995	6317	7988	0.23	0.32	0.43	9425	11514	14066	1100	1372	1712	628	784	978
2001	18543	24550	32503	5977	7669	9840	0.2	0.27	0.37	10780	13296	16398	1193	1473	1818	535	660	815
2002	18992	25270	33623	7038	9145	11882	0.17	0.24	0.32	12081	15099	18871	1320	1624	1997	529	651	800
2003	16604	22396	30209	8337	10989	14485	0.14	0.19	0.27	13608	17297	21986	1254	1559	1939	535	665	827
2004	15545	20835	27925	8415	11125	14706	0.1	0.14	0.2	13278	16991	21741	912	1142	1429	494	618	774
2005	13398	17936	24011	8203	10790	14194	0.13	0.19	0.26	13027	16489	20871	1032	1282	1591	585	726	902
2006	17510	23208	30759	7299	9642	12736	0.15	0.20	0.28	12835	16129	20269	756	934	1154	609	752	929
2007	20358	27272	36533	6025	7965	10531	0.16	0.22	0.31	9237	11725	14883	651	806	997	846	1046	1295
2008	16533	21940	29116	6052	7980	10522	0.12	0.17	0.24	10587	13315	16745	457	563	693	617	761	937
2009	12734	17347	23631	6841	9099	12102	0.09	0.12	0.17	9622	12375	15916	364	455	569	543	679	850
2010	17939	23865	31748	6948	9080	11868	0.14	0.19	0.27	11086	13945	17542	301	378	476	1221	1536	1933
2011	20956	28083	37634	8006	10765	14474	0.09	0.12	0.17	12294	15793	20288	481	594	735	293	362	447
2012	18232	24327	32461	6708	9067	12255	0.09	0.13	0.18	8823	11545	15107	406	501	618	491	606	748
2013	18348	24507	32733	8117	10989	14879	0.06	0.08	0.11	11748	15249	19795	245	303	374	352	435	537
2014	21853	30255	41887	8318	11204	15091	0.06	0.09	0.12	12020	15558	20139	232	287	355	458	566	699
2015	12505	17550	24631	10932	15234	21228	0.04	0.06	0.08	14387	19264	25796	353	440	548	276	343	428
2016	11054	16169	23653	16464	22686	31258	0.03	0.05	0.07	21117	28151	37527	543	684	861	197	249	313

Table 25.3.6. Irish Sea plaice. Input data for the short-term forecast.

Age	N2017	N2018	N2019	M	Mat	SWt	Sel	LWt	DWt
1	16 169	20475	20475	0.14	0	0.092	0.063	0.147	0.093
2	15 934	na	na	0.13	0.24	0.078	0.562	0.194	0.076
3	21 177	na	na	0.12	0.57	0.100	1.021	0.258	0.091
4	16 255	na	na	0.12	0.74	0.145	1.074	0.302	0.113
5	12 506	na	na	0.12	0.93	0.196	1.018	0.352	0.123
6	10 654	na	na	0.12	1	0.227	0.887	0.358	0.146
7	8603	na	na	0.11	1	0.295	0.579	0.431	0.153
8	17 013	na	na	0.11	1	0.485	0.579	0.589	0.153

Table 25.3.7. Short-term forecast. Annual catch options. All weights are in tonnes.

Basis	Total catch (2018)	Wanted catch* (2018)	Unwanted catch* (2018)	F_{total} (2018)	F_{wanted} (2018)	$F_{unwanted}$ (2018)	SSB (2019)	% SSB change **	% TAC change ***
ICES advice basis									
MSY approach: F_{MSY}	3254	1749	1505	0.164564	0.0366	0.12789	23013	-2.45	196.34
Other options									
F = 0	0	0	0	0	0	0	25859	9.62	-100
F_{pa}	6421	3472	2949	0.347218	0.0773	0.26984	20248	-14.17	484.80
F_{lim}	8474	4601	3873	0.480519	0.1070	0.37343	18459	-21.75	671.79
SSB (2019) = B_{lim}	25112	14215	10897	2.758924	0.6148	2.14409	4250	-81.98	2187.09
SSB (2019) = B_{pa}	23198	13060	10138	2.241954	0.4996	1.74234	5825	-75.31	2012.75
SSB (2019) = MSY $B_{trigger}$	17801	9875	7926	1.333999	0.2972	1.03671	10392	-55.95	1521.24
F = F_{2017}	978	524	455	0.047341	0.0105	0.03679	25003	5.99	-10.91
F = $F_{MSY\ lower}$	2278	1222	1056	0.113	0.0251	0.08781	23866	1.17%	107.45
F = $F_{MSY\ upper}$	4772	2572	2200	0.249	0.0554	0.19351	21687	-8.07%	334.62

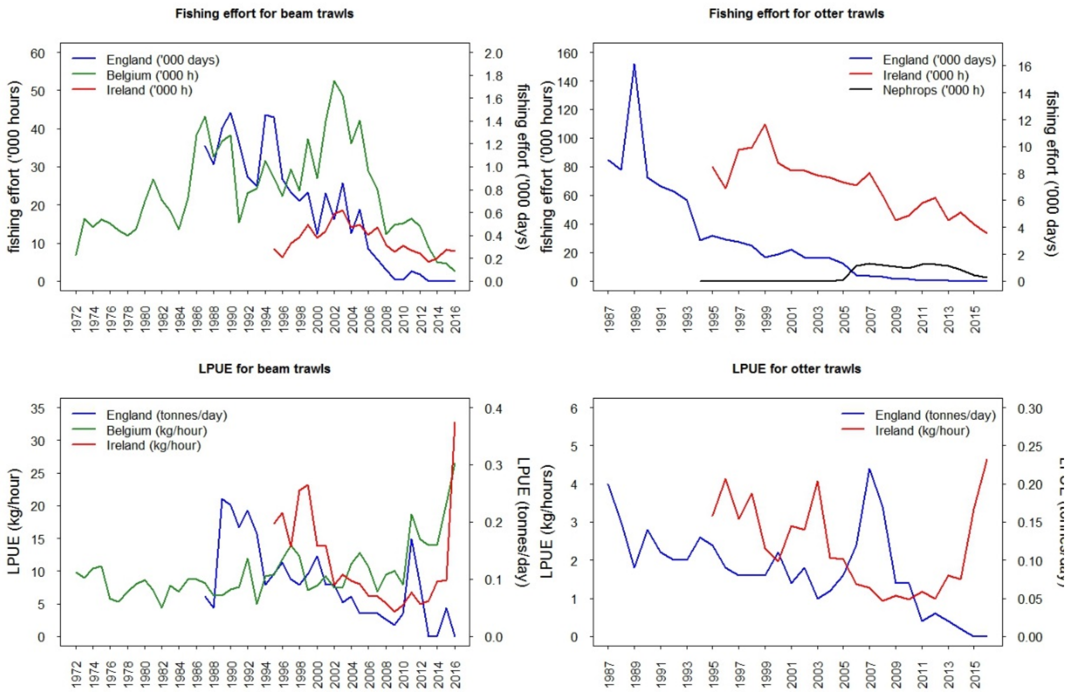


Figure 25.2.1. Irish Sea plaice: Effort and lpue for commercial fleets.

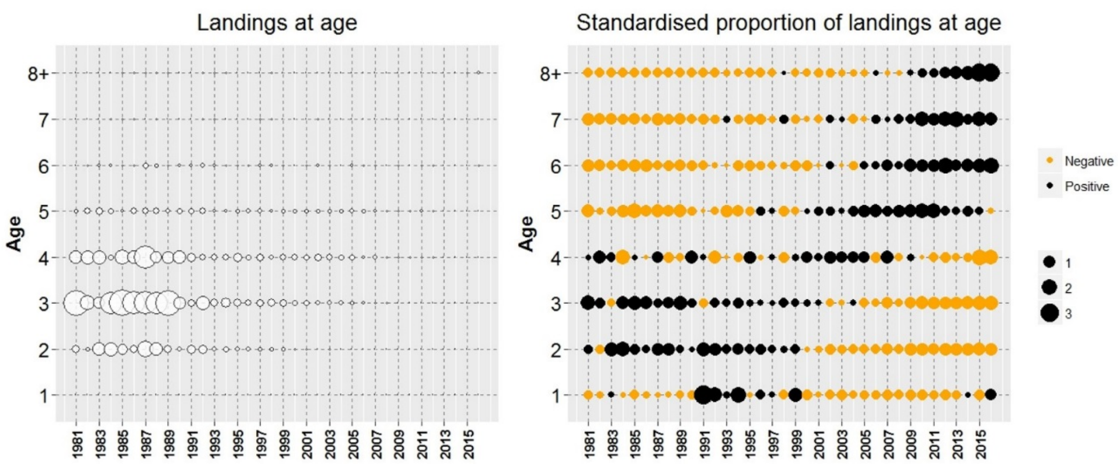


Figure 25.2.2a. Landings-at-age data (left) and mean standardised proportion-at-age (right, black bubbles are positive values and orange bubbles are negative).

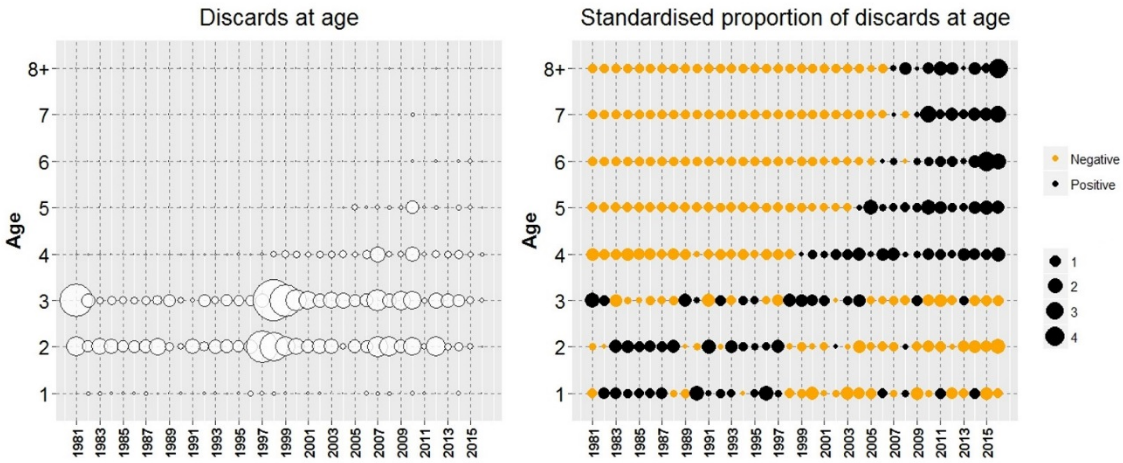


Figure 25.2.2b. Discards-at-age data (left) and mean standardised proportion-at-age (right, black bubbles are positive values and orange bubbles are negative).

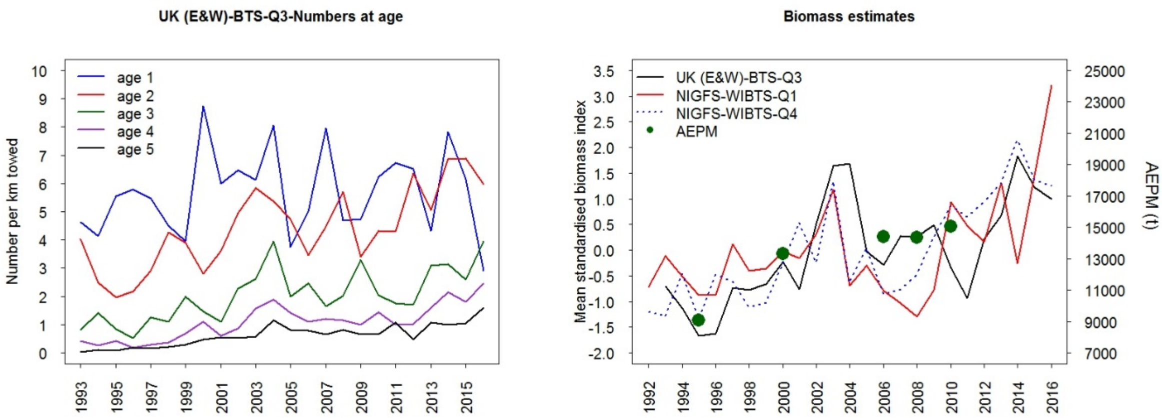


Figure 25.2.3. Left: UK(E&W)-BTS-Q3 (extended area) cpue by age. Right: standardised indices of SBB derived from NIGFS-WIBTS, biomass of ages 1–4 from UK(E&W)-BTS-Q3 (extended area) and the SSB estimates from the Annual Egg Production Methods (circles, right). Mean standardised proportion-at-age = [(proportion-at-age in year) – mean (proportion-at-age over all years)] / STDEV(proportion-at-age over all years).

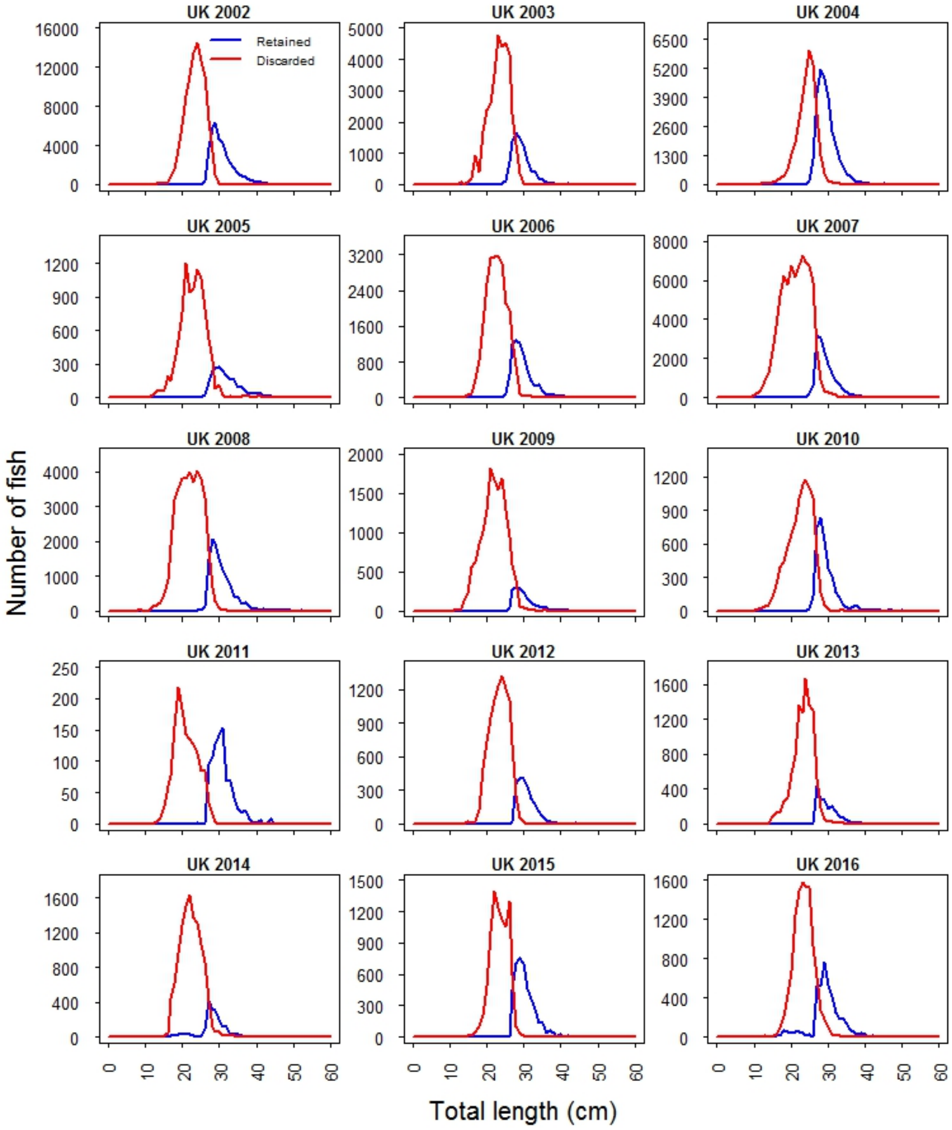


Figure 25.2.4. Length distributions of discarded and retained catches from UK(E&W).

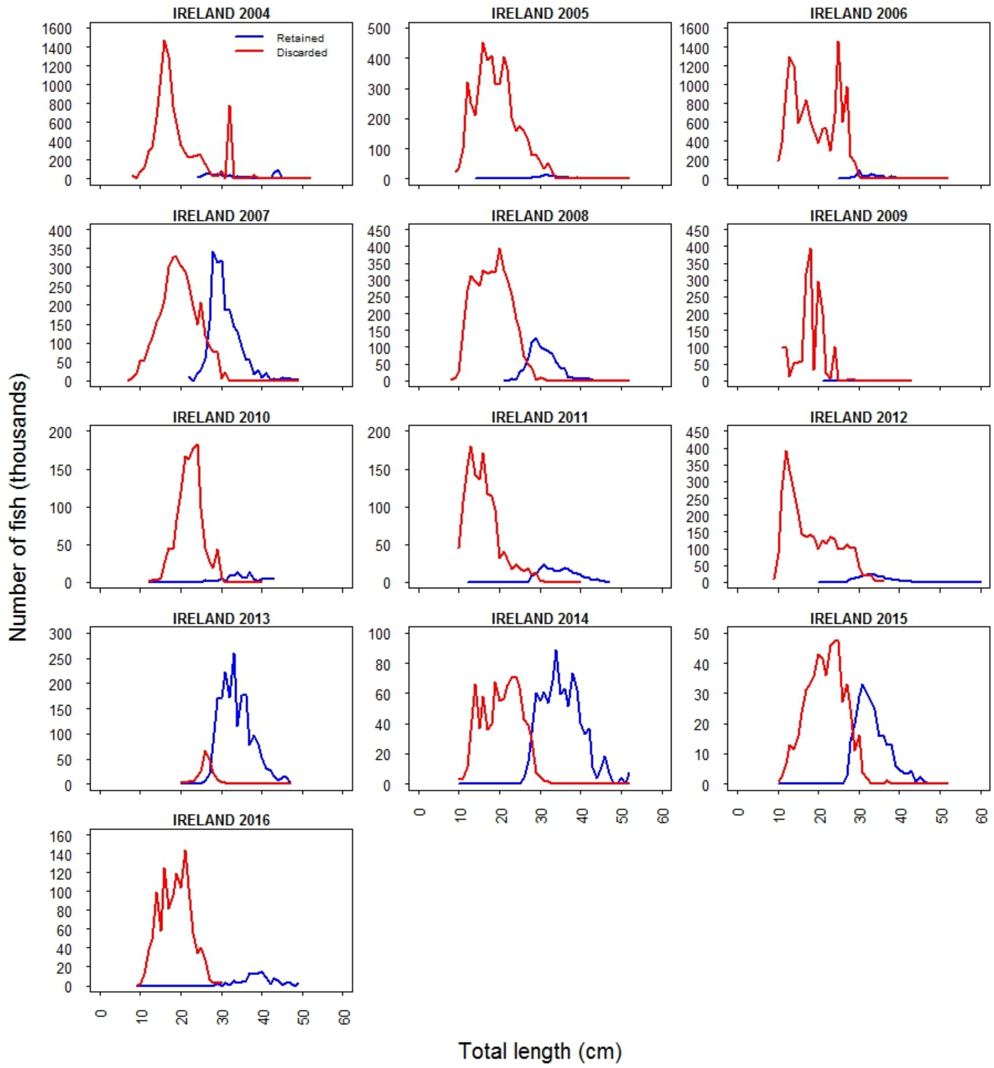


Figure 25.2.5. Length distributions of discarded and retained catches from Ireland.

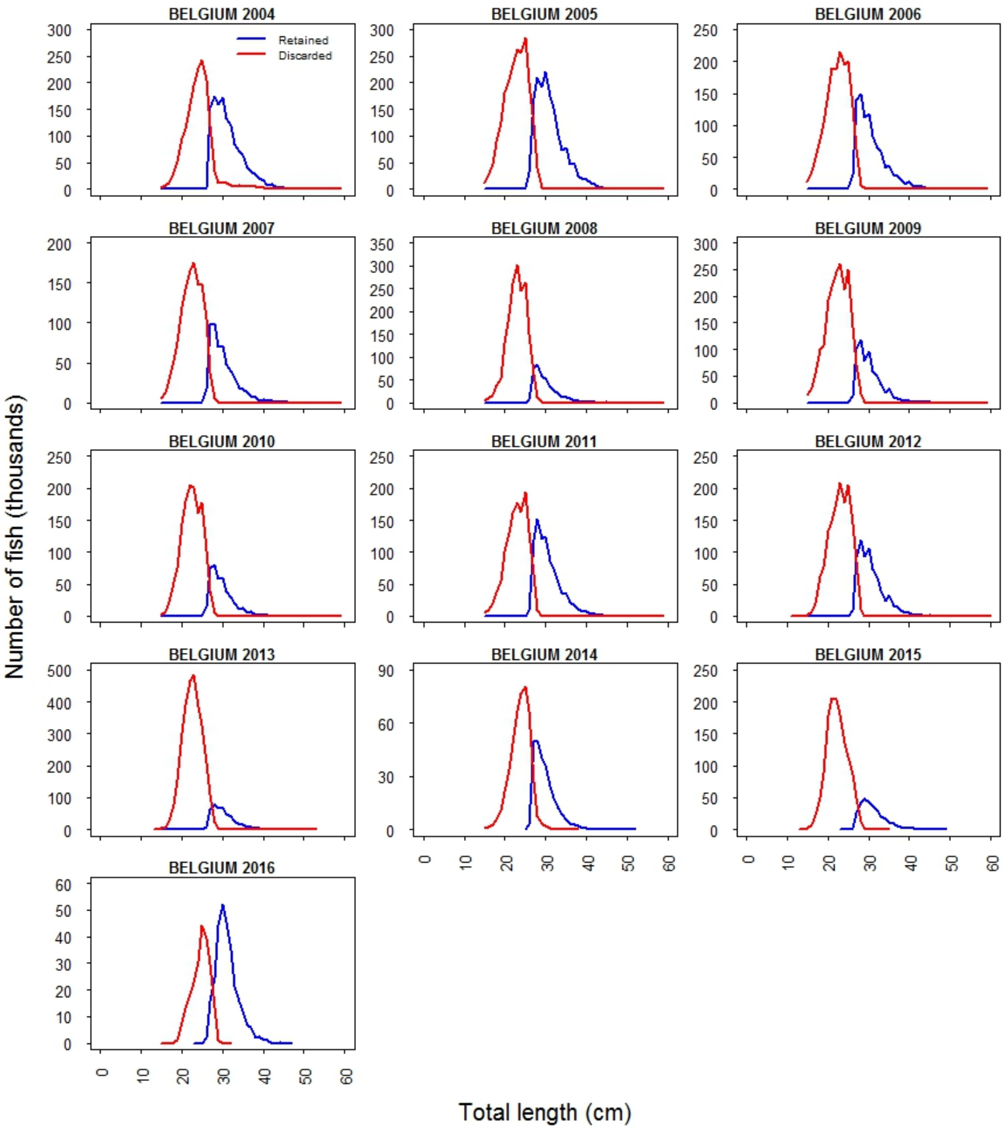


Figure 25.2.6. Length distributions of discarded and retained catches from Belgium.

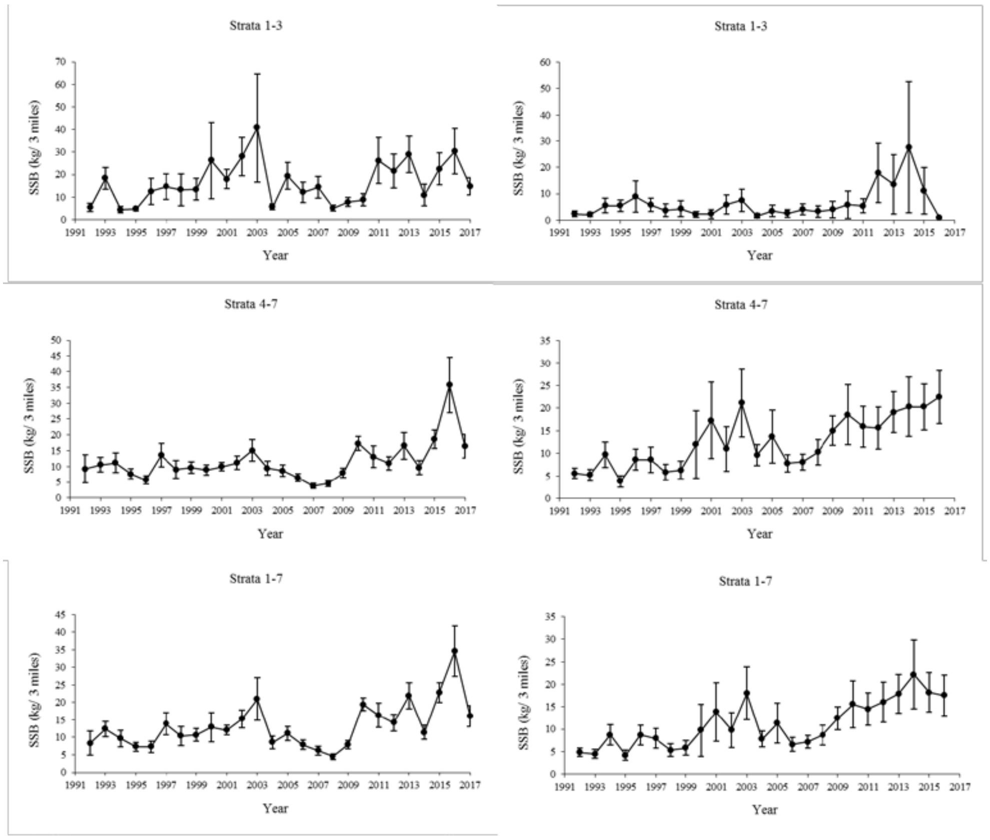


Figure 25.2.7. Northern Irish groundfish survey SSB indices split into spring (left hand panels) and autumn (right hand panels) sampling by western strata (1–3), eastern strata (4–7) and total survey area (strata 1–7) with confidence intervals (± 1 standard error, vertical lines).

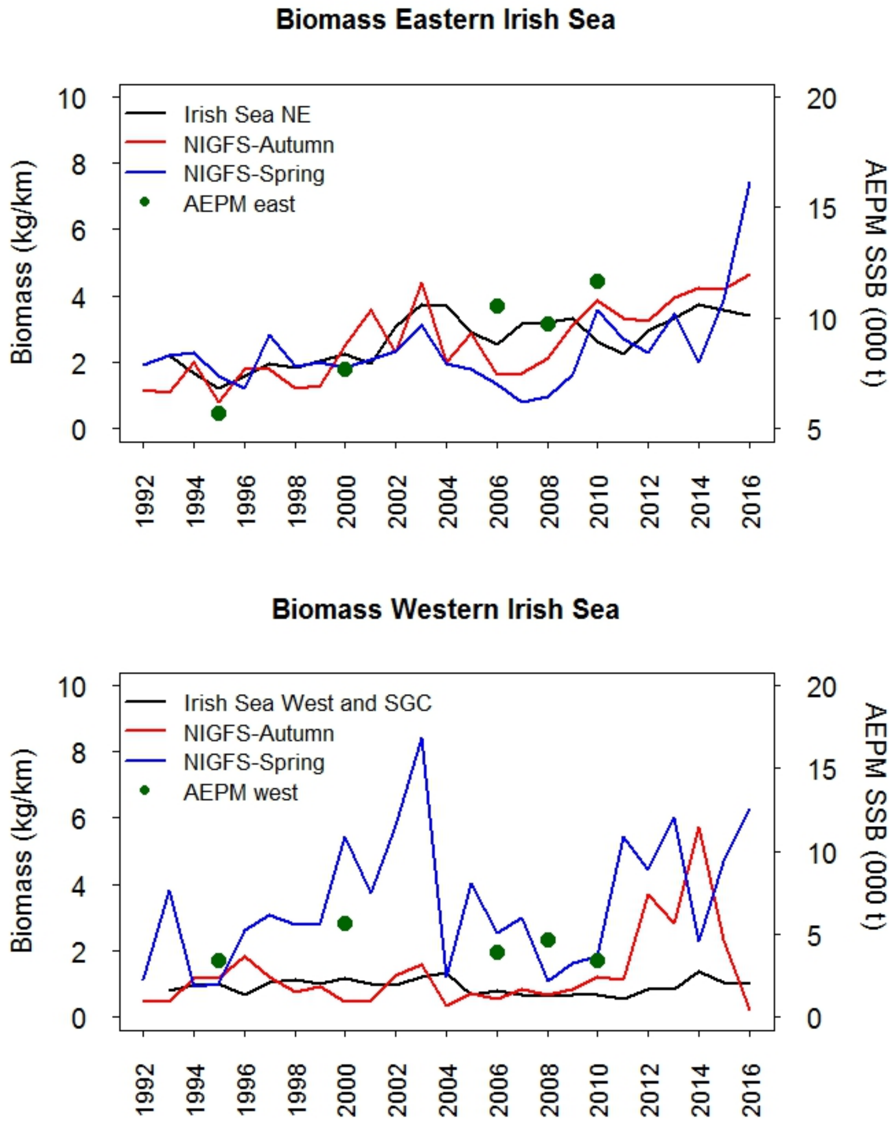


Figure 25.2.8. Trends in biomass indices (kg per km towed) from the UK(E&W)-BTS-Q3 (black line) and the NIGFS-WIBTS-Q1 and -Q3 (blue and red lines respectively) in the eastern Irish Sea (top) and the western and southern Irish Sea (bottom). Also shown (green dots, right axis) are the estimates of SSB from the Annual Egg Production Method (AEPM) from Armstrong *et al.* (2011).

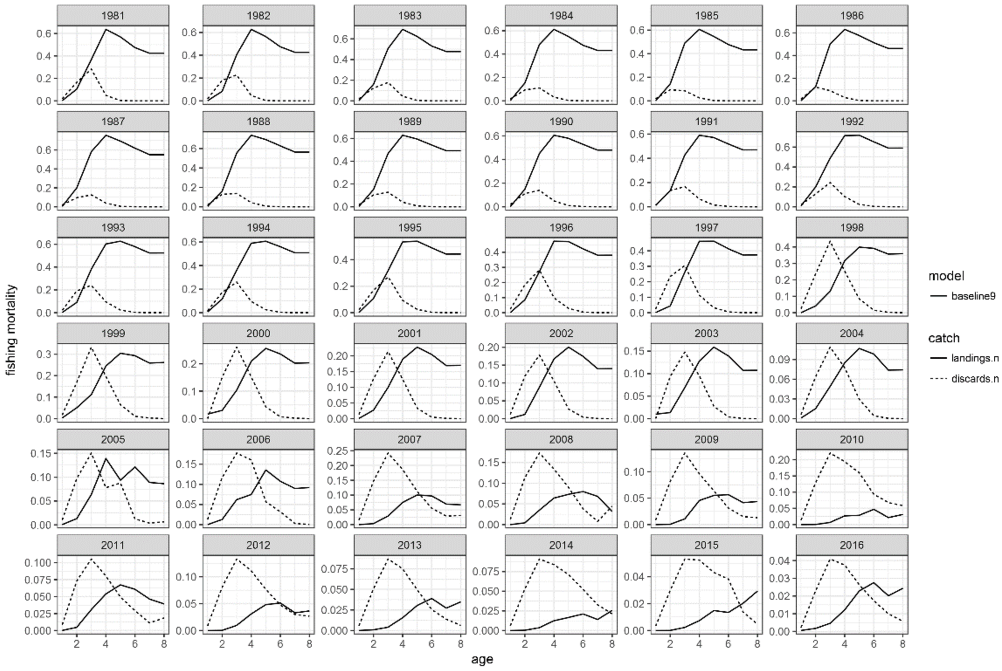


Figure 25.2.9. Selectivity of the fishery split into the landed (solid) and discarded (dashed) components as estimated by the SAM model, where the x-axis shows age and the y-axis gives the fishing mortality-at-age scaled so that the maximum value is 1 and split by the proportion of fish (by number) discarded and landed at-age.

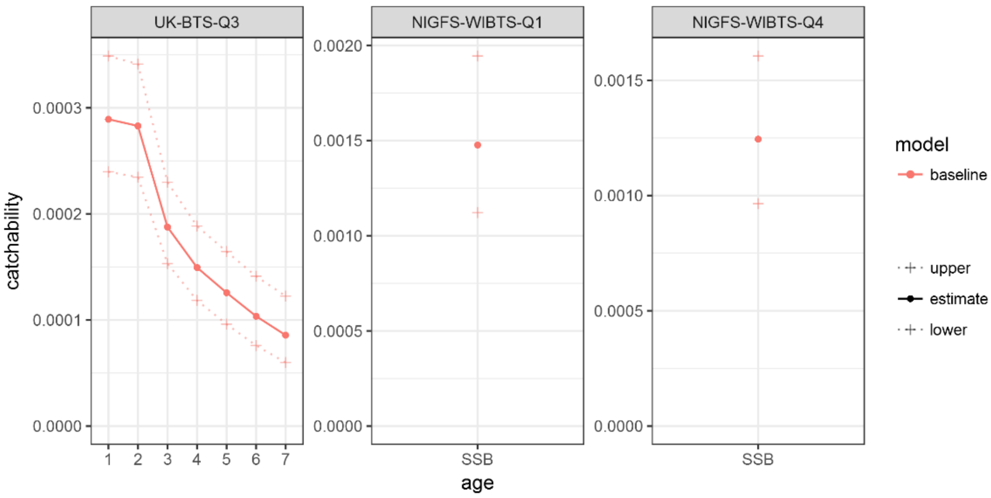


Figure 25.2.10. Catchability for the UK (E&W)-BTS-Q3 extended index by age, NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 as estimated by the SAM model.

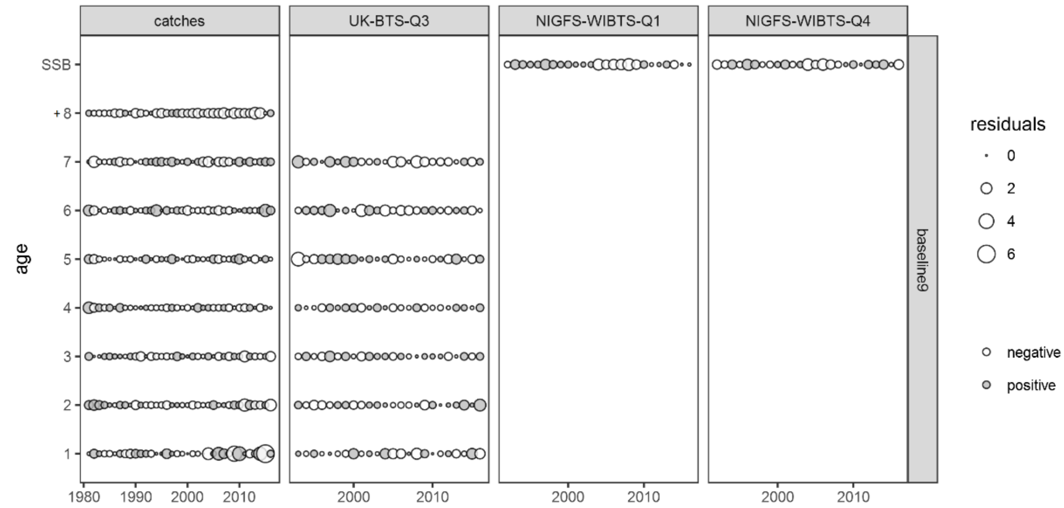


Figure 25.2.11. Residuals in fits to catch and survey data from the baseline model. Expected values were estimated by the SAM model.

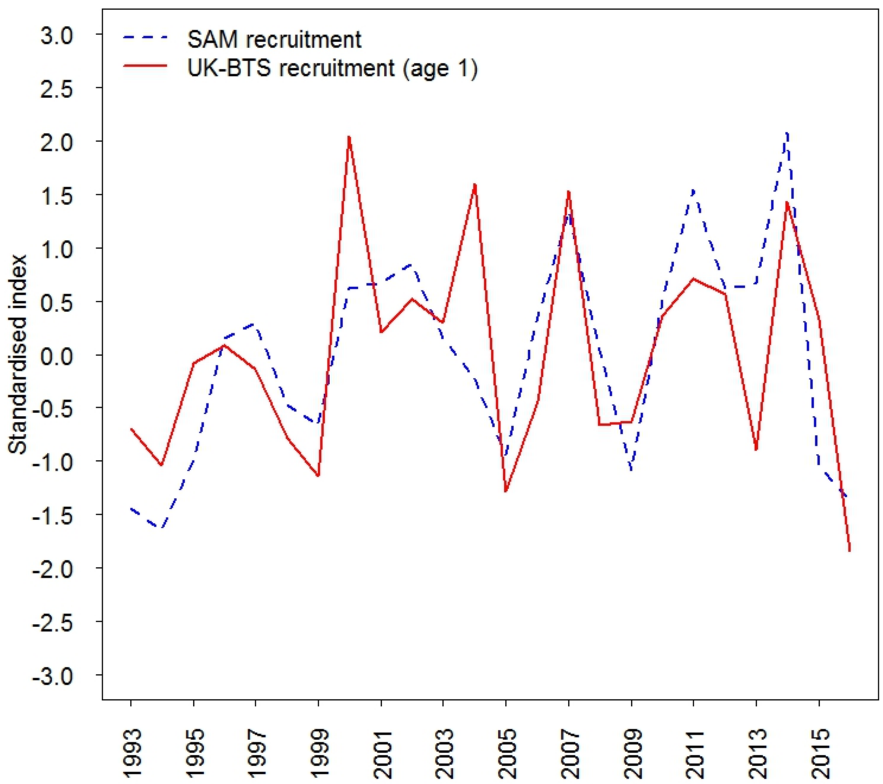


Figure 25.2.12. Comparison of the standardised age 1 index from the UK (E&W)-BTS-Q3 extended area (red) and the standardised recruitment (blue dashed line) estimated by the SAM model.

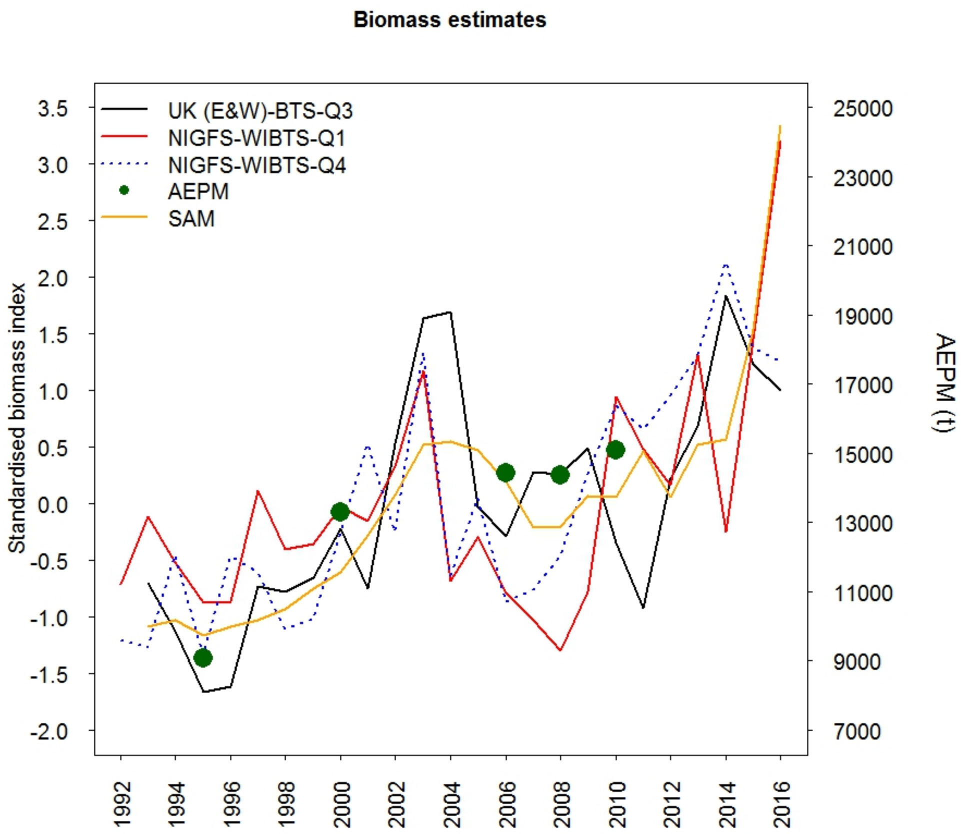


Figure 25.2.13. SAM model estimates of mean standardised SSB (orange line) overlain with standardised NIGFS in spring (red) and autumn (blue dashed) relative SSB indices, standardised (minus mean and divide by standard deviation) biomass (ages 1–4) from the UK(E&W)-BTS (black solid line) and AEPM SSB index (circles, right axis).

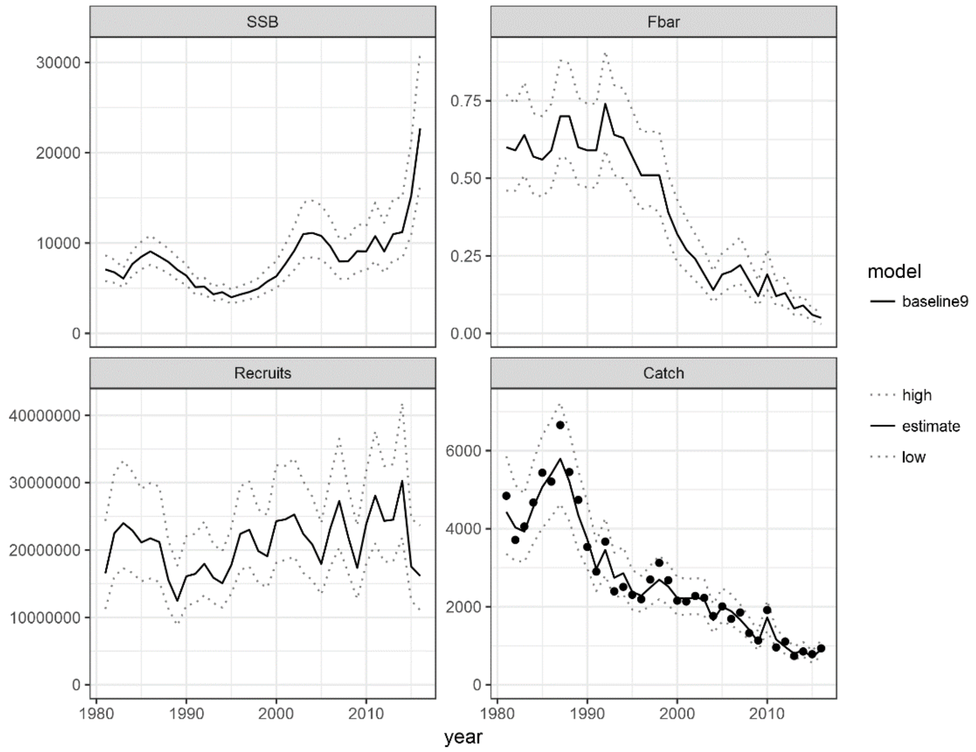


Figure 25.2.14. Modelled SSB (tonnes, top left), recruitment (thousands, bottom left), F_{bar} (ages 3–6, bottom right) catch tonnage (bottom right). Modelled using the SAM model. Error dashed lines indicate 2 × standard deviation.

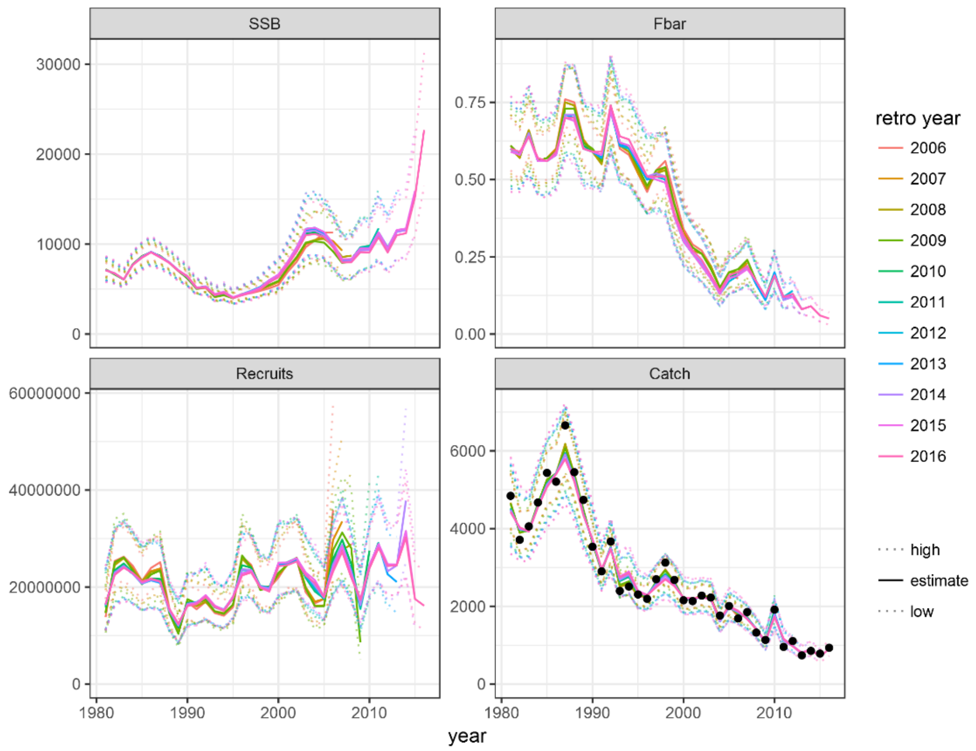


Figure 25.2.15. Retrospective assessments for years 2006–2016 from the baseline model. SSB (tonnes, top left), recruitment (thousands, bottom left), F_{bar} (ages 3–6, bottom right) catch tonnage (bottom right). Error dashed lines indicate 2 × standard deviation.

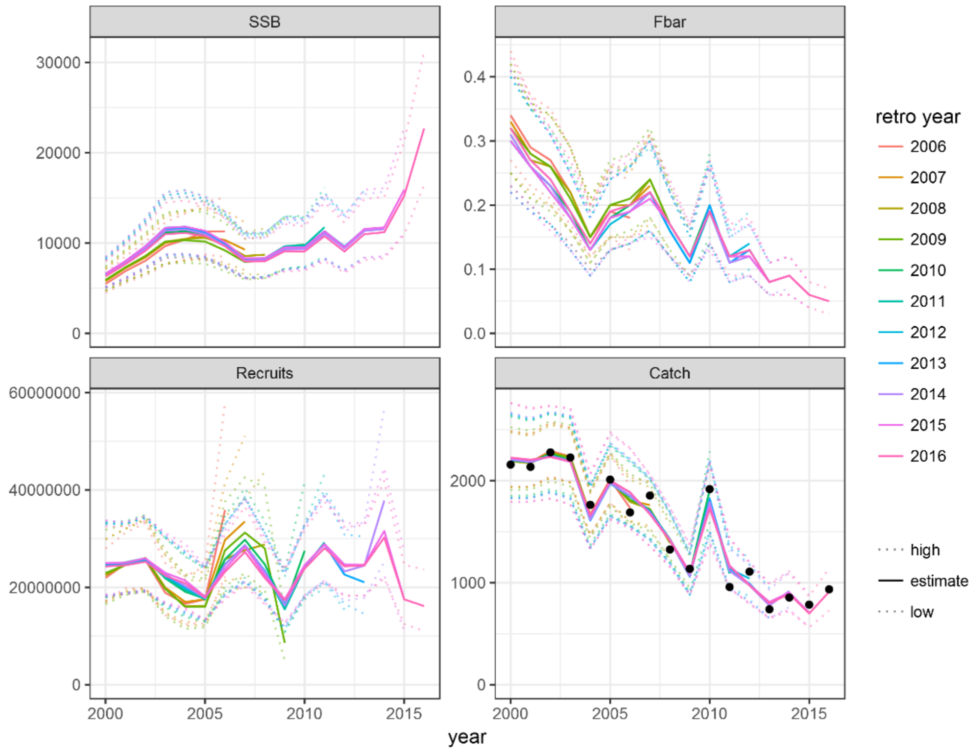


Figure 25.2.16. Zoom (time-series truncated in 2000) of the retrospective assessments for years 2006–2016 from the baseline model. SSB (tonnes, top left), recruitment (thousands, bottom left), FBAR (ages 3–6, bottom right) catch tonnage (bottom right). Error dashed lines indicate 2 × standard deviation.

26 Plaice in 7.bc (West of Ireland)

Type of assessment in 2016

No assessment was performed.

26.1 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 25.1 and Figure 25.1.

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 2016 was relatively good with 16 length samples (1300 fish measured), 291 fished aged and ten discard trips. The estimated age distribution of the catch is shown in Figure 25.2. The catch is dominated by age 3–9 year old fish. Discard estimates are relatively low mainly ages 1–5.

Table 26.1. 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		
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

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
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									

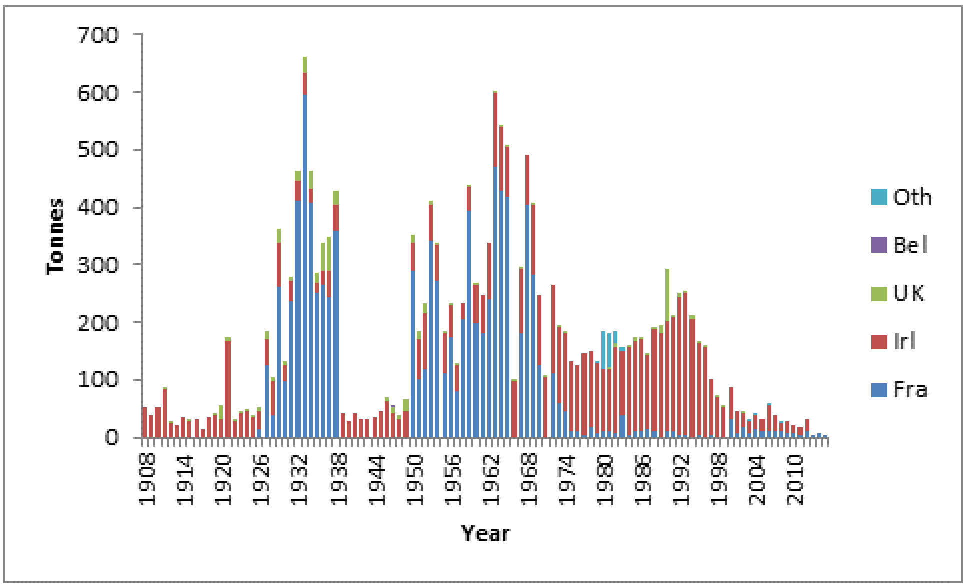


Figure 26.1. Landings of plaice in 7.bc as officially reported to ICES (1908–2016).

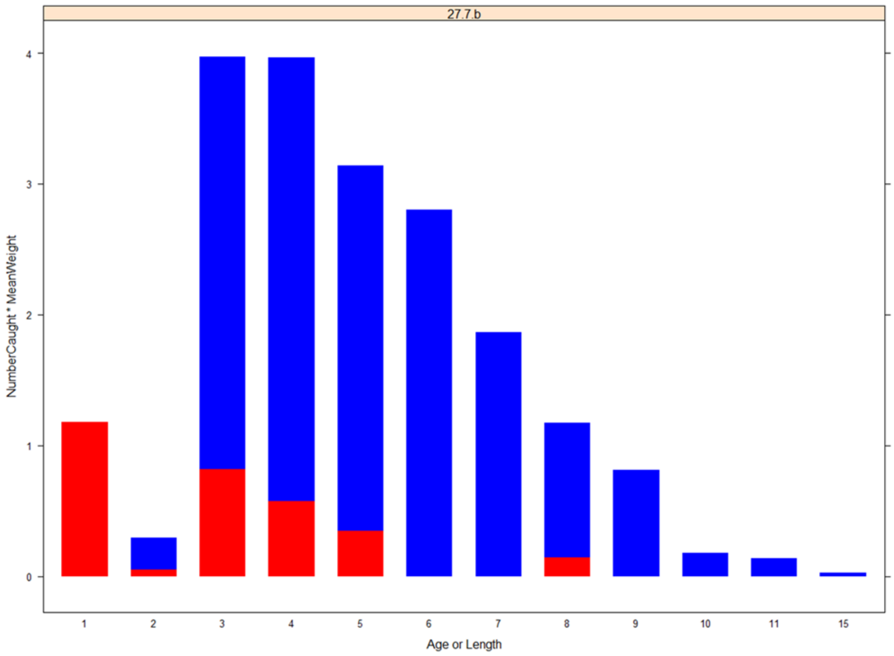


Figure 26.2. Estimated age distribution of plaice 7.bc in 2016 based on Irish sampling (landings in blue, discards in red).

27 Plaice in the Western Channel (ICES Division 7.e)

Type of assessment in 2016

Last year's assessment report is available at: http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2016/WGCSE/08.02_Plaice_VIIe_2016.pdf

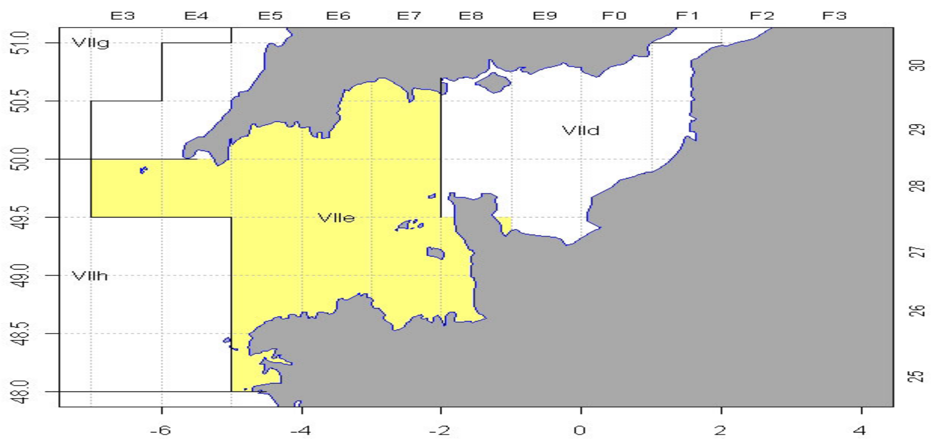
ICES advice applicable to 2017

Last year's advice is available at: http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/ple-echw.pdf

27.1 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 2016 and 2017

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 2016

Species	Plaice *Pleuronectes platessa*	Zone:	7.d and 7.e (PLE/7DE.)
Belgium	2037		
France	6788		
United Kingdom	3621		
Union	12 446		
TAC	12 446		Analytical TAC

(Source: Council Regulation (EU) 2016/72).

The TAC and the national quotas by country for 2017

Species	Plaice *Pleuronectes platessa*	Zone:	7.d and 7.e (PLE/7DE.)
Belgium	1640		
France	5467		
United Kingdom	2915		
Union	10 022		
TAC	10 022		Analytical TAC

(Source: Council Regulation (EU) 2017/127).

The fishery in 2016

A full description of the fishery is provided in the Stock Annex, Section A2.

In the Western English Channel, plaice are taken mainly as bycatch in bottom trawls targeting sole and anglerfish. In 2016, 69% of the landings were taken by beam trawls, 27% by otter trawls, 3% by fixed nets and 1% by other gears. Of the total international landings 80 % were reported by the UK, 12% by France, 8% by Belgium and 0.03% by Netherlands (Table 27. 1; Figure 27.1).

This stock is the smaller of the two plaice stocks that make up the larger TAC Area 7.d–e. The landings from this stock amounted to 26% of the TAC in 2015 and 18% of the TAC in 2016.

Landings

National landings data reported to ICES and estimates of total landings used by the Working Group are given in Table 27.1. Total international landings in 2016 for 7.e were 1777 t.

Landings increased to near 3000 t during the latter half of the 1980s due to a series of good recruitments in 1987–1989, but subsequently dropped to levels fluctuating around 1500 t. After this period, landings declined to below the long-term average of the time-series at about 1200 t per annum. Between 2011 and 2014 landings were stable at around 1350 t, dropped to 1246 t in 2015 and increased in 2016 to 1777 t.

Country	Fleet	Quarterly data provision					
		Landings			Discards		
		Age structure	Length structure	Tonnage	Age structure	Length structure	Tonnage
BELGIUM	OTB_CRU_70-99	–	–	Q1 - Q4	–	–	–
BELGIUM	SSC_DEF_70-99	–	–	–	–	–	–
BELGIUM	TBB_DEF_70-99	–	–	ANNUAL	–	–	ANNUAL
FRANCE	DRB_MOL_all	–	–	Q1 - Q4	–	–	–
FRANCE	GNS_DEF_>=100	–	–	Q1 - Q4	–	–	Q1 - Q4
FRANCE	GNS_DEF_all	–	–	Q1 - Q4	–	–	Q1, Q3, Q4
FRANCE	GTR_DEF_>=220	–	–	Q1 - Q4	–	–	Q1, Q2, Q3
FRANCE	GTR_DEF_100-119	–	Q1	Q1 - Q4	–	–	Q1
FRANCE	GTR_DEF_120-219	–	Q1	Q1 - Q4	–	–	Q1
FRANCE	GTR_DEF_all	–	–	Q1 - Q4	–	–	–
FRANCE	MIS_MIS	–	–	Q1 - Q4	–	–	–
FRANCE	OTB_DEF_100-119	–	Q2	Q1 - Q4	–	–	Q1 - Q4
FRANCE	OTB_DEF_70-99	–	Q1-Q4	Q1 - Q4	–	–	Q1 - Q4

Country	Fleet	Quarterly data provision					
		Landings			Discards		
		Age structure	Length structure	Tonnage	Age structure	Length structure	Tonnage
FRANCE	OTB_DEF_All	–	–	Q1 - Q4	–	–	–
FRANCE	OTT_DEF_>=70	–	–	Q1 - Q4	–	–	Q2
FRANCE	OTT_DEF_100-119	–	–	Q1 - Q4	–	–	–
FRANCE	SSC_DEF_All	–	–	Q1, Q2, Q3	–	–	–
FRANCE	TBB_DEF_all	–	Q2	Q1, Q2, Q3	–	–	Q2, Q3
NETHERLANDS	SSC_DEF_70-99	–	–	Q1, Q2	–	–	–
NETHERLANDS	SSC_DEF_70-99_FDF	–	–	Q1, Q2	–	–	–
UK (GUERNSEY)	MIS_MIS	–	–	Q1 - Q4	–	–	–
UK (JERSEY)	MIS_MIS	–	–	Q1 - Q4	–	–	–
UK (ENGLAND & WALES)	GNS_DEF_all	Q2, Q3, Q4	Q2, Q3, Q4	Q1	Q1, Q2	Q1, Q2	Q3
UK (ENGLAND & WALES)	GTR_DEF_all	–	–	Q1, Q2, Q3	Q2	Q2	Q3
UK (ENGLAND &	LLS_FIF_all	–	–	Q1 - Q4	–	–	–

COUNTRY	FLEET	QUARTERLY DATA PROVISION					
		LANDINGS			DISCARDS		
		AGE STRUCTURE	LENGTH STRUCTURE	TONNAGE	AGE STRUCTURE	LENGTH STRUCTURE	TONNAGE
WALES)							
UK (ENGLAND & WALES)	MIS_MIS	Q1 - Q4	Q1 - Q4	–	Q3	Q3	Q1, Q2, Q4
UK (ENGLAND & WALES)	OTB_CRU_16-31	–	–	Q2, Q3, Q4	–	–	–
UK (ENGLAND & WALES)	OTB_CRU_70-99	–	–	Q2, Q3, Q4	–	–	–
UK (ENGLAND & WALES)	OTB_DEF_>=120	Q1 - Q4	Q1 - Q4	–	Q4	Q4	–
UK (ENGLAND & WALES)	OTB_DEF_70-99	Q1 - Q4	Q1 - Q4	–	Q1 - Q4	Q1 - Q4	–
UK (ENGLAND & WALES)	OTM_SPF_32-69	–	–	Q1	–	–	–
UK (ENGLAND & WALES)	SSC_DEF_All	–	–	Q1, Q2	–	–	–
UK (ENGLAND & WALES)	TBB_DEF_>=120	–	–	Q4	–	–	–

Country	Fleet	Quarterly data provision					
		Landings			Discards		
		Age structure	Length structure	Tonnage	Age structure	Length structure	Tonnage
UK (ENGLAND & WALES)	TBB_DEF_70-99	Q1 - Q4	Q1 - Q4	–	Q1 - Q4	Q1 - Q4	–
7.d MIGRATION (INT)	ALL FLEETS	ANNUAL	ANNUAL		ANNUAL	ANNUAL	–

In addition to the estimated 2016 landings for 7.e, an extra of 235 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 2017. Figure 27.14 shows the total annual landings split by divisions 7.e and 7.d and Figure 27.15 the proportion of the landings landed in 7.d.

Data

Annual length composition data outside InterCatch for 2017 was provided by the UK, France and Belgium.

Again this year, all nations provided data disaggregated by fleet and by quarter and this was all uploaded into the ICES InterCatch database. Quarterly age compositions for landings in 2017 were available from the UK(E&W) only and were provided for five fleets. These data accounted for 79.7% of the total reported international landings. Additional landings data were available by quarter/fleet for Belgium, France, Netherlands, UK(E+W, Guernsey, Jersey). These datasets were aggregated to an international age structure using the ICES InterCatch platform and are shown in Figure 27.5.

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 27.10, Figure 27.11, Figure 27.12). Landings numbers-at-age (including the migration element) are given in Table 27.2 and plotted for the last five years in Figure 27.2. Landings and stock weights-at-age are given in Table 27.3 and Table 27.4 and plotted in Figure 27.13.

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. The standard settings used for natural mortality and the proportions of F and M before spawning were used (see the Stock Annex). This is consistent with the procedures developed and agreed at the benchmark workshop held in February 2010 (WKFLAT) and updated at the interbenchmark meeting (IBPWCFlat2) in 2015.

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 2012–2016. In 2016 France provided discard tonnages for the first time, but only for 2015. In 2017, France submitted discard data for the years 2014–2016. Belgium provided some discard data for the years 2012, 2013, 2015 and 2016. Age samples for discards have only been provided by the UK(E&W) but cover the years 2012–2016. Information about length distributions from samples for discards was provided by the UK, Belgium in 2017.

Available information on reported discard tonnage indicated a notable increase in discards in the recent years until 2015, but the rate dropped in 2016. Historically, the discard rate was calculated for those métiers for which discard data were available within InterCatch. The total discard ratio was then estimated by calculating the arithmetic mean of the individual ratios. At WGCSE 2016 it turned out that this methodology caused a crucial underestimation of the actual discards. The reason for this underestimation is that there are some fleets with low discard rate but these fleets only have a minor contribution to the total catches. Hence, the total ratio is biased towards these smaller fleets and does not reflect actual and reported discards. Even by looking at the total reported discards a substantial increase in discards was evident. At WGCSE 2016 it was decided to calculate the total discard ratio for plaice in 7.e as the weighted mean of available discard data, weighted by the contribution of the métier to the total catches.

At WGCSE 2017 the discard rate calculation was changed again and now uses total international landings and discard tonnages as raised within InterCatch and corrected for the migration from 7.d. The discard rates calculated by this approach are 23, 19, 43, 47 and 23% for the years 2012–2016. The final discard rate used for the catch advice is the average of these five years and is around 31%.

A comparison of the results from the different methods is shown in Figure 27.3.

In analogy to the landings, the discards are also uplifted by a migration correction from 7.d.

Revisions

The United Kingdom, France and Belgium revised their data for 2015 for ICES Division 27.7.e. Total reported landings changed only slightly by less than one tonne to 1424 t. Total international reported discards decreased from 1230 t down to 1116 t, due to revision from Belgium, France and the UK. Belgium added 3 t (before 0) of discards in 2015, France reduced their reported discards dramatically from 244 t to 108 t and the UK increased reported discards from 986 t 1005 t.

For 2014, reported international landings in ICES Division 27.7.e increased slightly by less than one tonne to now 1341 t due to revisions by France and the UK. Total reported international discards increased from 796 t to 861 t, due to revision by the UK (increase from 796 t to 795 t) and because France uploaded discards for 2014 (66 t) for the first time in 2017.

Biological

The natural mortality and the maturity ogives used were identical to previous assessments and as described in the stock annex.

Surveys

IBPWCFlat2 2015 updated the derivation of cpue estimates for the research surveys to make full use of the available sampling data. Updated cpue estimates exhibited similar temporal trends to those presented at previous Working Groups but with more variability due to the inclusion of additional numbers-at-age information.

Two surveys currently provide abundance estimates to the Working Group (Figure 27.9; Table 27.5). The UK(E&W) commercial beam trawl survey (UK-WEC-BTS) was terminated in 2013 due to a lack of UK science funding and excluded from the assessment input data in 2015. Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

Since 2003, the UK Fisheries Science Partnership (FSP: Cefas-UK industry cooperative project) has been conducting a survey using commercial vessels with scientific observers and following a standard grid of stations extending from the Scilly Isles to Lyme Bay (UK FSP-7e). This survey covers a substantially larger area than the UK-WEC-BTS survey and is thought to be more representative of stock dynamics in UK waters. This dataset was first included in the 2007 assessment. There have been a number of vessel changes, gear changes and temporal variations in this survey series, but overall the survey has performed well in tracking year classes. Aggregated cpue estimates for the UK FSP-7e survey increased continuously since 2009 and reached a time-series maximum in 2014 but dropped afterwards.

Indices of abundance-at-age for the Quarter 1 South West Beam trawl (Q1SWBeam) survey started in 2006 and were included in the assessment for the first time in 2015. Including the Q1SWBeam survey in the assessment was considered appropriate by IBPWCFlat 2015 given the ability to track the progression of year classes among ages with few clear year effects and the loss of abundance estimates from the UK-WEC-BTS survey after 2013.

The Q1SWBeam survey is based on a stratified random survey approach that covers the entire region of the management area and some adjacent waters. The survey shows strong gradients in species composition within the Western Channel justifying the stratification approach. Age information provides estimates of abundance for all ages in the assessment. Theoretically, this removes the necessity of retaining the commercial lpue-at-age estimates. Internal consistency estimation is very difficult given the short time-series, and relatively small contrast in cohort strength observed (based on other series). Despite this, some cohort tracking is apparent and the signal matches the cohort signal from other survey series, particularly the UK FSP-7e survey. 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. In 2015, the value dropped back to the level of 2013 but increased again in 2016.

Commercial fleet effort and lpue

IBPWCFlat2 2015 revised the effort time-series for the UK beam (UK WECBT) and otter trawl (UK WECOT) fleets due to fluctuations in lpue estimates after 2012 arising from modifications in the UK e-logbook effort recording system. Revised landings numbers, effort in days and lpue estimates in kg per 1000 days exhibited similar temporal trends to those presented previously, except with greater stability after 2012. UK(E&W) beam trawl and otter trawl time-series are shown in Figure 27.4.

UK(E&W) beam trawl effort (days fished-GRT corrected) are relatively stable at high levels since the early 2000s but the landings increased substantially in 2016.

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 vessel of at least 12 m length and in 2016 only smaller vessels deploying otter trawls reported any activity.

27.1.1 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.

For the plaice in 7.e stock 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 trialled.

Length-based indicators

The internationally raised length frequencies from InterCatch for the years 2014–2016 (Figure 27.6, Figure 27.7 disaggregated by country) were used as input data for the length-based indicator method. As landings predominated catches in 2016, the length frequencies derived from the total catches including discards were used and no assumptions about discard survival were made. The length-based method was conducted with the R scripts provided on the ICES GitHub site (https://github.com/ices-tools-dev/ICES_MSY).

Using this script provided by ICES, the method came up with the following result table:

Year	Lc_Lmat	L25_Lmat	Lmax5_Linf	Pmega	Lmean_Lopt	Lmean_LFeM
2014	0.82	**1.32**	0.66	0.01	0.69	**1.04**
2015	0.72	**1.38**	0.68	0.01	0.72	**1.15**
2016	0.72	**1.43**	0.7	0.01	0.75	**1.2**

The important column is the last column ("Lmean_LFeM") which is a proxy for the stock status according to the MSY approach. The values are above the threshold value of 1 indicating that the stock is a desirable state.

During WGCSE 2017 is was discovered that the R script provided by ICES contains several shortcomings and does not work with usual real life length frequencies. The approach in the script assumes a constant increase in the numbers-at-length until the maximum of the length–frequency distribution. The implemented method searches for the first peak in the length–frequency distribution and assumes the corresponding length is the maximum in the entire length distribution. The length at first capture (Lc) is then estimated by searching for the first length class where the abundance is equal or larger to 50% of this maximum value. This approach fails to account for local maxima at lengths smaller than the absolute maximum in the length–frequency distribution, particularly if few catches at very lower lengths exist.

For the plaice 7.e stock for all three year with available total length data, local maxima exist and lead to absurd values which should not be used.

During WGCSE a quick fix for the method was implanted, working with the absolute maximum to calculate Lc. This lead to the following result table:

Year	Lc_Lmat	L25_Lmat	Lmax5_Linf	Pmega	Lmean_Lopt	Lmean_LFeM
2014	**1.23**	**1.32**	0.66	0.01	0.7	0.88
2015	**1.32**	**1.38**	0.68	0.01	0.75	0.9
2016	**1.32**	**1.43**	0.7	0.01	0.77	0.93

According to this table, the stock is slightly below MSY reference points.

Due to the uncertainty in the calculation of the length-based indicator values and the non-clearly formulated methodology, the estimated values were rejected. Furthermore, for this stock a variety of data are available and falling back onto length data when a longer age-disaggregated catch history 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.

Since WKProxy SPiCT has been further advanced and WGCSE 2017 tried to rerun the assessment with a newer version of SPiCT. Using the same input data and model specifications as during WKProxy in a more recent version of SPiCT (v1.1 vs. v0.2) did not lead to convergence in the model and resulted in different results.

During WGCSE a new set of input data for use in SPiCT was created. This 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 27.8.

Even though the model converged, the results are not appropriate. The uncertainty in absolute as well as relative estimates is very high and indicates a lack of certainty about. 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. Several unsuccessful attempts were made to improve the model fit. The model was highly sensitive to the input data range.

The decision from this year's WGCSE is to reject the reference values calculated with SPiCT during WKProxy and not to use SPiCT to assess the stock status as the model does not seem to be able to track the dynamics of the stock properly.

Instead of using proxy reference points, this year WGCSE based the stock status evaluation for plaice in 7.e on analytical reference points from an XSA assessment, as described later in this report.

27.1.2 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. The cpue values for the FSP-7e and Q1SWBeam show a very similar pattern until 2015 (Figure 27.9). Older ages increased in recent years whereas the younger ages decreased. Furthermore, both surveys indicate low values for age 2 in 2012 and 2013. The UK FSP-7e survey data for 2008 continue to be excluded from the assessment as decided at WGCSE 2009. Both surveys aggregated over all ages showed a significant drop in the cpue for 2015 compared to 2014. The UK FSP cpue decreased further but the Q1SWBeam shows an increase again, driven by age 3.

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.

		2015 XSA	2016 XSA	2016 XSA DISCARD TRIAL	2017 XSA
Catch-at-age data	Landings	1980–2014, 2–10+,15% mature Q1 catch from 7.d added	1980–2015, 2–10+, 15% mature Q1 catch from 7.d added	1980–2015, 2–10+, 15% mature Q1 catch from 7.d added	1980–2016, 2–10+, 15% mature Q1 catch from 7.d added
	Discards	–	–	2012–2015, 2–10+, 15% mature Q1 catch from 7.d added	–
Fleets	UK-WEC-BTS – Survey	–	–	–	–
	UK WECOT – Commercial	–	–	–	–
	UK WECOT– Commercial historic	–	–	–	–
	UK WECBT – Commercial	–	–	–	–
	FSP-7e – Survey	2003–2014, 2–8 (exc. 2008)	2003–2015, 2–8 (exc. 2008)	2003–2015, 2–8 (exc. 2008)	2003–2016, 2–8 (exc. 2008)
	Q1SWBeam – Survey	2006–2014, 2–9	2006–2015, 2–9	2006–2015, 2–9	2006–2016, 2–9
Taper		No	No	No	No
Taper range		–	–	–	–
Ages catch dep. Stock size		None	None	None	None
q plateau		6	6	6	6
F shrinkage se		1.0	1.0	1.0	1.0
Year range		3	3	3	3
Age range		3	3	3	3
Fleet SE threshold		0.3	0.3	0.3	0.3
Prior weighting		–	–	–	–
Plus group		10	10	10	10
F Bar Range		F(3–6)	F(3–6)	F(3–6)	F(3–6)

The log catchability residuals for the XSA run (landings only) are shown in Figure 27.16. 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.

Fishing mortalities and stock numbers estimated from the final run are given in Table 27.6 and Table 27.7, and the assessment summary is shown in Table 27.8. SSB is still increasing and fishing mortality is increasing slightly in the last year due to increased landings, but still at low levels.

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 seven-year retrospective analysis (Figure 27.17) was conducted in accordance with the procedures agreed at IBPWCFlat2 2015. Compared to the last years, the retrospective pattern is less pronounced 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.

Comparison with previous assessments

Compared to last year's assessment, SSB is slightly higher in recent years and F slightly lower (Figure 27.19).

Alternative assessment with discards included

Due to time constraints during the working group, the additional discard trial assessment could not be conducted in 2017.

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 27. 8 and Figure 27.18. Relative values have been presented for recruitment, spawning–stock biomass and fishing mortality estimates given that the Category 3 assessment is indicative of trends only.

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.

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. But due to higher landings in 2017, the fishing mortality increased slightly in 2016.

This assessment estimates that recruitment has been above the long-term geometric mean (1980–2016) between 2010 and 2015 and is just below in 2016.

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.

If the absolute values from the XSA assessment are used, the fishing mortality in 2016 (0.237) is just below F_{MSY} (0.238) and the SSB in 2016 (8520 t) is above MSY $B_{trigger}$ (5355 t). Consequently, the stock is in a desirable state.

27.1.3 Short-term projections

As in the last three 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 landing corresponding to the catch advice, the total catches as raised in InterCatch, including the migration correction from 7.d is used. The average of the last five years (all years available from InterCatch) is 31.25%.

The basis for the catch options for 2017 has been presented in Table 27.9. For stocks in ICES data categories 3–6, one catch option is provided.

The index ratio suggests an increase by more than 20 % and therefore the uncertainty cap was applied, i.e. the recent advised catch (2714 t) is multiplied by 1.2.

Catches of the 7.e plaice stock should not exceed 3257 t in 2018 when the precautionary approach is applied. If discard rates do not change from the average (2012–2016), landings should be no more than 2239 t.

The average proportion of the landings of the 7.e plaice stock taken in division 2003–2016 is 9.55%. The year range (2003 until most recent year) was agreed between the two stocks 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.

Assuming the same proportion of the Division 7.e plaice stock is taken in Division 7.d as during 2003–2016, this will correspond to catches of plaice in Division 7.e of no more than 2946 t. If discard rates do not change from the average (2012–2016), this implies landings of plaice in Division 7.e of no more than 2025 t.

Comparing the absolute values from the XSA assessment with the reference points from WKMSYREF4 (ICES, 2016a) leads to the conclusion that the stock is in a desirable state, both in terms of fishing mortality as well as SSB and consequently the application of the PA buffer was not considered. Furthermore, the SSB has been continuously increasing for more than five years and is currently at the time-series maximum.

27.1.4 Biological reference points

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 point 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 as mentioned earlier in this report. Instead, the values from the WKMSYREF4 were restored. At WGCSE ICES asked for higher precision for the reference points and the highest precision as shown in the WKMSYREF4 report was used. For biomass reference points, the vales are rounded to the nearest tonne. For fishing mortality, all available digits were used. For F the last digit was extracted from the result plot depicted in the WKMSYREF4 report to achieve a value with 3 significant digits.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	5 355 t	Computed with Eqsim based on the 2015 assessment in a run without error.	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}	1 745 t	B_{loss}	ICES (2016a)
	B_{pa}	2 443 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)

27.1.5 Management plans

There is no management plan in place for this stock.

27.1.6 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 is 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.

Revisions to plaice migration rates between 7.d and 7.e outlined at WKPLE 2015 resulted in problems with the derivation of international catch numbers and weights-at-age in the time available at this year's Working Group. The revised migration correction included reallocating 15% of quarter 1 landings for the mature proportion of the catch from 7.d to 7.e and applying the associated age composition to plaice 7.e. Data corrected for the revised migration rate included an amended landings tonnage and an associated age composition (numbers and mean weights-at-age) between 1980 and 2014 provided by the plaice 7d stock assessor. For each year, the corrected data were added to the international annual age composition for plaice 7.e following standard procedures outlined in the Stock Annex. The resulting combined dataset consisted of revised annual landings, catch numbers-at-age and weights-at-age that was included in the assessment for the first time in 2015.

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.

Reliable discard data are only available for 2012–2016 and these data are mainly from the UK(E&W). Historical discards rate are highly uncertain but available discard data reported implies 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.

27.1.7 Recommendations for next Benchmark

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.

In 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 now 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 2012–2016. 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 reparameterization 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. There have been benchmarks for other plaice stocks and a similar approach could be pursuit for plaice in 7.e.

For completeness, the following issues from earlier reports are still mentioned, as they have not been addressed so far:

- 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 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 30% of the total landings of this stock. In particular, inclusion of French data would add information on the stock dynamics on the French coast.

27.1.8 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.

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. 9.6%, the average of 2003–2015, taking the age structure of the population into account). As the mixing rate of the two plaice stocks is uncertain, this calculation provides only a first 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 2017. 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. This year's trends-based assessment estimates that spawning–stock biomass is at a record high and fishing mortality only increased slightly from a record low in 2015.

27.2 References

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Table 27.1. Plaice in 7.e. Nominal landings (t) in Division 7.e, as used by the Working Group.

Year	Landings											Discards
	Belgium	Denmark	Netherlands	France	UK (E &W) incl. CI's	Others	Total reported	Unallocated*	Total	7.e stock caught in	As used by WG	ICES estimate 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	2	-	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	
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	935	-	1353	-19	1334	83	1417	
2012	134	-	2	224	1003	-	1363	3	1366	126	1492	448
2013	97	-	1	221	1040	-	1359	-8	1351	121	1472	351
2014	41	-	0	323	974	-	1338	3	1341	149	1490	1133

Year	Landings											Discards
	Belgium	Denmark	Netherlands	France	UK (E &W) incl. CI's	Others	Total reported	Unallocated*	Total	7.e stock caught in	As used by WG	ICES estimate discards***
2015	110	-	1	224	909	1	1245	1	1246	178	1424	1276
2016****	145		0	204	1429	-	1778	-1	1777	235	2013	618

***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 27.2. Plaice in 7.e. Landings numbers-at-age.

	Numbers at age [thousands]									
year/age	2	3	4	5	6	7	8	9	10+	TOTALNUM
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	29	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
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

Table 27.3. 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
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

Table 27.4. 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
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

Table 27.5. Plaice in 7.e. Tuning fleet data available.

```
W.CHANNEL PLAICE 2017 WGCSE
102
FSP-7e
2003 2016
1 1 0.75 0.80
2  9
1  0.344  0.344  0.216  0.041  0.042  0.051  0.034  0.022
1  0.230  0.842  0.160  0.279  0.026  0.017  0.045  0.011
1  0.327  0.426  0.240  0.090  0.040  0.013  0.017  0.037
1  0.623  0.420  0.187  0.100  0.044  0.021  0.005  0.006
1  0.114  0.278  0.159  0.066  0.026  0.008  0.006  0.006
1  0.494  0.213  0.124  0.032  0.019  0.015  0.005  0.002
1  0.440  0.446  0.153  0.061  0.034  0.023  0.008  0.003
1  0.740  0.583  0.385  0.048  0.042  0.012  0.006  0.002
1  1.036  0.801  0.314  0.110  0.010  0.018  0.013  0.002
1  0.321  1.243  0.582  0.136  0.135  0.012  0.014  0.012
1  0.227  1.464  1.267  0.440  0.203  0.076  0.028  0.008
1  1.320  1.665  2.131  0.833  0.624  0.157  0.035  0.037
1  0.826  1.253  0.915  1.010  0.507  0.121  0.013  0.056
1  0.389  1.501  0.816  0.390  0.343  0.235  0.019  0.057
Q1SWBeam
2006 2016
1 1 0  0.25
1  11
1  1.460  31.189  24.244  19.115  5.384  2.696  0.151  0.119  0.239  0.563  0.000
1  0.868  14.781  34.368  28.319  4.988  5.596  1.926  4.755  0.250  3.992  0.250
1  0.951  33.553  17.429  9.116  5.464  0.966  1.522  2.215  1.979  0.000  0.878
1  1.213  45.275  46.545  15.717  10.715  3.002  4.161  0.324  0.204  0.324  0.324
1  0.976  45.055  39.746  27.094  4.348  1.862  2.747  0.764  0.375  0.000  0.000
1  1.688  53.339  71.562  27.498  6.886  5.843  3.347  0.459  0.528  0.105  0.330
1  0.000  9.123  59.258  30.977  14.820  5.235  7.444  0.481  3.171  0.000  0.000
1  0.300  18.040  91.824  65.429  12.689  3.964  2.531  2.010  0.803  0.000  0.000
1  1.014  65.903  148.705  178.597  63.258  10.681  1.336  2.340  0.939  0.488  0.281
1  0.000  36.343  46.731  27.170  40.411  30.258  4.391  5.318  0.948  2.083  0.000
1  0.221  20.839  190.215  56.534  34.905  37.243  26.557  7.922  11.015  1.757  6.956
```

Table 27.6. Plaice in 7.e. Fishing mortality-at-age.

	Fishing mortality-at-age									
year/age	2	3	4	5	6	7	8	9	10+	F(3–6)
1980	0.120	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	0.540	0.469	0.469	0.438
1982	0.104	0.461	0.670	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	0.710	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	0.580	0.504	0.498	0.358	0.585	0.390	0.446	0.446	0.485
1987	0.080	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	0.520	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	0.610
1990	0.101	0.593	0.746	0.572	0.565	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	0.620	0.548	0.408	0.476	0.479	0.479	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	0.536	0.481	0.396	0.319	0.400	0.400	0.592
1995	0.159	0.590	0.725	0.580	0.472	0.453	0.470	0.467	0.467	0.592
1996	0.181	0.516	0.634	0.667	0.527	0.413	0.576	0.508	0.508	0.586
1997	0.170	0.645	0.686	0.628	0.529	0.664	0.360	0.520	0.520	0.622
1998	0.064	0.444	0.707	0.506	0.440	0.390	0.366	0.400	0.400	0.524
1999	0.172	0.354	0.650	0.556	0.577	0.454	0.422	0.486	0.486	0.534
2000	0.155	0.471	0.612	0.608	0.467	0.452	0.283	0.402	0.402	0.540
2001	0.143	0.548	0.621	0.587	0.323	0.346	0.383	0.352	0.352	0.520
2002	0.324	0.577	0.658	0.664	0.567	0.377	0.287	0.412	0.412	0.616
2003	0.214	0.526	0.500	0.535	0.596	0.587	0.332	0.507	0.507	0.539
2004	0.175	0.536	0.614	0.627	0.638	0.522	0.536	0.500	0.500	0.604
2005	0.220	0.517	0.606	0.630	0.552	0.627	0.731	0.561	0.561	0.576
2006	0.309	0.639	0.595	0.616	0.531	0.424	0.744	0.583	0.583	0.595
2007	0.171	0.583	0.733	0.713	0.700	0.680	0.362	0.626	0.626	0.682
2008	0.210	0.471	0.640	0.600	0.613	0.695	0.669	0.275	0.275	0.581
2009	0.155	0.446	0.337	0.311	0.332	0.320	0.310	0.275	0.275	0.357
2010	0.125	0.335	0.482	0.398	0.372	0.305	0.237	0.456	0.456	0.397
2011	0.113	0.336	0.407	0.269	0.214	0.252	0.263	0.247	0.247	0.306
2012	0.020	0.205	0.404	0.344	0.422	0.449	0.400	0.310	0.310	0.344
2013	0.021	0.128	0.257	0.313	0.286	0.430	0.334	0.750	0.750	0.246
2014	0.021	0.121	0.225	0.227	0.341	0.291	0.334	0.770	0.770	0.228
2015	0.009	0.071	0.158	0.207	0.208	0.359	0.189	0.385	0.385	0.161
2016	0.015	0.106	0.268	0.285	0.289	0.224	0.389	0.281	0.281	0.237

Table 27.7. Plaice in 7.e. Stock numbers-at-age.

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	7234	5611	2437	1293	388	303	218	84	180	17748
1987	14731	5555	2786	1306	697	240	150	131	151	25748
1988	12071	12064	2965	1194	548	403	132	87	186	29651
1989	8717	8994	6343	1606	630	346	253	82	259	27229
1990	3645	7478	5389	2920	647	306	195	136	172	20889
1991	3916	2922	3665	2267	1462	326	147	102	156	14963
1992	4421	2949	1469	1484	1111	816	192	89	137	12668
1993	4977	3263	1392	611	708	570	481	106	229	12338
1994	2312	3784	1597	640	295	377	302	271	201	9779
1995	2324	1744	1940	634	332	162	225	195	249	7804
1996	6728	1758	858	833	315	184	91	125	279	11171
1997	5863	4979	930	403	379	165	108	46	258	13131
1998	9132	4390	2318	416	191	198	75	67	195	16981
1999	4376	7595	2498	1013	222	109	119	46	123	16101
2000	2600	3269	4726	1156	515	111	61	69	166	12673
2001	3745	1976	1809	2272	558	287	62	41	133	10884
2002	3900	2880	1013	863	1120	358	180	38	126	10479
2003	4876	2501	1434	466	394	564	218	120	102	10674
2004	3109	3490	1310	771	242	192	278	139	102	9633
2005	4288	2314	1810	629	365	113	101	144	118	9883
2006	3975	3053	1223	876	297	187	54	43	127	9834
2007	2659	2589	1429	598	420	155	108	23	113	8094
2008	5151	1988	1282	609	260	185	70	67	129	9740
2009	4779	3703	1101	600	296	125	82	32	75	10792
2010	6856	3629	2103	697	390	188	81	53	66	14062
2011	11268	5366	2302	1151	415	238	123	56	89	21009
2012	10937	8928	3402	1359	781	297	164	84	138	26090
2013	6857	9508	6448	2014	855	454	168	98	71	26472
2014	7022	5952	7420	4422	1306	569	262	107	69	27130
2015	10677	6101	4680	5256	3127	823	377	166	116	31324
2016	4412	9385	5042	3546	3792	2252	510	277	235	29450

Table 27.8. Plaice in 7.e. Assessment summary. Note that relative values have been presented given that the full analytical assessment was rejected due to large retrospective patterns.

Year	Recruitment (age 2) [relative]	TSB [relative]	SSB [relative]	Landings [t]	Relative landings/ relative SSB	Fbar(3-6) [relative]
1980	1.163	0.483	0.725	1178	0.993	1.024
1981	1.146	0.574	0.861	1676	1.190	0.869
1982	0.495	0.626	0.939	1878	1.223	1.048
1983	1.051	0.604	0.907	1714	1.156	1.089
1984	0.953	0.603	0.905	1758	1.187	1.046
1985	1.146	0.613	0.921	1677	1.113	0.993
1986	1.191	0.721	1.082	2078	1.174	0.962
1987	2.425	0.840	1.261	2272	1.102	1.194
1988	1.987	0.913	1.371	2835	1.264	0.931
1989	1.435	0.991	1.488	2742	1.126	1.209
1990	0.600	0.959	1.440	2985	1.267	1.228
1991	0.645	0.781	1.172	2183	1.139	1.194
1992	0.728	0.663	0.996	1882	1.156	1.266
1993	0.819	0.574	0.862	1614	1.144	1.175
1994	0.381	0.492	0.738	1404	1.163	1.174
1995	0.383	0.444	0.667	1247	1.143	1.173
1996	1.108	0.436	0.655	1266	1.182	1.163
1997	0.965	0.460	0.690	1583	1.403	1.233
1998	1.503	0.475	0.713	1346	1.154	1.039
1999	0.720	0.527	0.791	1543	1.193	1.060
2000	0.428	0.572	0.859	1626	1.158	1.070
2001	0.616	0.515	0.773	1310	1.037	1.031
2002	0.642	0.473	0.710	1472	1.267	1.222
2003	0.803	0.483	0.725	1387	1.170	1.070
2004	0.512	0.443	0.665	1337	1.229	1.197
2005	0.706	0.428	0.642	1319	1.256	1.143
2006	0.654	0.407	0.611	1411	1.413	1.181
2007	0.438	0.350	0.526	1146	1.333	1.353
2008	0.848	0.373	0.560	1112	1.214	1.152
2009	0.787	0.405	0.608	1024	1.029	0.707
2010	1.129	0.515	0.774	1207	0.954	0.787
2011	1.855	0.672	1.009	1417	0.858	0.607
2012	1.800	0.835	1.253	1492	0.728	0.682
2013	1.129	1.085	1.629	1472	0.553	0.488
2014	1.156	1.185	1.778	1490	0.512	0.453
2015	1.758	1.487	2.233	1424	0.390	0.319
2016	0.897	1.639	2.461	2013	0.500	0.470

Table 27.9. Plaice in 7e. The basis for the catch options for 2017. Note that one catch option is provided for stocks in ICES data categories 3–6.

Division 7.e plaice stock		
Index A (2015–2016)	8126.3950028942 tonnes	
Index B (2012–2014)	5379.0001011012 tonnes	
Index ratio (A/B)	1.5107631251	
Uncertainty cap	Applied	1.2
Recent advised catch (2017)	2714 tonnes	
Discard rate (2012–2016)	0.3125470437	
Precautionary buffer	Not applied	-
Catch advice*	3257 tonnes	
Landings corresponding to catch advice	2239 tonnes	
Plaice in Division 7.e		
Proportion of Division 7.e stock catches taken in Division 7.e (2003–2016)	0.9044748639	
Catch of plaice in Division 7.e corresponding to the advice for the stock	2946 tonnes	
Landings of plaice in Division 7.e corresponding to the advice for the stock	2025 tonnes	

*** [recent adviced catch x uncertainty cap].**

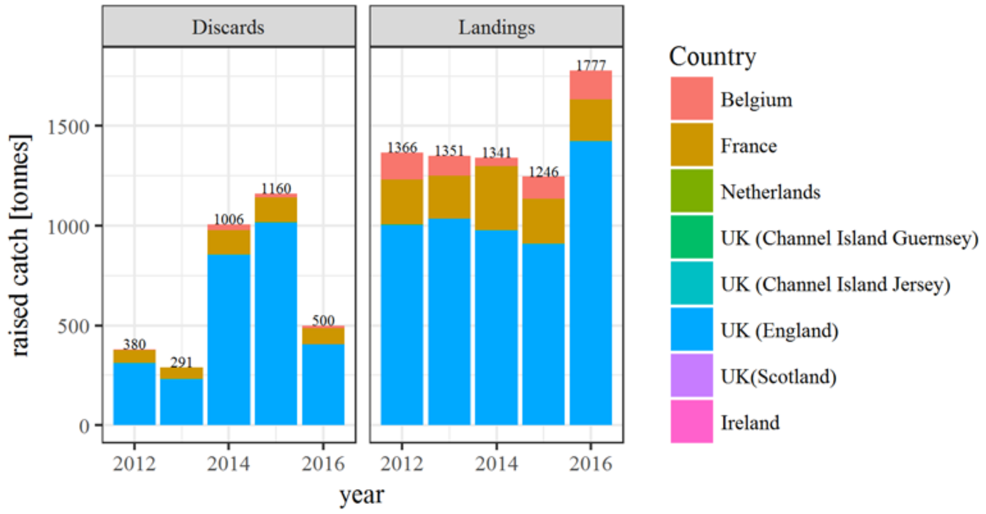

Figure 27.1. Plaice in 7.e. International landings and discards by country as uploaded to InterCatch for 2012–2016.

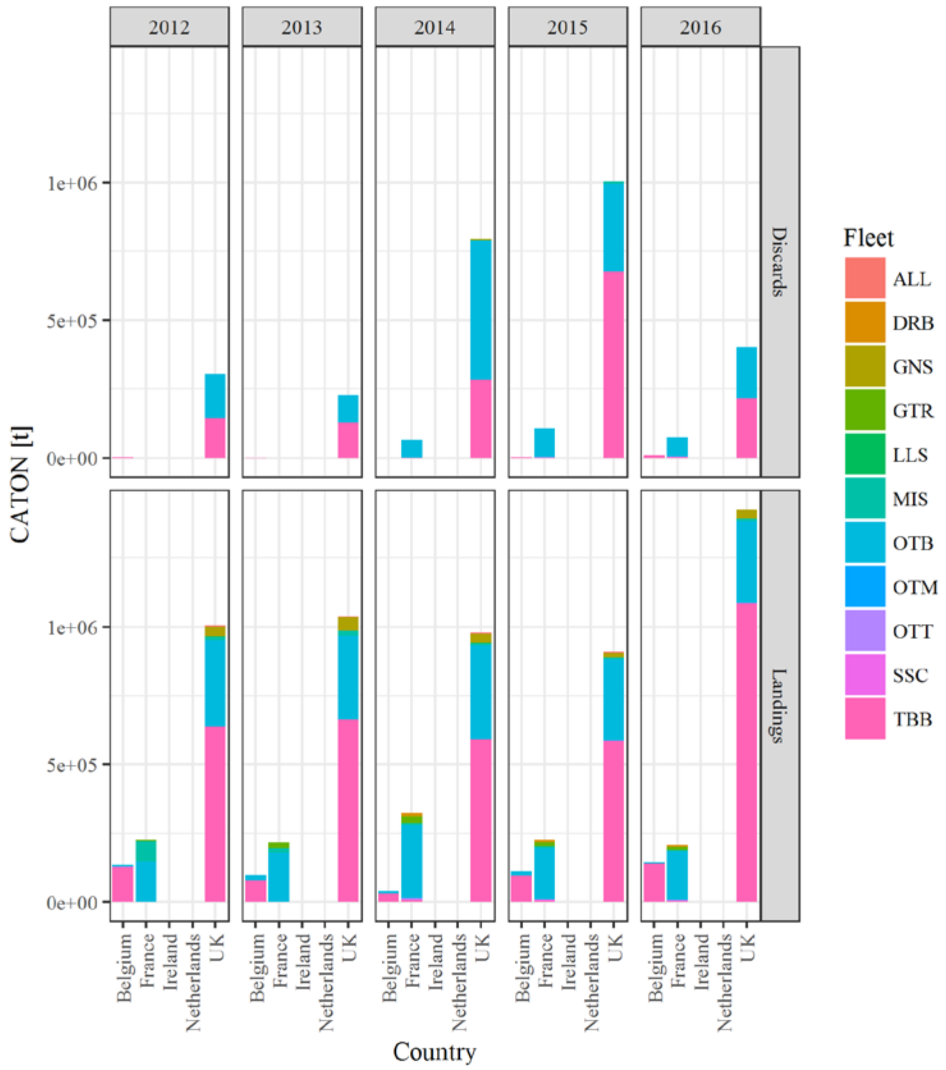

Figure 27.2. Plaice in 7.e. International landings and discards reported to InterCatch per country and fleet for the years 2012–2016.

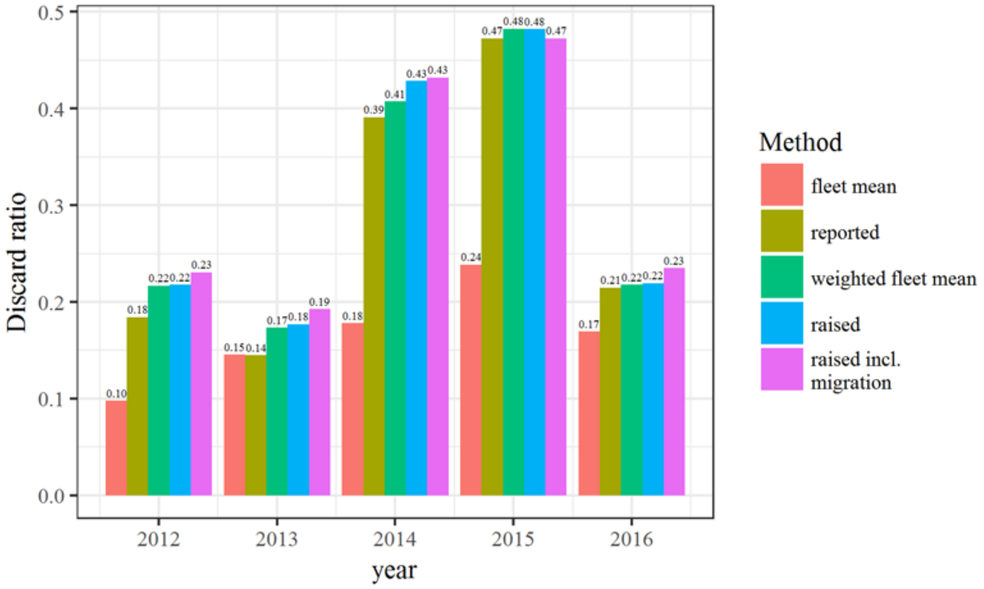

Figure 27.3. Plaice in 7.e. Discard ratios for 2012—2016. "Fleet mean" is the mean of the ratios for all fleets which reported discards, "reported" is the proportion of reported discards in the reported catches, "weighted fleet mean" is the mean of the ratios for all fleets which reported discards weighted 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.

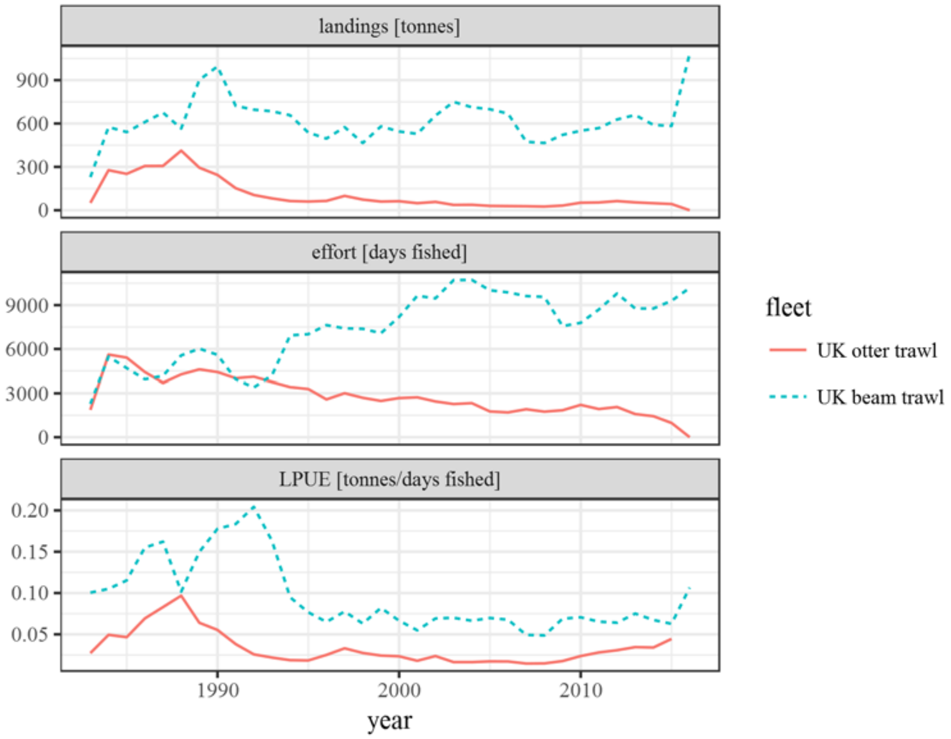

Figure 27.4. UK commercial lpue time-series. Lpue values are only shown for historical reasons but were not used in the assessment. The grey dot in the cpue plot is based on preliminary data from the Q1SWBeam survey in 2016.

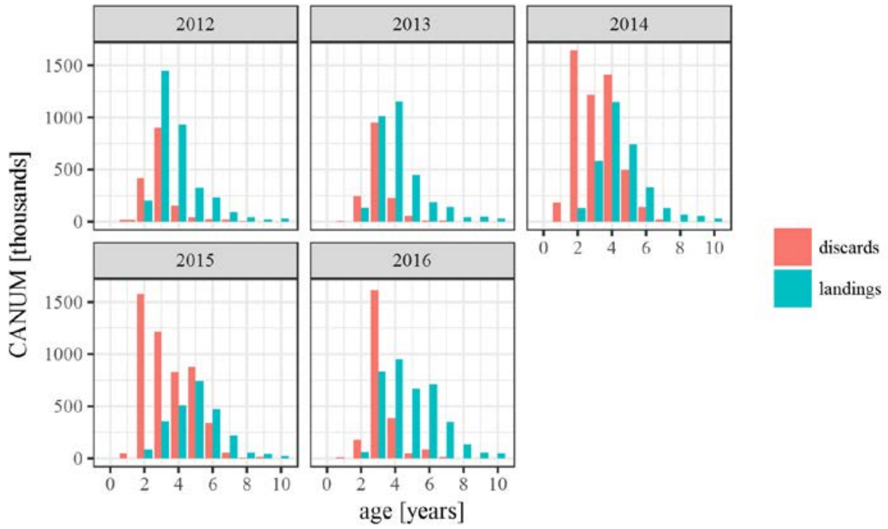

Figure 27.5. Plaice in 7.e. Age composition of reported international catches in InterCatch for Division 7.e.

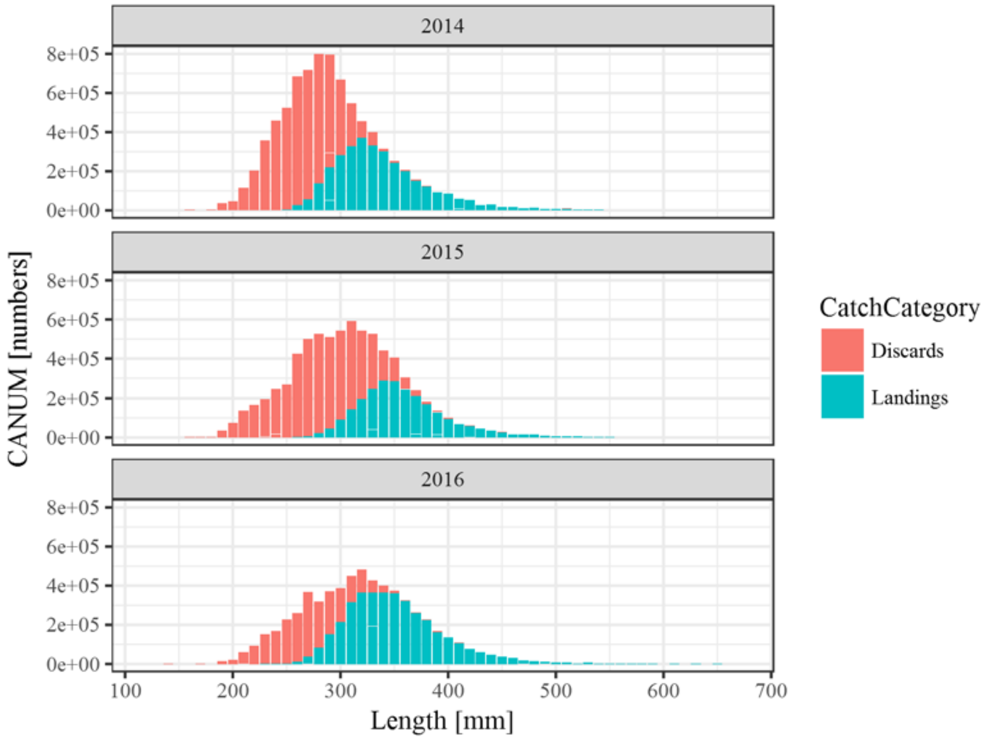

Figure 27.6. Plaice in 7.e. Total international length frequencies for 2014–2016 as raised within InterCatch for landings and discards.

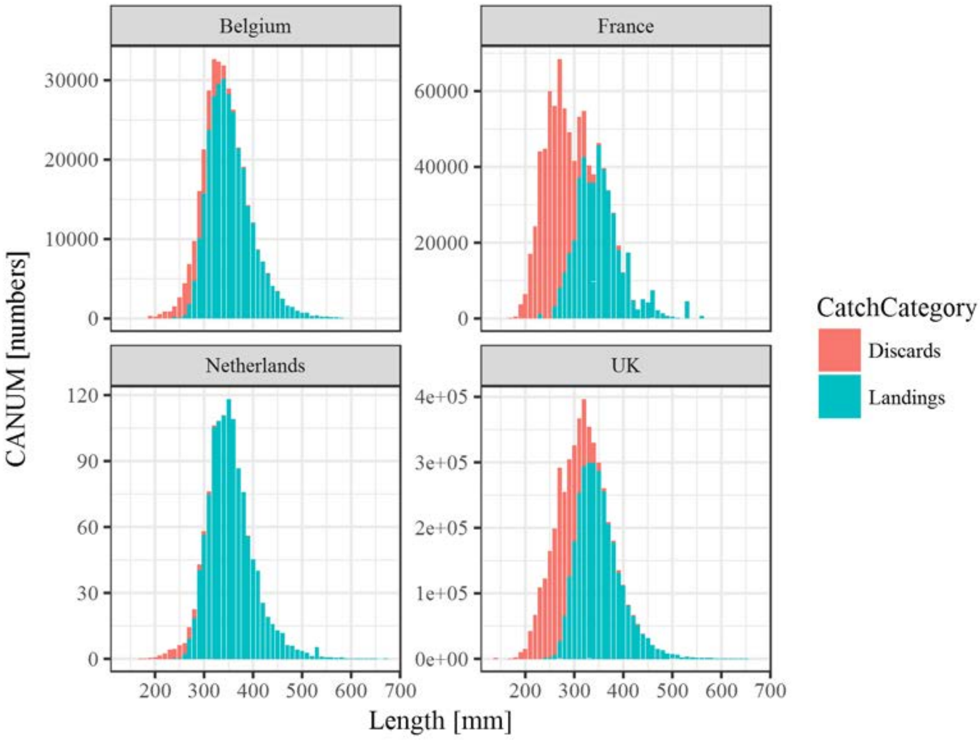

Figure 27.7. Plaice in 7.e. Total international length frequencies for 2014–2016 as raised within InterCatch for landings and discards, split by country.

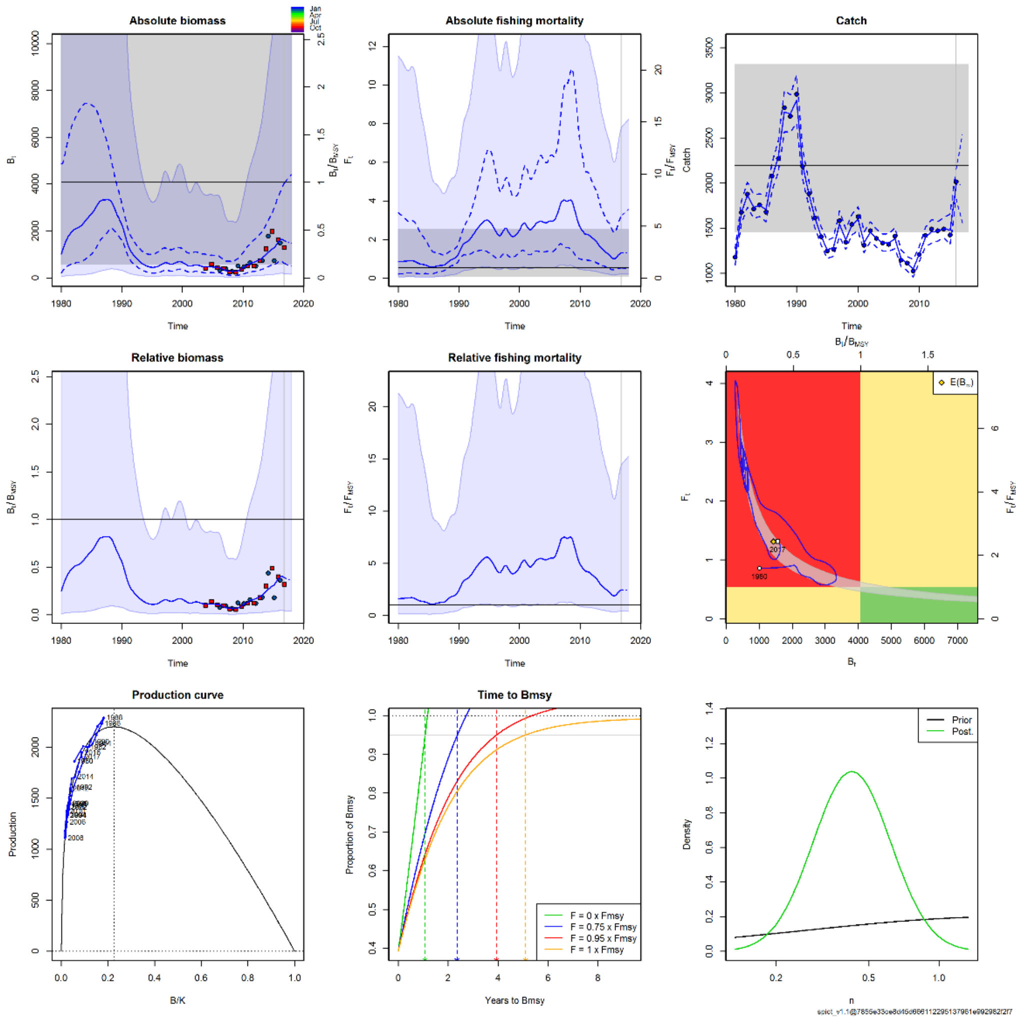

Figure 27.8. Plaice in 7.e. Results of fitting a SPiCT model to the plaice 7.e stock.

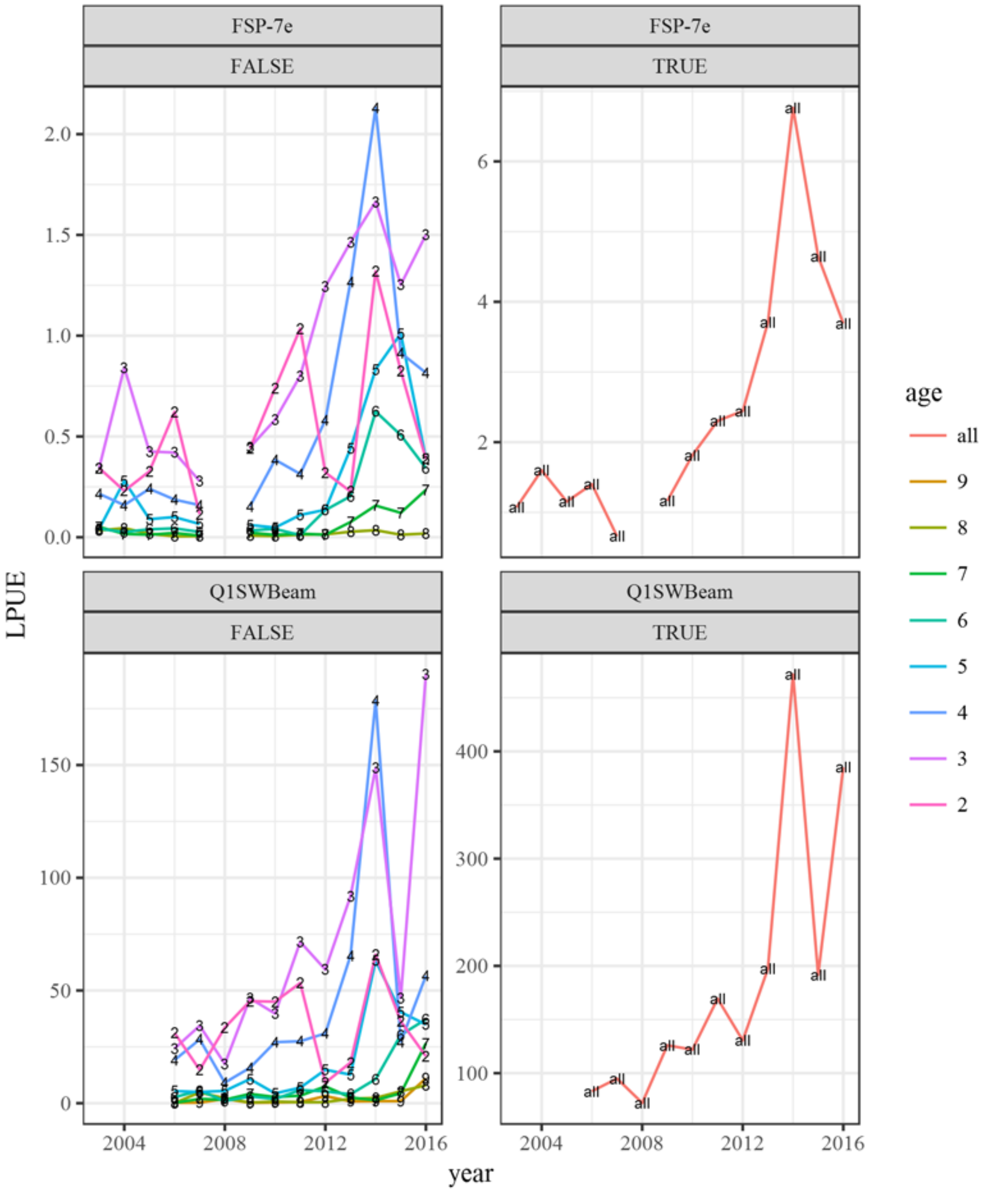

Figure 27.9. Plaice in 7.e. Scientific tuning information used in the assessment.

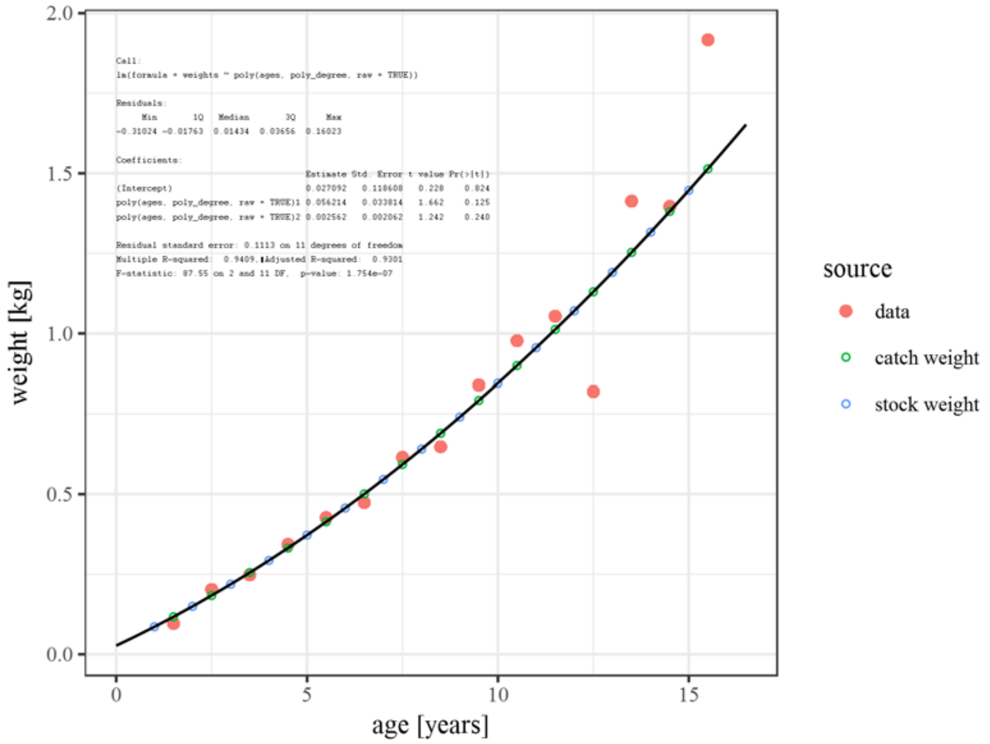

Figure 27.10. Plaice in 7.e. Derivation of the 2016 stock and catch weights by applying a polynomial model to the raw InterCatch weights-at-age.

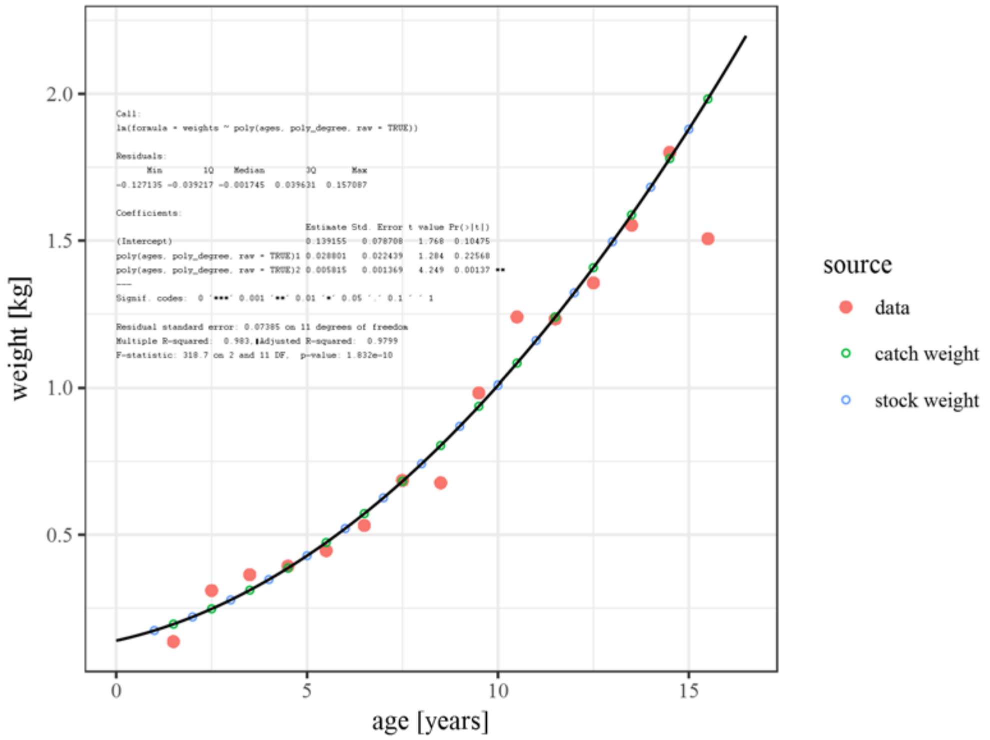

Figure 27.11. Plaice in 7.e. Derivation of the 2015 stock and catch weights by applying a polynomial model to the raw InterCatch weights-at-age.

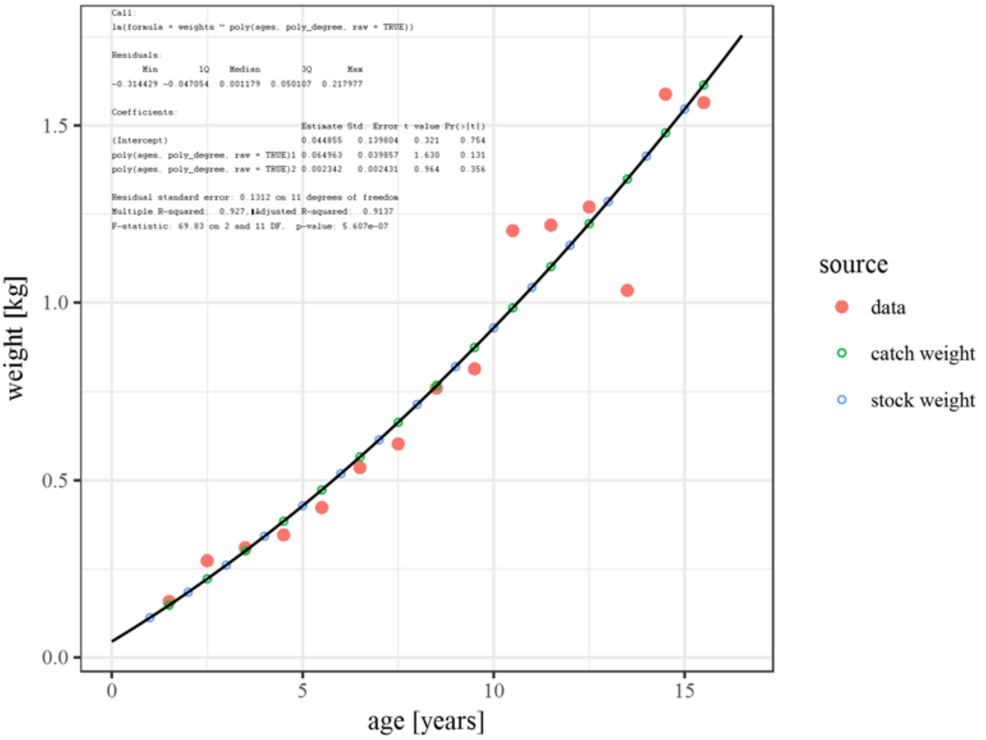

Figure 27.12. Plaice in 7.e. Derivation of the 2014 stock and catch weights by applying a polynomial model to the raw InterCatch weights-at-age.

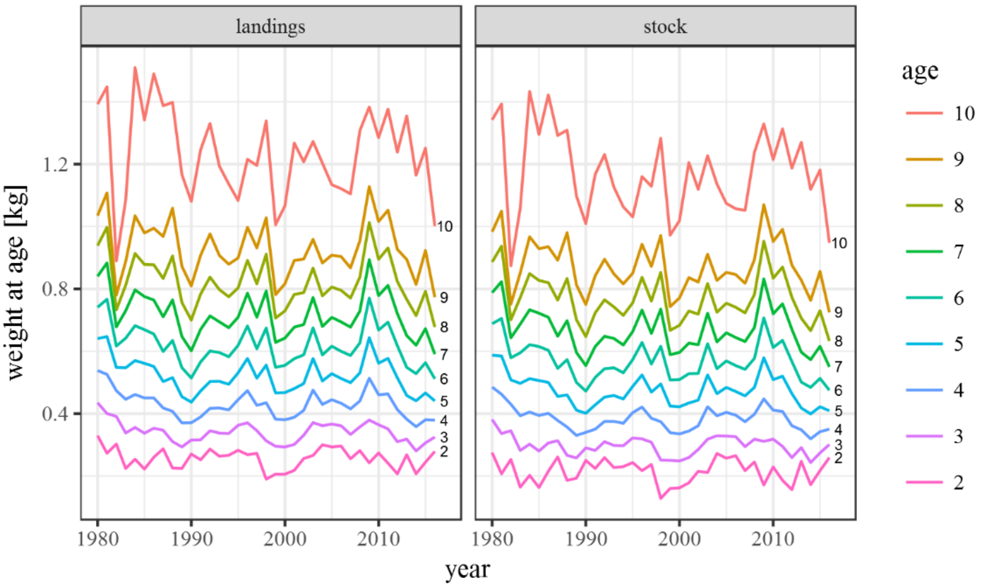

Figure 27.13. Plaice in 7.e. Landings and stock weights-at-age used in the assessment.

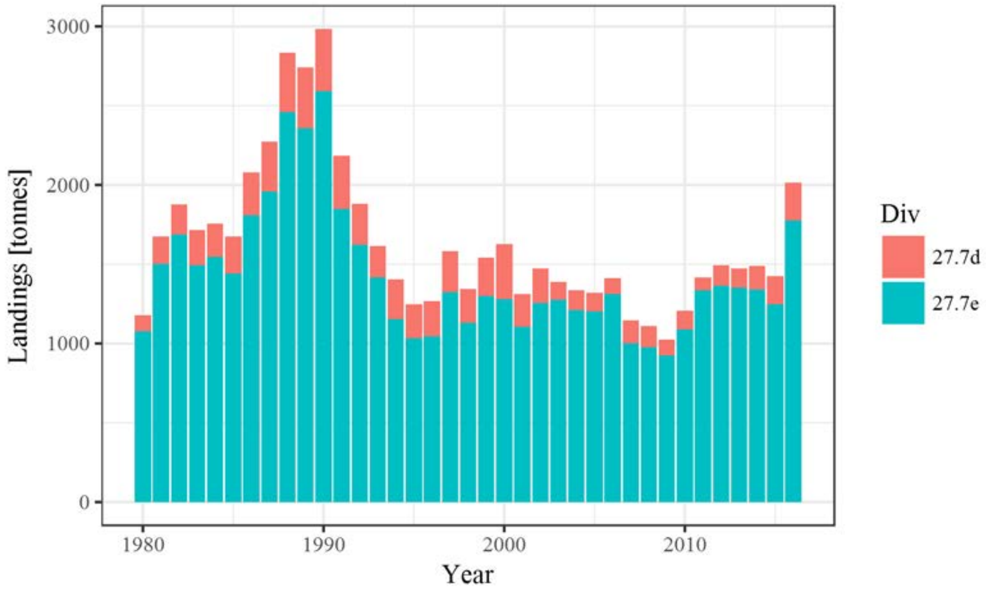

Figure 27.14. Plaice in 7.e. Total landings of the plaice 7.e stock disaggregated by the 7.e and the migration component from 7.d.

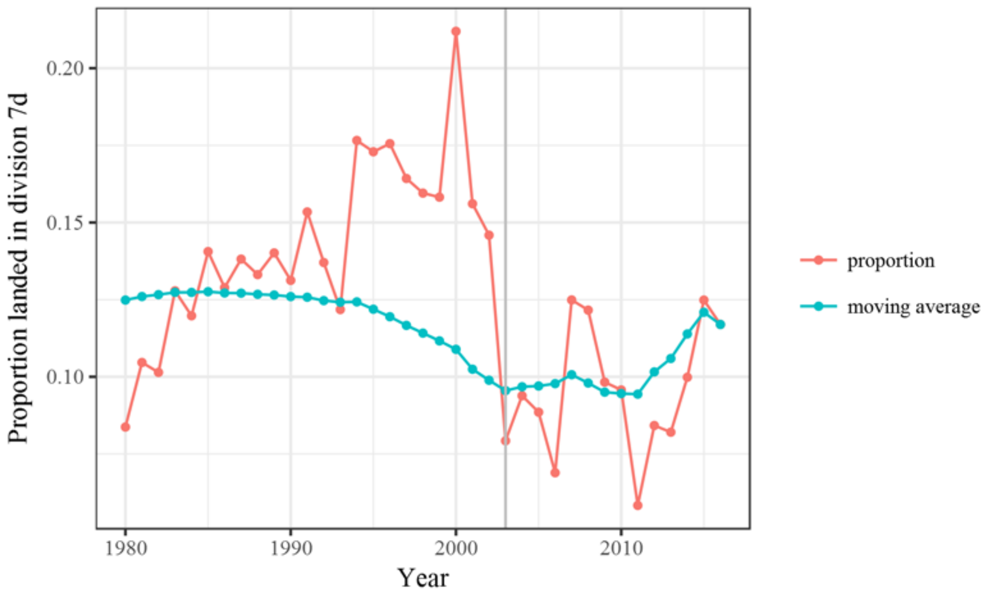

Figure 27.15. Plaice in 7.e. Proportion of the landings landed in 7.d (red line). The moving average displays the average of the proportion values, starting from the corresponding year up to and including the last value year in the time-series.

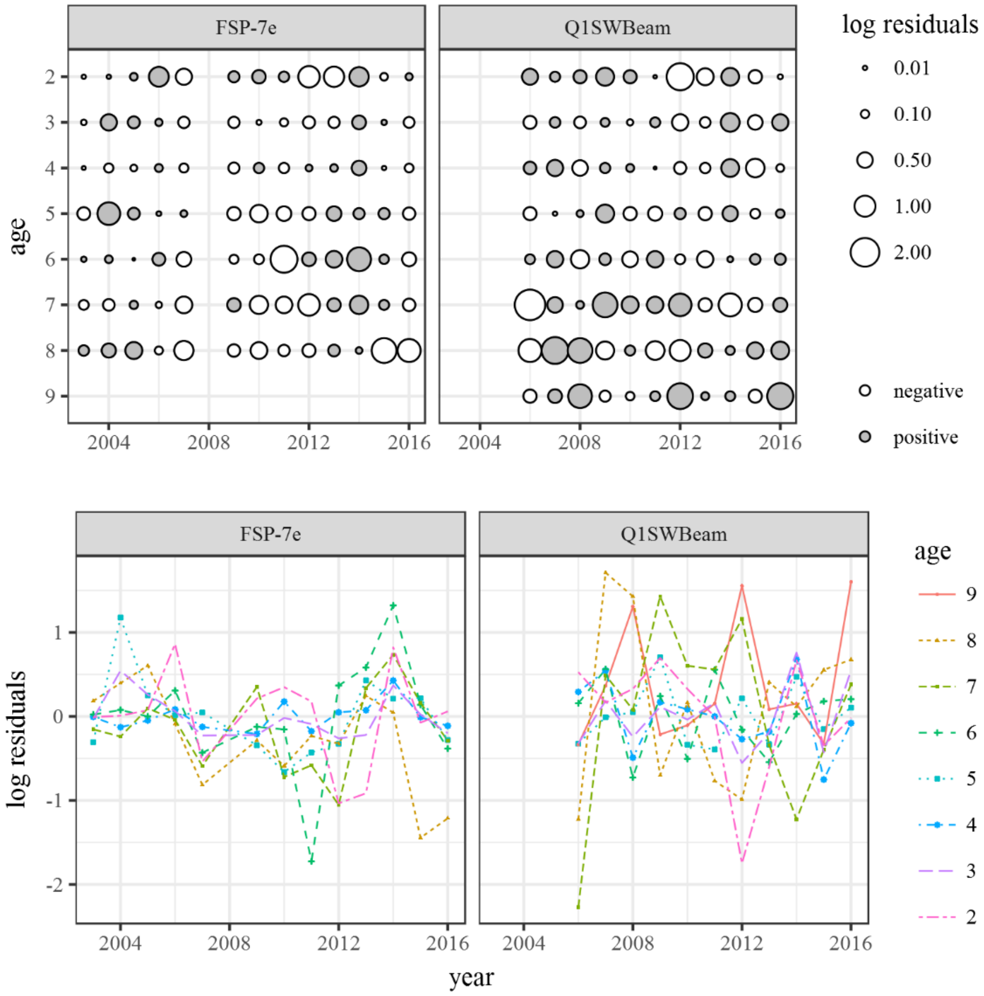

Figure 27.16. Plaice in 7.e. XSA survey log catchability residuals.

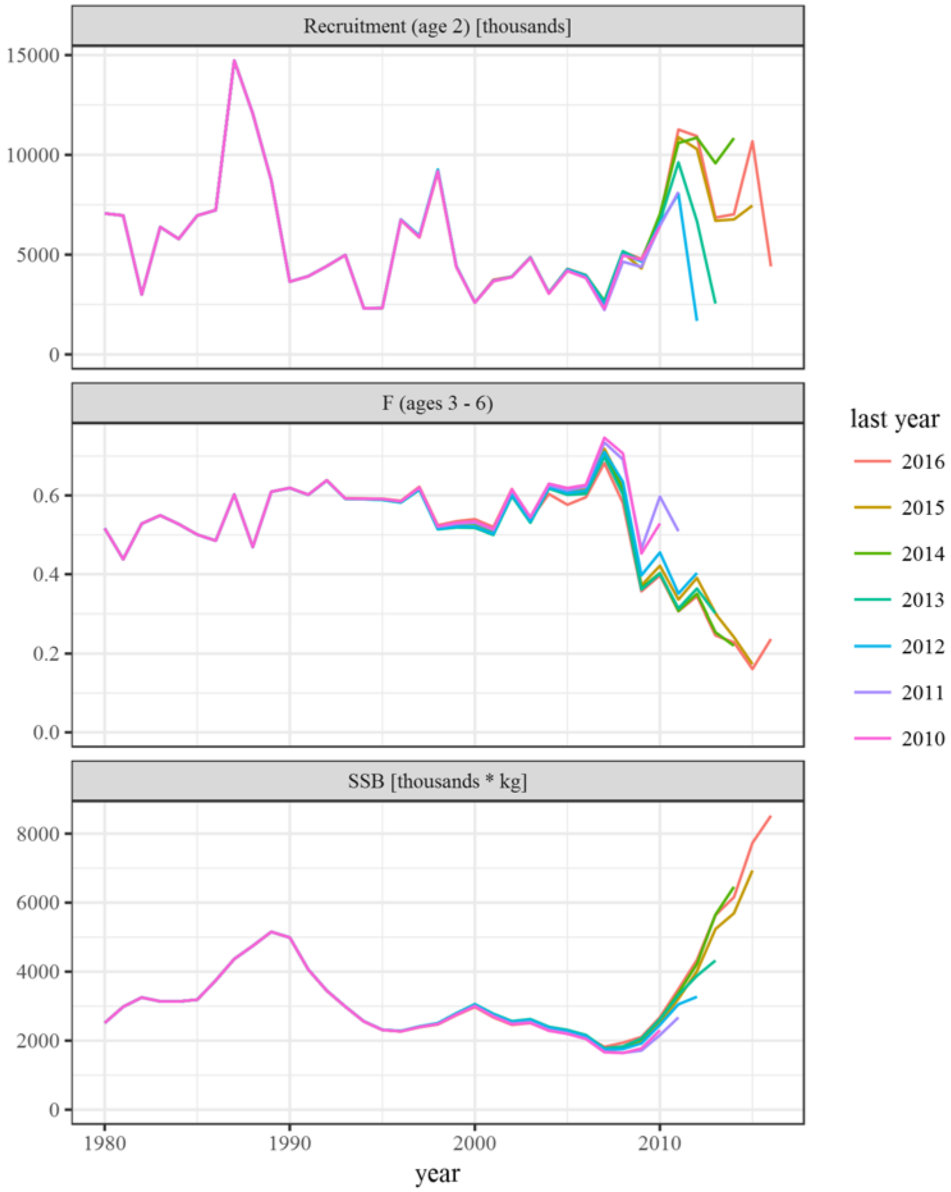

Figure 27.17. Plaice in 7.e. Seven-year retrospective of recruitment, spawning–stock biomass and fishing mortality estimates.

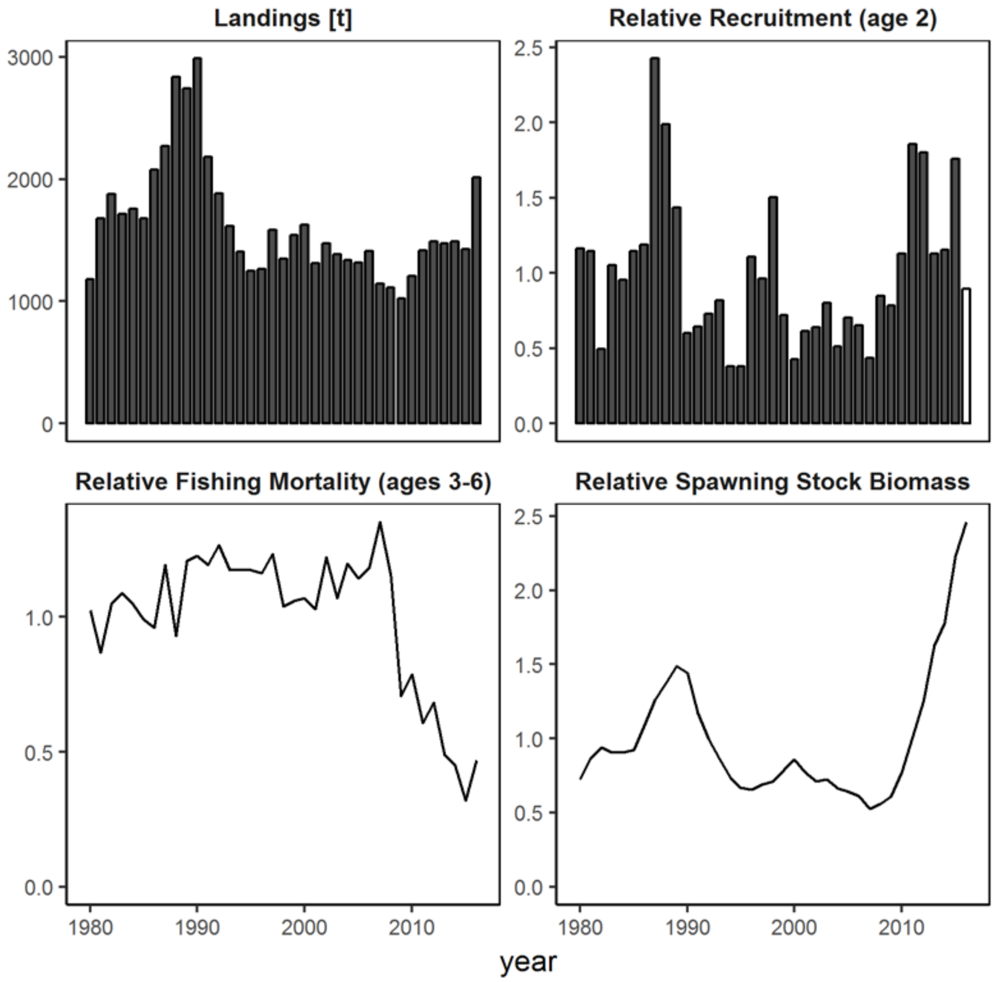

Figure 27.18. Plaice in 7.e. Summary of XSA final assessment.

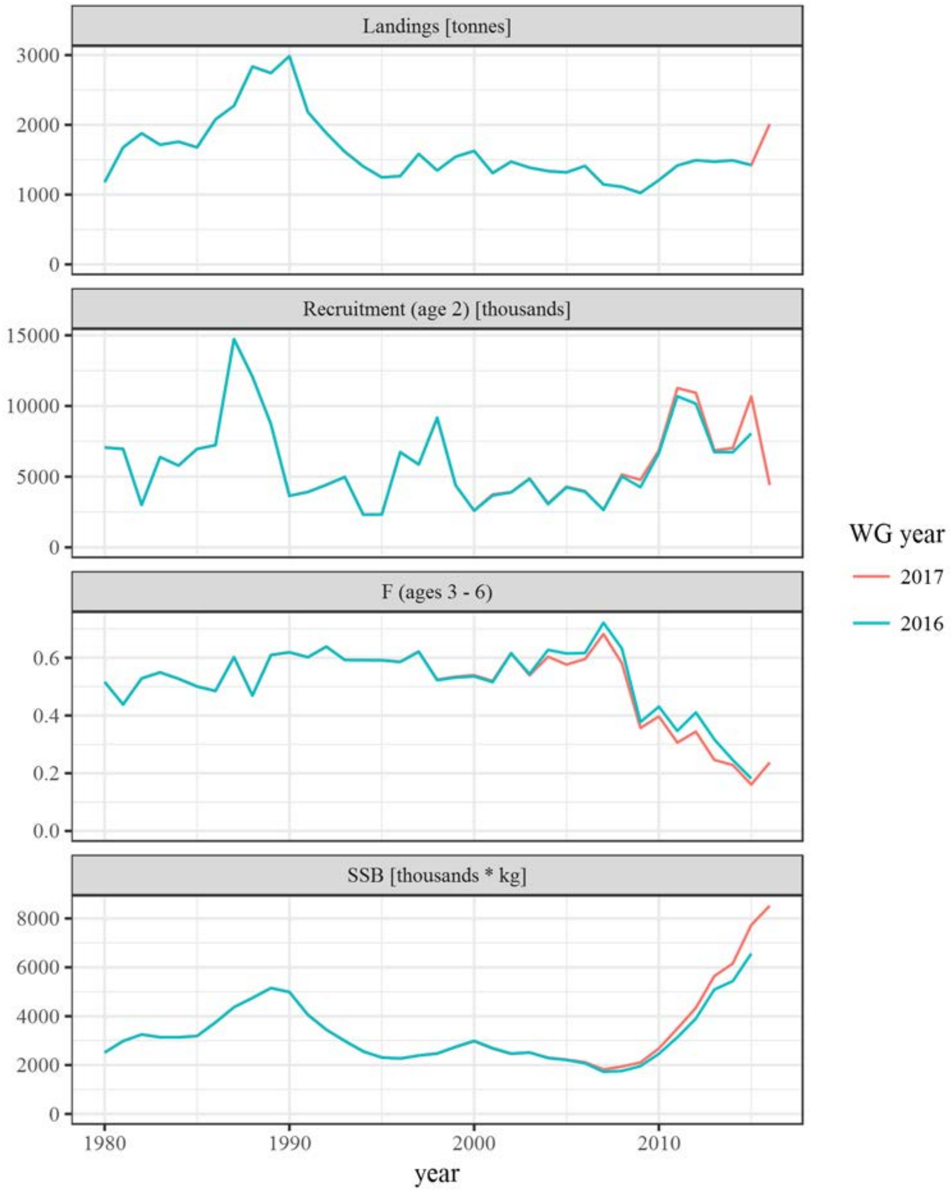

Figure 27.19. Plaice in 7.e. Comparison of the current XSA assessment run with the results from WGCSE 2016.

27.3 Audit of Plaice in 7.e

Date: 26th May 2017

Auditor: Sara-Jane Moore

General

For single stock summary sheet advice

- Assessment type: update
- Assessment: XSA indicative of trends only
- Forecast: N/A
- Assessment model: XSA
- Data issues: uncertainty with landings due to migration between 7.d and 7.e

  Age composition relies heavily on UK sampling and around 25% of landings are taken from other countries that don't provide age data;

  Reliable discard data only available for 2012–2016.
- **Consistency**: XSA as last year
- **Stock status**: indicative of trends only, F has declined since 2007. SSB has increased since 2008 and recruitment well above average since 2010
- Management Plan: None

General comments

Well written report, clear and concise

Technical comments

Conclusions

The assessment has been performed correctly

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? YES
- Is the assessment according to the stock annex description? YES
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?
- Have the data been used as specified in the stock annex? SA not updated in 2017
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes, where appropriate
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

27.4 WKProxy review of WGCSE Ple.27.7e, Plaice (*Pleuronectes platessa*) in Division 7.e (Western English Channel)

Category 3

General comments

1) **Assessment method(s)**: Proxy methods: Length-Based Indicators (LBI) and SPiCT. Other methods used were XSA and general trends.

2) Evaluating Uncertainties

- As a bycatch fishery, discards comprise a significant portion of the catch. However, discards were only recently considered and estimated, and previous years did not have discard estimates.
- There is some unknown amount of movement of mature plaice between areas. All of the category 3 proxy methods assume a closed system, and so these methods may not be appropriate if migration is extensive.
- Biological parameters were not specific to this stock and instead were borrowed from other stocks. The RG was curious if the EG was confident in these values.
- The EG questioned the R script's definition of Lc as the half-modal length for the LBI method and so used their own script to define the modal length as the absolute maximum. The LBI method should not be using local maxima to define the modal length, so the EG was correct in altering the script. This error was noticed by another EG who reported a bug in the Shiny app doing the calculations. The error has been corrected.

3) Consistency:

- SPiCT (and XSA runs) demonstrated large retrospective patterns in stock status, SSB, and F estimates.
- The surveys don't necessarily have the same trends. In addition, there are currently no surveys covering the coast of France.

4) Stock status:

- Reference points:
  - No proxy reference points were accepted.
  - The EG rejected LBI due to high uncertainty and conflicting results.
  - The EG rejected SPiCT because it would often not converge, was not robust to changing the range of the data input, and gave unreasonable results with high variance.

5) Comments & Suggestions:

- The RG agrees with the EG that the results from these proxy methods should be rejected.
- It appears to the RG that the input data (survey estimates and landings) are highly uncertain and need to be improved. In particular, discard rates need to be better estimated throughout the time-series to provide more accurate landings indices.
- The RG appreciates the EG showing LBIs for both definitions of Lc (based on using local vs. absolute maxima). It would have been useful for the EG to show annual length frequency plots so the RG could examine and evaluate the effect of the two Lcs.

- It was unclear to the RG if there were only three years of length data available, or if those were the only years considered for the LBI method. If there were more years of length data, it might be useful to examine other length-based methods and determine if they have the same shortcomings.

Conclusions

No proxy reference points were accepted.

28 Plaice in Divisions 7.f–g (Celtic Sea)

28.1 Type of assessment in 2017

In 2014 the analytic assessment by Aarts and Poos (2009) model was used to derive relative trends which include estimates of discards-at-age. The model was fitted at the benchmark meeting WGFLAT 2011. In 2015–2016 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 model has known issues in the recent years due to effort reporting, as well as changes in discard practice. Therefore, the AAP was not used to provide advice at WGCSE 2015–2016 and advice was based instead on survey trends. As previous ICES advice used a catch/landings and biomass index series, stock dynamics was investigated in 2017 by applying a biomass dynamic model (SPiCT – Stochastic Production model in Continuous Time) which provides model diagnostics. The model output suggests the stock is considered to be in a desirable state as F/ F_{MSY} proxy < 1 and B/MSY $B_{trigger}$ proxy > 1 (where MSY $B_{trigger}$ proxy = 0.5 B_{MSY}, a parameter estimated by the model). The diagnostics were found to be acceptable and therefore SPiCT was used as the basis for advice.

ICES advice applicable to 2017

Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 1800 tonnes. If discard rates remain unchanged from the average of the last three years, this implies landings of no more than 511 tonnes. Discards exceed landings and technical measures should be introduced to reduce discard rates.

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 2016 and 2017

TACs and quotas set for 2016 (source COUNCIL REGULATION (EU) No 72/2016).

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium 59

France 106

Ireland 200

United Kingdom 55

Total EU 420

Total TAC 420

TACs and quotas set for 2017 (source COUNCIL REGULATION (EU) No 127/2017).

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium 55

France 99

Ireland 199

United Kingdom 52

Total EU 405

Total TAC 405

Fishery in 2016

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 to Q4. The fleets harvesting plaice in the Celtic Sea primarily involve vessels from Belgium, France, Ireland and the UK. In 2016 Belgium reported 56.5% of the landings, France 21.2%, Ireland 12.1% and the UK 6.2%. The contribution of individual countries to total landings was similar to 2013–2015. The Working Group estimated that total international landings for 2016 were 430.9 t, ~2.6% above the TAC of 420 t. Discards were a significant component of catch (~70% in 2016), with the available time-series extending from 2004 to 2016. Discards have exceeded landings since 2006. Most of the catch (54.3%) were taken by beam trawlers, and 42.4%; by bottom otter trawlers. Other gears accounted for 3.3%. Efforts and lpues of fishing fleets are presented in Tables 28.2–28.4.

28.2 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. Discard information was available for Belgium, UK(E+W) and Ireland. The UK estimates were raised to produce equivalent levels of discards for France, Ireland and N Ireland (on the basis of similar gear type and quarter). The total estimates (Table 28.1) confirm the perception of the significant level of discarding; discards have therefore been included in the assessment since 2010. 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 2016 national discard sampling programmes are summarized in Figures 28.1a and b.

Biological information

Quarterly or annual age compositions for 2016 were available for Belgium, Ireland, UK(E+W), and one French metier all together representing approximately 80% of the total landings (Figure 28.2). International landings and discard numbers-at-age in years for which both are available (2004–2016) are compared in Figure 28.3; in recent years discards considerably exceeds landing in numbers at most ages. A strong cohort that appeared first in 2012 as 2 y.o., in 2015 attained the age of 5 y.o. and predominated landings, while the next strong generation (2 y.o.) appeared in the discards in 2015 and began be to important also in the 2016 landings. 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 (Table 28.6).

Discard weight-at-age

Discard length and weight-at-age raw data was available for UK(E+W), Belgium and Ireland. The three 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 from the three countries for each year and age (Tables 28.6 and 28.7).

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 data sets. 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 did not converge.

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) are presented in Table 28.10. Both surveys show consistent trends of the stock increase (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. WKFLAT (2011) noted that year effects in the survey catch rates dominate the abundance indices; year class and catch curve plots illustrated that the consistency of plaice year-class abundance estimates between ages is relatively poor. The survey was not fitted during preliminary runs of the assessment model in 2013, 2014, and 2015 but will be monitored for inclusion as the time-series progresses. Its tentative inclusion in assessment 2016 did not improve the AP model performance. These two survey time-series were used on the stock trends based advice in the years 2015 and 2016.

Commercial landings per unit of effort

Commercial indices of abundance from the UK(E&W) beam trawl and otter trawl data are presented in Table 28.11. In contrast to the survey data, they exhibit rather a declining trend (Figures 28.4 and 28.5), whereas the data from other fisheries (Figure 28.6) are contradictory.

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 2013–2016 mostly 3–4 y.o. fish (Figure 28.3. The UK beam and otter fleets, which were traditionally used in the assessment of this stock began to change discarding practice earlier, around the year 2011 (Figure 28.7).

Historically, the commercial lpue data illustrate a general pattern of steep decline since the high levels in the early 1990s, followed by a further more gradual decline in the late 1990s. Since 2000, lpue has been relatively stable at a low level with small increases in some metiers, notably - in Belgian beam-trawlers – the most important harvesters of the stock. 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 2016. There is relatively little information on the level of landings misreporting on this stock, although it 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). 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.

28.3 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 both 2015 and 2016 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 and data on lpues of commercial fleet 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 onwards. 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 2016 the AP model did not converge. 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 as 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 of 1500 tonnes.

Comparative model runs

Usage of the entire dataset on commercial lpues and survey cpues of +3-year-old plaice did not permit to the model to converge. Knowing the issue with reliability of recent commercial lpues, both lpue series (UK(E+W) BT and UK(E+W) OTB)) were truncated down to the year 2010. The catches time-series was approximated using average landings/discard ratio for the entire fishing history, 2004–2016 (K = 2.799). Then it was truncated up to the year 1989 to ensure 100% overlap between the catch time-series and at least one cpue/lpue time-series. The overlaps between commercial time-series and surveys series was 8–16 years. The model converged without unreasonable extension of catch series backwards as well as without necessity to fix an observation error. The results of SPiCT indicated that current stock status is well above the biomass reference point 0.5 B_{MSY}, and F (2016) is above F_{MSY} with satisfactory CIs.

An attempt to add a long series of lpues of Belgian beam trawlers (1996–2016, all ages combined) did not change perceived stock trends but increased drastically confidence intervals. So only four "traditional" cpue/lpue datasets were used for the assessment.

Final assessment

The settings and data for the model fits are set out in the table below:

ASSESSMENT YEAR		2016
Assessment model		SPiCT
Catch data		Including discards 1989–2016 (reported and raised discards for 2004–2016, and estimated discards for 1989–2003)
Discard rate		Average (proportion by number) 2004–2016. Calculated as discards/(landings + discards).
Tuning fleets	UK(E&W)-BTS-Q3	1995–2016 ages 3+
	IGFS-WIBTS-Q4	2003–2016 ages 3+
	UK commercial beam trawl	1990–2010 ages 4–8
	UK commercial otter trawl	1989–2010 ages 4–8

Figure 28.8 presents the output plots for the model. 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 2016, whereas F has been steadily declining from 2001 onwards (Figure 28.8, Table 28.13). The estimated biomass was above B_{MSY} from 2012, and the lower limit of this estimation exceeded B_{MSY} in 2016. Estimated F was below F_{MSY} from 2009, and upper limit of this estimation, from 2012. The stock increase is 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. As with some 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 global processes.

28.4 Short-term projections

The short-term projection from the model for 2017 (Table 28.14) forecasts B >B_{MSY} and F <F_{MSY} within 95% confidence intervals.

28.5 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 2016 application of the same model resulted in estimation of $B_{trigger}$ as 4550 t (50% of B_{MSY}) and F_{MSY} = 0.29. 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 more than 20%, so the uncertainty cap was applied.

28.6 Management plans

There is no management plan for Celtic Sea plaice.

28.7 Uncertainties in assessment and forecast

Landings

Sampling levels of landed catch (Figure 28.2) in recent years are sufficient to support current assessment approaches, and associated CVs of some national catch-at-age datasets are available in the Stock Annex.

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.

Consistency

In 2015 and 2016 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 2017 the WGCSE decided to use results of the SPiCT model, output of which was consistent with trends in abundance of commercial-sized fish aged 3+ as represented by data of research surveys.

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Table 28.1. Plaice in divisions 7.f–g. Nominal landings (t) as reported to ICES, and total landings as used by the working group.

	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

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Belgium	194	187	216	188	210	203	185	182	185	244
UK	61	63	55	54	45	44	41	25	25	27
France	104	62	N/A	136	98	126	106	155	111	108
Ireland	58	63	63	63	67	76	80	49	59	64
Total reported	417	375	N/A	442	420	450	412	411	381	443
Discards	1288	583	608	670	1107	1123	1274	1158	778	571
Unallocated	-7	62	N/A	-9	7	-8	-2	-1	0	-12
Landings used by WG	410	437	481	442	427	450	414	410	381	431
Catch as used by WG	1698	1020	1089	1112	1534	1565	1688	1568	1159	1002

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 VIIf (grp 1)		RECT. GROUP VIIg EAST (grp 2)		VIIg EAST (grp 2) Effort		RECT. GROUP VIIg WEST (grp 3)		VIIg WEST (grp 3) Effort		RECT. GROUP VIIf (grp 1)		RECT. GROUP VIIf (grp 1)			
YEAR	TRAWL	BEAM TRAWL	TRAWL	BEAM TRAWL	TRAWL (Days fished)	BEAM (Days fished)	TRAWL	BEAM TRAWL	TRAWL (Days fished)	BEAM (Days fished)	LANDINGS (t)	EFFORT (Days fished)	LANDINGS (t)	EFFORT (Days fished)	TRAWL (000 Days fished)	BEAM (000 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
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
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	0.00	2.50	0	24	0.90	156	10.25	959	165	1114
2015	18.82	11.87	37.87	14.58	3	245	0.00	3.65	0	56	1.39	79	7.80	726	82	1027
2016	0.00	14.91	0.00	9.57	0	396	0.00	0.05	0	34	0.00	0	11.28	915	0	1346

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	212.009	32.34	6.556

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		
Landings (t)	Effort (000 hr)	lpue (kg/h)	Landings (t)	Effort (000 hr)	lpue (kg/h)
94.23	63.56	1.48	9.55	6.43	1.49
133.66	60.04	2.23	14.20	9.73	1.46
119.84	65.10	1.84	38.79	16.13	2.40
96.72	72.30	1.34	21.38	14.94	1.43
60.05	51.66	1.16	10.40	8.01	1.30
28.78	60.60	0.47	11.40	9.90	1.15
23.82	69.43	0.34	10.93	16.33	0.67
42.30	77.69	0.54	16.42	20.86	0.79
26.35	86.79	0.30	13.80	20.91	0.66
26.62	96.99	0.27	5.04	19.38	0.26
22.78	124.40	0.18	6.47	14.81	0.44
25.17	119.23	0.21	5.10	14.79	0.34
30.99	136.52	0.23	4.76	15.82	0.30
39.17	125.81	0.31	8.38	11.65	0.72
43.81	137.11	0.32	7.98	8.19	0.98
44.29	140.65	0.31	10.71	9.69	1.11
44.68	120.33	0.37	11.12	11.01	1.01
43.21	121.08	0.35	18.41	14.15	1.30
31.91	118.13	0.28	11.10	12.06	0.84
28.00	127.40	0.22	7.60	12.00	0.61
35.05	133.07	0.26	8.36	9.29	0.90
34.61	147.43	0.23	9.37	10.44	0.90

	IR-TBB-7G					
Landings (t)	Effort (000 hr)	lpue (kg/h)	Year	Landings (t)	Effort (000 hr)	lpue (kg/h)
37.92	20.78	1.83	2006	14.46	60.48	0.24
53.02	26.76	1.98	2007	21.18	55.86	0.38
94.59	28.25	3.35	2008	14.18	37.22	0.38
122.13	35.25	3.46	2009	6.96	37.96	0.18
25.80	40.87	0.63	2010	6.56	40.22	0.16
12.62	37.03	0.34	2011	6.71	35.33	0.19
4.80	39.71	0.12	2012	33.63	40.33	0.83
7.08	31.62	0.22	2013	32.32	38.48	0.84
9.37	49.26	0.19	2014	12.50	37.80	0.33
6.17	54.86	0.11	2015	12.10	37.79	0.32
9.49	49.65	0.19	2016	9.71	39.33	0.25

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
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

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
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

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
SOPCOF %	0	0	0	100	100	100	100	100	100	100	100	100	100	100

AGE\YEAR	2015	2016
1	38	29
2	1527	224
3	1253	1610
4	753	615
5	1106	229
6	303	209
7	54	34
8	33	15
+gp	80	9
TOTALNUM	5145	2974
TONSLAND	870	591
SOPCOF %	103	103

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
1	0.12	0.148
2	0.124	0.153
3	0.143	0.177
4	0.171	0.205
5	0.219	0.261
6	0.315	0.288
7	0.208	0.341
8	0.204	0.416
+gp	0.529	0.462

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
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

Table 28.10. Plaice in divisions 7.f–g: Survey abundance indices.

IRGFS							
2003	2016						
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
E+W BT Survey							
1995 2016							
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		

Table 28.11. Plaice in divisions 7.f–g: Commercial fleet abundance indices.

UK (E+W) BEAM TRAWL 7F.					
1990 2016					
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
1	0.841	1.002	0.357	0.3	0.092
1	1.03	0.497	0.398	0.192	0.085
1	0.759	0.342	0.112	0.162	0.062
1	1.564	0.688	0.125	0.073	0.063
1	0.468	0.964	0.358	0.096	0.055
1	0.448	0.382	0.765	0.317	0.131

UK E+W OTTER TRAWL 7F					
1989	2015				
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
1	0.171	0.229	0.114	0.076	0.057
1	0.847	0.368	0.276	0.111	0.037
1	0.107	0.143	0.071	0.036	0.036
1	0.514	0.193	0.129	0.001	0.001
1	0.759	1.266	0.506	0.253	0.001

Table 28.12. Diagnostic of the SPiCT model, stochastic and deterministic reference points.

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 64.3716764
Euler time step (years):  1/16 or 0.0625
Nobs C: 28,  Nobs I1: 22,  Nobs I2: 14,  Nobs I3: 21,  Nobs I4: 22

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
 alpha1 2.106218e+00    1.0982583 4.039263e+00
 alpha2 1.932243e+00    0.9709785 3.845153e+00
 alpha3 9.339498e-01    0.4511693 1.933337e+00
 alpha4 1.838994e+00    1.0320304 3.276938e+00
 beta   4.443561e-01    0.1531830 1.288996e+00
 r      5.366204e-01    0.1433445 2.008877e+00
 rc     5.775540e-01    0.2966948 1.124282e+00
 rold   6.252480e-01    0.1792882 2.180484e+00
 m      2.779378e+03 1643.4376891 4.700479e+03
 K      1.981229e+04 9995.6827827 3.926965e+04
 q1     1.525950e-02    0.0071978 3.235030e-02
 q2     4.153300e-03    0.0019251 8.960400e-03
 q3     1.220000e-05    0.0000058 2.590000e-05
 q4     5.356000e-04    0.0002503 1.146200e-03
 n      1.858252e+00    0.6693795 5.158659e+00
 sdb    2.168589e-01    0.1331368 3.532292e-01
 sdf    2.387988e-01    0.1530494 3.725913e-01
 sdi1   4.567522e-01    0.3207009 6.505206e-01
 sdi2   4.190240e-01    0.2698735 6.506052e-01
 sdi3   2.025354e-01    0.1264440 3.244170e-01
 sdi4   3.988023e-01    0.2880237 5.521882e-01
 sdc    1.061117e-01    0.0467884 2.406512e-01
            log.est
 alpha1   0.7448939
 alpha2   0.6586812
 alpha3  -0.0683326
 alpha4   0.6092188
 beta    -0.8111290
```

```
 r        -0.6224643
 rc       -0.5489534
 rold     -0.4696068
 m         7.9299826
 K         9.8940579
 q1       -4.1825526
 q2       -5.4838548
 q3      -11.3099896
 q4       -7.5321681
 n         0.6196363
 sdb      -1.5285082
 sdf      -1.4321338
 sdi1     -0.7836143
 sdi2     -0.8698270
 sdi3     -1.5968408
 sdi4     -0.9192895
 sdc      -2.2432627

Deterministic reference points (Drp)
          estimate        cilow        ciupp
 Bmsyd 9624.653884 4715.5801089 1.964423e+04
 Fmsyd    0.288777    0.1483474 5.621408e-01
 MSYd  2779.378495 1643.4376891 4.700479e+03
         log.est
 Bmsyd  9.172083
 Fmsyd -1.242101
 MSYd   7.929983
Stochastic reference points (Srp)
           estimate        cilow        ciupp
 Bmsys 9100.3499700 4537.7851153 18250.394735
 Fmsys    0.2789739    0.1421171     0.547622
 MSYs  2533.6204525 1583.5117392  4053.795396

log.est rel.diff.Drp
 Bmsys  9.116068  -0.05761360
 Fmsys -1.276637  -0.03513978
 MSYs   7.837405  -0.09699876

States w 95% CI (inp$msytype: s)
                  estimate        cilow
 B_2016.88      1.592319e+04 7393.5761847
 F_2016.88      6.456550e-02    0.0278811
 B_2016.88/Bmsy 1.749734e+00    1.0607868
```

```
 F_2016.88/Fmsy 2.314391e-01    0.1249880
                       ciupp    log.est
 B_2016.88      3.429301e+04  9.6755318
 F_2016.88      1.495171e-01 -2.7400753
 B_2016.88/Bmsy 2.886130e+00  0.5594637
 F_2016.88/Fmsy 4.285537e-01 -1.4634383

Predictions w 95% CI (inp$msytype: s)
                  prediction        cilow
 B_2017.00      1.595031e+04 7396.0875234
 F_2017.00      6.451520e-02    0.0274358
 B_2017.00/Bmsy 1.752713e+00    1.0626932
 F_2017.00/Fmsy 2.312589e-01    0.1223281
 Catch_2017.00  1.036783e+03  612.3562385
 E(B_inf)       1.573003e+04           NA
                       ciupp    log.est
 B_2017.00      3.439822e+04  9.6772333
 F_2017.00      1.517073e-01 -2.7408544
 B_2017.00/Bmsy 2.890773e+00  0.5611651
 F_2017.00/Fmsy 4.371906e-01 -1.4642174
 Catch_2017.00  1.755381e+03  6.9438776
 E(B_inf)                 NA  9.6633266
```

Table 28.13. 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	B (est)	B low	B upp	F (est)	F low	F upp	B/Bmsy (est)	B/Bmsy low	B/Bmsy upp	F/Fmsy (estimate)	F/Fmsy low	F/Fmsy upp
1989	24509.49	10447.78	57546.24	0.250	0.107	0.581	2.693	1.248	5.842	0.896	0.505	1.593
1990	20203.69	8943.356	45644.12	0.273	0.121	0.614	2.220	1.157	4.262	0.978	0.609	1.572
1991	15832.29	7039.365	35609.57	0.274	0.119	0.627	1.740	0.938	3.227	0.981	0.616	1.563
1992	11490.37	5139.179	25691.32	0.293	0.128	0.672	1.263	0.695	2.294	1.052	0.662	1.671
1993	9548.866	4315.376	21129.97	0.335	0.148	0.759	1.049	0.577	1.908	1.201	0.758	1.904
1994	7401.438	3384.236	16187.54	0.408	0.183	0.908	0.813	0.454	1.458	1.463	0.940	2.276
1995	5875.01	2707.64	12747.68	0.477	0.219	1.039	0.646	0.362	1.150	1.710	1.116	2.621
1996	5292.578	2486.569	11265.76	0.512	0.242	1.084	0.582	0.329	1.027	1.836	1.212	2.783
1997	5353.242	2546.598	11253.21	0.584	0.282	1.207	0.588	0.334	1.035	2.092	1.383	3.165
1998	5123.55	2428.612	10809.09	0.583	0.279	1.218	0.563	0.321	0.989	2.090	1.386	3.151
1999	4499.762	2101.406	9635.884	0.587	0.274	1.256	0.494	0.282	0.867	2.103	1.386	3.193
2000	3664.317	1676.691	8008.212	0.556	0.255	1.212	0.403	0.229	0.707	1.993	1.304	3.045
2001	3562.944	1629.49	7790.714	0.542	0.248	1.181	0.392	0.222	0.689	1.941	1.270	2.968
2002	3509.494	1580.365	7794.15	0.506	0.228	1.124	0.386	0.217	0.687	1.815	1.171	2.812
2003	3469.536	1512.636	7958.562	0.444	0.191	1.032	0.381	0.208	0.700	1.593	0.996	2.548
2004	2748.048	1186.85	6363.206	0.320	0.131	0.785	0.302	0.166	0.549	1.149	0.690	1.911
2005	2470.503	1083.406	5634.042	0.293	0.124	0.695	0.271	0.152	0.486	1.051	0.653	1.691
2006	2881.526	1299.939	6387.946	0.316	0.139	0.719	0.317	0.179	0.561	1.134	0.723	1.779
2007	3663.279	1647.496	8145.703	0.385	0.171	0.865	0.403	0.223	0.725	1.380	0.864	2.206
2008	3794.162	1700.357	8466.481	0.290	0.127	0.660	0.417	0.233	0.747	1.039	0.657	1.643
2009	4707.2	2141.1	10349.32	0.232	0.103	0.521	0.517	0.289	0.925	0.831	0.522	1.323
2010	5652.987	2579.553	12388.39	0.200	0.090	0.444	0.621	0.348	1.110	0.717	0.442	1.164
2011	8262.69	3780.852	18057.34	0.179	0.082	0.392	0.908	0.501	1.646	0.642	0.384	1.072
2012	10634.69	4879.364	23178.63	0.150	0.068	0.330	1.169	0.652	2.094	0.537	0.314	0.920
2013	12882.89	5876.13	28244.66	0.125	0.057	0.275	1.416	0.796	2.519	0.449	0.260	0.773
2014	13127.91	6032.119	28570.83	0.094	0.042	0.210	1.443	0.842	2.473	0.338	0.195	0.585
2015	14630.02	6703.868	31927.47	0.078	0.035	0.173	1.608	0.945	2.735	0.280	0.162	0.485
2016	15634.46	7201.414	33943.67	0.067	0.030	0.151	1.718	1.027	2.875	0.239	0.134	0.428

Table 28.14. Short-term projection of the SPiCT model, plaice 7.fg.

Reference Point	Estimate	CI 95% low	CI 95% upp	CV, %
B/B_{MSYS}	1.767	1.072	2.914	25.5
F/F_{MSYS}	0.231	0.114	0.472	36.3

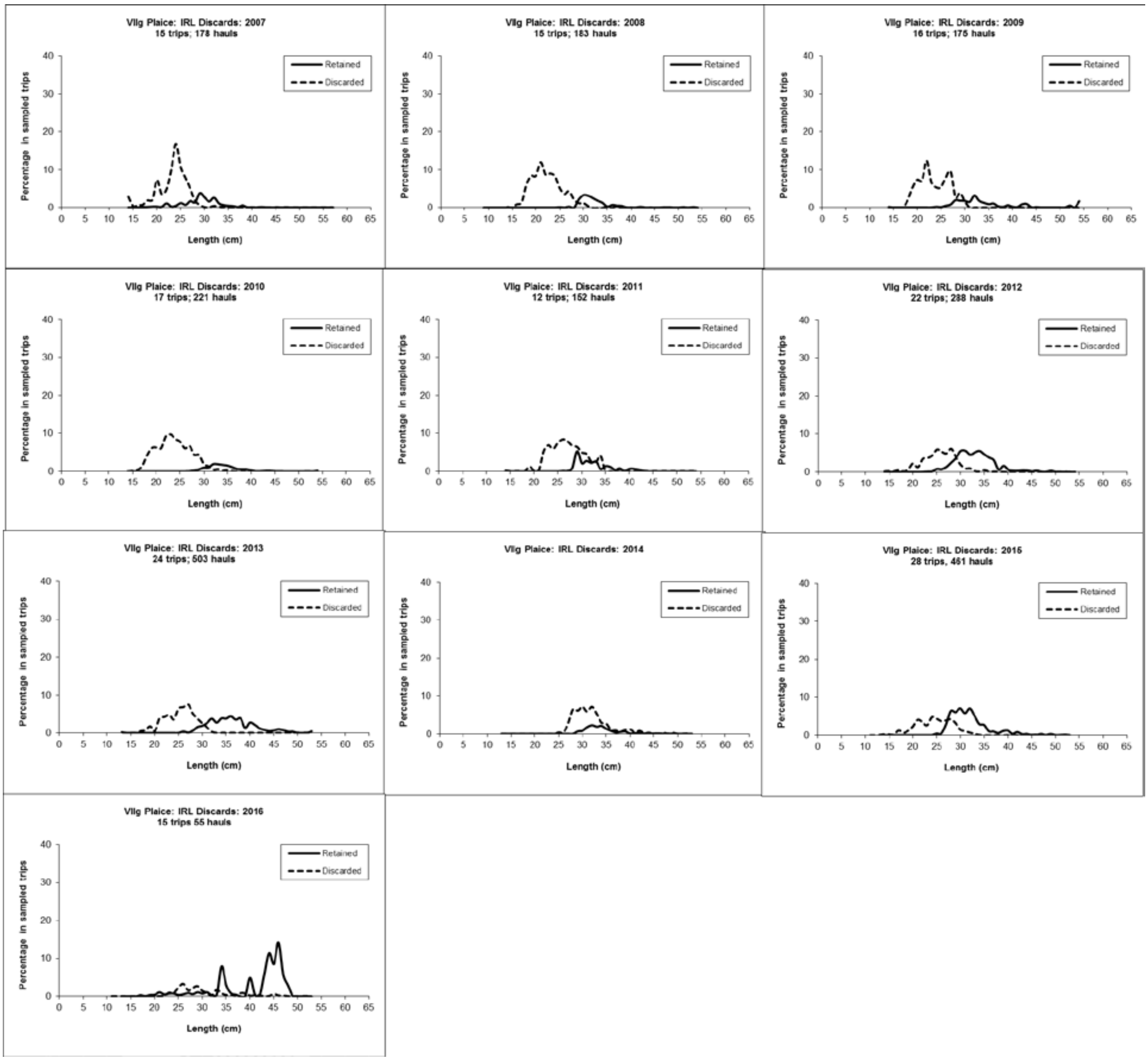


Figure 28.1a. Plaice in divisions 7.f–g: Ireland otter trawl discard sampling results in 2007–2016; raised to sampled trips.

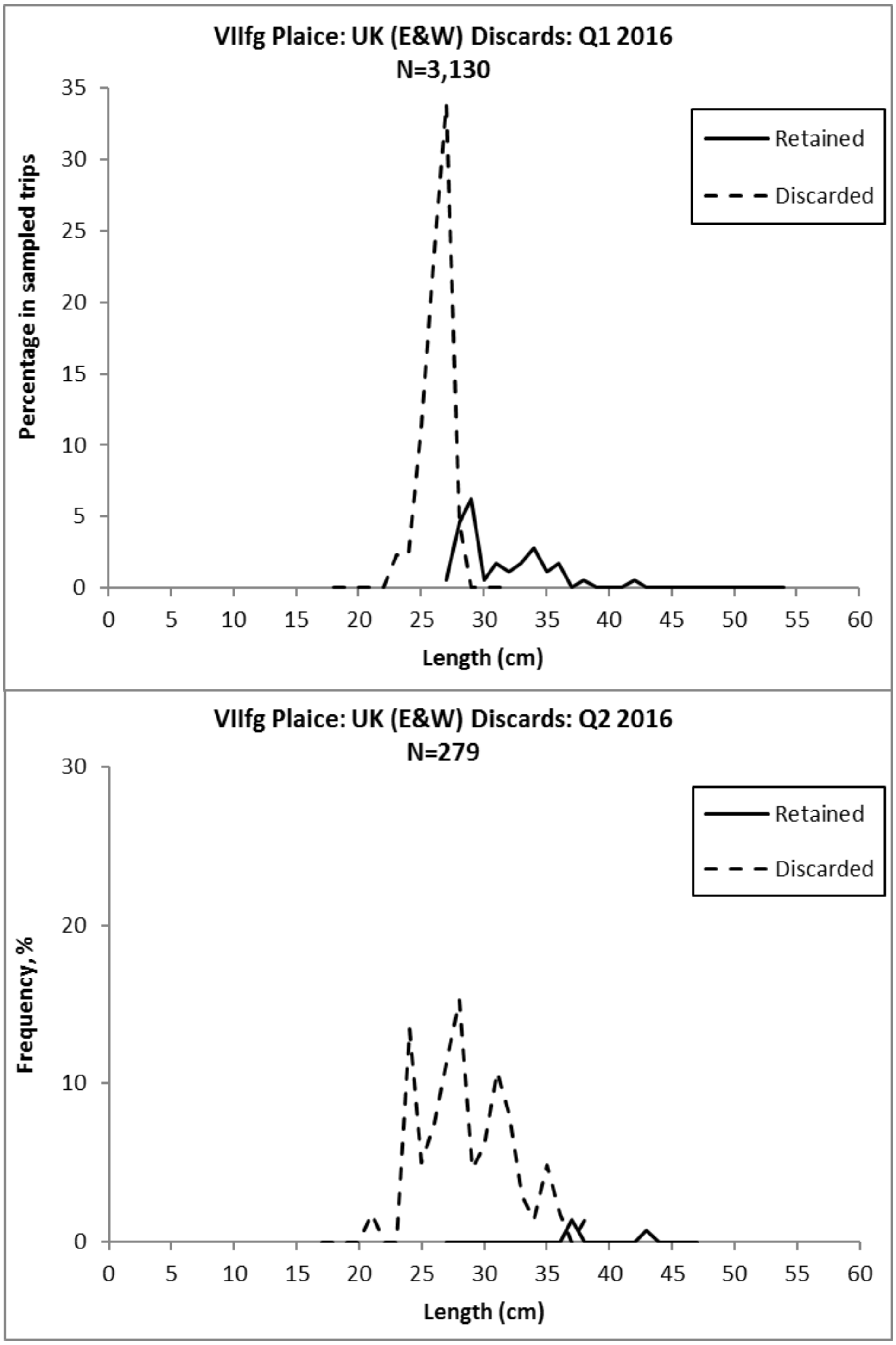


Figure 28.1b. Plaice in divisions 7.f–g: UK (E&W) Discard sampling results in 2016 (only data for Q1 and Q2 available); raised to sampled trips. All gears bar beam.

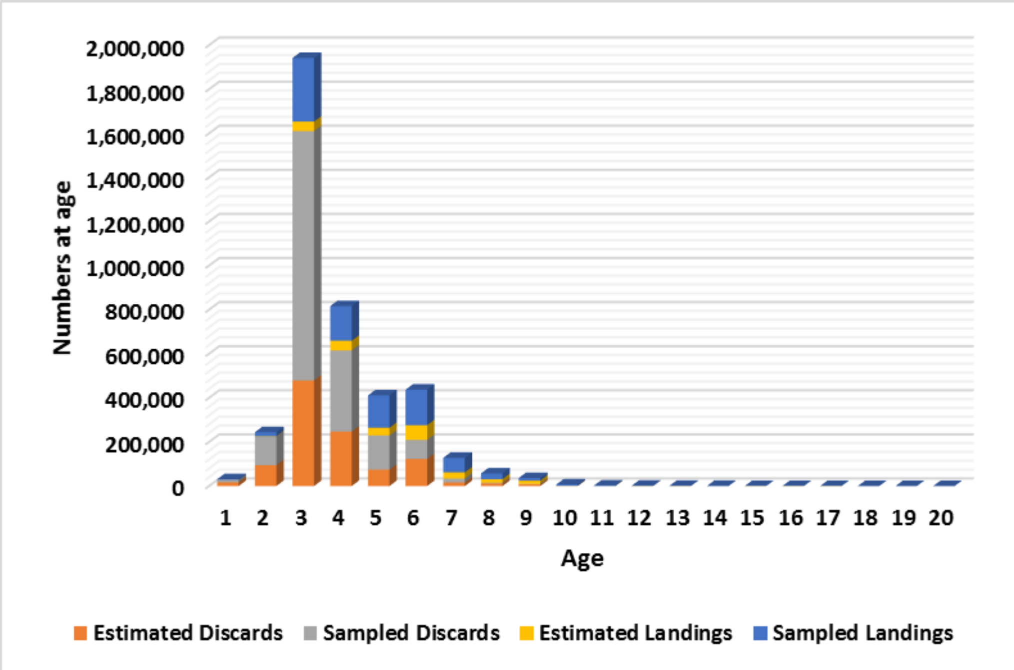


Figure 28.2. Plaice in Division 7.f–g: Contribution of sampled and unsampled landings and discards to final assessment catch numbers-at-age in 2016.

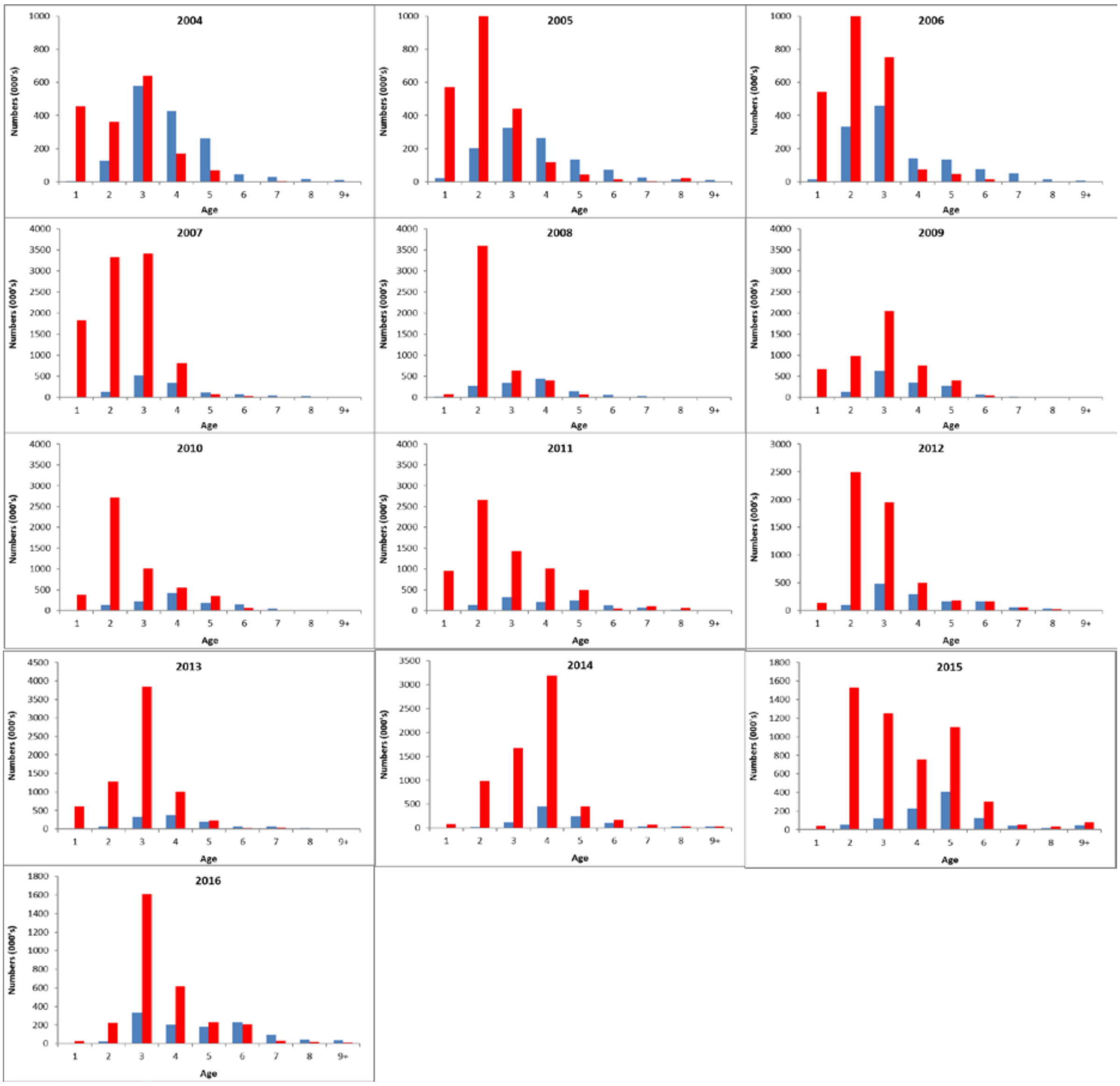


Figure 28.3. Plaice in divisions 7.f–g: Age composition of international landings and discards from 2004 to 2016.

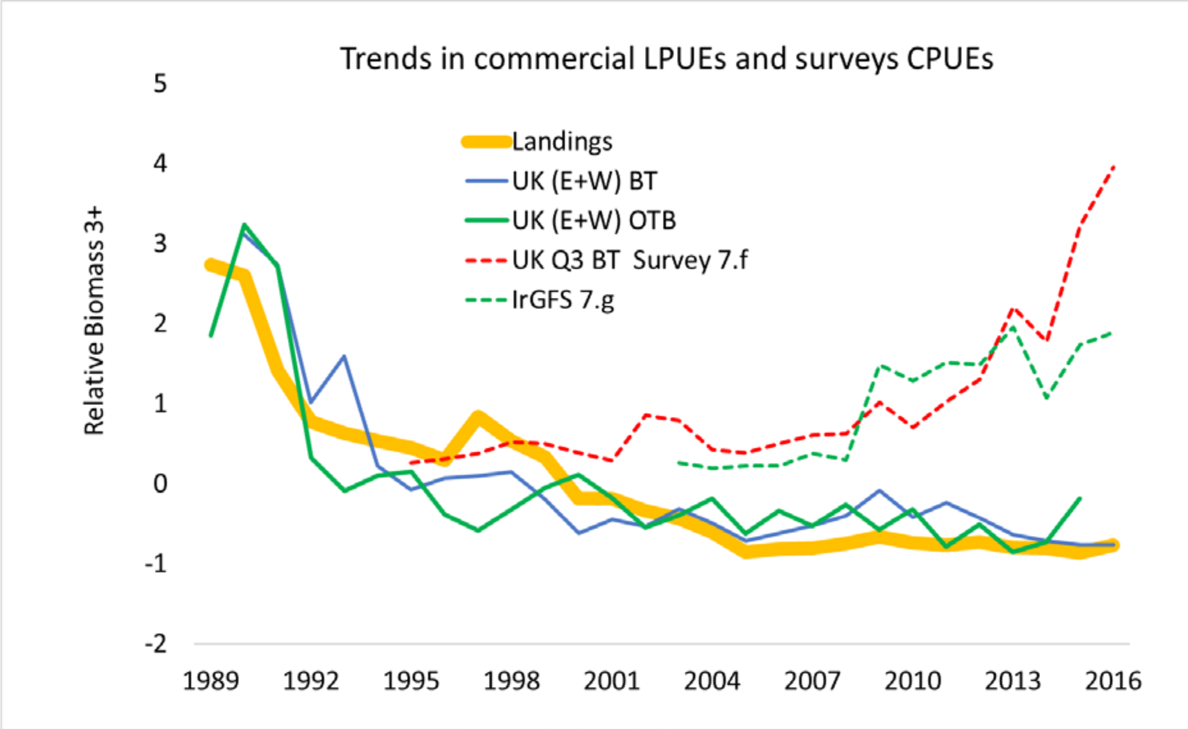


Figure 28.4. Trends in commercial lpues and survey cpues versus annual landings.

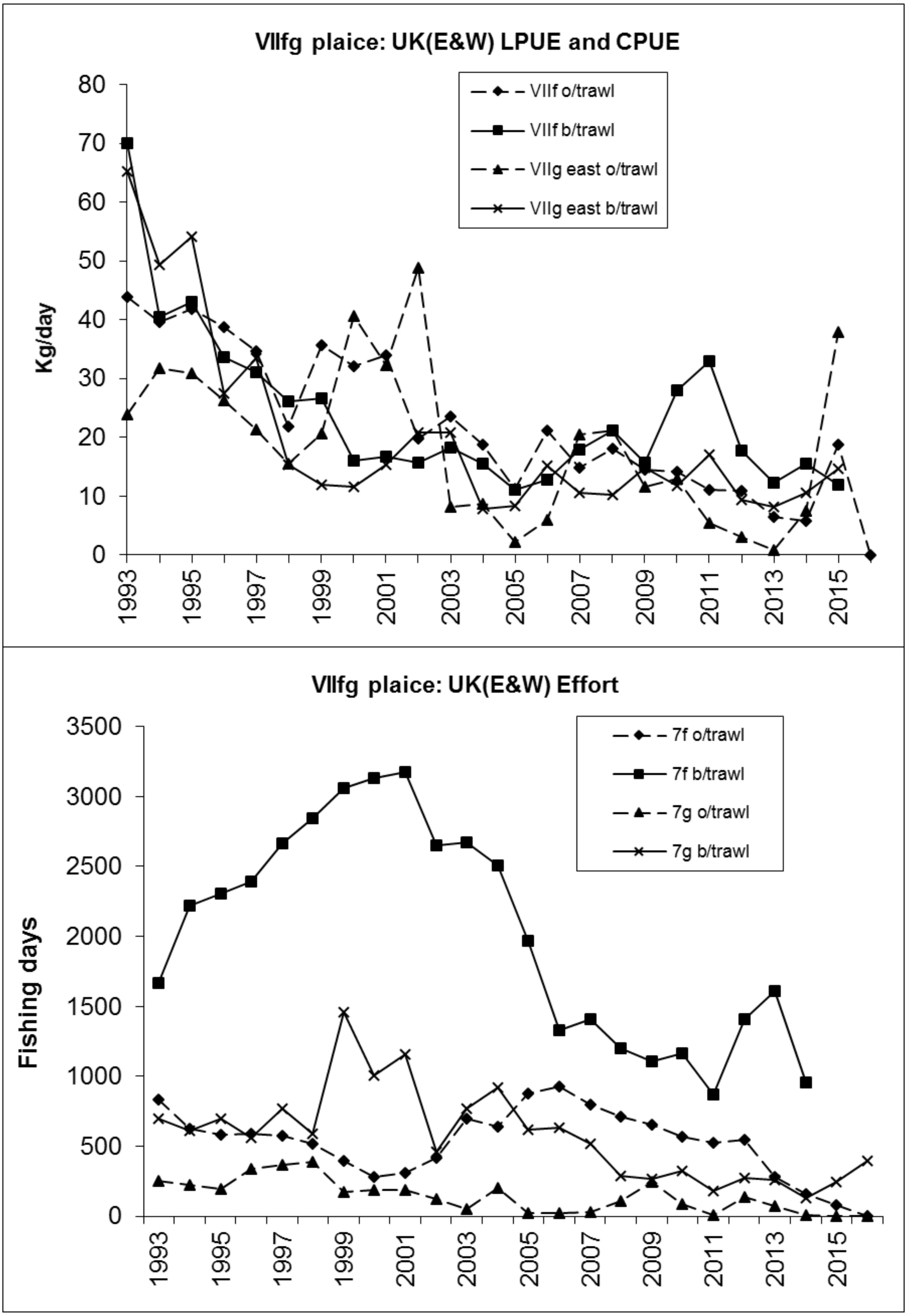


Figure 28.5. Plaice in divisions 7.f–g: UK (E&W) lpue and effort by fleet.

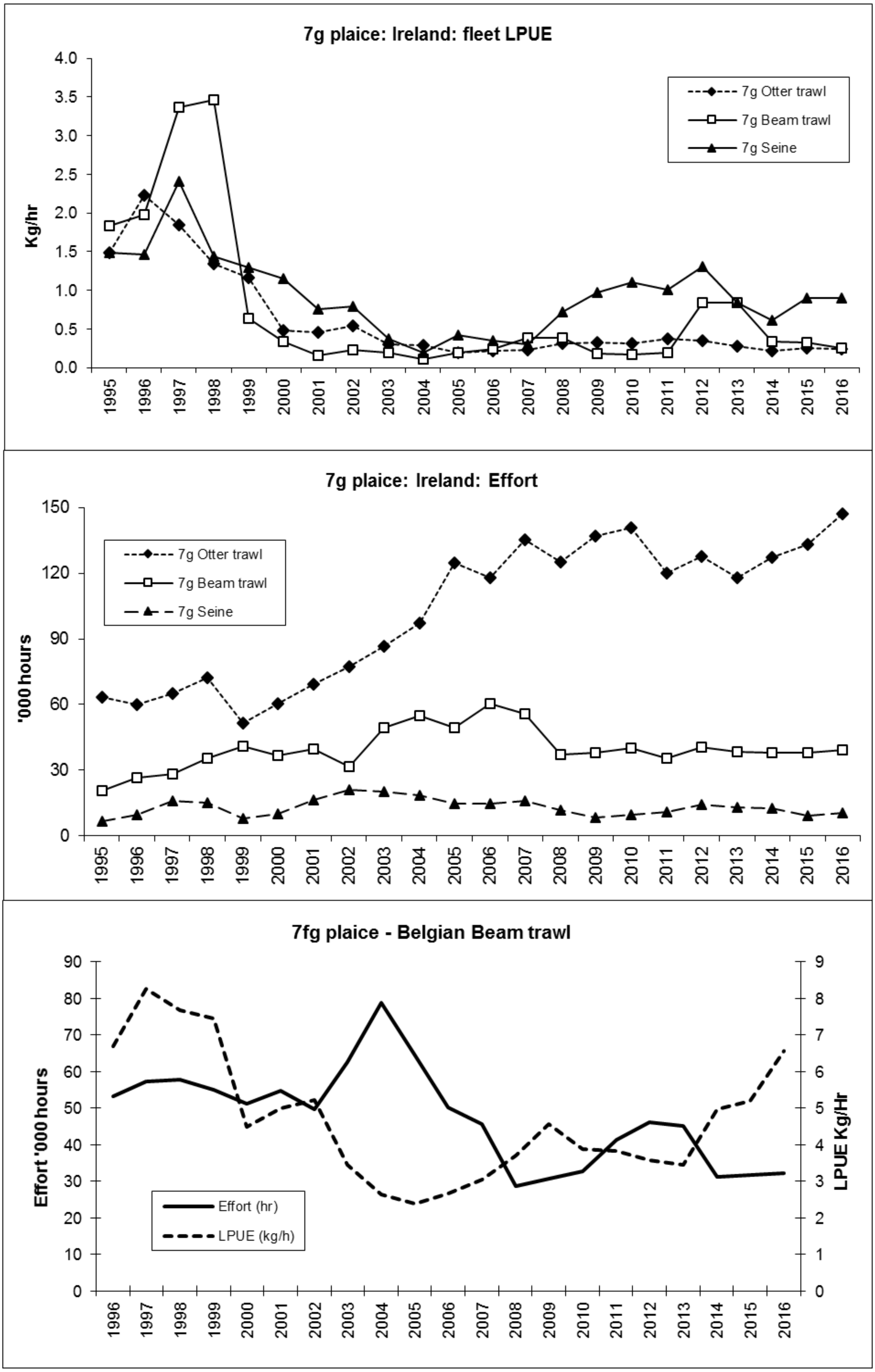


Figure 28.6. Plaice in divisions 7.f–g: Ireland and Belgium: lpue and effort by fleet.

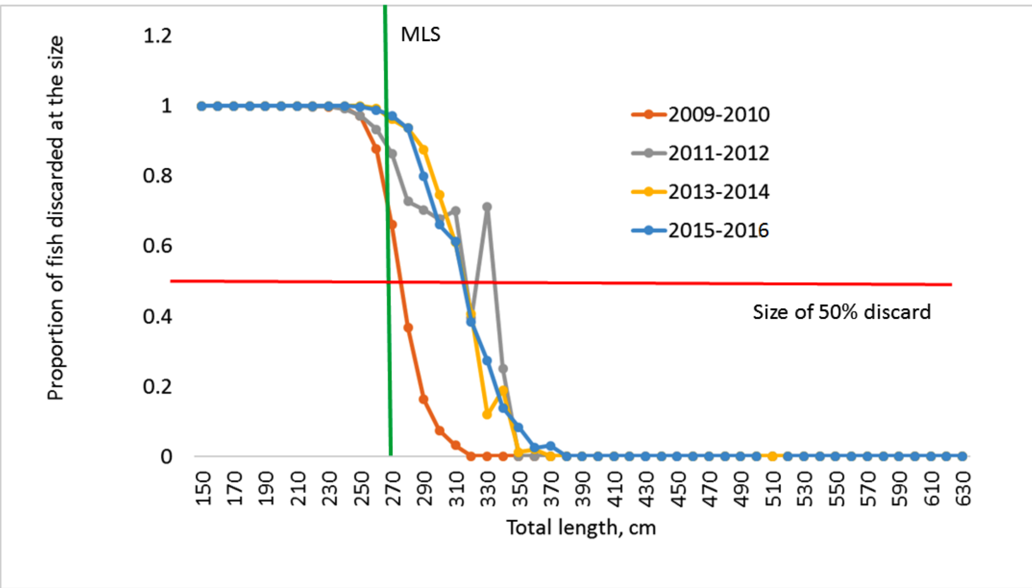


Figure 28.7. Discarding practices of the UK TBB_DEF_70_99 in respect to plaice in divisions 7.f–g.

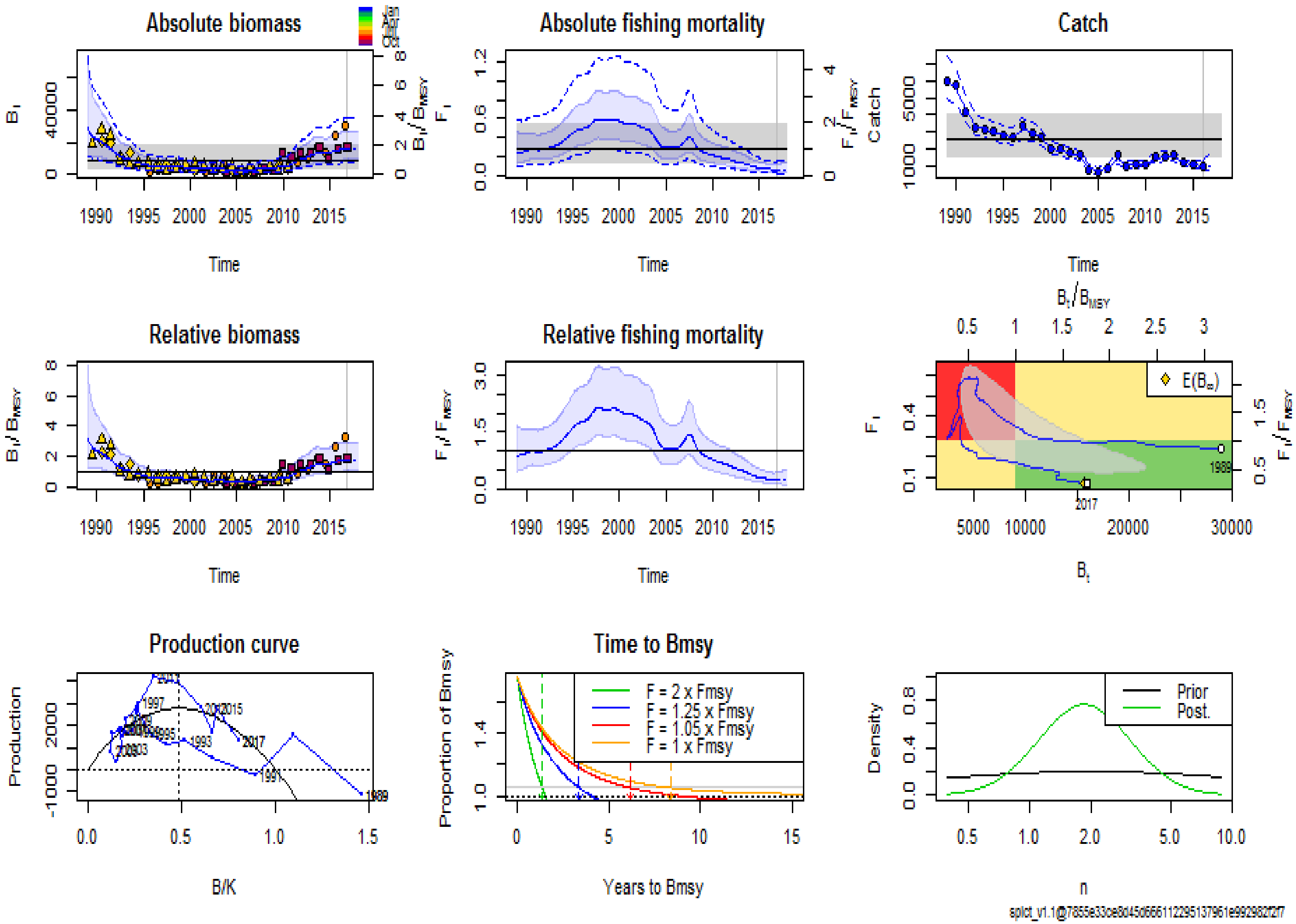
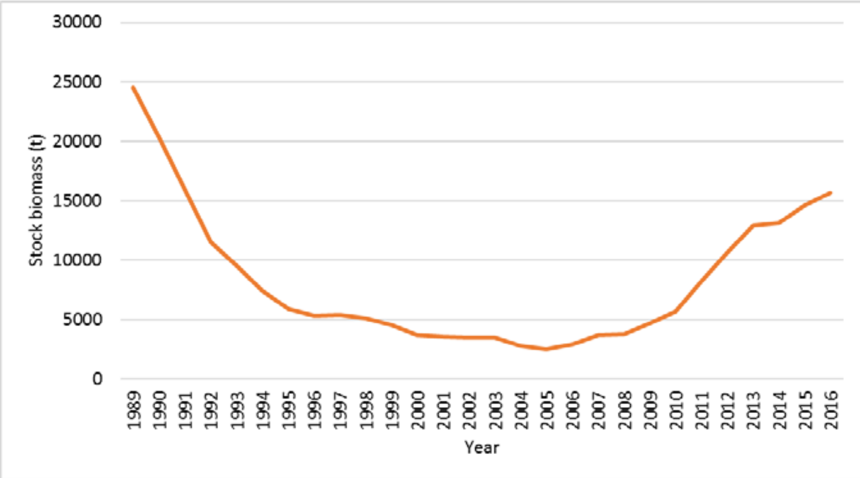


Figure 28.8. Output of the SPiCT model: dynamics of biomass, catch and fishing mortality.



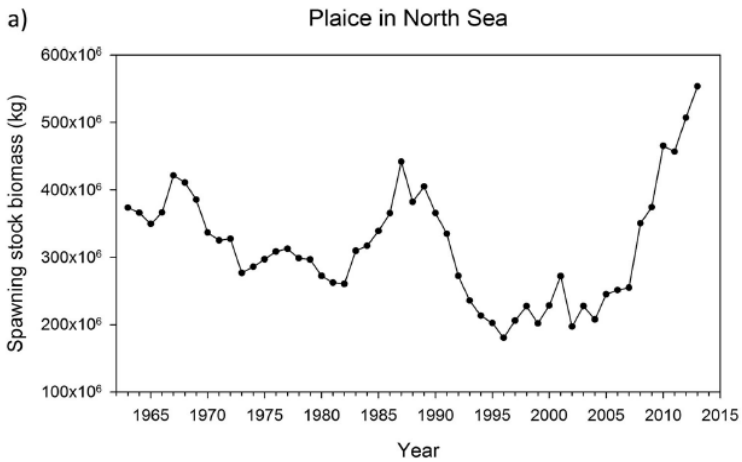


Figure 28.8. Changes in plaice biomass in the Division 7.fg (above) and the North Sea (below).

28.9 WKProxy review of WGCSE Ple.27.7.fg (ple-celt) Plaice (*Pleuronectes platessa)* in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)

Category 3.2

General comments

1) Assessment method(s): SPiCT

2) Evaluating Uncertainties

- Gaps in effort reporting in recent years.
- Very high levels of discard (sometimes exceeding landings). Discard data were made available starting in 2004 and an adjustment was made to the data prior to 2004 to estimate discard rates back in time.
- Changes in discard practices in recent years from discarding only fish below the minimum legal size (MLS) to discarding a large number of fish larger than the MLS.
- A majority of the landings are not reported. (In 2016 Belgium reported 56.5% of the landings, France 21.2%, Ireland 12.1% and the UK 6.2%).
- M=0.12 was borrowed from Irish Sea plaice (estimated from tagging studies).
- Maturity ogive estimates are potentially outdated; maturity was estimated from just two months of survey data carried out in 1993 and 1994.
- Survival rate of discarded fish is unknown (assumed 0 in the assessment).

3) Consistency:

- Results from the 2016 assessment also indicated the stock was not overfished and overfishing was not occurring.
- SPiCT output is consistent with trends in abundance of commercially-sized fish aged 3+ as represented by data of research surveys.

4) Proxy reference points & stock status:

- Proxy reference points:

  SPiCT: B_t/B_{MSY}, F_t/F_{MSY}

- EG's conclusions: Overfished/ Overfishing occurring?

  The SPiCT model indicates that the stock is not overfished and overfishing is not occurring. The EG accepted the SPiCT method and the proxy points.

- RG's conclusions: methods and stock status

  The RG agrees with the EG's choice of the method and concludes that the stock is not overfished and overfishing is not occurring.

5) Comments & Suggestions:

- The RG agrees with the EG that the SPiCT model was the most appropriate method to use given the available data.
- It is unclear to the RG whether the EG tried other stock assessment methods (e.g. length-based method) or had sufficient data to run other methods. The RG encourages the EG to look into the data availability and the potential to apply alternative stock assessment methods for this stock.

- The RG encourages the EG to conduct a retrospective analysis on the SPiCT model to explore the uncertainty of the model.

Proxy reference points: Conclusions

1) Proxy Reference Points:

$F/F_{MSY}<1$ and $B/B_{MSY}>1$ (SPiCT)

2) EG Conclusions:

The stock is not overfished with no overfishing occurring.

3) RG Conclusions:

The stock is not overfished with no overfishing occurring.

29 Plaice in the southwest of Ireland (ICES Divisions 7.h–k)

Type of assessment in 2017

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 2015

Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 135 tonnes, and bycatch and discards should be reduced.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/ple-7h-k.pdf

ICES advice applicable to 2016

Based on ICES approach to data-limited stocks, ICES advises that landings in 2016 should be no more than 86 tonnes. Discards are known to take place but cannot be quantified; therefore total catches cannot be calculated.

http://ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/ple-7h-k.pdf

29.1 General

Stock description and management units

Plaice in 7.h–k is on the southwestern margins of the species distribution. Plaice in 7.j are mainly caught by Irish vessels on sandy grounds off the southwest of Ireland. Irish VMS and logbook data indicate that the 7.j landings occur close to shore and this species is a small component (up to 5%) of the landings in a mixed fishery (Figure 29.1).

Plaice catches in 7.k are negligible. Division 7.h is also considered part of the stock for assessment purposes but plaice in 7.h are separated from the 7.j plaice by several hundred miles. The distribution of the landings (Figure 29.1) suggests that the 7.h plaice are a continuation of the plaice caught in the western English Channel (7.e).

The TAC is set for Divisions 7.h,j and k. However, because no age-disaggregated data are available for 7.h, the assessment is performed for 7.jk only.

Management applicable to 2016 and 2017

TAC table 2016

Species:	Plaice *Pleuronectes platessa*	Zone:	VIIh, VIIj and VIIk (PLE/7HJK.)
Belgium	8		
France	17		
Ireland	59		
The Netherlands	34		
United Kingdom	17		
Union	135		
TAC	135		Analytical TAC Article 12(1) of this Regulation applies

TAC table 2017

Species:	Plaice *Pleuronectes platessa*	Zone:	VIIh, VIIj and VIIk (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.

29.2 Data

Landings and discards

The nominal landings are given in Table 29.1. 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 29 concerns 7.jk only.

Discard and retained catch numbers for the Irish 7.j OTB fleet in 2016 are based on only four observer trips. Currently there are no reliable time-series of discards-at-age is currently available and discard numbers are not included in the assessment. The proportion of the 7.j catch that was discarded varied between 10% and 100% since 2001, however the number of trips in some years was very low. Since 2007 the number of trips has been >5 per year and the average proportion of the catch that has been discarded in that period in the order of 30%. Although not included in this assessment it is important to note here that discarding is part of this fishery. However we know from historical data and anecdotally information that discarding is quite high and may be 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 29.1b.

Landings numbers-at-age

Landings numbers-at-age are given in Table 29.3 and Figure 29.3. Figure 29.4 shows a bubble plot of the standardised landings proportions-at-age. There is very little contrast in the numbers-at-age matrix. Figure 29.5 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 (need to compare that to the stock annex).

Surveys and commercial tuning fleets

There is no survey index available for this stock (the Irish IBTS Q4 Groundfish Survey data are too noisy to be used). 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 plaice are caught by OTB vessels (Figure 29.6). Next the effort and landings of the OTB vessels inside the plaice area was estimated (Figure 29.6). 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 plaice (which is not the case further offshore).

The age composition of the Irish OTB fleet in 7.j was used for the tuning fleet (Table 29.5). Figure 29.7 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 a consequence of the lack of contrast in recruitment (see 'Data quality'). Figure 29.8 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. With only two years of data this would not currently form a valid index for this fishery.

Data quality

The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used. Sampling appears to be 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.

29.3 Historical stock development

Target category: 3.2.0.

Model used: XSA

Software used: Lowestoft vpa95.exe and FLR with R version 2.15.3 and packages FLCore 2.6.0; FLEDA 2.5 and FLAssess 2.5.0

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 1993–2016. The tuning fleet included ages 4–8 for the years 2007–2016.

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 29.6. 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 29.9 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. 2015 saw a big drop in SSB but with the addition of 2016 data this has been revised up.

The summary table with a time-series of landings, recruitment, SSB and F is given in Table 29.10 and Figure 29.7. Recruitment in 2003–2014 years was stable at a lower level than at the start of the time-series and it appears to have declined sharply in 2015 and rose again in 2016. The SSB has declined from around 400 tonnes in 1993 to around 100 t in recent years and it appears that SSB may have declined to a low of 44 t in 2015 and small revision upwards in 2016. F has been quite variable throughout the time-series but shows no clear trend.

29.4 MSY evaluation

Previously for this stock WKProxy (ICES, 2016a) proposed an F_{MSY} reference point of F = 0.25, 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 following WKMSYREF4 guidelines is presented here. Details on this evaluation can be found in the working document in appendix xxx. The stock–recruitment graph (Figure 29.11) 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 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		

29.5 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 are assumed to be representative of the whole stock area (7.hjk). No age information is available for Division 7.h. ICES is unable to assess stock trends in Division 7.h. 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. 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 29.1). 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.

29.6 Recommendations for the next benchmark

In 2012 WGCSE recommended that this stock is upgraded to a Category 2 stock (ICES, 2012) and that the reference points could be defined according to the procedures set out in WKMSYREF4 (ICES, 2016b). ACOM would need to decide if this requires a benchmark or whether an intersessional review of WGCSE's analysis is sufficient.

29.7 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. It is therefore not desirable to apply another PA buffer in the advice for 2017.

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. No further information on stock structure is likely to become available.

For Division 7.h, only landings data are available. 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.

29.8 References

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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 FMSY 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 29.1. Plaice in Divisions 7. h–k (Southwest Ireland). Nominal landings (t), 1993–2016, 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
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

	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**
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

*** Excluding Belgium.**

Table 29.3. Landings numbers-at-age for plaice in 7.jk, 1993–2016.

	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	126.1	274.6	177.1	57.1	33.0	15.9	9.8	8.3	10.7
2000	72.3	158.2	186.4	62.5	34.9	6.5	4.9	3.4	3.2
2001	55.3	164.8	145.6	47.1	5.9	21.5	2.3	7.4	0.0
2002	49.9	143.8	159.4	50.6	39.1	40.9	11.6	3.4	1.9
2003	71.8	161.4	63.6	28.4	5.8	14.5	10.2	1.5	3.6
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	13.6	113.4	79.4	30.7	10.8	4.8	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	19.2	85.4	55.3	36.5	22.7	10.9	3.8	0.8	1.3
2012	12.5	128.4	103.4	37.4	29.5	12.6	6.8	1.9	2.9
2013	5.8	44.2	84.8	32.0	7.8	4.9	3.0	1.1	0.5
2014	9.8	48.8	89.3	71.7	25.0	4.6	3.8	2.3	0.6
2015	6.1	14.8	20.9	17.5	12.7	4.6	0.8	0.9	0.4
2016	4.3	74.3	54.1	35.7	25.8	16.0	6.9	0.8	1.9

Table 29.4. 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

Table 29.5. Tuning data. The ages and years used in the assessment are in bold.

PLE7jk, WGCSE										
101										
IRL-VMS: nos per 1000 hours										
2006	2016									
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

Table 29.6. XSA diagnostics.

```
FLR XSA Diagnostics 2017-05-22 10:13:47

CPUE data from indices

Catch data for 24 years 1993 to 2016. Ages 4 to 8.

                        fleet first age last age first year last year alpha
1 IRL-VMS: nos per 1000 hours         4         7       2006      2016  <NA>
  beta
1 <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   2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
   year
age  2007  2008  2009  2010  2011  2012  2013  2014  2015  2016
  4 0.809 0.578 0.555 0.500 0.623 0.825 0.520 0.892 0.336 1.116
  5 0.847 0.643 0.490 0.606 0.591 1.077 0.593 1.050 0.383 1.467
  6 1.423 0.393 0.768 0.549 0.682 1.325 0.608 1.250 0.464 1.494
  7 0.823 0.502 0.781 0.731 0.681 0.946 0.728 0.812 0.727 1.819
  8 0.823 0.502 0.781 0.731 0.681 0.946 0.728 0.812 0.727 1.819


 XSA population number (Thousand)
      age
year     4   5  6  7  8
  2007 116  41 24  8  6
  2008 169  46 16  5  4
  2009 198  84 21  9  3
  2010 162 101 46  9  8
  2011 127  87 49 23 13
```

```
  2012 195  60 43 22 20
  2013 222  76 18 10  9
  2014 161 117 37  9 13
  2015  78  58 36  9  4
  2016  85  49 35 20 12


 Estimated population abundance at 1st Jan  2017
      age
year   4  5  6 7 8
  2017 0 25 10 7 3


 Fleet:  IRL-VMS: nos per 1000 hours

 Log catchability residuals.

   year
age  2006   2007   2008   2009   2010  2011  2012   2013  2014   2015   2016
  4 0.547  0.190  0.275 -0.137 -0.266 0.246 0.148 -0.212 0.416 -0.772 -0.434
  5 0.582  0.119  0.266 -0.378 -0.191 0.078 0.297 -0.196 0.463 -0.758 -0.282
  6 0.478  0.535 -0.326 -0.033 -0.390 0.120 0.397 -0.275 0.530 -0.671 -0.365
  7 0.085 -0.012 -0.071 -0.027 -0.108 0.122 0.062 -0.099 0.111 -0.203 -0.168


 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 1.9165 2.0308 2.1351 2.1351
S.E_Logq  0.3480 0.3480 0.3480 0.3480


 Terminal year survivor and F summaries:

 ,Age 4 Year class =2012

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.654        16  2012
fshk                            0.346        57  2012

 ,Age 5 Year class =2011

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.569         8  2011
fshk                            0.431        31  2011

 ,Age 6 Year class =2010

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.522         5  2010
fshk                            0.478        17  2010

 ,Age 7 Year class =2009

source
                            scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.643         2  2009
fshk                            0.357         5  2009
```

Table 29.7. Summary table for ple-7.jk. 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	0.9331	400
1994	578	317	507	0.7457	355
1995	667	419	647	0.7280	360
1996	560	336	481	0.7174	371
1997	551	375	474	0.8086	403
1998	454	306	366	0.8220	340
1999	385	311	360	0.7696	354
2000	337	225	353	0.6240	307
2001	313	182	229	0.5535	269
2002	316	183	251	1.1867	193
2003	237	147	151	0.6508	153
2004	232	104	182	0.5484	128
2005	170	94	158	0.9080	117
2006	143	71	102	0.8748	99
2007	142	94	116	1.0262	75
2008	122	79	169	0.5381	80
2009	148	80	198	0.6044	109
2010	156	78	162	0.5517	117
2011	179	80	127	0.6320	109
2012	199	112	195	1.0757	117
2013	141	65	222	0.5737	114
2014	148	89	161	1.0641	116
2015	107	33	78	0.3942	78
2016	99	37	85	1.3587	94

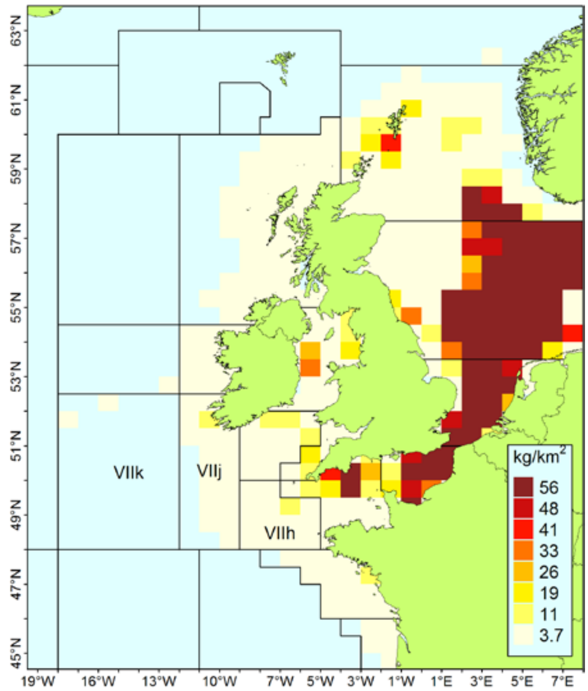


Figure 29.1.a. The spatial distribution of International landings of Plaice (2012 data, all gears combined; data from STECF).

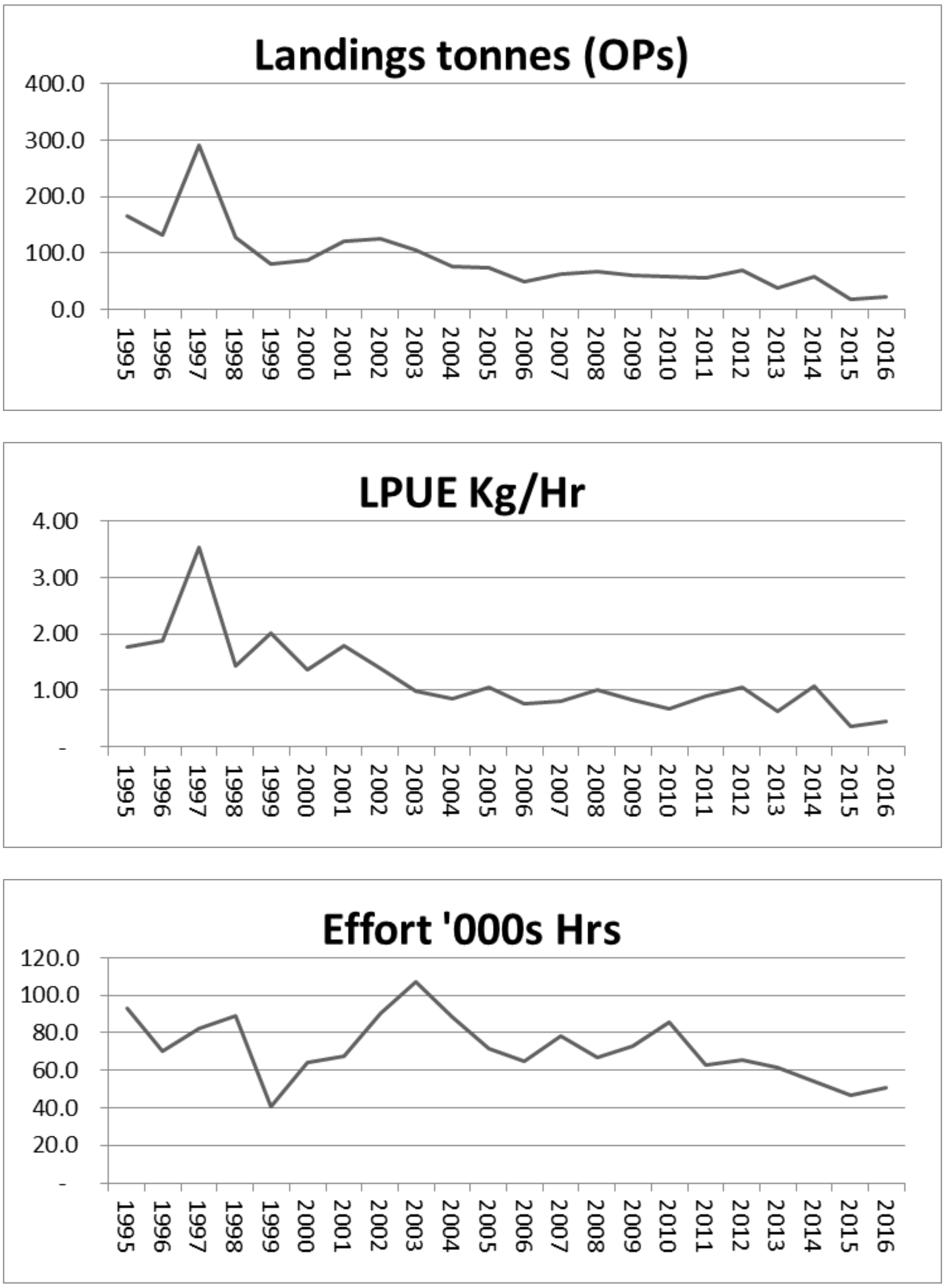


Figure 29.1b. Landings, Lpue and effort for Irish otter trawlers in 7.j.

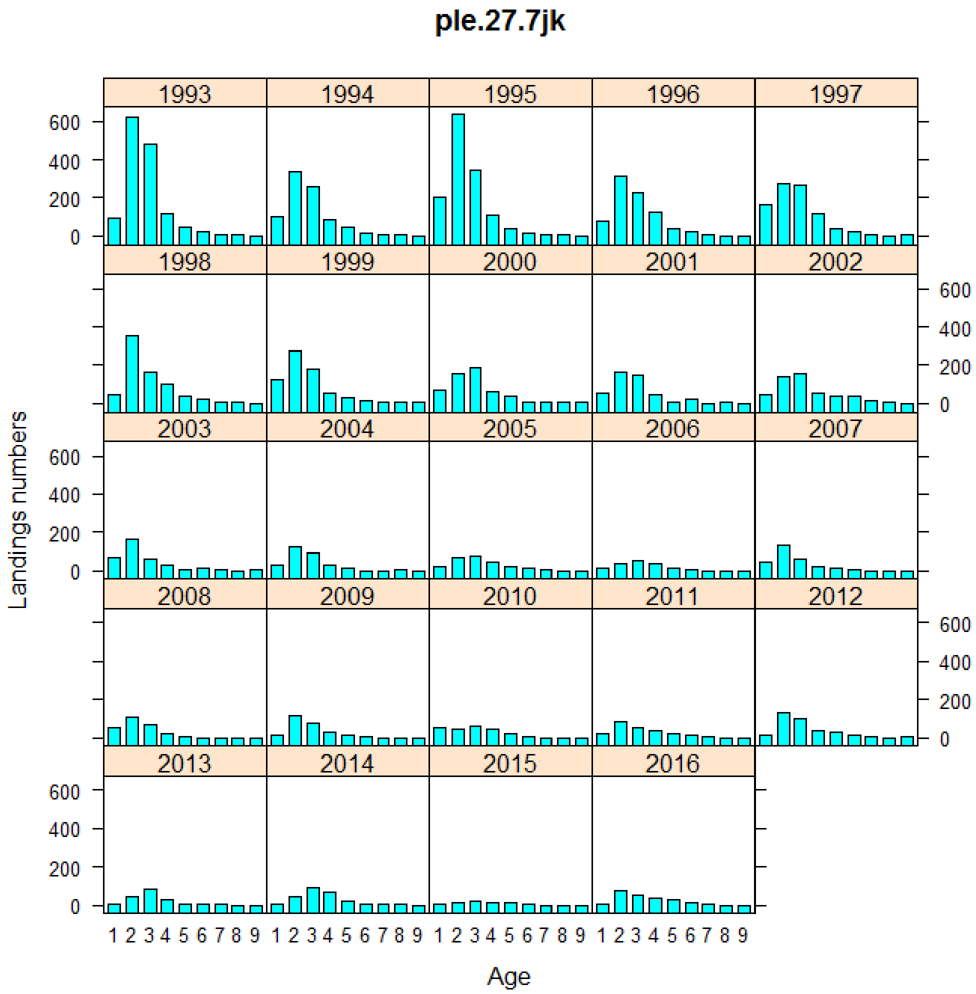


Figure 29.3. Age distribution of plaice landings in 7.jk between 1993 and 2016. All gears and quarters combined. The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used.

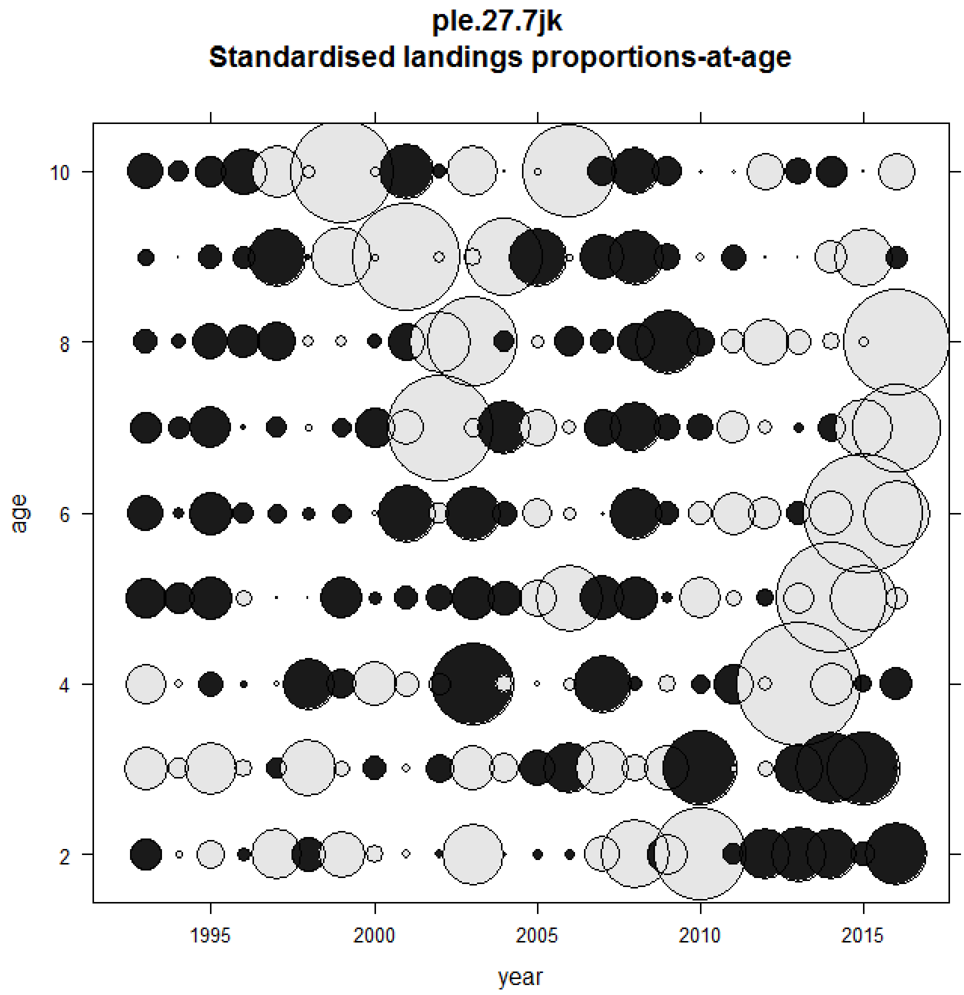


Figure 29.4. Standardised landings proportions-at-age for plaice in 7.jk. Grey bubbles represent higher than average catch-at-age and black bubbles represent lower than average catch-at-age.

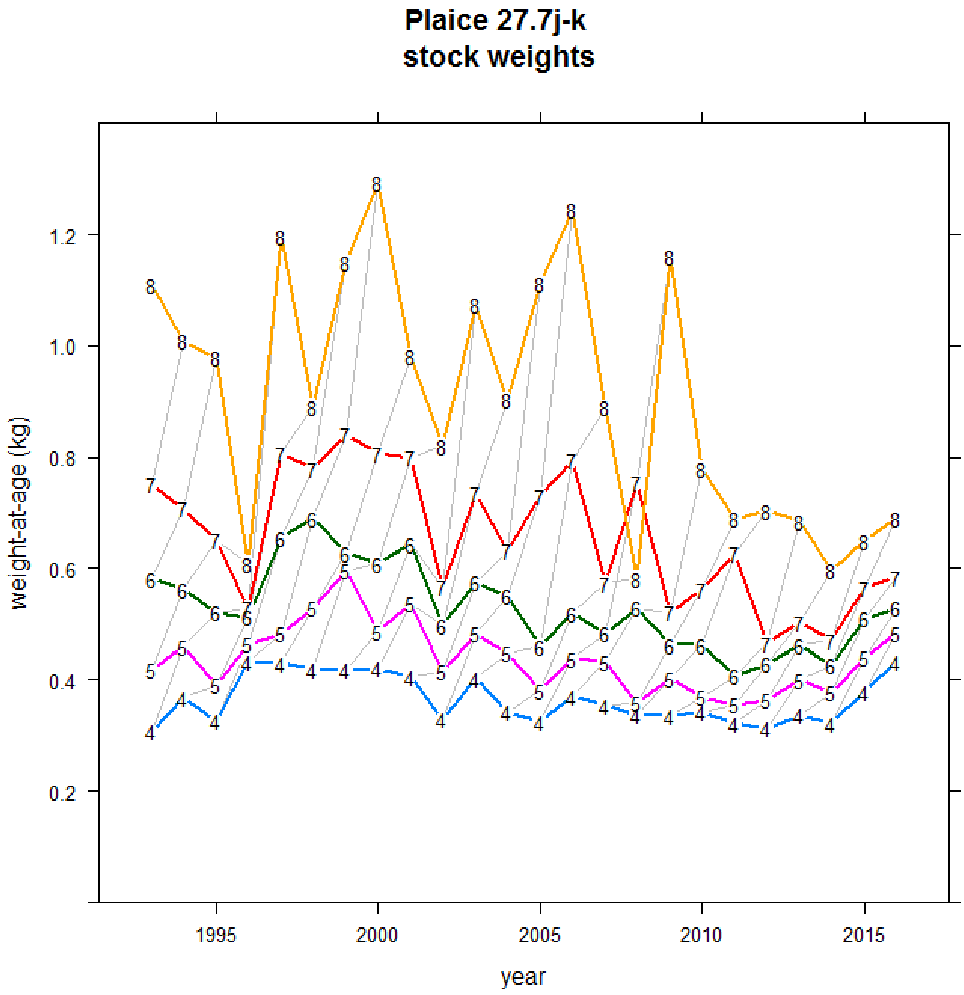
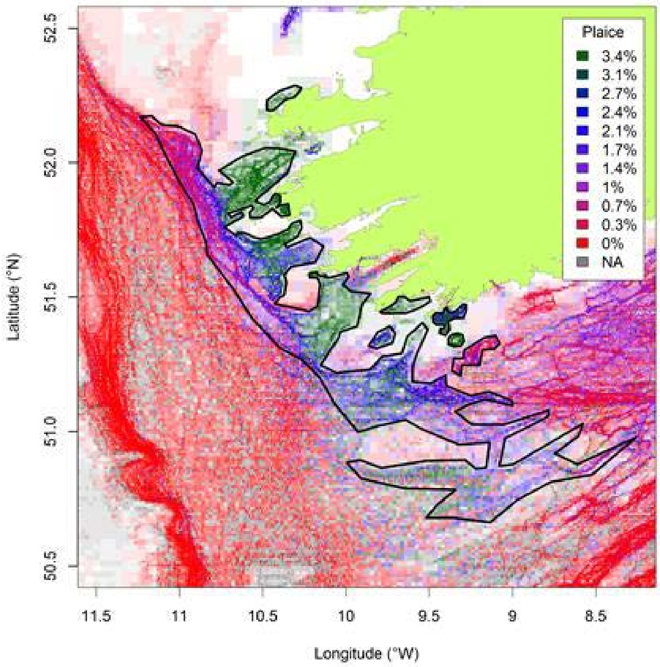


Figure 29.5. Landings weights / stock weights of ple7jk.



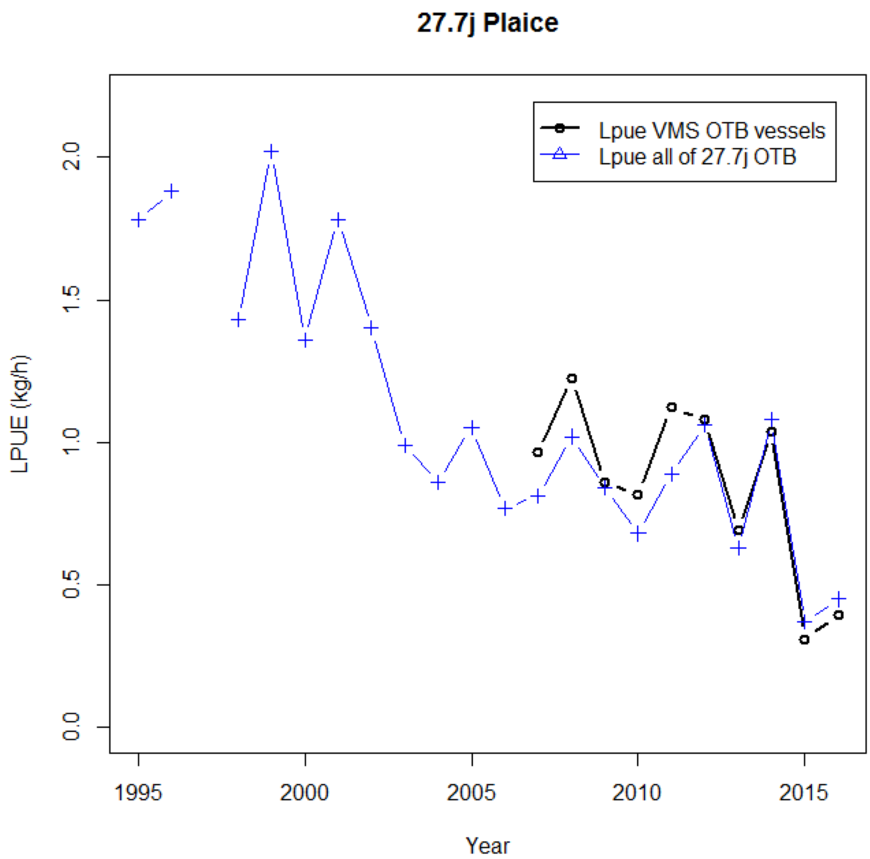
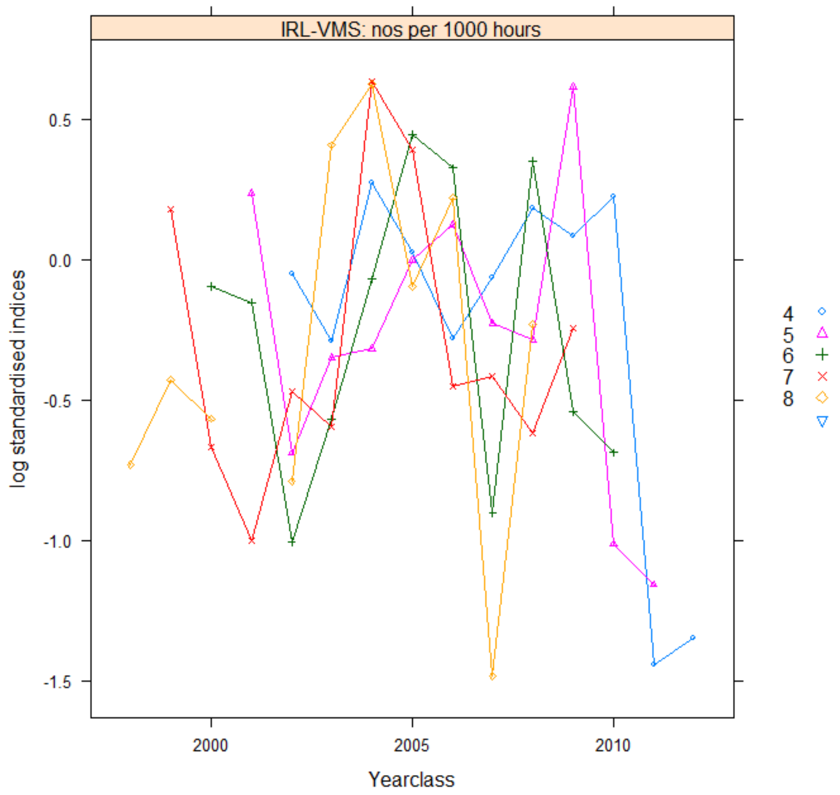


Figure 29.6. Top: the proportion of plaice in landings of Irish vessels with VMS over the years 2006–2016. The black line indicates the polygon inside which plaice are caught. Effort and landings from the VMS/logbooks data inside the polygon were used as a tuning index. Bottom: the VMS lpue index (black line) and the lpue of plaice in the whole of 7.j. This needs to be updated from the tunnning folder on the network.



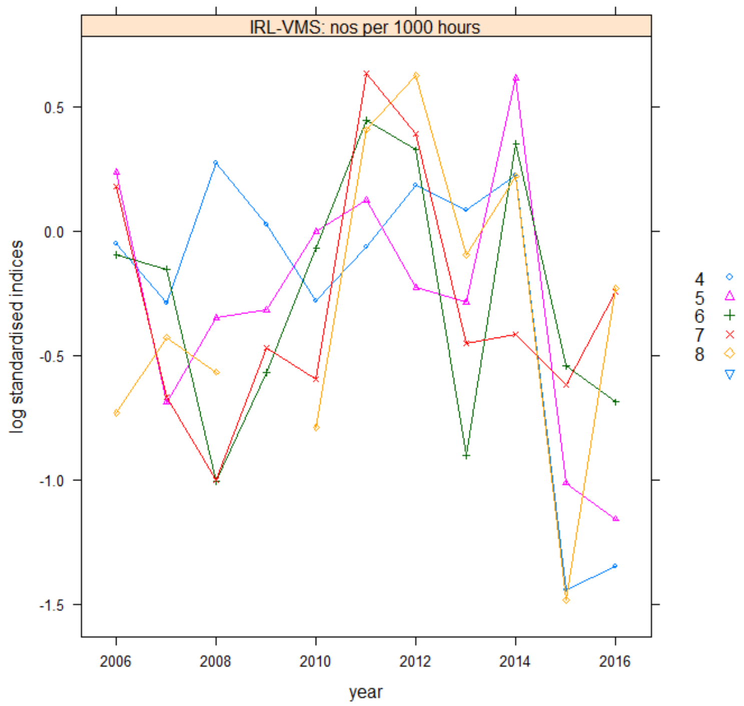


Figure 29.7. The log-standardised tuning index by year (top) and cohort (bottom). Due to the lack of contrast in the numbers-at-age cohorts are not tracked particularly well.

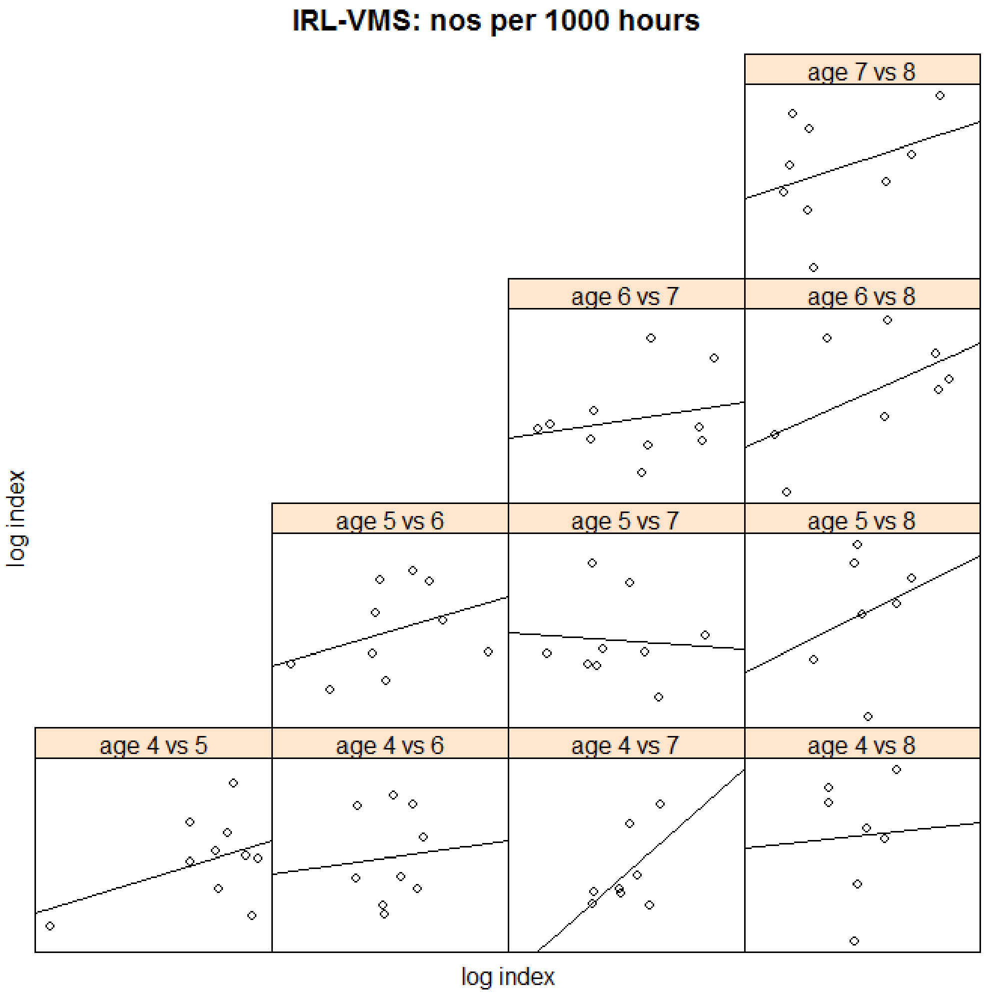


Figure 29.8. Internal consistency of the tuning fleet.

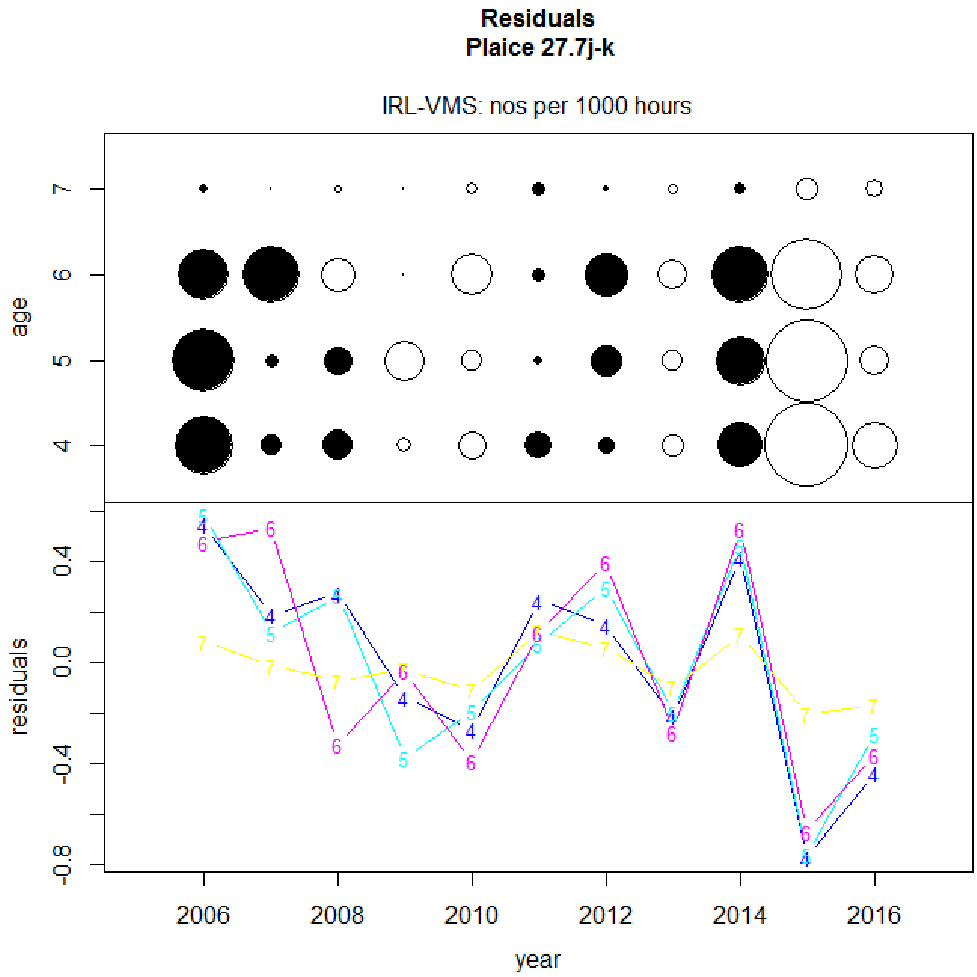


Figure 29.9. Residuals of the index fit.

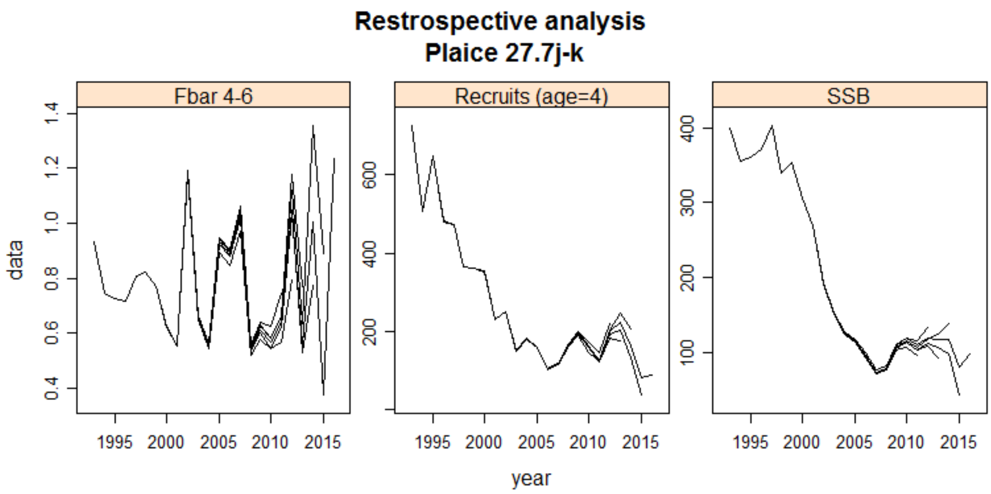


Figure 29.10. Retrospective analysis of the assessment.

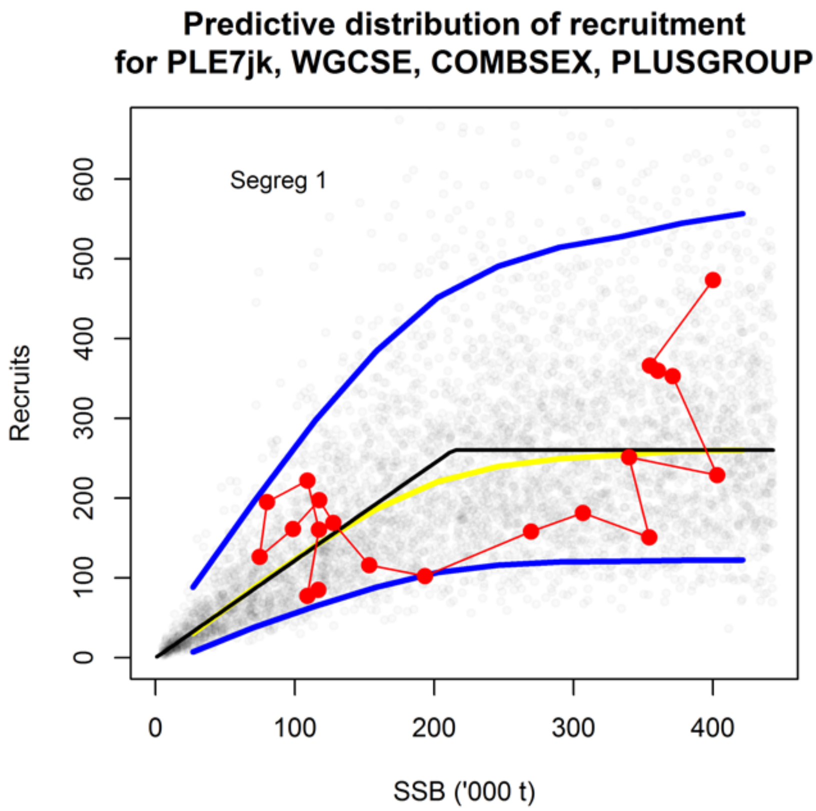


Figure 29.11. Ple7.jk stock–recruit plot. Because recruitment does not appear to be impaired at the lowest stock size, the inflection point of the segmented regression was chosen to be the lowest biomass that generated high recruitment.

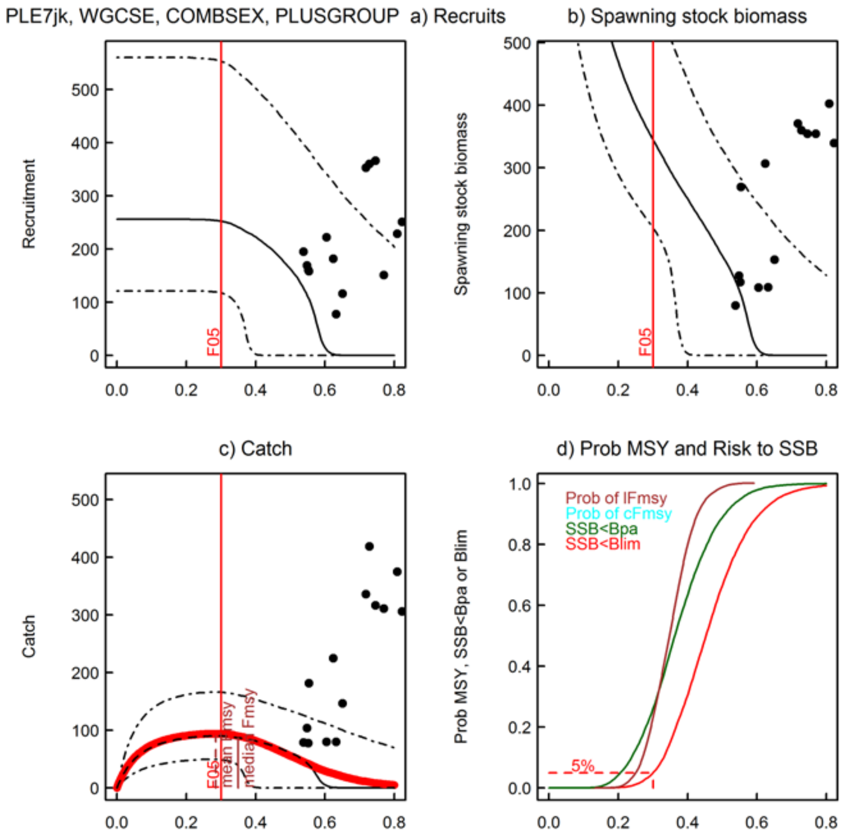


Figure 29.12. Ple7.jk Summary of MSY evaluations (without $B_{trigger}$ harvest control rule), a) simulated and observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}.

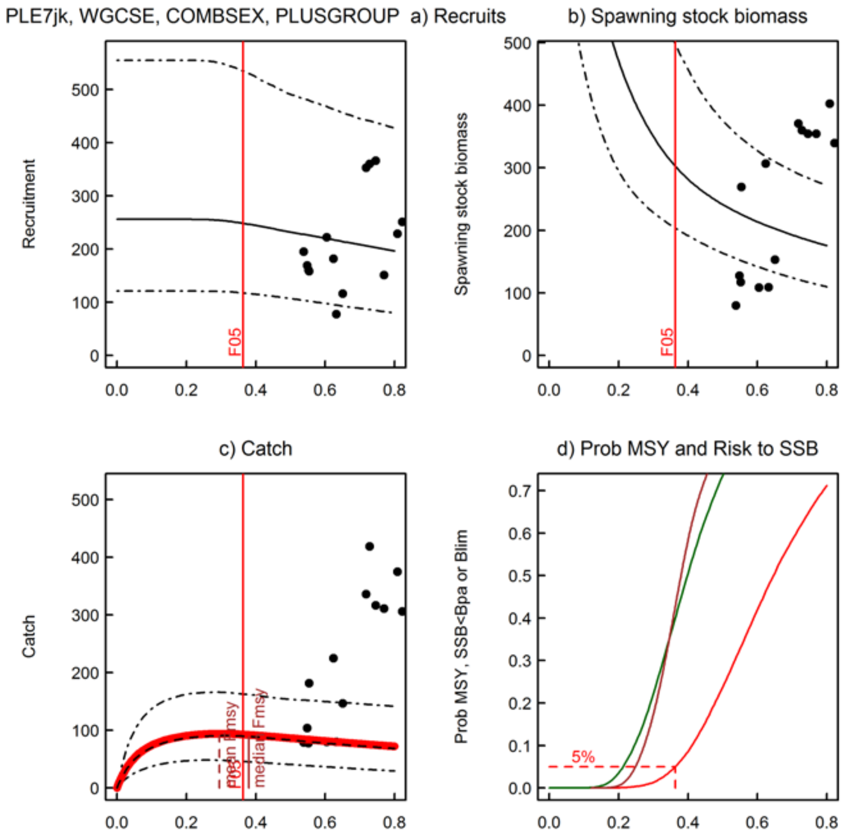


Figure 29.13. Ple7.jk Summary of MSY evaluations (with $B_{trigger}$=B_{lim} harvest control rule), a) simulated and observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}.

29.9 Audit of plaice in Division 7.h–k (ple-7h–k)

There is no audit available.

30 Pollack in the Celtic Seas (ICES subareas 6 and 7)

Type of assessment in 2017

The Celtic Sea and West of Scotland (Subareas 6 and 7) Pollack stock is considered as Data Limited Stock, classified by ICES WKLIFE II (ICES CM2012/ACOM:79) as category 4.1.2 stock. DCAC (Depletion-Corrected Average Catch) method is recommended to assess this stock. In complement of this method, ICES ACOM assumes that DLS methods developed within WKLIFE V (ICES CM2015/ACOM:56) and WKProxy (ICES CM2015/ACOM:61) should be applied in 2017 for category 3-6 stocks, in order to estimate MSY references points proxies.

ICES advice applicable to 2018

The ICES advice based on precautionary approach, renew last ICES advice: "Catches should be no more than 1% more than recent catch (last three years), and should not exceed 4200 tonnes for 2018."

30.1 General

30.1.1 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 6 and 7 constitutes a management unit for Pollack, and further work is required.

Nevertheless, WGNEW 2014 (ICES, 2014) bases on a study on genetic differences between Pollack populations in the North East Atlantic conducted by Charrier *et al.* (2006) to consider than Pollack population in the Western Channel extending into the Eastern Channel, the Celtic Sea, the Irish Sea, and the northern part of the French west coast (areas 7.e–j and 8.a,b - landings from the intermediate areas 6.a and 4.c are generally small) could constitute a single stock.

30.1.2 Management applicable to 2018

The TAC for Pollack is set for ICES subareas 6 (and 5.a,b; international waters of 12 and 14) and 7 separately, and for 2017 as follows:

Species:	Pollack *Pollachius pollachius*	Zone:	VI; Union and international waters of Vb; international waters of XII and XIV (POL/56-14)
Spain	6		
France	190		
Ireland	56		
United Kingdom	145		
Union	397		
TAC	397		Precautionary TAC

Species:	Pollack *Pollachius pollachius*	Zone:	VII (POL/07.)
Belgium	420 (76)		
Spain	25 (76)		
France	9 667 (76)		
Ireland	1 030 (76)		
United Kingdom	2 353 (76)		
Union	13 495 (76)		
TAC	13 495		Precautionary TAC Article 12(1) of this Regulation applies

Annex III to Council Regulation (EC) No 43/2009 (2), as amended by Regulation (EC) No 1288/2009 (3), and Regulation (EU) No 579/2011 of the European Parliament and of the Council (4), establishes within ICES Division 6.a zone in which fishing activities are prohibited. These regulations essentially make directed fisheries for Pollack in the West of Scotland illegal.

30.1.3 Biology

0-group Pollack are found in shallow coastal waters and may therefore be protected from fisheries in the early life stages. Pollack is benthopelagic, found mostly close to the shore over hard bottom (Quero and Vayne, 1997; Svetovidov, 1986). It usually occurs at 40–100 m depth but is found down to 200 m. A maximum size of 130 cm, a maximum weight of 18.1 kg and a maximum age of 15 years are reported (Cohen *et al.*, 1990). Growth is thus fairly rapid, approaching 10 cm per year, and probably more according to recent studies (Figure 30.1), and the maximum length probably shorter (L_{inf}=105 cm, Alemany *et al.*, 2017). There is a migration from the coast to deeper waters as it grows.

Cardinale *et al.* (2012) and Heino *et al.* (2012) suggested that 50% of the individuals are mature at a length between 35 and 42 cm. More recent studies of maturity stages on Pollack in Iberian waters (Alonso-Fernández *et al.*, 2013) show that length-at-maturity is significantly different between females (47.5 cm) and males (36.1 cm). Studies under process in France in 2017 (Alemany *et al.*, 2017) show that size-at-maturity could be higher for Celtic Sea Pollack (51.5 cm for females, 40.7 cm for males, 46.3 cm for males and females combined) (Figure 30.2). Spawning occurs mainly in the first half of the year, at about 100 m depth, but a lack of knowledge still remains.

30.1.4 The fisheries

Since ten years official landings in both subareas 6 and 7 are quite stable approximately around 4000 tonnes. They showed a significate increase from 2012 to 2014 (Tables 30.1 and 30.2 and Figure 30.3), followed by a slight decrease in 2015 (3741 tonnes) and 2016 (4132 tonnes). As previous years, in 2016 99% of the landings originated from Subarea 7, especially in ICES Division 7.e (Figure 30.4). UK, France and Ireland together comprised 99% of the official landings (Figure 30.5). Catches from Ireland (especially from subdivisions 7.g and 7.j) are relatively stable, even if the five year trend is slightly decreasing. French and UK catches showed severe decreases in 2015, mainly due to 7.e catches (60% decrease from 2014 to 2015, from 3084 tonnes in 2014 to 1224 tonnes in 2015), but 2016 catches increase again for both countries (1626 tonnes in 7.e).

Most Pollack in the Celtic Sea ecoregions is caught by trawls (especially as bycatch), gillnets and trolling lines, and other gears come to complement the landings, such as seine nets or beam trawls (Figure 30.6).

Pollack is also an important species for recreational fishing, especially by angling and spearfishing, both from shore and from boats, but data remain poor. A study conducted in France in 2011–2013 by Levrel *et al.* (2013) estimated to 3300 tonnes the yearly recreational fishery catches of Pollack, among which 2274 tonnes would be kept, but no other information on recreational Pollack catches in this stock area is known. WGRFS 2012 (ICES, 2012b) listed Pollack in the Northeast Atlantic as a species for which recreational fishery sampling should be included in the new DC-MAP because of the potential impact of recreational fisheries on its population dynamics and because it is of strong socio-economic importance.

30.1.5 Surveys

Pollack may be caught by Irish bottom trawl surveys such (IGFS-WIBTS). Only some individuals could be caught by French or UK survey. The abundance indexes estimated by IGFS-WIBTS are erratic, and the too low number of individuals caught by EVHOE-WIBTS-Q4 is not sufficient to estimate any trend of abundance indexes.

30.2 Data

30.2.1 Landings

The nominal landings are given in Table 30.1 and 30.2 for ICES subarea 6 and 7 respectively.

The French fishing locations for Pollack (Figure 30.7) shows a predominance of ICES division 7.e and inshore areas. Length frequencies of catches (French observers, all gears) are given in Figure 9.2.8.

In 2015, the total landings show a significant decrease (3741 tonnes) comparatively to the previous years (5255 tonnes in 2014, -28%). Catches are below the landings recommended by previous ICES advices (catch should not be more than 4200 tonnes). But nevertheless, respectively quotas allocated to the main fishing countries were not achieved, except for Ireland.

30.3 MSY explorations

30.3.1 DCAC model

This stock has been categorized by WKLIFE (ICES, 2012) as category 4 data-limited and in this situation it was suggested to run a DCAC (Depleted-Corrected Adjusted Catch) method to estimate a yield likely to be sustainable (MacCall, 2009). The DCAC-method was applied during WGCSE 2017 with the same model settings as applied the previous year (ICES, 2014).

The inputs to the DCAC method are further detailed:

Sum of catch: The period over which the catches is summed is 1986–2016, i.e. 31 years, as 1986 is the year where Ireland recomposed a time-series of landings after 13 years of missing declaration. In Subarea 6, the landings by Spain were removed as they appear only over the period 1981–1988. In Subarea 7, the French landings in 1999 are missing and are replaced by the mean of the previous and following year. The value used is 6674 tonnes for Subarea 6 and 162 346 tonnes for Subarea 7.

Natural mortality: set to 0.2 arbitrarily. The standard deviation and distribution are set at 0.4 and lognormal, after a series of trial settings.

F_{MSY} to M: MacCall (2009) proposes a value of 0.6 for vulnerable stocks. Values of 0.6, 0.8 and 1.0 are used in order to test the sensitivity of the outputs.

B_{MSY} to B_0: 0.5 will be used in line with a value proposed by MacCall (2009).

Depletion delta: is the fractional reduction in biomass from the beginning to the end of the time-series, relative to unfished biomass. A value of 0.5 is commonly used, whereas a value of 0 means that the biomass is unchanged and a value of 1 means that the stock is totally depleted. For Subarea 6, values of 0.8 and 0.9, for Subarea 7, values of 0.5, 0.6 and 0.7 will be used.

Given the fact that three F_{MSY}/M-values and two Depletion Deltas are tested for Subarea 6, a total of six DCAC-runs was carried out for this subarea. In the case of Subarea 7, nine DCAC-runs were completed (three F_{MSY}/M-values * three Depletion Deltas). Tables 30.3 and 30.4 give an overview of all the input parameters of the 15 runs.

The results are as below:

Subarea 6		F_{MSY} to M		
		0.6	0.8	1.0
Depl. Δ	0.8	143	156	165
	0.9	138	151	160
Average		152		

Subarea 7		F_{MSY} to M		
		0.6	0.8	1.0
Depl. Δ	0.5	3997	4239	4401
	0.6	3821	4087	4268
	0.7	3662	3947	4144
Average		4063		

The DCAC (Depletion-Corrected Average Catch) outputs (table above and Figure 30.10) suggest that yield in Subarea 6 could be increased up to 152 tonnes (comparable result as in the previous years' computations, when DCAC was 155 tonnes). The possibility to increase the catch is supported by evidence of very low effort on targeting this species due to restrictive regulations for inshore fisheries in the area. In 2012, the fisheries advice for this subarea was calculated as a 10% increase of the average landings of the three preceding years (2010–2012), as the three year average landings were only around 1/3 of the DCAC. The 2013 and following years examinations gave almost identical results, so the advice was not changed. The four year average landings (2013–2016) remains at a very stable and low level (55 tonnes), and is still only around 2/3 of the new DCAC-value (see Table 30.5). The perception of the stock does not change, and WGCSE confirms that the same advice as last year is still valid for Subarea 6.

In Subarea 7, the range of sustainable yield estimated by DCAC averaged 4063 tonnes (same as 2015, 4062 tonnes) (Table 30.5). This is supported by the observation than landings for the last 20 years have been around that level without any signs of decline (even if 2015 landings were a little less than 400 tonnes, total landings increased again to 4132 tonnes in 2016). The difference between the last four years average landings and the calculated mean DCAC-values remains weak (10%). 2016 official landings in Subarea 7 are inside the DCAC confidence interval and above the ICES advice (>4200 tonnes). Moreover, the global results given by DCAC computations made at the whole Subarea 7 level do not adequately bring out the decrease observed in 7.e for two years (even if the trend seems reversed in 2016), while trends of catches in other subdivisions stay quite stable.

The DCAC is not built to provide information on SSB and level of fishing effort (nor recent trends). In the absence of such information and basing on the stability of DCAC results, WGCSE would renew the same advice as last year for Subarea 7 (no decrease in landings advised, but *"Catches should be no more than 1% more than recent catch (last three years),* ***and should not exceed 4200 tonnes****"*).

Therefore also the combined advice for subareas 6 and 7 doesn't change in comparison with the 2016 advice.

30.3.2 Other DLS methods explorations

In 2017 ICES proposed for Expert Working Groups new points for the global Terms of References according to categories 3 to 6 stocks. It proposed to estimate MSY proxies reference points using methods provided in the ICES Technical Guidelines, i.e. peer reviewed methods developed by WKLIFE V and VI and WKProxy along with available data and expert judgement.

3 different methods were tested for Pollack in WGCSE 2017: SPiCT, Length-based indicators LBI and Mean length-based mortality estimators.

30.3.3 SPiCT

The Stochastic Surplus Production model in Continuous Time (SPiCT) has been developed by Pedersen and Berg (2017). The model needs as input data a time-series of catch and one or more time-series of indexes (tuning fleet, cpue, surveys indices…). The model provides as output estimates of reference points B_{MSY}, F_{MSY} and MSY.

The data used as input are a catch time-series (first run from 1950 to 2016, second run from 1995 to 2016) and two cpue indexes, one for the French trawlers and one for Irish trawlers (Table 30.6 and Figure 30.11).

For the first run the model cannot converge, probably due to minimal contrast in the time-series and the difference of length between catch and indexes time-series.

For the second run, where the durations of the catch and indexes time-series are comparable, the model presents relative convergence. Preliminary results show that there is high uncertainty around both the fishing mortality and biomass given very wide confidence intervals (Table 30.7). Stochastic F_{MSY} and B_{MSY} (Table 30.7 and Figure 30.12) have been estimated to be around 2.42 and 2397 tonnes respectively (but very wide 95% CI). The most recent F seems below F_{MSY} and biomass above B_{MSY} and MSY $B_{trigger}$. Nevertheless, the estimated value of F_{MSY} is really too high and unrealistic, even if the lowest values within the 95% IC could be acceptable, and appears highly suspicious.

The state of pol.27.67 seems to be in a good situation regarding the result of SPiCT (Figure 30.12, middle-right B/B_{MSY}), but caution is required when assessing the stock in relation to reference points and their CI.

30.3.4 Length-based indicators and reference points: LBI methods

Length-based indicators are used for screening catch-length composition and allow to classify the stock according to conservation/sustainability, yield optimization and MSY considerations.

A set of catch lengths for *Pollachius pollachius* in Subarea 7 was used (all gears combined), from 2006 to 2016. Data for years 2006–2014 came from specific data call for WKProxy, 2016 from InterCatch database, 2015 is missing.

Life-history parameters used as input data in the model came from Alemany *et al*. (2017, *in prep*.) (Table 30.8).

Outputs of the model are given in Figures 30.13 and 30.14, and Table 30.9. These figures show that length at first catch (L_c) is always below the length-at-maturity (L_{Mat}), because the minimum landing size (30 cm) is too small regarding L_{Mat} (46.28 cm). There is a real concern regarding fishing on immature Pollack in Subarea 7. Anyway, the level of immature fish catches is not very high, as the ratio 25th percentile of length distribution on L_{Mat} is close to 1 (should be above 1 in appropriate situations). The proportion of mega-spawners is also a little bit weak. The two other indicators on conservation (mean length of largest 5% $L_{max5\%}$ and the 95th percentile $L_{95\%}$) show a good situation for the stock. The indicators on yield optimization and MSY considerations confirm that acceptable situation.

In conclusion LBI results show that pol.27.67 seems to be in a desirable status as it is not exploited above the LB indicator of MSY. This is in accordance with the results of DCAC and SPiCT.

30.3.5 Mean length-based mortality estimators

The mean length-based estimators of total mortality rate was developed by Gedamke and Hoenig (2006) and completed by Then *et al*. (2011).

The model was developed from the Beverton and Holt estimator to allow for non-equilibrium conditions. It uses a time-series of length frequencies of catches, life-history parameters and natural mortality rate M as input data. The same von Bertalanffy parameters used previously for LBI (Table 30.8) are used again here. The model computes as output the mean length per year, and give two estimations of total mortality Z, the first one at the beginning of the time-series and the last at the end. It also estimates the year when a change of the slope between two situations of the stock status could be seen.

The results (Tables 30.10 and 30.11, Figure 30.15) show that the value of the last estimation of Z is smaller than the value of the first (Z2=0.24 and Z1=0.31). The model highlights a decrease of total mortality, combined to an increasing trend of predicted mean lengths. This model confirms than the status of pol.27.67 seems to be in an appropriate situation, in accordance with conclusions of previous models.

Nevertheless, the model estimates than the year of change of the situation of the stock status is the first year of the time-series (2005). Results must be kept this caution, the length of the time-series in entry is probably too short to fully use it.

30.4 Uncertainties in assessment and forecast

The main uncertainty in the assessment is that the recreational catch is not estimated and used. If we have no certainties, some signals (fishermen opinion, surveys…) let us think that recreational fishing recently increased. As for the last year, WGCSE highlights that if managers want to actively manage Pollack fisheries in 6 and 7 then better data on recreational fisheries will be needed. From preliminary data it seems likely that catches in recreational fisheries are of a similar order of magnitude to, or larger than, commercial landings.

Another important issue is directly linked to the choice of the assessment model used for Pol-celt stock. By construction, 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. In the other hand, DCAC method could not take into account trends of fishing effort. Outputs of the model could only conduct to a same advice as the last years. DCAC continues to be the reference model for Pollack assessment, even if other Data-Limited Stocks models have been tested this year. WGCSE considers it is relevant to continue to explore new assessment models for Pol.27.67 stock. The choice of a new model to assess the stock is also clearly relevant. This could be done within a specific Benchmark WS for Pollack.

Progress in the qualification of the status of Pollack in the Celtic Seas can be made by processing all the data available through the EU fisheries monitoring programmes in place in all EU Member States since 2002 (EU, 2010). This can only be achieved if experts are formally designated as stock coordinator and stock assessor in order to take the leadership on the needed analysis.

30.5 Ecosystem considerations

No information.

30.6 Management considerations

TAC for Subarea 7 includes ICES Division 7.d, 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.

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Table 30.1. Landings of Pollack in Subarea 6 as officially reported to ICES.

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Belgium	1	-	-	-	-	-	-	-	-	1
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	-	23	6
Ireland	-	-	-	-	-	-	-	-	-	-
Netherlands	-	-	1	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-
UK	295	484	503	422	452	566	528	547	710	607
Subarea VI	296	484	504	422	452	566	528	547	733	614

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Belgium	15	1	2	6	1	1	2	1	5	1
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-
Germany	-	1	8	2	1	1	-	1	2	4
Ireland	-	125	197	204	130	402	200	263	214	282
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	148	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	1106	1012	1224
UK	441	259	235	320	368	496	428	413	500	667
Subarea VI	456	386	442	532	500	900	630	1784	1881	2178

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Belgium	2	1	1	2	6	<0.5	7	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	196	196	310
Germany	1	5	1	-	-	1	-	-	-	-
Ireland	398	75	127	-	-	-	-	-	-	-
Netherlands	-	-	-	-	3	1	1	1	-	-
Norway	-	-	-	-	-	4	-	2	4	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
Sweden	756	750	779	-	-	-	-	-	-	-
UK	447	256	317	503	359	393	519	493	553	350
Subarea VI	1604	1087	1225	505	368	399	527	692	753	660

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Belgium	-	-	-	-	-	<0.5	-	-	-	-
Denmark	-	-	<0.5	-	-	-	-	<0.5	<0.5	<0.5
France	36	342	272	331	212	224	145	108	128	111
Germany	-	-	-	-	-	1	-	-	-	1
Ireland	-	-	-	-	-	-	223	103	163	103
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	55	95	86	222	283	2217	860	1925	-
Sweden	-	-	-	-	-	-	-	-	-	-
UK	233	185	103	148	194	328	187	259	221	179
Subarea VI	269	582	470	565	628	836	2772	1330	2437	394

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	-	-	-	-	-	-	-	-	-	-
Denmark	-	-	<0.5	-	-	-	<0.5	-	-	-
France	76	31	21	39	34	64	29	14	21	-
Germany	-	-	-	-	-	3	-	1	-	-
Ireland	150	145	23	12	26	83	97	69	60	73
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	1	-	-	-	-	-	1	2	-	3
Portugal	-	-	-	-	-	-	-	-	<0.5	-
Spain	-	4	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-
UK	192	189	203	273	276	354	210	162	147	136
Subarea VI	419	369	247	324	336	504	337	248	228	212

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium	-	-	-	<0.5	<0.5	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-
France	11	8	9	3	2	23	3	10	8	6
Germany	2	-	-	-	-	-	-	-	-	-
Ireland	62	108	26	88	68	28	25	21	21	5
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	1	1	-	-	6	1	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	4	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-
UK	116	101	96	111	65	16	5	21	23	25
Subarea VI	191	217	131	203	136	67	37	58	53	36

	2010	2011	2012	2013	2014	2015	2016
Belgium	-	2	-	-	-	-	-
Denmark	-	-	-	-	-	-	-
France	4	3	2	1	1	-	-
Germany	-	-	-	-	-	-	-
Ireland	34	8	10	34	25	23	44
Netherlands	-	-	-	-	-	-	-
Norway	<0.5	-	-	-	-	-	<0.5
Portugal	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-
UK	39	34	33	22	18	25	29
Subarea VI	78	47	45	57	44	48	74

Table 30.2. Landings of Pollack in Subarea 7 as officially reported to ICES.

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Belgium	93	74	80	34	17	38	67	219	342	158
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-
Germany	-	2	10	-	4	-	1	6	17	32
Ireland	-	-	-	-	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
UK	375	380	336	252	365	247	155	367	233	251
Subarea VII	468	456	426	286	386	285	223	592	592	441

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Belgium	317	268	367	95	299	362	456	417	214	142
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-
Germany	-	-	1	-	-	-	-	-	-	-
Ireland	-	360	369	411	342	335	438	474	508	794
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
UK	267	210	170	176	194	231	175	202	167	161
Subarea VII	584	838	907	682	835	928	1069	1093	889	1097

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Belgium	165	114	142	89	299	295	339	157	186	151
Denmark	-	-	-	-	-	-	-	1	21	18
France	-	-	-	-	-	-	-	3569	5496	5119
Germany	1	-	-	-	-	-	-	-	14	76
Ireland	724	673	1073	-	-	-	-	-	-	-
Netherlands	-	-	-	3	13	17	4	1	8	1
Norway	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
UK	120	116	123	127	223	290	421	465	515	696
Subarea VII	1010	903	1338	219	535	602	764	4193	6240	6061

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Belgium	237	244	154	167	207	269	241	149	191	145
Denmark	7	-	-	-	-	-	-	-	-	-
France	5242	5814	4253	6214	3927	3741	4574	5213	5211	3893
Germany	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	1335	848	1066	994
Netherlands	1	3	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Spain	1	23	32	26	486	20	17	19	22	18
UK	769	780	1022	1045	1100	1022	1795	2010	1740	1487
Subarea VII	6257	6864	5461	7452	5720	5052	7962	8239	8230	6537

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	133	76	62	55	94	88	94	99	92	86
Denmark	-	-	-	-	-	2	-	-	-	-
France	4831	3211	2849	2325	2621	2315	2684	2443	2375	-
Germany	-	-	-	-	-	-	-	-	-	-
Ireland	1066	1045	1014	1137	921	1107	1190	984	886	976
Netherlands	-	-	-	-	-	-	6	4	1	-
Norway	-	-	-	-	-	-	-	<0.5	-	3
Spain	26	22	19	7	8	4	5	7	11	19
UK	1914	1962	1889	2135	2391	2168	2519	2540	2347	1703
Subarea VII	7970	6316	5833	5659	6035	5684	6498	6077	5712	2787

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium	71	100	117	113	104	98	79	91	76	42
Denmark	-	-	-	-	-	-	-	-	-	-
France	2422	2515	2481	2284	1914	2198	2213	1970	1579	1641
Germany	-	-	-	-	-	-	-	-	-	-
Ireland	1069	1274	1308	1151	1049	728	809	782	738	828
Netherlands	-	-	-	-	1	1	1	3	1	4
Norway	-	-	-	-	-	-	-	-	-	-
Spain	5	9	17	12	13	16	28	1	14	3
UK	1810	1987	1999	1788	1705	1684	1531	1764	1453	1545
Subarea VII	5377	5885	5922	5348	4786	4725	4661	4611	3861	4063

	2010	2011	2012	2013	2014	2015	2016
Belgium	35	37	43	39	84	32	41
Denmark	-	-	-	-	-	-	-
France	1846	1784	1421	1790	2042	1142	1247
Germany	-	-	-	-	-	-	-
Ireland	942	967	1165	1249	1096	1060	934
Netherlands	2	2	1	1	1	-	-
Norway	-	-	-	-	-	-	-
Spain	3	4	3	11	14	21	16
UK	1381	1825	1836	1838	2122	1485	1893
Subarea VII	4209	4619	4469	4928	5359	3740	4131

Table 30.3. Input parameters for the six DCAC runs carried out for Pollack in Subarea 6.

	Pol.27.67 2017 – 6 – run 1	Pol.27.67 2017 – 6 – run 2	Pol.27.67 2017 – 6 – run 3	Pol.27.67 2017 – 6 – run 4	Pol.27.67 2017 – 6 – run 5	Pol.27.67 2017 – 6 – run 6
sumC	6674	6674	6674	6674	6674	6674
CV sumC	0	0	0	0	0	0
n° of yrs	31	31	31	31	31	31
iterations	10.000	10.000	10.000	10.000	10.000	10.000
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}/B_0	0,5	0,5	0,5	0,5	0,5	0,5
stdev B_{MSY}/B_0	0,1	0,1	0,1	0,1	0,1	0,1
up lim B_{MSY}/B_0	1	1	1	1	1	1
low lim B_{MSY}/B_0	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 30.4. Input parameters for the nine DCAC runs carried out for Pollack in Subarea 7.

	Pol.27.67 2017 – 7 – run 1	Pol.27.67 2017 – 7 – run 2	Pol.27.67 2017 – 7 – run 3	Pol.27.67 2017 – 7 – run 4	Pol.27.67 2017 – 7 – run 5	Pol.27.67 2017 – 7 – run 6	Pol.27.67 2017 – 7 – run 7	Pol.27.67 2017 – 7 – run 8	Pol.27.67 2017 – 7 – run 9
sumC	162346	162346	162346	162346	162346	162346	162346	162346	162346
CV sumC	0	0	0	0	0	0	0	0	0
n° of yrs	31	31	31	31	31	31	31	31	31
iterations	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
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								
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								

Table 30.5. Comparison of the 2017 and 2016 DCAC results.

DCAC	6	% change	7	% change
2017	152	-1.9	4063	0
2016	155	-0.64	4062	+1.04
2015	156	-1.3	4020	+0.9
2014	158	-2.5	3986	1.5
2013	162	0	3928	-2
Average landings	6	% diff. to DCAC	7	% diff. to DCAC
2013–2016	55	36.18%	4473	110.1%

Table 30.6. Irish and French trawlers cpue used as indexes as input data in SPiCT model.

Year	Irish CPUE	French CPUE
1995	1.15	NA
1996	1.36	NA
1997	0.91	NA
1998	0.89	NA
1999	0.78	NA
2000	1.07	6.10
2001	2.13	6.07
2002	2.15	5.93
2003	1.65	6.03
2004	1.4	6.55
2005	1.02	6.88
2006	0.98	8.24
2007	1.14	7.58
2008	1.25	7.82
2009	1.4	8.94
2010	1.42	8.10
2011	1.65	8.73
2012	1.68	10.06
2013	1.9	9.52
2014	1.46	10.86
2015	1.49	6.36
2016	1.36	NA

Table 30.7. SPiCT outputs for pol.27.67.

Stochastic reference points from SPiCT (95% CI)			
	estimate	cilow	ciupp
Bmsys	2397.05253	263.9730676	21766.84493
Fmsys	2.429614	0.2274539	25.95261
MSYs	5831.860198	4679.700311	7267.6862

Relative estimated states from SPiCT (95% CI)			
	estimate	cilow	ciupp
B_2016.50	5298.354686	2037.524799	13777.77703
F_2016.50	0.7859683	0.3040952	2.031424
B_2016.50/Bmsy	2.2103624	0.3951639	12.363736
F_2016.50/Fmsy	0.3234952	0.0470818	2.222711

Table 30.8. Life-history parameters for pol.27.67 used as input data in LBI model.

PARAMETER	ABBREVIATION	VALUE
Length-at-maturity	L_{MAT}	46.28
Von Bertalanffy growth parameter	K	87.96
Von Bertalanffy Length-at-infinity	L_{inf}	0.277
Von Bertalanffy length-at-birth	t_0	0.074
Length–weight relationship parameter a	a	1.98E-5
Length–weight relationship parameter b	b	2.84

Table 30.9. Celtic sea Pollack. Traffic light indicators from LBI for 2006 to 2016 (no data for 2015).

	Traffic ligths indicators for Celtic Sea Pollack						
	Conservation					Optimizing Yield	MSY proxy
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	L95%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
	>1	>1	>0.8		>30%	~1 (>0.9)	>=1
2006	0.583405359	0.605012965	0.588301645	0.51159618	0	0.556373119	0.772389198
2007	0.453759723	0.950734659	0.970935676	0.920873124	0.366941884	0.945157904	1.468576033
2008	0.583405359	1.123595506	0.902644403	0.864029104	0.291306519	0.993978084	1.379897605
2009	1.1019879	1.145203111	0.846176215	0.807185084	0.244828336	1.040970586	1.013321965
2010	1.231633535	1.188418323	0.903507736	0.8526603	0.335915882	1.111754968	1.007002029
2011	0.713050994	0.885911841	0.932302216	0.875397908	0.251577057	0.93192408	1.169191871
2012	0.972342264	1.080380294	0.892129335	0.8526603	0.236521899	1.019011606	1.072027998
2013	0.713050994	0.907519447	0.868065095	0.829922692	0.232328662	0.925472336	1.161097514
2014	0.842696629	1.080380294	0.897245245	0.8526603	0.279133451	0.995716647	1.139516475
2015							
2016	0.713050994	0.907519447	0.847237183	0.807185084	0.194524426	0.916182375	1.14944233

Table 30.10. Estimations of total mortality rates by Mean LB mortality model.

Parameter	Estimate	StdErr
Z1	0.3052926	0.0649865
Z2	0.2437555	0.02109403
Y1	2005.424428	5.40097334
sigma	648.6025436	NA
AIC	175.3956812	NA

Table 30.11. Estimations of mean lengths of catches by Mean LB mortality model.

year	observed	predicted	residual
2005	56.53895	54.03801	2.5009409
2006	53.05889	54.19942	-1.14052232
2007	60.55434	54.6055	5.94884648
2008	55.05055	55.06817	-0.01762756
2009	54.36112	55.52243	-1.1613083
2010	57.45983	55.93808	1.52174708
2011	55.53112	56.30334	-0.77222474
2012	55.02542	56.6161	-1.59067844
2013	58.54639	56.87914	1.6672543
2014	59.13852	57.09749	2.04102353
2015	53.84954	57.27697	-3.427428
2016	54.29327	57.42334	-3.13006833

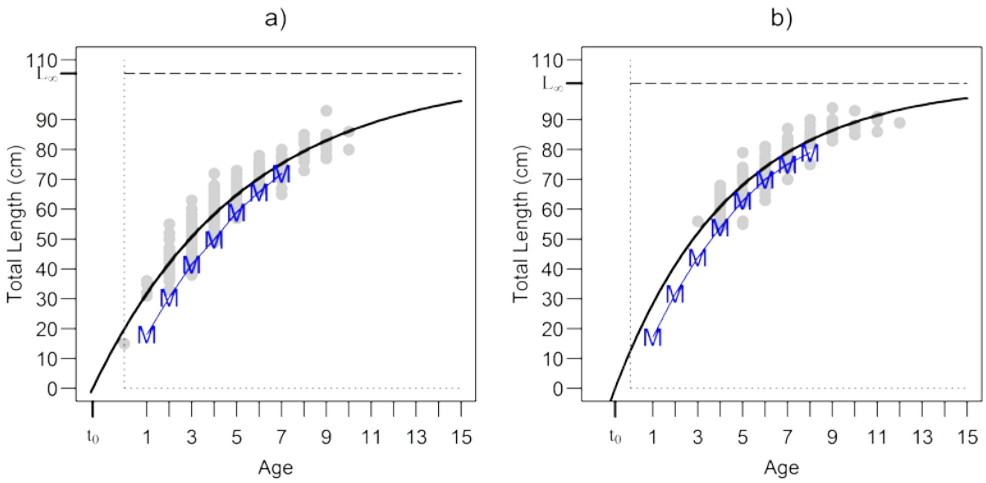

Figure 30.1. Comparison of the von Bertalanffy growth curve based on the recent sampling (solid bold line) with the curve based on the data from Moreau (1964) (solid line with "M") for a) The English Channel and b) the Bay of Biscay (Alemany *et al.*, 2017).

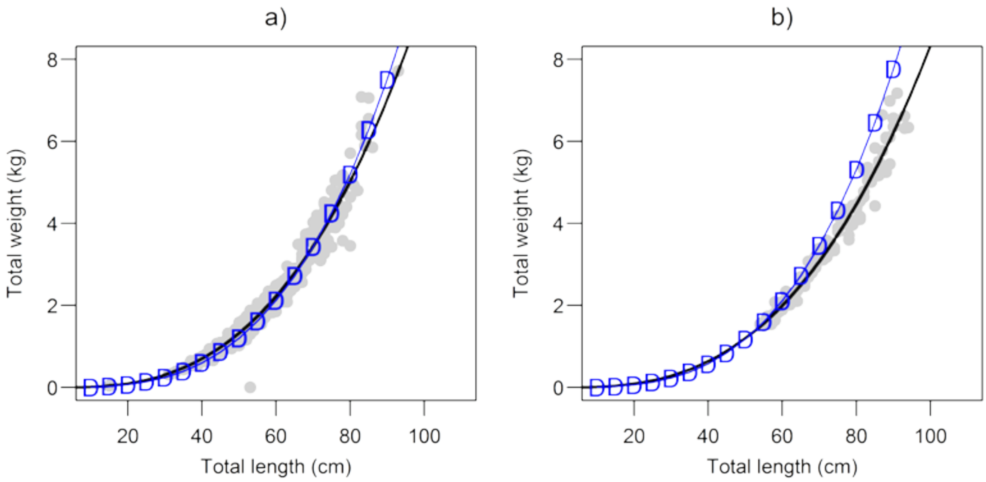

Figure 30.2. Comparison of the length–weight relationship based on the recent sampling (solid bold line) with the curve based on the data from Dorel (1986) (solid line with "D") for a) The English Channel and b) the Bay of Biscay (Alemany *et al.*, 2017).

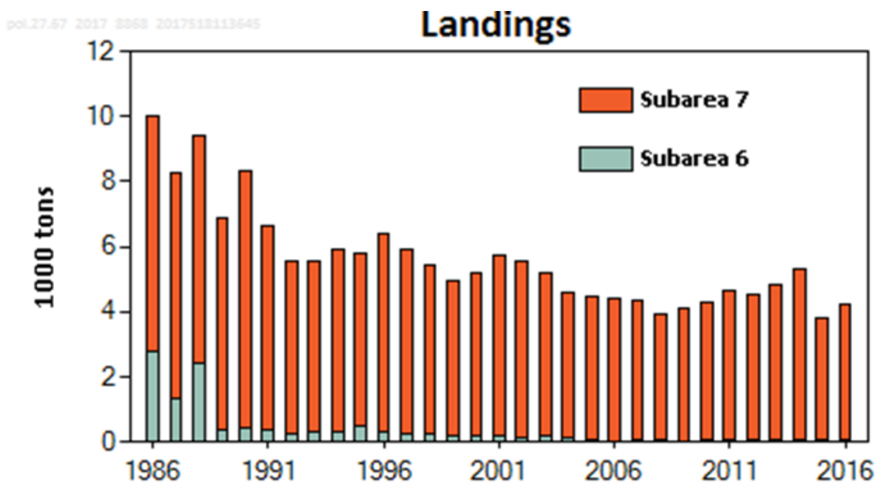

Figure 30.3. Pollack landings in 2016 in the Celtic Seas.

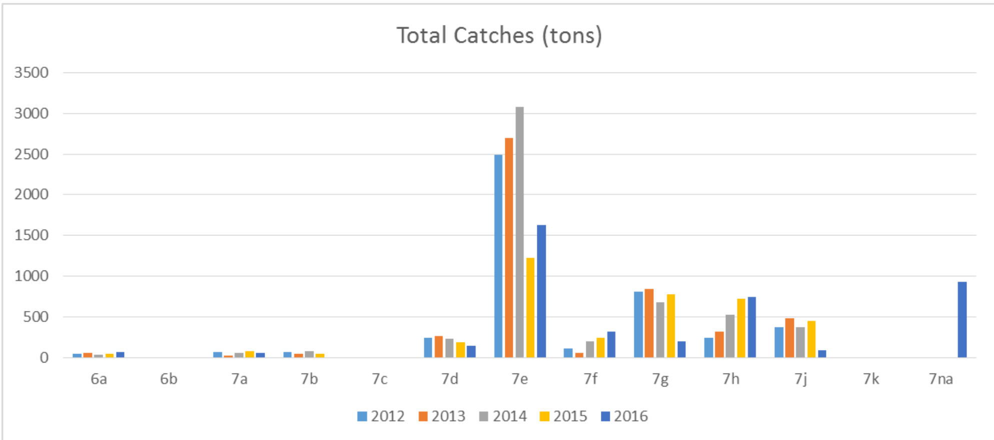

Figure 30.4 –Pollack landings by ICES division in the Celtic Seas.

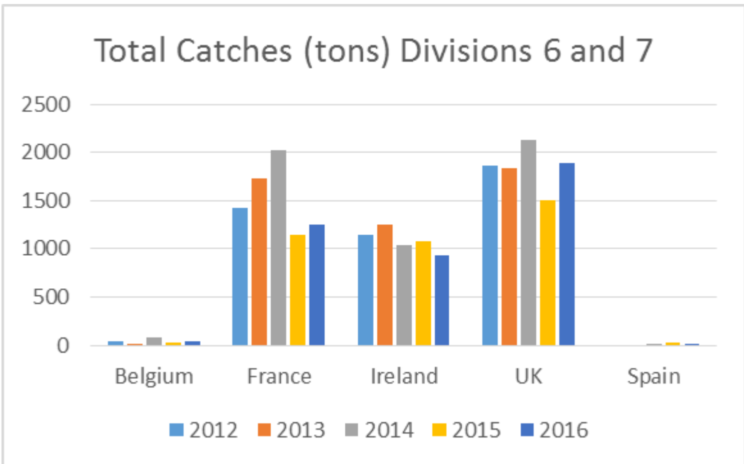

Figure 30.5. Contributions of different countries in Pollack landings in the Celtic Seas.

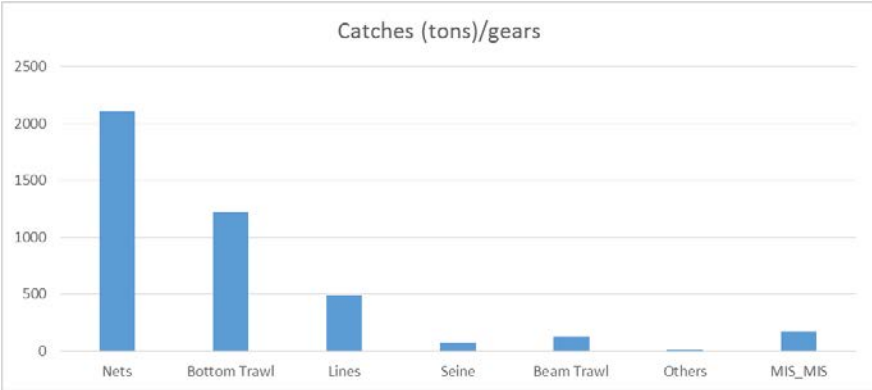

Figure 30.6. Pollack in the Celtic Seas. Catches per gear in 2016 (all countries).

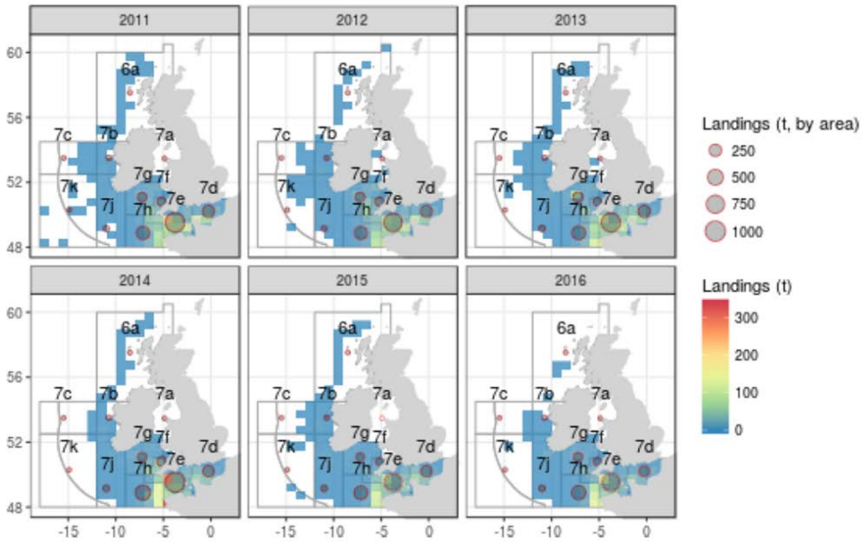

Figure 30.7. Pollack in the Celtic Seas. French landings by rectangle (raster map) and area (circle) from 2011 to 2016. The red circle is the average landings for the area over the range time (i.e. contraction of the grey circles around the red circle highlight the landings variability).

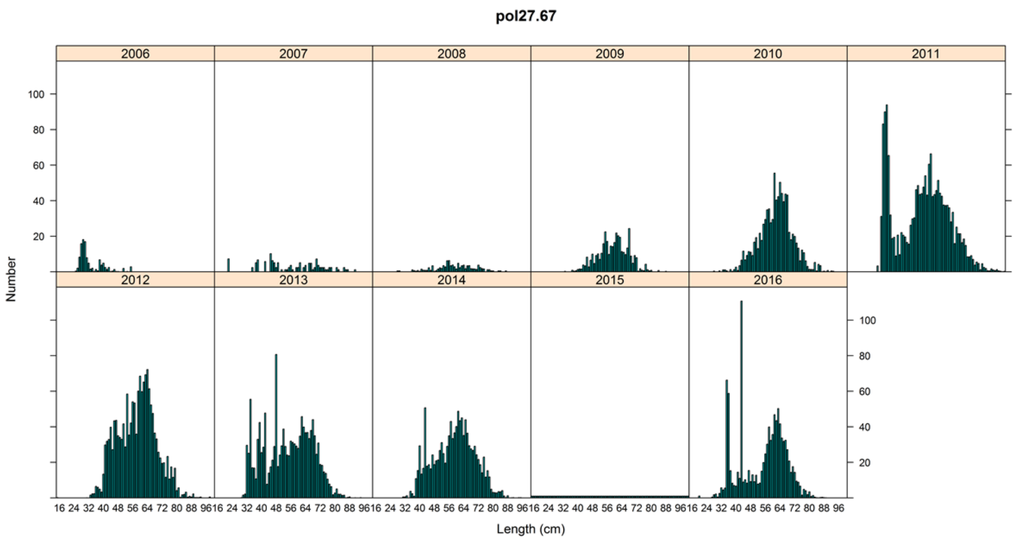

Figure 30.8. Length frequency of Pollack from 2006 to 2016 (no data for 2015).

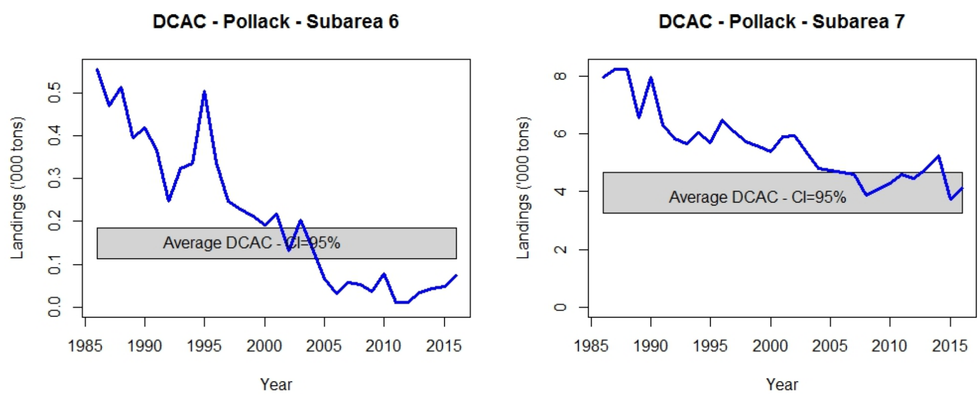

Figure 30.10. Pollack in the Celtic Seas. Results of DCAC for Subarea 6 (left panel) and Subarea 7 (right panel).

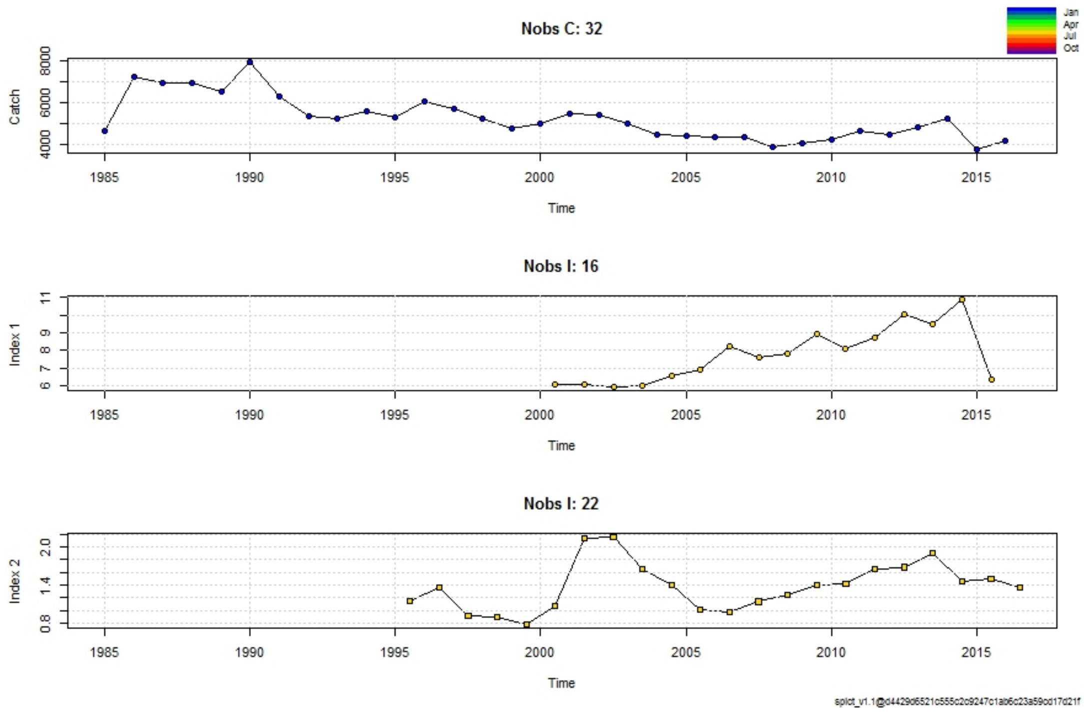

Figure 30.11. Pol.27.67 catch data and cpue indexes as input data in SPiCT model (index1: French trawlers cpue; index2: Irish trawlers cpue).

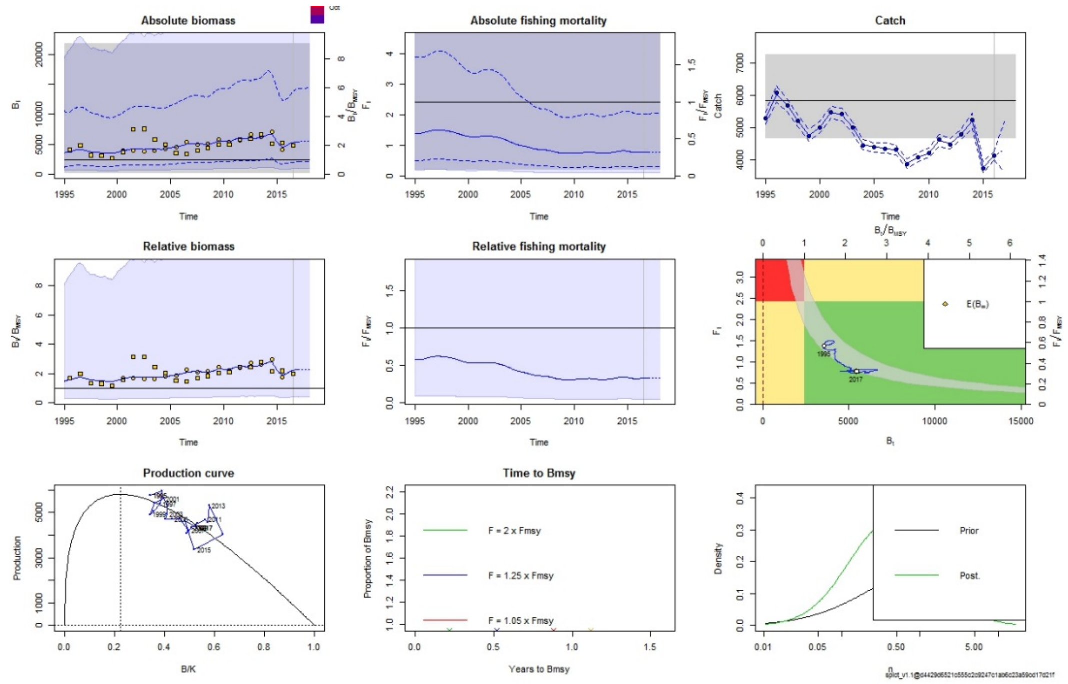

Figure 30.12. SPiCT outputs for pol.27.67 (from 1995 to 2016).

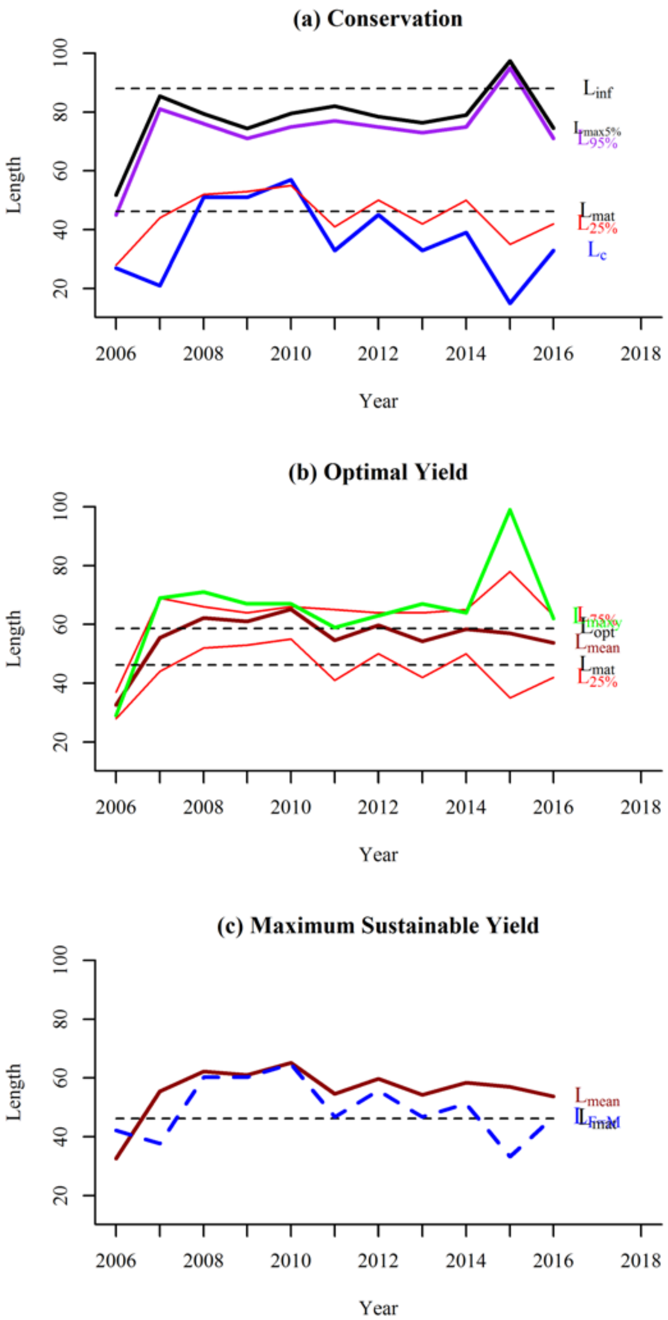

Figure 30.13. Screening of length indicators under three scenarios: (a) Conservation (b) Optimal yield and (c) MSY.

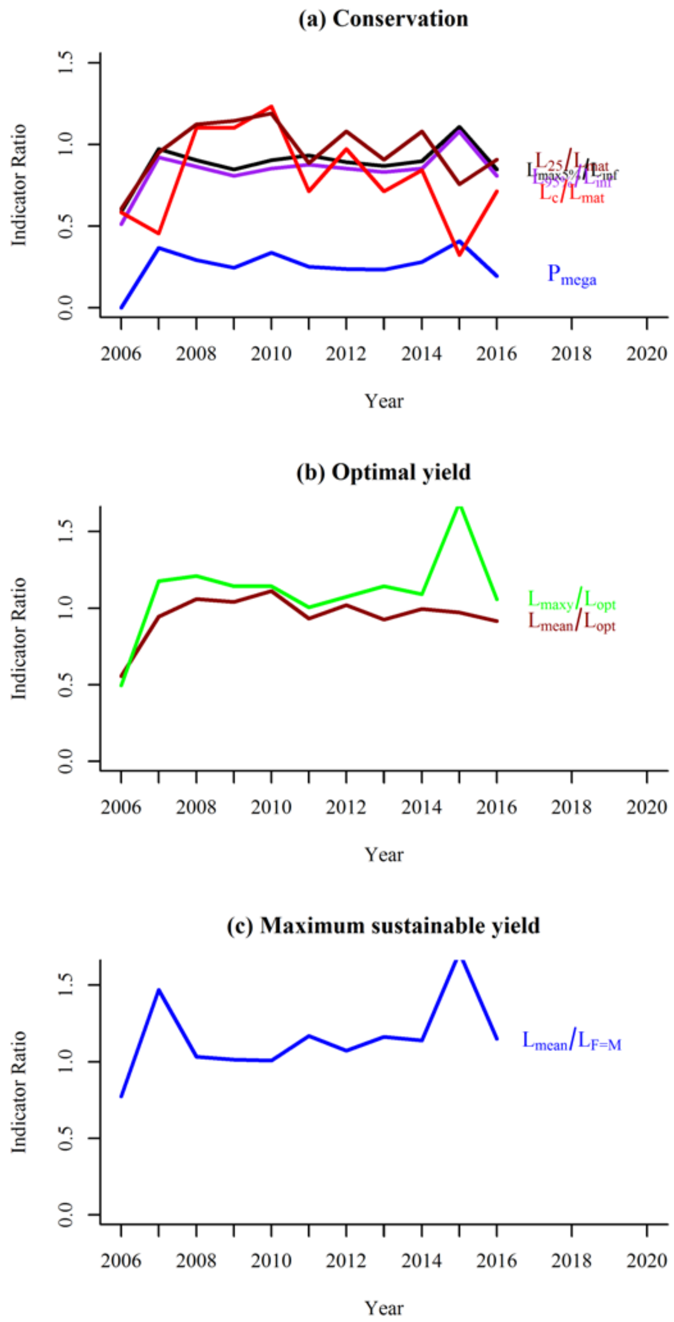

Figure 30.14. Screening of length indicators ratios under three scenarios: (a) Conservation (b) Optimal yield and (c) MSY.

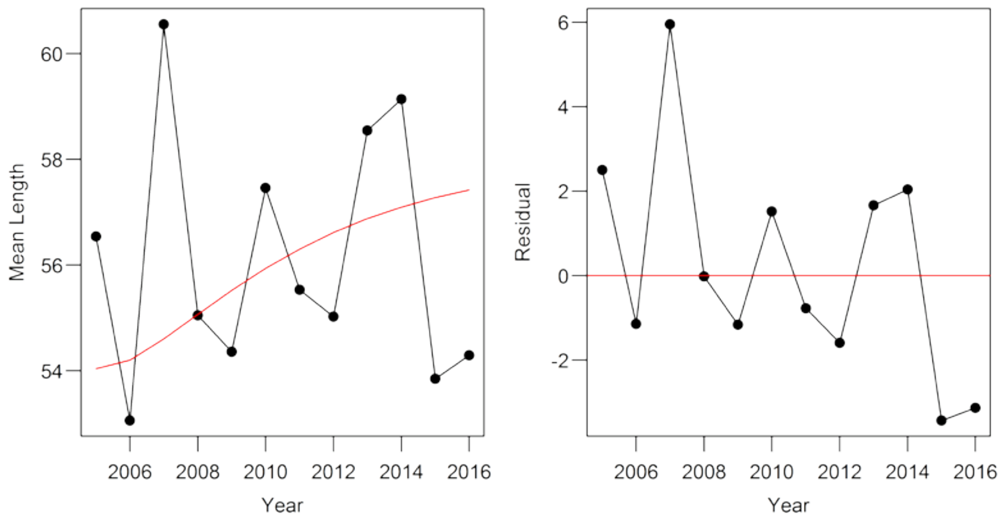

Figure 30.15. Observed and fitted mean lengths for Celtic sea Pollack.

31 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 carried out in WGCSE 2016 and accepted as the agreed methods to use at the benchmark workshop for the sea bass: IBPBass2 (ICES, 2016) a further benchmark to include discards and a commercial tuning series was carried out during March but remains incomplete and is expected to be finalised before the 2018 working group. The assessment is performed using the Stock Synthesis model implementation (SS3; Methot, 2000; 2011). The stock is treated as Category 1 with full analytical assessment. Last year's assessment is available in the WGCSE 2015 report.

(File names, WGCSE SharePoint paths and location in the files of key assessment model outputs are given in the readme file in the Sea bass 47 Report folder on WGCSE 2017 SharePoint).

ICES advice applicable to 2016

The ICES advice for management of sea bass fisheries in 2017 is available in the ICES Advice released in 2016, and states that "ICES advises that when the precautionary approach is applied, there should be zero catch (commercial and recreational) in 2017."

Technical consideration

IPBBass2 benchmark 2016 input data and parameters available for the WGCSE 2017 assessment are summarized in Table 10.1.1

Table 10.1.1. WKBASS inputs for assessment.

Data / parameter	Description	Source
Growth	Fixed values of VBGF K; Length at Amin and Amax; SD of length-at-age; age error vector	Unchanged from IBPBass 2016 and WGCSE 2016
Maturity	Female proportion mature at age	Unchanged from IBPBass 2016 and WGCSE 2016
Natural Mortality	Options: M=0.15 all ages	Unchanged from IBPBass 2016 and WGCSE 2016
Commercial landings 1985 - 2016	UK split by gear (otter trawl and nets combined; midwater pair trawl; lines); France all gears; other countries and other UK gears	Unchanged from IBPBass 2016 and WGCSE 2016
Commercial landings length/age composition	Length compositions and fleet-raised marginal age compositions: UK by gear-1985–2015 France combined fleets 2000–2015	Unchanged from IBPBass 2016 and WGCSE 2016
Recreational catches – kept and post-release mortality	Estimates from Surveys in France (2009–2011), Netherlands (2010–2011); UK (2012). Combined estimate allocated to 2012. Estimates from 2016 Surveys from UK and Netherlands raised to all countries. Baseline value of 15% from recent studies on sea bass and analogy with US striped bass marine studies.	From IBPBass 2016 and WGCSE 2016, with Belgium estimates removed. WGRFS 2017 WKBASS Data evaluation workshop
Recreational fishery length compositions	UK on-site surveys in 2012; data from diary survey in France are available only for combined Area 7 and 8 data; Netherlands data-no data on released lengths.	WKBASS Data evaluation workshop
Channel Groundfish survey (France)	Otter trawl survey in eastern Channel (7d) 1988–2014. Vessel and design change in 2015. Length compositions.	As used by WGCSE 2016
Solent trawl survey (UK)	Otter trawl survey of a major nursery area (1986–2015). Indices by age class for ages 2–4.	As used by WGCSE 2016 with minor edits.
French commercial LPUE series	GLIM analysis of individual French vessel lpue (tonnes/day) in selected rectangle and gear strata (2001–2015). Zero daily catches removed.	Submitted to WKBASS Data WK (Laurec and Drogou working document). Modified series excluding vessels with predominantly zero bass catch supplied to WKBASS assessment meeting by Laurec.

31.1 General

Bass, *Dicentrarchus labrax*, is a widely distributed species in Northeast Atlantic shelf waters with a range from southern Norway, through the North Sea, the Irish Sea, the Bay of Biscay, the Mediterranean and the Black Sea to North-west Africa. The species is at the northern limits of its range around the British Isles and southern Scandinavia. The IBP New 2012 reports that it is clear that further studies are needed on sea bass stock identity, using conventional and electronic tagging, genetics and other individual and population markers (e.g. otolith microchemistry and shape), together with data on spawning distribution, larval transport and VMS data for vessels tracking migrating sea bass shoals, to confirm and quantify the exchange rate of sea bass between sea areas that could form management units for this stock. No update of stock identity was available in advance of the data evaluation workshop (WKBASS), so the stock identity was assumed to be the same as previous descriptions with the following Atlantic stocks (Figure 10.1,1.1): Northern (ICES areas 4.b–c, 7.a,d–h); Southern Ireland and Western Scotland (ICES areas 6.a, 7.b and 7.j); Biscay (ICES areas 8.a–b); Portugal & Northern Spain (ICES areas 8.c & 9.) (ICES, 2012; 2014).

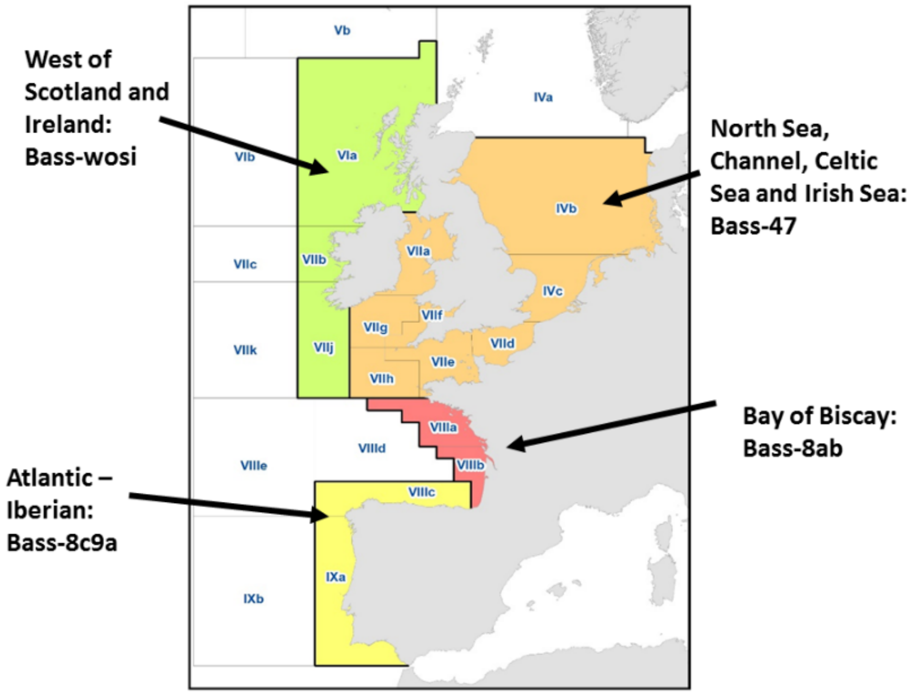

Figure 10.1.1.1. Sea bass stock units defined at ICES (IBP New 2012).

Two large tagging programmes are underway that will provide significant information on the movements of sea bass in the end of 2017, and could indicate the levels of mixing between stocks. The first programme (C-Bass) is being led by the Cefas (UK) and has tagged almost 200 seabass with electronic data storage tags (DSTs) in two locations (Lowestoft and Weymouth). Around 20 tags have been returned and significant effort is being made to improve the geolocation algorithms through the inclusion of bathymetry and temperature at depth. The BARGIP study is being led by Ifremer and has released 1220 fish with DSTs at ten locations in the Channel and Bay of Biscay. So far, 282 tags have been returned, and the movements of individual fish are being reconstructed. Cefas and Ifremer are working together to compare geolocation algorithms. Behavioural and genetic studies of sea bass are also underway at the Marine Institute, Ireland, with the aim of investigating the distribution of sea bass within Irish waters and the potential existence of an Irish subpopulation.

Sea bass movement patterns between ICES stock units are plausible, as evidenced from some individuals tagged with DSTs and fidelity to both spawning and feeding grounds may provide evidence of fine population structure that identified using genetics. However, it is not possible to quantify the proportion of fish migrating between the stocks currently due to the small numbers of fish tracks analysed. However, as further DSTs are analysed, it may be possible to quantify exchange between stocks, so the next benchmark should consider how exchange between stocks should be incorporated into the assessment process.

Further details on stock identity are available in WKBASS 2017 report.

31.1.1 Management applicable to 2015

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 with continued high levels of fishing; European Sea bass are not subject to EU TACs and quotas in

4.bc and 7.a,d–h (North Sea, Channel, Celtic Sea and Irish Sea). In 2015, the European Council has adopted measures to help sea bass recover. Effective emergency measures in January 2015 placed (i) a ban on targeting the fish stock by pair-trawling during the spawning season up until the end of April 2015.; (ii) a bag limit of three sea bass per day for recreational fishing has been imposed (EU Regulation 2015/523 of 25 March 2015); (iii) a monthly catch limit (1.5 t for pelagic trawlers; 1.8 t for bottom trawlers; 1 t for driftnets; 1.3 t for liners; 3 t for purse seiners) and (iv) an increase in the minimum size of northern sea bass from 36 cm to 42 cm from July 2015. Moreover, a continued area closure around Ireland for commercial fishing is set up (as in previous years). (source: http://ec.europa.eu/fisheries/cfp/fishing_rules/sea-bass/index_en.htm).

31.1.2 Management applicable to 2016

The European Commission is working with Member States to identify more effective control measures to reduce fishing mortality towards F_{MSY}. Measures introduced in 2015 and completed in 2016 (given in the table below), include reduction or prohibition of landings depending on gears and months. These developments affect the short-term forecast assumptions for this stock and will have implications for how the stock assessment is conducted in future years.

2016 measures	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Bottom trawlers	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	1 t	1 t	1 t	1 t	1 t	1 t
Seiners	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	1 t	1 t	1 t	1 t	1 t	1 t
Pelagic trawlers	X	X	X	X	X	X	1 t	1 t	1 t	1 t	1 t	1 t
Drift Gillnets	X	X	X	X	X	X	1 t	1 t	1 t	1 t	1 t	1 t
Hooks	1.3t	X	X	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t
Lines	1.3t	X	X	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t
Set Gillnets	1.3t	X	X	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t

31.1.3 Management applicable to 2017

According to scientific advice, sea bass (*Dicentrarchus labrax*) in the Celtic Sea, Channel, Irish Sea and southern North Sea (ICES divisions 4.b, 4.c and 7.a, 7.d–7.h) remains in a perilous state and the stock continues to decline. The conservation measures to prohibit fishing for sea bass should therefore be maintained in ICES divisions 7.a, 7.b, 7.c, 7.g, 7.j and 7.k, with the exception of the waters within 12 nautical miles of the baseline under the sovereignty of the United Kingdom. Spawning aggregations of sea bass should be protected with commercial catches restricted further in 2017. On the basis of social and economic impacts limited fisheries using hooks and lines should be permitted, while providing for a closure to protect spawning aggregations. Additionally, due to incidental and unavoidable bycatches of sea bass by vessels using demersal trawls and seines, such bycatches should be limited to 3% of the weight of the total catch of marine organisms on board with a maximum of 400 kilograms per month. For the same reasons, for fixed gillnets bycatches should be limited to 250 kilograms per month. Catches of recreational fishermen from the Northern stock and, for precautionary reasons, from the stock in the Bay of Biscay should be restricted by a daily limit (source: COUNCIL REGULATION (EU) 2017/127 of 20 January 2017).

31.1.4 Fishery in 2016

The time-series of official landings figures and the landings used by the WG are given in Table 10.1.1.2. Differences occur where national scientists have had to rework official figures, for example to attribute landings more accurately to the stock area.

A period of rapid growth in the fishery in the 1990s and early 2000s coincided with an expansion of the stock biomass and spatial distribution. As a non-TAC species, bass has provided additional fishing opportunities for vessels with restricted quotas for other species. The growth in fishery landings halted rapidly around 2005 and reported landings fluctuated around 4000 t up to 2013 (Figure 10.1.1.1a; Table 10.1.1.1). A decrease is observed since (mainly due to bad weather condition in 2014 and restrictive management in 2015 and 2016); 1295 tonnes were landed in 2016. Landings by Belgium and the Netherlands have only appeared in catch statistics since the 2000s as fisheries in the North Sea became established following the spatial expansion of the stock.

The bulk of the international landings was historically taken by French bottom trawlers and midwater (pelagic) pair trawlers (Figure 10.1.1.1b). The midwater pair trawl fleet targeted adult bass on or near spawning grounds in the Channel and Celtic Sea in late winter and spring. Since the mid-2000s, this fleet had shifted more of its activities from the Bay of Biscay to the Channel causing an increased fishing effort on adult bass in this area. In 2013, the fleet of around 40 French pair-trawlers and a small number of UK midwater trawlers accounted for 37% of the total international landings, but landings of this métier reduced from 1630 t in 2013 to only 243 t in 2014 due mainly to very bad weather conditions. The French pair trawlers switched from sea bass to fishing for hake. In 2015 because of the restrictive measures taken by the European Commission and the ban of pelagic trawlers, trends in landings have changed significantly with an expected decrease observed. Almost 50% of the French landings in 2016 were also made by bottom trawlers, corresponding to a mix between sea bass targeted or caught as a bycatch. A large decrease of around 50% in French landings is observed between 2015 and 2016 (1110 tonnes in 2015; 547 tonnes in 2016).

Some French vessels using Danish seines appeared in the offshore fisheries since 2009. Catches from this métier are low but increased from 27 t in 2009 to 112 t in 2012, falling to 18 t in 2016. Seining has also become more prevalent in the UK fleet in recent years although it is a small contributor to total landings.

Sea bass are targeted by relatively few UK inshore bottom trawlers, and are mainly a bycatch in that fleet. Total bottom-trawl landings of UK and French otter trawlers have been declining since the mid to late 2000s (Figure 10.1.1.1b,c). UK beam trawlers targeting flatfish and other benthic species in Area 7 also experienced a progressive decline in their normally small bycatches of sea bass over this period.

In 2016 25% of total reported landings (all countries) in the area are from bottom trawlers, 25% from netters and 28% from lines.

Despite the apparent decline in sea bass biomass indicated by the ICES assessment of the stock, reported landings of UK inshore <10 m vessels deploying fixed or drifting gillnets have been progressively increasing since the 2000s and reached their highest value in 2014 (Figure 10.1.1.1c), but returned to a “classical” level in 2015 and 2016. Netting for bass, or taking bass as bycatch, takes place all around the coast of England and Wales, both in inshore waters and in some areas such as the eastern Channel where netting extends into deeper water to intercept migrating adult bass in autumn and early winter. It is not known to what extent the reduction in pelagic pair trawl fishing in 2014 may have improved availability of bass to inshore fleets in subsequent months. An effect of this nature was not apparent in the French artisanal fleets.

In 2016, a total of 1295 tonnes was landed, 772 tonnes less than 2015 due to the EC regulations imposed.

31.2 Data

31.2.1 Landings data

Landings series for use in the assessment are given in Table 10.1.2.1 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 fishing mortality in 2012 for the period 1985–2015). 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) plus preliminary data for 2015;
2) French landings for 2000–2015 from a separate analysis by Ifremer of logbook, auction data and VMS data (SACROIS database, now treated as official statistics from 2010);
3) Landings for Belgian vessels supplied directly by the national fisheries laboratory;
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.

31.2.2 Length compositions: commercial landings

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.

31.2.3 Sampling rates

UK(E&W) sampling rates for age compositions, by gear group, are given in Table 10.1.2.2. 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 and 2016 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 sea bass landings in 2013 and landed only 1 t in 2014, less than 1 t in 2015 and 1 t in 2016.

Sampling of sea bass in France has also been very variable between areas and gears (Table 10.1.2.3). There has been a general increase in numbers of trips sampled for length from 2009 to 2014, a decrease is observed in the recent two years mainly due to the discontinuation of the French midwater pair trawlers from the fishery.

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 sea bass by ICES IBPNew, IBPBass and IBPBass2.

Based on those results, the input effective sample sizes were then iteratively adjusted using the Francis method of weighting reducing the disproportionate effect of the different dataset 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 be adjusted using the effective sample size multiplier for age and length compositions by fleet available in the stock annex.

31.2.4 Length composition estimates for landings

Table 10.1.2.4 gives fleet-raised length compositions for all French gears combined, updated to include 2015. Sampling levels are given in Table 10.1.2.3. French numbers-at-length are available from 2000 onwards. In the assessment (WGCSE 2015) a single fleet called "French fleet" is used. This fleet is the combination of several types of sub-fleets using various fishing gears: pelagic trawlers, bottom trawlers, netters, liners, Danish seiners and purse seiners.

31.2.5 Age composition estimates for landings

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&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 10.1.2.5, and the age compositions for the UK midwater pair trawl fleet since 1996 are given in Table 10.1.2.6a. During WGCSE 2015, French mixed gear landings by age class were made available (Table 10.1.2.6b) and were used for some exploratory assessment runs for comparison with the baseline Stock Synthesis run using French length data.

Following to the IBPBass2 (2016) age compositions for French commercial fishery landings of sea bass are 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 10.1.2.6b).

The age compositions for the trawls, nets and lines fleet show clear year-class signals and good tracking of year classes, and the year-class patterns appear similar in the constituent ICES division groups (Figure 10.1.2.1a). The impacts of strong year classes and periods of very weak year classes are clearly seen, particularly by standardising the annual catches-at-age to the mean of the time-series for that age (Figure 10.1.2.1b). The French data show some progression of year classes, for example a very weak 1996 year class and some stronger year classes after that (Figure 10.1.2.1.c.), observed also in the UK data. The UK and French data both show reduced landings of young bass from recent year classes which are indicated by surveys to be weak, though this is more apparent in the time-series standardised data in Figure 10.1.2.1b and c which also shows that sea bass over 20 years of age have become rarer in UK catches in each area. A direct comparison of the UK and French age-composition data (Figure 10.1.2.1.d) shows a relatively weak association, which is probably a reflection of very variable, and often low sample sizes in each country (see Tables 10.1.2.2a,b and 10.1.2.3).

31.2.6 Commercial discards

Data sources for discards estimates, and sampling design, are described in the stock annex. Discarding of sea bass 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), and where mesh sizes <100 mm are in use. Sampling rates and estimates of discards were provided to WGCSE from sampling in UK and France (Tables 10.1.2.7, 10.1.2.8, and 10.1.2.9. The annual estimated quantities discarded by UK and French vessels from 2009 to 2014 has been less than 5% of total landings (Table 10.1.2.9).

In 2016 a level of 22% of discarding in France is observed in the area (Table 10.1.2.9), mainly due to bottom trawlers (for which seabass is often a bycatch). For UK fleet a level of 9% is observed, mainly due to bottom trawlers. Discards estimates for 2016 suggest increased discarding following the increase in MCRS from 36 cm to 42 cm part way through 2015.

In the UK, the addition of discard estimates from non-sampled fleets could alter the overall discard rate depending on their discard quantities and rates. Most discards are fish below the MLS of 36 cm, and mostly from otter trawlers using 80–99 mm mesh in areas such inshore regions of the English Channel where juvenile bass are most common.

England provided information to WGCSE 2016 on discards sampling design and achieved sampling in 2012–2014 using the discards quality tables supplied with the 2015 WGCSE data call. It was noted that the distribution of samples was not well reflected in spatial fishing effort in 2012, however spatial and temporal distribution of sampling relative to fleet effort improved annually from 2012–2014. However, out of 528 sampled trips on vessels and in areas where sea bass could potentially be caught, only 27 trips had discards of sea bass. This reflects the small proportion of trips where bass are caught. Sampling at sea on under 10 m vessels, which take the bulk of the UK sea bass catch, was very infrequent until 2007, and line gears have seldom been sampled (but mortality of discards for this gear can probably be considered as low). Therefore, there is a large potential for bias in the discards estimates. It was recommended by England that the discards data for sea bass should be used with caution.

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 for local fisheries such as trawling in inshore waters. Restrictive bycatch limits for trawls and nets in the new legislation are also likely to cause increased discarding. Without an evaluation of historical fishery selectivity and discard patterns, and changes caused by the new legislation, it is not possible to evaluate the short-term impact of the measures or to monitor how selectivity and discarding will alter in the future as fleets adapt to the new regulations. WKBASS (ICES, 2017) explored the performance of the Stock Synthesis model including recent (noisy) estimates of commercial discards and length compositions. For years prior to inception of observer schemes, a history of discards can be constructed based on the estimates of fishery selectivity and discarding ogives estimated for the recent years that have discards observations.

Note that the lack of discards data for line fishing boats in the UK and France is a deficiency for any assessment including discards, given the importance of line fishing in both countries.

31.2.7 Recreational catches

Recreational marine fishery surveys covering different parts of the sea bass stock in the North Sea, Channel, Celtic Sea and Irish Sea have been developed in France, Netherlands, England and Belgium (ICES, 2012c). Methods and description of national surveys are described in the stock annex and in ICES (2012c).

The available estimates are summarised in Table 10.1.2.11. WGRFS 2017 concluded from these surveys that around 1501 t and 1627 t of sea bass were either landed or died after being released by recreational fishing (mainly sea angling) in 2012 and 2016 respectively. This estimate will have some bias because it is incomplete (no surveys in Wales, for example) and there was considerable uncertainty in the figure for England due to limitations in the data available for estimating sea angling effort and for estimating private boat catches. An additional survey result for the Netherlands was available to WGCSE for the period March 2012–March 2013 indicating an increase in recreational harvest from 138 t to 229 t (van der Hammen *et al.*, 2015). However, there is no additional information to allow any further estimates of total international recreational harvests.

From information available, the precision of combined international estimates is likely to be moderate, with relative standard errors of at least 20%. However, the ratio of recreational removals estimates in each country is a very consistent proportion of the combined recreational and reported commercial fishery landings (France: 25%; England: 28%; Netherlands: 26%; Belgium: 29%) giving greater confidence in the estimates, although the figure for the 2012 Netherlands survey is much higher at 38%. The recreational catch estimates exclude figures for Wales or any other European countries without surveys.

The proportion of fishery removals comprising recreational harvests has additional uncertainty due to unknown rates of post-release mortality, biases in reported commercial fishery landings, and unaccounted-for commercial (dead) discards. Extensive studies have been carried out to estimate post-release mortality in recreational fisheries for a wide range of species (see stock annex) but no information is available for European sea bass. For the purposes of the assessment, post-release mortality of recreational caught fish has been assumed to be zero, but studies are needed to estimate the mortality. This will become more critical due to the imposition of bag limits and likely increases in MLS which will elevate the released rate further.

A bias in the proportion of total removals due to recreational fishing is unreported commercial fishery landings. For under 10 m vessels which do not have to submit EU logbooks, Article 65(2) of the EU Control regulation 1224/2009 allows disposal of up to 30 kg of fish for personal consumption without supplying sales slips. For small-scale, low-volume fisheries catching sea bass, this missing catch could be substantial but is poorly understood. French under 10 m vessels are all required to supply logbooks but this is currently not the case in all other countries including the UK. A separate logbook scheme for sea bass was developed in England by Cefas in the 1980s and indicated that total sea bass landings by commercial under 10 m boats using nets and lines could have been three or more times larger than reported landings (see results in stock annex). The scheme was terminated in 2010, so it is not known if the bias has continued at the same level.

It is concluded that recreational fishing may have accounted for up to 30% of total fishery removals and fishing mortality in 2012, and this represents a significant missing catch from the assessment. IBPBass (ICES, 2014b) developed a method to reflect this additional mortality in the Stock Synthesis model. This is described further in the stock assessment section and the stock annex. The historical trends in recreational catches and fishing mortality are unknown, but they are likely to differ from commercial catch trends. It is possible that, before the large growth in biomass of the stock in the 1990s, recreational fishing may have been a much larger proportion of total fishery removals than today.

In blue : WKBASS REPORT TEXT

The WKBASS Data WK documented and reviewed all available recreational catch estimates for sea bass in Areas 4.bc, 7.d.e–h (Table 4.2.6.1). It proposed that the assessment workshop explores ways to reflect the likely reduction in recreational fishing mortality due to the MCRS and bag limits especially in 2016.

The few national surveys that are available have not been internationally coordinated and cover different years, preventing the compilation of coherent annual estimates derived from national surveys in the same year. Previous ICES assessments have added together the retained and released catch estimates from surveys in France in 2009–2011; UK in 2012 and Netherlands in 2010–2011, together with a retained catch figure of 60 t for Belgium in 2012 (provided informally to ICES WGCSE) to give an amalgamated figure of 1500 t retained catch that was arbitrarily assumed to represent recreational fishery removals in 2012. Dead releases were not accounted for.

Fleet 6 (Recreational fishery) in the SS3 data file (Annex XX) is now landings plus the released catch that is expected to die due to post-release mortality of 15%, but is an output of the model for all years other than 2012 for which a value of 1500 t is assumed based on recreational fishery surveys in UK, France and Netherlands. The addition of dead released fish has compensated for the removal of the Belgian retained catch figure of 60 t, as WKBass could not locate direct evidence from analysis of data for this figure, hence the total removals has remained at 1500 t.

Table 4.2.6.1. 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. The source of the data is also provided.

			Numbers (thousands)	Weight (tonnes)													
Country	Year	Area	Retained	RSE	Released	RSE	Total	RSE	% released	Retained	RSE	relapsed	RSE	Total	RSE	% released	Source
France	2009–2011	4 & 7	781		796		1578	>26	50	940		332		1272	>26	26	ICES (2014c)
	2009–2011	Biscay	1168		1190		2357	>26	50	1405		496		1901	>26	26	Calculated
	2009–2011	All	1949		1986		3935	26	50	2345		828		3173	26	26	Rocklin *et al*. (2014)
	2011–2012	4 & 7	2043		1581		3624		44	2458		659		3117		21	Ifremer
	2011–2012	Biscay	572		281		852		33	688		117		805		15	Ifremer
	2011–2012	All	2615		1861		3935		47	3146		776		3922		20	Ifremer
Netherlands	2010–2011	North Sea	234	38	131	27	366	30	36	138	37						van der Hammen and de Graaf (2013)
	2012–2013	North Sea	335	26	332	21	667		50	229	26						van der Hammen and de Graaf (2015)
	2014–2015	North Sea	176	19	499	20	675		74	138	20						van der Hammen and de Graff (unpublished data.)
UK	2012–2013	4 & 7	367		576		943		61	230–440		150–250		380–690	26–38	36–39	Armstrong *et al*. (2013)

The combined figure of 1500 t represents around a quarter of total commercial and recreational fishery landings. IBPBass 2014 (ICES, 2014) considered it necessary to have the catch and fishing mortality due to recreational fishing represented in the assessment model. There are no data to indicate how the recreational catch may have changed over time. The large growth in both the sea bass stock and the commercial fisheries in the 1990s is unlikely to have been reflected in a similar growth in recreational fishing which is an activity targeting a wide range of species. IBPBass 2014 considered it more plausible to treat recreational fishing as having a more stable participation and effort over time than the commercial fishery. Historical surveys of angling participation in the UK tended to support this idea, although targeting of sea bass is likely to have changed according to fish availability, and improvements in sea angling technology and skills will have occurred. A decision was therefore made to apply a constant recreational fishing mortality-at-age vector to all years, with selectivity the same as UK commercial lines, and iteratively adjust the mean recreational F in successive Stock Synthesis runs until a retained catch of 1500 t was obtained for 2012. This was done by IBPBass 2014 by iteratively adjusting the recreational F-at-age vector and adding it to the natural mortality vector in each iteration. The annual recreational catch was then calculated by applying the catch equation with recreational F to the population numbers at each age estimated in the model. This approach had a disadvantage that estimation of virgin biomass at zero F in the model output was incorrect because the recreational F was added into the M vector in the control file. IBPBass 2016 modified this procedure by calculating the historical landings series that gives constant recreational F (and 1500 t landings in 2012), and including this as a landings series in the SS3 data input file rather than having the recreational F added to the M vector. WKBASS decided to continue this approach. WKBass agreed that the final values estimated for recreational catch from the approved benchmark assessment will remain fixed for the historic series until the next benchmark or when new data become available.

31.2.8 Biological data

This section provides biological parameters of growth, maturity and natural mortality required for stock assessment of sea bass. 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, 2017)

31.2.8.1 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 sea bass 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 sea bass show 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.

31.2.8.2 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.

31.2.8.3 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 sea bass 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.

31.2.8.4 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

31.2.8.5 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:

$$\mathrm{Pmat}(L) = 1/(1+e^{-(a+bL)})$$

defined by the parameters slope *b* and length intecept*a*. These parameters were estimated separately for females and males. This can also be expressed as:

$$\mathrm{Pmat}(L) = 1/(1+e^{-b(L+c)}) \text{where } c = a/b$$

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 ($L^{50\%}$ = 40.65 cm).

The parameters of the model Pmat(*L*) = $1/(1+e^{-b(L+c)})$ are given in Table 31.2.8.5.1.

Table 31.2.8.5.1. 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

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 31.2.8.5.2. 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

31.2.8.6 Natural mortality

The current assessment uses a value of M=0.15 for all ages and years. This was derived in previous inter benchmarks 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 31.2.8.6.1). 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.$K^{0.73}$.$Linf^{-0.33}$) which predicts M = 0.17 for sea bass in areas 4 and 7. The WKBASS Data WK proposed 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 multi-species 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 sea bass by age are given in Tables 31.2.8.6.1 and 31.2.8.6.2 and Figure 31.2.8.6.1. 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 31.2.8.6.2 and Figure 31.2.8.6.1 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 therefore explored:

1) M = 0.15 at all ages (continuity with current 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;
5) M=0.1 and 0.2 at all ages to explore likelihoods in comparison with the other options.

Table 31.2.8.6.1. Bss-47: inferences on natural mortality rate from a range of life-history based methods (WKBASS Data WK update of table provided by ICES, IBPNEW 2012 sea bass 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 31.2.8.6.2. 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

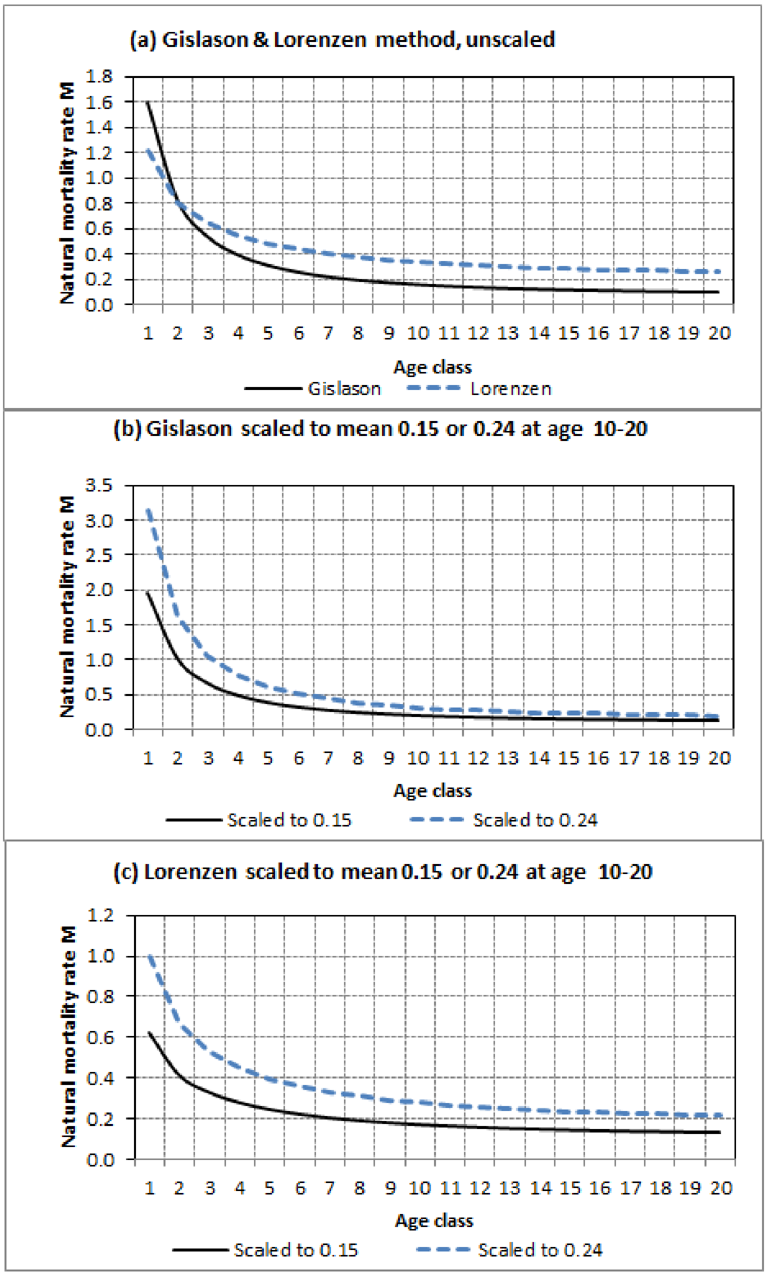

Figure 31.2.8.6.1. Bss-47 stock: (a) Natural mortality values inferred from Gislason *et al.* (2010) and Lorenzen (1996); (b) Gislason M values rescaled to average M=0.15 or 0.24 at ages 10–20); (c) Lorenzen M values rescaled to average M=0.15 or 0.24 at ages 10–20).

31.2.8.7 Hooking mortality, and mortality of discarded bass from commercial vessels

Hooking mortality in recreational fisheries is discussed in the report section on recreational fish catches. Sea bass discarded from commercial line vessels and netters may survive depending on the extent of injury or stress. This will affect the calculation of fishing mortality reference points that are conditional on selectivity patterns. Trawl-caught undersized bass are less likely to survive. Unfortunately, no estimates of survival rates of commercial bass discards are available.

31.2.9 Survey data used in assessment

31.2.9.1 Pre-recruit surveys

An inshore trawl survey in autumn in the vicinity of a major bass nursery area in the Solent (7.d English coast, Figure 10.1.2.3) 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 10.1.2.12). 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. Similar surveys, carried out by Ifremer, commenced on the coast of France from 2014. At this stage, the methodology has been set and give good results in term of gear used, catchability of seabass group 0,1,2,3 and understanding of nurseries dynamics but in 2017, there is still uncertainty to its continuation.

Abundance indices for ages 2–4 in the Solent autumn survey have large interannual variability (Table 10.1.2.12; Figure10.1.2.4). 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.

WKBASS Data WK (ICES, 2017) made some small changes to the Solent bass survey indices for the most recent two years to ensure consistency with values for previous years. This resulted in an improved model fit to the data. The CVs of the aggregated index are substantially inflated because there are expected to be substantial additional variability in the index in relation to assessment model estimates of population trends at ages 2–4 which relate to the entire stock area.

31.2.9.2 Channel Groundfish survey

The Ifremer Channel Groundfish survey, carried out in October each year since 1988, provides swept-area indices of sea bass abundance in the eastern Channel (7.d) together with annual length compositions. Details of the survey are given in Coppin *et al.* (2002), which includes a full description of the GOV trawl used in October each year at the 82 stations in ICES Division 7.d shown in Figure 10.1.2.5. The majority of sea bass are caught in the coastal waters of England and France (Figure 10.1.2.5).

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 10.1.2.13. The trends in both the index and in the proportion of stations with sea bass 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 10.1.2.6).

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 10.1.2.13 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 meshsize codend), using the same Research Vessel Gwen Drez since 1988 to 2015. The RV Gwen Drez was decommissioned in 2015, and it was decided to 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 sea bass 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 the new index introduced significant changes that requires it to be reviewed and evaluated the WG decided not to use the new index, and to review and explore the use of it during the next benchmark in 2017.

31.2.10 Commercial landings per unit of effort

A major shortcoming of the current Bss-47 assessment is the absence of relative abundance indices for adult fish covering the majority of the stock area. The Solent survey covers only pre-recruits at ages 2–4 at one nursery area in 7.d, and the Channel groundfish survey predominantly selects small sea bass in the length range 30–45 cm, also only in area 7.d. Even if the recruitment time-series is estimated robustly by SS3, the estimates of stock size and fishing mortality for adult seabass in the most recent years are driven mainly by the fitting to catch data conditional on assumptions regarding fleet selectivity and stability of selectivity. The absence of a relative abundance index series covering adult sea bass has been routinely identified as a major data deficiency in ICES assessment reports and annual advice.

There are no scientific surveys providing sufficient data on adult sea bass to develop abundance indices. Therefore, Ifremer has investigated the potential for deriving an index from commercial fishery landings and effort data derived from the improved fishery data available since 2000 from commercial logbooks. This allows the possibility to model lpue at the resolution of ICES rectangle and gear strata. The methods and results of a GLIM analysis of data covering areas 7 and 8 were presented in a Working Document by Laurec and Drogou to the WKBASS data WK (ICES, 2017).

Analysis of trip data by rectangle and month showed very coherent seasonal and spatial patterns in lpue, matching what is known about the fisheries using different types of gears (otter trawl; midwater trawl; nets; lines) and the seasonal movements of sea bass to and from spawning sites. This provided confidence in the ability of the lpue data to provide information on relative abundance. Lpue relative abundance indices covering 2000–2015 were provided to WKBASS data WK for groups of rectangles and gears both as analytical solutions and as bootstrap estimates with confidence intervals. The lpue was calculated excluding all vessel-days where no sea bass were landed. Full diagnostics of the model fits were not available. Some unusual patterns were noted in the time-series by WKBASS members, including a large drop in lpue for Bss-47 from 2000 to 2001, and a large step change in lpue in this stock between 2008 and 2009 in some gears and areas as well as the combined index. Ifremer considered the 2000 data to be unreliable as it was the year in which the new database was being introduced, and should not be used, however the 2008–2009 change could not be adequately explained.

During the WKBASS benchmark assessment meeting, a new index series was and a further update with a truncated index provided to the EWG, both excluding a large number of vessels with predominantly zero landings of seabass. This reduced the size of the lpue fleet but produced smoother lpue trends (Figure 4.2.7.3). The index combines trends from otter trawls, nets and lines, but excludes midwater trawls which target spawning aggregations and have not fished on the Bss-47 stock since 2014. However, WKBass decided that more detailed diagnostics of the GLIM fits, and supporting data, should be requested and evaluated by the external reviewers and other WKBass members before accepting the lpue series for use in the assessments.

31.2.11 Other relevant data

None.

31.3 Stock assessment

31.3.1 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 developed by IBPBass 2 are summarized below:

31.3.1.1 Model structure

- Temporal unit: annual based data (landings, survey indices, age–frequency and length–frequency);
- Spatial structure: One area;
- Sex: Both sexes combined.

31.3.1.2 Fleet definition

Six fleets defined: 1. UK bottom trawls, nets; 2. UK lines; 3. UK midwater pair trawls; 4. French fleets (combined); 5. Other (other countries and other UK fleets combined); 6. Recreational fisheries.

31.3.1.3 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 and 2016 with the time-series from 1985 to 2015 was iteratively reconstructed conditioned on the 2012 estimated value of 1501 t.

31.3.1.4 Abundance indices

Channel Groundfish Survey in 7.d in autumn (France), 1988 to 2014: total swept-area abundance index and associated length composition data. Number of stations with sea bass is used as input effective sample size. Input CV for survey = 0.30 all years. First three years of composition data are excluded.

Cefas Solent Autumn bass survey (7.d), years 1986 to 2009, 2011, 2013 to 2015, 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.

31.3.1.5 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 2015 (no samples for 1997, 2013–2014, 2016); French all fleets were input from 2000 to present.

31.3.1.6 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, 2013–2016); French all fleets combined were input from 2000 to present.

31.3.1.7 Model assumptions and parameters

Table 10.1.3.1 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.

31.3.1.8 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 15% of all released fish, was generated using the selectivity for commercial UK line fisheries 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 1501 t in 2012. The calculations for the final assessment run are given in Table 10.1.3.2.

31.3.1.9 Final update assessment: diagnostics

The likelihood components (log L * Lambda) for the update SS3 assessment are given below:

Likelihood components	Likelihood
TOTAL	553.097
Catch	1.51759e-12
Equilibrium catch	0.480357
Survey	-1.22319
Length compositions	207.776
Age compositions	316.154
Recruitment	29.877
Parameter soft bounds	0.0136829

A range of model outputs and diagnostics are given in Figures 10.1.3.4–10.1.3.17.

Good correspondence was found between the observed and fitted length and age compositions for each fleet (Figures 10.1.3.6–10.1.3.14), although the fit to the French length compositions in 2014 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 10.1.3.8 and 14).

The survey abundance indices are fit reasonably well (Figure 10.1.3.15 and 16). The UK Solent autumn survey is characterised by a large variability with outliers present in the model fit (Figure 10.1.3.15). 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 10.1.3.17) 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 10.1.3.17) although this perception is affected by the imposition of a steepness value of 0.999 for the fitted Beverton–Holt stock–recruit curve. IBPBass and IBPBass 2 found that likelihoods progressively worsened as steepness value was reduced.

31.3.2 Retrospective analyses

Retrospective analysis with a five-year peel was carried out. For the runs with data up to 2012, 2013 and 2014, it was necessary to re-estimate the recreational F vector to give recreational landings of 1501 t in 2012. For runs with final data year 2011 or earlier, the recreational F vector for the run ending 2012 was adopted. There is some evidence of a retrospective pattern (Figure 10.1.3.18) although the WGCSE 2017 update assessment has higher SSB and lower F than the 2016 EWG assessment (Figure 10.1.3.20).

The model is sensitive to the addition of new data and its associated weightings with the more recent data having more influence given the higher sampling levels.

31.3.3 Final update assessment: long-term trends

The time-series of estimates of numbers-at-age, combined recreational and commercial $F_{(5–11)}$, are given in Tables 10.1.3.2–10.1.3.3, and a summary of SSB, total stock biomass (TSB), recruitment and F are given in Table 10.1.3.4 and Figure 10.1.3.19. These series are based on the final SS3 update run with 2015 set as the final year. In order to obtain biomass estimates for 2016 and Fs for 2015 for the forecast the final year is set to 2016.

A sharp increase in F between 2010 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 sea bass 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 however remained high despite the sharp reduction in landings in 2014. The most recent F estimates are the least precise, and it is therefore possible that the F estimate for 2014 could be revised downwards in future assessments.

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 is well above the F_{MSY} proxy. Recruitment has been declining since the mid-2000s, and has been very poor since 2008, however the recruitment estimated for 2013 is above the geometric mean. The combination of declining recruitment and increasing F is causing a rapid decline in biomass. Uncertainties in the assessment are explored in a subsequent section.

31.3.4 Comparison with previous assessments

The addition of catch and survey data for 2015 causes only a small change in historical biomass and fishing mortality compared with the IBPBass 2 assessment (Figure 10.1.3.20).

31.3.5 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 sea bass 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 10.1.3.19). It is likely that in the 1970s or earlier, sea bass were primarily the target of recreational fishing. Even at the relatively small natural mortality value of 0.15, removals due to natural deaths are a relatively large component of total removals. Consumption of sea bass by predators has not been estimated.

31.3.6 Sensitivity of the final update assessment to data and assumptions

Sensitivity of the assessment to the use of different estimates of recreational fishery harvest in 2012 was explored in IBPBass and IBPBass 2. Decreasing the assumed recreational harvest from 1500 t down to zero in steps had no effect on the relative trends in SSB and recruitment, but scales the overall biomass and recruitment downwards due the reduction in F. The assumption of constant recreational fishing mortality over time is an important potential source of bias in the assessment. WGCSE (2014) showed some historical UK estimates of sea angling participation that varied without clear trend, but the number of anglers and other recreational fishers targeting bass is likely to alter over time in response to changes in abundance.

IBPBass and IBPBass 2 also examined sensitivity to the use of different natural mortality estimates. The effect of this is to scale the biomass and recruitment throughout the series without altering the relative trend.

IBPBass considered the potential underestimate of UK commercial fishery landings due at least in part to the ability of fishermen to dispose of small catches below 25 kg or 30 kg depending on region, for personal consumption without supplying sales slips. Given the very many small-scale fishing activities of under 10 m vessels catching sea bass close inshore, this can amount to substantial quantities. IBPBass used separate landings estimates for UK nets and lines obtained by an independent bass logbook scheme and port census carried out since the 1980s by Cefas (UK) to increase the input landings of UK nets and lines by a factor of three throughout the series (see stock annex). This factor is approximate, as the logbook scheme has some unquantified biases. Again as expected, this acts to scale recruitment and biomass upwards without affecting the trend, and F stays the same. The assessment trends would be affected if the proportion of catch not reported changes over time, however the Cefas logbooks estimates are not good enough to accurately detect recent trends. The logbook scheme is no longer in operation due to a decline in numbers of fishers participating in the scheme. However, there is an urgent need to develop methods for more accurate recording to total catches of sea bass for these fleets, particularly for monitoring the effectiveness of any additional control measures to be implemented.

31.4 Biological reference points

The F_{MSY} and B_{lim} reference points defined by IBPBass 2 2016 have not been altered.

The YPR curve is flat topped and F_{MAX} is not definable (Figure 10.1.4.1). The estimates of $F_{0.1}$ (0.11) and $F_{35\%SPR}$ (0.13) are similar. WGCSE 2014 proposed $F_{35\%SPR}$ as a suitable candidate for an F_{MSY} proxy for sea bass, particularly in view of the delayed maturity, slow growth and inherent longevity (to ~30 years). The historical combined F for commercial and recreational fishing has exceeded $F_{35\%SPR}$ in all years since 1985 (Figure 10.1.3.16).

WGCSE 2015 noted that fishing at $F_{35\%SPR}$ would lead to a long-term average SSB of almost 21 kt if recruitment varied around the long-term average, above any SSB observed historically. However, the SSB achieved will vary according to periods of above-average or below-average recruitment as have been observed historically.

It was not possible to conduct MCMC runs of the Stock Synthesis model through to the forecast period in order to examine probabilities of falling below candidate reference points for biomass. WGCSE 2014 proposed that a B_{lim} could be set as B_{loss}, the lowest observed SSB, which the current assessment has revised B_{loss} to 7507 t (Figure 10.1.3.16) but it is not recommended to change the B_{lim} after only one year of additional data particularly as the revised B_{loss} lies within the confidence limits for the 1992 SSB estimate in the IBPBass 2 assessment.

The absence of a B_{pa} or $MSYB_{trigger}$ is problematic for reporting on stock status. In the absence of a full stochastic evaluation of risks, WGCSE 2015 suggests that B_{pa} and $MSYB_{trigger}$ could be set using the approach proposed by ICES (1992) where it was suggested that $B_{lim} = B_{pa} * \exp(-1.645\ \sigma)$ where σ is the relative standard error of the biomass estimate. The SS3 estimates of relative standard error and associated B_{pa} values given the IBPBass 2 B_{lim} value of 8075 t are as follows:

Year	σ	B_{lim}	B_{pa}
2012	0.1532	8075	10 389
2013	0.1981	8075	11 186
2014	0.274	8075	12 673

As the population numbers and biomass surviving at the start of 2015 is the metric of interest in relation to forecasts and management decisions, IBPBass 2 suggests that 12 673 t could be adopted as a value for B_{ps}, retaining 8075 t as B_{lim}). The stock summary Figure 10.1.3.19 shows that the point estimate of SSB in 2015 is just below this value of B_{pa}, whilst B_{lim} lies around 0.5 of a standard error below the point estimate for 2015.

The following table summarises what the reference points would be under this method of computing B_{pa}. Ranges for reference points will be evaluated by ICES later in 2017:

	Type	Value	Technical basis
BPrecautionary approach	B_{lim}	8075 t	Lowest observed SSB (IBPBass 2 2016)
	B_{pa}	12 673 t	B_{lim} * exp(1.645 σ), σ = RSE of SSB(2015) estimate = 0.274
	F_{lim}	Undefined	
	F_{pa}	Undefined	
MSY approach	F_{MSY}	0.13	Based on F giving SSB per recruit 35% of value at zero F.
	$MSYB_{trigger}$	12 673 t	B_{pa}

F_{MAX} is not definable.

31.5 Short-term predictions

Inputs for a short-term forecast are given in Table 10.1.5.1, and their derivation is explained below.

31.5.1 Recruiting year-class strength

Recruitment estimates for sea bass are well below average from 2008 to 2012 (Table 10.1.3.4). 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 2013 and after. This value (7321 thousand) differs slightly from the 1985 to 2013 geometric mean (6469 thousand) which was adopted for subsequent year classes for the forecast. This is summarised in the text table below:

Year class	SS3 (age 0)	LTGM 1985-2013
2013	10 576 thousand	
2014		6469 thousand
2015		6469 thousand
2016		6469 thousand

WGCSE (2013 and 2014) reviewed some information on environmental influences on sea bass recruitment which supports the apparent recent reduction in recruitment from 2008–2012. Survival of 0-gp and 1-gp sea bass 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 2014 indicated that numbers of 1-gp bass (2013 year class) had returned to around the series average. Although the evidence is weak, it is not a critical assumption for short-term forecasts as these year classes have very little impact on the short-term forecast.

31.5.2 Numbers of fish in 2016

These were derived from the update Stock Synthesis run with final year set at 2016. The numbers for ages 0–2 in 2016 were adjusted using the ratio of LTGM to SS3 values for 2014–2015 age 0 as explained above.

31.5.3 F-at-age vectors

Status quo F-at-age for the commercial fishery was taken as the 2015 estimates scaled to the previous three years derived from the update Stock Synthesis run with final year set at 2016. This approach was taken to allow for the change in selectivity associated with the large reduction in French pelagic trawl catch (Figure 10.1.5.1a), assuming that this will continue into 2015 and 2016 due to the emergency closure of that fishery and possible continuation of the closure. The recreational F vector was the same as input to the SS3 model in combination with the assumed M of 0.15. The imposition of a three fish per day bag limit part way through 2015 is intended to reduce the F due to recreational fishing, and an increase in MLS to 42 cm is expected to improve selectivity. WGCSE has no way to determine how the recreational F will be altered by these measures until survey information becomes available in future on recreational catches, releases and catch composition in European countries taking the bulk of the recreational catch, which may allow an evaluation of how recreational F has changed since 2012.

31.5.4 Weights-at-age

Mean weight-at-age in the stock were taken from the Stock Synthesis output. The commercial fishery weights for 2015 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 A_{MAX} (30 years) was estimated as 84.12 cm.

31.5.5 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.

31.5.6 Detailed short-term forecast output at *status quo* F

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. Fishing at the same fishing mortality as in 2015 (i.e. with continued reduction in pelagic pair trawl catches) will result in a further decline in SSB from 7352 t in 2016 to 6219 t in 2017, and to 5845 t in 2018, below the B_{lim} of 8075 t. It is expected that the commercial fishery landings would decline from 2040 t in 2015 to 1633 t in 2016, then to 1475 t in 2017. The recreational fishery harvests would decline from 799 t in 2015 to 642 t in 2016 and to 560 t in 2017.

This forecast is highly uncertain, 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 sea bass in 2015, 2016 and 2017 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.

31.5.7 Management options

WGCSE provides management options in which F multipliers are applied equally to commercial and recreational F-at-age (Table 10.1.5.3). 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 0 to 2, including the multiplier giving the proposed F_{MSY} proxy of 0.13 for combined commercial and recreational fishing. With zero F in 2016, SSB is expected to increase from 6219 t in 2016 to 7583 t in 2017. At F_{MSY}, the combined commercial and recreational catch in 2016 is expected to be around 944 t. However, as SSB is predicted to be below MSY $B_{trigger}$ in 2017 F_{MSY} is adjusted accordingly and expected landings are thus reduced to 478 t. When compared with estimated landings for all fisheries of 2305 t in 2016, this represents an almost 80% reduction in combined commercial and recreational landings. The allocation between commercial and recreational fisheries depends on the balance of controls applied on recreational and commercial fishing in 2017.

31.6 Uncertainties and bias in assessment and forecast

31.6.1 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 not included in the assessment. The overall discard rate by weight is thought to be less than 5% due to the predominance of offshore fisheries from France targeting adult bass. 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.

31.6.2 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 sea bass 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 sea bass 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.

31.6.3 Recreational fishery harvests

IBPBass 2 2016 accommodated an estimate of recreational fishery landings in the assessment and forecasts based on landing from 2012. This is however, a crude approach based on surveys for only a year or two in France, UK, Netherlands and Belgium and leads to an assumption of constant recreational fishing mortality over time. This assumption is as unlikely to be correct as the assumption of a constant natural mortality (which is around 50% larger than the estimated recreational F). The estimate of recreational harvest in the Netherlands increased between 2010/2011 and 2012/2013.

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.

More work is needed on post-release (e.g. hooking) mortality rates given the high incidence of catch-and-release practices in sea angling for sea bass. Release rates are expected to increase due to bag limits and increases in MLS that are in place or planned. WGCSE must collaborate closely with the ICES Working Group on Recreational Fishery Surveys to identify priorities for future surveys and hooking mortality studies.

31.6.4 Surveys

The surveys included in the assessment since 2014 include the Channel Groundfish Survey which 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 will no longer use the scientific vessel "Gwen Drez" which will be replaced by the larger vessel "Thalassa". A calibration was done in 2014. WGCSE is concerned 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 is possible with the previous vessel) and how the continuity of the Index could be kept. This could degrade the bass index due to the inshore distribution of the bulk of the fish caught. Statistically robust calibration data will be required to allow continuity of the index for 7.d pending establishment of a series for the larger area. If there are changes to the gear, size selectivity for sea bass may be altered, requiring a new year-block for selectivity estimation. These issues should be carefully considered by Ifremer in designing the new survey if the time-series for sea bass is to be continued.

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 10.1.5.31) shows clearly that sea bass nurseries in the Channel have asynchronous patterns of abundance of young bass. In the UK, 37 sea bass 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 sea bass management plan.

31.6.5 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) appears promising and should be further developed for the next benchmark assessment. In parallel a study on effect of vessel selection is done (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 sea bass catches have been recorded, was presented to IBPNEW in 2012. There were divergent trends between fleets where sea bass 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.

31.6.6 Model formulation

Following from advice given by WGCSE in 2013, the Stock Synthesis model formulation was altered to include a more rational combination of fleets with more realistic selectivity patterns. It remains a complex model and further intersessional work would be beneficial to see if robustness can be further improved. A particular improvement may be conversion of the CGFS length compositions, to age compositions using age material collected by Ifremer. These data should be further investigated as part of a future benchmark or inter-benchmark assessment.

31.6.7 Stock structure and migrations

The assessment treats all sea bass 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 sea bass 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.

31.6.8 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 sea bass may be spawning at sizes smaller than recorded historically (see stock annex). This would alter the F_{MSY} based on $F_{35\%spr}$, 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.

31.6.9 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 2017 under the same measures are likely to be similar to those in 2016. In the absence of any data on changes in selectivity there would be no reason to deviate much from this assumption.

Tables 10.1.6.1 and 2 provide the management options from the forecast run. Given the assumed F and catches in 2018 is set to zero SSB in 2019 remains below B_{lim}, and therefore below $MSYB_{trigger}$.

31.7 Recommendations for completion of the 2017 benchmark assessment

31.7.1 Full benchmark of NE Atlantic sea bass stocks

WGCSE proposes a full benchmark for 2017, preferably in conjunction with the other stocks of sea bass particularly the Bay of Biscay stock. ICES, WGBIE 2015 encouraged documentation of the quality of the sea bass data for the Bay of Biscay, and studies to better understand the stock dynamics and movements between the current stock areas. In the longer term, Stock Synthesis could be configured to include spatially disaggregated data covering populations within Areas 4, 7 and 8, with estimates of exchange rates between the areas. New data on fish movements from electronic and conventional tagging, and modelling of egg/larva dispersal, will be available from the UK C-bass and French BarGip projects currently underway. New relative abundance indices for bass-47 based on commercial lpue data by rectangle and vessel trip are under development and will be available. The benchmark will allow a full evaluation and further development of the Stock Synthesis application and diagnostics as well as developing other simpler assessment approaches for comparison. The issues list for the proposed benchmark assessment is given in Table 10.1.7.2.

31.7.2 Management considerations

Sea bass 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 sea bass 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 sea bass. Many small-scale artisanal fisheries, especially line fishing and some forms of netting, have developed a high seasonal dependency on sea bass, 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 sea bass 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 sea bass 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.

A reduction in fishing mortality on sea bass 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 are under consideration. 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 sea bass 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 sea bass.

WGCSE notes that protection of juvenile fish through technical measures is good to improve the fishery selectivity and increase the number of sea bass 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 sea bass nursery areas where certain types of fishing on sea bass is prevented annually or seasonally. However, catching and discarding of sea bass 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 sea bass 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 sea bass fall under the landings obligation.

ICES also previously advised that "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 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 sea bass 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 sea bass 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 sea bass 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 (Anon., 2014) 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 sea bass, based on economic considerations, and work is urgently needed in this area. The importance of sea bass 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 sea bass 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 sea bass. This is a subject of a new scientific study on sea bass in the UK.

The current stock structure assumptions are pragmatic, and need further evaluation. The sea bass 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 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. Moreover, the Bay of Biscay is also currently considered as a separate stock although tagging program 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 sea bass in Area 7. The fisheries on sea bass 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 is above the F_{MSY} proxy 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 sea bass is urgently needed through appropriate measures.

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Table 10.1.1.1. Bass-47: Annual landings from 4.b,c and 7.d,e–h.

	Belgium	Denmark	Germany	France	UK	Netherlands	Channel Is.	Total	Total WG figures1
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	0	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	3458
2004	159	1	0	1883	617	191	159	3010	3731
2005	206	1	0	1937	512	327	220	3203	4430
2006	211	2	0	2033	574	308	162	3290	4377
2007	178	1	0	1975	713	376	142	3385	4064
2008	188	0	0	1420	791	380	123	2902	4107
2009	173	0	0	2732	697	395	91	4088	3889
2010	215	4	0	3294	736	399	120	4768	4563
2011	152	2	0	2566	793	395	90	3998	3858
2012	154	3	0	2399	892	376	55	3879	3987
2013	145	5	2	2786	803	370	37	4148	4136
2014	146	1	0	1309	1038	253	37	2784	2682
2015	40	0	0	1110	683	207	26	2066	2066
2016	23	0	0	547	551	151	23	1295	1295

Source: Official Landings Statistics 1950–2013 and 2006–2013 datasets and 2016 provisional data, ICES, Copenhagen. [1.] Includes figures supplied directly to WGCSE by France and Belgium.

Table. 10.1.2.1. Bass-47: 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	1052
1986	84	33	2	1180	19	963
1987	96	18	0	1840	25	901
1988	129	30	8	1028	44	883
1989	141	29	7	917	67	836
1990	128	18	22	849	47	735
1991	152	60	14	971	29	640
1992	105	23	8	1001	49	621
1993	146	62	1	979	68	766
1994	354	154	0	786	76	1090
1995	424	169	4	1057	181	1293
1996	308	128	87	2395	104	1289
1997	335	119	71	1984	111	1210
1998	241	121	85	1773	170	1151
1999	274	148	220	1843	185	1177
2000	236	53	52	1805	261	1259
2001	263	58	97	1883	199	1314
2002	361	75	110	1825	251	1415
2003	353	65	127	2471	443	1504
2004	380	72	131	2604	544	1581
2005	353	59	68	3161	789	1586
2006	359	119	11	3259	629	1559
2007	413	166	37	2771	677	1618
2008	514	163	17	2750	663	1723
2009	486	147	9	2649	598	1768
2010	452	183	42	3236	649	1713
2011	462	143	98	2526	629	1617
2012	564	185	49	2610	579	1501
2013	530	191	39	2871	506	1320
2014	751	236	1	1303	391	1132
2015	440	199	0	1110	317	957
2016*	305	210	2	547	231	1627

***Preliminary.**

[1].Preliminary.

Table 10.1.2.2. (a) Bass-47: Sampling of commercial fishery landings of otter and pelagic midwater trawls 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/midwater				
	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

Table 10.1.2.2. (b) Bass-47: Sampling of commercial fishery landings of lines and net gears for length and age by area in the UK (England and Wales). Nsamp = number of landings sampled; Nfish = number of fish.

	UK Lines					UK Nets				
	Age		Length		Landings (t)	Age		Length		Landings (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

Table 10.1.2.3. Bass-47: Sampling of commercial fishery landings by area in France, giving numbers of fishing trips sampled, number of fish measured, and the total landings.

Year	FR_lines			FR_nets			FR_bottom 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

Year	FR_pelagic trawl			FR_danish 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

Table 10.1.2.4. Bass-47: Numbers-at-length in French commercial all-gears fishery landings (input to assessment at lengths 14–94 cm).

Length	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
20	0	0	0	0	0	0	0	0	0	0	717	0	0	0	0	0	0
22	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
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	3455	0	0	0	0	0	292	0	0	1219	0	0	291	0
30	0	0	1015	13054	14	0	15689	0	0	473	0	0	0	146	0	346	71
32	0	0	0	58717	13057	9903	32459	181	8250	2239	9811	1976	1583	0	3076	2678	1481
34	9931	17962	12469	105655	78811	29872	179130	4715	28986	10714	28290	13885	6518	1504	3620	5102	1440
36	34932	19809	38249	125326	127801	97890	285704	39335	229758	124925	169311	57121	85760	29667	33532	44175	2814
38	85866	68920	46427	180475	124051	128022	217657	102714	263071	211881	177571	87842	172510	88507	68262	75546	4340
40	126730	76594	62503	119495	227214	231750	178250	146272	266408	225545	182105	128838	140273	149070	74871	93273	7417
42	102836	98008	82461	145456	282390	266905	196868	145122	237160	193030	283064	187586	147895	146130	82684	115713	24816
44	80478	109595	91064	104545	243107	344681	289998	164011	270810	222613	251956	201447	162333	123170	51365	122460	20422
46	93344	106857	86723	130023	188494	270532	285451	130859	228996	238849	230227	199487	180752	140677	61292	95208	22427
48	80934	77694	62163	115806	126685	239265	263272	100043	142650	155222	188149	194697	158490	127136	39844	59668	20653
50	55399	57055	55905	91915	72581	169478	200874	99210	112385	159658	186310	145447	130759	116842	38109	51436	15619
52	52948	51658	46180	93878	82331	115269	119836	75929	74336	114530	109212	124239	107214	99156	29929	37860	10415
54	42094	36737	35998	48742	50633	62106	99509	74405	66260	84649	120550	92526	90638	103818	39911	21406	16034
56	26460	35839	26001	60839	60284	67741	99674	55147	48853	96257	71590	72471	78934	89197	32298	20681	9753
58	27357	22762	19019	31614	31334	61132	54522	46087	39689	51578	62211	46869	54869	59004	30016	13591	12328
60	23581	25834	14210	33688	19126	43591	45908	28056	29840	36547	31544	31690	35387	65851	21467	11946	7678

Length	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
62	14295	18773	11129	30691	23996	35774	23763	23057	28335	57472	19076	19998	33085	64579	16797	11776	7506
64	18044	13532	16771	18823	14799	25788	20607	18091	14420	24016	62005	17624	17714	53482	16261	9356	4348
66	10773	11068	11011	13230	10650	12456	14969	8715	12694	21415	26388	14720	15170	37744	8387	6653	2634
68	9903	9120	5447	7960	8569	13360	13976	8793	9039	27466	9340	7906	9374	23884	5579	2485	4465
70	5709	11771	4795	5374	4880	8908	9653	4835	6821	20198	8541	6114	8114	32512	8995	1163	1353
72	5721	5733	4559	5617	2974	8053	4521	2707	4714	12083	29128	2082	4147	14996	3027	660	956
74	2345	5345	1825	3275	2675	9811	3424	1962	1623	7551	1884	1163	2313	9001	642	628	219
76	2595	2782	1260	1356	2567	5020	2883	1010	1257	979	2114	1096	1540	2640	773	431	0
78	2102	1691	357	297	548	2378	731	399	534	1765	182	476	1134	2073	0	9	127
80	888	583	155	783	425	1365	201	158	261	264	5525	148	282	176	198	16	0
82	1021	296	109	112	149	107	261	37	8	1004	6097	104	451	1566	0	278	0
84	548	204	0	148	295	0	30	59	0	0	863	0	29	0	0	0	0
86	123	0	0	0	0	0	0	0	0	0	0	0	27	1115	0	0	301
88	0	61	0	0	149	0	0	0	0	0	1207	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10.1.2.6b. Bass-47: Numbers-at-age in French commercial fishery landings, 2000–2016, all gears combined.

Age class	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2	0	0	0	2611	3	0	3138	0	1208	315	717	0	0		0	47	24
3	0	2651	8114	10800	4	24195	74600	5307	79917	23355	1962	0	406	36	603	1394	565
4	9440	55640	73892	364427	80483	77794	131099	73224	175402	119979	39409	6087	14357	491	6846	20917	3419
5	222655	47734	125531	241694	627951	253455	564668	135809	545960	282754	221063	172404	65157	34169	11735	116939	23364
6	273687	298773	90294	318445	438799	735235	361515	460583	401231	473020	515711	252236	262593	61973	123435	139446	25335
7	139562	211740	236147	96562	297961	352182	841651	124606	456312	238022	411737	312186	346334	331051	149938	125305	22790
8	79413	90962	86108	254050	65297	443765	146484	139879	143871	408951	437222	303804	308183	213427	133129	191220	29076
9	47258	44742	31151	114829	131612	39104	253945	79978	147881	100487	200328	314164	264012	237503	143241	88543	38383
10	43924	21074	23025	57883	77533	161572	13655	69214	40719	200417	172430	125800	214803	332529	39242	67528	26822
11	49293	39908	17823	26223	25416	69617	132370	33191	57341	73570	109342	89188	83939	174544	39476	24658	18455
12	20207	36007	14760	19879	14848	26314	84910	65868	17882	37114	75421	34465	50701	119858	12679	17551	4964
13	10767	17787	15912	14232	14254	17996	22068	68599	35092	32657	46461	28352	24784	37411	7347	5046	3114
14	4925	4394	9752	18088	13528	19238	6648	11131	12669	55506	21880	12942	8470	18454	3067	5387	1866
15	4927	6838	3743	6600	7628	17974	6999	9034	5518	33537	4806	5585	3191	12343	198	431	381
16+	10901	8034	1553	4028	5270	22718	16069	5486	6091	23529	16480	337	1583	9852	0	428	429

Table 10.1.2.5. Bass-47: Numbers-at-age in UK(England and Wales) mixed bottom otter trawl, nets.

Age class	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	65	0	0	0	33417	0	1533	0	16	2	0	191	59	0	720
3	21068	16250	548	1963	5411	3341	7064	17177	1183	1399	6085	11683	2944	4780	337
4	42318	29242	31315	22613	1761	2585	45358	61023	93082	35028	44006	52635	11603	53363	105572
5	9562	22103	62176	67860	15831	3955	2852	38824	77756	489199	103508	44119	79613	60382	183644
6	15593	4386	15885	46777	79957	17331	1460	1477	29427	60011	432323	79955	56652	92118	57430
7	2131	10016	2676	15201	28734	34915	7368	1064	1941	25472	25312	230860	47517	35851	42279
8	5027	1062	2915	2272	9373	23427	22990	2475	916	2072	12244	12802	196226	21588	14900
9	14846	3955	1088	3330	3180	5939	20272	5943	2727	467	1182	8600	10958	69289	11193
10	3630	15932	1249	989	3109	2543	8875	6395	8745	4036	1114	343	6091	5619	38594
11	3275	2793	7308	906	1937	1832	678	1793	7264	11256	1877	825	1189	1951	2781
12	2233	2274	3409	7367	3111	1040	3846	581	2867	9958	9124	818	993	234	2767
13	390	3842	2100	2919	9953	1343	4005	628	1373	2801	6911	4403	537	292	287
14	963	1794	928	2027	1614	6098	847	308	1438	1290	3782	3261	4884	1178	1047
15	420	2333	996	1325	1373	434	11490	640	1118	920	3539	1834	2777	2005	412
16+	1828	4901	3984	3566	3770	3532	6561	4612	6135	6507	7412	4130	3805	2065	4144

Age class	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	668	368	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	9949	11556	12224	5778	4685	19532	20541	977	9537	2974	1133	853	1711	0	7868	50	0
4	2878	99793	46215	82420	39967	137879	157456	40217	115884	81472	84129	33839	15830	46202	38480	3716	1591
5	170896	30457	254649	78332	227996	94261	180880	200850	324302	189812	200773	136163	185326	67527	144449	20172	7863
6	85149	123033	19465	179281	85254	139121	67783	125021	181154	206263	172945	117249	248476	217993	87567	45807	13991
7	14468	33031	85004	10886	112443	39325	78587	58933	69178	90693	118126	90388	84826	150073	171438	36830	31088
8	14330	9415	23779	49065	5131	37161	23139	51895	32104	31018	44773	71006	62555	51505	117204	63272	24925
9	6468	11980	10071	17334	18592	3701	36865	21376	29898	23763	16968	44808	49578	44984	56803	35025	40386
10	5885	7495	13201	6262	7666	13053	3852	25317	14118	14085	9373	15385	25467	33060	40965	17302	24807
11	13020	9896	4145	4178	2764	3234	6609	16694	11088	14002	8953	17293	17152	28016	44939	12685	10618
12	1147	11296	5607	3056	2183	1358	3535	7648	2223	8357	3352	9042	7086	17931	28854	10431	8218
13	442	1244	13853	2279	1973	1671	1164	6740	1825	3045	2605	4874	6536	6638	10843	2917	4788
14	30	1069	966	5641	669	207	568	95	4419	2377	2632	4390	4704	5573	3953	7265	1960
15	143	96	294	1123	3272	839	1203	598	515	0	616	1197	1134	4386	3859	7308	2098
16+	1203	1179	749	922	364	1449	2167	913	1815	249	1940	2350	1751	4071	3012	966	1528

Table 10.1.2.5. Bass-47: Numbers-at-age in UK(England and Wales) Lines.

Age class	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	22	0	0	0	16	0	0	0	59	0	479	0
3	577	108	33	0	305	131	1195	526	71	486	210	454	3676	255	421
4	8939	1052	1751	538	82	8420	5473	11652	4059	6943	8804	3102	8366	25158	294
5	3343	3719	13389	8171	185	471	5267	11776	119784	21979	12487	15613	10920	37306	19380
6	933	2132	5067	36046	1284	177	294	7569	18540	97509	15338	11415	22630	13589	12402
7	2354	581	2398	1842	3456	792	269	590	9393	7380	57127	8287	10485	13697	2696
8	358	477	551	371	2407	4927	518	289	943	5313	4566	50819	6452	5288	3285
9	758	432	1014	104	897	4024	1193	931	173	480	4979	2853	28231	5001	1476
10	5428	523	209	208	357	1842	1633	3941	1754	699	127	1635	2949	20522	1248
11	960	1578	456	58	369	89	563	3344	5414	831	510	557	1091	1669	4697
12	871	845	1863	215	193	1229	130	1367	5570	5684	364	354	138	2038	330
13	953	211	895	1040	242	1685	195	663	1205	3696	2521	243	196	247	258
14	573	167	715	115	1261	367	169	703	639	1936	1573	2195	793	777	16
15	645	179	523	87	81	4831	143	643	274	840	1300	1065	1381	315	88
16+	1307	1187	977	334	828	2887	1411	3789	2790	4733	2346	1570	1254	3314	559

Age class	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	54	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	471	729	80	279	621	44	22	199	315	814	8	91	0	980	6	0
4	7385	2609	7166	1697	2669	16121	6611	5010	8415	7029	5209	1695	1187	4985	1834	742
5	1392	14173	7917	13884	5059	35990	31578	27319	19843	45515	11538	18362	6979	26081	5941	7020
6	17864	2686	25014	8601	14699	13714	28396	42071	33661	54766	24667	28593	35135	20743	23369	11858
7	7702	17358	2167	17310	5529	22306	14511	21561	25695	39716	19293	23507	32251	39548	22221	20142
8	2027	7757	10164	2398	6985	5794	17834	12265	12017	15835	16668	22946	18057	28357	31442	15479
9	3239	2621	3262	6365	589	12717	8499	12566	9320	5147	13032	17909	14762	15323	19014	25838
10	1685	5179	1473	3626	5697	1644	10951	5458	5021	2395	4947	10199	10333	12440	10344	13362
11	1761	1463	982	1181	1845	3135	5163	4960	5371	2910	6066	7725	10543	12413	8210	7406
12	3774	1766	796	1189	236	1258	3121	1372	4748	706	2695	2994	6106	8018	7036	5904
13	440	3687	681	1172	1307	305	5119	1032	811	522	1941	2672	3730	4889	2504	4674
14	301	322	1704	406	33	358	85	3431	1075	359	2187	2158	2886	1976	3136	2548
15	27	101	186	2243	189	1016	344	198	0	81	522	596	1957	1673	744	3894
16+	420	180	166	143	606	734	485	992	0	277	657	820	1938	1322	798	2567

Table 10.1.2.6a. Bass-47: Numbers-at-age in UK(England and Wales) midwater pair trawl fleet (no samples for 1997, 2013, 2014, 2015, 2016).

Age class	1996	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	15	0	3	0	7	0	0	0	45	0	9	0	0
4	289	245	2983	60	179	37	2689	1254	114	227	385	445	90	36	255	391
5	796	5979	18409	2476	899	2380	10619	12502	2103	567	2517	1540	635	1741	4397	4461
6	3892	11845	15106	7587	19777	1578	39257	14372	15321	608	7038	3279	2175	5546	10231	10776
7	71666	8553	27147	3270	20290	24087	7971	48109	14397	4076	5387	1787	2596	8261	13640	10016
8	5583	8135	13818	4497	7042	9693	40551	3199	17408	1423	6833	1412	843	6678	15909	8757
9	1648	25138	18060	1459	5268	6297	10293	20694	1907	3085	2795	1557	784	4755	13642	5789
10	21	2517	43097	2830	3124	5978	3162	8010	5182	254	1900	755	168	403	4424	2741
11	334	345	4389	7077	2845	450	3254	353	0	176	631	960	298	3786	4233	1134
12	154	93	1686	634	9666	5664	618	1797	1831	111	807	30	173	152	2773	290
13	622	53	324	174	857	9215	169	1141	99	0	12	183	11	294	1688	433
14	485	119	387	39	636	0	4043	91	0	0	37	490	169	313	1003	143
15	199	893	308	96	123	0	77	968	40	0	19	0	0	551	264	127
16+	559	569	2689	420	261	530	281	18	599	53	121	40	0	50	423	226

Table 10.1.2.7. 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
4	16	34	56	37	41	85	58	49	46	42	54	30	53	45	12
7.afg	8	15	23	8	11	43	50	28	22	22	22	12	14	16	2
7.d	1	2	4	3	1	2	1	6	7	9	4	5	7	3	13
7.eh	9	24	37	31	49	90	87	38	29	32	29	45	73	68	29
total	34	75	120	79	102	220	196	121	104	105	109	92	147	132	56
(b) Fixed/driftnets															
Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
4	0	0	2	1	11	31	15	20	15	11	13	18	10	7	0
7.afg	3	7	5	3	7	8	9	10	7	16	22	16	25	12	3
7.d	0	0	1	0	0	17	6	4	1	7	10	42	25	17	10
7.eh	1	5	9	2	3	16	10	14	19	17	25	24	24	15	0
total	4	12	17	6	21	72	40	48	42	51	70	100	84	51	13
(c) Lines															
Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
4	0	1	0	0	0	1	2	0	0	0	0	0	1	1	0
7.afg	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
7.d	0	0	0	0	0	0	0	0	0	0	0	0	1	0	33
7.eh	0	0	1	0	0	0	0	0	0	0	1	0	8	5	4
total	0	1	1	0	0	1	2	0	0	0	2	1	10	6	37

(d) Midwater trawls															
Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
4	1	0	0	1	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
7.d	0	0	0	1	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
total	1	1	1	3	2	1	0	0	0	0	0	2		0	0

(e) Other gears															
Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
4	8	5	10	1	2	1	1	7	6	8	4	10		0	6
7.afg	4	11	8	4	9	1	2	3	3	1	4	8		0	5
7.d	0	1	5	2	3	1	1	2	4	1	2	3	1	2	0
7.eh	10	17	27	16	24	32	18	13	17	27	22	21	14	15	1
total	22	34	50	23	38	35	22	25	30	37	32	42	15	17	12

Table 10.1.2.8a. Estimated annual numbers and weight of sea bass 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		
	discards	retained	rate (%)	No. trips sampled	discards	retained	rate %	No. trips sampled	discards	retained	rate %	No. trips sampled	discards	retained	rate (%)	No. trips sampled	discards	retained	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
Mean	27	148	14	113	10	298	4	42	1	14	5		8	210	4	37	38	474	8

Table 10.1.2.9. Number of fishing trips sampled for retained and discarded weight of sea bass on French vessels using different gear types: 2009–2016.

pelagic trawl FR VIIIab provisional						
year	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

bottom trawlFR VIIIab provisional						
year	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	271.43102	31.86%	NA	512	90

netsFR VIIIab provisional						
year	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	64.04074	23.25%	NA	258	209

linesFR VIIIab provisional						
year	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		156.15459		NA		

OtherFR VIIIab provisional						
year	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

FR_ALL						
year	***discards (t)***	***Landings (t)***	***discard rates***	***cv indicator***	***Nb trip sampled***	***lb fish sample***
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

Table 10.1.2.11. Estimates of annual recreational fishery catches of sea bass in France, Netherlands and UK (England) from surveys in recent years. RSE = relative standard error. An additional 60 t of removals was estimated by Belgium in 2013. Estimates are by weight except for Netherlands where weight and numbers are given.

(a) France		Kept	RSE	Released	RSE	Total	RSE	Release rate
2009-2011	NE Atlantic	2,343t		830t		3,173t	26%	26%
	ICES IV & VII	940t		332t		1,272t	>26%	26%
2011-2012	NE Atlantic	3,146t		776t		3,922t		20%

RSE was 26% for area VII and VIII combined; area VII represented 40% of total.

~ 80% by weight in 2009/11 was recreational sea angling

(b) Netherlands			Kept	RSE	Released	RSE	Total	RSE	Release rate
March 2010-Feb 2011	Southern North Sea	By number	234000	38%	131000	27%	365000	26%	64%
		By weight	138t	37%					
March 2012-Feb 2013	Southern North Sea	By number	335000	26%	332000	21%	667000	17%	50%
		By weight	229t	26%					

93% by weight in 2010/11 was recreational sea angling. 2012/13 figure is angling only

(c) England		Kept	RSE	Released	RSE	Total	RSE	Release rate
2012	ICES IVbc, VIIa,d,e,f	230– 440t		150-250t		380 – 690t	26-38%	36-39%

Survey covered only recreational sea angling

Range of values is for different effort estimation procedures

Table 10.1.2.12. Updated time-series of Cefas Solent autumn survey of juvenile sea bass, 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

Table 10.1.2.13. Sea bass 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)).2015 not updated (Intercalibration need to be reviewed during benchmark 2017).

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

Numbers-at-age in Solent Survey1986–2015: updated time-series of Cefas Solent autumn survey of juvenile sea bass (2015 revised).

AGE CLASS	1986	1987	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2005	2006	2007	2008	2009	2011	2013	2014	2015	2016
2	0.27	0.05	6.68	2.81	3.08	0.95	6.65	3.33	4.83	5.52	33.62	1.22	19.37	6.07	34.42	7.42	8.37	13.12	9.51	3.42	18.52	13.25	2.25	1.34	1.17	6.95	3.75
3	4.26	0.28	0.37	1.15	0.21	18.59	3.59	1.84	4.69	0.43	4.52	5.5	0.67	11.35	3.92	3.87	4.6	7.98	9.21	1.78	6.66	6.25	1.39	0.08	1.02	0.44	2.17
4	1.31	2.27	0	0.02	0.03	0.16	4.39	0.29	0.72	0.11	0.06	0.61	0.87	0.03	1.57	0.4	0.59	0.84	1.02	0.3	0.34	0.33	0.42	0.1	0.11	0.05	0.11
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

10.1.3.1. Key model assumptions and parameters from the WGCSE 2014 update assessment.

Characteristic	Settings
Starting year	1985
Ending year	2016
Equilibrium commercial catch for starting year	0.82* landings in 1985 by fleet.
Equilibrium recreational catch for starting year	Constant F estimated using F from 2012
Number of areas	1
Number of seasons	1
Number of fishing fleets	6
Number of surveys	two surveys: CGFS; Solent autumn survey.
Individual growth	von Bertalanffy, parameters fixed, combined sex
Number of active parameters	86
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, length-based
Fleet 5: Other fleets/gears selectivity	Asymptotic: mirrors French fleet
Fleet 6: Rrecreational fishery	Asymptotic: mirrors UK Lines fleet
Survey characteristics	
Solent autumn survey timing (yr)	0.83
CGFS survey timing (yr)	0.70
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
Fixed biological characteristics	
Natural mortality	0.15
Beverton–Holt steepness	0.999
Recruitment variability (σR)	0.9
Weight–length coefficient	0.00001296

Characteristic	Settings
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[1]
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	1969
Last year for recruit deviations	2014 (last year class with survey indices)
Last year no bias adjustment	1971
First year full bias adjustment	1882.5
Last year full bias adjustment	2011
First year recent year no bias adjustment	2013
Maximum bias adjustment	0.92

[1] as recommended by R. Methot after scrutinizing earlier SS3 runs during IBPNew 2012, and used by IBPNew and WGCSE.

Table 10.1.3.2. Final sea bass update assessment: stock numbers-at-age (thousands of fish). Shaded figures for 2013–2015 year classes are values over-written at age 0 by the long-term geometric mean, decremented by natural mortality to give numbers-at-ages 1 and 2.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1985	336	480	8 229	3 602	2 472	728	695	605	887	2 192	612	385	288	228	182	140	108
1986	667	290	413	7 082	3 092	2 068	573	521	446	651	1 609	449	283	212	167	133	103
1987	7 302	574	249	356	6 077	2 574	1 598	417	371	316	461	1 139	318	200	150	119	94
1988	5 730	6 285	494	214	305	5 012	1 922	1 099	278	245	209	304	752	210	132	99	78
1989	35 611	4 931	5 409	425	184	254	3 858	1 394	781	197	173	147	215	532	148	93	70
1990	3 070	30 651	4 244	4 655	365	153	195	2 797	992	553	139	123	104	153	377	105	66
1991	5 921	2 643	26 378	3 652	3 993	302	117	140	1 977	699	390	98	87	74	107	265	74
1992	8 789	5 096	2 274	22 698	3 131	3 285	226	81	95	1 340	474	264	67	59	50	73	180
1993	4 069	7 565	4 386	1 957	19 465	2 586	2 472	158	55	65	906	320	179	45	40	34	49
1994	12 726	3 503	6 510	3 774	1 679	16 127	1 968	1 759	110	38	45	626	221	123	31	27	23
1995	19 541	10 954	3 014	5 602	3 238	1 394	12 443	1 442	1 270	79	28	32	451	159	89	22	20
1996	1 002	16 819	9 426	2 594	4 805	2 680	1 065	8 992	1 026	902	56	20	23	321	113	63	16
1997	23 064	862	14 474	8 111	2 223	3 943	1 977	723	5 925	672	591	37	13	15	210	74	41
1998	8 025	19 851	742	12 455	6 952	1 825	2 919	1 355	483	3 938	447	393	24	9	10	140	49
1999	22 301	6 907	17 084	638	10 678	5 725	1 362	2 018	911	323	2 631	298	262	16	6	7	93
2000	10 866	19 195	5 944	14 701	547	8 783	4 250	930	1 335	598	212	1 725	196	172	11	4	4
2001	12 580	9 353	16 520	5 115	12 607	452	6 616	2 975	634	904	405	143	1 167	132	116	7	3
2002	19 908	10 828	8 049	14 216	4 387	10 414	341	4 635	2 029	430	612	274	97	790	90	79	5
2003	21 024	17 135	9 319	6 926	12 190	3 621	7 845	239	3 174	1 383	293	417	187	66	539	61	54

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2004	14 253	18 096	14 746	8 019	5 937	10 019	2 681	5 342	158	2 081	906	192	273	122	43	353	40
2005	10 794	12 267	15 573	12 689	6 873	4 876	7 398	1 818	3 510	103	1 356	590	125	178	80	28	230
2006	12 097	9 290	10 557	13 401	10 873	5 618	3 537	4 870	1 154	2 210	65	853	371	79	112	50	18
2007	10 083	10 412	7 995	9 085	11 481	8 878	4 065	2 322	3 085	725	1 387	41	535	233	49	70	31
2008	7 091	8 679	8 960	6 880	7 785	9 403	6 500	2 723	1 507	1 988	467	893	26	345	150	32	45
2009	6 169	6 104	7 469	7 710	5 896	6 378	6 907	4 391	1 788	984	1 298	305	583	17	225	98	21
2010	735	5 309	5 253	6 427	6 609	4 841	4 722	4 727	2 926	1 185	652	860	202	387	11	149	65
2011	2 003	633	4 569	4 520	5 506	5 398	3 516	3 129	3 032	1 865	755	415	548	129	246	7	95
2012	977	1 724	545	3 932	3 873	4 509	3 961	2 373	2 051	1 977	1 215	492	271	357	84	161	5
2013	6 424	841	1 484	469	3 367	3 151	3 250	2 612	1 521	1 310	1 263	777	315	173	228	54	103
2014	5 033	5 529	724	1 276	401	2 721	2 222	2 070	1 611	933	804	775	477	193	106	140	33
2015	6 161	4 332	4 757	623	1 092	324	1 936	1 468	1 351	1 055	614	529	511	314	127	70	92
2016	6 161	5 303	3 727	4 093	533	887	234	1 305	973	897	702	409	352	340	209	85	47
2017	6 161	5 303	4 563	3 207	3 500	429	624	151	821	612	565	443	258	222	215	132	53

Table 10.1.3.3. Final sea bass update assessment: 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	0.000	0.000	0.003	0.028	0.090	0.138	0.155	0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159
1986	0.000	0.000	0.000	0.003	0.033	0.108	0.167	0.189	0.194	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195
1987	0.000	0.000	0.000	0.004	0.043	0.142	0.224	0.256	0.264	0.265	0.266	0.266	0.266	0.266	0.266	0.266	0.266
1988	0.000	0.000	0.000	0.003	0.035	0.112	0.171	0.192	0.196	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197
1989	0.000	0.000	0.000	0.003	0.036	0.114	0.172	0.191	0.194	0.195	0.194	0.194	0.194	0.194	0.194	0.194	0.194
1990	0.000	0.000	0.000	0.003	0.038	0.118	0.178	0.197	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1991	0.000	0.000	0.000	0.004	0.045	0.142	0.213	0.235	0.239	0.239	0.239	0.238	0.238	0.238	0.238	0.238	0.238
1992	0.000	0.000	0.000	0.004	0.041	0.134	0.208	0.235	0.241	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242
1993	0.000	0.000	0.000	0.003	0.038	0.123	0.190	0.214	0.219	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220
1994	0.000	0.000	0.000	0.003	0.036	0.109	0.161	0.176	0.178	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177
1995	0.000	0.000	0.000	0.004	0.039	0.120	0.175	0.190	0.192	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191
1996	0.000	0.000	0.000	0.004	0.048	0.154	0.237	0.267	0.273	0.274	0.274	0.274	0.274	0.274	0.274	0.274	0.274
1997	0.000	0.000	0.000	0.004	0.048	0.151	0.228	0.254	0.258	0.259	0.258	0.258	0.258	0.258	0.258	0.258	0.258
1998	0.000	0.000	0.000	0.004	0.044	0.142	0.219	0.247	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253
1999	0.000	0.000	0.000	0.004	0.045	0.148	0.231	0.263	0.271	0.272	0.272	0.272	0.272	0.272	0.272	0.272	0.272
2000	0.000	0.000	0.000	0.004	0.041	0.133	0.207	0.234	0.240	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241
2001	0.000	0.000	0.000	0.004	0.041	0.133	0.206	0.233	0.239	0.239	0.240	0.240	0.240	0.240	0.240	0.240	0.240
2002	0.000	0.000	0.000	0.004	0.042	0.133	0.204	0.229	0.233	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234
2003	0.000	0.000	0.000	0.004	0.046	0.151	0.234	0.265	0.272	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2004	0.000	0.000	0.000	0.004	0.047	0.153	0.238	0.270	0.277	0.278	0.278	0.278	0.278	0.278	0.278	0.278	0.278
2005	0.000	0.000	0.000	0.005	0.052	0.171	0.268	0.305	0.313	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314
2006	0.000	0.000	0.000	0.005	0.053	0.173	0.271	0.306	0.314	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
2007	0.000	0.000	0.000	0.004	0.050	0.162	0.251	0.283	0.289	0.290	0.290	0.290	0.290	0.290	0.290	0.290	0.290
2008	0.000	0.000	0.000	0.004	0.049	0.158	0.242	0.271	0.276	0.277	0.277	0.277	0.277	0.277	0.277	0.277	0.277
2009	0.000	0.000	0.000	0.004	0.047	0.151	0.229	0.256	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261
2010	0.000	0.000	0.000	0.005	0.052	0.170	0.261	0.294	0.300	0.301	0.301	0.301	0.301	0.301	0.301	0.301	0.301
2011	0.000	0.000	0.000	0.004	0.050	0.159	0.243	0.272	0.278	0.278	0.278	0.278	0.278	0.278	0.278	0.278	0.278
2012	0.000	0.000	0.000	0.005	0.056	0.177	0.266	0.294	0.299	0.298	0.298	0.298	0.298	0.298	0.298	0.298	0.298
2013	0.000	0.000	0.000	0.005	0.063	0.200	0.301	0.334	0.339	0.338	0.338	0.338	0.338	0.338	0.338	0.338	0.338
2014	0.000	0.000	0.001	0.006	0.065	0.190	0.264	0.277	0.273	0.269	0.268	0.267	0.267	0.267	0.267	0.267	0.267
2015	0.000	0.000	0.000	0.005	0.058	0.172	0.245	0.261	0.260	0.258	0.257	0.257	0.256	0.256	0.256	0.256	0.256
2016	0.000	0.000	0.000	0.006	0.068	0.203	0.290	0.313	0.313	0.312	0.311	0.311	0.311	0.311	0.311	0.311	0.311

Table 10.1.3.4. Final sea bass update assessment: stock summary table.

	Recruitment (age 0)			SSB (t)			TSB (t)		Landings	
Year	Estimate ('000)	lower	upper	Estimate	lower	upper	Estimate	F(5-11)	Commercial	Recreational
1985	336	17	656	12 923	10 586	15 260	16 226	0.146	994	1 052
1986	667	65	1 270	11 718	9 577	13 859	15 576	0.177	1 318	963
1987	7 302	5 302	9 302	10 654	8 712	12 597	14 603	0.240	1 979	901
1988	5 730	3 142	8 317	9 629	7 886	11 373	12 974	0.180	1 239	883
1989	35 611	30 927	40 296	9 477	7 851	11 102	12 196	0.179	1 161	836
1990	3 070	729	5 412	8 895	7 301	10 488	12 011	0.185	1 064	735
1991	5 921	3 415	8 427	7 939	6 353	9 526	13 121	0.221	1 226	640
1992	8 789	6 085	11 493	6 973	5 415	8 531	14 655	0.220	1 186	621
1993	4 069	1 978	6 161	7 163	5 646	8 679	16 689	0.201	1 256	766
1994	12 726	9 180	16 273	9 019	7 563	10 476	18 714	0.165	1 370	1 090
1995	19 541	15 787	23 295	12 034	10 558	13 510	20 183	0.179	1 835	1 293
1996	1 002	57	1 947	13 924	12 332	15 515	20 952	0.251	3 022	1 289
1997	23 064	18 790	27 338	13 559	11 889	15 228	20 638	0.238	2 620	1 210
1998	8 025	3 759	12 291	12 923	11 206	14 639	20 750	0.232	2 390	1 151
1999	22 301	17 004	27 598	12 619	10 873	14 364	21 621	0.247	2 670	1 177
2000	10 866	6 771	14 962	12 771	11 007	14 536	22 502	0.219	2 407	1 259
2001	12 580	7 251	17 910	13 629	11 790	15 467	24 009	0.218	2 500	1 314
2002	19 908	13 249	26 567	14 392	12 453	16 332	25 530	0.214	2 622	1 415

	Recruitment (age 0)			SSB (t)			TSB (t)		Landings	
Year	**Estimate ('000)**	**lower**	**upper**	**Estimate**	**lower**	**upper**	**Estimate**	**F(5-11)**	**Commercial**	**Recreational**
2003	21 024	14 911	27 137	15 518	13 486	17 550	27 077	0.249	3 459	1 504
2004	14 253	9 173	19 332	16 228	14 126	18 330	28 068	0.253	3 731	1 581
2005	10 794	6 670	14 918	16 850	14 698	19 002	28 976	0.286	4 430	1 586
2006	12 097	7 882	16 311	16 660	14 440	18 880	29 190	0.287	4 377	1 559
2007	10 083	5 785	14 381	16 609	14 328	18 890	29 330	0.265	4 064	1 618
2008	7 091	3 200	10 982	17 406	15 054	19 757	29 473	0.254	4 107	1 723
2009	6 169	3 315	9 022	18 317	15 812	20 822	28 989	0.240	3 889	1 768
2010	735	- 7	1 478	18 770	16 022	21 519	28 004	0.276	4 562	1 713
2011	2 003	907	3 099	17 875	14 822	20 928	25 685	0.255	3 858	1 617
2012	977	291	1 664	17 007	13 575	20 439	23 317	0.276	3 987	1 501
2013	6 424	2 003	10 845	15 528	11 640	19 415	20 195	0.313	4 137	1 320
2014	5 033	787	9 279	13 285	8 908	17 662	16 490	0.258	2 682	1 132
2015	6 161			11 633	6 802	16 463	14 064	0.244	2 066	957
2016	6 161			9 880	4 721	15 038	12 323	0.293	1 295	1 627
2017	6 161			7 820	2 474	13 166	10 810			

Table 10.1.5.1. 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	2017	weight in stock	Proportion mature (female)	H.Cons mean F (2014)	H.Cons mean weights	Recreational F	Recreational removals mean weight	M
0	6161	0.003	0.000	0.000	0.000	0.000	0.000	0.15
1	5303	0.023	0.000	0.000	0.051	0.000	0.112	0.15
2	4563	0.096	0.000	0.000	0.268	0.000	0.267	0.15
3	3207	0.209	0.000	0.003	0.458	0.003	0.456	0.15
4	3500	0.368	0.087	0.036	0.626	0.033	0.621	0.15
5	429	0.570	0.290	0.103	0.789	0.100	0.783	0.15
6	624	0.807	0.576	0.140	0.987	0.150	0.982	0.15
7	151	1.072	0.798	0.143	1.231	0.169	1.229	0.15
8	821	1.357	0.915	0.139	1.512	0.174	1.511	0.15
9	612	1.657	0.965	0.137	1.813	0.175	1.812	0.15
10	565	1.965	0.985	0.136	2.121	0.175	2.121	0.15
11	443	2.276	0.993	0.135	2.431	0.176	2.431	0.15
12	258	2.585	0.997	0.135	2.738	0.176	2.738	0.15
13	222	2.889	0.998	0.135	3.038	0.176	3.038	0.15
14	215	3.185	0.999	0.135	3.329	0.176	3.329	0.15
15	132	3.471	0.999	0.135	3.610	0.176	3.610	0.15
16+	162	4.193	1.000	0.135	4.297	0.176	3.878	0.15

Age 0,1,2 over-written as follows:

2017 yc 2017 age 0 replaced by 1985–2014 LTGM (6161);

2016 yc 2017 age 1 from SS3 survivor estimate at-age 1, 2017 * LTGM / SS3 estimate of age 0 in 2016;

2015 yc 2017 age 2 from SS3 survivor estimate at-age 2, 2017 * LTGM / SS3 estimate of age 0 in 2015.

Table 10.1.5.2. Bass-47: Detailed short-term *status quo* forecast.

Year:	Intermediate year	2017		
	H.cons F mult:	1	F(5-11):	0.133
	Recreational F mult	1	F(5-11):	0.160

Age	F(5-11): Commercial	F(5-11): Recreational	Catch Nos: Commercial	Yield: Commercial	Catch Nos: Recreational	Yield: Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.0	0.0	0.0	0.0	6161	17	0	0
1	0.000	0.000	1.4	0.1	0.0	0.0	5303	124	0	0
2	0.000	0.000	1.4	0.4	0.4	0.1	4563	436	0	0
3	0.003	0.003	9.0	4.1	9.8	4.5	3207	669	0	0
4	0.036	0.033	112.5	70.5	102.6	63.7	3500	1289	306	113
5	0.103	0.100	37.3	29.4	36.0	28.2	429	244	124	71
6	0.140	0.150	70.6	69.7	75.9	74.5	624	503	359	290
7	0.143	0.169	17.3	21.3	20.5	25.1	151	162	120	129
8	0.139	0.174	91.6	138.5	114.4	172.9	821	1115	751	1020
9	0.137	0.175	67.0	121.5	85.9	155.6	612	1014	591	979
10	0.136	0.175	61.4	130.3	79.4	168.4	565	1110	557	1094
11	0.135	0.176	48.0	116.7	62.2	151.3	443	1007	440	1001
12	0.135	0.176	27.9	76.5	36.2	99.2	258	666	257	664
13	0.135	0.176	24.1	73.2	31.3	95.0	222	642	222	641
14	0.135	0.176	23.2	77.4	30.2	100.5	215	683	214	683
15	0.135	0.176	14.3	51.6	18.6	67.0	132	458	132	458
16+	0.135	0.176	17.5	75.4	22.8	88.3	162	679	162	679
Total			625	1056	726	1294	27365	10820	4235	7820

Year:	Intermediate year + 1	2018		
	H.cons F mult:	1	F(5-11):	0.133
	Recreational F mult	1	F(5-11):	0.160

Age	F(5-11): Commercial	F(5-11): Recreational	Catch Nos: Commercial	Yield: Commercial	Catch Nos: Recreational	Yield: Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.0	0.0	0.0	0.0	0	0	0	0
1	0.000	0.000	1.4	0.1	0.0	0.0	5303	124	0	0
2	0.000	0.000	1.4	0.4	0.4	0.1	4563	436	0	0
3	0.003	0.003	11.0	5.1	12.0	5.5	3925	819	0	0
4	0.036	0.033	88.2	55.2	80.4	49.9	2743	1010	240	88
5	0.103	0.100	244.6	193.0	236.3	185.0	2813	1603	817	465
6	0.140	0.150	34.1	33.7	36.7	36.0	301	243	173	140
7	0.143	0.169	46.1	56.8	54.4	66.9	401	430	320	343
8	0.139	0.174	10.6	16.0	13.2	20.0	95	129	87	118
9	0.137	0.175	56.6	102.5	72.5	131.4	517	856	499	826
10	0.136	0.175	41.9	88.9	54.2	115.0	386	758	380	747
11	0.135	0.176	38.6	93.9	50.1	121.8	356	811	354	805
12	0.135	0.176	30.3	82.8	39.3	107.5	279	722	278	719
13	0.135	0.176	17.6	53.5	22.9	69.5	163	470	162	469
14	0.135	0.176	15.2	50.6	19.7	65.7	140	447	140	446
15	0.135	0.176	14.7	52.9	19.0	68.7	135	470	135	470
16+	0.135	0.176	20.1	86.3	26.1	101.1	185	778	185	777
Total			672	972	737	1144	22306	10105	3771	6414

Year:	Intermediate year + 2	2019				
	H.cons F mult:	1	F(5-11):	0.133	combined	0.293
	Recreational F mult	1	F(5-11):	0.160		

Age	F(5-11): Commercial	F(5-11): Recreational	Catch Nos: Commercial	Yield: Commercial	Catch Nos: Recreational	Yield: Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.0	0.0	0.0	0.0	0	0	0	0
1	0.000	0.000	0.0	0.0	0.0	0.0	0	0	0	0
2	0.000	0.000	1.4	0.4	0.4	0.1	4563	436	0	0
3	0.003	0.003	11.0	5.1	12.0	5.5	3925	819	0	0
4	0.036	0.033	107.9	67.6	98.4	61.1	3357	1236	294	108
5	0.103	0.100	191.6	151.3	185.1	145.0	2205	1256	640	365
6	0.140	0.150	223.9	220.9	240.6	236.3	1977	1595	1138	918
7	0.143	0.169	22.3	27.4	26.3	32.3	194	208	155	166
8	0.139	0.174	28.2	42.6	35.2	53.2	253	343	231	314
9	0.137	0.175	6.5	11.9	8.4	15.2	60	99	58	96
10	0.136	0.175	35.4	75.1	45.8	97.0	326	640	321	630
11	0.135	0.176	26.4	64.1	34.2	83.1	243	553	242	550
12	0.135	0.176	24.3	66.7	31.6	86.5	225	581	224	579
13	0.135	0.176	19.1	58.0	24.8	75.2	176	509	176	508
14	0.135	0.176	11.1	37.0	14.4	48.0	103	327	102	326
15	0.135	0.176	9.6	34.6	12.4	44.9	88	307	88	307
16+	0.135	0.176	21.9	94.2	28.5	110.4	202	849	202	848
Total			741	957	798	1094	17896	9757	3870	5714

Table 10.1.5.3. 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.

2017		Commercial fishery			Recreational fishery			Total fishery	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Catch	Total Fbar	Total landings
10820	7820	1	0.133	1056	1	0.160	1294	0.293	2351

2018		Commercial fishery			Recreational fishery			Total fishery		**2019**	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Catch	Total Fbar	Total landings	Biomass	SSB
10105	6414	0	0.000	0	0	0.000	0	0.000	0	11819	7521
		0.276	0.037	295	0.276	0.044	348	0.081	642	11191	6968
		0.2	0.027	216	0.2	0.032	255	0.059	470	11359	7116
		0.4	0.053	420	0.4	0.064	495	0.117	915	10925	6734
		0.435	0.058	455	0.435	0.070	536	0.128	991	10851	6669
		0.6	0.080	614	0.6	0.096	723	0.176	1337	10514	6374
		0.8	0.107	797	0.8	0.128	939	0.235	1737	10125	6034
		1	0.133	972	1	0.160	1144	0.293	2116	9757	5714
		1.2	0.160	1137	1.2	0.192	1338	0.352	2475	9410	5412
		1.4	0.187	1294	1.4	0.224	1521	0.411	2815	9081	5128
		1.6	0.213	1443	1.6	0.256	1695	0.469	3138	8769	4859
		1.8	0.240	1584	1.8	0.288	1860	0.528	3444	8475	4606
		2	0.267	1719	2	0.320	2016	0.587	3735	8196	4367

Table 10.1.5.31. 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%														

Table 10.1.7.1. Proposed Inter-benchmark assessment amendment to IBPBass assessment procedure by correspondence, February 2016.

Stock	Sea bass in 4.bc and 7.a,d–h

Issue	Problem/Aim	Work needed / possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	External expertise needed at benchmark type of expertise / proposed names
Validation of use of French fishery age compositions in the assessment	WGCSE 2015 carried out a Stock Synthesis run using French age compositions from 2000–2014 rather than length compositions. This removed an unusual sharp increase in F in recent years, and the fit to the data, though noisy, showed no residual patterns which are apparent in the residuals to the fit of the length data. A change to the agreed methods from IBPBass needs to be agreed to allow use of the age data in the 2016 update assessment.	Evaluation of the French landings-at-age data. Review outcome of 2015 age calibration study between UK and France. Develop input data including empirical weights-at-age for French and UK fleets. More detailed comparison of model performance using age rather than length data. Establish the most appropriate selection pattern and input priors/soft bounds. Explore methods of deriving age compositions for the Channel groundfish surveys from the length data and evaluate performance in the assessment.	All data are available.	Stock assessment expert. For continuity, external review by one of the IBPBass benchmark meeting would be valuable. E.g. Chris Legault, NOAA.

Suggested ToRs: (a) Review quality and performance of age composition data for French fishery landings in the Stock Synthesis model formulated by IBPBass; (b) Develop input data including empirical weights-at-age; (c) Develop age compositions for the Channel groundfish survey and test in SS3 model.

Table 10.1.7.2. Proposed full benchmark to be done together with WGBIE bass stocks in ICES 8, 9, 10. Benchmark assessment around March 2017, data compilation / evaluation late 2016 or January 2017.

Stock	Sea bass in 4.bc and 7.a,d-h

Issue	Problem/Aim	Work needed/ possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	External expertise needed at benchmark type of expertise / proposed names
Fishery landings data	The assessment is heavily driven by fishery landings data and age/length compositions. Historical landings are subject to several biases, and this will bias the assessment trends.	Review the French landings prior to 2000. Develop more accurate series of UK small scale national fisheries landings. Develop plausible alternative scenarios for landings series for testing in SS3 including pre-1985 data..	Historical national landings data (available). Cefas sea bass logbook data (available) plus other regional observations (to be sourced)	
Fishery composition data and selectivity	SS3 model relies on fitting selectivity by fleet, and this needs sufficiently accurate data on age/length composition and to properly account for any changes in selectivity whilst minimising numbers of parameters to estimate. Current implementation of age and length selectivity could be a source of bias in estimating stock trends.	Review quality and amount of sampling for length and age composition by fleet; examine evidence for shapes of selectivity curves and for changes in selectivity over time; identify minimum sufficient disaggregation of fleets; evaluate parameter correlations and minimise numbers of parameters to estimate; review availability of French sampling data prior to 2000; evaluate sampling data by métier from other countries (Netherlands; Belgium). Identify leverage of individual fleet data on final results.	Sample and fleet data held nationally. Available	

Issue	Problem/Aim	Work needed/ possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	External expertise needed at benchmark type of expertise / proposed names
Recreational catches and selectivity	Recreational fishery catches are considered to be around quarter of total removals but current assessment uses only one annual estimate to provide a crude value for recreational fishing mortality to apply to all years. This assumption is almost certainly incorrect and it will be necessary to account for changes in recreational catches based on successive survey estimates as they become available. Selectivity of recreational catches is based on limited data and is likely to change over time.	Update results of new surveys conducted since WGCSE 2015, if available. Develop and test alternative methods for accounting for recreational fishery catches in the assessment. Liaise with ICES WGRFS to develop inputs and methods.	Recreational survey estimates available nationally and from submissions to ICES WGRFS.	
Relative abundance indices	The assessment currently includes the French Channel Groundfish Survey and the UK Solent pre-recruit survey. These are restricted to 7.d and not the full stock area, and are mainly focused on young bass. They show similar trends to analysis of commercial landings-at-age/length data without the surveys included, and appear to have limited influence on the model fit. The design of the Channel GFS is expected to change in 2015 and this may render it unsuitable for inclusion in the assessment. Relative abundance indices are needed that cover the full age range and stock area.	Evaluate the calibration and the area covered by the new vessel for the redesigned CGFS survey. Collate and evaluate information on changes in abundance of young bass in nursery areas in the UK and France, and evaluate the need for a more coordinated pre-recruit survey in terms of potential benefits vs costs. A study modelling French commercial fishery lpue is available and should be further developed and tested in the assessment. Evaluate UK data for inclusion in the lpue analysis.	Ifremer data for the CGFS calibration (available); UK and French pre-recruit dataseries for as many nursery areas as possible (mostly available). UK and French landings and effort data by rectangle and trip, with vessel/gear data (available). Data from the Netherlands and Belgium should be requested also.	

Issue	Problem/Aim	Work needed/ possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	External expertise needed at benchmark type of expertise / proposed names
Discards	Discards estimates are imprecise due to small numbers of sampled trips with sea bass catches, are available only for a recent period, and are not included in assessment though considered low. However absence of data in assessment could cause some bias, and prevents correct estimation of selectivity to allow evaluation of technical conservation measures such as minimum conservation reference size	Compile historical estimates; evaluate precision and bias; test some scenarios for including data in the assessment	Discards data are held nationally and are available	
Post release mortality	Inclusion of discards estimates in the assessment needs an evaluation of potential survival rates of released fish. Post release mortality in recreational fisheries needs to be accounted for. Increases in MLS and recreational bag limits will lead to more releases.	Provide updated review of studies on post release mortality in liaison with WGRFS. Test sensitivity of assessment and advice to assumptions regarding post release mortality.	Literature review.	
Stock structure and migration	Stock structure remains uncertain. Trends in recruitment could vary between areas whilst current surveys are spatially limited. Movements between 4/7 and 8, particularly if changing over time, would bias the assessment trends.	Review findings of the UK C-Bass and French BarGip projects which have carried out tagging studies and hydrographic modelling of egg and larval dispersal. SS3 could potentially be configured to include spatially disaggregated data covering population within area 4, 7 and 8, as an exploratory exercise and to see if this could improve the advice for both areas.	Results of UK and French studies should be available; assessment input data for Bass-47 and Bass-8ab needed and will be available.	

Issue	Problem/Aim	Work needed/ possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	External expertise needed at benchmark type of expertise / proposed names
Biological Parameters	Natural mortality is considered as constant over time at a relatively low value of 0.15, set for all ages. Maturity ogives are based on long-term historical UK sampling data and do not account for any trends that may have occurred. Inappropriate treatment of growth and M could bias the assessment and reference points, whilst not accounting for changes in maturity would bias SSB trends and reference points.	Review evidence for spatio-temporal variation in growth and maturity, and age-dependent M. Examine sensitivity of assessment and advice to this. Develop parameter inputs for future assessments.	Historical and recent sampling data for growth and maturity. Available nationally. Review methods for identifying appropriate M values and plausible ranges.	
Assessment method	Stock Synthesis 3 is complex, highly parameterised and requires considerable expertise to fully understand how to set up the model and interpret the diagnostics. If age data become available for French fishery and survey data, alternative models could be explored more easily. If SS3 is retained, more comprehensive evaluation of model performance is needed, e.g. jitter analysis, and this needs to be developed.	Comparison of performance of alternative assessment models of differing structure and complexity including very simple approaches. Further development of SS3 and presentation / interpretation of diagnostics, forecasts and MCMC evaluation of confidence intervals.	Will be done with available data.	Expertise in Stock Synthesis and other statistical and simpler assessment methods. Suggest: Neil Klaer (CSIRO, Hobart), Chris Legault (NOAA),
Biological Reference Points	Current reference point is F_{MSY} proxy = F35%spr. This is driven by the choice of M. The assessment forces stock-recruit steepness as 1.0 as there is little information in the stock-recruit data to define steepness.	Review of choice of M as discussed above. Further evaluation of S/R steepness including S/R data from alternative assessment models.	Agreed stock assessment inputs.	As for assessment methods

Proposed Terms of Reference for Data Compilation and Evaluation meeting:

a) Evaluate quality of historical fishery landings data and develop series by country, area and gear including plausible alternative scenarios where biases are known or suspected. Develop scenarios for pre-1985 landings.

b) Compile and evaluate historical estimates of discards by fleet and provide indicators of precision and bias.

c) Compile and evaluate length and age composition by fleet for landings and discards, and weights-at-length or -age, and provide indicators of precision and bias.

d) Compile historical estimates of recreational catches and length–age compositions by country and area, for retained and released components, and provide indicators of precision and bias.

e) Provide updated review of studies on post release mortality in commercial and recreational fisheries, and propose candidate ranges of values for sea bass.

f) Review findings of the UK C-Bass and French BarGip projects and identify if any changes to stock areas are needed based on connectivity of populations in neighbouring areas shown by tagging and hydrographic modelling of egg/larva dispersal.

g) Compile and evaluate available series of fishery-independent and fishery-dependent indices of abundance, and propose series for use in assessment together with quality indicators that could guide relative weightings in the assessment.

h) Update previous review of methods to establish the value of natural mortality, and propose any changes needed including age-dependent values if appropriate.

i) Review evidence for spatio-temporal variation in growth and maturity and develop parameter inputs for the benchmark assessment.

ToRs for benchmark assessment meeting to be decided.

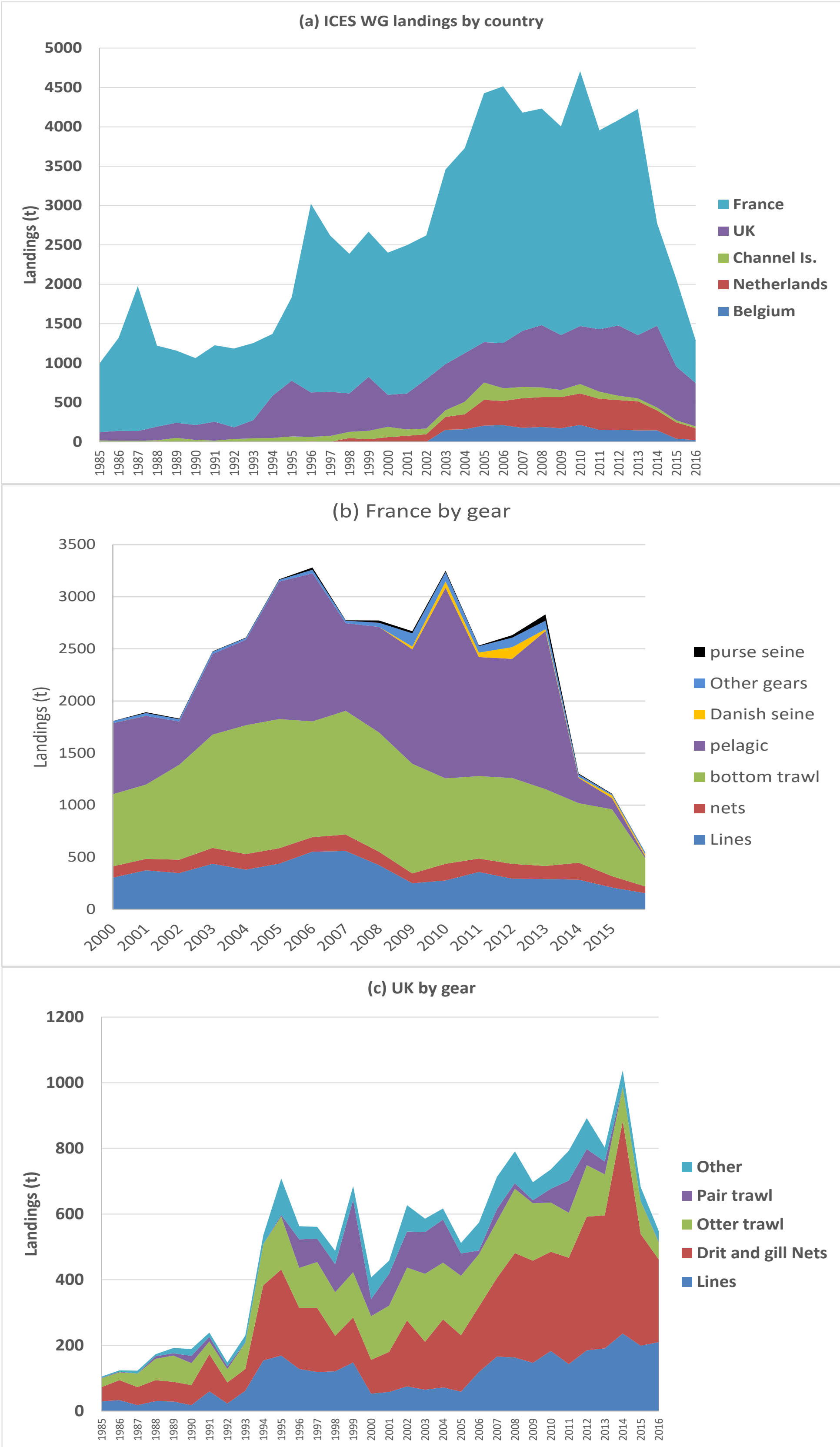


Figure 10.1.1.1. Bass-47: Trends in ICES Working Group landings by (a) country and (b, c) by gear group in France and the UK (Source: Official Catch Statistics 1985–2015 and data supplied by national laboratories).

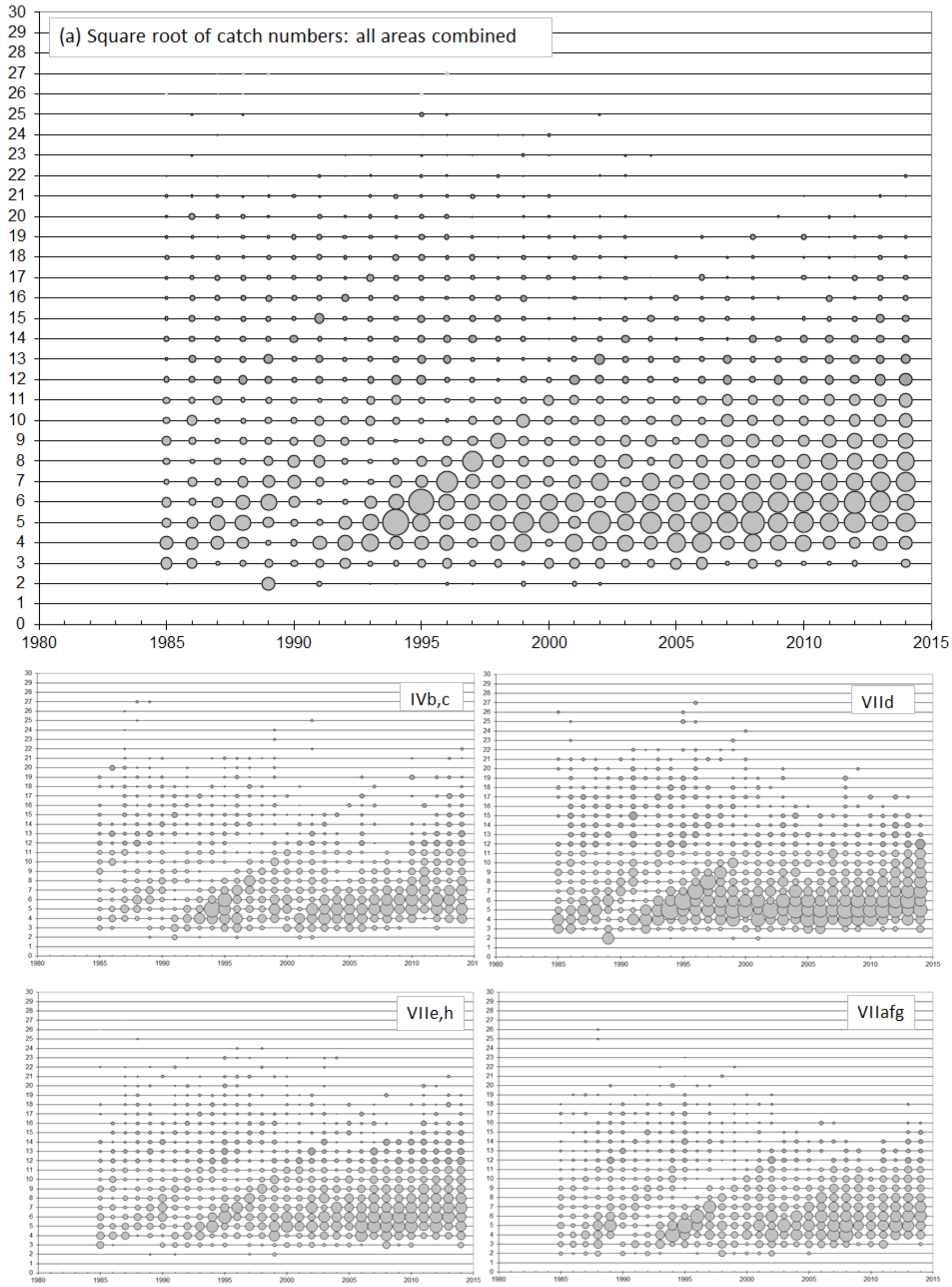


Figure 10.1.2.1. (a) Annual landings-at-age in the combined UK(E&W) trawls, nets and lines fleet. Bubble diameter is proportional to the square root of the catch number. Data for the four separate regions with independent length compositions and age–length keys are shown below. All plots are standardised so will not show actual differences in catches between regions.

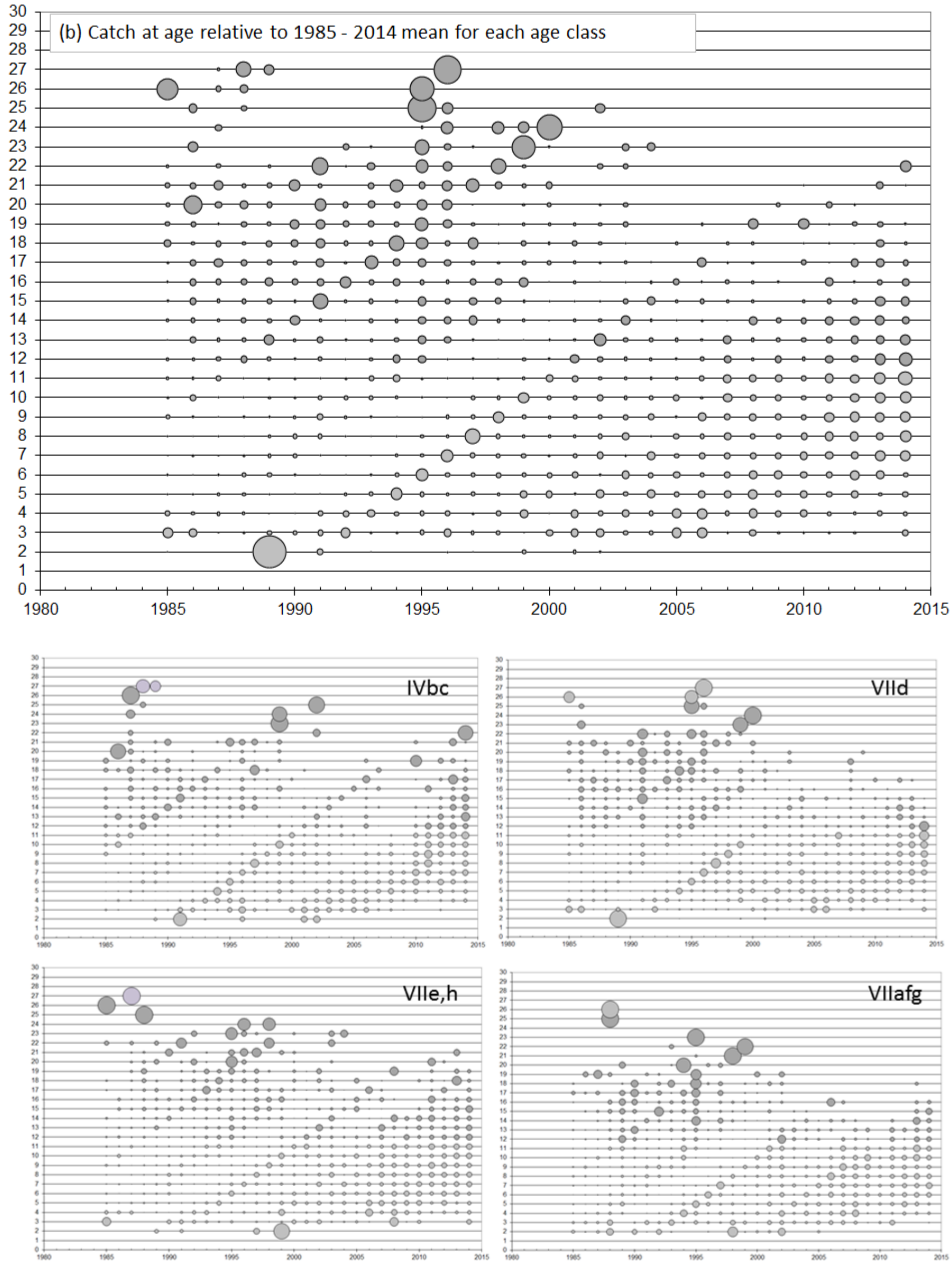


Figure 10.1.2.1. (b) Annual landings-at-age in the combined UK(E&W) trawls, nets and lines fleet, standardised at each age class by dividing by the 1985–2014 mean catch numbers for the age class. Data for the four separate regions with independent length compositions and age–length keys are shown below.

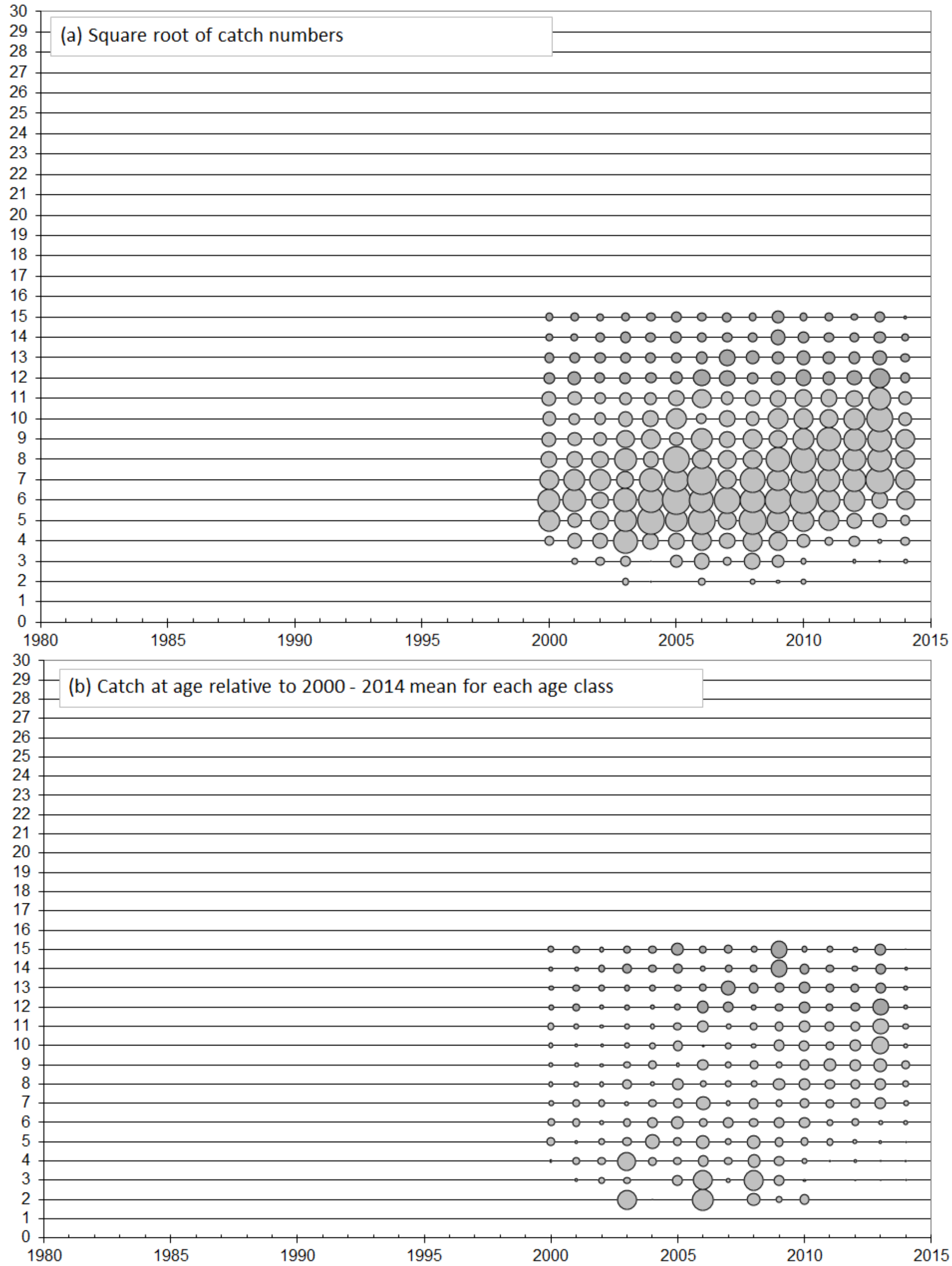


Figure 10.1.2.1. (c) Annual landings-at-age in the combined French fleets, as (top) square root of catch numbers, and (bottom) standardised at each age class by dividing by the 2000–2014 mean catch numbers for the age class.

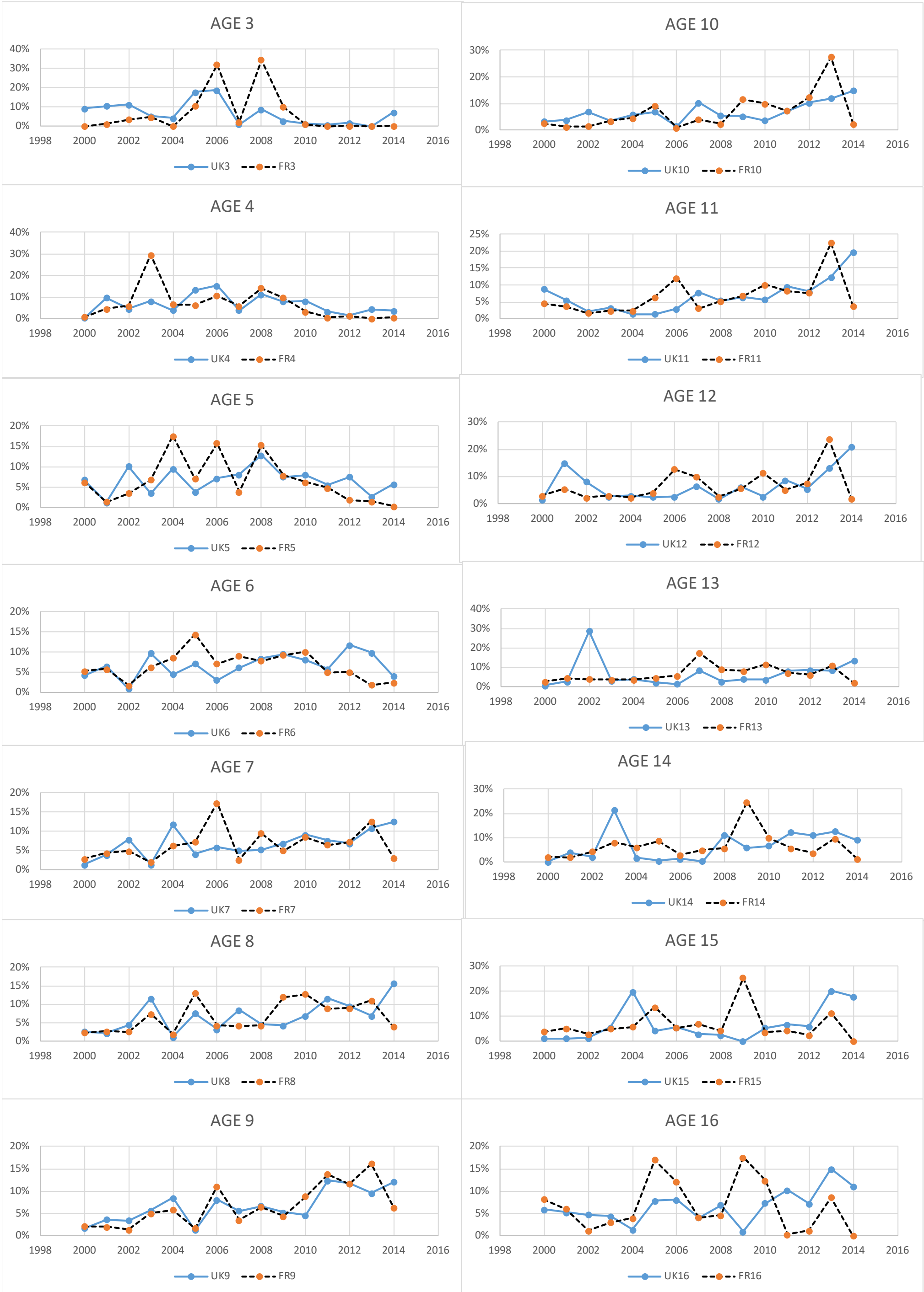


Figure 10.1.2.1. (d) Comparison of UK and French landings numbers-at-age from 2000 to 2014. Data for each age class are shown as percentage of 2000–2014 mean.

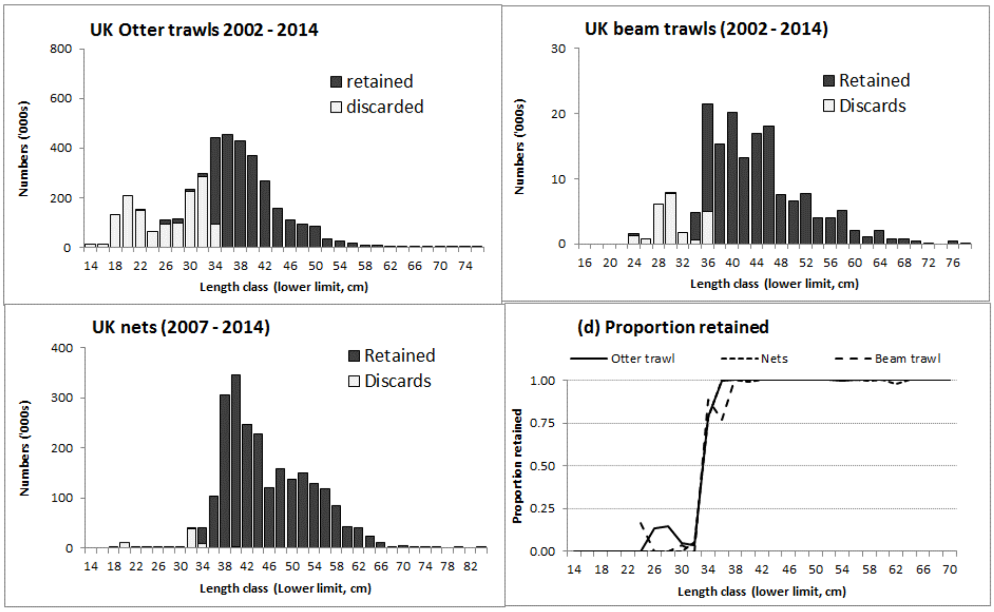


Figure 10.1.2.2. Numbers of bass retained and discarded, summed over the period 2002–2014 for otter trawls and beam trawls, and 2007–2014 for fixed and driftnets. The retention ogives for the three gears are shown at right.

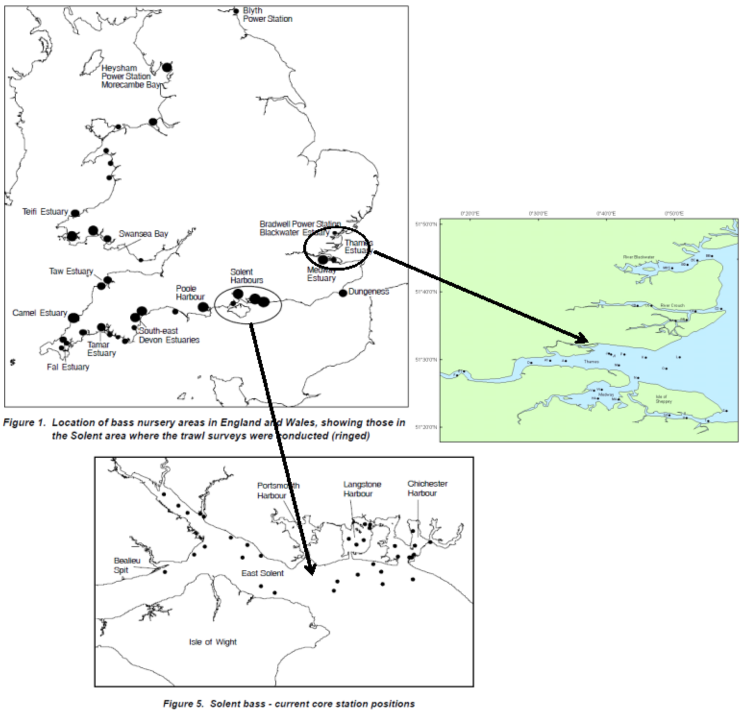


Figure 10.1.2.3. Location of Cefas Solent and Thames juvenile sea bass surveys.

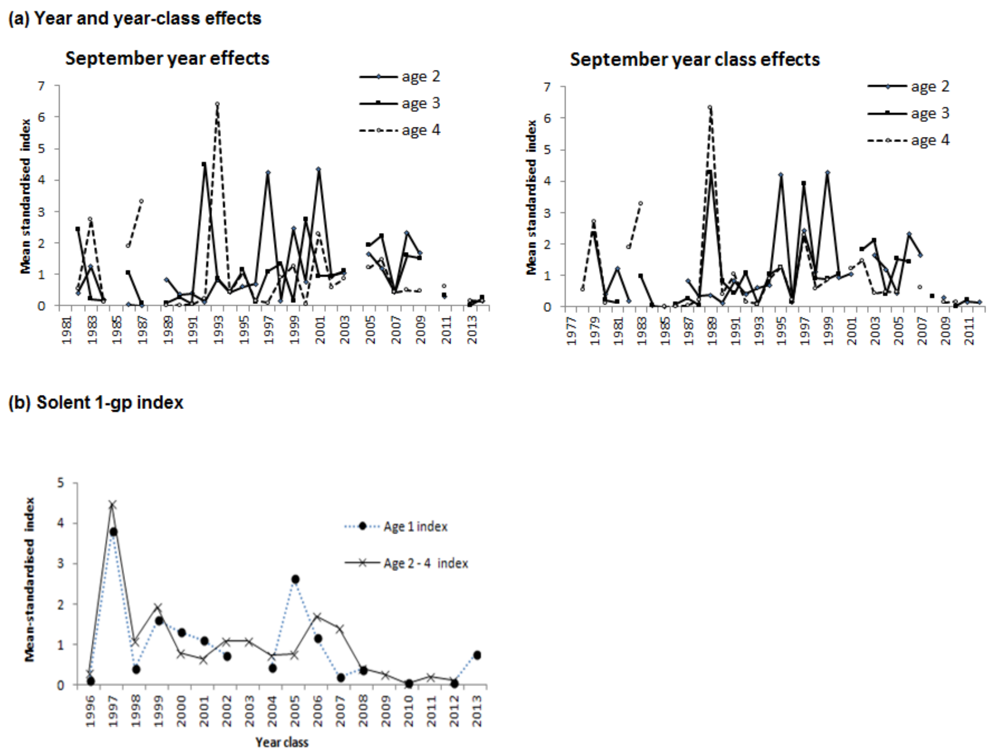


Figure 10.1.2.4. Cefas Solent survey in autumn: (a) year and year-class effects in indices; (b) 1-gp index from 1996 onwards compared with a composite year-class index derived from the age 2–4 indices.

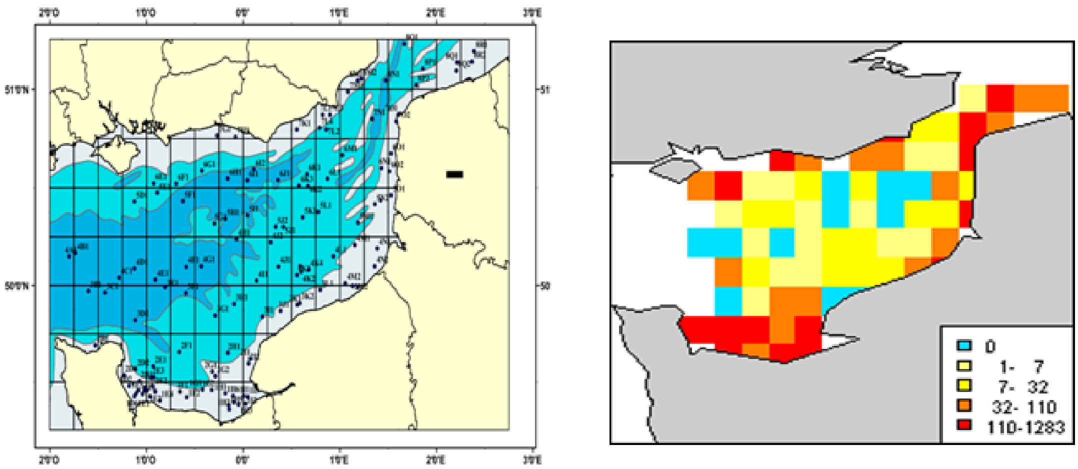


Figure 10.1.2.5. Left: stations fished during the Channel Groundfish Survey carried out annually by France. Right: distribution of total catches of sea bass over the survey series.

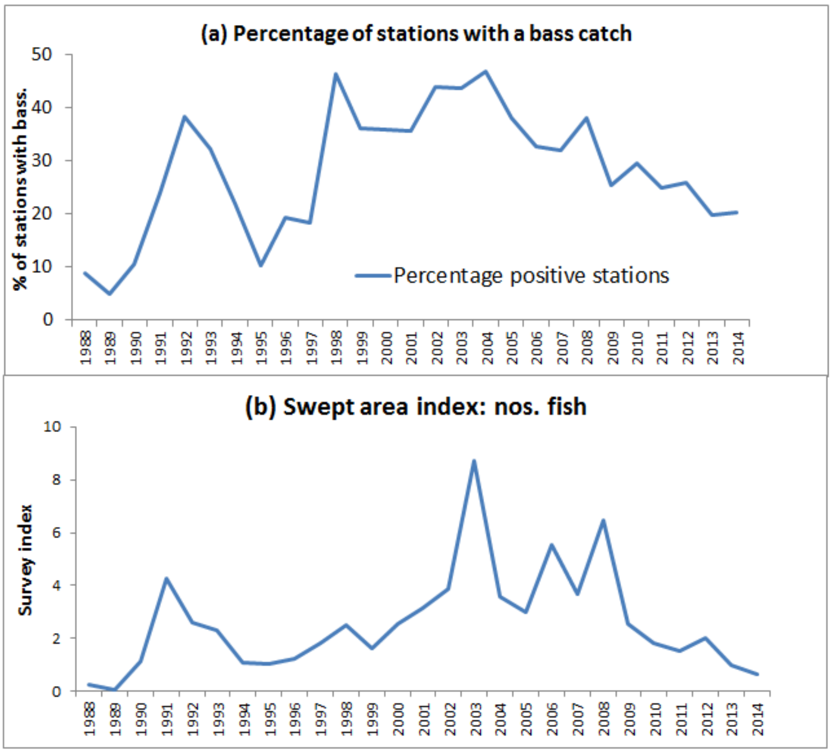


Figure 10.1.2.6. Mean standardised time-series of (a) percentage of stations with sea bass, and (b) swept-area abundance indices (millions of fish) from the Ifremer Channel Groundfish Survey.

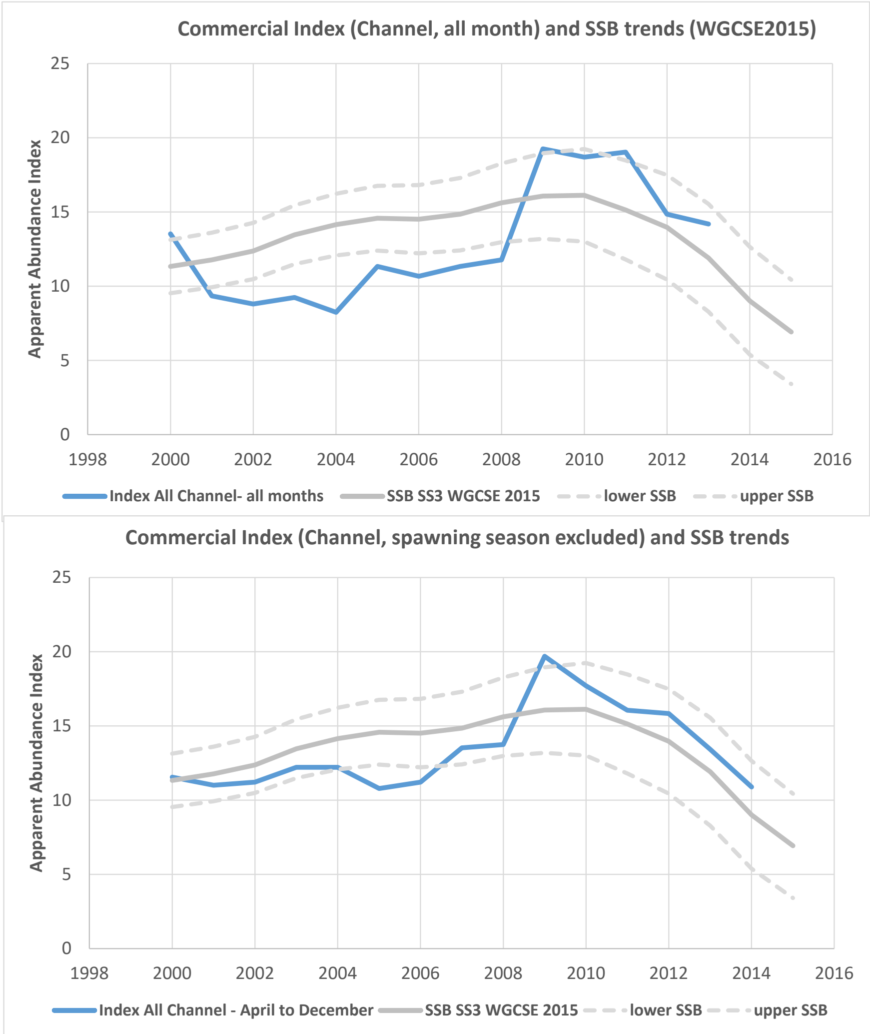


Figure 10.1.2.7. Bass-47: Trends in commercial lpue index for French fleets overlaid on this year's update assessment estimates of spawning–stock biomass (+/- 2 standard errors). Top: index based on data from all 12 months; bottom: index excluding fishing trips during spring spawning season.

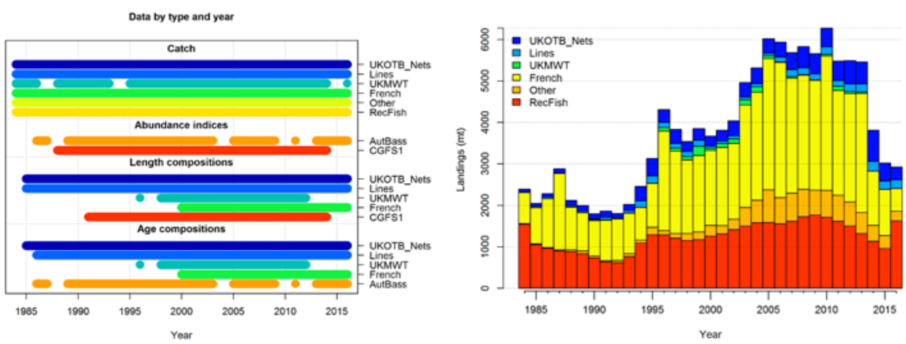


Figure 10.1.3.4. Left: Datasets used in the final sea bass update assessment. Right: landings series for the six fleets.

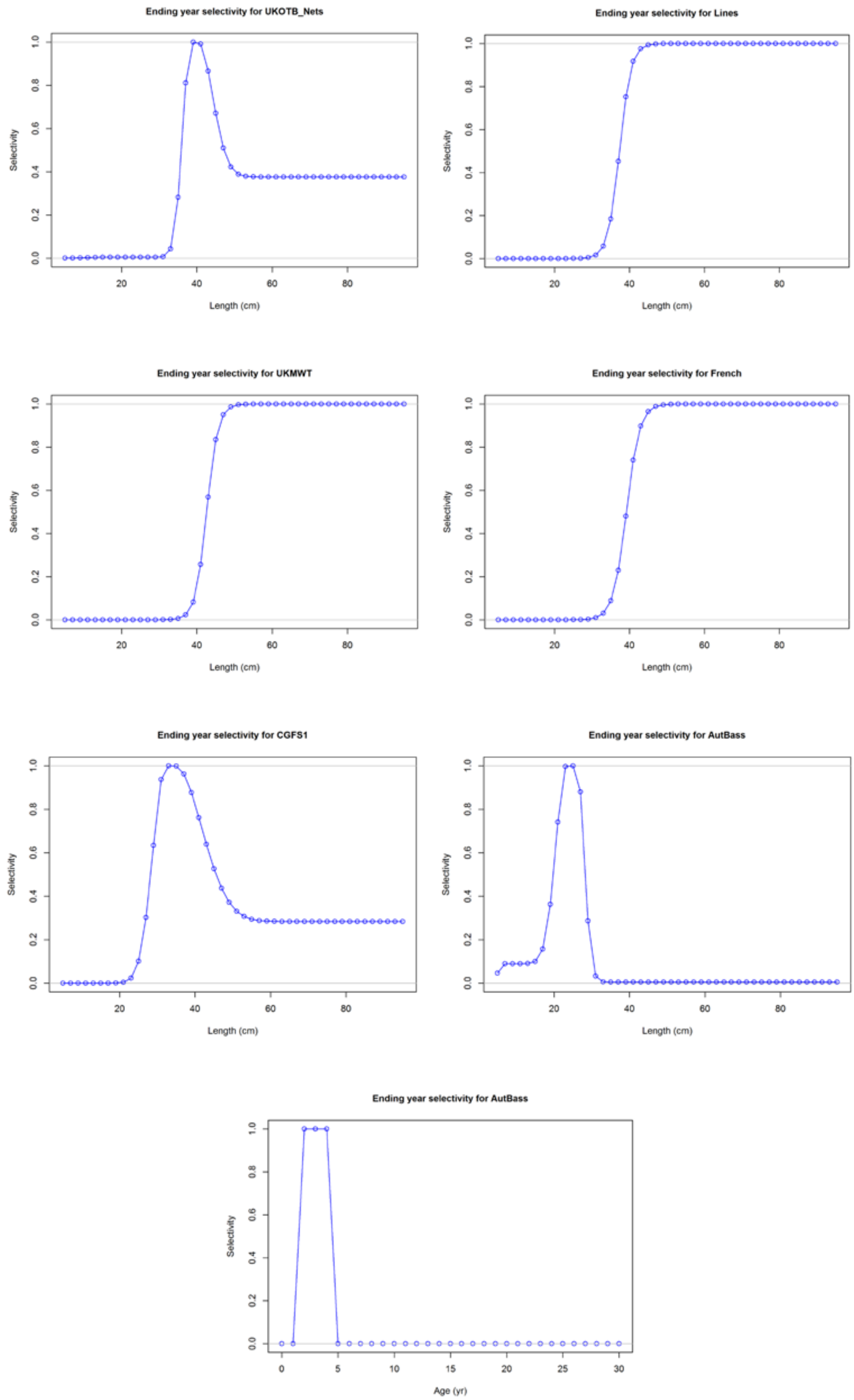
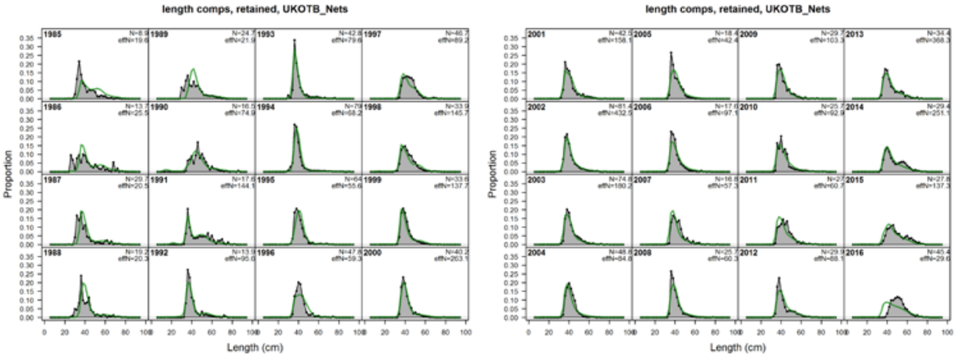


Figure 10.1.3.5. Final sea bass update assessment: Fitted length-based and age-based selectivity curves.



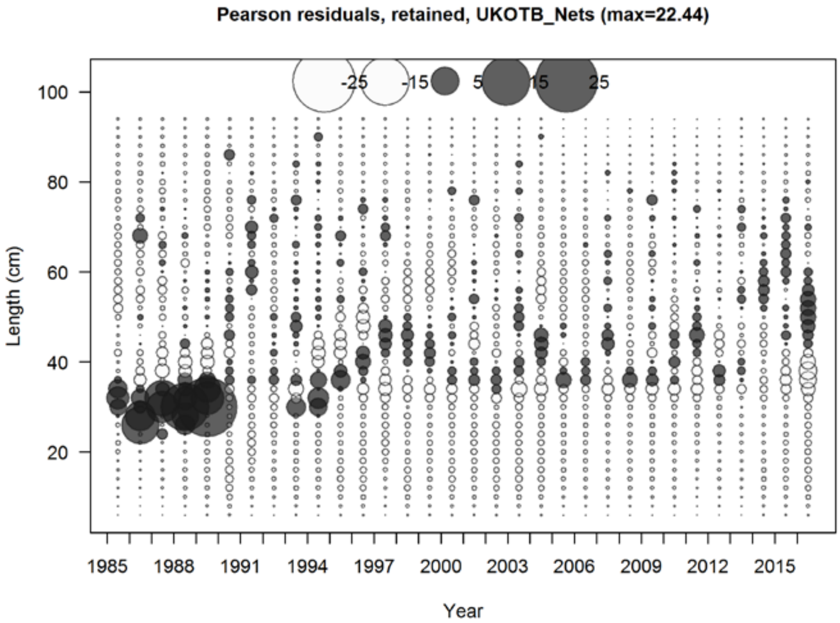


Figure 10.1.3.6. Final sea bass update assessment: fit to UK trawl and net fishery length composition data.

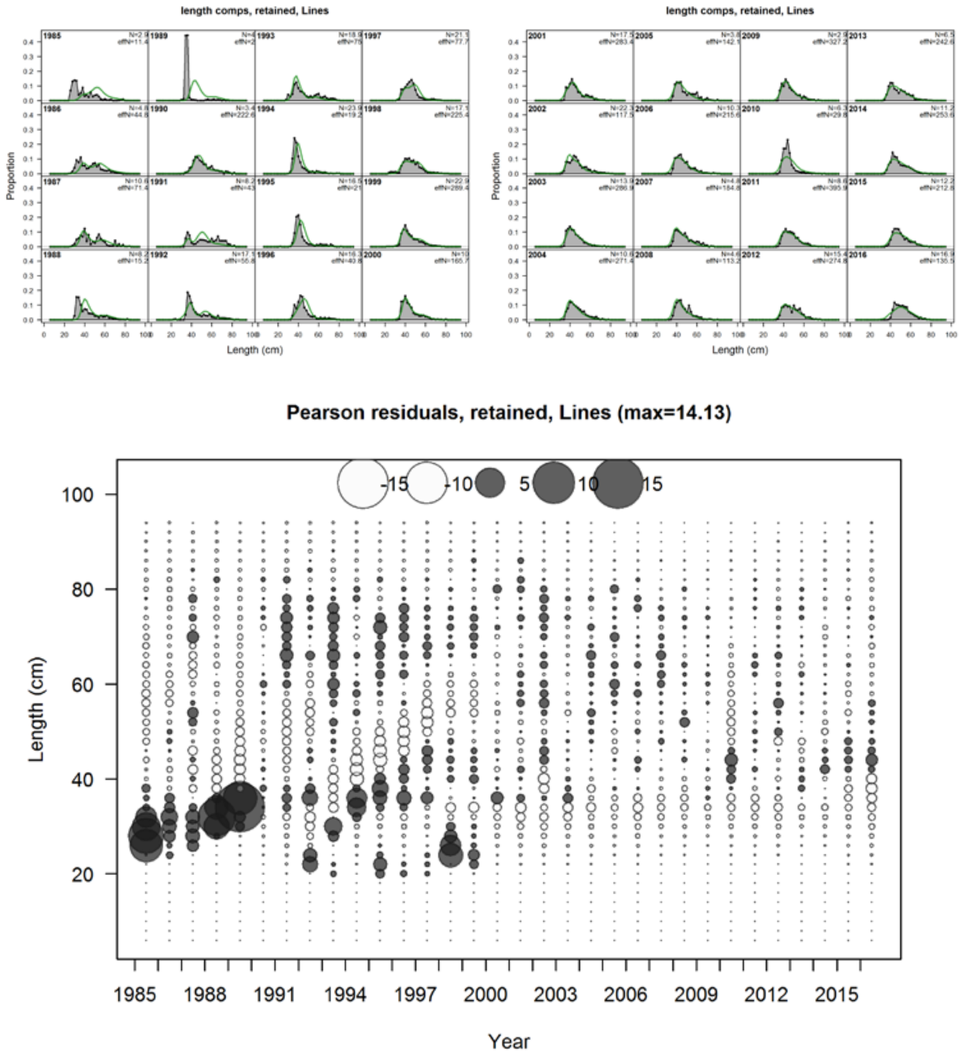
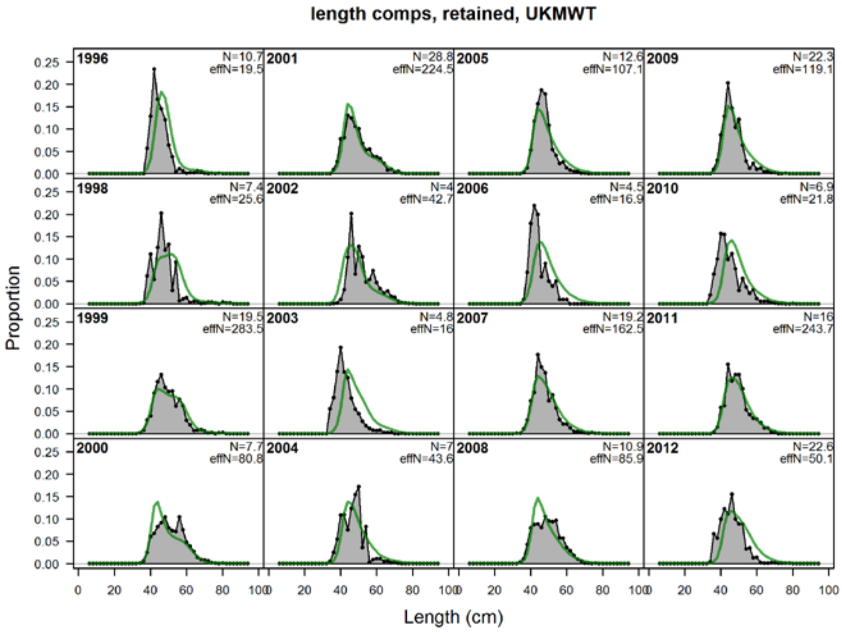


Figure 10.1.3.6. Final sea bass update assessment: fit to UK lines length composition data.



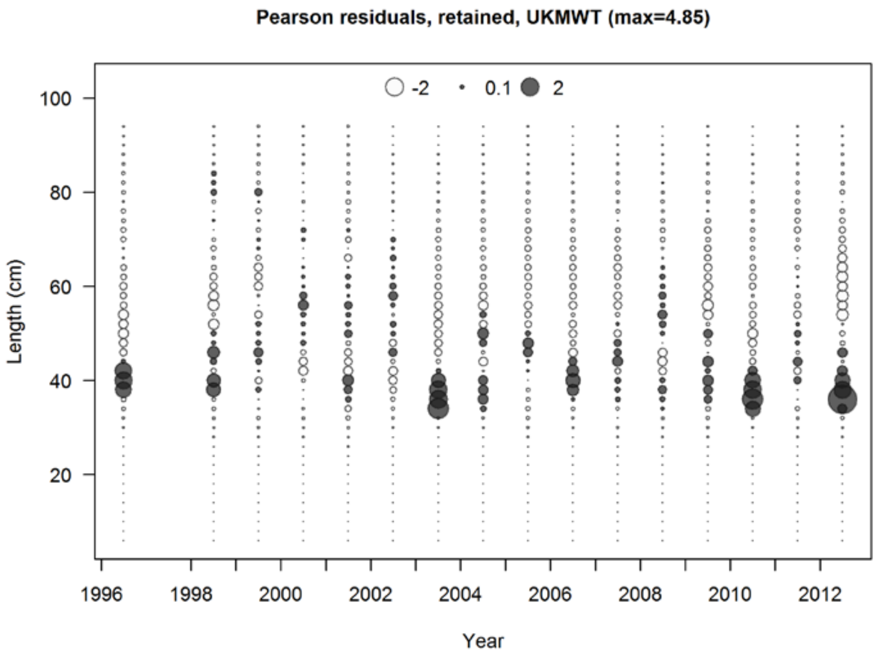


Figure 10.1.3.6. Final sea bass update assessment: fit to UK midwater trawl fishery length composition data.

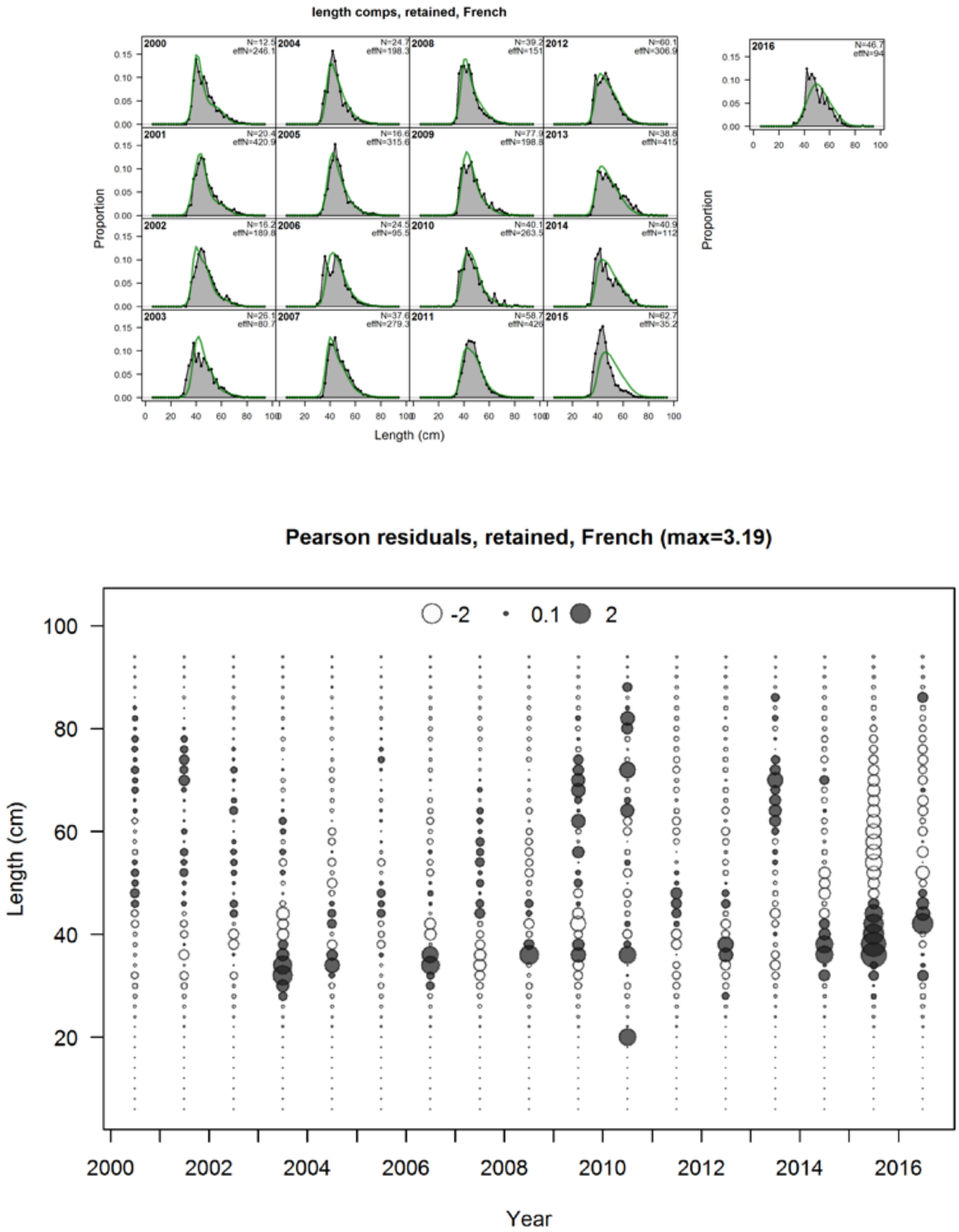
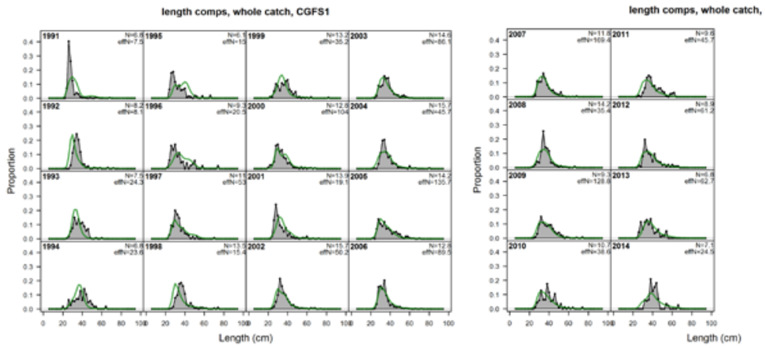


Figure 10.1.3.6. Final sea bass update assessment: fit to French fishery length composition data.



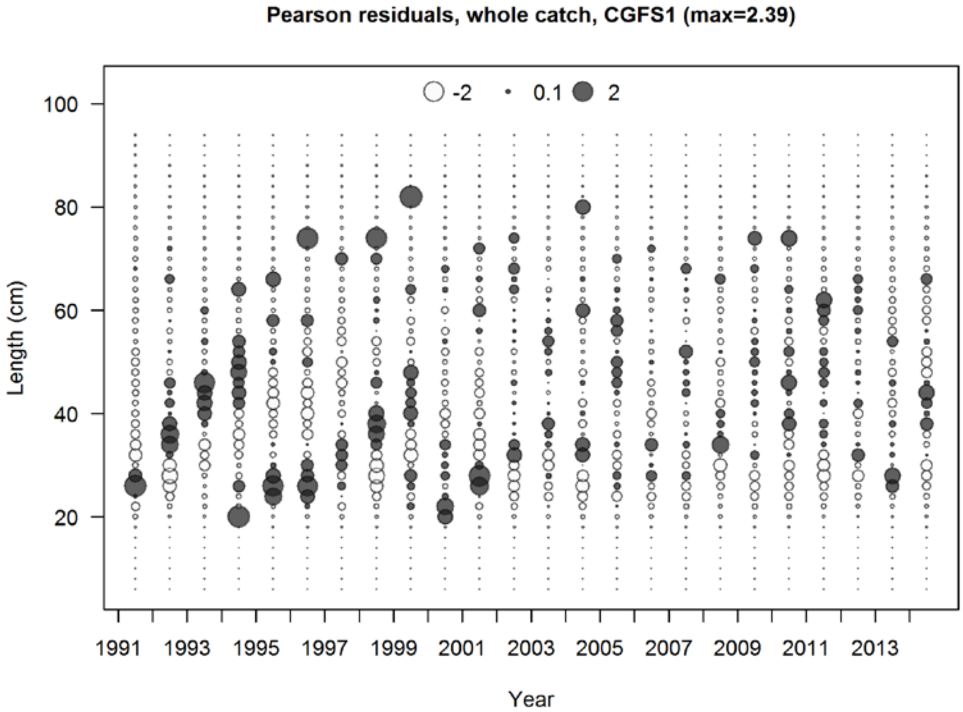
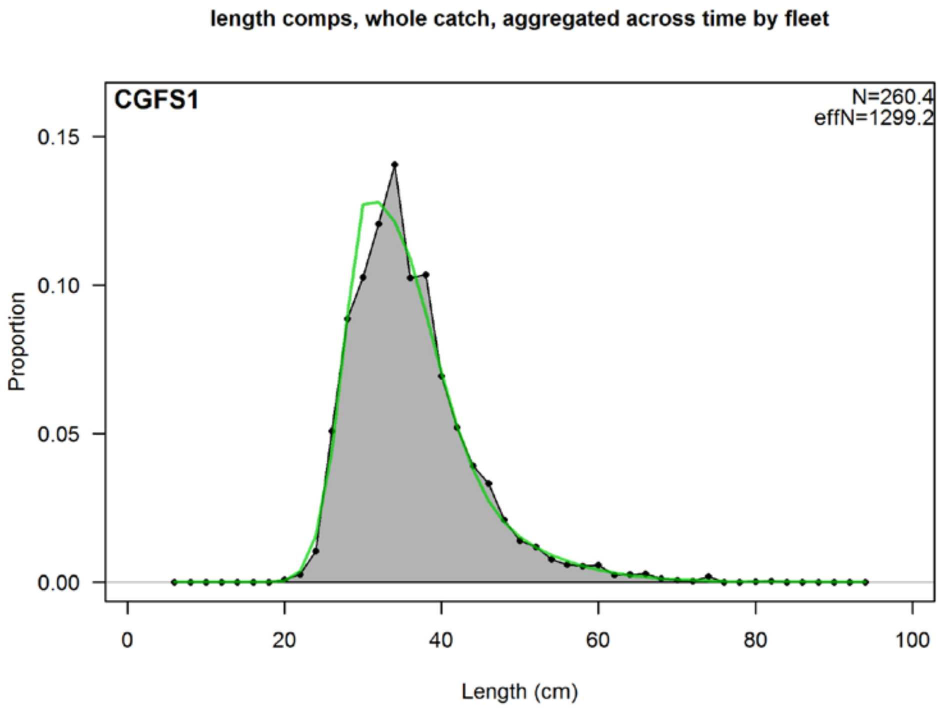


Figure 10.1.3.7. Final sea bass update assessment: Fit to Channel groundfish survey length compositions.



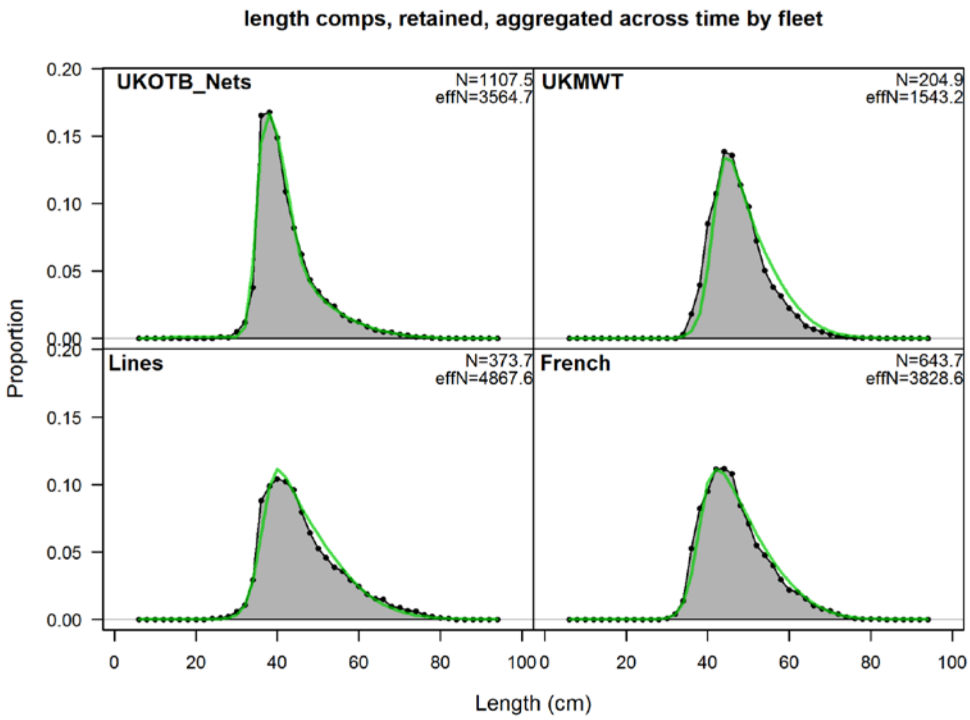
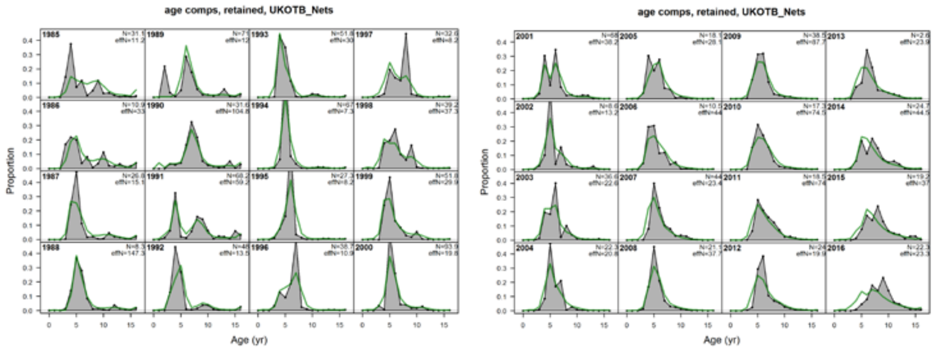


Figure 10.1.3.8. Final sea bass update assessment: Fit to the commercial fisheries and Channel groundfish survey length compositions, aggregated across time.



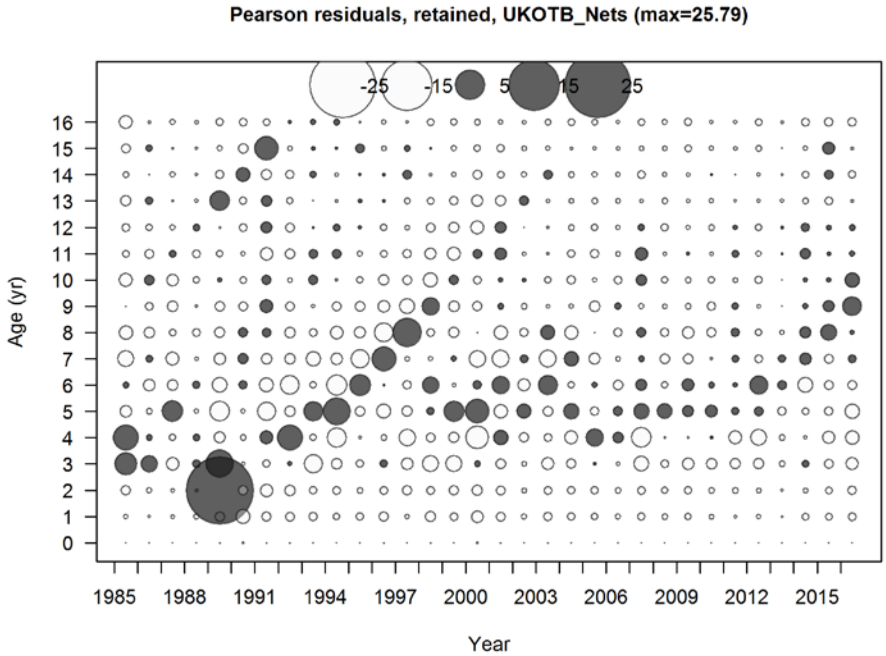


Figure 10.1.3.9. Final sea bass update assessment: Fit to age composition data for the combined UK otter trawl and nets fleets.

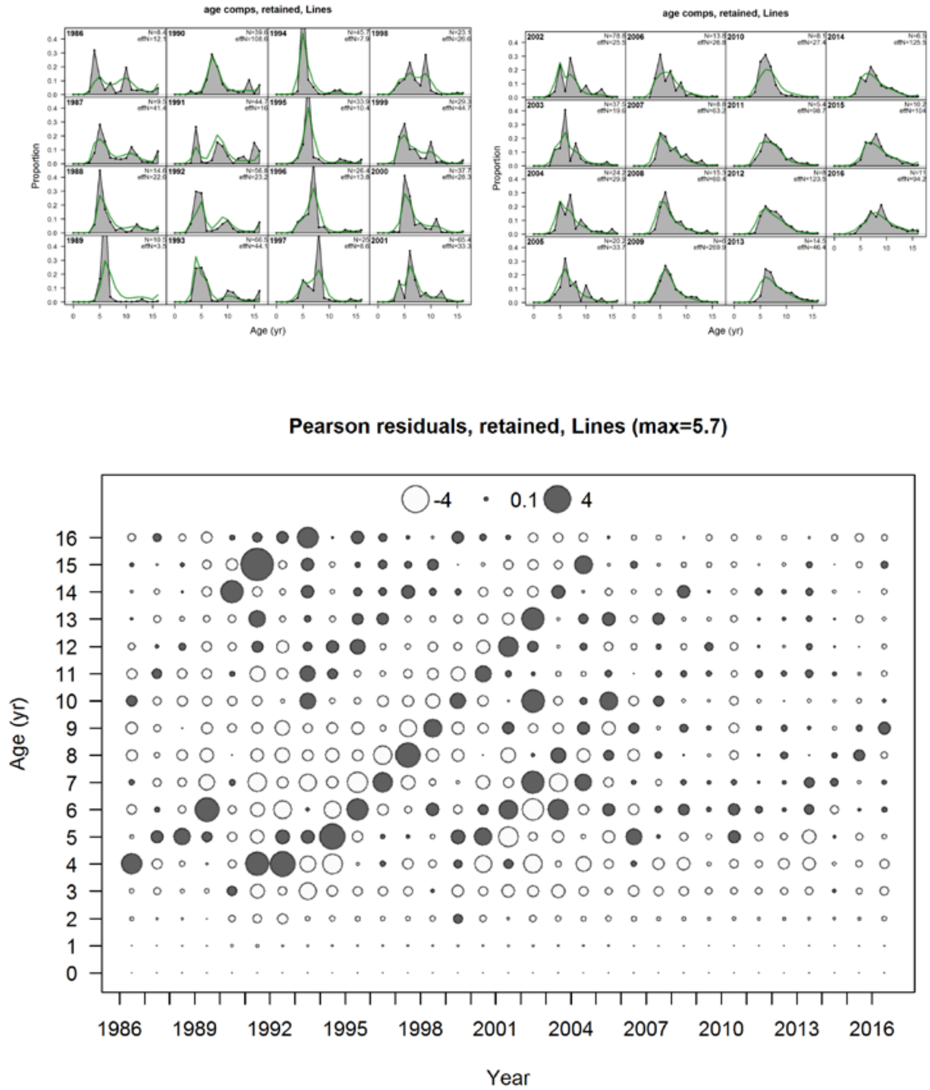
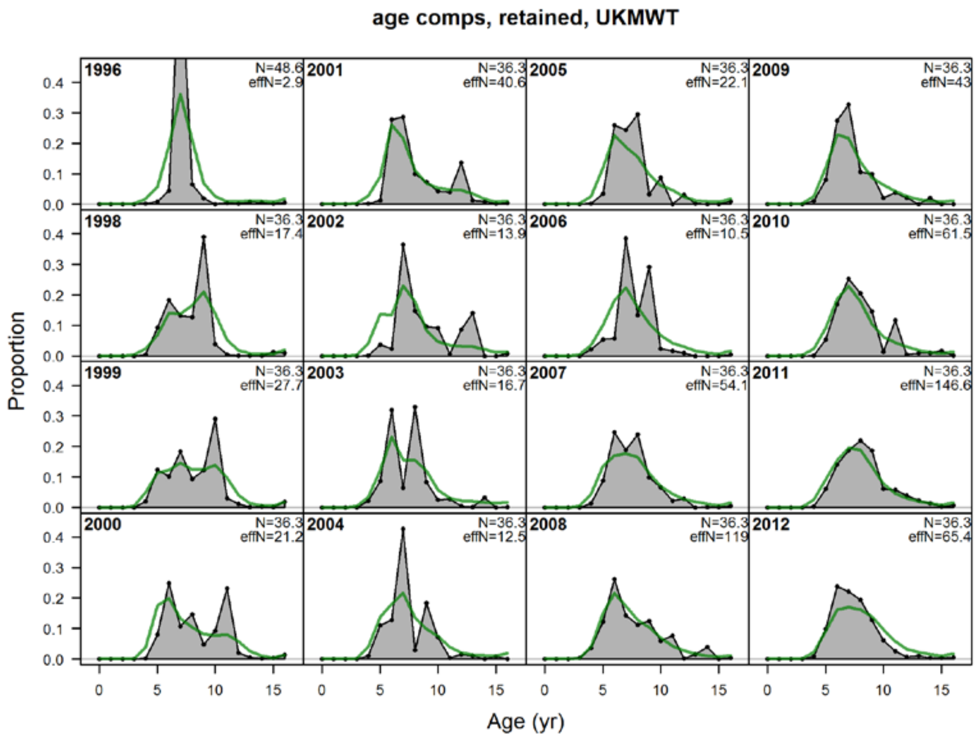


Figure 10.1.3.10. Final sea bass update assessment: Fit to age composition data for the combined UK otter trawl and nets fleets.



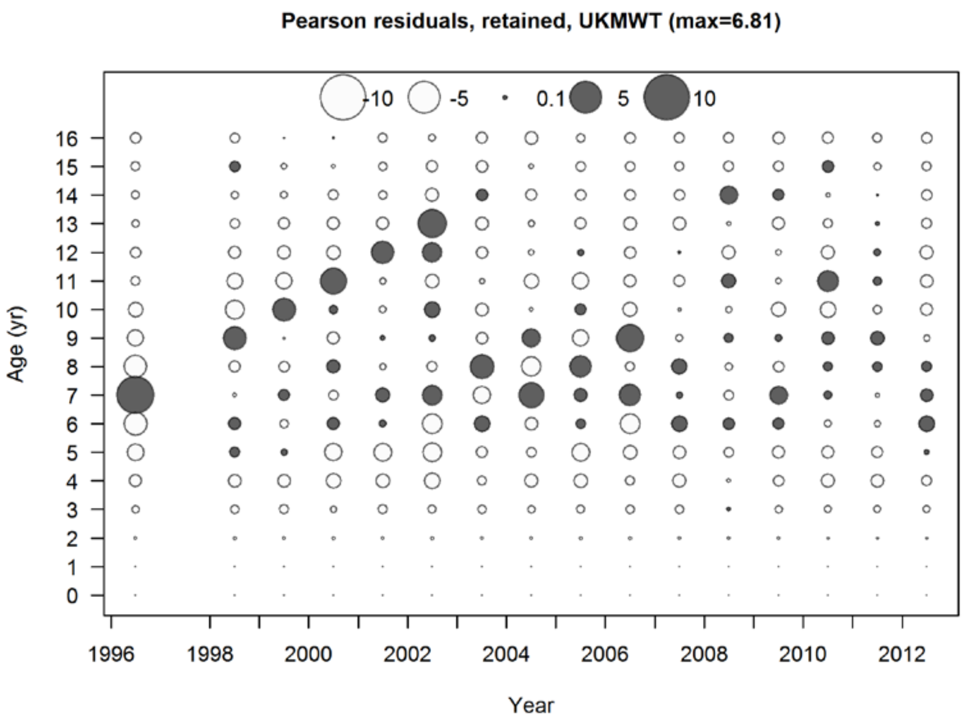
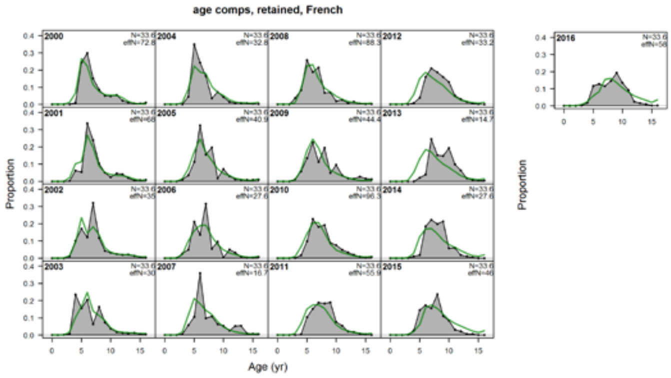


Figure 10.1.3.11. Final sea bass update assessment: Fit to age composition data for the UK midwater trawl fleet.



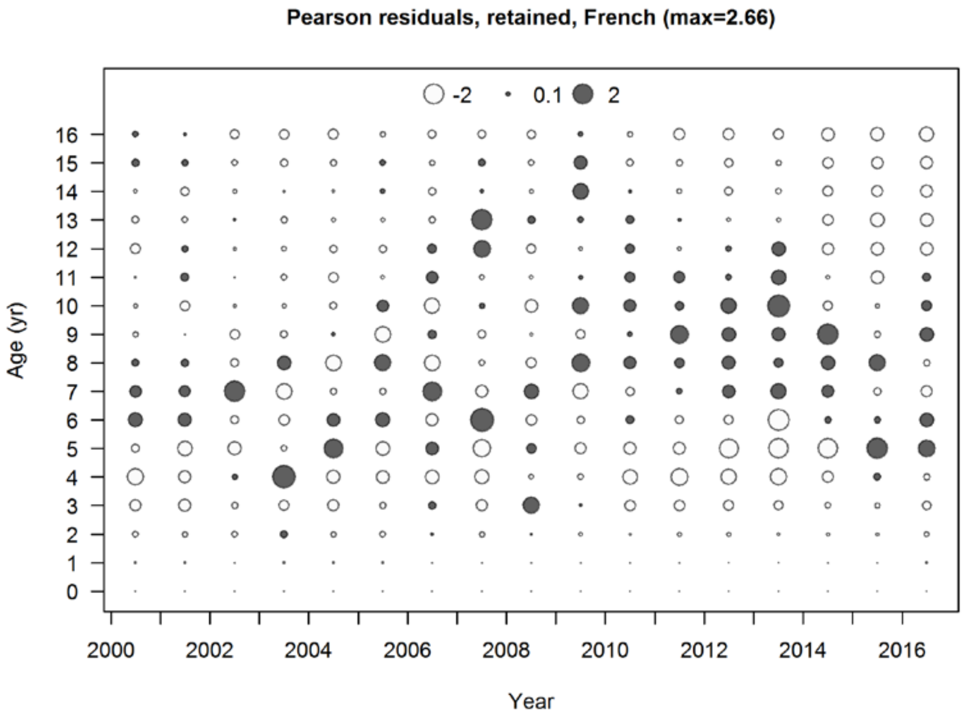


Figure 10.1.3.12. Final sea bass update assessment: Fit to age composition data for the combined French fleets.

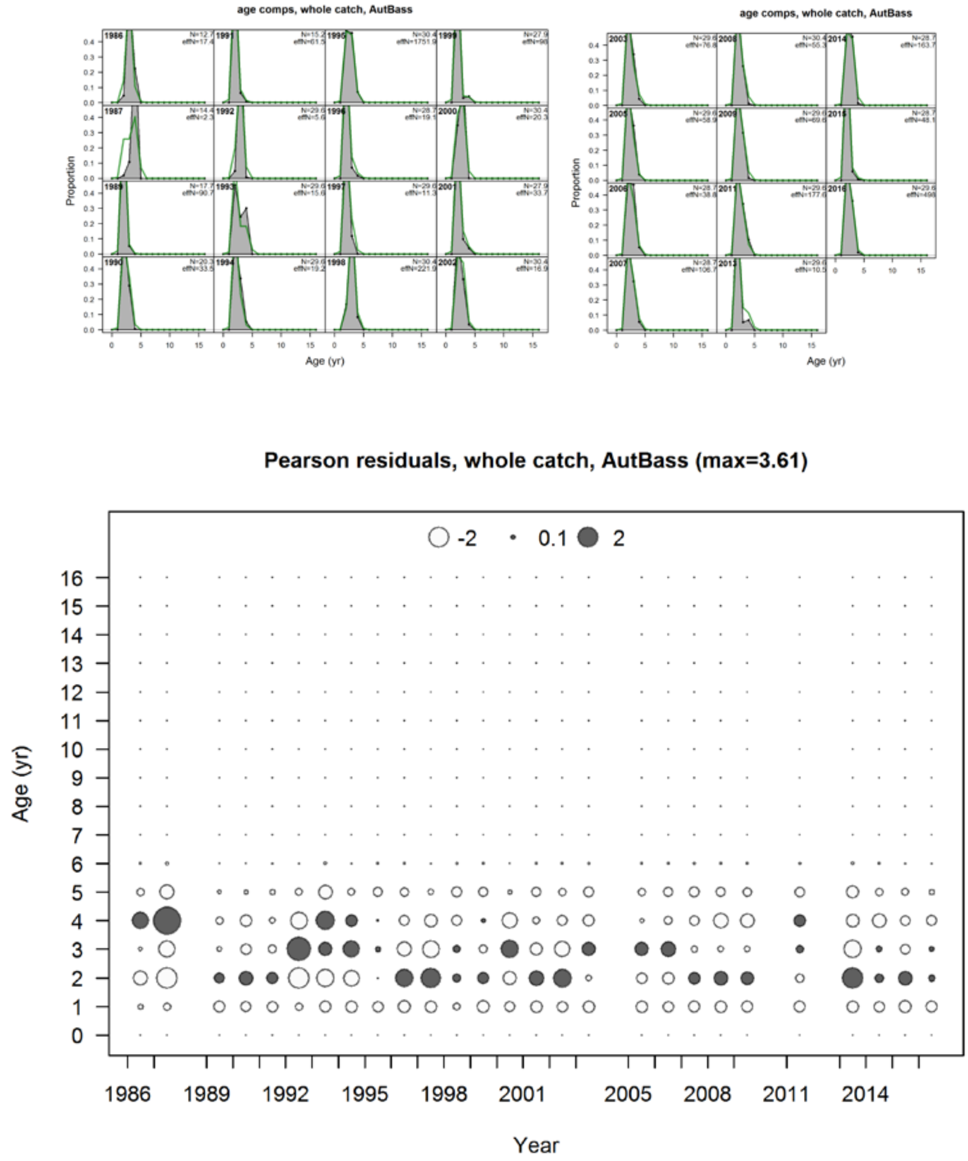


Figure 10.1.3.13. Final sea bass update assessment: Fit to age composition data for the Solent Autumn bass survey.

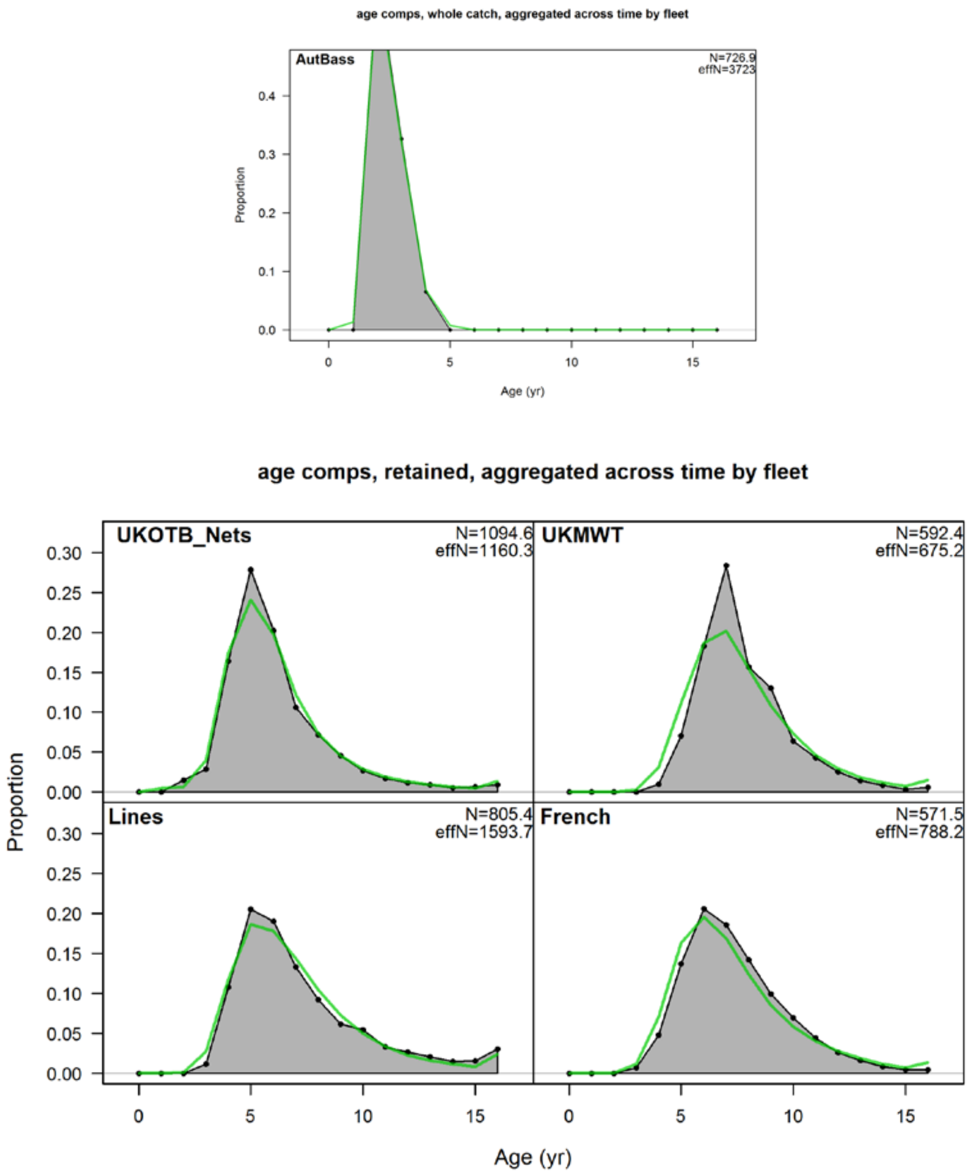
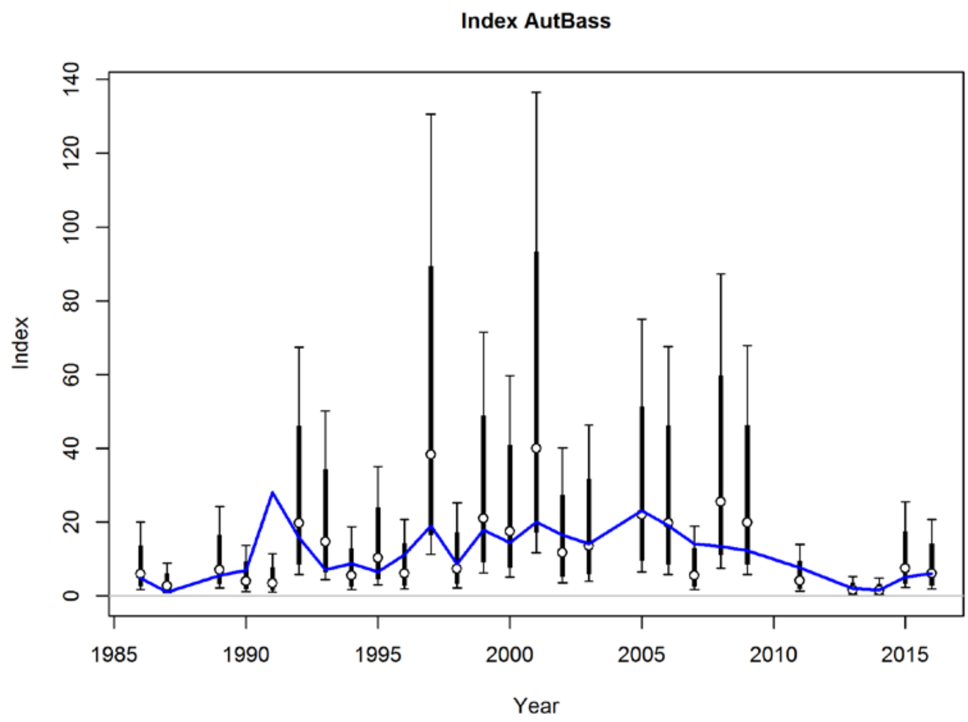


Figure 10.1.3.14. Final sea bass update assessment: Fit to UK fleets age compositions, aggregated across time.



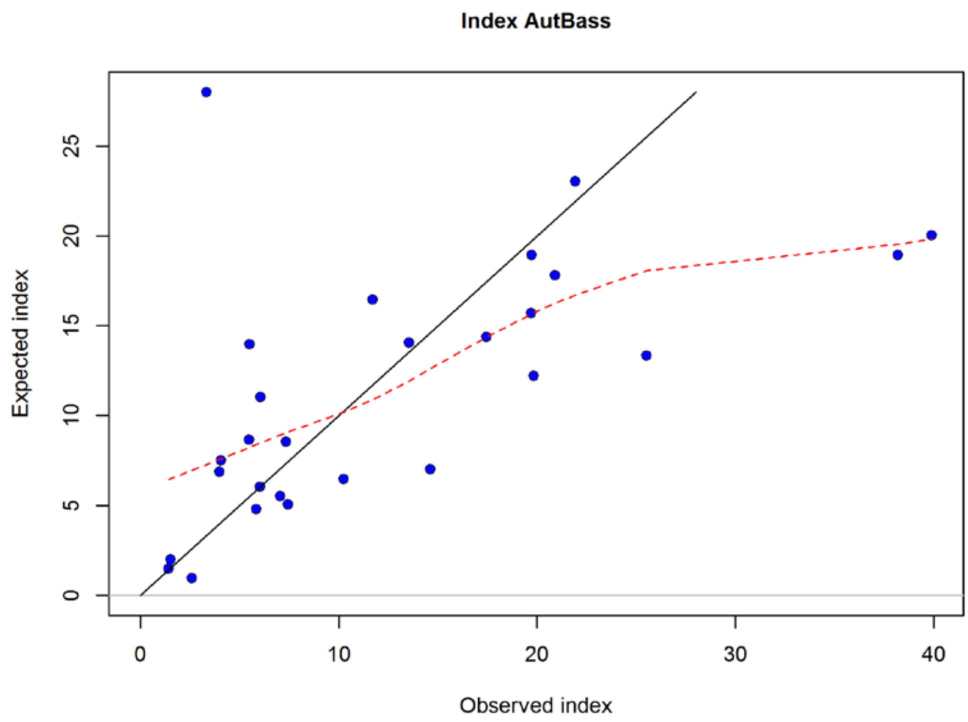
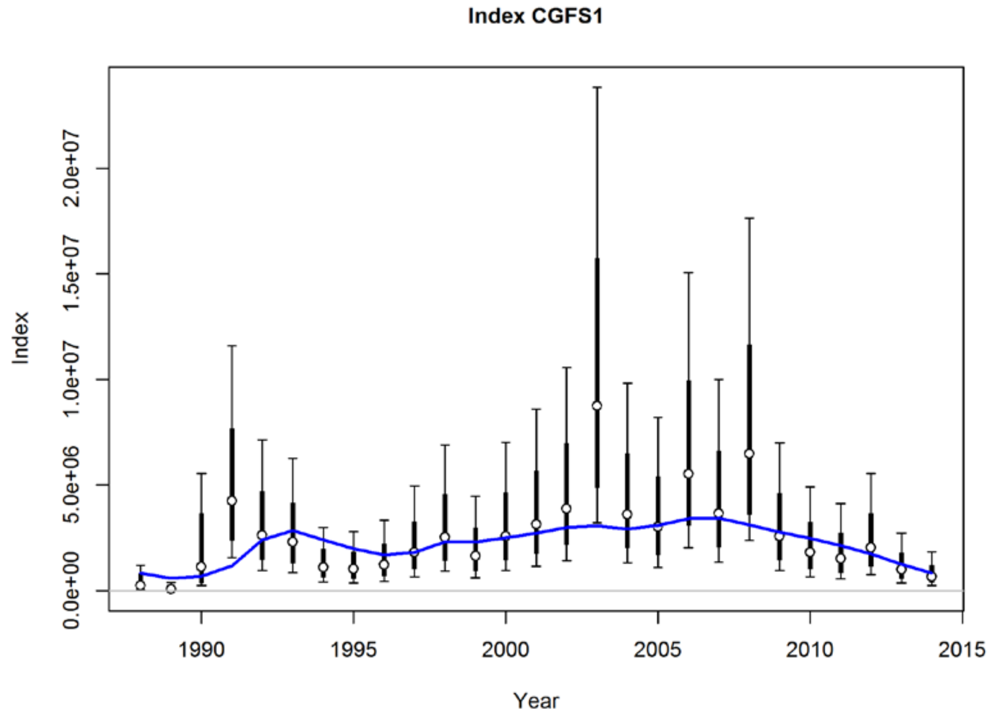


Figure 10.1.3.15. Final sea bass update assessment: Fit to Solent Autumn bass survey total abundance index, accounting for age and length-based selectivity.



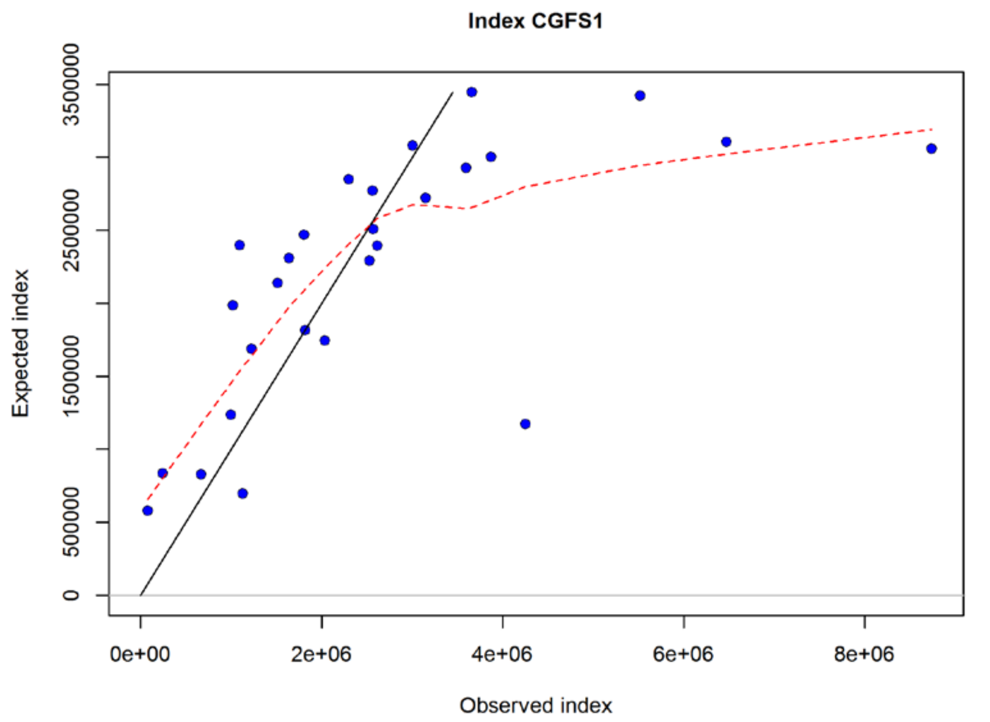
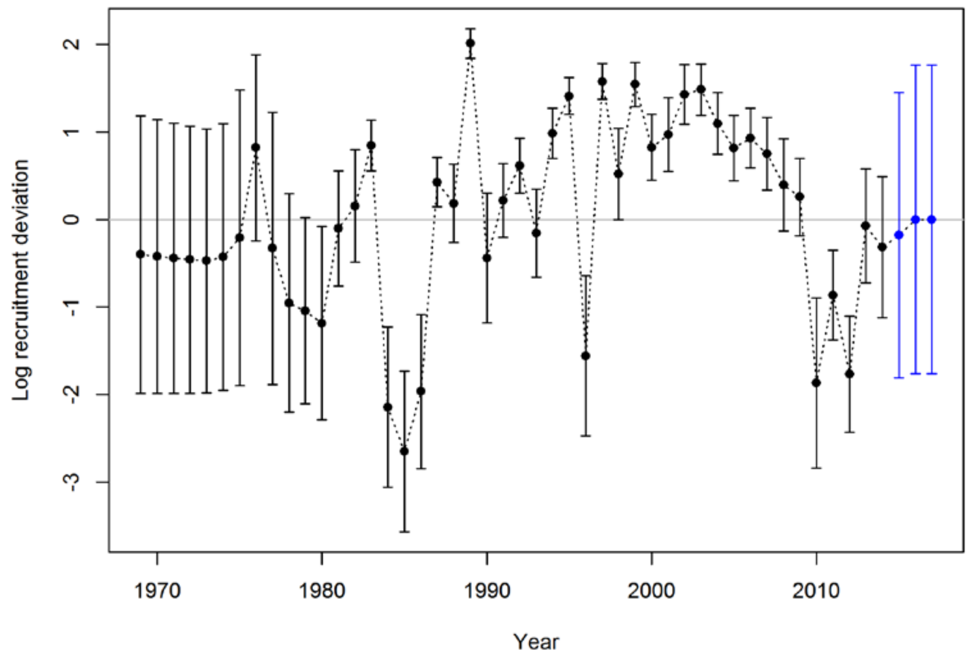
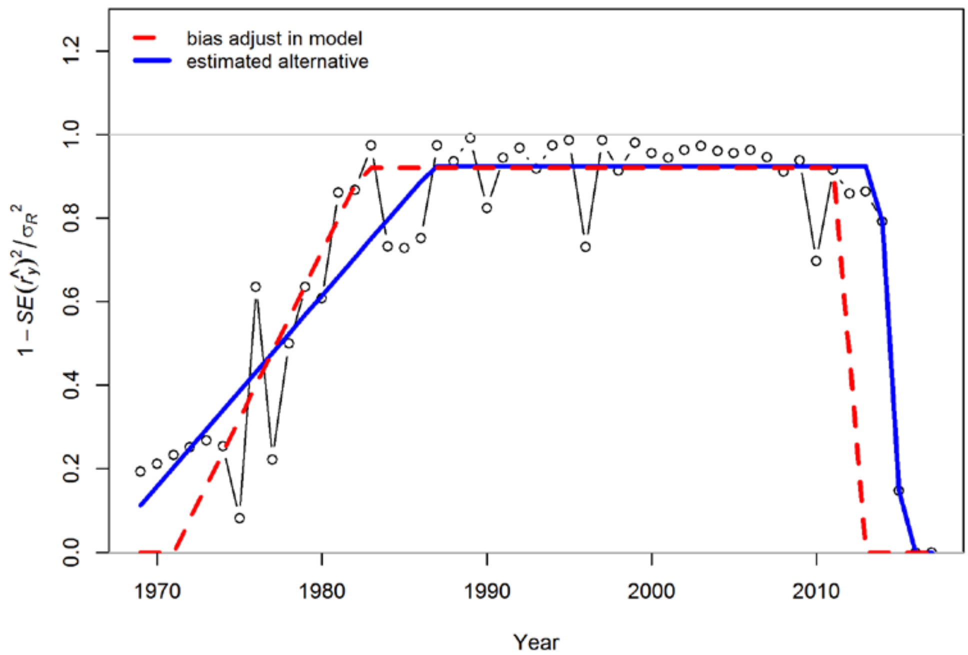


Figure 10.1.3.16. Final sea bass update assessment: Fit to Channel groundfish survey total abundance index, accounting for length-based selectivity.


Log recruitment deviation
Year


bias adjust in model
estimated alternative
Year

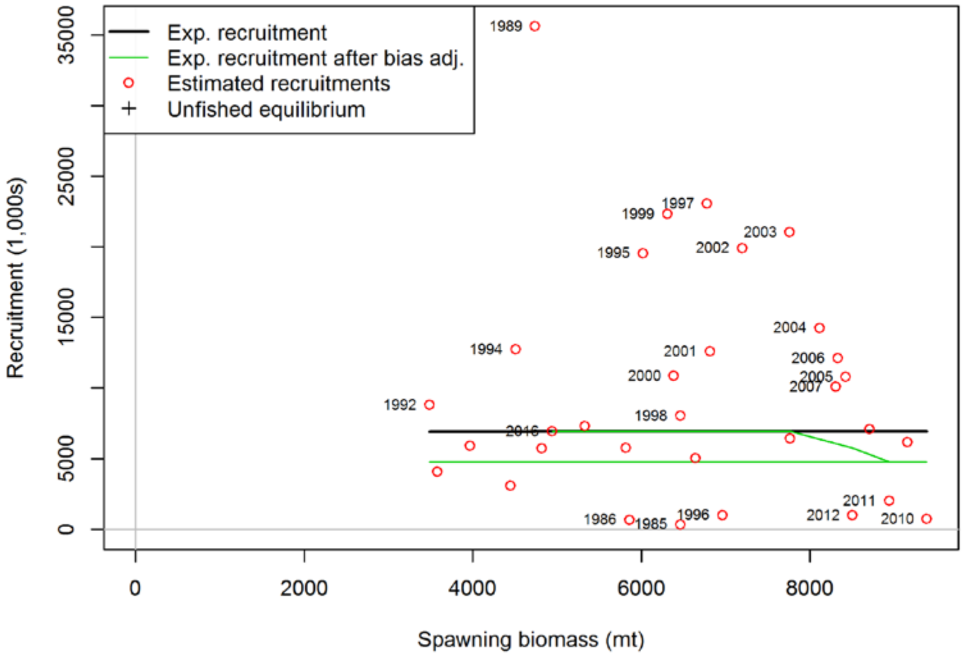


Figure 10.1.3.17. Final sea bass update assessment: Top: time-series of log-recruit deviations (deviations for 1965–1984 precede the period of input catch data). Below: stock–recruit scatter (model is fitted assuming Beverton–Holt stock–recruit model and steepness = 0.999.)

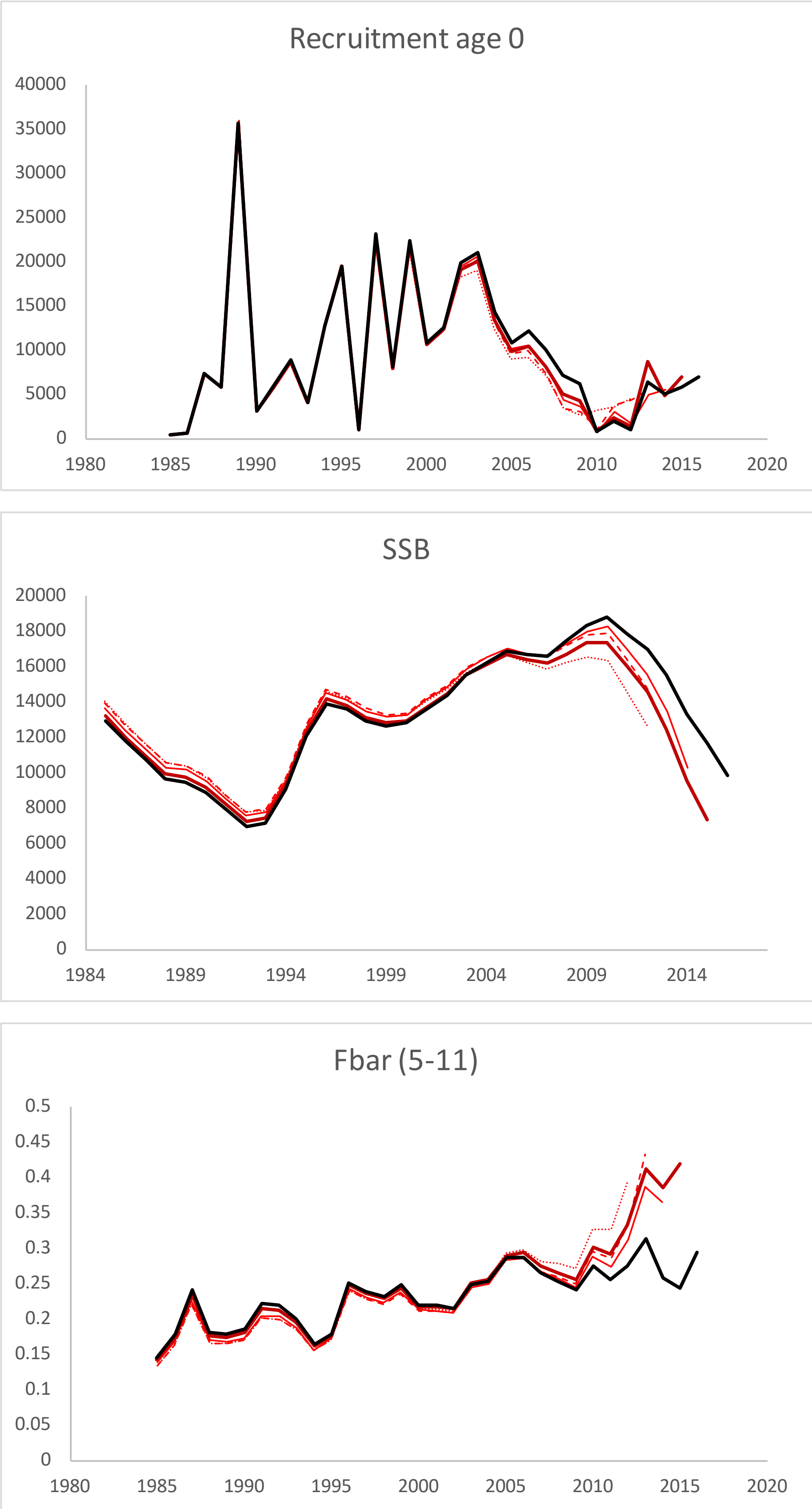


Figure 10.1.3.18. Retrospective analysis of stock trends from final update assessment, based on Stock Synthesis run final year set to 2015 and peeling back five years (for the final run, terminal F is for 2014 and SSB and total biomass terminate in 2015).

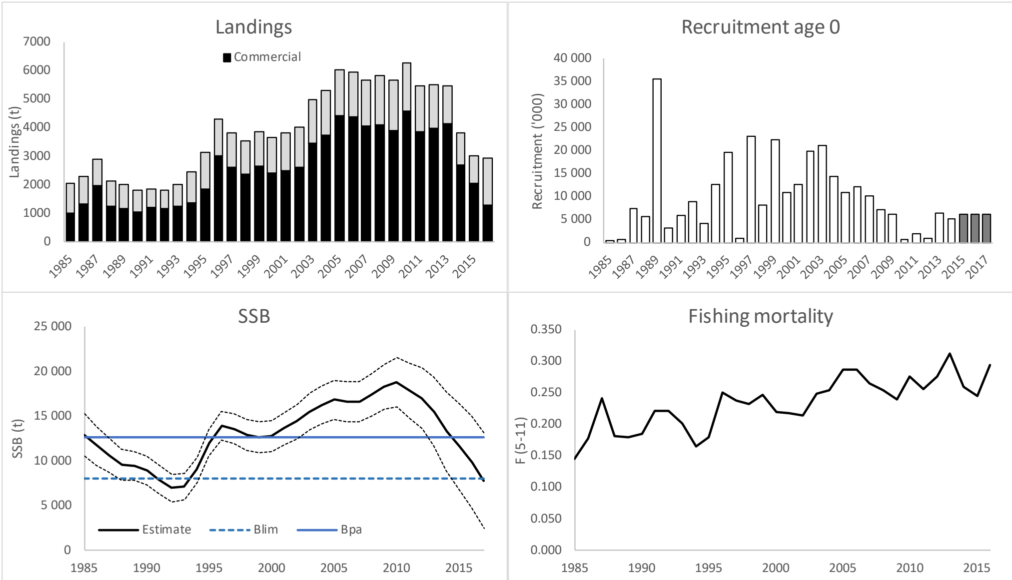
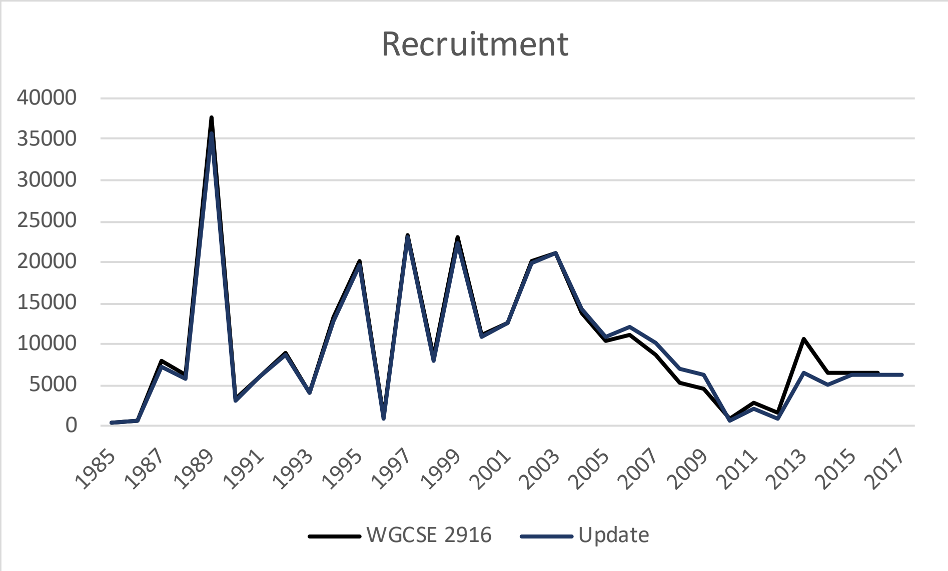
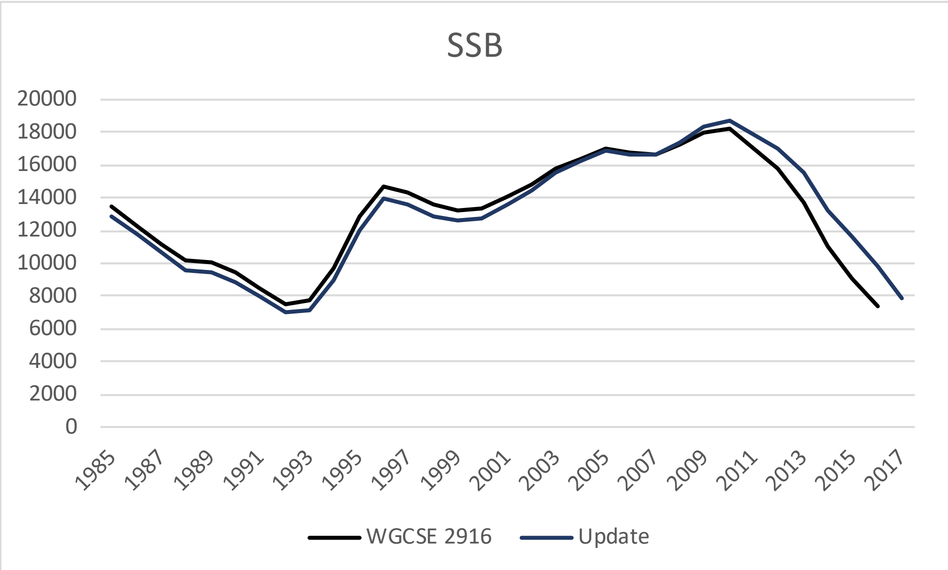


Figure 10.1.3.19. Stock trends from final update assessment, based on Stock Synthesis run final year set at 2016 to give 2016 numbers and biomass and 2014 F. Recruitment in 2014 and 2015 is the long-term geometric mean. The F_{MSY} proxy is $F_{35\%SPR}$ = 0.13. Error bars on recruitment plot and dotted lines on SSB plot are ± 2 standard errors.





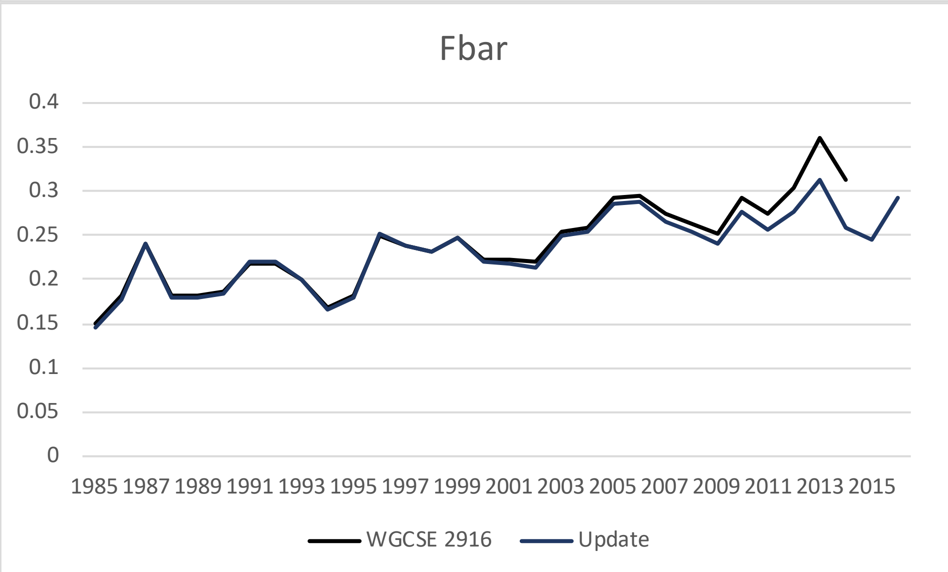


Figure 10.1.3.20. Comparison between stock trends from this year's final update assessment and the 2016 WGCSE assessment.

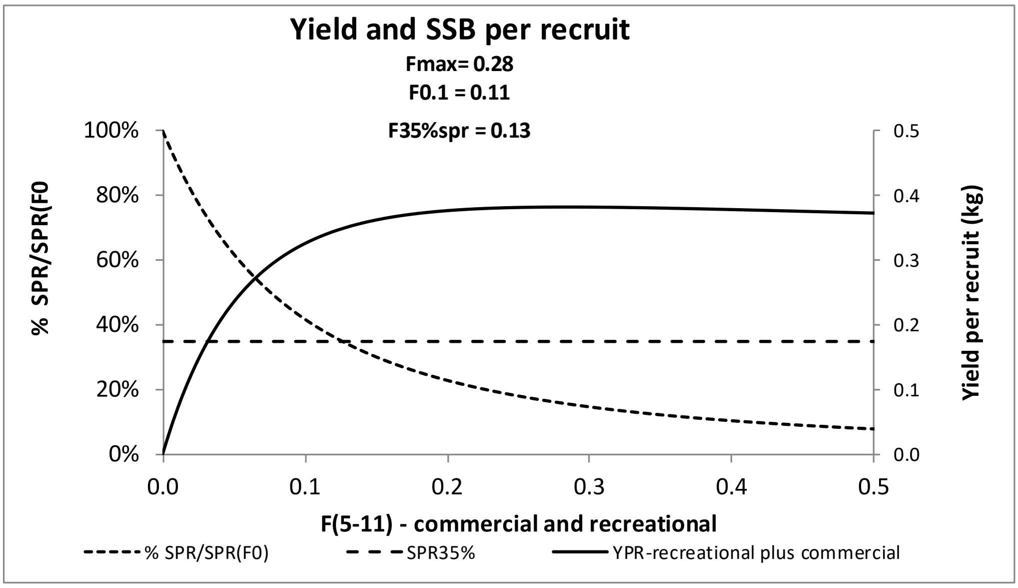


Figure 10.1.4.1. Bass-47: Yield and biomass per recruit analysis from 2016 IBPBass 2 conditional on mean pattern of F-at-age for 2012–2014 for the combined commercial and recreational fishing.

32 European sea bass in divisions 6.a, 7.b and 7.j (West of Scotland and Ireland)

Type of assessment

There is no assessment for this stock component.

ICES advice applicable to 2018 & 2019

"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 and 2019. 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."

32.1 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 and 2017

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 area 6 and 7, very restrictive measures introduced in 2016 may have some effect on sea bass in 6.a, 7.b and 7.j: .see Article 10 « Measures on Sea bass fisheries » COUNCIL REGULATION (EU) 2016/72 of 22 January 2016 which consist in catch limits (from 0 to 1300 kg/month depending of the period and gear used).

Fishery in 2016

Landings data used by the WG are given in Table 10.2.1. 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.

32.2 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.

32.3 Historical stock development

No information is available for this stock area.

32.4 Management plans

There are no existing management plans for European sea bass.

32.5 Management considerations

Sea bass grow slowly, do not mature until 4–7 years of age, and have been recorded 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 over-exploitation 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. 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 sea bass in Area 7.

32.6 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.

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.

32.7 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). Source: ICES official catch statistics.

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*

* Preliminary.

33 Sole in Division 7.a (Irish Sea)

Type of assessment in 2017

This assessment is an Update Assessment.

ICES advice applicable to 2016

In the advice for 2016, the stock status was presented as follows:

		Fishing pressure			
		2012	2013	2014	
Maximum Sustainable Yield	F_{MSY}	✗	✓	✓	Below
Precautionary approach	F_{pa}, F_{lim}	✓	✓	✓	Harvested sustainably
Management Plan	F_{MGT}	-	-	-	Not applicable

		Stock size			
		2013	2014	2015	
Maximum Sustainable Yield	MSY $B_{trigger}$	✗	✗	✗	Below trigger
Precautionary approach	B_{pa}, B_{lim}	✗	✗	✗	Reduced reproductive capacity
Management Plan	SSB_{MGT}	-	-	-	Not applicable

MSY approach

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

ICES advice applicable to 2017

In the advice for 2017, the stock status was presented as follows:

		Fishing pressure					Stock size			
		2013	2014	2015			2014	2015	2016	
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	SSB_{MGT}	-	-	-	Not applicable

ICES advises that when the MSY approach is applied, there should be zero catch in each of the years 2017 and 2018.

Comments made by the audit of last year's assessment

No major deficiencies for the sole assessment in the Irish sea were reported.

33.1 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 2010–2017, 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, Council Regulation (EC) N°2016/72 and Council Regulation (EC) N°2017/127 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 2016 and 2017

TAC 2016

Species:	Common sole *Solea solea*	**Zone:**	VIIa (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 2017

Species:	Common sole *Solea solea*	**Zone:**	VIIa (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) (2)		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.
(2) In addition to this TAC, the Member States having quota for sole in VIIa may decide by common agreement to allocate an overall total of 7 tonnes to one or more vessels carrying out the directed scientific fishery assessed by the STECF in order to improve scientific information on this stock (SOL/*07A.). The Member States concerned shall communicate the name(s) of the vessel(s) to the Commission before allowing any landings.

Fishery in 2016

A full description of the fishery is provided in the Stock Annex, Section A2.

The Working Group estimated the total international landings at 35 t in 2016 (Table 33.1), which is 12.5% below the 2016 TAC (40 t) and last year's forecast.

The main countries fishing for Irish Sea sole are Belgium, Ireland and UK(E&W).

The Belgian beam trawl effort shows a declining trend since 2003, then remaining stable over the period 2008–2012 at this low level. In 2013 it continues the downward trend and in 2016 it dropped to the lowest level in the time-series. After a peak in

2003, the Irish beam trawl effort has shown a declining trend and dropped to the lowest level in the time-series in 2013. Since 2014, the Irish beam trawl effort has slightly increased. The Irish otter trawl effort has fallen sharply from the higher level observed over the period 2011–2012, and is in 2016 at the lowest level in the time-series.

The significant decline in effort in the Irish Sea reported by all of the major fleets in 2013 and the Belgian beam trawlers in 2014, is in line with the substantial reductions of the TAC in 2013 and 2014. This situation continues in 2015 and 2016 as the TAC and effort drop to record low levels.

Since the beginning of the nineties the UK beam trawl and UK otter trawl effort has continued to decline. However, it should be noted that the UK beam trawl effort value of 2013 is stated as zero. As the UK administration switched to the EU electronic logbook system, a lot of the reported effort is missing and therefore 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, for 2014 and 2015 both the UK beam trawl and otter trawl effort values are unavailable because of the reporting issues. Inspection of an alternate effort indicator (days fished) suggests that beam trawl effort in 2013–2015 is significantly reduced and has slightly increased again in 2016. As, in 2015 and 2016 all otter trawl vessels active in the Irish Sea were under 12 m, no effort (days fished) was recorded.

Landings

An overview of the landings data provided and used by the WG is shown in Table 33.1. 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 (Table 33.1). 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 35 t in 2016, of which Belgium landed 40% (14 t), Ireland 43% (15 t), 10% (3 t) by the UK (England & Wales) and the remainder by Northern Ireland, the Netherlands, Scotland and France. These landing-figures are the lowest in the time-series, corresponding to an international uptake of 87.5% of the agreed TAC in 2016 (40 t).

The Working Group estimate of the 2015 landings was not revised.

Data

Quarterly age compositions for 2016 were available from the countries that take the major part of the international landings (92%) (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, the Netherlands, Scotland and France to obtain the catch numbers-at-age for 2016 (Table 33.2, Figure 33.1). Annual length distributions of the three major countries involved are given in Table 33.3. Because of the substantial reduction of the TAC in the last two years, sampling levels are also substantially reduced.

Catch weights-at-age for 2016 were taken from the combined age–weight key (Table 33.4).

Stock weights-at-age for 2016 were derived from the mean catch weights by cohort interpolation to the first of January (Rivard weight calculator) (Table 33.5).

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, the Netherlands and Scotland were uploaded to InterCatch. The landings from France were not 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 33.6) 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 2016 (Figure 33.2a) indicate that predominantly 2–3-year old fish are discarded. Observer information from UK and Irish beam trawl and 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 2014–2016 from the main métiers and countries were averaged to obtain an overall discard rate (Table 33.6b). The percent of the métiers with discard information covering the total international landings is 50%, 60% and 65% for 2014, 2015 and 2016 respectively. Assuming that discard rates do not change from the average of the last three years (2014–2016) and a fixed proportion of discards survive, a discard rate of around 0.06 (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) (1988–2016) and the UK(E&W) March beam trawl survey (UK(E&W)-BTS-Q1) (1993–1998) (Tables 33.7b and Figure 33.3c). 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). In the last 4 years it slightly increased to 69.35 kg/100 Km fished in 2016.

Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

Commercial lpue

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 (2013–2016) and the UK(E&W) otter trawlers (2014–2016) are not available as the effort values for those years are missing.

Trends in lpue and effort are given in Table 33.7 and Figure 33.3–33.4.

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. 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. The effort of the Irish beam trawlers shows a slow decline since 2004 and reached the lowest level in the time-series in 2013. 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. The Irish otter trawlers have shown a striking reduction in effort since 2000, followed by a slight increase in the period 2010–2012. In 2016 the Irish otter trawl effort fell back to the lowest observed level in the time-series. Nearly all effort time-series show a substantial decrease in the last four years.

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. Since 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 2013–2016 was not available. However, the alternate lpue indicator (kg/days fished) suggests that the UK beam trawl lpue is increased in 2015. For 2016 no catches of sole 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 2016 it dropped to the lowest level in the time-series (6.5 kg/hour fished). 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. In the most recent years, the lpue of Irish otter trawlers are fluctuating at a lower level.

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 33.8). 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.

33.2 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 33.5) and consistency between ages for year-class strength (Figure 33.6).

Final update assessment

The model settings for the final assessment are summarized below:

Assmnt Year	:2010	:2011–2017
Assmnt Model	:XSA	:XSA
Fleets	:	:
Bel Beam Trwl	: omitted	:omitted
UK Trawl	: omitted	:omitted
UK Sept BTS	:1988–2009 2–7	:1988–2016 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
F_{bar}	: 4–7	: 4–7

The final XSA output is given in Table 33.9 (diagnostics), Table 33.10 (fishing mortalities) and Table 33.11 (stock numbers). Log catchability residuals for the final assessment are given in Figure 33.7. A summary of the XSA results is given in Table 33.12 and trends in yield, fishing mortality, recruitment and spawning–stock biomass are shown in Figure 33.8. Retrospective patterns for the final run are shown in Figure 33.9.

Adding the 2016 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 (>93%) at all ages.

This assessment shows no retrospective bias and 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 33.10.

Trends in fishing mortality, SSB and recruitment are very similar. In last year's assessment, F and SSB for 2015 were estimated to be 0.075 and 1337 t respectively; this year's estimates for 2015 are 0.070 and 1374 t, a downward revision of 7% for F and an upward revision of 3% for SSB. The estimated recruitment by XSA in 2015 (2149 thousand fish) was revised downward by 3% in this year's assessment (2094 thousand fish).

State of the stock

Estimated trends of Irish Sea sole landings, SSB, fishing mortality and recruitment are presented in Table 33.12 and Figure 33.8. Since the late eighties the landings of Irish Sea sole have been declining to the lowest level of the time-series (35 t) in 2016. 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}. In 2014 SSB declined to the lowest estimate of the time-series (916 t), but in 2015 SSB increased (1337 t) again to the level of 2008. In 2016 SSB remained at this higher level. 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 Fpa and F_{MSY} (0.164 in 2013, 0.114 in 2014 and 0.070 in 2015). In 2016 the lowest level of the time-series was recorded (0.034). 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 (5683 thousand fish) and the 2011 recruitment (year class 2009) is estimated to be the lowest in the time-series (640 thousand fish). The 2015 recruitment (2094 thousand fish, year class 2013) is estimated to be 3.3 times higher than the record low recruitment in 2011. The increasing trend in recruitment is continuing as the incoming recruitment (year class 2014) is estimated to be 4658 thousand fish (7.3 times higher than the record low recruitment in 2011), which is 287% higher than the short term GM (1205 thousand fish) used in last year's forecast.

33.3 Short-term projections

No short-term projections were performed this year as last year's advice is valid for 2017 and 2018.

33.4 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-iris	0.16	0.20	0.24	0.22

33.5 Biological reference points

Precautionary approach reference points

The Working Group's current approach to reference points is outlined in Section 33.4. 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

33.6 Management plans

No management plan is currently in place for Irish Sea sole.

33.7 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 and 2016, 84% and 87.5% 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 6% 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 33.4–33.5).

33.8 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.

33.9 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 33.11).

Recruitment-at-age 2 has been well below average since 2001, and is estimated in 2011 to be the lowest in the time-series. In the last two years recruitment has substantially increased. 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 not possible for the stock to reach B_{pa} 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.

33.10 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

33.11 References

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Table 33.1. Sol.27.7.a. Nominal landings (tonnes) as officially reported by ICES, and working group estimates of the landings. Last year's landings are preliminary.

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
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

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
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

[1] 1989 onwards: N. Ireland included with England & Wales.

Table 33.2 - 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
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
2	15	1
3	36	18
4	37	22
5	30	14
6	17	10
7	21	7
+gp	74	32

Table 33.3 - Sol.27.7a - Annual lenght distributions by country (2016)

Length (cm)	UK (England & Wales) All gears	Belgium All gears	Ireland All gears
22			40
23	38	288	121
24	86	2311	258
25	1120	4830	874
26	1080	5654	1225
27	1228	5930	2402
28	1271	4447	2733
29	1384	4310	2729
30	574	3561	2336
31	747	3234	3506
32	838	2414	3300
33	1135	2495	2801
34	322	2042	2213
35	649	1632	1729
36	307	1106	2270
37	325	1037	1778
38	219	664	1714
39	68	496	952
40	70	544	1162
41	10	432	875
42	48	178	613
43	0	254	302
44	0	77	254
45	10	66	201
46	10	46	131
47		67	41
48		23	82
49			41
50			32
51			8
Total	11539	48138	36723

Table 33.4 - 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
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
2	0.18	0.187
3	0.221	0.223
4	0.309	0.269
5	0.342	0.356
6	0.381	0.332
7	0.4	0.414
+gp	0.384	0.436

Table 33.5 - 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
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
2	0.153	0.127
3	0.194	0.2
4	0.246	0.244
5	0.303	0.332
6	0.353	0.337
7	0.384	0.397
+gp	0.397	0.411

Table 33.6.a. Sol.27.7.a. 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 33.6b - Sol.27.7a - Discard rates.

Country	Year	Landings (L) (t)			Discards (D) (t)
BE		TBB	OTB	other	
	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
UK	2012	7.278	5.459	1.229	0
	2013	0.168	5.108	1.258	0
	2014	0.149	3.579	1.582	1.195
	2015	0.164	3.505	0.491	0
	2016	0.110	2.700	0.641	0.006
IR	2012	38.79	8.162	3.824	1
	2013	30.934	9.23	0.009	0
	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

	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	3.88	0.078
2015	71.88	42.89	0.60	3.74	0.080
2016	32.61	21.08	0.65	0.62	0.029
average			0.58	2.75	0.06

Table 33.7a - Sol.27.7a - Effort series.

Year	Belgium	UK(E&W)				Ireland	
	beam[1]	beam[2]	beam[3]	otter[2]	otter[3]	otter[4]	beam[4]
	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
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	14.67
2000	26.0	6.3	410.7	27.0	2034.9	82.7	11.42
2001	36.8	12.5	767.4	32.8	2352.9	77.5	13.13
2002	47.0	8.0	535.1	24.8	1774.0	77.9	17.67
2003	43.6	14.0	863.7	23.9	1728.3	73.9	18.70
2004	32.0	7.4	419.9	23.5	1727.0	72.5	14.19
2005	37.5	11.4	627.8	16.7	1313.6	68.3	14.67
2006	24.6	4.6	280.1	5.2	478.5	66.2	12.22
2007	19.4	3.2	193.5	4.4	397.2	74.1	14.18
2008	9.6	1.3	98.0	2.7	320.4	58.8	9.54
2009	11.1	0.5	24.9	1.5	157.7	42.8	7.59
2010	11.1	0.2	10.2	1.4	151.0	45.8	9.42
2011	12.5	1.6	91.2	0.7	72.7	54.5	8.12
2012	10.9	0.9	60.7	0.4	85.0	58.3	7.17
2013	7.0	0.0	1.3	0.3	31.9	42.6	4.99
2014	3.9	-	0.4	-	16.1	47.7	5.96
2015	3.5	-	0.9	-	0.0	39.8	8.34
2016*	1.8	-	3.9	-	0.0	33.4	7.87

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 33.7b - 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	161.92	-	-	-
1989	21.9	9.17	1750.6	0.70	138.9	150.07	-	-	-
1990	17.5	9.52	2300.9	0.61	119.7	196.90	-	-	-
1991	18.7	10.43	2420.9	1.12	177.4	175.76	-	-	-
1992	19.2	9.50	2763.0	1.02	126.0	162.64	-	-	-
1993	20.0	7.60	1879.8	0.54	69.1	100.16	104.7	-	-
1994	19.1	11.76	1479.9	0.74	88.1	110.71	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	155.79	63.3	0.23	8.53
1998	19.0	8.42	907.8	0.48	50.5	144.97	89.3	0.38	7.77
1999	19.5	9.94	1124.9	0.60	64.8	116.02	-	0.29	9.22
2000	15.5	12.90	1604.7	0.44	34.6	130.70	-	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
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

All LPUE values in Kg/hr

[1] Kg/000'hr

2Kg/day

[3] Kg/000'hr fished (GRT corrected > 40' vessels)

4Kg/100km fished

* Provisional

Table 33.8 - Sol.27.7a - Tuning series (values in bold are used in the assessmen

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	2016								
	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

Table 6.8.8 - 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 6.8.8 - Sole in VIIa. 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 is 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 33.9. Sol.27.7.a. Diagnostics.

```
FLR XSA Diagnostics 2017-05-11 10:46:37
CPUE data from indices
Catch data for 47 years. 1970 to 2016. Ages 2 to 8.
            fleet first age last age first year last year alpha
beta
1 UK (E&W)-BTS-Q3         2        7       1988      2016  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   2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
  all    1    1    1    1    1    1    1    1    1    1
 Fishing mortalities
   year
age  2007  2008  2009  2010  2011  2012  2013  2014  2015  2016
  2 0.101 0.054 0.043 0.014 0.028 0.018 0.035 0.016 0.008 0.000
  3 0.419 0.276 0.298 0.196 0.178 0.324 0.126 0.088 0.053 0.010
  4 0.322 0.368 0.404 0.243 0.337 0.355 0.241 0.093 0.080 0.037
  5 0.313 0.268 0.474 0.346 0.261 0.361 0.175 0.161 0.056 0.035
  6 0.307 0.304 0.261 0.355 0.288 0.246 0.147 0.079 0.093 0.021
  7 0.391 0.299 0.383 0.199 0.495 0.220 0.095 0.122 0.052 0.044
  8 0.391 0.299 0.383 0.199 0.495 0.220 0.095 0.122 0.052 0.044
 XSA population number (Thousand)
      age
year      2    3    4   5   6   7    8
  2007 1876 1091 1329 949 341 133  963
  2008 1969 1535  649 872 628 227  850
  2009 2287 1688 1054 406 603 419  533
```

```
  2010 1622 1982 1134 637 229 420  921
  2011  640 1447 1473 804 408 145  327
  2012  990  563 1095 952 560 277  611
  2013  701  880  369 695 601 397  955
  2014  821  612  702 262 528 469  515
  2015 2094  731  507 579 202 441 1554
  2016 4658 1881  627 424 495 166  784
 Estimated population abundance at 1st Jan  2017
      age
year     2    3    4   5   6   7   8
  2017 438 4215 1685 547 370 438 144
 Fleet:  UK (E&W)-BTS-Q3
 Log catchability residuals.
```

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.060	0.043	0.426	0.524	-0.035	-0.258	0.176	0.195	-0.264	0.109	0.456	-0.136	0.015	-0.028	-0.884	0.155
3	0.601	0.382	-0.110	-0.279	0.486	-0.258	-0.030	0.308	-0.660	-0.059	0.121	0.017	-0.196	-0.210	-0.213	-0.159
4	0.012	0.075	-0.236	-0.920	0.454	-0.094	-0.280	0.055	-0.243	-0.156	-0.761	0.323	0.325	-0.483	0.072	0.239
5	-0.379	-0.014	0.972	-0.610	-0.015	-0.310	0.032	-0.577	-0.217	0.033	-0.749	0.340	-0.117	-0.139	-0.389	0.206
6	-0.228	-0.232	0.303	-0.196	0.172	-0.070	0.538	-0.020	-0.174	-0.157	-0.283	0.360	0.153	-0.097	0.073	0.000
7	-0.118	0.085	0.188	-0.194	-0.198	-0.088	0.183	-0.344	-0.158	0.271	0.200	0.182	-0.123	-0.022	-0.019	-0.237

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2	0.055	0.014	0.291	-0.219	0.029	0.015	-0.581	-0.149	-0.257	0.223	-0.232	0.074	0.183
3	0.434	-0.353	0.160	0.263	0.040	0.058	-0.100	0.054	-0.241	-0.064	-0.225	0.192	0.040
4	-0.093	-0.212	-0.089	0.268	0.054	0.212	-0.067	0.383	0.304	0.488	0.236	-0.009	0.145
5	0.448	-0.062	0.721	0.269	0.395	0.476	-0.187	0.265	-0.162	0.253	0.359	-0.020	0.165
6	0.041	0.176	0.249	-0.029	0.126	0.368	-0.380	-0.106	-0.457	-0.230	0.213	-0.463	0.181
7	0.347	-0.030	-0.207	-0.031	-0.205	-0.087	-0.525	-0.006	0.141	0.297	0.151	-0.180	0.190

```
     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 -7.4609 -7.7873 -7.9164 -7.9164 -7.9164 -7.9164
S.E_Logq   0.2957  0.2957  0.2957  0.2957  0.2957  0.2957
 Terminal year survivor and F summaries:
 Age 2 Year class =2014
source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.962      5059  2014
fshk                0.038        44  2014
 Age 3 Year class =2013
source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.961      1754  2013
fshk                0.039       101  2013
 Age 4 Year class =2012
source
                scaledWts survivors yrcls
```

```
UK (E&W)-BTS-Q3      0.95        633  2012
fshk                 0.05         83  2012
 Age 5 Year class =2011
source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.931        436  2011
fshk                0.069         58  2011
 Age 6 Year class =2010
source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.961        525  2010
fshk                0.039         50  2010
 Age 7 Year class =2009
source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3      0.96        174  2009
fshk                 0.04        208  2009
```

Table 33.10 - 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	0.1426	0.1335	0.1488
4	0.2956	0.3987	0.3520	0.3621	0.3158	0.3032	0.4192	0.3255	0.2866	0.3645	0.3931	0.3288
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	0.3751	0.3815	0.4260	0.9492	0.6027
7	0.3909	0.4415	0.4519	0.4310	0.4453	0.3962	0.4281	0.3704	0.3583	0.4758	0.6392	0.4825
+gp	0.3909	0.4415	0.4519	0.4310	0.4453	0.3962	0.4281	0.3704	0.3583	0.4758	0.6392	0.4825
FBAR 4-7	0.3901	0.4404	0.4508	0.4300	0.4442	0.3953	0.4270	0.3695	0.3575	0.4746	0.6372	0.4812

Age/Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	0.0034	0.0070	0.0452	0.0100	0.0062	0.0590	0.0096	0.0439	0.1125	0.1153	0.0800	0.0142
3	0.0953	0.0813	0.1808	0.1342	0.2752	0.1798	0.1717	0.2987	0.3984	0.3512	0.2869	0.1481
4	0.4771	0.3834	0.2428	0.3601	0.4212	0.5639	0.3693	0.4492	0.6777	0.4837	0.4096	0.3522
5	0.4077	0.5319	0.3793	0.3203	0.5516	0.7591	0.5592	0.5340	0.6609	0.3940	0.6060	0.4166
6	0.4370	0.3920	0.4326	0.3271	0.3367	1.2541	0.7260	0.6248	0.6066	0.4957	0.4124	0.5374
7	0.4421	0.4372	0.3526	0.3368	0.4379	0.8634	1.0944	0.6878	0.6580	0.6272	0.6720	0.8940
+gp	0.4421	0.4372	0.3526	0.3368	0.4379	0.8634	1.0944	0.6878	0.6580	0.6272	0.6720	0.8940
FBAR 4-7	0.4410	0.4361	0.3518	0.3361	0.4369	0.8601	0.6872	0.5739	0.6508	0.5001	0.5250	0.5500

Age/Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.0247	0.0716	0.0255	0.1040	0.0257	0.0619	0.0271	0.0568	0.0692	0.1624	0.0901	0.2107
3	0.2947	0.2334	0.3450	0.4158	0.3079	0.2034	0.2388	0.2823	0.2880	0.5803	0.4858	0.4561
4	0.4273	0.5228	0.4706	0.6176	0.4649	0.3428	0.2376	0.3152	0.5221	0.4837	0.4462	0.6968
5	0.4699	0.5205	0.4937	0.5066	0.7117	0.5398	0.2426	0.2669	0.4602	0.4641	0.3036	0.6786
6	0.5160	0.5516	0.5808	0.4925	0.3900	0.7243	0.5083	0.2990	0.3161	0.3064	0.2873	0.4069
7	0.5399	0.4136	0.5278	0.7399	0.3987	0.2584	0.8226	0.4963	0.2123	0.1688	0.2009	0.4112
+gp	0.5399	0.4136	0.5278	0.7399	0.3987	0.2584	0.8226	0.4963	0.2123	0.1688	0.2009	0.4112
FBAR 4-7	0.4883	0.5021	0.5182	0.5891	0.4913	0.4663	0.4528	0.3444	0.3777	0.3557	0.3095	0.5484

Age/Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	FBAR 14-16
2	0.0929	0.1006	0.0541	0.0432	0.0144	0.0283	0.0182	0.0351	0.0155	0.0076	0.0002	0.0078
3	0.3916	0.4195	0.2765	0.2980	0.1964	0.1784	0.3236	0.1260	0.0882	0.0534	0.0099	0.0505
4	0.5008	0.3215	0.3685	0.4035	0.2435	0.3367	0.3549	0.2409	0.0929	0.0802	0.0368	0.0700
5	0.4485	0.3132	0.2684	0.4739	0.3457	0.2613	0.3606	0.1749	0.1613	0.0564	0.0346	0.0841
6	0.5911	0.3073	0.3037	0.2612	0.3547	0.2875	0.2456	0.1469	0.0790	0.0932	0.0210	0.0644
7	0.3102	0.3914	0.2986	0.3829	0.1986	0.4951	0.2202	0.0945	0.1218	0.0516	0.0443	0.0726
+gp	0.3102	0.3914	0.2986	0.3829	0.1986	0.4951	0.2202	0.0945	0.1218	0.0516	0.0443	
FBAR 4-7	0.4627	0.3333	0.3098	0.3804	0.2856	0.3452	0.2953	0.1643	0.1137	0.0703	0.0342	

Table 33.11 - 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	15773	9041	8849	5071	4499	2463
3	8349	3316	9101	2853	11533	5288	5795	3462	14061	8119	7905	4411	4004
4	4145	6703	2588	7595	2236	9588	4087	4887	2737	11812	6370	6259	3439
5	1368	2791	4071	1647	4784	1476	6406	2432	3193	1859	7424	3890	4076
6	4389	794	1451	2221	960	2699	822	3581	1465	1930	894	3809	2112
7	939	2585	498	802	1234	504	1642	509	2227	905	1140	313	1886
+gp	8212	5534	4321	3418	2829	3220	2221	2193	2042	1713	2536	2366	1164
TOTAL	31097	31900	25214	31667	29447	29455	24831	32836	34766	35188	31340	25546	19144

Age/Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	5560	15488	16262	23779	3465	3503	4380	5573	12708	4962	6201	5262	2007
3	2221	4996	13395	14568	21382	2955	3139	3793	4506	10246	4145	5532	4645
4	3294	1852	3773	10598	10010	16163	2252	2107	2304	2869	6959	3234	3728
5	1931	2031	1315	2382	6293	5154	10109	1300	968	1285	1724	4427	1909
6	2453	1026	1258	864	1241	2666	2666	5363	608	591	634	1028	2504
7	1234	1500	603	821	558	320	1167	1291	2645	335	354	335	555
+gp	2095	1964	2707	2502	1458	807	536	1011	1029	1982	1210	1315	1082
TOTAL	18789	28857	39312	55513	44407	31568	24248	20437	24767	22271	21226	21133	16429

Age/Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	2502	8406	6927	5273	6980	4569	2334	3062	3650	2965	1323	1876	1969
3	1690	2207	6855	6109	4485	6147	3906	1971	2355	3018	2173	1091	1535
4	3328	1083	1318	4559	4510	3196	4194	2649	998	1311	1731	1329	649
5	2000	1881	529	749	2928	3218	2110	2252	1478	578	591	949	872
6	1026	1105	1025	235	395	2079	2230	1205	1281	987	265	341	628
7	1305	520	611	628	103	215	1395	1471	803	870	595	133	227
+gp	886	1062	1348	1069	479	728	1188	2327	1041	1143	1490	963	850
TOTAL	12737	16264	18611	18621	19880	20150	17356	14936	11605	10871	8168	6683	6730

Age/Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	GMST 70-14
2	2287	1622	640	990	701	821	2094	4658	0	4176
3	1688	1982	1447	563	880	612	731	1881	4214	
4	1054	1134	1473	1095	369	702	507	627	1685	
5	406	637	804	952	695	262	579	424	547	
6	603	229	408	560	601	528	202	495	370	
7	419	420	145	277	397	469	441	166	438	
+gp	533	921	327	611	955	515	1554	784	823	
TOTAL	6990	6944	5244	5048	4597	3909	6109	9035	8077	

Table 33.12 - Sol.27.7a - Summary

	RECRUITS Age 2	SSB	BIOMASS	LANDINGS	FBAR 4- 7	YIELD/SSB
1970	3695	6436	7132	1785	0.3901	0.28
1971	10177	6222	7406	1882	0.4404	0.3
1972	3186	5011	5727	1450	0.4508	0.29
1973	13133	5123	6553	1428	0.4300	0.28
1974	5870	5068	6189	1307	0.4442	0.26
1975	6680	5359	6229	1441	0.3953	0.27
1976	3857	4889	5501	1463	0.4270	0.3
1977	15773	4490	5510	1147	0.3695	0.26
1978	9041	5092	6245	1106	0.3575	0.22
1979	8849	5685	6888	1614	0.4746	0.28
1980	5071	5514	6430	1941	0.6372	0.35
1981	4499	5166	5909	1667	0.4812	0.32
1982	2463	4332	4747	1338	0.4410	0.31
1983	5560	4097	4919	1169	0.4361	0.29
1984	15488	4606	6792	1058	0.3518	0.23
1985	16262	5645	7864	1146	0.3361	0.2
1986	23779	6961	9528	1995	0.4369	0.29
1987	3465	7173	8567	2808	0.8601	0.39
1988	3503	5528	6006	1999	0.6872	0.36
1989	4380	4644	5193	1833	0.5739	0.39
1990	5573	3640	4302	1583	0.6508	0.43
1991	12708	3200	4492	1212	0.5001	0.38
1992	4962	3462	4471	1259	0.5250	0.36
1993	6201	3243	3874	1023	0.5500	0.32
1994	5262	4067	5001	1374	0.4883	0.34
1995	2007	3537	3979	1266	0.5021	0.36
1996	2502	2725	3095	1002	0.5182	0.37
1997	8406	2511	3458	1003	0.5891	0.4
1998	6927	3042	4273	911	0.4913	0.3
1999	5273	3338	4346	863	0.4663	0.26
2000	6980	3140	3931	818	0.4528	0.26
2001	4569	3584	4335	1053	0.3444	0.29
2002	2334	3600	4043	1090	0.3777	0.3
2003	3062	3239	3640	1014	0.3557	0.31
2004	3650	2314	2797	709	0.3095	0.31
2005	2965	2087	2527	855	0.5484	0.41
2006	1323	1650	1901	569	0.4627	0.34
2007	1876	1405	1665	492	0.3333	0.35
2008	1969	1343	1597	332	0.3098	0.25
2009	2287	1087	1361	325	0.3804	0.3
2010	1622	1212	1477	277	0.2856	0.23
2011	640	1109	1270	330	0.3452	0.3
2012	990	1181	1326	298	0.2953	0.25
2013	701	1125	1247	148	0.1643	0.13
2014	821	916	1011	99	0.1137	0.11
2015	2094	1374	1621	76	0.0703	0.06
2016	4658	1333	1816	35	0.0342	0.03
Arith. Mean	5683	3649		1098	0.4231	0.29
Units	(Thousands)	(Tonnes)		(Tonnes)		

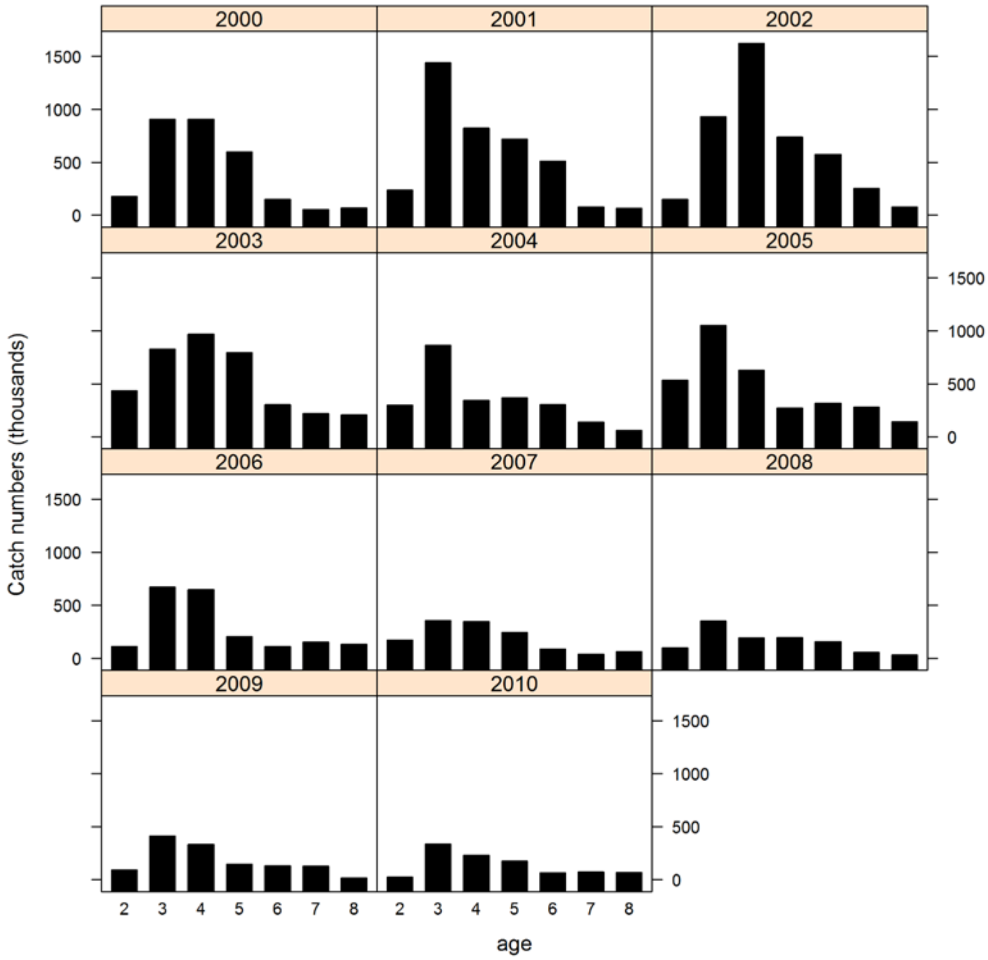


Figure 33.1.a. Sol.27.7.a. Age composition of landings.

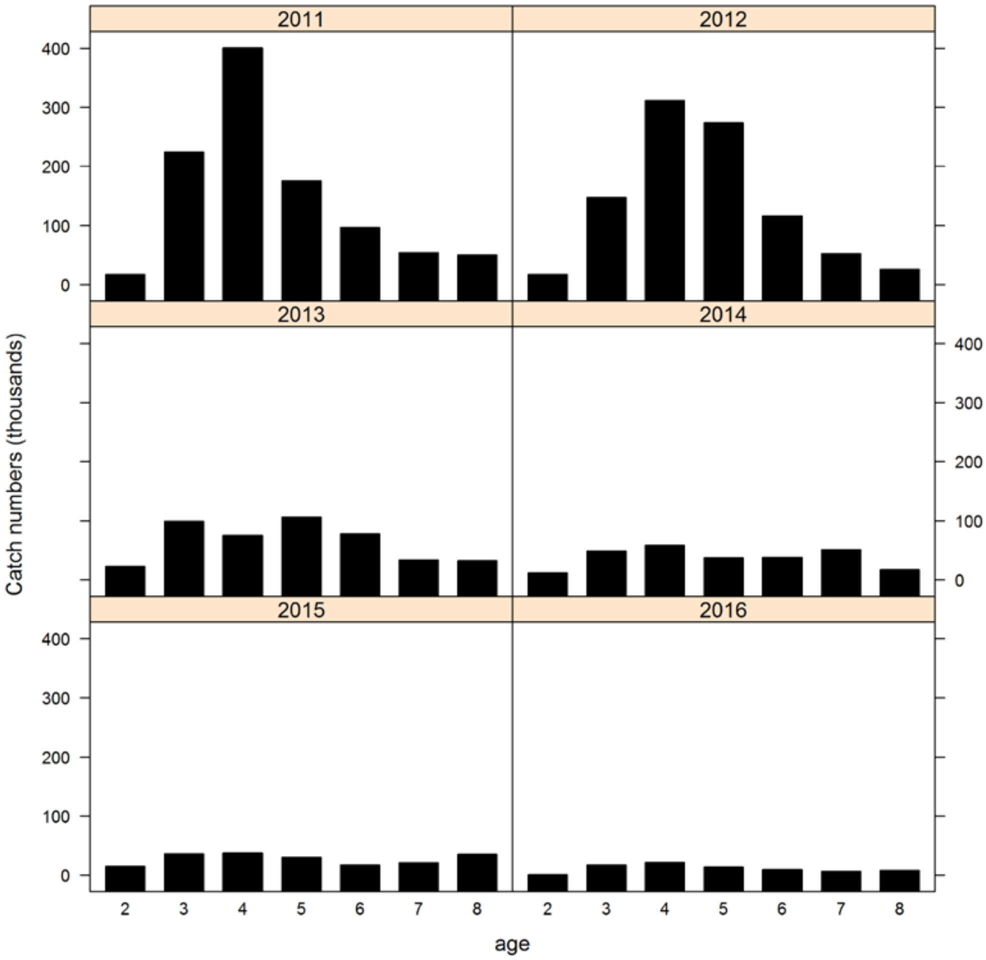


Figure 33.1.b. Sol.27.7.a. Age composition of landings.

Figure 33.2a - Sol.27.7a - BE Length distributions of discarded and retained fish from discard sampling studies (Beam trawl)

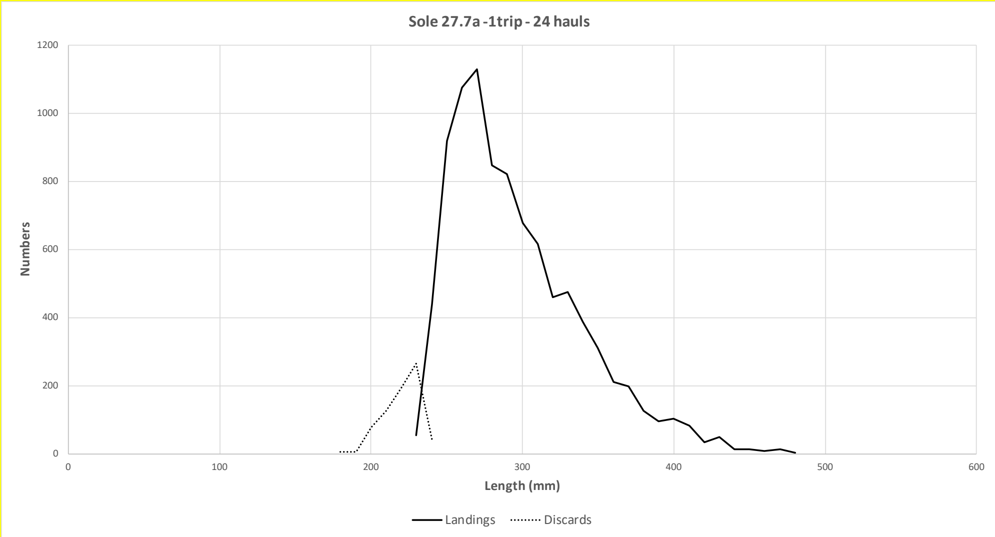


Figure 33.2b - Sol.27.7a - IR Length distributions of discarded and retained fish from discard sampling studies (Otter trawl)

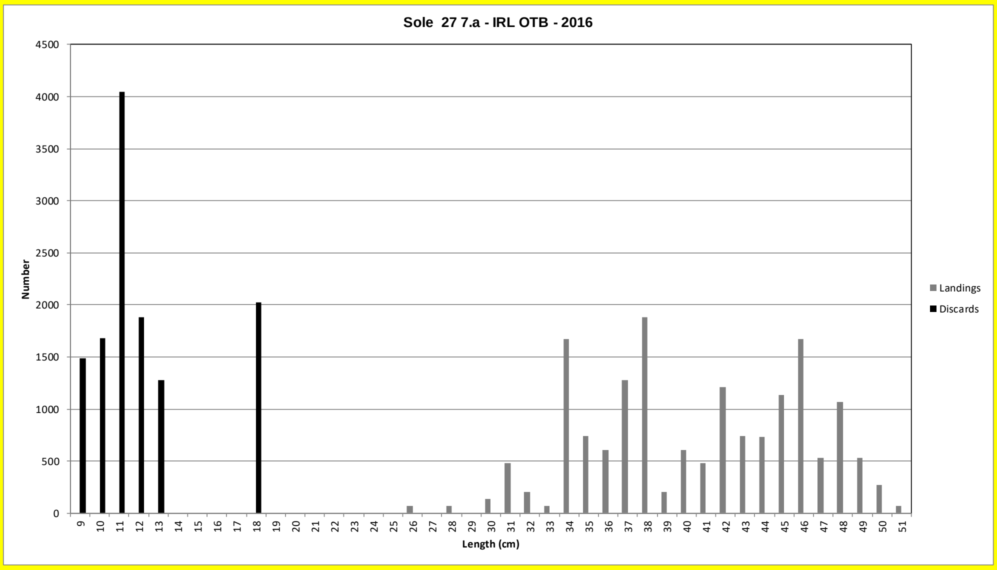


Figure 33.3a - Sol.27.7a - Effort series

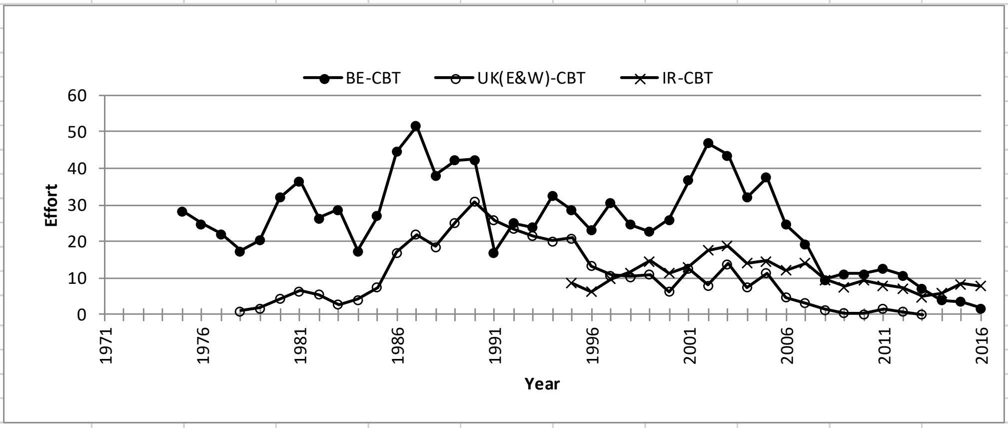


Figure 33.3b - Sol.27.7a - Relative effort series

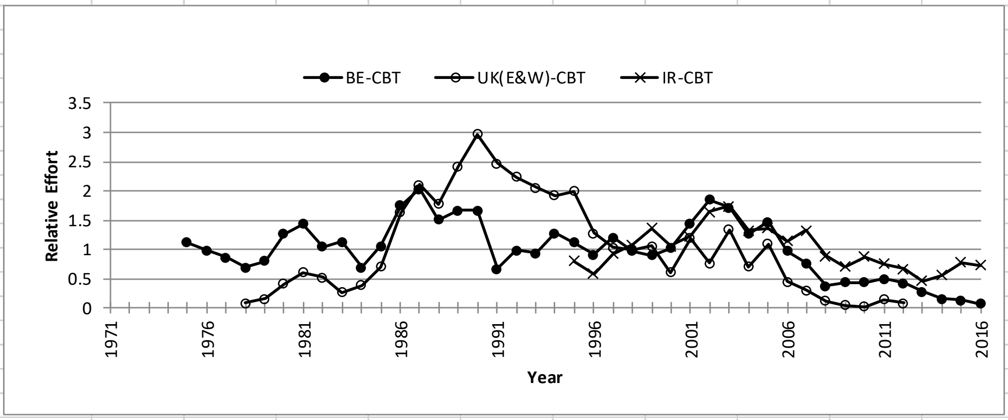


Figure 33.3c - Sol.27.7a - Relative LPUE series

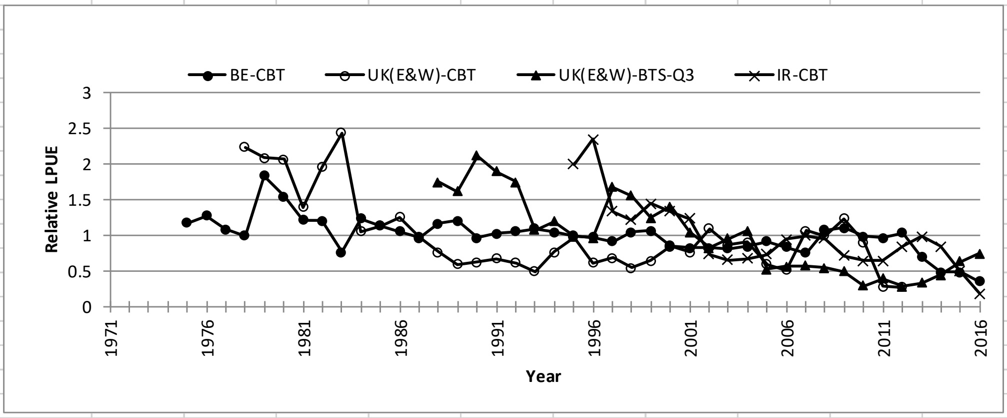


Figure 33.4a - Sol.27.7a - Effort series

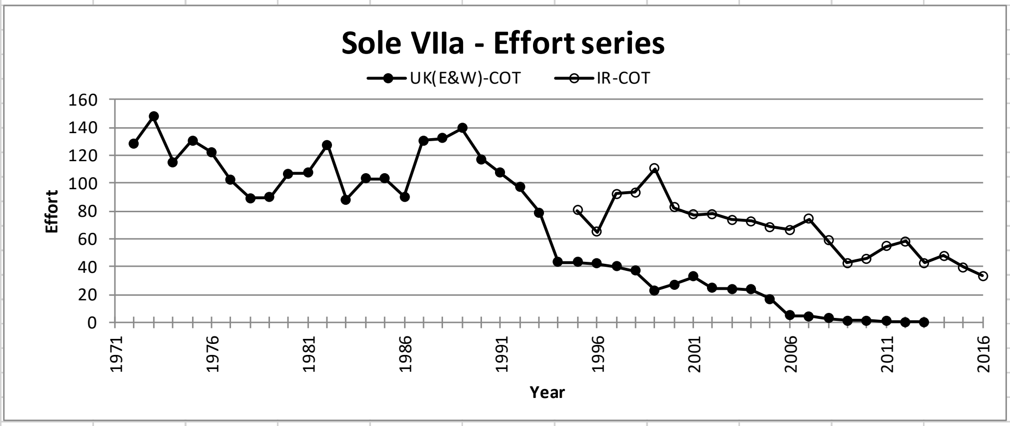


Figure 33.4b - Sol.27.7a - Relative effort series

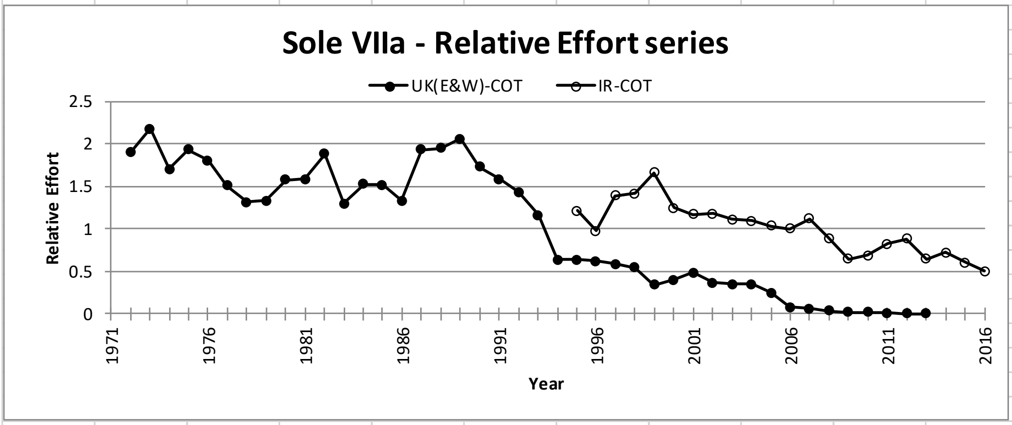


Figure 33.4c - Sol.27.7a - Relative LPUE series

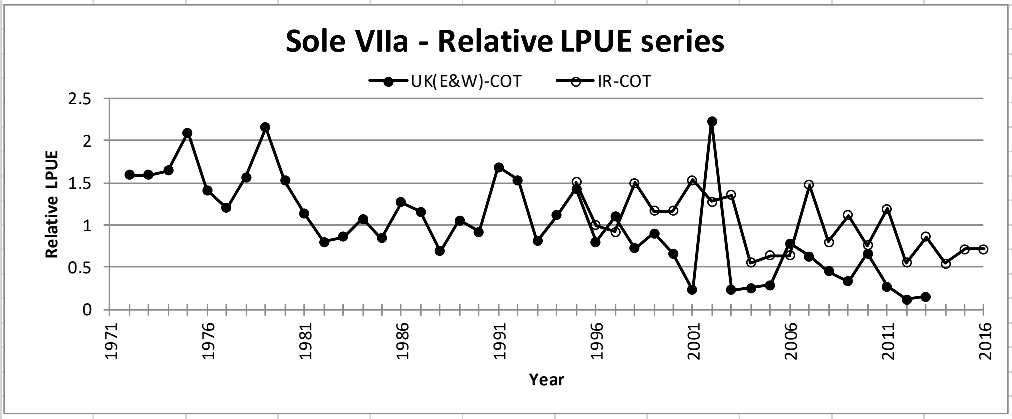


Figure 33.5 - Sol.27.7.a - Mean-standardised indices

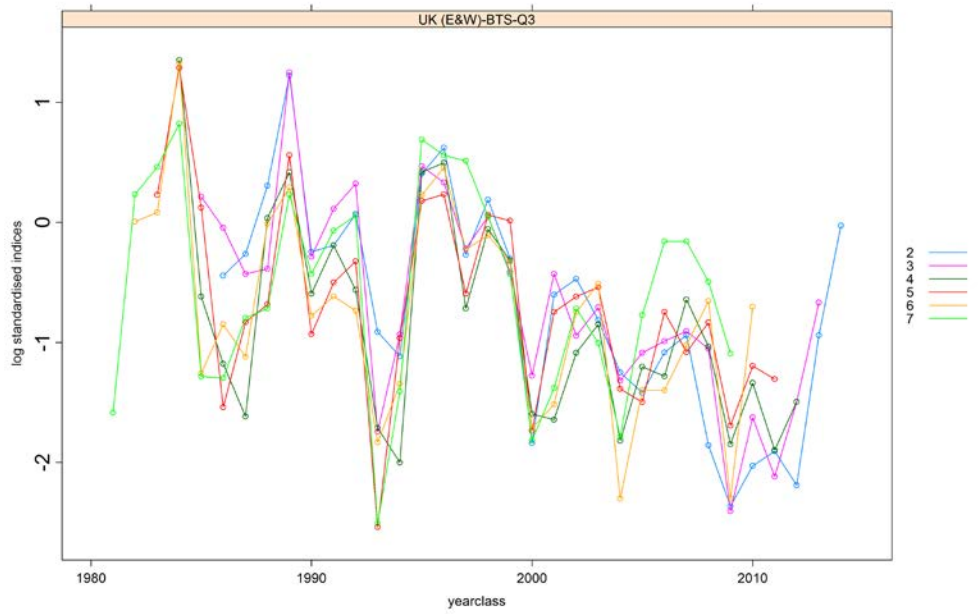


Figure 33.6 - Sol.27.7a - Consistency plot UK(E&W)-BTS-Q3 survey

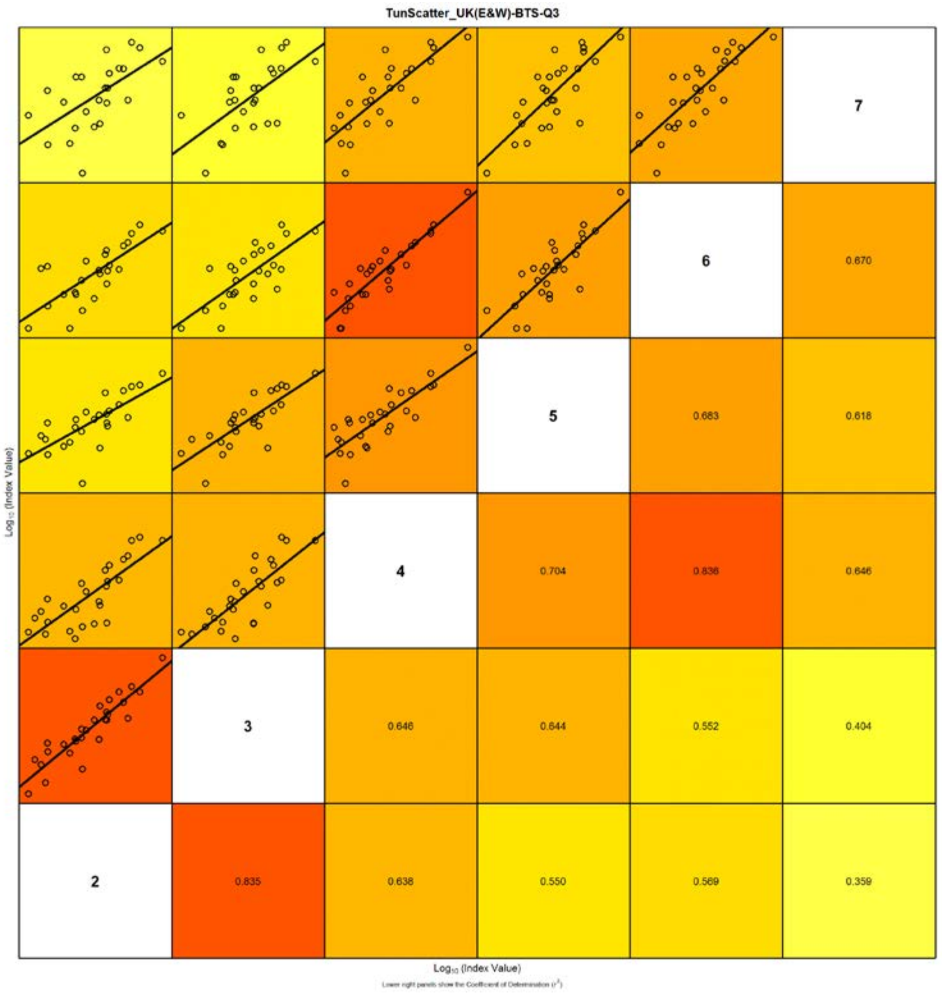


Figure 33.7 - Sol.27.7a - LOG CATCHABILITY RESIDUAL PLOTS - Final XSA

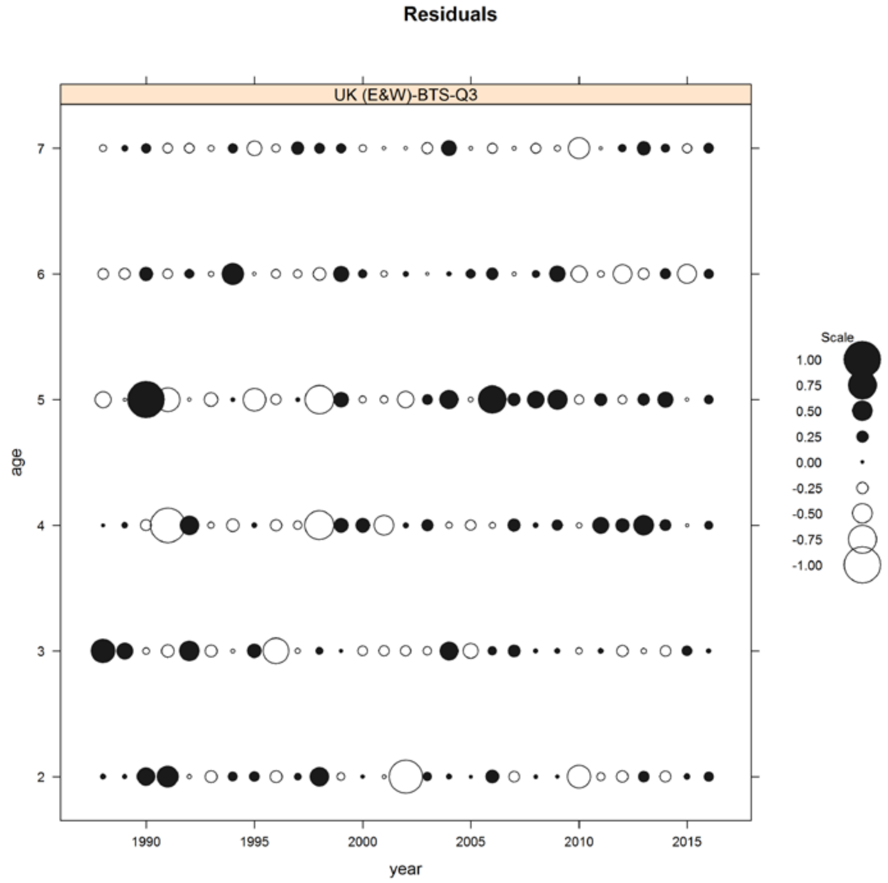


Figure 33.8 - Sol.27.7a - Summary plots

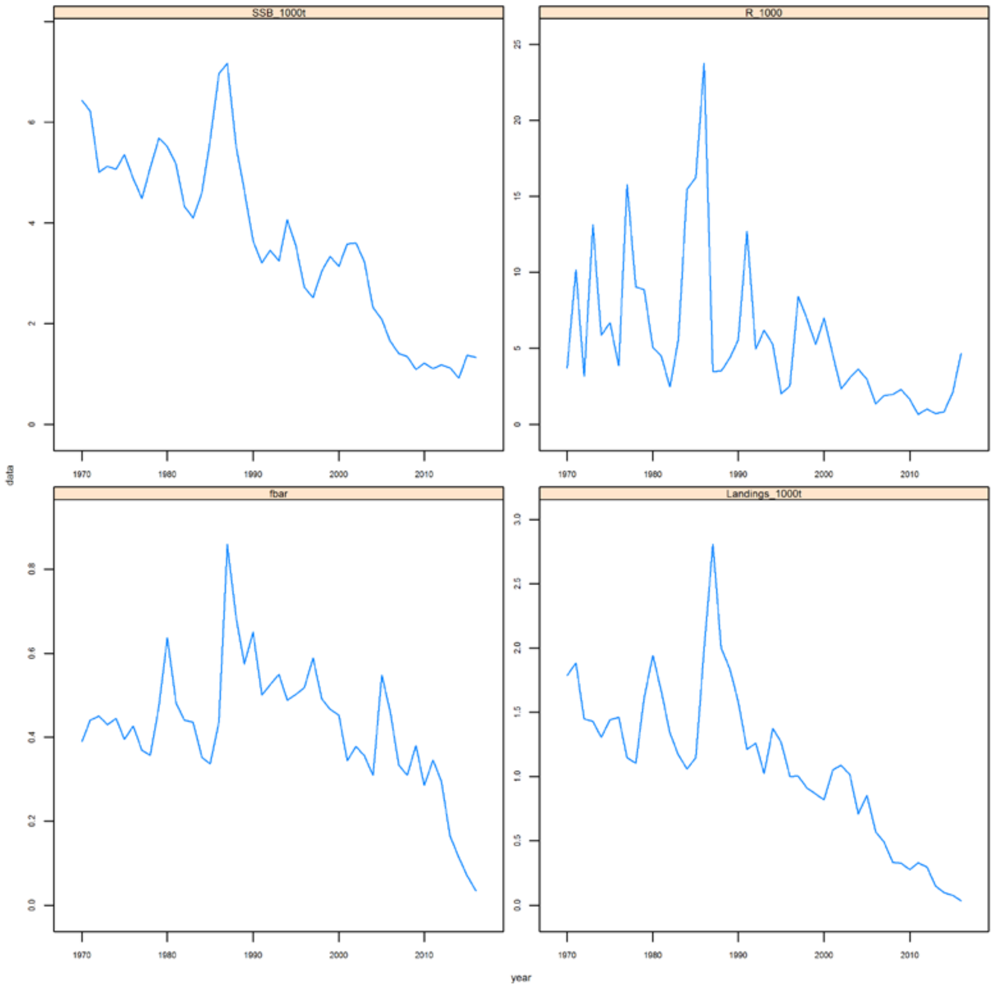


Figure 33.9 - Sol.27.7a - Retrospective XSA analysys (shinkage SE=1.5)

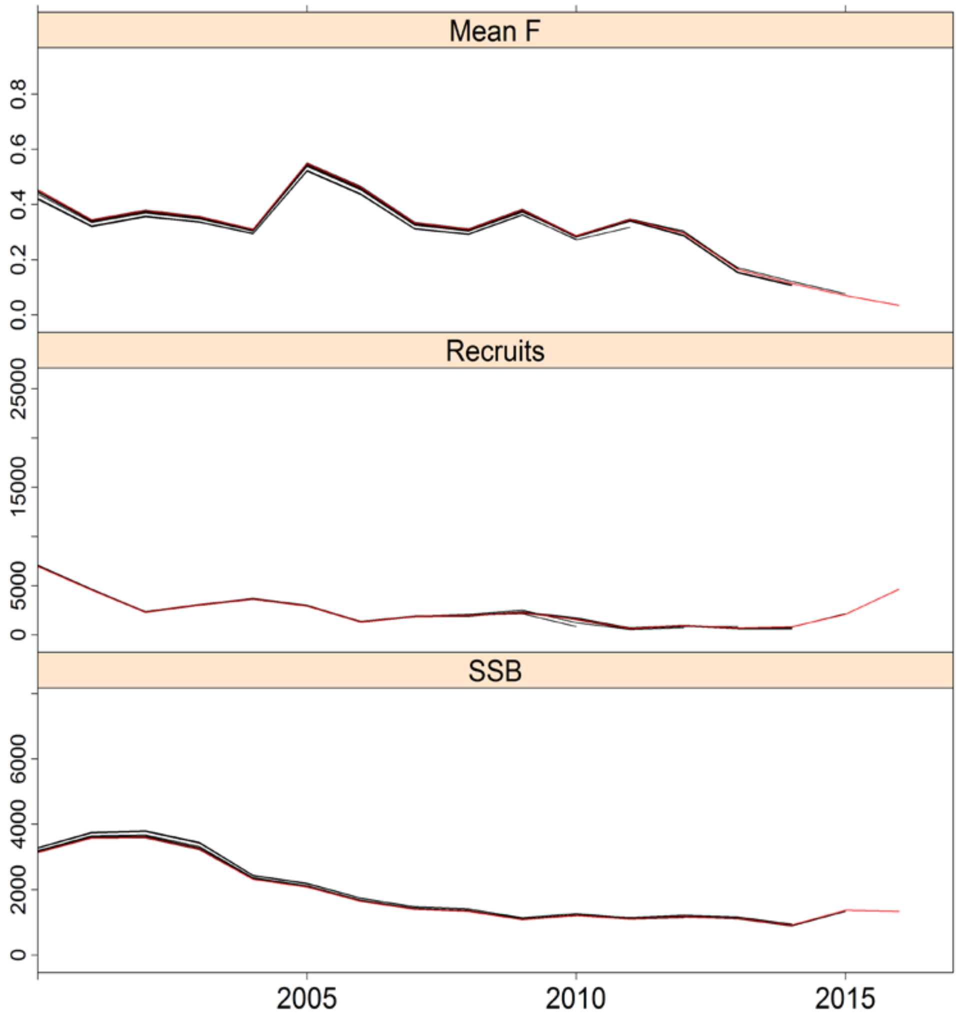


Figure 33.10 - Sol.27.7a - comparison with last year's assessment

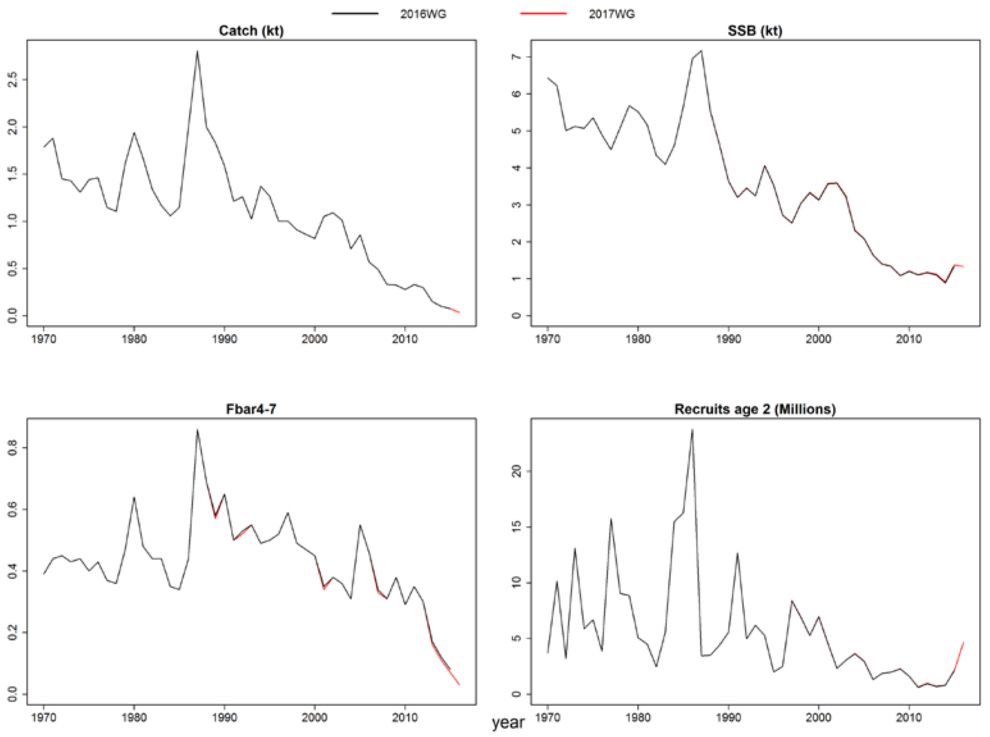
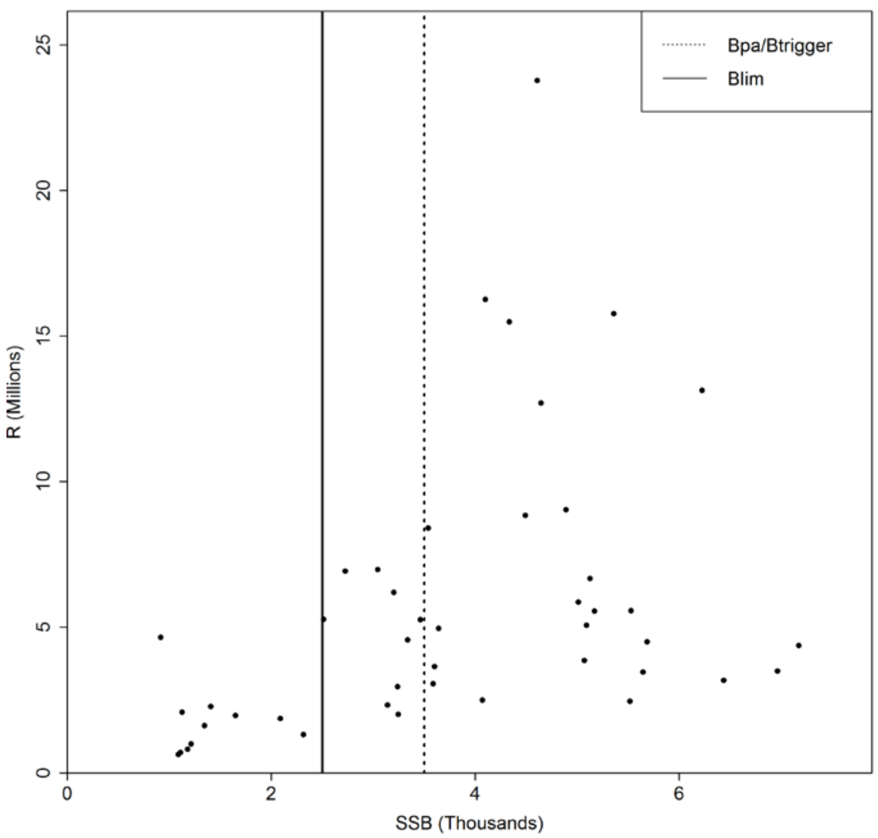


Figure 33.11 - Sol.27.7a - Stock–recruitment plot



34 Sole in West of Ireland Division 7.bc

Type of assessment in 2016

No assessment was performed.

34.1 General

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.

Data

The time-series of official landings is presented in Table 33.1 and Figure 33.1.

The time-series of otter-trawl landings effort and lpue since 1995 are shown in Figure 33.2. 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 2016 was good with 20 length samples taken, 1863 fish measured, 452 fish aged and ten discard trips. The estimated age distribution for the stock is shown in Figure 33.3. This shows a broad age distribution with fish >10 years still fairly abundant. There is also an indication that the 2007 and 2008 year classes were strong (ages 8 and 9 in 2016). Discard estimates are negligible <300 kg.

Historical stock development

No analytical assessment was performed.

Table 33.1. 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		
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

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
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									

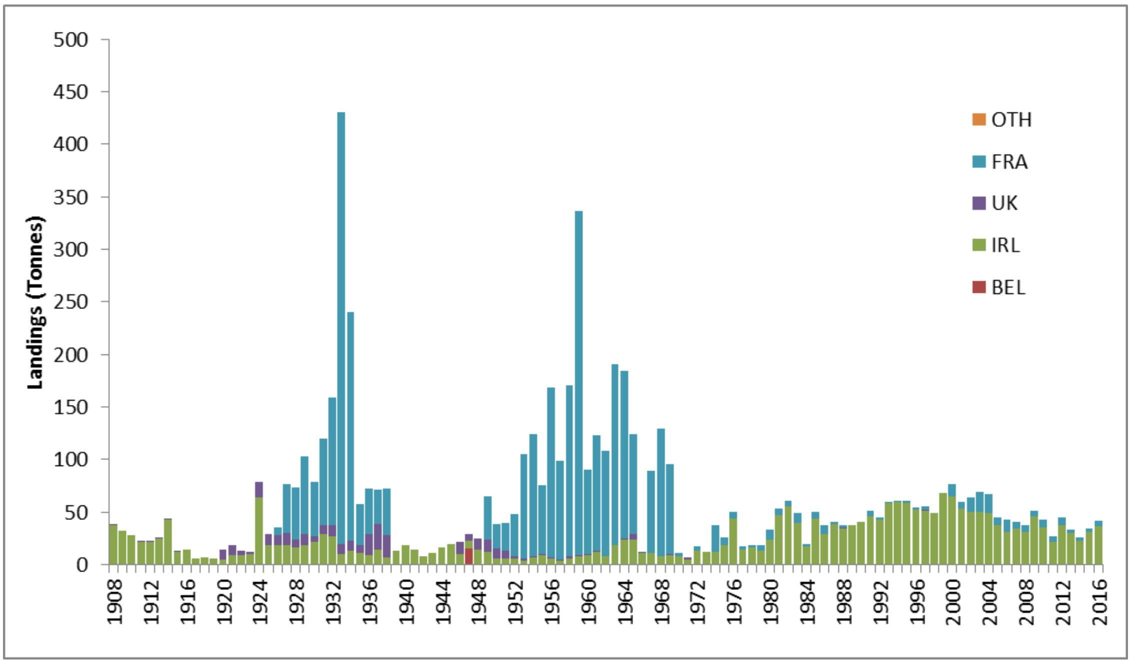


Figure 33.1. Landings of Sole in 7.bc as officially reported to ICES (1908–2016).

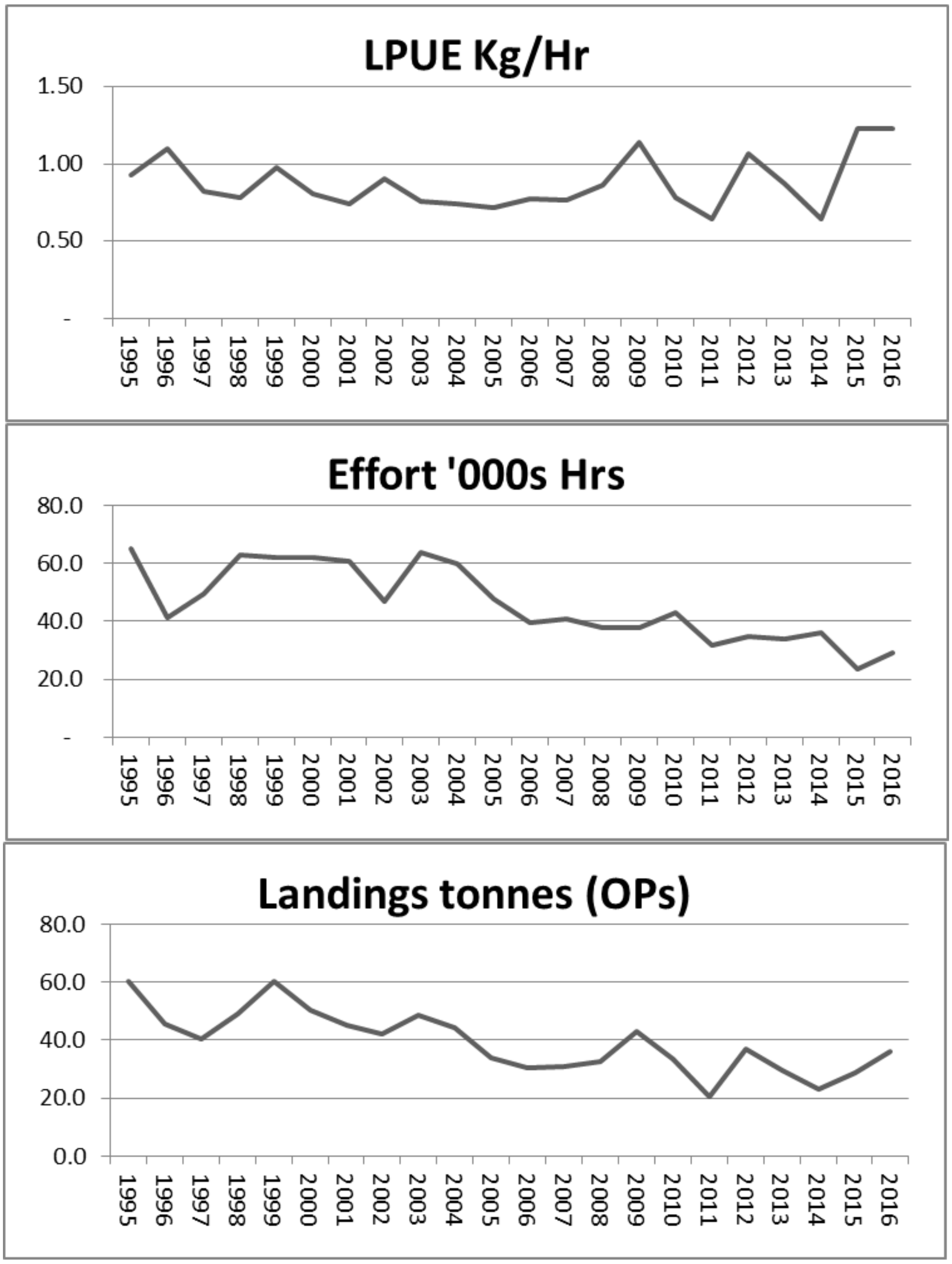


Figure 33.2. Sole in 7.b Irish otter trawl landings effort and lpue since 1995.

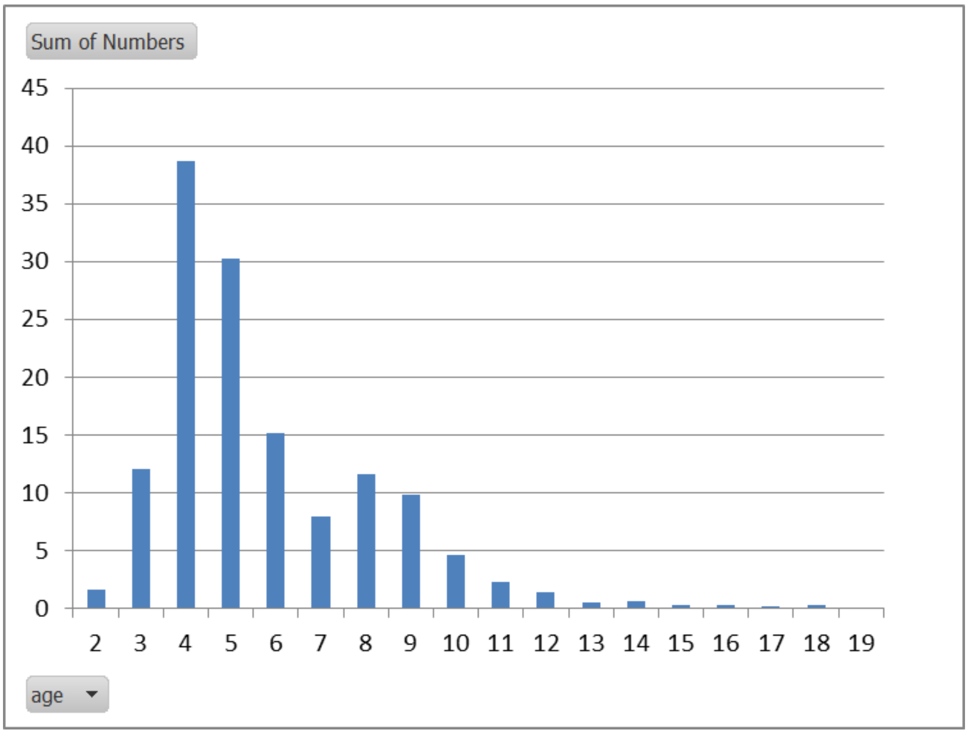


Figure 33.3. Estimated age distribution of sole 7.bc catches in 2016 based on Irish sampling.

35 Sole in Division 7.e

Type of assessment in 2016

Last year's assessment report is available at:

http://ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2016/WGCSE/08.03_Sole%20VIIe_2016.pdf

ICES advice applicable to 2016

Last year's advice is available at:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/sol-echw.pdf

35.1 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 35.1.

Official landings in 2016 were 913t, an 8% undershoot of the TAC in 2016 (979 t). A UK single area licence scheme introduced at the end of 2008 stopped the previous practice of misreporting; previous UK landings estimates have been corrected for area misreporting to ICES Division 27.7.d which brought UK landings into line with the national quota.

The TAC and the national quotas by country for 2017

Species:	Plaice *Pleuronectes platessa*	Zone:	7.d and 7.e (PLE/7DE.)
Belgium	42		
France	443		
United Kingdom	693		
Union	1178		
TAC	1178	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) 2017/127, ANNEX IA)

The TAC and the national quotas by country for 2016

Species:	Plaice *Pleuronectes platessa*	Zone:	7.d and 7.e (PLE/7DE.)
Belgium	35		
France	369		
United Kingdom	575		
Union	979		
TAC	979		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) 2016/72, ANNEX IA)

Landing obligation

In 2016, the landing obligation applied to the sole 7.e stock for the first time.

The Commission Delegated Regulation (EU) 2015/2438 (EC, 2015) introduced the landings obligation for this stock covering the years 2016–2018. According to this regulation all catches of sole with trammelnets and gillnets are subject to the landing obligation. For beam trawls, landings are subject to the landing obligation for those vessels, where the total landings consisted of more than 10% of sole during the reference years 2013 and 2014. However, a *de minimis* exemption applied. For trammelnets and gillnets up to a maximum of 3% of the total annual sole catches may be discarded. Additionally, for beam trawls, vessels using gear with increased selectivity (TBB 80–199 mm) may also discard up to 3% of the total annual sole catches.

The landing obligation for this stock was refined in Commission Delegated Regulation (EU) 2016/2375 (EC, 2016), covering the years 2017–2018. The rules for trammelnets and gillnets remained the same. For beam trawls the reference period was changed to 2014–2015 and the threshold reduced from 10% to 5%. The current landing obligation for beam trawls now applies if the annual landings of during 2014–2015 consisted of more than 5% of sole. The *de minimis* exemption applies as before, except for the mesh size for the beam trawls with increased selectivity, which was changed from 80–199 to 80–119.

Given the low discards observed in the fishery the landings obligation is unlikely to have a significant impact on this stock or the advice.

The current rules as set out by the Commission Delegated Regulation (EU) 2016/2375 (EC, 2016) are shown below:

Fisheries in ICES Division 7.e for common sole.

Fishery	Gear Code	Fishing gear	Mesh Size	Landing Obligation
Common Sole (*Solea solea*)	TBB	All Beam trawls	All	All catches of common sole where the total landings per vessel of all species in 2014 and 2015 (*6) consisted of more than 5% of common sole
Common Sole (*Solea solea*)	GNS, GN, GND, GNC, GTN, GTR, GEN	All Trammelnets & Gillnets	All	All catches of common sole

(*6) Vessels listed as subject to the landing obligation in this fishery in accordance with Delegated Regulation (EU) 2015/2438 remain on the list indicated in Article 4 of this Regulation despite the change in the reference period and continue being subject to the landing obligation in this fishery.

Source: Commission Delegated Regulations (EU) 2016/2375 (EC, 2016)

Furthermore, Article 3 defined the following *de minimis* exemptions:

By way of derogation from Article 15(1) of Regulation (EU) No 1380/2013, the following quantities may be discarded:

> For common sole (*Solea solea*), up to a maximum of 3% in 2017 and 2018 of the total annual catches of that species by vessels using trammel and gillnets to catch common sole in ICES divisions 7.d, 7.e, 7.f and 7.g;
>
> For common sole (*Solea solea*), up to a maximum of 3% in 2017 and 2018 of the total annual catches of that species by vessels obliged to land common sole and using TBB gear with mesh size of 80–119 mm with increased selectivity, such as a large mesh extension, in ICES divisions 7.d, 7.e, 7.f, 7.g and 7.h.

Source: Commission Delegated Regulations (EU) 2016/2375 (EC, 2016)

35.2 Data

InterCatch

International catch data are collated using the ICES InterCatch platform. For 2016, Belgium, France, the United Kingdom (England, Scotland, the Channel Islands Guernsey and Jersey) uploaded data into InterCatch (Figures 35.1 and 35.2).

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 1980 and have been around 1000 t since the 1990s. Landings were relative low in 2015 (774 t) but increased again to 913 t in 2016.

Only the UK and France provided age-structured landings samples in InterCatch.

Total international landings numbers-at-age (Table 35.2, Figure 35.5) and landings and stock weights-at-age (Tables 35.3 and 35.4; Figure 35.6) as used in the assessment were derived in accordance with the procedures outlined in the stock annex. Some

UK age information was used to supplement sparse French age information at larger lengths between 2009 and 2014.

Sampling levels are detailed in InterCatch.

Discards

Discards for this stock are low and not included in the assessment.

For 2016, France and the UK provided discard information for some fleets in InterCatch. Age-structured discard samples are very sparse and only provided by the UK. As discard are considered to be low, discards were not raised to an international level or allocated with an age structure from sample data.

Discard data are only available from InterCatch for the years 2012–2016. In general, the discard rates are low (Figure 35.3). The reported discards accounted for 6.6% in 2015 and 1.1% in 2016. The three-year average (2014–2016) is 2.9%. The current discard rate is comparable to 2014 and a decrease compared to 2015. In 2016 10.5 t of discards were reported. This reduction in the discard rate might potentially be linked to the introduction of the landings obligation in 2016.

The discards rate by fleet and country are shown in Figure 35.3 (shown are only reported discards and for those fleets that reported discards). For the UK, the discard rates are very low and below 0.6%. France reported discard rates higher than 1% for three fleets: OTB_DEF_70-99_0_0 3.9%, OTT_DEF_>=70_0_0 12.5% and TBB_DEF_all_0_0_all 4.7%. The OTT gears are not specifically covered by the landing obligation, as the landing obligation only refers to beam trawls, trammelnets and gillnets. OTB however, should have been covered by the landing obligation in 2016, if the vessel caught more than 10% sole in 2014 and 2015. As the amount of sole landed by the French OTB_DEF_70-99_0_0 is substantially (144 t), and the reported discard rate is above the *de minimis* exemption of 3%, not all vessels might have strictly adhered to the landing obligation. In general, on an international level compliance with the landing obligation seems well.

Available length frequency information from discard observer trips are shown in Figures 35.8 and 35.9.

Substantial discarding of undersized sole occurs occasionally in the coastal waters by French trawlers using modified gears to target cuttlefish. However, it has not been possible up until now to use these data when extrapolating discards samples to the fleet-level given the relatively low sampling rate of this seasonal activity. The French discards estimates in 2016 include all samples to show the magnitude of the issue, and highlight the need for further work to build a coherent time-series of discard estimates. The selectivities of the gears used to target sole are highly selective for fish above the minimum landings size and only a few sporadic cases of high-grading (included in the numbers above) have been observed. Consequently, discarding of sole is relatively low compared to other stocks.

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

Only the United Kingdom revised data for 2015, increasing the landings from 487 to 489 t.

Biological

Natural mortality was assumed to be constant over ages and years at 0.1 and 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. The review group suggested developing temporally variable maturity data for this stock. However, the surveys usually used for such estimates are conducted in September due to the much better quality control on staging individuals. This time of year has been determined to be unreliable for estimating maturity for this species as gonadal development has not commenced. A new quarter 1 survey may provide better data which could be considered at another benchmark meeting.

In agreement with the stock annex stock and catch weights-at-age were derived by fitting a 2nd degree polynomial model to the raw landings weights-at-age extracted from InterCatch (Figure 35.7).

Survey indices

IBPWCFlat2 2015 (ICES, 2015) updated the derivation of cpue estimates for the UK-FSP and Q1SWBeam surveys to make full use of the available sampling data. Updated cpue estimates exhibited similar temporal trends to those presented previously but with more variability due to the inclusion of additional numbers-at-age information.

Aggregated cpue estimates for the UK-FSP and Q1SWBeam surveys increased between 2012 and 2014 to reach the highest levels of the time-series. Cpue estimates for ages 6–8 increased in both survey indices during this time period. A decrease in aggregated cpue estimates was evident in both survey indices between 2014 and 2015 due to reductions in the abundance of sole aged 3–7. Year-class estimates from the surveys have remained below average since 2012.

Abundance estimates derived from the surveys are given in Table 35.6 and shown in, Figures 35.11, 35.12 and 35.13. Year-class tracking was relatively good with historical consistency in the estimation of strong and weak cohorts and no major year effects in cpue estimates. Notable differences between the commercial and survey tuning series are the 1998 year class. This is well represented in the commercial data, but less clearly in the survey data. The 1998 year class was also seen to be very strong in the 7.f and 7.g stock and may represent some overspill of recruitment from that stock in the adjacent western part of 7.e, not observed by the Q1SWbeam survey.

The UK-FSP survey

The UK Fisheries Science Partnership (UK-FSP) conducted another survey, now in its 14th year (only 13 years used for sole due to data issues), of sole and plaice abundance in the Western English Channel. The results indicate that sole continue to be widespread in the area and that a large number of cohorts contribute to the stock. The working group has reported on this survey on several occasions and the information is now included in the assessment following the benchmark in 2012. Abundance estimates for the UK-FSP survey increased markedly from 2010 to 2014, but dropped in 2015 and slightly further in 2016.

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 for the fourth time. The survey shows strong gradients in species composition within the Western English Channel (justifying the stratification approach), although there is some indication that more appropriate post stratification could potentially provide an increase in precision of single-species abundance estimates. Aggregated cpue estimates for the Q1SWBeam survey increased to reach the highest levels on record 2014, dropped markedly in 2015 but recovered again in 2016.

Commercial fleets effort and lpue

IBPWCFlat2 (ICES, 2015) revised the effort time-series for the UK commercial beam (UK-CBT) and otter trawl (UK-COT) fleets due to fluctuations in lpue estimates after 2012 arising from modifications in the UK e-logbook effort recording system. Revised landings numbers, effort in days and lpue estimates in kg per 1000 days exhibited similar temporal trends to those presented previously, except with greater stability after 2012.

Effort for under 24 m UK beam trawlers in days fished steadily increased between 1992 and 2012 to reach the highest levels on record and stayed around this level until the end of the time-series (Figure 35.10). 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 thereafter, reaching a minimum in 2013. Since then, the effort increased again slightly and almost reached the long-term average in 2016. Beam trawlers over 24 m have declined in favour of smaller boats due to a combination of the UK decommissioning scheme and the substantial increases in fuel costs, making the larger boats commercially unviable. The decline of the larger boats has resulted in a resurgence of the use of under 24 m vessels. Given the licence transfer rules currently in force in the UK, restructuring of the fleets will lead to a 10% decrease in the kW day capacity of replaced vessels not withstanding any latent capacity. 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. The reason for is likely to be linked to a shift in the size of fishing vessels to smaller vessels. Gross registered tonnage corrected effort used in the assessment shows a strong decline in effort in the main fleet exploiting the stock in 2009 as vessels moved out of the area following the introduction of the UK single area licensing scheme.

Otter trawl effort included as tuning information in the assessment has declined steadily since 1989 and is now at historically low levels, but this fleet took only a small proportion (8%) of the landings in the last year in which it showed any activity (2015).

All fleets exhibited an increase in lpue estimates from the low point in 2004 to around the average of the time-series thereafter. Lpue estimates for UK beam trawlers under and over 24 m steadily decreased from 1988 to 2004 and then increased from 2004 to 2005. Since 2008, lpue estimates for the UK-CBT fleet have been relatively stable below the average of the time-series. For the UK-COT fleet, lpue estimates have been relatively consistent, fluctuating around the average of the time-series since 1993, but reported no activity in 2016.

Age disaggregated commercial abundance indices for the UK-CBT-late and UK-COT fleets are given in Table 35.5 and plotted mean standardised by cohort and year in Figures 35.11 and 35.12. The UK-CBT-late fleet shows good year-class tracking indicated by the consistent estimation of strong and weak year classes at different ages with little indication of year effects in the time-series. In addition, the UK-COT fleet shows good year-class tracking over the middle of the time period and indicates a decline in lpue in the early 1980s. This is likely in part caused by the strong year effect seen for this fleet in 1991 and to a lesser degree in 2004. The causes of this are not clear from anecdotal evidence, but sampling for the fleet is now at relatively low levels due to the small size of the fleet and landings. In 2013, the review group commented on the use of commercial tuning data which appear to show undesirable trends. The reasons for using these data were justified by WKFLAT 2012 (ICES, 2012) and these reasons still apply.

Information from the fishing industry

No comments were received in 2017 regarding the assessment or management of this stock beyond the information from the UK fisheries–science partnership already formally included in the assessment process. Industry reports from France indicated a decrease in fishing effort on sole in 2015, with fleets increasingly targeting other economically valuable species and some vessels exiting the fishery.

35.3 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 four tuning fleets (two fishery-independent surveys: UK-FSP and Q1SWBeam; and two commercial lpue time-series: UK-CBT-late and UK-COT). At IBPWCFlat2 2015, the XSA model parameterisation was updated to incorporate revised tuning information due to modifications in the UK e-logbook effort recording system.

Data screening

Data screening procedures identified no anomalies in the catch numbers-at-age, weights or tuning information used in the 2017 assessment.

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). Commercial lpue estimates in kg per 1000 days fished for the UK-CBT-late and UK-COT fleets were included in the assessment for the third time. IBPWCFlat2 2015 decided to exclude the UK-CBT-early fleet from the tuning indices due to the time-series contributing relatively little to assessment outputs except for noise and the log catchability residuals from the fitted data showed a decreasing trend over time.

The UK commercial otter trawl fleet (UK-COT) reported zero effort in 2016 and therefore a lpue value for 2016 for this fleet does not exist. 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 35.6. All four of the tuning indices possess relatively consistent year-class estimates with few clear year effects (Figures 35.11, 35.11 and 35.12).

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), which had no major impacts on the diagnostics or the interpretation of the assessment.

The XSA assessment settings used at the last three working groups are shown in the table below and more historic settings have been included in the stock annex.

	WGCSE 2015*	WGCSE 2016	WGCSE 2017
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	2006–2014 2–11 (non-offset)	2006–2015 2–11 (non-offset)	2006–2016 2–11 (non-offset)
UK-FSP	2004–2014 2–11	2004–2015 2–11	2004–2016 2–11
UK combined beam (early) Ages	–	–	–
UK combined beam (late) Ages	2003–2014 3–11	2003–2015 3–11	2003–2016 3–11
UK otter trawl Ages	1988–2014 3–11	1988–2015 3–11	1988–2016** 3–11
UK-WEC-BTS Ages	–	–	–
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

***Note that the XSA assessment settings were updated to incorporate revised tuning information at IBPWCFlat2 (ICES, 2015).**

****the UK otter trawl fleet as used in the assessment reported zero effort in 2016 and consequently only the data up to and including 2015 has an impact on the assessment.**

Figure 35.15 shows the results from the final XSA model fit, Figure 35.16 the residuals, Figure 35.17 a comparison of the current assessment with the assessment from last year, Figure 35.18 XSA survivor weightings for the last years and Figure 35.19 a five year retrospective.

Recruitment, SSB and F estimates only exhibited minor deviation from the 2016 assessment (Figure 35.17). Temporal trends in recruitment, SSB and F estimates were virtually identical with relatively minor differences in absolute values over the last decade.

XSA diagnostic tables, stock numbers-at-age and fishing mortalities-at-age for the final assessment are shown in Tables 35.7, 35.8, 35.9 and 35.10

A five year retrospective analysis showed some small retrospective bias starting in the 2000s. Spawning–stock biomass seems to be slightly overestimated. Some of the retrospective bias in SSB and F estimates observed in the assessment undoubtedly results from the loss of influence of the UK-FSP and Q1SWBeam survey time-series which is too short for an unbiased retrospective analysis. Temporal variation in SSB and F estimates in the most recent period likely resulted from noise rather than retrospective bias.

State of the stock

Stock trends are shown in Table 35.10 and plotted in Figure 35.15. The stock is in a favourable 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 increased and reached 4522 t, i.e. is well above all biomass reference points.

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 over the last decade has been fluctuating around the long-term average of the time-series.

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. Fishing mortality was estimated to be 0.21 in 2016, well below all reference points.

Information consistent with the decrease in fishing mortality in the most recent years is provided by the recent decline in UK landings and effort. Total international landings are around the agreed TAC, but vary year to year. Slight increases in effort for UK beam trawlers from 2009 to 2012 did not have the commensurate effect on F due to a shift in the spatial distribution of the fleet. UK beam trawlers are operating further offshore than in the past in areas of lower sole abundance to take advantage of other fishing opportunities.

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.

35.4 Short-term projections

Reported landings were 6% above the TAC in 2014 but 9% below in 2015 and 7% below in 2016. Reported landings and working group estimates are trending around the TAC estimate, but French landings are still subject to a lag between reaching the TAC and closure of the fishery so that a rescaled F interim year assumption remains prudent.

F estimates 2014–2016 fluctuate around 0.2. Consequently, rescaling F_{2016} by average $F_{14\text{–}16}$ is considered appropriate for the forecast as per the stock annex to account for the slight retrospective pattern. The mean catch and stock weights-at-age 2014–2016 were also used.

Recruitment was forecast using a long-term geometric mean (1969–2016) due to temporal variability in the time-series and the lack of distinct periods of successive high or low recruitment in recent years.

Complete input data for the short-term forecast are shown in Table 35.11 and the resulting forecast estimates landings in 2017 to be 932 t, 246 t (-21%) less than the TAC (1178 t) in 2017.

SSB estimated at 4370 t in 2017 will decrease slightly to 4354 t in 2018 at the current level of F assuming long-term geometric (1969–2016) recruitment for the 2015 year class.

The proportions that the 2014–2018 year classes will contribute to landings in 2017 and to SSB in 2018 are given in Table 35.13. The 2015 year class that has been replaced with long-term geometric (1969–2016) recruitment contributes to 12.0% of the landings in 2018 and 15.6% of the SSB in 2019.

A full management options table is provided in Table 35.14. Implementing the management plan for this stock with F_{MGT}=0.27 leads to a yield of 1129 t in 2018 and an SSB of 4150 t in 2019. Implementing the MSY approach with F_{MSY}=0.29 leads to a yield of 120 2t in 2018 and an SSB of 4079 t in 2018. The output for the short-term forecast under the MSY approach is presented in Figure 35.20.

35.5 Biological reference points

The most recent reference points for this stock were developed by WKMSYREF4 in 2015 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		ICES (2016a)
	F_{MSY} upper	0.34		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)
Management plan	SSB_{MGT}	Not defined		
	F_{MGT}	0.27		EU (2007)

35.6 Management plan

The Commission implemented a management plan for the recovery of the stock early in 2007 (Council Regulation (EC) No 509/2007). ICES evaluated the management plan and 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).

35.7 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 but the effect is beginning to re-emerge as the trimmed commercial fleet increases in length, as predicted by WKFLAT 2012 (ICES, 2012). Modifications to the UK e-logbook effort recording system in 2012 and the loss of lpue estimates from the UK Western Channel Beam Trawl survey (UK-WEC-BTS) in 2013 are also likely to have contributed to the minor retrospective patterns in SSB and F. The short-term forecast is relatively insensitive to such problems and management targets and limits are sufficiently removed from the current state so that the risk to the stock is small.

Two uncertainties that cannot be quantified in the assessment limit the accuracy of the short-term forecast. Firstly, the likely F in 2017 remains uncertain. Secondly, the size of recent year classes have been estimated to be weak in the assessment, except for in the terminal year. Previous assessments have estimated recruitment in the most recent period to be among the lowest on record. However, recruitment in 2016 is estimated to be around the long-term average of the time-series. Recruitment in 2017 was forecasted using a long-term geometric mean (1969–2016) due to temporal variability in the time-series and the lack of distinct periods of successive high or low recruitment in recent years.

Discarding

Discarding is considered to be negligible in this fishery, averaging 2.9% of total international catch weight in 2016. Nevertheless, a time-series of available discard 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 applied to some fleets catching sole in 2016. 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 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 particularly when the duration of the time-series remains relatively short. 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. 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.

Consistency

The assessment for this stock was last benchmarked in 2012 and an inter-benchmark was held in 2015. The 2017 assessment is consistent with the previous assessment conducted in recent years. Temporal trends in recruitment, SSB and F estimates were virtually identical. Across the entire time-series, SSB and F estimates were less than 1% lower and higher, respectively, than the previous assessment. SSB in 2014 was revised down by 6% and F was revised up by 5%.

Misreporting

Area misreporting, mainly to Area 7.d had declined to low levels in recent years, through a combination of enforcement and a substantial increase in the TAC in 2005. Some attempts to prosecute UK fishers for misreporting to area 7.h have been made, however to date, none of those prosecutions have been successful due to a lack of legally acceptable evidence.

Levels of underreporting are thought to have been serious in the early 1980s prior to the shift to area misreporting. Although it is clear that levels of under reporting are also much lower now, no quantitative information is available on the size of the problem in the fishery.

Landings from the UK beam-trawl fleet, historically the main contributors to area misreporting, in 2010–2015 were in line with the TAC, suggesting improved compliance. The decrease in landings is also consistent with a reduction in effort by the main fleet and a decline in F observed on the plaice 7.e stock, a major bycatch of the sole fishery.

35.8 Recommendation for the next benchmark

There is no requirement to benchmark this stock in the short term.

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. 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. Depending on whether there might be fishing activity or not in the future, a benchmark could investigate the removal of this commercial tuning information 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 landings obligation in 2016 unlikely to become a problem in the future.

35.9 Management considerations

Effort restrictions have been sufficient to ensure an observable decrease in F in recent years. Decommissioning in the UK fleet in 2007–2008 reduced the capacity of the fleet. In addition, the UK single area licensing scheme appears to have been effective since 2009 and resulted in the UK fleet utilising fishing opportunities in other ICES divisions so that effective effort and F in Division 7.e dropped markedly. A catch quota scheme based on an assumed 30% discarding by weight is currently running in the UK for beam trawlers. This value is well in excess of the likely discarding in the fleet, which was less than 1% of total catch weight in 2015. Consequently, as this concession continues to be granted to boats in the fishery this will lead to additional mortality.

France provided discard estimates for the first time at the 2016 working group. Discard estimates from France were higher (17%) than the UK (0.8%) and Belgium (0.6%). Data for 2016 showed a much lower discard rate for France of 2.8% and the high discard rate of 2015 is unlikely to repeat, particularly in the light of the introduction of the landings obligation in 2016.

Plaice is taken as bycatch in this fishery, and therefore management advice for sole must also take into account the advice for plaice. The effort reductions in 2009 positively impacted the plaice stock with a sizeable reduction in F. Anglerfish, cuttlefish, and lemon sole are also important bycatches in this fishery. The UK beam-trawl fleet has recently started to land sizeable quantities of gurnards for human consumption (information as of WGCSE 2016).

35.10 Ecosystem considerations

See stock annex.

35.11 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. To date, the latter restrictions have not been limiting in this fishery, in part due to the large numbers of days available, but also because in the UK fleet there appears to remain some latent effort/over-capacity in the beam-trawl fleet despite decommissioning. WKFLAT 2012 (ICES, 2012) observed a change in the distribution of the fleet due to multispecies considerations (foregoing higher cpue for sole in favour of taking a larger proportion of other available resources). Under the current pattern of exploitation, effort restrictions are commensurate with the TAC as indicated by the negligible contribution of high-grading to the total mortality. However if the availability of other resources such as monkfish, scallops, cuttlefish and lemon sole were to decrease, then economics may drive the fishery back to areas of higher sole abundance in which case current effort restrictions may not be sufficient to ensure an appropriate relationship between TAC and effort restrictions.

In November 2008, the UK introduced a single area licensing scheme for beam trawlers, which is thought to be highly effective in eliminating the current practice of area misreporting by this fleet, but will have had little effect on the fishery in 2008. UK landings and effort data indicate that the measure has been effective since 2009.

Mesh restrictions for towed gears are set to 80 mm codends, which correspond well with the minimum landing size of sole at 24 cm. Consequently, there is little discarding of sole in this fishery and this view has not changed in spite of the more restrictive TAC on the UK beam-trawl fleet.

35.12 Changes in fishing technology and fishing patterns

The UK industry applied for MSC certification in 2009 and started to adopt larger codend meshes and square mesh panels to limit the impact of fishing activities on vulnerable marine habitats. However, these changes appear to minimally affect the catch rates of sole and the degree of uptake of these measures in the fleet remains unclear. Changes in fishing patterns to make the most of available opportunities for other species in this multispecies fishery have changed fleet behaviour. To date, the evidence suggests that these effects are more substantial than those associated with changes in the fishing gear, but both will need to be monitored in the future.

35.13 Changes in the environment

See stock annex.

35.14 References

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Table 35.1. Sole in Division 7.e. Nominal landings in tonnes as used by ICES.

Year	Landings							Discards
	Belgium	France	Netherlands	Ireland	UK and the Channel Islands	Unallocated	Total	ICES estimate
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	
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			576	56	1022	
2007	34	384		2	531	64	1015	
2008	28	312		0	472	96	908	
2009	17	386			381	–83	701	
2010	17	375			368	–62	698	
2011	22	401			428	–50	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	243		0	490	-1	774	54
2016*	46	245			623	-1	913	10

*** preliminary.**

Table 35.2. Sole in Division 7.e. Landings numbers at age (thousands).

year	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
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

year	2	3	4	5	6	7	8	9	10	11	12+	total
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

Table 35.3. 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
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

year\age	2	3	4	5	6	7	8	9	10	11	12+
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

Table 35.4. 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

year\age	2	3	4	5	6	7	8	9	10	11	12+
1996	0.189	0.238	0.285	0.331	0.376	0.42	0.463	0.504	0.544	0.583	0.677
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

Table 35.5. Sole in Division 7.e. Landings, effort and mean standardised lpue for the UK commercial fleets.

Fleet	Year	Effort (days)	Landings (tonnes)	LPUE (kg/1000 days)	means standardised LPUE
UK-CBT	1988	5497	684	124.51	2.44
UK-CBT	1989	5894	503	85.27	1.67
UK-CBT	1990	5476	493	89.97	1.76
UK-CBT	1991	3870	341	88.02	1.72
UK-CBT	1992	3334	339	101.69	1.99
UK-CBT	1993	4111	349	84.79	1.66
UK-CBT	1994	6814	397	58.23	1.14
UK-CBT	1995	6935	391	56.37	1.1
UK-CBT	1996	7591	284	37.41	0.73
UK-CBT	1997	7368	331	44.99	0.88
UK-CBT	1998	7302	263	36.07	0.71
UK-CBT	1999	7031	256	36.47	0.71
UK-CBT	2000	8150	285	34.92	0.68
UK-CBT	2001	9620	290	30.13	0.59
UK-CBT	2002	9439	214	22.69	0.44
UK-CBT	2003	10596	186	17.59	0.34
UK-CBT	2004	10612	132	12.46	0.24

Fleet	Year	Effort (days)	Landings (tonnes)	LPUE (kg/1000 days)	means standardised LPUE
UK-CBT	2005	9990	427	42.7	0.84
UK-CBT	2006	9873	460	46.57	0.91
UK-CBT	2007	9621	421	43.75	0.86
UK-CBT	2008	9552	367	38.42	0.75
UK-CBT	2009	7563	300	39.7	0.78
UK-CBT	2010	7791	294	37.79	0.74
UK-CBT	2011	8703	350	40.22	0.79
UK-CBT	2012	9797	400	40.82	0.8
UK-CBT	2013	8767	422	48.15	0.94
UK-CBT	2014	8769	413	47.05	0.92
UK-CBT	2015	9298	411	44.17	0.86
UK-CBT	2016	10175	518	50.93	1
UK-CBT<24m	1988	2527	293	115.97	1.96
UK-CBT<24m	1989	1956	162	83.06	1.4
UK-CBT<24m	1990	1958	179	91.51	1.55
UK-CBT<24m	1991	1458	134	92.22	1.56
UK-CBT<24m	1992	1342	142	106.22	1.79
UK-CBT<24m	1993	1432	154	107.71	1.82
UK-CBT<24m	1994	2241	161	71.97	1.22
UK-CBT<24m	1995	2017	134	66.28	1.12
UK-CBT<24m	1996	1999	106	52.99	0.9
UK-CBT<24m	1997	1991	132	66.3	1.12
UK-CBT<24m	1998	2357	99	42.12	0.71
UK-CBT<24m	1999	2518	115	45.7	0.77
UK-CBT<24m	2000	2913	134	45.85	0.77
UK-CBT<24m	2001	3746	148	39.57	0.67
UK-CBT<24m	2002	3482	110	31.55	0.53
UK-CBT<24m	2003	3785	93	24.44	0.41
UK-CBT<24m	2004	3512	64	18.12	0.31
UK-CBT<24m	2005	3305	191	57.72	0.98

Fleet	Year	Effort (days)	Landings (tonnes)	LPUE (kg/1000 days)	means standardised LPUE
UK-CBT<24m	2006	3277	224	68.27	1.15
UK-CBT<24m	2007	4027	225	55.77	0.94
UK-CBT<24m	2008	4629	213	45.94	0.78
UK-CBT<24m	2009	4040	185	45.85	0.77
UK-CBT<24m	2010	4727	201	42.42	0.72
UK-CBT<24m	2011	5913	258	43.65	0.74
UK-CBT<24m	2012	7188	314	43.65	0.74
UK-CBT<24m	2013	6322	329	52.02	0.88
UK-CBT<24m	2014	5870	308	52.54	0.89
UK-CBT<24m	2015	6260	310	49.54	0.84
UK-CBT<24m	2016	6096	352	57.82	0.98
UK-CBT>24m	1988	2971	391	131.77	2.92
UK-CBT>24m	1989	3938	340	86.37	1.91
UK-CBT>24m	1990	3518	314	89.12	1.97
UK-CBT>24m	1991	2412	206	85.47	1.89
UK-CBT>24m	1992	1993	197	98.63	2.18
UK-CBT>24m	1993	2678	194	72.54	1.61
UK-CBT>24m	1994	4574	236	51.5	1.14
UK-CBT>24m	1995	4917	257	52.3	1.16
UK-CBT>24m	1996	5592	178	31.84	0.71
UK-CBT>24m	1997	5377	199	37.1	0.82
UK-CBT>24m	1998	4945	164	33.19	0.73
UK-CBT>24m	1999	4512	141	31.32	0.69
UK-CBT>24m	2000	5237	151	28.84	0.64
UK-	2001	5874	142	24.11	0.53

Fleet	Year	Effort (days)	Landings (tonnes)	LPUE (kg/1000 days)	means standardised LPUE
CBT>24m					
UK-CBT>24m	2002	5957	104	17.51	0.39
UK-CBT>24m	2003	6810	94	13.78	0.31
UK-CBT>24m	2004	7100	69	9.66	0.21
UK-CBT>24m	2005	6684	236	35.27	0.78
UK-CBT>24m	2006	6595	236	35.79	0.79
UK-CBT>24m	2007	5594	196	35.1	0.78
UK-CBT>24m	2008	4924	154	31.36	0.69
UK-CBT>24m	2009	3523	115	32.66	0.72
UK-CBT>24m	2010	3064	94	30.64	0.68
UK-CBT>24m	2011	2790	92	32.95	0.73
UK-CBT>24m	2012	2609	86	33.01	0.73
UK-CBT>24m	2013	2444	93	38.13	0.84
UK-CBT>24m	2014	2900	104	35.95	0.8
UK-CBT>24m	2015	3039	101	33.12	0.73
UK-CBT>24m	2016	4080	166	40.64	0.9
UK-COT	1988	4265	29	6.77	1.43
UK-COT	1989	4607	28	6.18	1.31
UK-COT	1990	4423	26	5.97	1.27
UK-COT	1991	4004	14	3.39	0.72
UK-COT	1992	4108	12	3.02	0.64
UK-COT	1993	3761	15	3.95	0.84
UK-COT	1994	3423	18	5.27	1.12
UK-COT	1995	3294	13	3.99	0.84
UK-COT	1996	2589	12	4.83	1.02
UK-COT	1997	3011	15	4.96	1.05
UK-COT	1998	2699	11	4.22	0.89
UK-COT	1999	2486	13	5.16	1.09
UK-COT	2000	2681	11	4.11	0.87
UK-COT	2001	2732	13	4.9	1.04
UK-COT	2002	2448	9	3.66	0.78
UK-COT	2003	2273	8	3.31	0.7

Fleet	Year	Effort (days)	Landings (tonnes)	LPUE (kg/1000 days)	means standardised LPUE
UK-COT	2004	2334	6	2.46	0.52
UK-COT	2005	1762	12	6.86	1.45
UK-COT	2006	1699	8	4.57	0.97
UK-COT	2007	1917	9	4.9	1.04
UK-COT	2008	1750	7	4.26	0.9
UK-COT	2009	1847	10	5.36	1.14
UK-COT	2010	2213	10	4.53	0.96
UK-COT	2011	1930	8	4.08	0.86
UK-COT	2012	2068	12	5.96	1.26
UK-COT	2013	1587	8	4.96	1.05
UK-COT	2014	1440	8	5.56	1.18
UK-COT	2015	978	5	4.98	1.06
UK-COT	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 35.6 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,
104
UK-CBT-late
2003 2016
1 1 0 1

3 11

10.59557	130.7	168.87	129.96	21.43	18.32	10.28	13.49	6.67	2.19	2.06	3.35	2.82
10.61183	146.5	61.53	53.46	75.23	11.35	14.96	7.49	5.98	4.27	2.12	1.18	1.89
9.98951	210.39	326.3	132.94	155.21	132.09	27.41	32.6	22.54	14.24	8.3	5.95	4.84
9.87254	376.87	186.46	243.45	85.59	108.34	106.98	37.22	20.67	13.69	13.61	6.68	2.99
9.6207	456.04	261.42	105.82	103.55	54.21	62.07	51.47	15.34	11.12	10.41	8.44	8.17
9.55231	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
7.79112	80.09	179.7	157.57	101.24	51.98	25.24	22.59	8.23	16.75	25.39	7.42	3.88
8.70287	243.76	148.58	186.66	121.43	81.66	35.56	15.79	20.25	10.83	14.11	8.26	2.1
9.79734	129.79	307.88	139.02	143.59	91.49	66.22	30.49	17.81	14.83	8.55	12.25	11.03
8.76655	81.92	242.49	288.92	134.34	93.18	72.27	44.15	24.5	10.73	9.84	8.14	9.84
8.7692	111.72	201.15	169.62	201.19	99.91	67.46	43.84	30.63	15.94	7.71	9.34	4.9
9.29849	137.05	178.21	198.83	135.74	117.19	65.74	45.95	31.78	20.59	11.01	5.52	5.96
10.17526	262.1	216.2	158.1	161	118.2	101.6	48.81	44.98	21.18	23.01	12.96	5.66

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 2016
1 1 0.1 0.25
2 11

1	13.9827	17.7418	9.8877	19.4529	11.9525	9.8066	10.4549	4.74613	3.23665	7.00007
1	12.3291	36.7717	16.2021	2.0082	7.3474	2.5642	2.7218	6.92397	5.55754	4.41774
1	11.9556	27.2521	26.915	11.617	8.7491	3.3699	10.2461	9.66501	5.70182	2.42857
1	3.3789	24.1601	18.2609	15.6175	6.4364	2.5672	2.8808	1.45679	4.30936	5.37546
1	21.1326	26.0624	27.4407	19.3966	11.162	11.8984	2.0858	1.94805	2.06037	1.40477
1	12.4384	25.0406	20.7327	17.9799	8.7678	4.4703	6.4495	2.72388	0.29235	1.9532
1	2.3036	23.2228	26.7927	11.0111	9.7258	11.4579	5.9073	3.97145	0.13376	1.82684
1	3.7142	12.4853	23.6131	21.5683	14.7024	11.8911	8.5158	7.77601	6.54977	1.0211
1	5.2342	25.2683	31.1232	13.363	19.2418	13.2925	24.9744	7.5189	2.67556	3.84886
1	5.0564	10.4716	13.1777	16.4052	13.1156	12.5791	7.5394	7.55054	3.25374	3.63526
1	14.2613	29.7948	14.0505	14.3579	10.8978	9.6971	12.9744	2.26091	2.49797	4.98397

FSP-UK
2004 2016
1 1 0.7 0.75
2 11

1	0.153824204	0.547681643	0.306598463	0.260341438	0.128202976
	0.058539491	0.088039872	0.036080529	0.015391278	0.016189065
1	0.103329518	0.19641048	0.241991372	0.109126628	0.156802612
	0.145326301	0.036140277	0.029396359	0.014350801	0.015371889
1	0.153481326	0.340850506	0.155281433	0.213275765	0.098438279
	0.115716826	0.133540754	0.026435039	0.025857425	0.018344075
1	0.119241548	0.44701361	0.204189719	0.077363475	0.090584633
	0.059564942	0.048392134	0.103423228	0.018747854	0.026135604
1	0.218979316	0.30433917	0.264569783	0.247314819	0.043056202
	0.03740343	0.01459082	0.056655904	0.032866413	0.002043144
1	0.087175684	0.299624141	0.311159869	0.161288882	0.060718142
	0.039957338	0.028000462	0.015193089	0.017913114	0.047375509
1	0.119863413	0.196874246	0.245797705	0.181168944	0.127269974
	0.035676999	0.020992322	0.027191027	0.017568869	0.023533383
1	0.08434561	0.454242063	0.099822858	0.198143553	0.092414777
	0.051026632	0.004550745	0.013069111	0.007266136	0.010694232
1	0.046242932	0.366107405	0.375112338	0.171327639	0.117372943
	0.033525922	0.044422343	0.027607474	0.003111774	0.006368894
1	0.049788133	0.358433744	0.430170523	0.361132406	0.16996429
	0.091513266	0.052297487	0.037267927	0.006358564	0
1	0.099297931	0.313276906	0.404824384	0.318775666	0.21442343
	0.120233411	0.07079201	0.034672021	0.042728627	0.002023089
1	0.109960059	0.242341369	0.344948703	0.18515098	0.128097028
	0.109022188	0.07705002	0.058290808	0.023876194	0.025259617
1	0.106692296	0.462891223	0.153264215	0.144225902	0.123064161
	0.078114192	0.102312786	0.030107449	0.047801647	0.014684173

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 35.7. Sole in Division 7.e. Detailed XSA survivor diagnostics.

```
FLR XSA Diagnostics 2017-04-25 17:19:05

CPUE data from indices

Catch data for 48 years 1969 to 2016. Ages 2 to 12.

               fleet first age last age first year last year alpha beta
1        UK-CBT-late         3       11       2003      2016  <NA> <NA>
2             UK-COT         3       11       1988      2016  <NA> <NA>
3 Q1SWBeam-nonoffset         2       11       2006      2016  <NA> <NA>
4             FSP-UK         2       11       2004      2016  <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
     year
age    2007 2008  2009 2010  2011  2012  2013  2014  2015 2016
  all 0.482 0.61 0.725 0.82 0.893 0.944 0.976 0.993 0.999    1

 Fishing mortalities
    year
age   2007  2008  2009  2010  2011  2012  2013  2014  2015  2016
  2  0.054 0.071 0.049 0.014 0.026 0.010 0.043 0.073 0.041 0.028
  3  0.271 0.260 0.170 0.124 0.121 0.074 0.122 0.140 0.150 0.117
  4  0.411 0.319 0.184 0.162 0.223 0.162 0.199 0.230 0.229 0.294
  5  0.376 0.327 0.228 0.211 0.223 0.264 0.249 0.242 0.231 0.222
  6  0.426 0.330 0.262 0.191 0.204 0.278 0.266 0.243 0.205 0.240
  7  0.404 0.354 0.192 0.234 0.196 0.284 0.240 0.226 0.165 0.266
  8  0.264 0.390 0.210 0.191 0.201 0.235 0.262 0.170 0.212 0.201
  9  0.248 0.202 0.207 0.283 0.205 0.233 0.235 0.196 0.155 0.164
  10 0.307 0.212 0.191 0.150 0.193 0.332 0.234 0.202 0.145 0.126
  11 0.259 0.331 0.147 0.170 0.283 0.306 0.255 0.178 0.130 0.137
  12 0.259 0.331 0.147 0.170 0.283 0.306 0.255 0.178 0.130 0.137

 XSA population number (Thousand)
      age
year      2    3    4    5    6    7    8   9  10  11  12
  2007 4031 3778 2357  981 1097  565  589 526 221 123 454
  2008 4301 3456 2608 1414  610  648  341 409 371 147 332
  2009 3640 3624 2412 1715  922  397  412 209 302 272 502
  2010 5158 3136 2765 1816 1235  642  296 302 154 226 524
  2011 3790 4602 2506 2127 1330  923  460 221 206 120 395
  2012 3317 3342 3689 1815 1540  982  687 340 163 154 494
  2013 2973 2972 2808 2839 1261 1056  669 491 244 106 512
  2014 2955 2576 2381 2081 2002  874  752 465 351 175 625
  2015 4598 2486 2026 1711 1478 1422  631 574 346 260 708
  2016 3520 3992 1936 1458 1228 1090 1090 462 444 271 878


 Estimated population abundance at 1st Jan  2017
      age
year   2    3    4    5    6   7   8   9  10  11  12
  2017 0 3098 3213 1306 1057 874 756 807 355 354 214

 Fleet:  UK-CBT-late

 Log catchability residuals.

    year
age    2003   2004   2005   2006   2007   2008   2009   2010   2011   2012
2013   2014   2015   2016
  3  -0.277 -0.493  0.572  0.753  0.871  0.523  0.230 -0.541  0.076 -0.375 -
```

```
0.584 -0.122  0.064  0.133
  4   -0.563 -1.204  0.231  0.306  0.286  0.240  0.039 -0.154 -0.328 -0.133
0.030  0.023  0.004  0.183
  5   -0.807 -1.387 -0.053  0.337  0.142 -0.064  0.123  0.058 -0.035 -0.270
0.118 -0.108  0.183  0.019
  6   -1.644 -0.987  0.086 -0.059 -0.020  0.108  0.173 -0.060 -0.057 -0.119
0.120  0.050 -0.116  0.166
  7   -1.252 -1.878  0.157  0.245  0.072  0.107 -0.166  0.034 -0.006 -0.031
0.006  0.257 -0.157  0.075
  8   -1.344 -1.131 -0.557  0.356  0.102  0.330 -0.125  0.065 -0.138 -0.019
0.219 -0.011  0.099 -0.108
  9   -0.685 -1.354  0.131  0.156  0.020 -0.007 -0.196 -0.021 -0.216 -0.094
0.021  0.049 -0.191  0.001
  10 -1.049 -1.073  0.179  0.131 -0.295  0.008 -0.375 -0.420  0.099  0.150
0.132 -0.025 -0.059 -0.061
  11 -1.168 -0.995  0.289  0.076 -0.051  0.076 -0.511 -0.084  0.057  0.015
0.151  0.010 -0.213 -0.314

 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 -5.0693 -4.5044 -4.4043 -4.3527 -4.4388 -4.4388 -4.4388 -4.4388 -
4.4388
S.E_Logq   0.4647  0.4647  0.4647  0.4647  0.4647  0.4647  0.4647  0.4647
0.4647


 Fleet:  UK-COT

 Log catchability residuals.

    year
age    1988  1989   1990   1991   1992   1993   1994   1995   1996   1997
1998   1999   2000   2001   2002
  3    0.878 0.517  0.789  0.516  0.481  0.438  0.671  0.120  0.565  0.875
0.536  0.635  0.221  0.567  0.262
  4    0.587 0.403  0.401 -0.053 -0.096  0.140  0.394  0.475  0.468  0.284
0.263  0.156  0.235 -0.101 -0.460
  5    0.548 0.428  0.313 -0.249 -0.407  0.283  0.209  0.199  0.317  0.367
0.049  0.266  0.063  0.103 -0.429
  6    0.441 0.399  0.559 -0.471 -1.253 -0.017 -0.028 -0.154  0.106  0.072
0.258  0.095 -0.067  0.043  0.041
  7   -0.167 0.351  0.262 -0.646 -0.800 -0.016  0.273  0.199 -0.028  0.402
0.082  0.378 -0.359  0.163 -0.056
  8    0.024 0.082  0.073 -0.602 -1.018 -0.287 -0.319  0.126  0.166 -0.193 -
0.215  0.597 -0.188 -0.147 -0.179
  9   -0.358 0.325  0.290 -0.963 -1.121  0.189  0.198 -0.320  0.097 -0.031 -
0.313 -0.033  0.452  0.382 -0.842
  10 -1.084 0.036  0.106 -0.677 -1.550 -0.394  0.783 -0.420 -0.060 -0.739 -
0.257  0.115  0.071  0.537 -0.272
  11  -0.193 0.600 -0.259 -0.933 -1.905  0.047  0.264 -0.157 -0.009 -0.333
0.136  0.458  0.006  0.274  0.468
    year
age    2003   2004   2005   2006   2007   2008   2009   2010   2011   2012
2013   2014   2015 2016
  3   -0.002 -0.086  0.900  0.596  0.673  0.340  0.548 -0.589  0.039 -0.162 -
0.503 -0.196 -0.042   NA
  4   -0.174 -0.652  0.645  0.232  0.236  0.069  0.150 -0.111 -0.413  0.117 -
0.027  0.007 -0.034   NA
  5   -0.322 -0.806  0.297  0.263  0.170 -0.227  0.113  0.057 -0.156 -0.027
0.135 -0.096  0.008   NA
  6   -0.895 -0.379  0.430 -0.207  0.030 -0.038  0.097 -0.036 -0.215  0.106
0.142  0.057 -0.076   NA
  7   -0.540 -1.326  0.487  0.052  0.110  0.032 -0.218  0.074 -0.164  0.085 -
0.022  0.290 -0.125   NA
  8   -0.604 -0.641 -0.191  0.246  0.174  0.237  0.013  0.129 -0.504  0.152
0.290  0.082  0.053   NA
  9   -0.120 -0.814  0.519  0.031  0.058 -0.031 -0.066  0.063 -0.397  0.090
0.070  0.214 -0.215   NA
  10 -0.473 -0.531  0.498 -0.066 -0.190  0.001 -0.155 -0.229 -0.154  0.356
0.307  0.217  0.111   NA
  11 -0.209 -0.404  0.813 -0.147 -0.163  0.201 -0.214  0.089 -0.236  0.341
0.384  0.212 -0.128   NA


 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 -14.0567 -13.6217 -13.5561 -13.4953 -13.5902 -13.5902 -13.5902 -
13.5902 -13.5902
S.E_Logq    0.4199   0.4199   0.4199   0.4199   0.4199   0.4199   0.4199
0.4199   0.4199
```

```
 Fleet:  Q1SWBeam-nonoffset

 Log catchability residuals.

    year
age    2006   2007   2008   2009   2010   2011   2012   2013   2014   2015
2016
  2   0.462  0.478  0.386 -0.715  0.764  0.544 -1.012 -0.419 -0.065 -0.547
0.755
  3  -0.212  0.420  0.207  0.024  0.236 -0.188  0.049 -0.446  0.405 -0.439
0.128
  4  -0.256 -0.156  0.234 -0.099  0.168 -0.004 -0.144  0.009  0.455 -0.243 -
0.122
  5   0.337 -1.307  0.074  0.159  0.316  0.084 -0.240 -0.018 -0.188  0.212
0.237
  6   0.444 -0.241  0.505 -0.228  0.018 -0.296 -0.325  0.285  0.088  0.002
0.008
  7   0.199 -0.676 -0.549 -0.358  0.701 -0.648  0.247  0.204  0.502 -0.050 -
0.027
  8   0.392 -0.682  1.211 -0.277 -0.274  0.417 -0.066  0.331  1.274  0.258
0.252
  9   0.451  0.362  0.939 -0.282 -0.345  0.287  0.239  0.544  0.557  0.346 -
0.642
  10  0.618  1.020  0.509  0.431  0.362 -1.874 -2.399  1.072 -0.194  0.007 -
0.511
  11  1.768  1.371  0.604  0.751 -0.402  0.582  0.271  0.052  0.865  0.402
0.677


 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 -6.2411 -4.9873 -4.7348 -4.801 -4.6733 -4.6312 -4.6312 -4.6312 -
4.6312 -4.6312
S.E_Logq    0.5830   0.5830   0.5830   0.583   0.5830   0.5830   0.5830   0.5830
0.5830  0.5830


 Fleet:  FSP-UK

 Log catchability residuals.

    year
age     2004   2005  2006   2007   2008   2009   2010   2011   2012   2013
2014   2015   2016
  2    0.835   0.034 0.320   0.174   0.730 -0.040 -0.096 -0.130 -0.610 -0.402
0.316 -0.047  0.180
  3    0.328  -0.068 0.076   0.247 -0.056 -0.184 -0.493 -0.043   0.028   0.158
0.180 -0.034  0.116
  4    0.351  -0.154 0.031  -0.071   0.021   0.163 -0.225 -0.984 -0.091   0.346
0.473  0.473 -0.246
  5    0.196  -0.279 0.172  -0.242   0.520  -0.173 -0.126 -0.186 -0.143   0.145
0.325 -0.030 -0.127
  6   -0.191   0.292 0.270   0.029 -0.197 -0.316   0.080 -0.305 -0.158   0.403
0.156 -0.083  0.088
  7    0.114   0.551 0.598   0.453 -0.186   0.254 -0.311 -0.344 -0.761   0.138
0.589 -0.038 -0.033
  8    1.002   0.011 0.860   0.103 -0.460 -0.126 -0.098 -2.060 -0.158   0.052
0.171  0.460  0.189
  9   0.565   0.332 0.102   0.963   0.580 -0.062   0.208 -0.271   0.067   0.001 -
0.045  0.236 -0.202
  10  0.253   0.019 0.655   0.166   0.139 -0.278   0.349 -0.794 -1.309 -1.067
0.449 -0.159  0.272
  11  0.716   0.654 0.649   1.052 -1.626   0.769   0.271   0.199 -0.551      NA -
1.919  0.173 -0.406


 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 -10.4913 -9.0206 -8.9130 -8.8612 -9.0498 -9.2450 -9.2450 -9.2450 -
9.2450 -9.2450
S.E_Logq     0.4907   0.4907   0.4907   0.4907   0.4907   0.4907   0.4907   0.4907
0.4907  0.4907


 Terminal year survivor and F summaries:

 ,Age 2 Year class =2014

source
```

```
                   scaledWts survivors yrcls
Q1SWBeam-nonoffset     0.166      6590  2014
FSP-UK                 0.503      3708  2014
fshk                   0.331      1615  2014

 ,Age 3 Year class =2013

source
                   scaledWts survivors yrcls
UK-CBT-late            0.211      3669  2013
Q1SWBeam-nonoffset     0.290      3650  2013
FSP-UK                 0.290      3607  2013
fshk                   0.209      2712  2013

 ,Age 4 Year class =2012

source
                   scaledWts survivors yrcls
UK-CBT-late            0.278      1567  2012
Q1SWBeam-nonoffset     0.278      1156  2012
FSP-UK                 0.206      1021  2012
fshk                   0.238      1813  2012

 ,Age 5 Year class =2011

source
                   scaledWts survivors yrcls
UK-CBT-late            0.266      1077  2011
Q1SWBeam-nonoffset     0.256      1339  2011
FSP-UK                 0.266       931  2011
fshk                   0.212       962  2011

 ,Age 6 Year class =2010

source
                   scaledWts survivors yrcls
UK-CBT-late            0.262      1032  2010
Q1SWBeam-nonoffset     0.262       881  2010
FSP-UK                 0.262       955  2010
fshk                   0.213       881  2010

 ,Age 7 Year class =2009

source
                   scaledWts survivors yrcls
UK-CBT-late            0.301       815  2009
Q1SWBeam-nonoffset     0.205       736  2009
FSP-UK                 0.242       731  2009
fshk                   0.251       981  2009

 ,Age 8 Year class =2008

source
                   scaledWts survivors yrcls
UK-CBT-late            0.421       724  2008
Q1SWBeam-nonoffset     0.143      1039  2008
FSP-UK                 0.107       975  2008
fshk                   0.329       748  2008

 ,Age 9 Year class =2007

source
                   scaledWts survivors yrcls
UK-CBT-late            0.304       355  2007
Q1SWBeam-nonoffset     0.163       187  2007
FSP-UK                 0.304       290  2007
fshk                   0.229       293  2007

 ,Age 10 Year class =2006

source
                   scaledWts survivors yrcls
UK-CBT-late            0.470       334  2006
Q1SWBeam-nonoffset     0.048       213  2006
FSP-UK                 0.140       465  2006
fshk                   0.342       222  2006

 ,Age 11 Year class =2005

source
                   scaledWts survivors yrcls
UK-CBT-late            0.470       156  2005
Q1SWBeam-nonoffset     0.117       421  2005
FSP-UK                 0.067       142  2005
fshk                   0.345       142  2005
```

Table 35.8. 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	12149
1975	2967	2769	1461	1238	1667	365	406	544	138	248	1756	13559
1976	2791	2607	1966	1160	931	1399	304	317	468	105	1598	13645
1977	6556	2367	1960	1330	896	714	1178	230	231	375	1866	17703
1978	4657	5527	1839	1408	1007	714	580	995	199	186	1385	18497
1979	4389	3976	3933	1334	1070	732	548	456	827	144	1493	18901
1980	4702	3755	2834	2787	970	751	497	397	327	650	1702	19373
1981	8130	4088	2866	2092	1923	758	506	316	298	243	934	22154
1982	4680	7124	2933	1974	1448	1370	516	337	214	214	1035	21845
1983	3866	4113	5066	1782	1260	976	1011	337	198	117	828	19555
1984	5968	3412	3006	3087	1058	806	629	635	192	110	982	19886
1985	6982	5083	2457	1934	2073	649	535	446	430	123	532	21243
1986	3766	6045	2982	1504	1304	1320	417	392	306	309	529	18872
1987	5849	3173	3931	1775	961	874	874	297	283	191	754	18962
1988	3880	4828	2102	2519	1199	675	578	573	224	208	713	17501
1989	3736	3089	3001	1335	1587	729	465	369	415	166	743	15637
1990	2818	3009	1966	1543	736	952	446	317	232	268	739	13027
1991	7169	2225	1865	1226	870	434	610	268	189	139	656	15651
1992	3908	6059	1619	1229	835	578	304	447	177	136	528	15819
1993	3354	3236	4118	1068	829	646	416	217	334	136	345	14700
1994	2373	2836	2259	2673	633	542	441	302	140	249	488	12935
1995	3434	2055	1942	1513	1888	466	389	352	219	84	647	12989
1996	3987	3017	1566	1158	962	1317	297	257	260	167	651	13641
1997	3388	3261	2307	1071	765	648	948	205	174	189	413	13367
1998	4468	2860	2160	1399	660	521	401	693	144	138	649	14093
1999	3599	3791	2011	1444	946	398	328	287	506	97	478	13884
2000	6693	2990	2560	1345	928	613	251	199	208	356	369	16512
2001	5495	5764	2136	1602	867	622	453	177	116	140	525	17896
2002	3857	4834	3883	1427	977	530	394	314	108	64	295	16683
2003	5452	3174	3184	2712	923	578	357	256	195	67	295	17193
2004	2893	4364	2078	1974	1840	712	452	276	177	116	280	15161
2005	4063	2239	2921	1454	1363	1165	488	298	192	108	428	14720
2006	4701	3431	1580	1850	888	886	776	333	194	131	367	15137
2007	4031	3778	2357	981	1097	565	589	526	221	123	454	14721
2008	4301	3456	2608	1414	610	648	341	409	371	147	332	14638
2009	3640	3624	2412	1715	922	397	412	209	302	272	502	14407
2010	5158	3136	2765	1816	1235	642	296	302	154	226	524	16255
2011	3790	4602	2506	2127	1330	923	460	221	206	120	395	16681

year\age	2	3	4	5	6	7	8	9	10	11	12+	total
2012	3317	3342	3689	1815	1540	982	687	340	163	154	494	16522
2013	2973	2972	2808	2839	1261	1056	669	491	244	106	512	15930
2014	2955	2576	2381	2081	2002	874	752	465	351	175	625	15238
2015	4598	2486	2026	1711	1478	1422	631	574	346	260	708	16240
2016	3520	3992	1936	1458	1228	1090	1090	462	444	271	878	16370

Table 35.9. 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	0.203	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	0.434	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	0.061	0.229	0.341	0.298	0.39	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	0.314	0.322	0.182	0.205	0.256	0.256	0.288
1988	0.128	0.376	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	0.393	0.285	0.363	0.337	0.359	0.359	0.409
1990	0.136	0.379	0.372	0.473	0.428	0.345	0.41	0.417	0.413	0.404	0.404	0.403
1991	0.068	0.218	0.317	0.285	0.309	0.256	0.212	0.311	0.23	0.264	0.264	0.272
1992	0.089	0.286	0.316	0.293	0.156	0.229	0.237	0.191	0.167	0.196	0.196	0.244
1993	0.068	0.26	0.332	0.423	0.326	0.282	0.22	0.341	0.194	0.273	0.273	0.312
1994	0.044	0.279	0.301	0.248	0.206	0.23	0.125	0.223	0.404	0.238	0.238	0.23
1995	0.029	0.172	0.417	0.352	0.26	0.349	0.317	0.202	0.171	0.26	0.26	0.295
1996	0.101	0.168	0.28	0.315	0.296	0.23	0.274	0.288	0.22	0.262	0.262	0.265
1997	0.069	0.312	0.4	0.384	0.284	0.379	0.213	0.254	0.131	0.253	0.253	0.318
1998	0.064	0.252	0.302	0.291	0.406	0.364	0.235	0.215	0.295	0.303	0.303	0.295
1999	0.085	0.293	0.303	0.342	0.334	0.36	0.399	0.221	0.253	0.314	0.314	0.322
2000	0.049	0.236	0.369	0.338	0.301	0.203	0.249	0.443	0.297	0.299	0.299	0.306
2001	0.028	0.295	0.303	0.395	0.392	0.357	0.266	0.396	0.495	0.382	0.382	0.343
2002	0.095	0.318	0.259	0.335	0.426	0.295	0.33	0.377	0.383	0.362	0.362	0.334
2003	0.123	0.324	0.378	0.288	0.161	0.146	0.158	0.271	0.417	0.246	0.246	0.246

2004	0.156	0.301	0.257	0.27	0.357	0.278	0.315	0.263	0.39	0.383	0.383	0.292
2005	0.069	0.248	0.357	0.393	0.331	0.307	0.28	0.331	0.281	0.269	0.269	0.321
2006	0.119	0.276	0.377	0.422	0.352	0.308	0.288	0.312	0.359	0.286	0.286	0.334
2007	0.054	0.271	0.411	0.376	0.426	0.404	0.264	0.248	0.307	0.259	0.259	0.343
2008	0.071	0.26	0.319	0.327	0.33	0.354	0.39	0.202	0.212	0.331	0.331	0.312
2009	0.049	0.17	0.184	0.228	0.262	0.192	0.21	0.207	0.191	0.147	0.147	0.208
2010	0.014	0.124	0.162	0.211	0.191	0.234	0.191	0.283	0.15	0.17	0.17	0.2
2011	0.026	0.121	0.223	0.223	0.204	0.196	0.201	0.205	0.193	0.283	0.283	0.196
2012	0.01	0.074	0.162	0.264	0.278	0.284	0.235	0.233	0.332	0.306	0.306	0.219
2013	0.043	0.122	0.199	0.249	0.266	0.24	0.262	0.235	0.234	0.255	0.255	0.225
2014	0.073	0.14	0.23	0.242	0.243	0.226	0.17	0.196	0.202	0.178	0.178	0.207
2015	0.041	0.15	0.229	0.231	0.205	0.165	0.212	0.155	0.145	0.13	0.13	0.193
2016	0.028	0.117	0.294	0.222	0.24	0.266	0.201	0.164	0.126	0.137	0.137	0.215

Table 35.10. Sole in Division 7.e. Assessment summary.

Year	Recruitment Age 2 [000's]	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	2791	4102	3403	616	0.18	0.18
1977	6556	5339	4098	606	0.15	0.13
1978	4657	5429	4074	861	0.21	0.178
1979	4389	6014	4865	1181	0.24	0.242
1980	4702	6387	5338	1269	0.24	0.232
1981	8130	5957	4572	1215	0.27	0.27
1982	4680	5916	4575	1446	0.32	0.321
1983	3866	5377	4374	1498	0.34	0.363
1984	5968	5463	4430	1370	0.31	0.3
1985	6982	5569	4009	1409	0.35	0.329
1986	3766	5258	4014	1419	0.35	0.31
1987	5849	5311	4112	1280	0.31	0.288
1988	3880	5121	4044	1444	0.36	0.333
1989	3736	4319	3443	1390	0.4	0.409
1990	2818	4224	3288	1315	0.4	0.403
1991	7169	4222	2993	852	0.28	0.272
1992	3908	4104	2940	895	0.3	0.244
1993	3354	3584	2814	904	0.32	0.312
1994	2373	3791	3058	800	0.26	0.23
1995	3434	3878	3073	856	0.28	0.295
1996	3987	4163	3059	833	0.27	0.265

Year	Recruitment Age 2 [000's]	TSB [tonnes]	SSB [tonnes]	Landings [tonnes]	Yield/SSB	Fbar (Ages 3-9)
1997	3388	3851	2928	949	0.32	0.318
1998	4468	3975	2927	880	0.3	0.295
1999	3599	3988	2859	957	0.33	0.322
2000	6693	4377	2912	914	0.31	0.306
2001	5495	4601	2957	1069	0.36	0.343
2002	3857	4288	3097	1106	0.36	0.334
2003	5452	4515	3388	1078	0.32	0.246
2004	2893	4134	3200	1075	0.34	0.292
2005	4063	4167	3279	1039	0.32	0.321
2006	4701	3878	2888	1023	0.35	0.334
2007	4031	4002	2951	1015	0.34	0.343
2008	4301	3974	2825	908	0.32	0.312
2009	3640	4174	3224	701	0.22	0.208
2010	5158	4643	3622	698	0.19	0.2
2011	3790	4967	3730	801	0.21	0.196
2012	3317	4809	3960	872	0.22	0.219
2013	2973	4652	3854	883	0.23	0.225
2014	2955	4924	4114	885	0.22	0.207
2015	4598	5055	4097	774	0.19	0.193
2016	3520	5689	4522	913	0.2	0.215

Table 35.11. Sole in Division 7.e. Input data for the short-term forecast.

Age	N2017	N2018	N2019	M	Mat	PF	PM	SWt	Sel	CWt
2	3890	3890	3890	0.1	0.14	0	0	0.161	0.05	0.196
3	3098	3349	3349	0.1	0.45	0	0	0.229	0.142	0.262
4	3213	2431	2628	0.1	0.88	0	0	0.293	0.264	0.324
5	1306	2233	1690	0.1	0.98	0	0	0.352	0.243	0.379
6	1057	926	1584	0.1	1	0	0	0.405	0.241	0.43
7	874	752	659	0.1	1	0	0	0.454	0.23	0.477
8	756	629	541	0.1	1	0	0	0.497	0.204	0.518
9	807	558	464	0.1	1	0	0	0.536	0.18	0.553
10	355	610	421	0.1	1	0	0	0.569	0.166	0.584
11	354	272	467	0.1	1	0	0	0.597	0.156	0.61
12	906	976	966	0.1	1	0	0	0.704	0.156	0.709

Table 35.12. Sole in Division 7.e. Single option output.

Age	F	Catch.No	Yield	Stock.No	Biomass	SSNo	SSB
Year = 2017, F / $F_{2014\text{-}2016}$ = 1.034, Fbar = 0.215							
2	0.05	180	35	3890	625	545	87
3	0.142	392	103	3098	710	1394	320
4	0.264	710	230	3213	941	2827	828
5	0.243	269	102	1306	459	1280	450
6	0.241	215	93	1057	428	1057	428
7	0.23	171	82	874	397	874	397
8	0.204	133	69	756	376	756	376
9	0.18	127	70	807	432	807	432
10	0.166	52	30	355	202	355	202
11	0.156	49	30	354	212	354	212
12+	0.156	125	88	906	638	906	638
Total		2423	932	16616	5420	11155	4370
Year = 2018, F / $F_{2014\text{-}2016}$ = 1.034, Fbar = 0.215							
2	0.05	180	35	3890	625	545	87
3	0.142	423	111	3349	768	1507	346
4	0.264	537	174	2431	712	2139	627
5	0.243	460	174	2233	785	2189	770
6	0.241	189	81	926	375	926	375
7	0.23	147	70	752	341	752	341
8	0.204	111	57	629	313	629	313
9	0.18	88	49	558	299	558	299
10	0.166	89	52	610	347	610	347
11	0.156	37	23	272	162	272	162
12+	0.156	134	95	976	687	976	687
Total		2395	921	16626	5414	11103	4354
Year = 2019, F / $F_{2014\text{-}2016}$ = 1.034, Fbar = 0.215							
2	0.05	180	35	3890	625	545	87
3	0.142	423	111	3349	768	1507	346
4	0.264	581	188	2628	770	2313	678
5	0.243	348	132	1690	594	1656	582
6	0.241	323	139	1584	642	1584	642
7	0.23	129	61	659	299	659	299
8	0.204	95	49	541	269	541	269
9	0.18	73	40	464	248	464	248
10	0.166	61	36	421	240	421	240
11	0.156	64	39	467	279	467	279
12+	0.156	133	94	966	680	966	680
Total		2410	924	16659	5414	11123	4350

Input units are in 000's and kg; output in tonnes.

Table 35.13. Sole in Division 7.e. Year-class sources and contributions for the short-term forecast.

cohort	Yield 2017	Yield 2018	SSB 2017	SSB 2018	SSB 2019
2014	11	18.9	7.3	14.4	13.4
2015	3.8	12	2	7.9	15.6
2016		3.8		2	7.9
2017					2

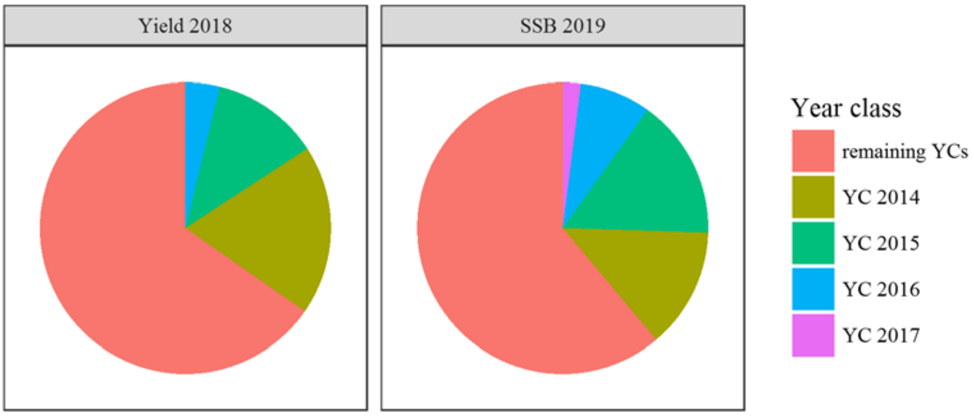


Table 35.14. Sole in Division 7.e. Management option output.

BASIS	CATCH_2018	LANDING_2018	DISCARDS_2018	FBAR_2018	SSB_2019	SSB_CHANGE	TAC_CHANGE
F0	0	0	0	0	5243.569	20.43368	-100
Fsq0.6	592.4061	575.005	17.40116	0.128936	4685.371	7.613066	-51.188
FMSY_lower	724.7385	703.4503	21.28825	0.16	4561.039	4.757412	-40.2844
F=0.17	766.5277	744.012	22.51575	0.17	4521.805	3.856301	-36.8411
Fsq0.8	774.4838	751.7343	22.74945	0.171914	4514.337	3.68478	-36.1855
F=0.18	807.9289	784.197	23.73186	0.18	4482.95	2.963882	-33.4298
F=0.19	848.946	824.0093	24.93668	0.19	4444.47	2.080069	-30.0501
F=0.2	889.5827	863.4524	26.13034	0.2	4406.36	1.204772	-26.7018
F=0.21	929.843	902.5301	27.31293	0.21	4368.618	0.337906	-23.3845
Fsq	949.4067	921.5191	27.88759	0.214893	4350.283	-0.08321	-21.7726
F=0.22	969.7306	941.2461	28.48458	0.22	4331.239	-0.52062	-20.098
F=0.23	1009.249	979.6039	29.64538	0.23	4294.219	-1.37088	-16.8418
TAC085	1031.602	1001.3	30.30197	0.235698	4273.286	-1.85166	-15
F=0.24	1048.403	1017.607	30.79546	0.24	4257.555	-2.21296	-13.6157
F=0.25	1087.194	1055.259	31.93492	0.25	4221.244	-3.04696	-10.4194
MP2	1103.408	1070.996	32.41116	0.254207	4206.071	-3.39544	-9.08349
F=0.26	1125.628	1092.564	33.06386	0.26	4185.281	-3.87294	-7.25261
MP	1163.707	1129.525	34.18239	0.27	4149.664	-4.691	-4.11503
F=0.27	1163.707	1129.525	34.18239	0.27	4149.664	-4.691	-4.11503
F=0.28	1201.436	1166.145	35.29061	0.28	4114.388	-5.50121	-1.00635
TAC	1213.649	1178	35.64937	0.283257	4102.971	-5.76343	-3.33E-14
FMSY	1238.816757	1202.428126	36.38863089	0.29	4079.450717	-6.303649167	2.073694923

BASIS	CATCH_2018	LANDING_2018	DISCARDS_2018	FBAR_2018	SSB_2019	SSB_CHANGE	TAC_CHANGE
FMSY_fbar_mean_int	FMSY_fbar_mean_int	1249.268047	1212.572423	36.69562394	0.29	4109.774303	-6.43675547
FMSY_TAC	1174.320053	1139.825929	34.49412411	0.29	3892.123085	-5.431522417	-3.240583248
F=0.3	1275.854	1238.377	37.47655	0.3	4044.848	-7.0984	5.125406
F=0.31	1312.55	1273.996	38.55446	0.31	4010.577	-7.88554	8.14906
Fpa	1348.909852	1309.28738	39.62247236	0.32	3976.633381	-8.665145803	11.14493886
F=0.32	1348.91	1309.287	39.62247	0.32	3976.633	-8.66515	11.14494
F=0.33	1384.936	1344.255	40.68068	0.33	3943.015	-9.43729	14.11332
TAC115	1395.697	1354.7	40.99678	0.333005	3932.975	-9.66788	15
FMSY_upper	1420.630851	1378.901668	41.72918341	0.34	3909.717579	-10.20206018	17.05447093
Flim	1760.117	1708.416	51.70115	0.44	3593.723	-17.4598	45.02681
Bpa	2510.93126	2437.17592	73.75533974	0.699982133	2900	-33.39313641	106.8909949
Btrigger	2510.93126	2437.17592	73.75533974	0.699982133	2900	-33.39313641	106.8909949
Blim	3501.415631	3398.566101	102.8495298	1.17242569	2000	-54.06423201	188.5030646

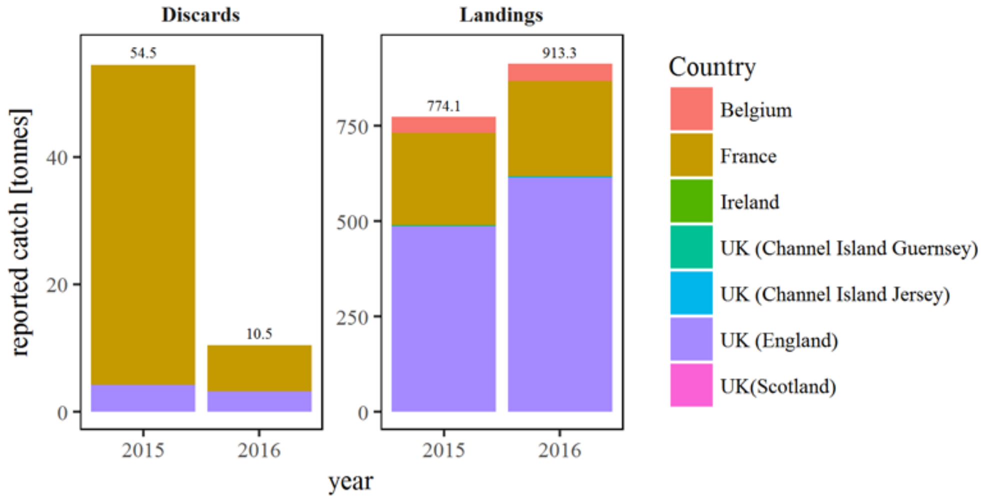


Figure 35.1. Sole in Division 7.e. Reported landings and discards.

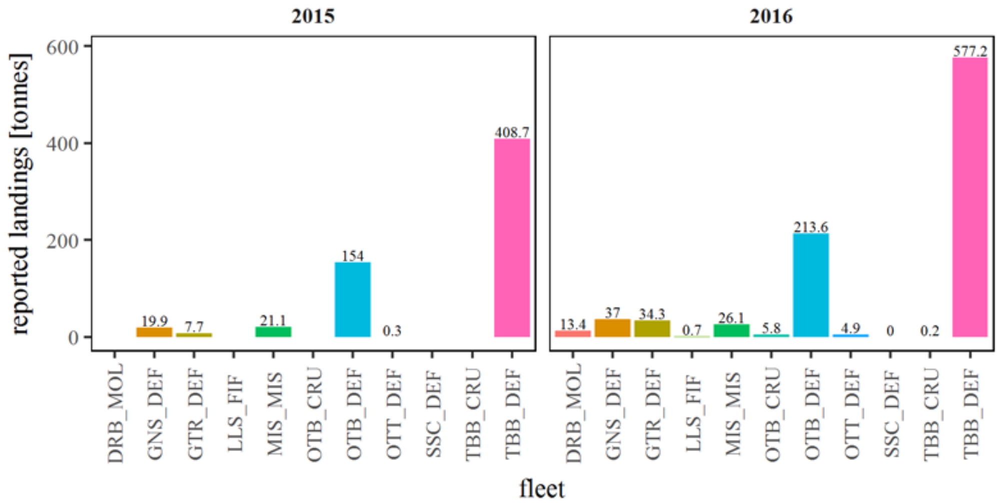


Figure 35.2. Sole in Division 7.e. International landings by fleet.

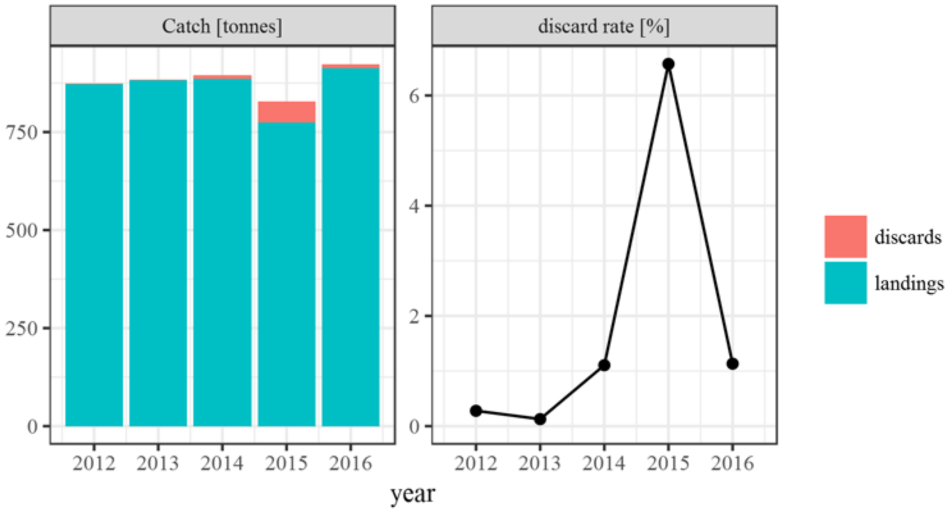


Figure 35.3. Sole in Division 7.e. Discard rates for discards reported in InterCatch.

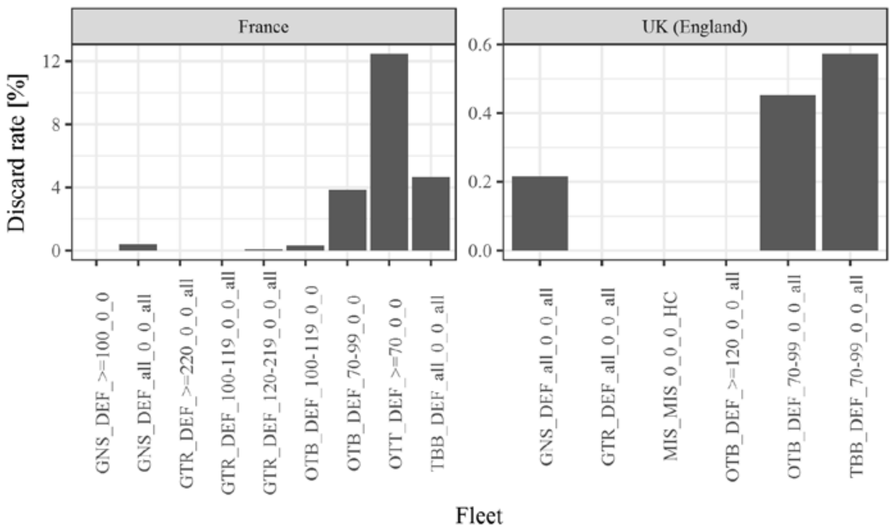


Figure 35.4. Sole in Division 7.e. Annual reported discard rates by fleet and country.

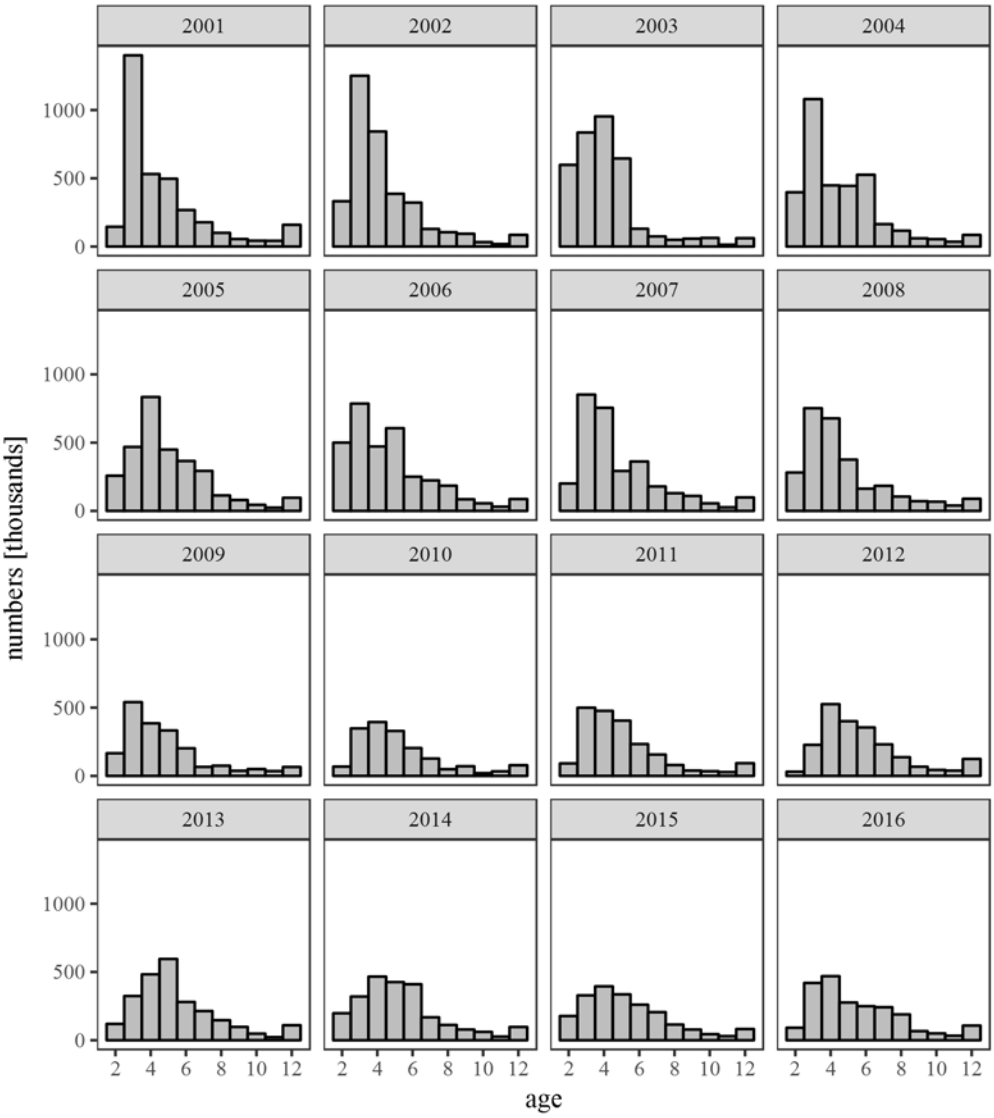


Figure 35.5. Sole in Division 7.e. International landings numbers-at-age.

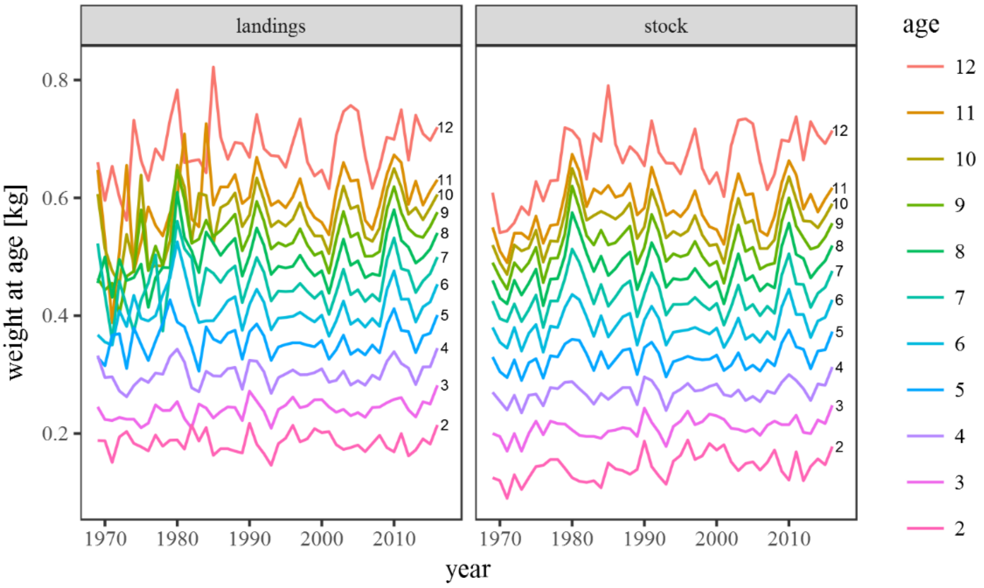


Figure 35.6. Sole in Division 7.e. Catch and stock weights-at-age.

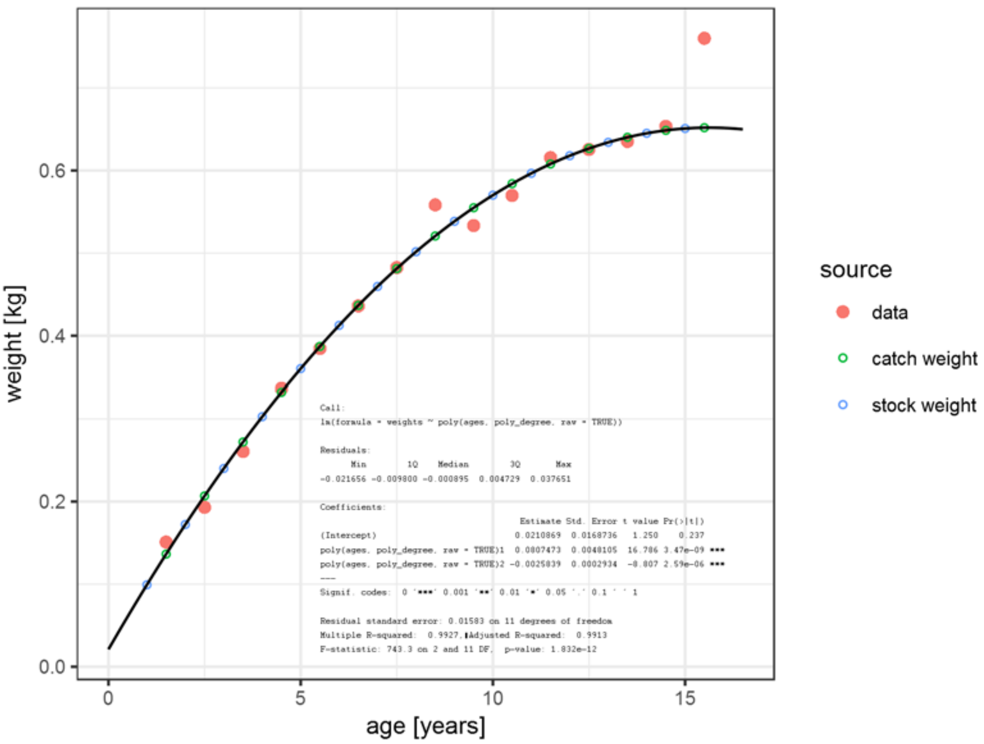


Figure 35.7. Sole in Division 7.e. Generation of stock and catch weights from landings weights-at-age.

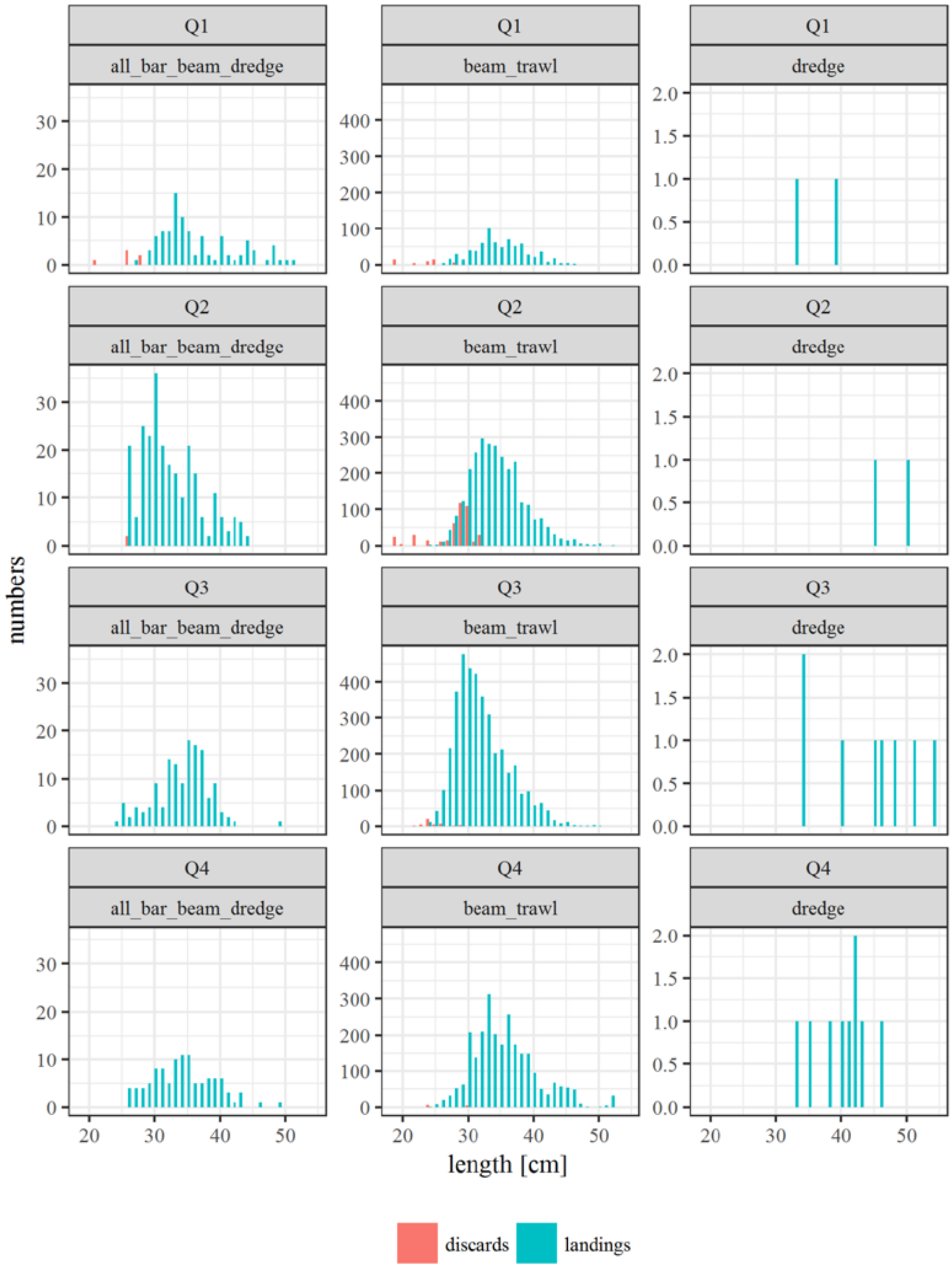


Figure 35.8. Sole in Division 7.e. Discards by quarter and fleet from sampled trips for the UK.

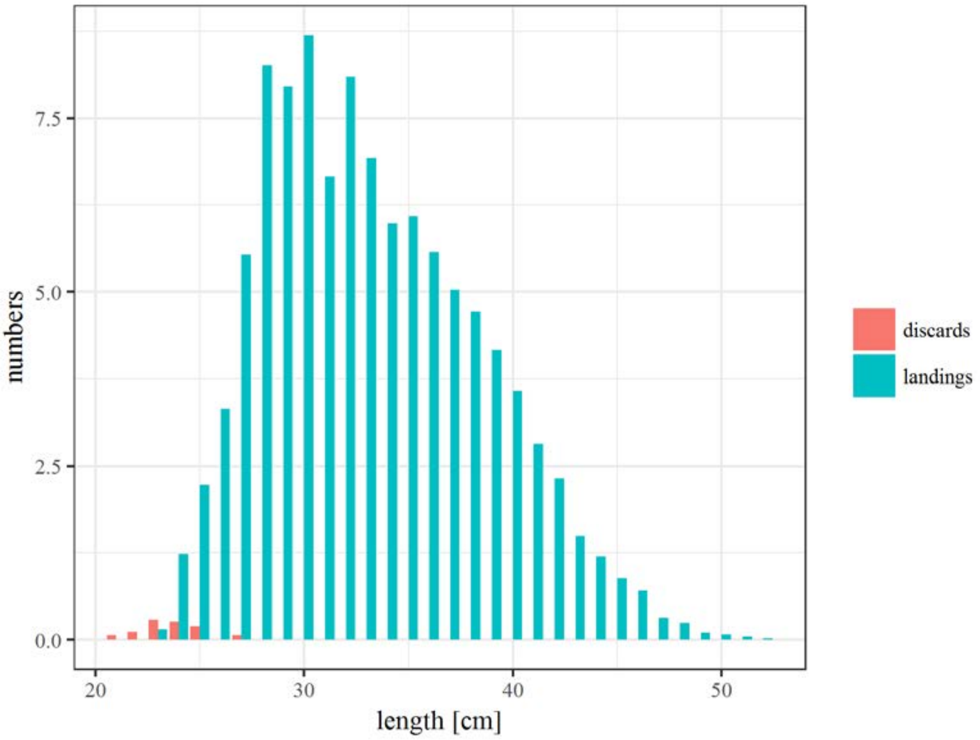


Figure 35.9. Sole in Division 7.e. Discards from sampled trips for Belgium. Figure shows only annual numbers for fleet TBB_DEF_70-99_0_all. The numbers are raised to the catch for this fleet. Four samples were taken for landings and discards, for landings 3285 fish were measured and for discards 19.

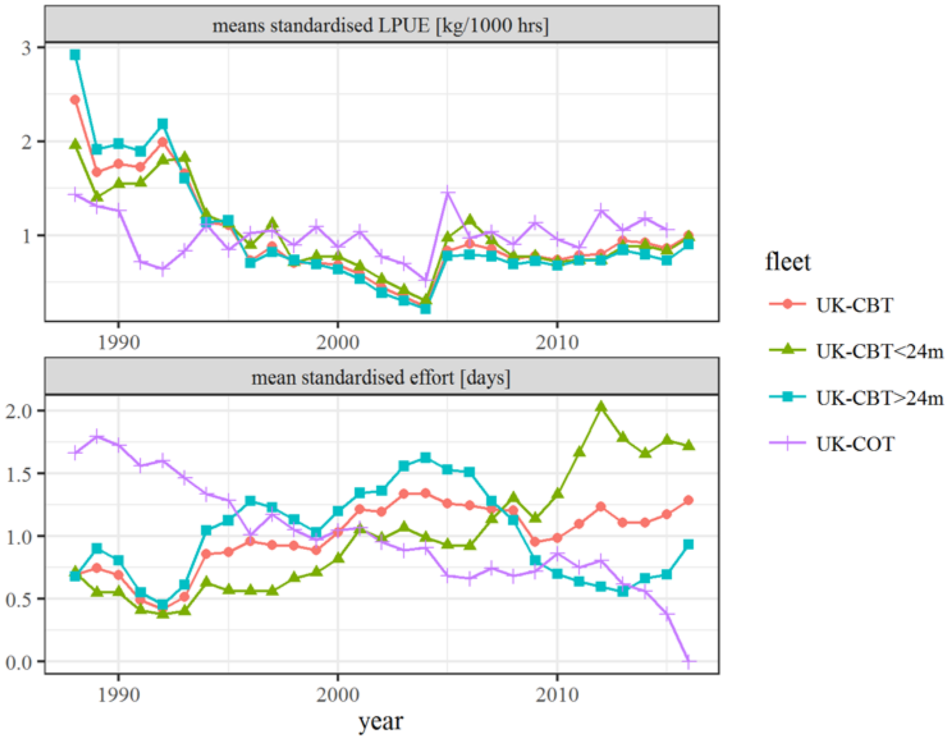


Figure 35.10. Sole in Division 7.e. Means standardised lpue and effort for the UK commercial fleets.

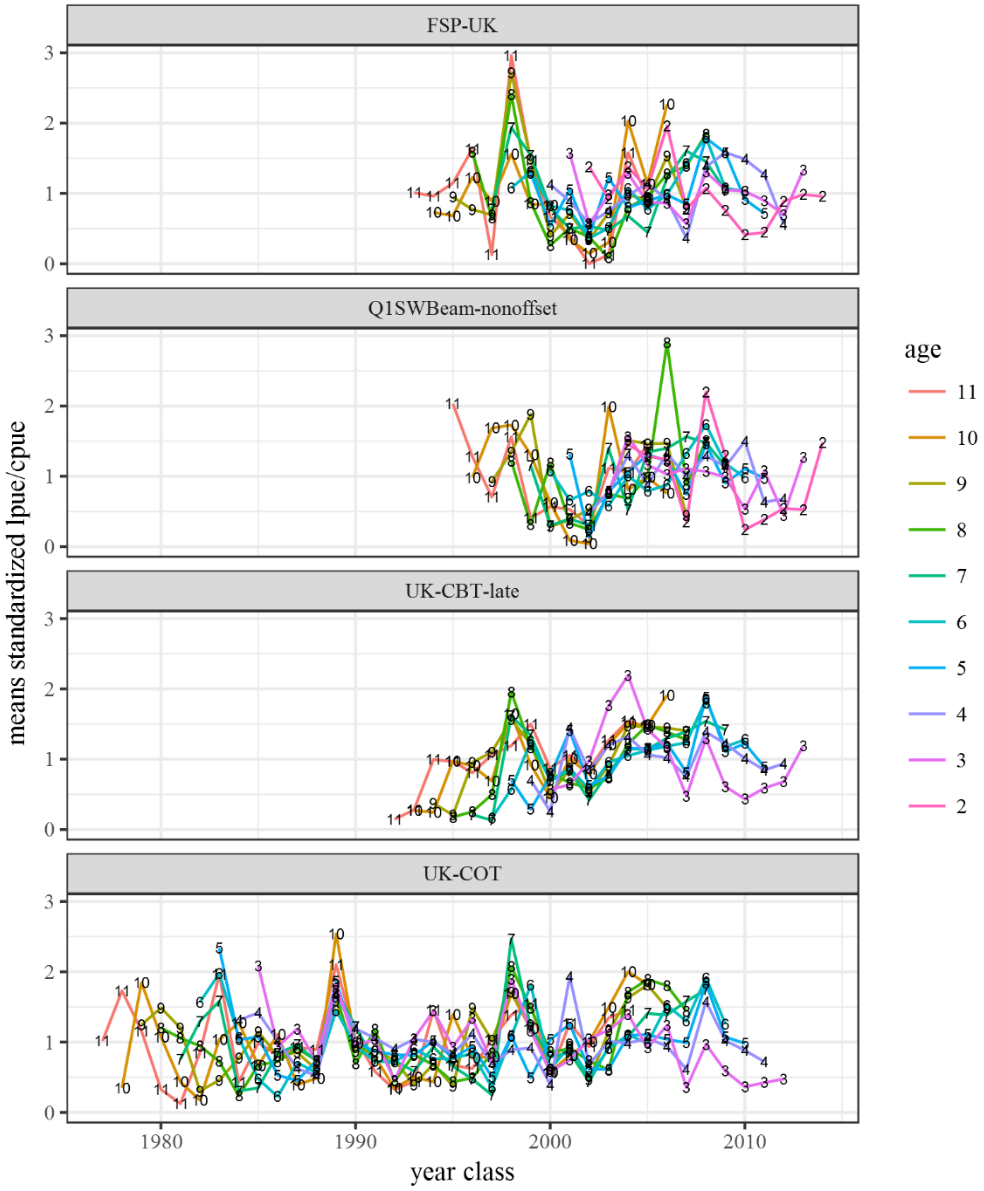


Figure 35.11. Sole in Division 7.e. Means standardised lpue/cpue by year class. Note the cohorts differ on the x-axes due to the differences in the length and age ranges of the tuning series.

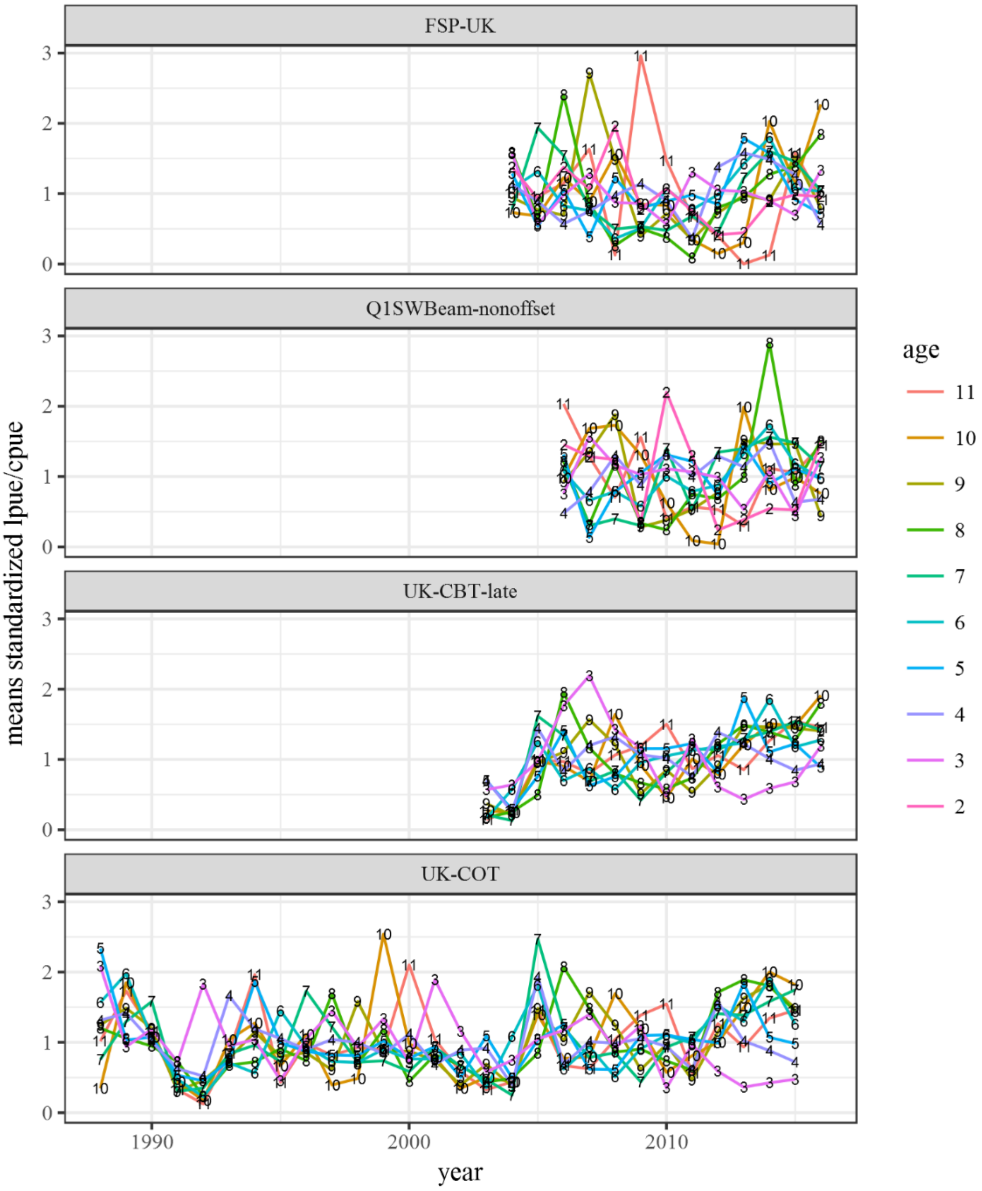


Figure 35.12. Sole in Division 7.e. Means standardised lpue/cpue by year. Note the cohorts differ on the x-axes due to the differences in the length and age ranges of the tuning series.

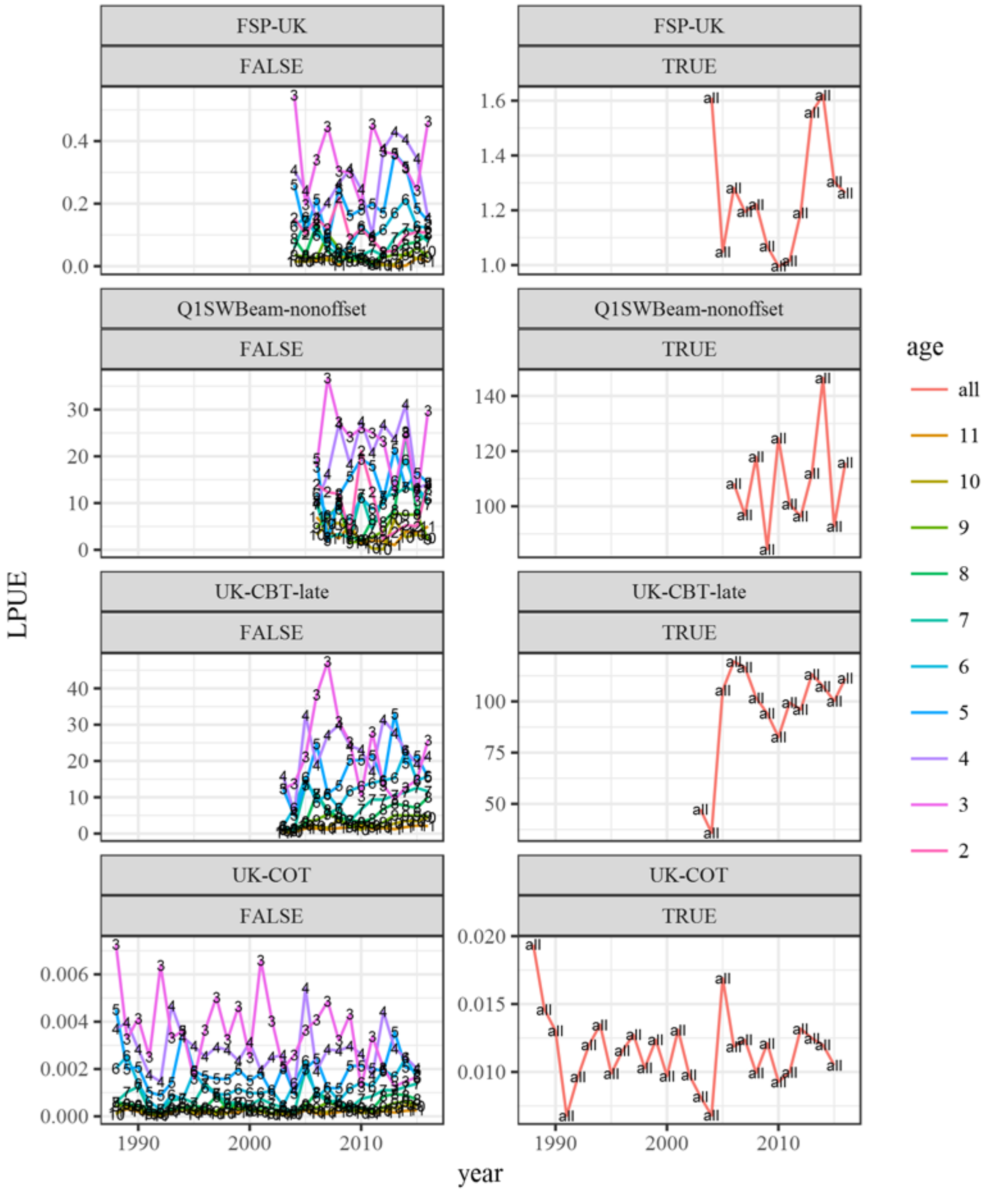


Figure 35.13. Sole in Division 7.e. Survey indices for all commercial and scientific surveys.

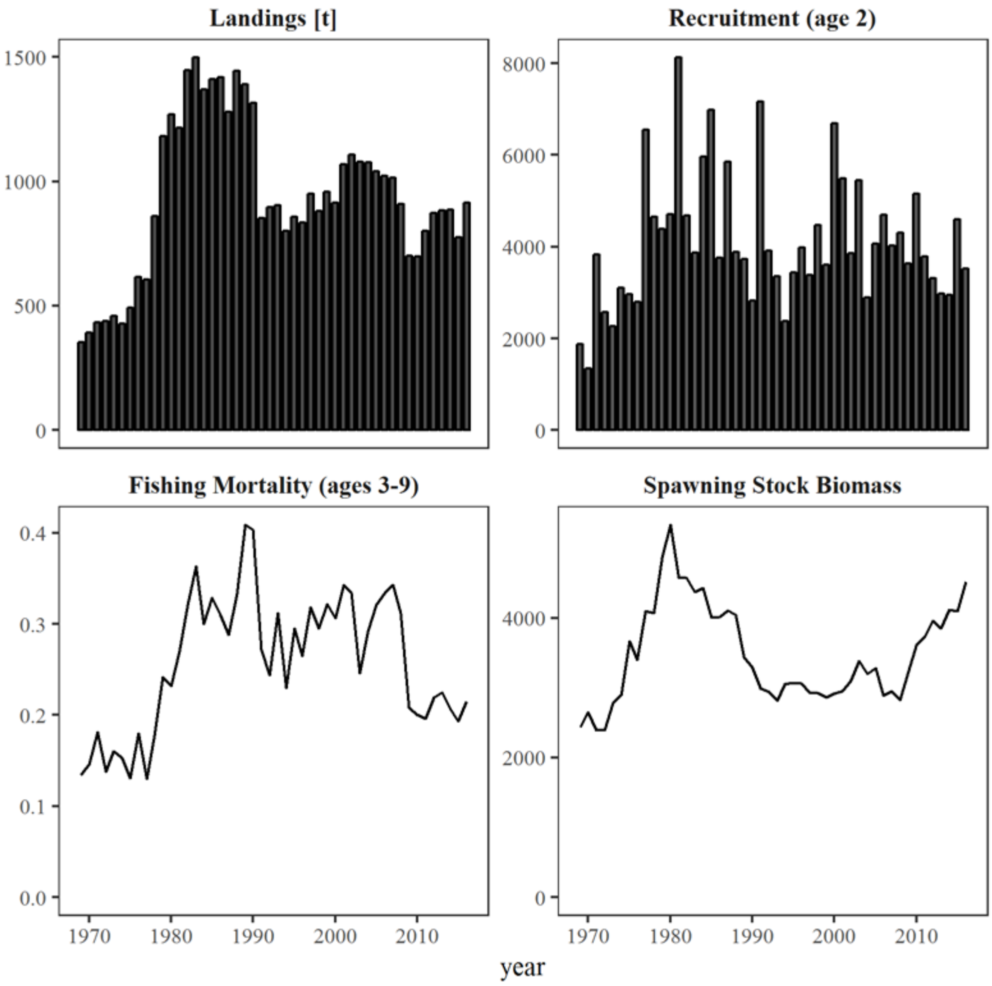


Figure 35.15. Sole in Division 7.e. Results of the final XSA run.

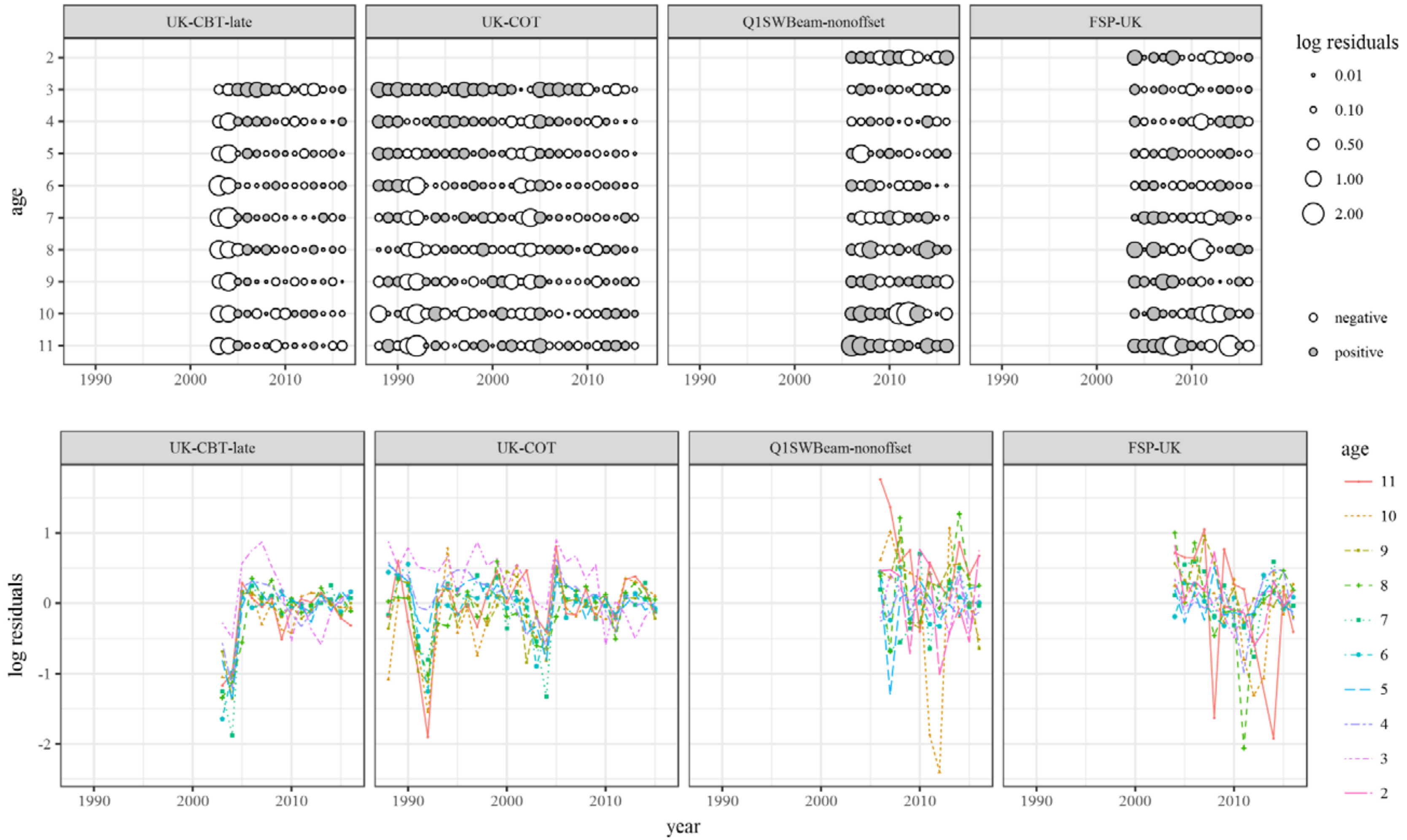


Figure 35.16. Sole in Division 7.e. XSA fleet log catchability residuals. Note that the application of time-series weighting set as a tricubic taper with a range of 15 years excludes log catchability residuals for the UK-COT fleet prior to 2001.

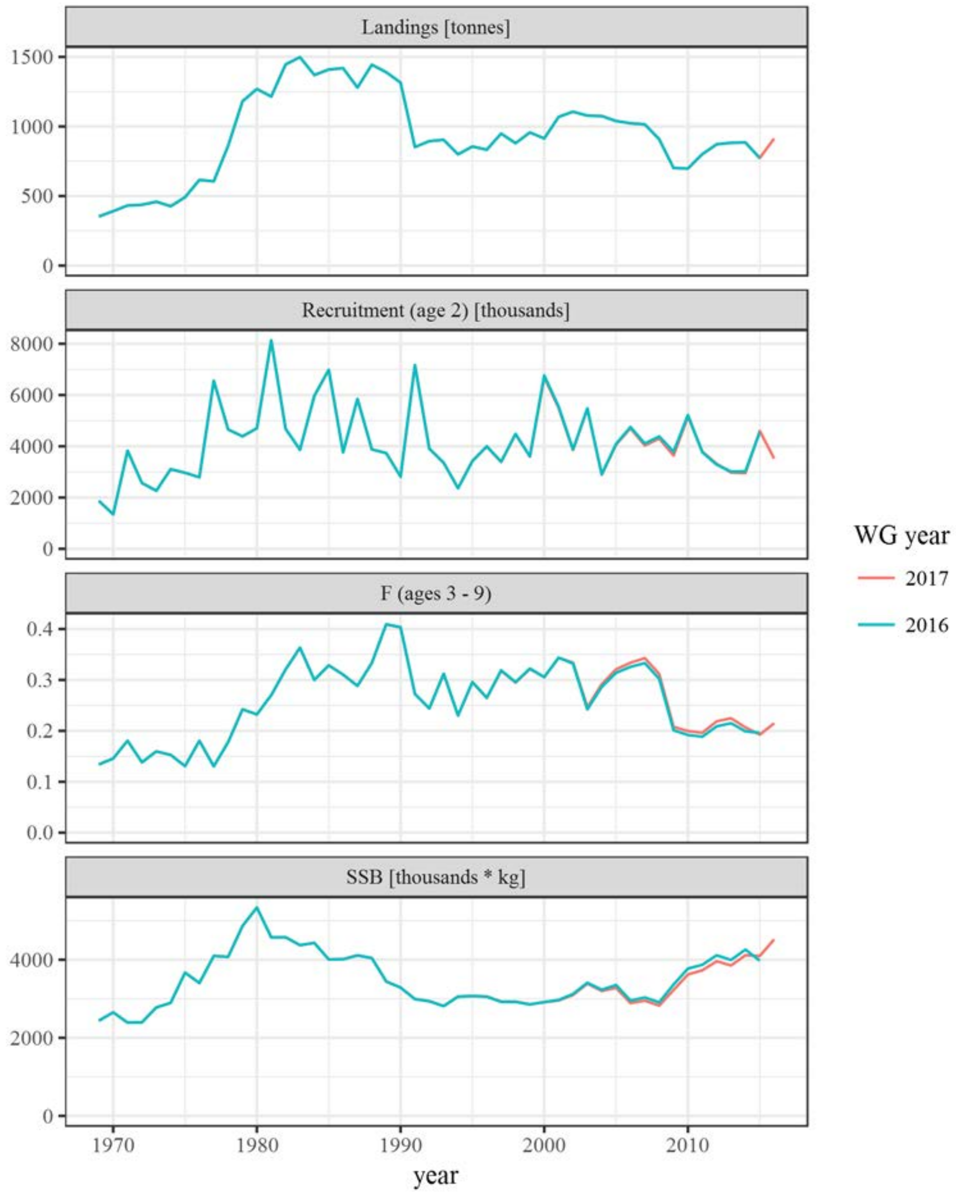


Figure 35.17. Sole in Division 7.e. Comparison of the current XSA assessment with the final assessment run from last year's WGCSE.

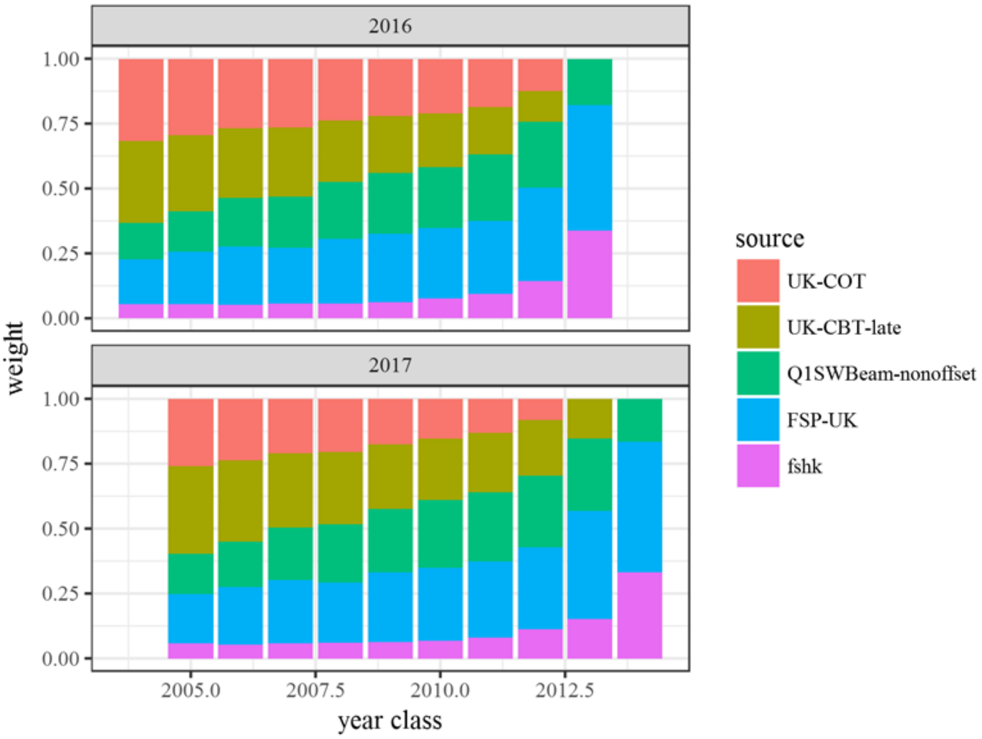


Figure 35.18. Sole in Division 7.e. Scaled weights for the current XSA assessment and the previous XSA assessment conducted at ICES, WGCSE 2016.

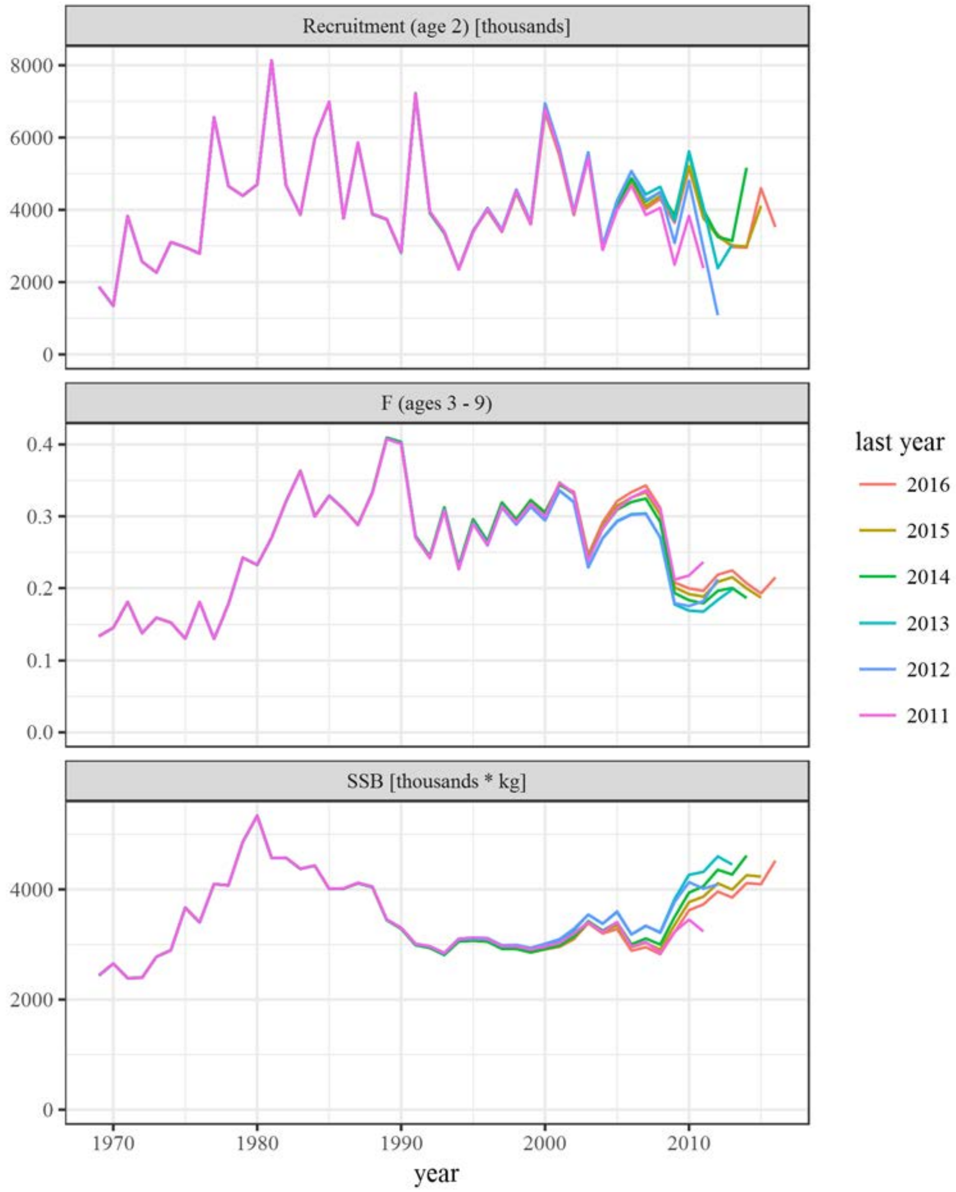


Figure 35.19. Sole in Division 7.e. Five-year retrospective of stock status and fishing mortality estimates.

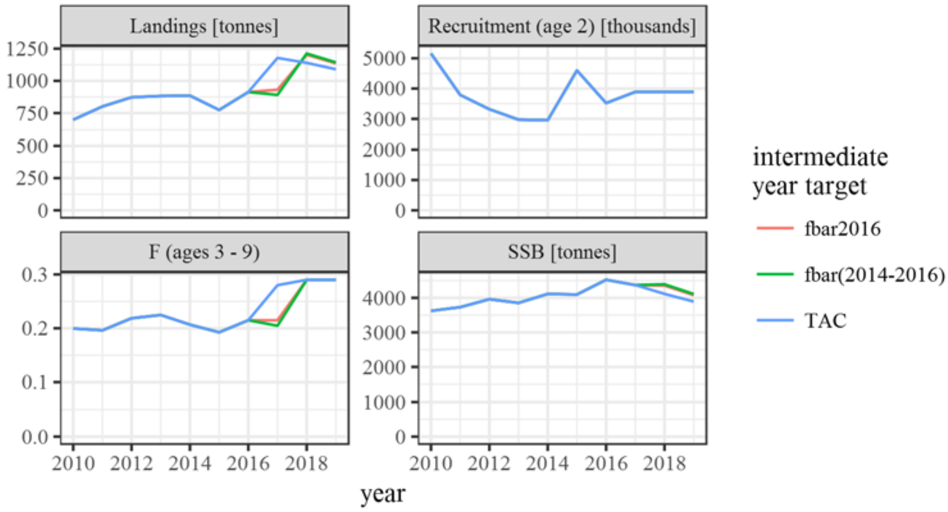


Figure 35.20. Sole in Division 7.e. Options for the intermediate year in the short-term forecast.

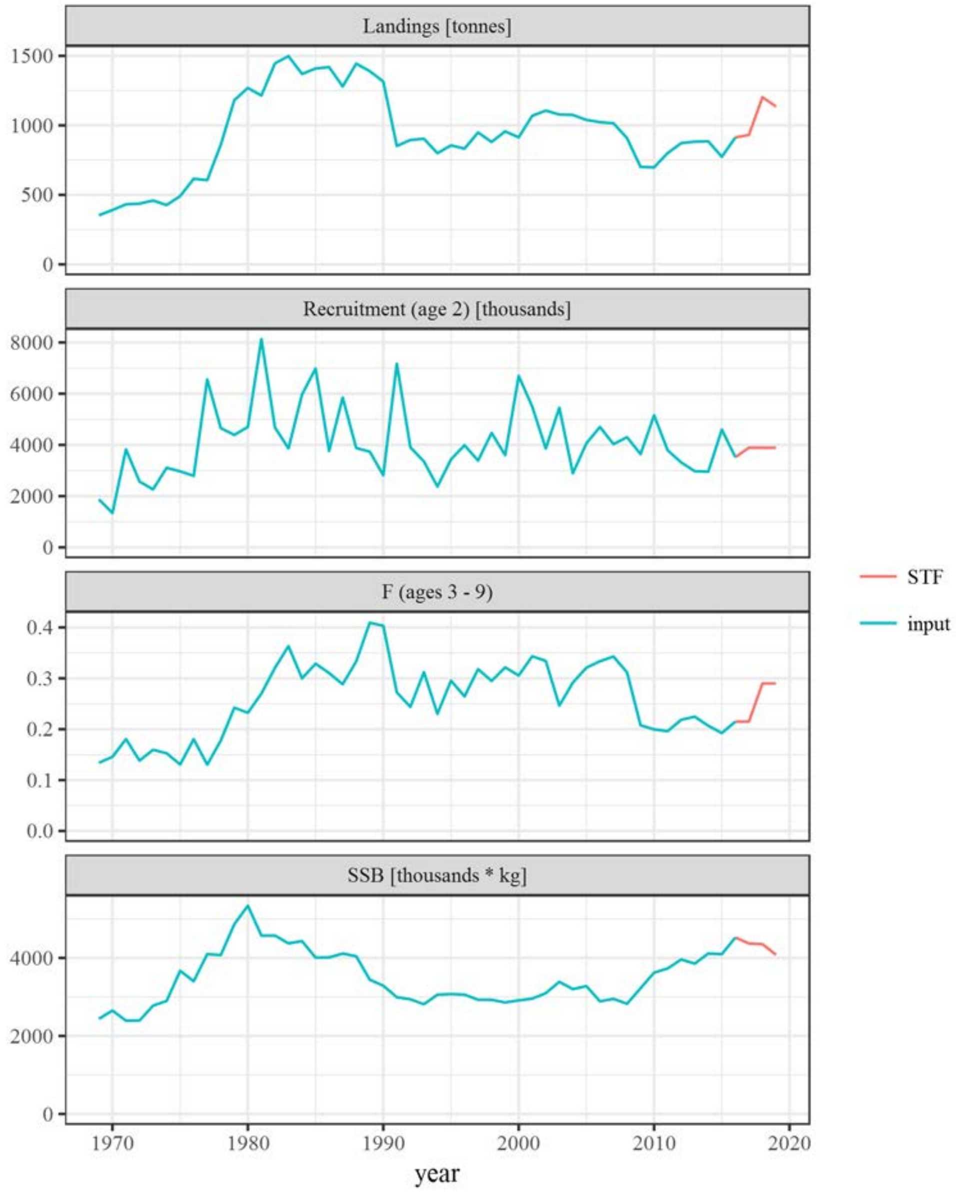


Figure 35.21. Sole in Division 7.e. Output for the short-term forecast under the MSY approach.

Figure 35.22. Sole in Division 7.e. Output of the short-term forecast of the MSY approach, including F_{MSY} ranges.

35.15 Audit of Sole in 7.e

Marianne Robert

17 May 2017

General

ICES provides annual catch advice for this stock based on the MSY approach. Advice is topped up based on average discards rate. Last benchmark WKFLAT 2012 but IBPWCFlat2 2015 (The second Inter-benchmark Protocol of Western English Channel Flatfish) provides new recommendation for the assessement. At IBPWCFlat2 2015, the XSA model parameterisation was updated to incorporate revised tuning information due to modifications in the UK e-logbook effort recording system. During WGCSE 2017, the same procedure as last year was applied (the one described in the stock annex) In agreement with the stock annex stock and catch weights-at-age were derived by fitting a 2nd degree polynomial model to the raw landings weights-at-age extracted from InterCatch. This fit is not checked within the audits procedure.

In 2016, the landing obligation applied to the sole 27.7.e stock for the first time. However, a *de minimis* exemption applied.

For single stock summary sheet advice

Data

The report says "As discard are considered to be low, discards were not raised to an international level or allocated with an age structure from sample data." I can understand why the age structure is not raised (no allocation scheme for discards) but the reason why raising discards procedure at international level is not applied is unclear to me.

UK commercial tuning fleet UK COT has dropped to zero this year. The implication of this on assessment results should be better documented.

Assessment

1) Assessment type: update/DALY XSA Extended Survivors Analysis (XSA) as outlined in the stock annex.
2) Assessment: analytical FLXSA (and VPA.95) used two UK commercial time-series (UK-CBT-late and UK-COT) and two UK standardised research surveys (UK-FSP and Q1SWBeam). Biological parameter are in line with the stock annex. These XSA settings are as outlined in the stock annex (including the FLXSA control is specified the stock annex). XSA setting are in line with the stock annex.

Forecast

- Forecast: Short-term forecast is presented and conducted in R. However, the stock annex says "Software used: MFDP".

The stock annex mentioned "appropriate forecast parameter are largely based on diagnostics of the assessment"

Advice sheet and report: F(2013–2015) rescaled : " French landings are still subject to a lag between reaching the TAC and closure of the fishery so that a rescaled F interim year assumption remains prudent. F estimates 2014–2016 fluctuate around 0.2. Consequently, rescaling F_{2016} by average $F_{14–16}$ is considered appropriate for the forecast as per the stock annex to account for the slight retrospective pattern. The mean catch and stock weights-at-age 2014–2016 were also used."

The report says : rec=gm(1969–2016) => "Recruitment was forecast using a long-term geometric mean (1969–2016) due to temporal variability in the time-series and the lack of distinct periods of successive high or low recruitment in recent years." This reasoning is the same as last year.

The stock annex stipulates "In 2015, IBPWCFlat2 decided to forecast recruitment using a long-term geometric mean (1969–2014) due to temporal variability in the time-series and the lack of distinct periods of successive high or low recruitment in recent years. IBPWCFlat2 also issued a caveat that recruitment should be forecast using a short-term geometric mean if distinct periods of successive low or high recruitment is evident over the final three years (ICES, 2015b)."

Stock annex is therefore unclear on the forecast recruitment assumption to be used. Need to be clarified.

Diagnostics

- Consistency: The assessment is consistent with last year assessment.
- retro: Downward revision in SSB and upward revision in F are observed in the retro plots. The amplitude of this revision are low to moderate.

Recruitment has been very noisy in the last five years of the retro

- Stock status: F is estimated below F_{MSY} since 2009 and SSB above $MSYB_{trigger}$. Recruitment is variable without clear trend.
- Management Plan: A management plan has been agreed by the EU in 2007 (EC, 2007). In its current phase, it aims at keeping F at the target value of 0.27 with a 15% TAC constraint. This plan has not been evaluated by ICES.

Conclusion

The assessment and forecast have been performed correctly. Report is clear and well written. Stock annex is very detailed.

The catch options inputs and table in the advice sheet are consistent with the tables and description in the WG report. Minors erros has been spoted:

=> please check in the advice : Landings and discards in 2017; 2015 and 2016 catches per countries , rounding of 2016 catches between the different tables and documents (report and advice)

Clarification on forecast recruitment assumption need to be added to the stock annex

One of the tuning indices (UK COT) has dropped to zero in 2016. This needs to be better explained in the report and impact on the assessment better highlight in the report and maybe in the advice.

Some minor suggestions, corrections are highlighted in the report word document and in the advice.

General aspects

Has the EG answered those TORs relevant to providing advice? Yes.

Is the assessment according to the stock annex description? Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? A management plan exists and the catch option table includes the management plan rationale.

Have the data been used as specified in the stock annex? Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes

Is there any major reason to deviate from the standard procedure for this stock? No

Does the update assessment give a valid basis for advice?

If not, suggested what other basis should be sought for the advice? Yes

This an r-Markdown document to check and validate the assessment and STF for Sole 7e (echw) at WGCSE 2016.

```
#install.packages("FLCore", repos="http://flr-project.org/R")
#install.packages("FLXSA", repos="http://flr-project.org/R")
#install.packages("FLAssess", repos="http://flr-project.org/R")
#install.packages("knitr", repos="http://flr-project.org/R")
#install.packages("tidyr", repos="http://flr-project.org/R")



rm(list=ls())
library(FLCore)

## Warning: package 'FLCore' was built under R version 3.1.2

## Loading required package: lattice

## Loading required package: MASS

## FLCore (Version 2.5.20150116, packaged: 2015-01-23 08:53:29 UTC)

##
## Attaching package: 'FLCore'

## The following objects are masked from 'package:base':
##
##     cbind, rbind

library(FLAssess)

## Loading required package: FLash

## Warning: package 'FLash' was built under R version 3.1.2

library(FLXSA)
library(knitr)

## Warning: package 'knitr' was built under R version 3.1.3

# instal en .zip # sinon ca plante
library(tidyr)

##
## Attaching package: 'tidyr'

## The following object is masked from 'package:FLCore':
##
##     expand

sessionInfo()
```

```
## R version 3.1.1 (2014-07-10)
## Platform: i386-w64-mingw32/i386 (32-bit)
##
## locale:
## [1] LC_COLLATE=French_France.1252  LC_CTYPE=French_France.1252
## [3] LC_MONETARY=French_France.1252 LC_NUMERIC=C
## [5] LC_TIME=French_France.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] tidyr_0.2.0          knitr_1.12.3         FLXSA_2.5.20140808
## [4] FLAssess_2.5.20130716 FLash_2.5.2          FLCore_2.5.20150116
## [7] MASS_7.3-33          lattice_0.20-29
##
## loaded via a namespace (and not attached):
## [1] digest_0.6.8    evaluate_0.9    grid_3.1.1      htmltools_0.2.6
## [5] rmarkdown_0.9   stats4_3.1.1    stringr_0.6.2   tools_3.1.1
## [9] yaml_2.1.13
```

```
# R3.1.1. 32 bits
```

Read the stock objext

set the main directory and data and output directories.

```
#maindir <- 'C:/Users/marobert/Documents/work/ICES/2016/WGCSE/audit sol echw/'
maindir <- 'C:/Users/marobert/Documents/work/ICES/2017/WGCSE/audit/sol7e/'
#datadir <- 'C:/Users/marobert/Documents/work/ICES/2016/WGCSE/audit sol echw/VPA/VPA/'
datadir <-'C:/Users/marobert/Documents/work/ICES/2017/WGCSE/audit/sol7e/sharepointdownload_160517/sol-echw/data/vpa_files'


assessment_year<- 2017 # année du groupe WGCSE 2017
TAC<-1178 # check 2017 TAC # update every year
discard_rate <-2.93737 # in % # copy from advise sheet : average of the last 3 years 2014:2016
```

read in the input files for this stock.

```
stock <- readFLStock(file.path(datadir,"SOL7EIND.DAT",sep=""),no.discards=T)
tun<- readFLIndices(file.path(datadir,"SOL7ETU3a.dat",sep=""),type="VPA")

units(stock)[1:17] <- as.list(c(rep(c("tonnes","thousands","kg"),4), "NA", "NA", "f", "NA", "NA"))
summary(stock)
```

```
## An object of class "FLStock"
##
## Name: W CHANNEL SOLE 2016 WGCSE SEXES COMB
## Description: Imported from a VPA file. (
C:/Users/marobert/Documents/work/ICES/2017/WGCSE/audit/sol7e/sharepointdownload_160517/sol-echw/data/vpa_files/SOL7EIND.DAT ).  Wed May 17 17:35:17 2017
## Range:    min    max pgroup  minyear maxyear minfbar maxfbar
##  2   15  NA  1969    2016    2   15
## Quant: age
##
## catch         : [ 1 48 1 1 1 1 ], units =  tonnes
## catch.n       : [ 14 48 1 1 1 1 ], units =  thousands
## catch.wt      : [ 14 48 1 1 1 1 ], units =  kg
## discards      : [ 1 48 1 1 1 1 ], units =  tonnes
## discards.n    : [ 14 48 1 1 1 1 ], units =  thousands
## discards.wt   : [ 14 48 1 1 1 1 ], units =  kg
## landings      : [ 1 48 1 1 1 1 ], units =  tonnes
## landings.n    : [ 14 48 1 1 1 1 ], units =  thousands
## landings.wt   : [ 14 48 1 1 1 1 ], units =  kg
## stock         : [ 1 48 1 1 1 1 ], units =  tonnes
## stock.n       : [ 14 48 1 1 1 1 ], units =  thousands
## stock.wt      : [ 14 48 1 1 1 1 ], units =  kg
## m             : [ 14 48 1 1 1 1 ], units =  NA
## mat           : [ 14 48 1 1 1 1 ], units =  NA
## harvest       : [ 14 48 1 1 1 1 ], units =  f
```

```
## harvest.spwn  : [ 14 48 1 1 1 1 ], units =  NA
## m.spwn        : [ 14 48 1 1 1 1 ], units =  NA
```

stock@m

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age  1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982
##   2  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   3  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   4  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   5  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   6  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   7  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   8  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   9  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   10 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   11 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   12 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   13 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   14 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   15 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##     year
## age  1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996
##   2  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   3  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   4  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   5  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   6  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   7  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   8  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   9  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   10 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   11 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   12 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   13 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   14 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   15 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##     year
## age  1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
##   2  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   3  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   4  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   5  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   6  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   7  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   8  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   9  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   10 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   11 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   12 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   13 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   14 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   15 0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##     year
## age  2011 2012 2013 2014 2015 2016
##   2  0.1  0.1  0.1  0.1  0.1  0.1
##   3  0.1  0.1  0.1  0.1  0.1  0.1
##   4  0.1  0.1  0.1  0.1  0.1  0.1
##   5  0.1  0.1  0.1  0.1  0.1  0.1
##   6  0.1  0.1  0.1  0.1  0.1  0.1
##   7  0.1  0.1  0.1  0.1  0.1  0.1
##   8  0.1  0.1  0.1  0.1  0.1  0.1
##   9  0.1  0.1  0.1  0.1  0.1  0.1
##   10 0.1  0.1  0.1  0.1  0.1  0.1
##   11 0.1  0.1  0.1  0.1  0.1  0.1
##   12 0.1  0.1  0.1  0.1  0.1  0.1
##   13 0.1  0.1  0.1  0.1  0.1  0.1
##   14 0.1  0.1  0.1  0.1  0.1  0.1
```

```
## 15 0.1 0.1 0.1 0.1 0.1 0.1
##
## units: NA
```

stock@mat

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age  1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982
##   2  0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14
##   3  0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45
##   4  0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88
##   5  0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98
##   6  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   7  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   8  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   9  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   10 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   11 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   12 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   13 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   14 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   15 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##     year
## age  1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996
##   2  0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14
##   3  0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45
##   4  0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88
##   5  0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98
##   6  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   7  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   8  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   9  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   10 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   11 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   12 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   13 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   14 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   15 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##     year
## age  1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
##   2  0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.14
##   3  0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45
##   4  0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88 0.88
##   5  0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98 0.98
##   6  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   7  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   8  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   9  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   10 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   11 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   12 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   13 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   14 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##   15 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##     year
## age  2011 2012 2013 2014 2015 2016
##   2  0.14 0.14 0.14 0.14 0.14 0.14
##   3  0.45 0.45 0.45 0.45 0.45 0.45
##   4  0.88 0.88 0.88 0.88 0.88 0.88
##   5  0.98 0.98 0.98 0.98 0.98 0.98
##   6  1.00 1.00 1.00 1.00 1.00 1.00
##   7  1.00 1.00 1.00 1.00 1.00 1.00
##   8  1.00 1.00 1.00 1.00 1.00 1.00
##   9  1.00 1.00 1.00 1.00 1.00 1.00
##   10 1.00 1.00 1.00 1.00 1.00 1.00
##   11 1.00 1.00 1.00 1.00 1.00 1.00
##   12 1.00 1.00 1.00 1.00 1.00 1.00
##   13 1.00 1.00 1.00 1.00 1.00 1.00
```

```
##   14 1.00 1.00 1.00 1.00 1.00 1.00
##   15 1.00 1.00 1.00 1.00 1.00 1.00
##
## units:  NA
```

stock@m.spwn

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age  1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982
##   2 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   3 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   4 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   5 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   6 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   7 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   8 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   9 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   10 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   11 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   12 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   13 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   14 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   15 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##     year
## age  1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996
##   2 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   3 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   4 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   5 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   6 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   7 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   8 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   9 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   10 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   11 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   12 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   13 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   14 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   15 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##     year
## age  1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
##   2 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   3 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   4 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   5 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   6 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   7 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   8 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   9 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   10 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   11 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   12 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   13 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   14 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##   15 0    0    0    0    0    0    0    0    0    0    0    0    0    0
##     year
## age  2011 2012 2013 2014 2015 2016
##   2 0    0    0    0    0    0
##   3 0    0    0    0    0    0
##   4 0    0    0    0    0    0
##   5 0    0    0    0    0    0
##   6 0    0    0    0    0    0
##   7 0    0    0    0    0    0
##   8 0    0    0    0    0    0
##   9 0    0    0    0    0    0
##   10 0    0    0    0    0    0
##   11 0    0    0    0    0    0
##   12 0    0    0    0    0    0
```

```
## 13 0 0 0 0 0 0
## 14 0 0 0 0 0 0
## 15 0 0 0 0 0 0
##
## units: NA
```

stock@harvest.spwn

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
## year
## age 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982
## 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 11 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 12 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 13 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 14 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## year
## age 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996
## 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 11 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 12 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 13 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 14 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## year
## age 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
## 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 11 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 12 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 13 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 14 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## year
## age 2011 2012 2013 2014 2015 2016
## 2 0 0 0 0 0 0
## 3 0 0 0 0 0 0
## 4 0 0 0 0 0 0
## 5 0 0 0 0 0 0
## 6 0 0 0 0 0 0
## 7 0 0 0 0 0 0
## 8 0 0 0 0 0 0
## 9 0 0 0 0 0 0
## 10 0 0 0 0 0 0
## 11 0 0 0 0 0 0
```

```
##   12 0    0    0    0    0    0
##   13 0    0    0    0    0    0
##   14 0    0    0    0    0    0
##   15 0    0    0    0    0    0
##
## units:  NA
```

```
stock@stock.wt  [,40:48]
```

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age  2008  2009  2010  2011  2012  2013  2014  2015  2016
##   2  0.172 0.136 0.121 0.169 0.120 0.144 0.157 0.147 0.178
##   3  0.221 0.215 0.215 0.231 0.202 0.200 0.223 0.217 0.248
##   4  0.268 0.287 0.300 0.290 0.276 0.256 0.284 0.282 0.313
##   5  0.315 0.354 0.376 0.347 0.343 0.310 0.340 0.342 0.373
##   6  0.360 0.415 0.445 0.402 0.402 0.363 0.391 0.397 0.427
##   7  0.404 0.469 0.505 0.454 0.453 0.414 0.438 0.448 0.476
##   8  0.447 0.518 0.557 0.504 0.497 0.464 0.480 0.493 0.519
##   9  0.489 0.560 0.600 0.552 0.532 0.513 0.517 0.533 0.557
##   10 0.529 0.596 0.636 0.597 0.561 0.560 0.549 0.568 0.590
##   11 0.569 0.626 0.663 0.639 0.581 0.606 0.576 0.598 0.617
##   12 0.607 0.650 0.682 0.680 0.594 0.650 0.599 0.623 0.639
##   13 0.644 0.668 0.692 0.717 0.599 0.693 0.616 0.643 0.656
##   14 0.680 0.680 0.694 0.753 0.597 0.735 0.629 0.658 0.668
##   15 0.671 0.736 0.735 0.802 0.752 0.769 0.778 0.760 0.787
##
## units:  kg
```

```
stock@catch.wt  [,40:48]
```

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age  2008  2009  2010  2011  2012  2013  2014  2015  2016
##   2  0.197 0.176 0.169 0.200 0.162 0.172 0.191 0.182 0.214
##   3  0.245 0.252 0.258 0.261 0.240 0.228 0.254 0.250 0.281
##   4  0.292 0.322 0.339 0.319 0.311 0.283 0.313 0.313 0.344
##   5  0.337 0.385 0.412 0.375 0.373 0.337 0.366 0.370 0.400
##   6  0.382 0.443 0.476 0.428 0.428 0.389 0.415 0.423 0.452
##   7  0.425 0.494 0.532 0.480 0.476 0.439 0.459 0.471 0.498
##   8  0.468 0.540 0.580 0.528 0.516 0.489 0.499 0.513 0.539
##   9  0.509 0.579 0.619 0.575 0.548 0.536 0.533 0.551 0.574
##   10 0.549 0.612 0.650 0.618 0.572 0.583 0.563 0.583 0.604
##   11 0.588 0.639 0.673 0.660 0.589 0.628 0.588 0.611 0.629
##   12 0.626 0.660 0.688 0.699 0.597 0.672 0.608 0.634 0.648
##   13 0.662 0.675 0.694 0.735 0.599 0.714 0.623 0.651 0.662
##   14 0.698 0.684 0.693 0.770 0.592 0.755 0.634 0.664 0.671
##   15 0.671 0.736 0.735 0.802 0.752 0.769 0.778 0.760 0.787
##
## units:  kg
```

For sole 7.e discards are not included in the assessment currently. (catch and landings number identical, discards slots empty) Natural mortality set to 0.1: in line with the stock annex Maturity:in line with the stock annex catch weight and stock weight different => ok harvest.spwn and m.spwn equal to zero : in line with the stock annex

```
summary(tun)
```

```
## An object of class "FLIndices"
##
## Elements: UK-CBT-late UK-COT Q1SWBeam-nonoffset FSP-UK
##
## Name: UK-CBT-late
##  Description: W CHANNEL SOLE 2017 WGCSE, 2-11, SEXES COMBINED, . Imported from VPA file.
##  Range:   min    max pgroup  minyear maxyear startf  endf
##     3   11  11  2003    2016    0   1
```

```
## Quant: age
## dim: 9 14 1 1 1
## Name: UK-COT
## Description: W CHANNEL SOLE 2017 WGCSE, 2-11, SEXES COMBINED, . Imported from VPA file.
## Range: min max pgroup minyear maxyear startf endf
##   3  11  11  1988  2016  0  1
## Quant: age
## dim: 9 29 1 1 1
## Name: Q1SWBeam-nonoffset
## Description: W CHANNEL SOLE 2017 WGCSE, 2-11, SEXES COMBINED, . Imported from VPA file.
## Range: min max pgroup minyear maxyear startf endf
##   2  11  11  2006  2016  0.1 0.25
## Quant: age
## dim: 10 11 1 1 1
## Name: FSP-UK
## Description: W CHANNEL SOLE 2017 WGCSE, 2-11, SEXES COMBINED, . Imported from VPA file.
## Range: min max pgroup minyear maxyear startf endf
##   2  11  11  2004  2016  0.7 0.75
## Quant: age
## dim: 10 13 1 1 1
```

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).

save the stock object in case we need to load it independently later.

```
save(stock,tun,file=file.path(datadir,'sol7e_stock.Rdata'))
```

set some of the parameters for this stock i.e. F_{bar} range, plusgroup, recruit age, F_{MSY}, $MSYB_{trigger}$, interim year TAC.

```
stock@range[c("minfbar","maxfbar")] = c(3,9)
fbarage <- 3:9
stock <- setPlusGroup(stock,plusgroup=12)
fmsy <- 0.291
fmsylower<-0.160
fmsyupper<-0.342
msybtrig <- 2900
blim<-2000
rage <- 2 #Recruitment age
```

run XSA output the F-at-age matrix to compare with the final assessment. Final XSA output is saved generate a stock summary table which will be used for output later.

```
xsa.control <- FLXSA.control(tol = 1e-09, maxit = 200,  min.nse = 0.4,  fse  = 0.5,
                        rage = 0,   qage  = 7,   shk.n   = FALSE, shk.f = TRUE,
                        shk.yrs = 3, shk.ages= 5,  tsrange = 15,
                        tspower = 3)
# in the script of Jonathan
#control <- FLXSA.control(fse = 0.5, rage = 0, qage = 7, shk.n = FALSE, shk.f = TRUE, shk.ages = 5, shk.yrs = 3, min.nse =
#0.4, tspower = 3, tsrange = 15, maxit= 200)


tun.sel<-tun
xsa<-FLXSA(stock=stock, indices=tun.sel, control=xsa.control)
fout <- as.data.frame(xsa@harvest)
fout <-fout[,c(1,2,7)]
names(fout)[3] <- 'f'
fout <- tidyr::spread(fout,age,f)

save(xsa,file=file.path(datadir,'sol7e_xsa.Rdata'))
stock@stock.n <- xsa@stock.n;  stock@harvest <- xsa@harvest

summary<-data.frame(year=stock@range['minyear']:stock@range['maxyear']
            #,catch=c(stock@catch)
            ,land=c(stock@landings)
            ,recruit=c(stock@stock.n[as.character(rage)])
            ,tsb=c(tsb(stock))
```

```
        ,ssb=c(ssb(stock))
        ,fbar=c(apply(stock@harvest[as.character(fbarage)],2,mean))
        )

knitr::kable(subset(fout,year>2000),row.names=F, digits=3)
```

year	2	3	4	5	6	7	8	9	10	11	12
2001	0.028	0.295	0.303	0.395	0.392	0.357	0.266	0.396	0.495	0.382	0.382
2002	0.095	0.318	0.259	0.335	0.426	0.295	0.330	0.377	0.383	0.362	0.362
2003	0.123	0.324	0.378	0.288	0.161	0.146	0.158	0.271	0.417	0.246	0.246
2004	0.156	0.301	0.257	0.270	0.357	0.278	0.315	0.263	0.390	0.383	0.383
2005	0.069	0.248	0.357	0.393	0.331	0.307	0.280	0.331	0.281	0.269	0.269
2006	0.119	0.276	0.377	0.422	0.352	0.308	0.288	0.312	0.359	0.286	0.286
2007	0.054	0.271	0.411	0.376	0.426	0.404	0.264	0.248	0.307	0.259	0.259
2008	0.071	0.260	0.319	0.327	0.330	0.354	0.390	0.202	0.212	0.331	0.331
2009	0.049	0.170	0.184	0.228	0.262	0.192	0.210	0.207	0.191	0.147	0.147
2010	0.014	0.124	0.162	0.211	0.191	0.234	0.191	0.283	0.150	0.170	0.170
2011	0.026	0.121	0.223	0.223	0.204	0.196	0.201	0.205	0.193	0.283	0.283
2012	0.010	0.074	0.162	0.264	0.278	0.284	0.235	0.233	0.332	0.306	0.306
2013	0.043	0.122	0.199	0.249	0.266	0.240	0.262	0.235	0.234	0.255	0.255
2014	0.073	0.140	0.230	0.242	0.243	0.226	0.170	0.196	0.202	0.178	0.178
2015	0.041	0.150	0.229	0.231	0.205	0.165	0.212	0.155	0.145	0.130	0.130
2016	0.028	0.117	0.294	0.222	0.240	0.266	0.201	0.164	0.126	0.137	0.137

Consistent with the report: Table 8.3.10. Sole in Division 7.e. Fishing mortality-at-age continued at least the last two lines checked

Running the STF

```
years<-stock@range['minyear']:stock@range['maxyear']
nyears <-length(years)
ages <- stock@range['min']:stock@range['max']
nages <- length(ages)

catchoptions <- function() {
 out <- data.frame(Catch=round(c(landings(stf1)[,nyears+2]+discards(stf1)[,nyears+2]))
        ,Land=round(c(landings(stf1)[,nyears+2]))
        ,Dis=round(c(discards(stf1)[,nyears+2]))
        ,FCatch=round(mean(harvest(stf1)[as.character(fbarage),nyears+2]),2)
        ,FLand=round(mean((harvest(stf1)*landings.n(stf1)/catch.n(stf1))[as.character   (fbarage),nyears+2]),2)
        ,FDis=round(mean((harvest(stf1)*discards.n(stf1)/catch.n(stf1))[as.character(fbarage),nyears+2]),2)
        ,SSB=round(c(ssb(stf1)[,nyears+3]),0)
        ,SSB.change= round((c(ssb(stf1)[,nyears+3])/ssbInt-1)*100,0)
        ,TAC.chanage=round((c(landings(stf1)[,nyears+2])/TAC-1)*100,0)
 )
 names(out) <- paste0(names(out),c(rep(max(years)+2-2000,6),max(years)+3-2000,
          max(years)-2000+2, max(years)-2000+1))
 return(out)
}
#Extends an FLStock object along the year dimensin and prepares some of the slots for forward stock projection,
stf0 <- stf(stock, nyears=3, wts.nyears=3, fbar.nyears=3)


# recruitment assumtion
GM <- round(exp(mean(log(c(stock@stock.n[as.character(rage)])[1:(nyears)]))),0)
GM
```

```
## [1] 3890

stock.n(stf0)[1,nyears+1] <- GM
stock.n(stf0)[1,nyears+2] <- GM
stock.n(stf0)[1,nyears+3] <- GM

srr <- FLSR(segreg) # not used as we are using GM but required under setup

# F assumption
# fsq <- mean(harvest(stf0)[as.character(fbarage),nyears-2:0])

# from jonathan's scrip : F recalcted to the last year
Fy <- as.vector(fbar(stf0)[,ac(assessment_year-1)])#F2015 value saved as a vector
Fy1 <- apply(harvest(stf0)[,ac((assessment_year-3):(assessment_year-1))],1,mean)#Mean F at age for the last 3 years
Fy1 <- ((Fy1/mean((Fy1)[ac(3:9),,,,,]))*(Fy))#Average F at age weighted by terminal year Fbar
fsq <- quantMeans(Fy1[ac(3:9)])
#fsq <- round(fsq, digits = 2)
fsq

## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##      year
## age   1
##   all 0.21489
##
## units:  f

# a copier a la main 0.21489 sinon il une ligne () qui marche pas
fsq<- 0.21489


ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fsq,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)

ssbInt <- c(ssb(stf1)[,nyears+2]) # ssb in intermediate year (1 jan)
tsbInt <- c(tsb(stf1)[,nyears+2]) # ssb in intermediate year (1 jan)
landInt <- c(landings(stf1)[,nyears+1]) # catch in intermediate year, assuming fsq

out <- NULL
for(f in seq(0,2,by=0.1)){
  ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,f*fsq,0),quantity=rep('f',3)))
  stf1  <- project(stf0, ctrl, srr)
  out <- rbind(out,data.frame(Fmult=f,catchoptions()))
}




#setup for other options
fmsyapproach <- fmsy*ifelse(ssbInt/msybtrig>1,1,ssbInt/msybtrig)

# other options
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fmsyapproach,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
msyapproach <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fmsy,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
msy <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fmsylower,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
msylow <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fmsyupper,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
msyup <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,0.27,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
mngplan <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,TAC,0),quantity=c('f','landings','f')))
stf1  <- project(stf0, ctrl, srr)
```

```
TACstable <- catchoptions()
#ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,TAC*1.15,0),quantity=c('f','landings','f')))
#stf1  <- project(stf0, ctrl, srr)
#TACplus15 <- catchoptions()
#ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,TAC*0.85,0),quantity=c('f','landings','f')))
#stf1  <- project(stf0, ctrl, srr)
#TACminus15 <- catchoptions()
```

Outputs

The detailed catch option table and other stock specific catch options are also listed.

```
summary <- rbind(summary, c(max(years)+1,landInt, GM, tsbInt, ssbInt, fsq))
```

```
knitr::kable(summary,row.names=F, digits = c(0, 0, 0, 0, 0 , 2))
```

year	land	recruit	tsb	ssb	fbar
1969	353	1874	2927	2437	0.13
1970	391	1343	3023	2652	0.15
1971	432	3826	2838	2390	0.18
1972	437	2568	3091	2395	0.14
1973	459	2264	3266	2778	0.16
1974	427	3107	3512	2896	0.15
1975	491	2967	4429	3670	0.13
1976	616	2791	4102	3403	0.18
1977	606	6556	5339	4098	0.13
1978	861	4657	5429	4074	0.18
1979	1181	4389	6014	4865	0.24
1980	1269	4702	6387	5338	0.23
1981	1215	8130	5957	4572	0.27
1982	1446	4680	5916	4575	0.32
1983	1498	3866	5377	4374	0.36
1984	1370	5968	5463	4430	0.30
1985	1409	6982	5569	4009	0.33
1986	1419	3766	5258	4014	0.31
1987	1280	5849	5311	4112	0.29
1988	1444	3880	5121	4044	0.33
1989	1390	3736	4319	3443	0.41
1990	1315	2818	4224	3288	0.40
1991	852	7169	4222	2993	0.27
1992	895	3908	4104	2940	0.24
1993	904	3354	3584	2814	0.31
1994	800	2373	3791	3058	0.23
1995	856	3434	3878	3073	0.30
1996	833	3987	4163	3059	0.26
1997	949	3388	3851	2928	0.32
1998	880	4468	3975	2927	0.29
1999	957	3599	3988	2859	0.32
2000	914	6693	4377	2912	0.31

year	land	recruit	tsb	ssb	fbar
2001	1069	5495	4601	2957	0.34
2002	1106	3857	4288	3097	0.33
2003	1078	5452	4515	3388	0.25
2004	1075	2893	4134	3200	0.29
2005	1039	4063	4167	3279	0.32
2006	1023	4701	3878	2888	0.33
2007	1015	4031	4002	2951	0.34
2008	908	4301	3974	2825	0.31
2009	701	3640	4174	3224	0.21
2010	698	5158	4643	3622	0.20
2011	801	3790	4967	3730	0.20
2012	872	3317	4809	3960	0.22
2013	883	2973	4652	3854	0.22
2014	885	2955	4924	4114	0.21
2015	774	4598	5055	4097	0.19
2016	913	3520	5689	4522	0.21
2017	930	3890	5415	4354	0.21

Consistent with Table 8.3.11

```
other <- rbind(msyapproach, msy, msylow, msyup,mngplan, TACstable)
# need to be updated FLand18 a la main
other$Fmult <- other$FLand18/fsq
out <- rbind(out,other[, c(10,1:9)])
out$basis <- c(paste0('Fsq*',seq(0,2,by=0.1)),'msyapproach', 'msy', 'msylow', 'msyup', 'mngplan','TACstable')
out$Dis18 <- (out$Land18*discard_rate)/100
out$Catch18<- out$Dis18 +out$Land18
knitr::kable(out,row.names=F, digits= c(2,0,0,0,2,2,2,0,0,0,0))
```

Fmult	Catch18	Land18	Dis18	FCatch18	FLand18	FDis18	SSB19	SSB.change18	TAC.chanage17	basis
0.00	0	0	0	0.00	NaN	NaN	5244	20	-100	Fsq*0
0.10	104	101	3	0.02	0.02	0	5146	18	-91	Fsq*0.1
0.20	205	199	6	0.04	0.04	0	5050	16	-83	Fsq*0.2
0.30	305	296	9	0.06	0.06	0	4956	14	-75	Fsq*0.3
0.40	402	391	11	0.09	0.09	0	4864	12	-67	Fsq*0.4
0.50	497	483	14	0.11	0.11	0	4774	10	-59	Fsq*0.5
0.60	591	574	17	0.13	0.13	0	4685	8	-51	Fsq*0.6
0.70	682	663	19	0.15	0.15	0	4599	6	-44	Fsq*0.7
0.80	773	751	22	0.17	0.17	0	4514	4	-36	Fsq*0.8
0.90	861	836	25	0.19	0.19	0	4432	2	-29	Fsq*0.9
1.00	947	920	27	0.21	0.21	0	4350	0	-22	Fsq*1
1.10	1032	1003	29	0.24	0.24	0	4271	-2	-15	Fsq*1.1
1.20	1115	1083	32	0.26	0.26	0	4193	-4	-8	Fsq*1.2
1.30	1196	1162	34	0.28	0.28	0	4117	-5	-1	Fsq*1.3
1.40	1276	1240	36	0.30	0.30	0	4042	-7	5	Fsq*1.4
1.50	1355	1316	39	0.32	0.32	0	3969	-9	12	Fsq*1.5
1.60	1431	1390	41	0.34	0.34	0	3897	-10	18	Fsq*1.6
1.70	1506	1463	43	0.37	0.37	0	3827	-12	24	Fsq*1.7
1.80	1580	1535	45	0.39	0.39	0	3758	-14	30	Fsq*1.8
1.90	1652	1605	47	0.41	0.41	0	3691	-15	36	Fsq*1.9
2.00	1723	1674	49	0.43	0.43	0	3625	-17	42	Fsq*2
1.35	1240	1205	35	0.29	0.29	0	4076	-6	2	msyapproach
1.35	1240	1205	35	0.29	0.29	0	4076	-6	2	msy
0.74	724	703	21	0.16	0.16	0	4561	5	-40	msylow

Fmult	Catch18	Land18	Dis18	FCatch18	FLand18	FDis18	SSB19	SSB.change18	TAC.chanage17	basis
1.58	1425	1384	41	0.34	0.34	0	3903	-10	17	msyup
1.26	1161	1128	33	0.27	0.27	0	4150	-5	-4	mngplan
1.30	1213	1178	35	0.28	0.28	0	4102	-6	0	TACstable

Consistent with Table 6.3.45.3 advice sheet (except minor difference coming from rounding) discards and catches are calculated using the discards rate given in the advice sheet

The stfout function below generates detailed STF output tables for the *status quo* forecast. These are picked up to make the Landings and SSB contribution plot.

```
# les hypothse de projection standard
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fsq,fsq),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)

p <- c(1,1,1,1,1,1,1) # fudge because this is a landings only STF
stfout <- function(i){
 out <- data.frame(Age=ages
  ,LF=round(c(harvest(stf1)[,i])*p,3)
  ,CatchNos=round(c(landings.n(stf1)[,i]))
  ,Yield=round(c((landings.n(stf1)*landings.wt(stf1))[,i]),0)
  ,DF=round(c(harvest(stf1)[,i])*(1-p),3)
  ,DCatchNos=round(c(discards.n(stf1)[,i]))
  ,DYield=round(c((discards.n(stf1)*discards.wt(stf1))[,i]),0)
  ,StockNos=round(c(stock.n(stf1)[,i]))
  ,Biomass=round(c((stock.n(stf1)*stock.wt(stf1))[,i]))
  ,SSNos=round(c((stock.n(stf1)*mat(stf1))[,i]))
  ,SSB=round(c((stock.n(stf1)*stock.wt(stf1)*mat(stf1))[,i]))
  )
 out <- rbind(out,colSums(out))
 nrows <- nrow(out)
 out[nrows,1] <- 'Total'
 out[nrows,2] <- round(mean((harvest(stf1)[,i]*p)[as.character(fbarage)]),3)
 out[nrows,5] <- round(mean((harvest(stf1)[,i]*(1-p))[as.character(fbarage)]),3)
 return(out)
 }


stfout1 <- stfout(nyears+1)

## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court

## Warning in c(harvest(stf1)[, i]) * (1 - p): la taille d'un objet plus long
## n'est pas multiple de la taille d'un objet plus court

knitr::kable(stfout1,row.names=F)
```

Age	LF	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
2	0.050	180	35	0	0	0	3890	625	545	87
3	0.142	392	102	0	0	0	3098	710	1394	320
4	0.264	710	230	0	0	0	3213	941	2827	828
5	0.243	269	102	0	0	0	1306	459	1280	450
6	0.241	215	93	0	0	0	1057	428	1057	428
7	0.230	171	81	0	0	0	874	397	874	397
8	0.204	133	69	0	0	0	756	376	756	376
9	0.180	127	70	0	0	0	807	432	807	432
10	0.166	52	30	0	0	0	355	202	355	202
11	0.156	49	30	0	0	0	354	212	354	212
12	0.156	125	88	0	0	0	906	638	906	638
Total	0.215	2423	930	0	0	0	16616	5420	11155	4370

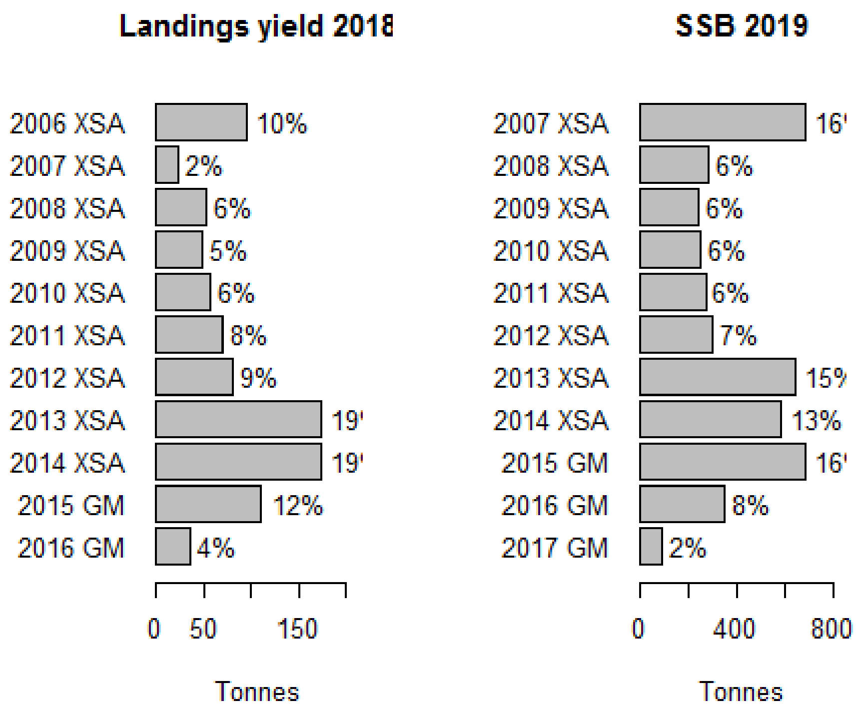
```
stfout2 <- stfout(nyears+2)

## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court

## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court

knitr::kable(stfout2,row.names=F)
```

Age	LF	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
2	0.050	180	35	0	0	0	3890	625	545	87
3	0.142	423	111	0	0	0	3349	768	1507	346
4	0.264	537	174	0	0	0	2431	712	2139	627
5	0.243	460	174	0	0	0	2233	785	2189	770
6	0.241	189	81	0	0	0	926	375	926	375
7	0.230	147	70	0	0	0	752	341	752	341
8	0.204	111	57	0	0	0	629	313	629	313
9	0.180	88	48	0	0	0	558	299	558	299
10	0.166	89	52	0	0	0	610	347	610	347
11	0.156	37	23	0	0	0	272	162	272	162
12	0.156	134	95	0	0	0	976	687	976	687
Total	0.215	2395	920	0	0	0	16626	5414	11103	4354

```
stfout3 <- stfout(nyears+3)

## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court

## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court

knitr::kable(stfout3,row.names=F)
```

Age	LF	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
2	0.050	180	35	0	0	0	3890	625	545	87
3	0.142	423	111	0	0	0	3349	768	1507	346
4	0.264	581	188	0	0	0	2628	770	2313	678
5	0.243	348	132	0	0	0	1690	594	1656	582
6	0.241	323	139	0	0	0	1584	642	1584	642
7	0.230	129	61	0	0	0	659	299	659	299
8	0.204	95	49	0	0	0	541	269	541	269
9	0.180	73	40	0	0	0	464	248	464	248
10	0.166	61	36	0	0	0	421	240	421	240
11	0.156	64	39	0	0	0	467	279	467	279
12	0.156	133	94	0	0	0	966	680	966	680
Total	0.215	2410	924	0	0	0	16659	5414	11123	4350

```
par(mfrow=c(1,2),mar=c(5,8,4,1),cex=0.8)
nrows <- nrow(stfout2)
yield <- stfout2[-nrows,'Yield']
prop <- paste0(round(100*yield/sum(yield)),'%')
labels <- paste(max(years)-ages+2,rep(c('GM','XSA'),c(2,nages-2)))
b <- barplot(yield,horiz=T,names=labels,las=1,xlab='Tonnes',main=paste('Landings
yield',max(years)+2),xlim=c(0,max(yield)*1.25))
text(yield,b,prop,adj=-0.2)

ssb <- stfout3[-nrows,'SSB']
prop <- paste0(round(100*ssb/sum(ssb)),'%')
labels <- paste(max(years)-ages+3,rep(c('GM','XSA'),c(3,nages-3)))
b <- barplot(ssb,horiz=T,names=labels,las=1,xlab='Tonnes',main=paste('SSB',max(years)+3),xlim=c(0,max(ssb)*1.25))
text(ssb,b,prop,adj=-0.2)
```



Input table and management option table are consistent with the report.

Year-class sources and contributions for short-term forecast consistent with the report.

36 Sole in divisions 7.f and 7.g

Type of assessment in 2017

This assessment is an update assessment.

ICES advice applicable to 2016

In the advice for 2016, the stock status was presented as follows:

		Fishing pressure		
		2012	2013	2014
Maximum Sustainable Yield	F_{MSY}			Above
Precautionary approach	F_{pa}, F_{lim}			Increased risk
Management Plan	F_{MGT}	-	-	- Not applicable

		Stock size		
		2013	2014	2015
Maximum Sustainable Yield	MSY $B_{trigger}$			Above trigger
Precautionary approach	B_{pa}, B_{lim}			Full reproductive capacity
Management Plan	SSB_{MGT}	-	-	- Not applicable

MSY approach

ICES advises that when the MSY approach is applied, catches in 2016 should be no more than 760 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 745 tonnes.

ICES advice applicable to 2017

In the advice for 2017, the stock status was presented as follows:

		Fishing pressure		
		2013	2014	2015
Maximum sustainable yield	F_{MSY}			Above
Precautionary approach	F_{pa}, F_{lim}			Harvested sustainably
Management plan	F_{MGT}	-	-	- Not applicable

		Stock size		
		2014	2015	2016
Maximum sustainable yield	MSY $B_{trigger}$			Above trigger
Precautionary approach	B_{pa}, B_{lim}			Full reproductive capacity
Management plan	SSB_{MGT}	-	-	- Not applicable

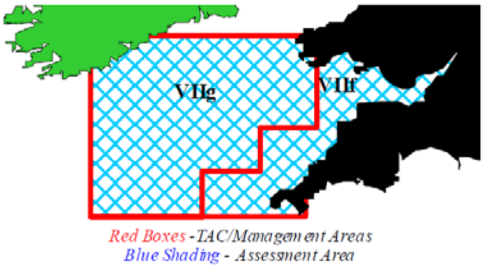
ICES advises that when the MSY approach is applied, catches in 2017 should be no more than 806 tonnes.

Technical comments made by the audit

No major deficiencies for the sole assessment in the Celtic Sea were reported.

36.1 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 2016 and 2017

The sole fisheries in the Celtic Sea are managed by TAC and technical measures. The agreed TACs in 2016 and 2017 are presented in the text tables below. Technical measures in force for this stock are minimum mesh sizes and minimum landing size (24 cm and 25 cm for Belgian vessels from March 11th 2017 until December 31th 2017). National regulations also restricted areas for certain types of vessels.

2016 TAC

Species:	Common sole *Solea solea*	**Zone:**	VIIf and VIIg (SOL/7FG.)
Belgium	487		
France	49		
Ireland	24		
United Kingdom	219		
Union	779		
TAC	779		Analytical TAC

2017 TAC

Species:	Common sole *Solea solea*	**Zone:**	VIIf and VIIg (SOL/7FG.)
Belgium	528		
France	53		
Ireland	26		
United Kingdom	238		
Union	845		
TAC	845		Analytical TAC Article 7(2) of this Regulation applies

Three rectangles in the Celtic Sea (30E4, 31E4 and 32E3) 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 2016

The Expert Group estimated the total international landings at 831 t in 2016 (Table 36.1), which is 6.7% above the 2016 TAC or last year's forecast (779 t).

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 2014). In the recent years, the estimates are more similar.

36.2 Data

Landings

Annual length compositions for 2016 are given by fleet in Table 36.2. Length distributions of the total Belgian and UK(E&W) landings for the last seventeen years are plotted in Figure 36.1. Belgian land a greater proportion of small fish compared to the UK(England & Wales).

Belgium, Ireland and UK have provided data this year under the ICES InterCatch format on a métier basis. Quarterly/yearly data for 2016 were available for landing numbers and weight-at-age, for most of the Belgian, Irish and UK fleets. These comprise 86% of the international landings. Allocation has been made as follows: five groups of métiers with age distributions were set up: e.g. OTB_DEF_70-99, OTB_DEF_100-119, OTB_DEF_>=120, GNS_DEF_all métiers and a group of all available métiers with age distributions (Overall). The OTB_DEF_70-99 (<1% of overall landings), OTB_DEF_100-119 (5.7% of overall landings), OTB_DEF_>=120 (<1% 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_DEF_>=120 and GNS_DEF_all respectively. The rest of the métiers without age distributions (7.6% of overall landings) were allocated to the group Overall.

For the period 2008–2016, 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 seventeen 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 is usually minor. For 2007 up to 2016, discarding of sole in the UK fleet was estimated at about 1–9% in numbers. Discard rates of sole in the Belgian beam trawl fleet were available to the expert group for 2004–2005 and 2008–2016 accounting for about 2%–5% of the total sole catches in weight. The length distributions of retained and discarded catches of sole from the Belgium beam trawl fleet for 2016 are presented in Figure 36.4a. The UK length distributions for 2016 from samples of UK gear except beam trawls and beam trawls are given in Figure 36.4b. The Irish length distributions for 2016 from samples of beam and otter trawls are shown in Figure 36.4c. It should be noted that the Irish otter trawl landings only amount to about 1.7% of the total international landings.

As an attempt, estimating an overall discard rate for the stock, individual discard estimates for 2014, 2015 and 2016 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 90%, 93% and 87% for 2014, 2015 and 2016 respectively.

Assuming that discard rates do not change from the average of the last three years (2014–2016) and a fixed proportion of discards survive, a discard rate of around 0.03 (of the catch) could be assumed for this stock at the moment.

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.

Belgian beam trawl (BE-CTB) effort was at highest levels in 2003–2005. During these years effort shifted from the Eastern English Channel (7.d) to the Celtic Sea 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 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. In 2014–2015, effort decreased again to the lower level in 2009. In 2016 a slight increase was recorded. Lpue 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, a decrease to 15.63 kg/hour was recorded.

The effort from the UK(E&W) beam trawl fleet (UK(E&W)-CBT) has declined sharply since the early 2000s to a record low in 2009 since 1983, and stayed at that level since. However, it should be noted that the UK beam trawl effort value for 2013 is extremely low compared to previous years and the 2014, 2015 and 2016 values are unavailable. As the UK administration switched to the EU electronic logbook system, a lot of the reported effort is missing. Therefore, the absolute effort numbers for 2013–2016 could not be used and the UK(E&W)-CBT tuning indices for the four most recent years were excluded in this year's assessment.

Details of the 2013–2016 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, for 2014, 2015 and 2016 also the UK otter trawl effort is unavailable. Inspection of an alternate effort indicator (days fished) suggest that the beam trawl and otter trawl effort in 2014–2016 significantly decreased. As, in 2016 all otter trawl vessels active in the Celtic Sea were under 12 m, no effort (days fished) was recorded.

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. Because of the effort reporting issues, the 2013–2016 values are unavailable. Inspection of an alternate lpue indicator (kg/days fished) suggest that the beam trawl lpue in 2014–2016 increased.

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.

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-CBT2(1997–2016)), show high consistencies for the entire age range (Figures 36.8–36.9). However, the internal consistencies between the younger and older ages in the new Belgian commercial lpue series BEL-CBT2 (1997–2016) are rather low (Figure 36.9b).

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.

36.3 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 1997–2016). It should also be noted that the 2002, 2003 and 2004 numbers-at-age have been corrected for misreporting (See WKCELT). Table 36.10 also includes tuning indices of the Irish ground fish survey (IGFS-IBTS_Q4) and the commercial UK otter trawl fleet (UK(E&W)-COT) which are not used in this assessment.

Data screening

As mentioned in Section 36.2, the 2013–2016 data from the UK(E&W) commercial tuning series was excluded from the assessment.

Adding the 2016 data to the time-series did not cause any additional anomalies compared to previous years.

Final update assessment

The final settings used in this year's assessment are as detailed below:

	2014–2017 assessment		
Fleets:	Years	Ages	α–β
BEL-CBT commercial	1971–1996	2–9	0–1
BEL-CBT2 commercial	1997–2016	2–9	0–1
UK-CBT commercial	1991–2012	2–9	0–1
UK(E&W)-BTS-Q3 survey	1988– 2016	1–5	0.75–0.85
-First data year -Last data year	1971 assessment year-1		
-First age -Last age	1 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 (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 decreasing trend in the UK beam trawl fleet (UK(E&W)-CBT) with predominantly positive residuals since 2007. The UK beam trawl survey (UK(E&W)-BTS-Q3) shows a similar trend over the same time-series with predominantly negative residuals, indicating a possible conflicting signal between these two fleets.

In this year's assessment the estimates for the recruiting year class 2015 were estimated solely by the UK beam trawl survey UK(E&W)-BTS-Q3) (Figure 36.11).

With the inclusion of the new commercial Belgian tuning series BE-CBT2 (1997–2016), the weighting of the final survival estimates are more equally spread over the two commercial series and the survey for the older ages with relative similar estimates by the commercial tuning files. However, as the most recent UK(E&W)-CBT indices (2013–2016) are not included in the assessment, the UK(E&W)-CBT gives no information on the youngest year classes (Figure 36.11).

However, it should be noted that the UK beam trawl survey 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 estimates of year-class strength at different ages.

F shrinkage gets low weights for all ages (max 3.5%). The weighting of the survey decreases for the older ages as only the tuning indices for the younger ages are used in the assessment (age range: 1–5). Information on age 1 is solely defined by the survey. The commercial fleets (UK(E&W)-CBT and BE-CBT2) on the other hand are given more weight (Figure 36.11) for the older ages.

Retrospective patterns for the final run are shown in Figure 36.12. There appears to be no apparent retrospective bias in estimating fishing mortality and SSB for the most recent years. In the most recent years, F was slightly underestimated whereas SSB was slightly overestimated. Recruitment in the first year may sometimes be overestimated but the overall retrospective pattern show reasonable consistent estimates.

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 the addition of the 2016 data, F was slightly up scaled whereas SSB was slightly downscaled. In last year's assessment, F and SSB for 2015 were estimated to be 0.31 and 2714 t respectively; this year's estimates for 2015 are 0.33 and 2561 t, an upward revision of 8% for F and a downward revision of 6% for SSB. The estimated recruitment by XSA in 2015 (10 172 thousand fish) was downscaled by 16% in this year's assessment (8587 thousand fish).

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 between this higher level and F_{pa}. Since 2006 fishing mortality decreased and fluctuated between F_{pa} (0.34) and F_{MSY} (0.27). In 2012 fishing mortality begins to increase again and is estimated in 2014 to be at 0.44. After a drop in 2015 to below F_{pa}, the F in 2016 increased again and is estimated to be between F_{pa} and F_{lim} at 0.37.

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 (14 756 thousand fish) and the 2007 year class is also one of the stronger year classes (9740 thousand fish). The 2013 year class is by far the lowest in the time-series (1765 thousand). The 2014 year class and the incoming recruitment (year class 2015) are estimated to be well above the average (8587 and 7762 thousand fish).

SSB has declined almost continuously from the highest value of 7540 t in 1971 to the lowest observed in the time-series in 1998 (1664 t). The exceptional year class of 1998 has increased SSB to above the long-term average. The above average recruitment in 2012, the strong 2014 and 2015 year classes are predicted to keep SSB just above B_{pa}/$B_{trigger}$.

36.4 Short-term projections

The long-term GM71-14 recruitment (4802 thousand fish) was assumed for the 2016 and subsequent year classes.

Population numbers at the start of 2017, estimated for ages 2 and older, were taken from the XSA output.

The 2015 year class is estimated at 7762 thousand fish at age 1, which is 57% higher than the GM (4933 thousand fish) used in last year's forecast. The estimate is solely coming from the UK(E&W)-BTS-Q3 survey. The exponential decay model was applied to calculate the age 2 survivors of this cohort (7024 thousand fish).

The 2014 year class is estimated to be above average at 8587 thousand fish at age 1.

The working group estimates of year-class strength used for prediction can be summarised as follows:

Year class	At age in 2017	XSA	GM	Source
2014	3	6541		XSA
2015	2	7024		XSA
2016	1	-	4802	GM 1971–2014
2017 & 2018	recruits	-	4802	GM 1971–2014

Fishing mortality was set as the mean over the last three years not scaled to 2016. Weights-at-age in the catch and in the stock are averages for the years 2014–2016. 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 (2017) as recent landings have been close to the TAC or only limited overshot. Moreover, *status quo* fishing mortality gives higher landings (1054 t) in the intermediate year than the agreed TAC (845 t).

Assuming a TAC constraint for 2017 of 845 t, implies a fishing mortality in 2017 of 0.29. The assumed landings using a *status quo* fishing mortality in 2018 is 1206 t. This results in a SSB of 3112 t in 2018 and 3149 t in 2019.

Assuming a TAC constraint for 2017 and a *status quo* F in 2018, 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 3% of the landings in 2018 and about 10% of the 2019 SSB.

There are no known specific environmental drivers known for this stock.

36.5 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 (PLOTMSY 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, 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 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.

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-celt	0.154	0.274	0.419	0.36

36.6 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 are given in the text table below:

Reference points	ACFM 98 onwards	2016 onwards
F_{MSY}	0.31 (PLOTMSY, WG2010)	0.274 (Eqsim, WKMSYREF 4)
F_{lim}	0.52 (based on F_{loss}, WG1998)	0.488 (based on segmented regression with B_{lim} as breakpoint)
F_{PA}	0.37 (F_{lim} x 0.72)	0.34857 (F_{lim}/1.4)
B_{lim}	Not defined	1700 t (B_{loss} estimated in 2015)
B_{PA}	2200 t (based on B_{loss} (1991), WG1998)	2380 t (B_{lim} *1.4)
$B_{trigger}$	B_{PA}	2380 t

36.7 Management plans

There are no explicit management plans for Celtic Sea sole.

In 2006, the working group presented results from a series of medium-term scenarios, carried out in conjunction with 7.f and 7.g plaice, to simulate some possible management plans for the two stocks. Results indicated that an F in the range 0.27 to 0.49 in the long term would maintain yield at or above 95% of that given by F_{MAX}, whilst posing a low probability (<5%) of SSB falling below B_{lim}. Three year average exploitation patterns were calculated and are given in Figure 36.16. The results of the F_{MSY} analysis, carried out during the 2014 WKMSYREF4 (ICES, 2016c) also confirm that a fishing mortality of 0.274 could be the long-term management objective for sole in 7.f and 7.g. Other species caught in the fishery (mixed fisheries) should also be considered.

36.8 Uncertainties and bias in assessment and forecast

Sampling

The major fleets fishing for 7.f and 7.g sole are sampled (approximately 86% of the total landings). Sampling is considered to be at a reasonable level.

Discards

Discard estimates, which are low (average discarding by weight is 3% of the catch) 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 strong year classes have sometimes been revised downward in previous assessments and therefore estimates of very strong year classes may cause bias in the forecast.

Consistency

The assessment provided by the Expert Group revised down SSB by 6% and F up by 8%, indicating that there is no major concern about the uncertainty in the assessment and the forecast. Recruitment was revised down by 16% relative to last year's assessment. There is no apparent retrospective pattern in estimating F and SSB in the last few years. Recruitment in the first year may sometimes be overestimated but the overall retrospective pattern show reasonable consistent estimates.

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.

36.9 Recommendation for next Benchmark

Sole in 7.f and 7.g has been benchmarked in February 2014. A new benchmark is proposed for the moment.

Issue	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?
Tuning series	**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 *Investigate if commercial tuning fleets should still be used in future assessments of sole in 7.f and 7.g.	*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

36.10 Management considerations

There is no apparent stock–recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 36.17).

SSB has declined almost continuously from the highest value of 7540 t in 1971 to the lowest observed in the time-series in 1998 (1664 t). The exceptional year class of 1998 has increased SSB to above the long-term average. The above average recruitment in 2012, the strong 2014 and 2015 year classes are predicted to keep SSB just above $B_{pa}/B_{trigger}$.

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).

36.11 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.

36.12 References

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.

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ICES. 2016d. 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 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

^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				
21		544		
22	5	2908		
23	22	20604		
24	417	112048	294	
25	1549	170147	503	1678
26	4342	242722	0	2464
27	8941	288813	3105	492
28	13232	251899	5766	13257
29	19510	203980	5596	14473
30	22232	169243	4509	8245
31	28081	122818	2447	3208
32	33898	108330	8409	4284
33	30742	89755	8665	2440
34	36279	65844	2029	5137
35	29139	53348	3963	4347
36	24232	41732	4897	1799
37	25899	26536	2730	3240
38	14428	22437	4075	1326
39	18403	15896	836	1177
40	11897	12342	2351	2564
41	10320	6539	503	971
42	9502	5205	418	139
43	5997	2780	1003	277
44	3317	2093	729	
45	1645	715	1481	
46	1430	612	644	
47	866	702		
48	177	150		
49	420	67		
50	227			
51	151			
52				
53				
54				
55				
56				
57				
58				
59				
60				
Total	357298	2040809	64953	71518

Table 36.3 - Sol.27.7fg - Catch numbers at age (in thousands)

Age/Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0	0	0	0	0	0	0	0	0	0
2	386	541	364	155	119	312	314	317	328	657
3	270	903	1883	438	287	833	438	739	561	971
4	1341	314	748	863	336	559	349	338	748	875
5	625	671	305	411	638	610	271	154	208	584
6	433	329	352	209	304	558	244	159	154	180
7	537	213	119	239	110	261	404	99	197	62
8	763	232	110	97	102	131	120	198	124	96
9	376	314	116	109	67	197	28	71	153	100
+gp	1220	731	644	541	372	462	365	174	169	352

Age/Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0	0	0	0	0	0	0	0	0	0
2	602	342	647	671	196	494	318	526	479	277
3	675	830	1078	845	1475	1296	958	464	1163	993
4	792	309	729	605	767	1173	798	878	601	1175
5	399	467	284	541	566	526	578	441	621	399
6	377	280	349	184	296	358	273	387	237	452
7	150	207	225	277	100	193	205	127	188	138
8	120	92	192	106	140	87	100	78	82	115
9	94	111	52	47	73	103	61	67	24	50
+gp	380	326	320	274	240	328	179	268	102	129

Age/Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0	0	0	0	0	0	0	0	0	0
2	1458	433	354	295	129	177	245	197	608	1721
3	690	1699	862	790	1154	1036	890	931	1719	1480
4	658	644	1103	739	1096	905	599	724	834	683
5	496	409	332	864	419	424	400	297	282	241
6	151	253	186	283	482	229	252	171	143	60
7	156	61	161	149	133	192	127	108	80	56
8	55	59	63	65	112	57	126	51	31	43
9	46	28	83	42	65	43	45	52	23	19
+gp	162	89	99	146	109	106	106	87	44	51

Age/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0	0	0	0	0	0	0	0	0	0
2	701	29	132	476	290	684	335	214	607	281
3	1909	1465	776	1927	917	1329	865	452	464	1316
4	856	2202	1262	886	897	714	743	559	426	744
5	434	660	2070	889	508	576	474	565	346	347
6	241	249	448	807	426	163	325	277	292	258
7	65	95	248	128	373	148	157	198	173	164
8	39	54	89	67	51	178	145	76	103	118
9	26	36	29	38	44	44	184	109	44	66
+gp	81	51	84	55	45	51	70	172	193	118

Age/Year	2011	2012	2013	2014	2015	2016
1	0	0	0	0	0	0
2	124	160	436	115	85	514
3	1013	233	1065	629	806	428
4	1443	1029	343	743	863	607
5	398	1308	837	217	382	663
6	273	364	693	430	140	245
7	194	207	227	421	217	86
8	133	136	80	138	117	143
9	66	91	66	84	82	97
+gp	199	246	166	218	132	93

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
1	0.140	0.110	0.125	0.073	0.134	0.130
2	0.162	0.162	0.179	0.170	0.163	0.187
3	0.184	0.213	0.205	0.208	0.200	0.211
4	0.223	0.247	0.253	0.273	0.254	0.262
5	0.272	0.279	0.285	0.366	0.319	0.293
6	0.354	0.324	0.334	0.393	0.352	0.353
7	0.420	0.341	0.350	0.425	0.443	0.462
8	0.447	0.377	0.475	0.484	0.516	0.434
9	0.475	0.409	0.412	0.530	0.436	0.476
+gp	0.622	0.538	0.576	0.685	0.549	0.604

Table 36.5 - Sol.27.7fg - Stock weights at age (kg)

Age/Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	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
3	0.136	0.157	0.142	0.159	0.141	0.160	0.174	0.167	0.163	0.157
4	0.190	0.222	0.203	0.221	0.215	0.210	0.236	0.257	0.255	0.238
5	0.239	0.298	0.263	0.305	0.295	0.269	0.366	0.360	0.392	0.354
6	0.406	0.351	0.334	0.450	0.353	0.354	0.392	0.413	0.437	0.394
7	0.472	0.352	0.322	0.448	0.593	0.432	0.454	0.521	0.485	0.622
8	0.389	0.593	0.400	0.464	0.423	0.462	0.505	0.508	0.595	0.556
9	0.346	0.417	0.539	0.624	0.465	0.425	0.907	0.560	0.657	0.704
+gp	0.583	0.600	0.582	0.671	0.711	0.728	0.701	0.783	0.696	0.771

Age/Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
2	0.113	0.113	0.113	0.118	0.113	0.113	0.113	0.113	0.113	0.113
3	0.159	0.164	0.175	0.173	0.175	0.180	0.153	0.158	0.152	0.164
4	0.232	0.255	0.262	0.274	0.268	0.273	0.242	0.233	0.227	0.247
5	0.306	0.356	0.370	0.429	0.472	0.398	0.361	0.363	0.308	0.369
6	0.385	0.487	0.488	0.517	0.433	0.462	0.473	0.466	0.465	0.476
7	0.462	0.543	0.633	0.641	0.462	0.546	0.468	0.687	0.546	0.523
8	0.551	0.610	0.606	0.613	0.480	0.636	0.587	0.687	0.526	0.753
9	0.737	0.766	0.464	0.836	0.944	0.890	0.820	0.676	0.542	0.847
+gp	0.663	0.856	0.823	0.978	0.798	0.843	0.838	0.818	0.752	0.973

Age/Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
2	0.113	0.113	0.148	0.113	0.113	0.104	0.113	0.113	0.110	0.062
3	0.179	0.184	0.196	0.135	0.143	0.186	0.178	0.195	0.204	0.169
4	0.230	0.265	0.267	0.227	0.233	0.284	0.276	0.282	0.317	0.306
5	0.356	0.388	0.392	0.329	0.335	0.387	0.386	0.371	0.433	0.434
6	0.536	0.498	0.470	0.430	0.441	0.486	0.495	0.454	0.541	0.534
7	0.376	0.751	0.492	0.521	0.540	0.573	0.598	0.529	0.635	0.603
8	0.859	0.754	0.576	0.599	0.629	0.647	0.689	0.593	0.712	0.648
9	0.735	0.475	0.636	0.661	0.705	0.708	0.766	0.644	0.772	0.677
+gp	0.679	0.896	0.727	0.757	0.845	0.808	0.892	0.732	0.852	0.707

Age/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.108	0.115	0.112
2	0.113	0.113	0.158	0.116	0.149	0.143	0.117	0.141	0.151	0.143
3	0.187	0.189	0.205	0.176	0.213	0.188	0.177	0.176	0.190	0.183
4	0.312	0.289	0.258	0.248	0.275	0.235	0.236	0.232	0.223	0.226
5	0.434	0.403	0.317	0.329	0.337	0.284	0.294	0.274	0.287	0.280
6	0.538	0.512	0.381	0.415	0.399	0.334	0.350	0.261	0.349	0.333
7	0.619	0.609	0.449	0.502	0.459	0.386	0.406	0.389	0.357	0.399
8	0.680	0.691	0.521	0.587	0.520	0.441	0.460	0.542	0.437	0.410
9	0.725	0.757	0.594	0.667	0.579	0.496	0.513	0.526	0.501	0.495
+gp	0.783	0.873	0.812	0.868	0.737	0.641	0.662	0.495	0.581	0.579

Age/Year	2011	2012	2013	2014	2015	2016
1	0.130	0.086	0.107	0.049	0.113	0.107
2	0.143	0.151	0.140	0.146	0.109	0.158
3	0.172	0.186	0.182	0.193	0.184	0.186
4	0.204	0.213	0.232	0.237	0.230	0.229
5	0.250	0.249	0.265	0.304	0.295	0.273
6	0.331	0.297	0.305	0.335	0.359	0.336
7	0.381	0.347	0.337	0.377	0.417	0.403
8	0.425	0.398	0.403	0.412	0.468	0.439
9	0.438	0.428	0.394	0.502	0.459	0.496
+gp	0.591	0.559	0.551	0.638	0.574	0.565

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
UK	2012	153.388	21.528	4.346	1.138	0
	2013	177.3898	22.156	2.421	2.258	2.602
	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	5.664
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

	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	22.66	0.023
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	29.63	0.04
average 14-16			0.90	24.25	0.03

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	211	54	23	6	2	3	1	2
1997	32	433	180	18	11	12	4	3	5	0
1998	90	770	411	51	10	7	4	2	1	5
1999	24	2464	250	32	14	5	4	4	1	0
2000	13	916	1356	31	22	5	0	2	1	1
2001	22	379	599	259	20	7	5	2	0	2
2002	8	663	238	127	102	12	6	2	3	0
2003	12	392	530	47	26	47	8	3	3	0
2004	56	749	377	87	13	19	37	4	2	0
2005	37	343	225	32	14	6	4	14	1	2
2006	11	273	201	39	13	7	0	2	10	0
2007	91	357	108	43	14	7	6	3	3	11
2008	5	1039	104	13	15	6	8	3	3	4
2009	1	509	318	24	6	8	3	2	2	2
2010	18	85	471	122	17	2	4	7	3	1
2011	17	501	52	139	69	7	2	6	3	0
2012	13	542	231	7	53	24	1	1	1	2
2013	9	279	518	43	13	24	15	1	5	1
2014	34	244	258	76	14	5	23	8	1	1
2015	28	747	48	44	31	7	3	13	6	0
2016	26	574	359	12	27	12	7	3	5	8
Geomean	16	375	272	50	19	8	1	0.5	0.2	0.0
Mean	28	495	335	68	23	11	7	3	2	2

Table 36.8 - Sol.27.7fg- Indices of effort.

	England & Wales				Belgium		Ireland		
Year	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	-	50.28	118.04	14.78	63.21
2007	10.66	798	15.37	1407	-	45.72	135.36	15.81	56.59
2008	10.13	711	13.83	1202	-	28.71	125.41	11.65	38.66
2009	8.97	656	12.31	1105	-	30.85	137.11	8.18	39.11
2010	7.67	565	14.44	1162	-	32.22	140.79	9.68	40.97
2011	7.44	525	13.79	868	-	39.58	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	1608	-	45.16	118.20	13.15	38.74
2014	-	156	-	959	-	31.27	127.34	12.46	37.88
2015	-	79	-	726	-	31.79	132.69	9.29	37.79
2016*	-	0	-	915	-	32.34	147.18	10.44	39.33

[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	-	10.70	0.11	0.05	0.26
2007	80.95	0.78	10.75	1.00	15.04	9.87	92.17	-	11.74	0.13	0.02	0.20
2008	115.96	0.82	11.94	0.86	10.67	9.46	94.85	-	14.51	0.12	0.02	0.29
2009	90.64	0.94	13.13	0.46	6.88	6.37	69.37	-	12.90	0.10	0.00	0.28
2010	109.55	1.01	13.59	0.63	8.63	5.92	79.90	-	16.00	0.13	0.01	0.20
2011	99.47	1.47	20.78	0.31	4.47	6.72	109.20	-	16.14	0.19	0.01	0.20
2012	101.45	1.67	24.10	0.47	5.17	6.47	80.16	-	16.36	0.15	0.01	0.48
2013	119.38	1.76	27.81	0.34	4.62	-	82.82	-	15.90	0.14	0.01	0.65
2014	86.75	-	6.19	-	11.56	-	107.25	-	20.48	0.12	-	0.34
2015	85.45	-	51.13	-	5.62	-	103.07	-	19.36	0.11	-	0.31
2016 *	113.55	-	0.00	-	0.00	-	113.16	-	15.63	0.10	0.01	0.20

[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	2016												
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
61.87	497	890	418	297	80	59	41	16	6	3	2	1	0
59.16	232	564	458	269	153	83	64	55	5	5	1	3	3
39.95	134	234	283	322	138	82	33	43	36	11	1	0	0
43.35	389	263	222	169	142	93	43	19	25	36	9	2	0
50.59	212	895	491	205	141	85	67	28	23	7	6	12	0
57.92	87	705	960	252	165	120	79	34	57	13	16	6	0
65.37	128	167	749	985	264	139	89	58	36	42	14	21	25
66.6	392	755	251	617	476	154	36	38	15	10	11	8	12
45.85	105	462	493	141	256	255	63	46	21	16	18	12	13
48.12	70	693	683	278	86	148	76	56	23	26	9	11	7
51.05	438	306	425	460	144	24	76	50	2	5	4	3	1

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													
40.81		0	52	98	189	171	60	67	23	20	16	13	5	4	4
35.78		0	18	220	103	83	69	22	21	10	13	5	3	1	1
39.64		2	6	83	198	77	50	41	11	24	9	5	4	3	4
37.03		0	23	80	59	116	36	31	19	11	15	8	5	5	4
37.59		0	16	87	73	56	105	24	30	23	8	8	4	5	3
39.78		0	22	96	128	70	45	53	15	13	12	4	9	5	2
43		0	10	60	86	69	53	27	39	11	11	5	5	3	2
47.84		0	13	101	73	77	50	17	13	20	7	6	4	2	1
50.87		0	31	204	107	52	50	28	13	6	10	4	2	1	0
51.19		0	72	152	150	75	27	28	20	9	4	8	3	2	2
49.32		0	37	272	99	89	48	19	17	11	9	3	7	1	2
37.53		0	11	149	375	90	63	28	18	14	9	6	4	4	1
40.71		0	18	101	176	369	77	45	18	6	7	3	4	1	2
32.37		0	19	91	65	114	180	34	27	15	7	3	5	1	1
27.73		0	27	78	126	55	60	115	15	14	4	5	2	2	1
18.57		0	16	86	94	103	32	39	69	13	8	4	2	2	1
15.37		1	18	77	89	77	82	32	41	76	8	8	4	2	3
13.83		0	12	76	100	67	52	54	19	32	42	10	5	2	3
12.31		0	23	54	72	72	63	27	29	12	12	29	4	3	1
14.44		0	2	98	65	48	46	34	19	18	5	5	13	1	1
13.79		0	7	57	125	41	34	22	19	12	12	4	7	16	1
12.77		0	3	14	84	108	26	18	17	9	7	6	1	3	3

UK(E&W)-BTS-Q3		UK(E+W) 7.f Corystes (automated indices since 1995)									
	1988	2016									
	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

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	2016									
	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	0.0

Table 36.11. Sol.27.7fg – Diagnostics.

FLR XSA Diagnostics 2017-04-29 16:17:33

CPUE data from indices

Catch data for 46 years. 1971 to 2016. Ages 1 to 10.

	fleet	first age	last age	first year	last year	alpha	beta
1	BE-CBT	2	9	1971	1996	0	1
2	BE-CBT2	2	9	1997	2016	0	1
3	UK(E&W)-CBT	2	9	1991	2012	0	1
4	UK(E&W)-BTS-Q3	1	5	1988	2016	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

age	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.113	0.058	0.075	0.049	0.079	0.041	0.085	0.031	0.058	0.072
3	0.309	0.197	0.155	0.207	0.224	0.187	0.373	0.153	0.276	0.400
4	0.324	0.299	0.257	0.351	0.327	0.330	0.407	0.428	0.290	0.307
5	0.358	0.389	0.272	0.307	0.286	0.490	0.434	0.434	0.362	0.336
6	0.317	0.326	0.317	0.298	0.374	0.407	0.462	0.369	0.490	0.370
7	0.377	0.289	0.309	0.263	0.341	0.478	0.425	0.502	0.286	0.564
8	0.303	0.281	0.214	0.319	0.314	0.378	0.304	0.441	0.223	0.275
9	0.354	0.349	0.233	0.185	0.264	0.328	0.283	0.531	0.452	0.262
10	0.354	0.349	0.233	0.185	0.264	0.328	0.283	0.531	0.452	0.262

XSA population number (Thousand)

year	1	2	3	4	5	6	7	8	9	10
2007	4409	3289	3422	2819	1656	1259	526	583	648	246
2008	9740	3989	2657	2274	1844	1047	830	326	389	613
2009	6815	8813	3406	1974	1525	1130	684	562	223	975
2010	1897	6167	7397	2641	1381	1051	745	454	411	733
2011	4581	1717	5313	5441	1682	920	706	518	299	899
2012	6183	4145	1435	3844	3550	1144	572	454	342	923
2013	4422	5595	3598	1077	2499	1968	688	321	281	706
2014	1765	4001	4648	2243	648	1466	1122	407	214	554

```
  2015 8587 1597 3511 3608 1323   380   917 614 237 380
  2016 7762 7770 1364 2410 2443   834   211 623 444 425
```

```
 Estimated population abundance at 1st Jan  2017
      age
year    1     2     3    4     5     6    7    8    9   10
  2017 0 7024 6541 827 1604 1580 521 109 428 310
```

Fleet: BE-CBT

Log catchability residuals.

age \ year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	0.073	-0.010	0.397	-0.038	-0.293	0.391	0.050	0.218	0.248	1.022	0.381	0.050
3	-0.510	0.160	0.371	-0.111	-0.351	0.396	0.129	0.051	0.058	0.027	0.191	0.088
4	0.265	-0.183	0.119	-0.044	-0.311	-0.019	-0.002	0.054	0.389	0.249	-0.108	-0.167
5	0.303	0.147	0.157	0.125	0.001	0.247	-0.092	-0.450	0.109	0.167	-0.164	0.020
6	0.102	0.270	-0.115	0.433	0.219	-0.207	0.051	-0.253	0.034	-0.096	0.134	0.147
7	0.445	-0.029	-0.321	0.122	0.310	0.117	0.178	-0.403	0.596	-0.876	0.130	0.351
8	0.288	0.179	-0.414	-0.015	-0.432	0.523	-0.027	-0.155	0.299	-0.171	-0.122	0.347
9	0.021	-0.102	-0.198	0.174	-0.083	0.109	-0.305	-0.222	0.055	0.013	0.109	0.483

age \ year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
2	0.283	0.000	-1.824	-0.258	0.254	-0.110	-0.472	-0.079	1.436	0.618
3	-0.054	-0.224	-0.087	-0.020	-0.194	-0.570	-0.513	0.148	0.377	0.383
4	-0.273	-0.367	-0.150	-0.114	-0.018	-0.213	-0.167	0.104	0.057	0.279
5	-0.264	-0.015	0.077	-0.074	-0.032	-0.077	-0.137	-0.066	-0.027	0.211
6	-0.241	-0.161	0.004	0.034	0.317	-0.085	0.043	0.165	-0.400	-0.038
7	0.094	0.170	-0.106	0.005	0.634	-0.025	0.149	0.184	-0.484	-0.880
8	0.470	-0.100	0.170	-0.284	-0.152	0.575	0.160	0.262	-0.357	-0.967
9	-0.192	-0.289	-0.037	-0.047	0.203	0.067	-0.214	-0.095	-0.301	-0.328

age	1993	1994	1995	1996
2	0.238	-0.336	-1.295	-0.944
3	0.244	-0.243	0.055	0.199
4	-0.073	0.190	0.370	0.133
5	-0.237	0.134	-0.024	-0.035
6	-0.398	0.263	-0.134	-0.089
7	0.196	-0.122	0.007	-0.440
8	0.443	-0.730	-0.023	-0.360
9	0.349	0.078	-0.196	-0.242

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	-6.2006	-5.0658	-4.8507	-4.8620	-4.8859	-4.9729	-4.9729	-4.9729
S.E_Logq	0.3408	0.3408	0.3408	0.3408	0.3408	0.3408	0.3408	0.3408

Fleet: BE-CBT2

Log catchability residuals.

age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2	0.132	-0.377	0.668	0.817	0.582	-0.529	-0.937	0.036	-0.675	0.759	0.326
3	0.555	0.448	0.771	0.419	-0.226	0.306	-0.377	0.080	-0.220	0.084	-0.079
4	0.373	0.874	0.665	-0.092	0.262	0.130	-0.125	-0.161	-0.359	-0.357	-0.318
5	0.400	0.259	0.542	-0.509	0.104	0.624	0.065	-0.286	0.055	-0.459	-0.327
6	0.669	0.315	0.047	-1.129	0.591	0.167	0.615	-0.511	-0.059	-0.687	-0.481
7	0.690	1.044	0.045	-0.893	0.087	0.183	0.582	-0.512	-0.692	-0.965	-0.084
8	0.231	0.543	-0.242	-0.507	-0.401	0.355	0.394	-1.266	-0.617	-1.443	-0.481
9	0.585	-0.023	0.347	-0.365	-0.191	0.086	0.361	-0.719	-0.465	-0.403	-0.716

age \ year	2008	2009	2010	2011	2012	2013	2014	2015	2016
2	-0.050	0.150	-0.267	0.000	-0.634	0.187	-0.448	0.030	0.230
3	-0.366	-0.599	-0.280	-0.315	-0.585	0.073	-0.403	0.292	0.419
4	-0.204	-0.406	-0.014	-0.213	-0.233	-0.038	0.287	0.025	-0.097
5	0.152	-0.439	-0.285	-0.421	0.168	0.007	0.254	0.138	-0.043
6	-0.004	-0.138	-0.235	-0.044	0.102	0.155	0.160	0.426	0.042
7	-0.201	0.046	-0.305	-0.005	0.293	0.168	0.592	0.103	-0.179
8	-0.181	-0.574	-0.023	-0.127	0.033	-0.579	0.180	-0.193	-0.242
9	-0.062	-0.457	-0.857	-0.443	-0.136	-0.402	0.547	0.560	-0.329

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	-6.9533	-5.6065	-5.3747	-5.3499	-5.5050	-5.6132	-5.6132	-5.6132
S.E_Logq	0.4428	0.4428	0.4428	0.4428	0.4428	0.4428	0.4428	0.4428

Fleet: UK(E&W)-CBT

Log catchability residuals.

age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	0.421	0.163	-1.113	0.296	0.159	0.467	-0.586	-0.738	-0.049	-0.052	-0.097
3	0.041	0.303	-0.161	-0.252	-0.121	0.176	-0.343	-0.136	0.238	-0.191	-0.493
4	0.501	0.078	-0.032	-0.523	-0.396	0.238	0.012	-0.181	-0.167	-0.106	-0.689
5	0.523	0.043	-0.112	-0.251	-0.283	-0.060	-0.030	0.136	-0.119	-0.258	-0.413
6	0.391	0.151	-0.237	-0.409	0.119	-0.090	0.145	0.036	0.055	-0.426	-0.330
7	0.370	-0.045	0.078	-0.192	-0.208	-0.062	-0.030	-0.317	-0.090	-0.094	-0.409
8	0.489	-0.177	-0.311	-0.023	0.471	-0.116	0.181	-0.151	0.049	0.047	-0.134
9	0.657	0.412	0.430	0.527	0.859	0.393	0.157	0.012	-0.397	0.215	0.047

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	-0.460	-0.506	0.098	0.464	0.558	1.150	0.630	0.613	-1.645	0.948	-0.723
3	-0.218	-0.178	-0.413	-0.123	0.245	0.572	0.865	0.370	0.056	-0.101	-0.136
4	-0.132	-0.300	-0.541	-0.037	0.265	0.302	0.727	0.637	0.128	0.093	0.122
5	-0.269	0.018	-0.293	-0.289	0.298	0.382	0.255	0.579	0.129	-0.189	0.203
6	-0.180	0.045	-0.044	-0.412	-0.139	0.503	0.342	0.569	0.160	0.072	-0.322
7	-0.079	-0.020	0.131	0.089	-0.092	0.394	0.526	0.152	0.115	-0.183	-0.035
8	0.363	0.031	0.390	-0.038	0.364	0.504	0.411	0.374	0.054	-0.034	0.094
9	0.462	-0.163	0.860	0.408	0.676	1.039	0.787	0.426	0.038	0.034	-0.283

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	-8.9855	-6.9007	-6.2849	-5.9620	-5.7658	-5.6964	-5.6964	-5.6964
S.E_Logq	0.3879	0.3879	0.3879	0.3879	0.3879	0.3879	0.3879	0.3879

Fleet: UK(E&W)-BTS-Q3

Log catchability residuals.

age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-1.403	-0.213	-0.503	-0.258	0.175	-0.708	0.323	-0.684	-0.681	0.079	0.506	0.816
2	0.080	0.354	0.448	0.210	0.164	0.352	0.386	0.143	0.148	-0.196	0.303	-0.279
3	0.375	1.136	0.182	0.541	0.616	-0.008	0.841	0.212	0.524	-0.550	0.227	-0.425
4	-0.176	0.506	-0.120	0.124	0.734	-0.244	0.306	-0.215	0.598	0.111	0.076	0.080
5	-0.119	0.424	-0.041	0.695	1.023	-1.039	-0.245	0.062	0.101	0.961	0.645	0.601

year
age
2
3
4
5

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0.428	0.170	0.266	0.018	0.550	-0.068	0.018	0.093	0.367	0.012
0.578	0.333	-0.042	0.303	0.314	-0.361	-0.222	-0.577	-0.846	-0.513
-0.633	0.494	0.417	-0.095	0.231	-0.526	-0.418	-0.109	-1.169	-0.792
0.212	-0.113	0.486	-0.224	-0.333	-0.656	-0.466	-0.570	-0.257	-0.961
-0.159	-0.088	0.259	0.623	0.325	-0.281	-0.635	-0.451	-0.667	-0.214

age	2010	2011	2012	2013	2014	2015	2016
1	-0.498	0.394	0.171	-0.157	0.626	0.163	0.000
2	0.215	-0.680	-0.105	0.437	0.029	-0.708	-0.268
3	0.077	0.551	-1.072	-0.108	0.029	-0.141	-0.409
4	-0.260	0.408	0.495	0.458	-0.259	-0.006	0.266
5	-1.697	-0.524	0.145	0.486	0.260	-0.223	-0.229

Mean log catchability and standard error of ages with catcha-
bility

independent of year class strength and constant w.r.t. time

	1	2	3	4	5
Mean_Logq	-7.1307	-7.2740	-8.5462	-9.0377	-9.2913
S.E_Logq	0.4865	0.4865	0.4865	0.4865	0.4865

Terminal year survivor and F summaries:

```
Age =  1 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2015

Fleet =  UK(E&W)-BTS-Q3
                   1
Survivors   7024.000
Raw weights    4.203


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "UK(E&W)-BTS-Q3" "7024"       "0.488"   "Inf"     "Inf"     "1" "1"         "0"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "7024"   ""       ""       ""        "0"



Age =  2 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2014

Fleet =  BE-CBT2
                   2
Survivors   8229.000
Raw weights    3.585


Fleet =  fshk
                   2
Survivors   8069.000
Raw weights    0.444


Fleet =  UK(E&W)-BTS-Q3
                   2        1
Survivors   5006.000 7696.000
Raw weights    5.801    3.911


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT2"        "8229"       "0.509"   "Inf"     "Inf"     "1" "0.261"     "0.058"
[2,] "fshk"           "8069"       "1.447"   "Inf"     "Inf"     "1" "0.032"     "0.059"
[3,] "UK(E&W)-BTS-Q3" "5952"       "0.31"    "0.211"   "0.681"   "2" "0.707"     "0.079"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "6541"   ""       ""       ""        "0.072"
```

```
Age =  3 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2013

Fleet =  BE-CBT2
                   3       2
Survivors   1257.000 852.000
Raw weights    3.943   2.437


Fleet =  fshk
                   3
Survivors   1479.000
Raw weights    0.444


Fleet =  UK(E&W)-BTS-Q3
                  3       2        1
Survivors   550.000 407.000 1546.000
Raw weights   2.087   3.944    2.659


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT2"        "1084"       "0.321"   "0.189"   "0.589"   "2" "0.411"     "0.319"
[2,] "fshk"           "1479"       "1.228"   "Inf"     "Inf"     "1" "0.029"     "0.243"
[3,] "UK(E&W)-BTS-Q3" "658"        "0.272"   "0.41"    "1.507"   "3" "0.56"      "0.482"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "827"    ""       ""       ""        "0.4"


Age =  4 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2012

Fleet =  BE-CBT2
                   4        3        2
Survivors   1456.000 2148.000 1025.000
Raw weights    5.942    3.282    2.084


Fleet =  fshk
                   4
Survivors   1343.000
Raw weights    0.444


Fleet =  UK(E&W)-BTS-Q3
                   4        3        2        1
Survivors   2093.000 1393.000 1651.000 1370.000
Raw weights    4.252    1.737    3.373    2.274


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT2"        "1528"       "0.239"   "0.179"   "0.749"   "3" "0.484"     "0.32"
[2,] "fshk"           "1343"       "1.286"   "Inf"     "Inf"     "1" "0.019"     "0.358"
[3,] "UK(E&W)-BTS-Q3" "1692"       "0.23"    "0.102"   "0.443"   "4" "0.497"     "0.294"

 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "1604"   ""       ""       ""        "0.307"
```

```
Age =  5 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2011

Fleet =  BE-CBT2
                   5        4       3        2
Survivors   1514.000 1620.000 1056.0 1906.000
Raw weights    5.951    4.323    2.7    1.623


Fleet =  fshk
                   5
Survivors   1273.000
Raw weights    0.444


Fleet =  UK(E&W)-BTS-Q3
                   5        4        3        2        1
Survivors   1257.000 1570.000 1626.000 2446.000 1876.000
Raw weights    1.948    3.094    1.429    2.627    1.771


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT2"        "1483"       "0.2"     "0.101"   "0.505"   "4" "0.563"     "0.354"
[2,] "fshk"           "1273"       "1.268"   "Inf"     "Inf"     "1" "0.017"     "0.402"
[3,] "UK(E&W)-BTS-Q3" "1737"       "0.217"   "0.113"   "0.521"   "5" "0.419"     "0.31"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "1580"   ""       ""       ""        "0.336"



Age =  6 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2010

Fleet =  BE-CBT2
                  6       5       4       3       2
Survivors   543.000 598.000 694.000 561.000 276.000
Raw weights   3.233   4.006   2.534   1.271   0.799


Fleet =  fshk
                  6
Survivors   444.000
Raw weights   0.444


Fleet =  UK(E&W)-BTS-Q3
                  5       4       3       2       1
Survivors   417.000 402.000 468.000 469.000 773.000
Raw weights   1.312   1.814   0.673   1.292   0.871


Fleet =  UK(E&W)-CBT
                  2
Survivors   253.000
Raw weights   0.421


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT2"        "567"        "0.196"   "0.106"   "0.541"   "5" "0.634"     "0.344"
[2,] "fshk"           "444"        "1.247"   "Inf"     "Inf"     "1" "0.024"     "0.422"
[3,] "UK(E&W)-BTS-Q3" "469"        "0.225"   "0.108"   "0.48"    "5" "0.319"     "0.404"
[4,] "UK(E&W)-CBT"    "253"        "0.702"   "Inf"     "Inf"     "1" "0.023"     "0.653"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "521"    ""       ""       ""        "0.37"
```

```
Age =  7 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2009

Fleet =  BE-CBT2
                 7       6       5       4      3       2
Survivors   91.000 166.000 140.000 105.000 60.000 109.000
Raw weights  2.032   1.632   1.881   1.214  0.733   0.444


Fleet =  fshk
                  7
Survivors   163.000
Raw weights   0.444


Fleet =  UK(E&W)-BTS-Q3
                  5       4      3      2      1
Survivors   141.000 172.000 37.000 55.000 66.000
Raw weights   0.616   0.869  0.388  0.718  0.484


Fleet =  UK(E&W)-CBT
                 3       2
Survivors   95.000 280.000
Raw weights  1.103   0.234


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT2"        "113"        "0.198"   "0.135"   "0.682"   "6" "0.62"      "0.547"
[2,] "fshk"           "163"        "1.131"   "Inf"     "Inf"     "1" "0.035"     "0.408"
[3,] "UK(E&W)-BTS-Q3" "90"         "0.22"    "0.287"   "1.305"   "5" "0.24"      "0.649"
[4,] "UK(E&W)-CBT"    "114"        "0.303"   "0.412"   "1.36"    "2" "0.105"     "0.543"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "109"    ""       ""       ""        "0.564"

Age =  8 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2008

Fleet =  BE-CBT2
                  8       7       6       5       4       3       2
Survivors   336.000 474.000 502.000 431.000 339.000 312.000 328.000
Raw weights   2.199   2.036   1.845   2.127   1.483   0.864   0.539


Fleet =  fshk
                  8
Survivors   343.000
Raw weights   0.444


Fleet =  UK(E&W)-BTS-Q3
                  5       4       3       2       1
Survivors   696.000 702.000 743.000 531.000 433.000
Raw weights   0.696   1.062   0.457   0.871   0.587


Fleet =  UK(E&W)-CBT
                  4       3      2
Survivors   484.000 387.000 83.000
Raw weights   1.303   1.299  0.284


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT2"        "399"        "0.193"   "0.072"   "0.373"   "7" "0.613"     "0.293"
[2,] "fshk"           "343"        "1.307"   "Inf"     "Inf"     "1" "0.025"     "0.333"
[3,] "UK(E&W)-BTS-Q3" "611"        "0.218"   "0.096"   "0.44"    "5" "0.203"     "0.201"
[4,] "UK(E&W)-CBT"    "368"        "0.237"   "0.356"   "1.502"   "3" "0.159"     "0.314"


 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "428"    ""       ""       ""        "0.275"
```

```
Age =  9 .  Catchability constand w.r.t. time and dependant on age
 Year class =  2007

Fleet =  BE-CBT2
                  9       8       7       6       5       4       3       2
Survivors   223.000 255.000 560.000 361.000 366.000 250.000 234.000 360.000
Raw weights   3.295   1.782   1.329   1.098   1.197   0.838   0.496   0.301


Fleet =  fshk
                  9
Survivors   206.000
Raw weights   0.444


Fleet =  UK(E&W)-BTS-Q3
                  5       4       3       2       1
Survivors   358.000 466.000 334.000 185.000 447.000
Raw weights   0.392   0.599   0.262   0.487   0.329


Fleet =  UK(E&W)-CBT
                  5       4       3       2
Survivors   379.000 340.000 327.000 571.000
Raw weights   1.597   0.736   0.746   0.159


     Fleet            Est.Suvivors Int. s.e. Ext. s.e. Var Ratio N   Scaled Wgts Estimated F
[1,] "BE-CBT2"        "294"        "0.21"    "0.118"   "0.562"   "8" "0.643"     "0.274"
[2,] "fshk"           "206"        "1.316"   "Inf"     "Inf"     "1" "0.028"     "0.372"
[3,] "UK(E&W)-BTS-Q3" "340"        "0.218"   "0.179"   "0.821"   "5" "0.129"     "0.241"
[4,] "UK(E&W)-CBT"    "365"        "0.191"   "0.069"   "0.361"   "4" "0.201"     "0.226"

 Weighted prediction:

     Suvivors Int.s.e. Ext.s.e. Var.Ratio F
[1,] "310"    ""       ""       ""        "0.262"
```

Table 36.12 - Sol.27.7fg - Fishing mortality

Age/Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0840	0.0696	0.1069	0.0559	0.0428	0.1320	0.0734	0.0838	0.0727	0.2458	0.1477	0.0856
3	0.1471	0.2569	0.3244	0.1624	0.1252	0.4128	0.2473	0.2210	0.1872	0.2832	0.3806	0.2779
4	0.3953	0.2280	0.3125	0.2157	0.1620	0.3386	0.2699	0.2739	0.3235	0.4389	0.3495	0.2668
5	0.4059	0.3120	0.3213	0.2518	0.2191	0.4354	0.2430	0.1635	0.2413	0.3996	0.3251	0.3181
6	0.3238	0.3447	0.2389	0.3378	0.2667	0.2704	0.2757	0.1961	0.2194	0.3017	0.4318	0.3535
7	0.4183	0.2333	0.1796	0.2260	0.2664	0.3421	0.2853	0.1533	0.3532	0.1153	0.3924	0.3967
8	0.3585	0.2854	0.1624	0.1949	0.1274	0.5129	0.2325	0.1966	0.2615	0.2584	0.3033	0.3939
9	0.2728	0.2186	0.2014	0.2144	0.1796	0.3422	0.1725	0.1873	0.2060	0.3090	0.3847	0.4496
+gp	0.2728	0.2186	0.2014	0.2144	0.1796	0.3422	0.1725	0.1873	0.2060	0.3090	0.3847	0.4496
FBAR 4-8	0.3804	0.2807	0.2429	0.2452	0.2083	0.3799	0.2613	0.1967	0.2798	0.3028	0.3604	0.3458

Age/Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1680	0.1227	0.0501	0.1079	0.1257	0.1133	0.1332	0.0905	0.2188	0.1270	0.0963	0.0800
3	0.3736	0.3064	0.3814	0.4695	0.2800	0.2428	0.3474	0.3957	0.3024	0.3783	0.3543	0.2869
4	0.3723	0.3298	0.4460	0.5245	0.5234	0.3966	0.4999	0.6233	0.4390	0.4526	0.4005	0.5149
5	0.3724	0.4620	0.5172	0.5552	0.4702	0.5445	0.4781	0.6460	0.5167	0.4756	0.3947	0.5553
6	0.3706	0.3893	0.4393	0.6418	0.5552	0.5874	0.5619	0.6794	0.4779	0.4799	0.3654	0.6087
7	0.4731	0.4989	0.3379	0.5059	0.8437	0.4796	0.5607	0.6639	0.4640	0.3194	0.5677	0.4952
8	0.6926	0.3775	0.4501	0.4879	0.4737	0.8124	0.5783	0.7099	0.5367	0.2833	0.5612	0.4171
9	0.3593	0.3143	0.4310	0.6191	0.6687	0.5940	0.5555	0.7501	0.6111	0.5100	0.7116	0.8092
+gp	0.3593	0.3143	0.4310	0.6191	0.6687	0.5940	0.5555	0.7501	0.6111	0.5100	0.7116	0.8092
FBAR 4-8	0.4562	0.4115	0.4381	0.5431	0.5733	0.5641	0.5358	0.6645	0.4869	0.4022	0.4579	0.5182

Age/Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0445	0.0641	0.0735	0.0431	0.1192	0.1456	0.1063	0.0078	0.0226	0.1122	0.0594	0.1742
3	0.4467	0.5176	0.4576	0.3864	0.5532	0.4162	0.2134	0.2998	0.2643	0.4587	0.2912	0.3705
4	0.7125	0.6692	0.5678	0.7371	0.6293	0.3922	0.4005	0.3613	0.4046	0.4810	0.3559	0.3439
5	0.5490	0.5881	0.6261	0.5425	0.6343	0.3281	0.4113	0.5442	0.6017	0.4917	0.4959	0.3612
6	0.6127	0.5832	0.7450	0.5295	0.4841	0.2334	0.5603	0.3896	0.7811	0.4395	0.4103	0.2583
7	0.5703	0.4657	0.6631	0.7420	0.4484	0.3139	0.3758	0.3967	0.7447	0.4687	0.3315	0.2162
8	0.7583	0.4542	0.5617	0.5402	0.4299	0.4093	0.3319	0.5461	0.7027	0.4002	0.3059	0.2318
9	0.8468	0.6591	0.6953	0.4210	0.4423	0.4519	0.4101	0.5167	0.5653	0.6546	0.4423	0.4163
+gp	0.8468	0.6591	0.6953	0.4210	0.4423	0.4519	0.4101	0.5167	0.5653	0.6546	0.4423	0.4163
FBAR 4-8	0.6406	0.5521	0.6327	0.6183	0.5252	0.3354	0.4160	0.4476	0.6469	0.4562	0.3799	0.2823

Age/Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	FBAR 14-16
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1133	0.0581	0.0751	0.0491	0.0789	0.0414	0.0854	0.0307	0.0576	0.0721	0.0535
3	0.3089	0.1972	0.1545	0.2071	0.2236	0.1871	0.3726	0.1534	0.2762	0.4003	0.2766
4	0.3245	0.2994	0.2572	0.3510	0.3269	0.3305	0.4075	0.4280	0.2896	0.3075	0.3417
5	0.3580	0.3893	0.2724	0.3066	0.2859	0.4899	0.4338	0.4342	0.3618	0.3359	0.3773
6	0.3167	0.3261	0.3168	0.2983	0.3739	0.4074	0.4621	0.3693	0.4897	0.3698	0.4096
7	0.3768	0.2891	0.3090	0.2630	0.3409	0.4783	0.4254	0.5024	0.2862	0.5639	0.4508
8	0.3032	0.2812	0.2138	0.3187	0.3143	0.3783	0.3036	0.4412	0.2234	0.2754	0.3134
9	0.3542	0.3488	0.2325	0.1849	0.2640	0.3276	0.2830	0.5314	0.4522	0.2620	0.4152
+gp	0.3542	0.3488	0.2325	0.1849	0.2640	0.3276	0.2830	0.5314	0.4522	0.2620	
FBAR 4-8	0.3358	0.3170	0.2739	0.3075	0.3284	0.4169	0.4065	0.4350	0.3301	0.3705	

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	1981	1982
1	9356	4173	3312	3301	2928	5154	4585	5438	3501	5095	4839	4862
2	5035	8466	3776	2996	2986	2649	4663	4149	4921	3168	4610	4378
3	2075	4189	7145	3070	2564	2589	2101	3921	3452	4140	2242	3599
4	4317	1621	2931	4674	2362	2047	1550	1484	2845	2590	2822	1386
5	1969	2630	1167	1940	3409	1817	1320	1071	1021	1863	1511	1801
6	1645	1187	1742	766	1365	2477	1064	937	823	726	1130	988
7	1651	1077	761	1241	495	946	1711	731	697	598	486	664
8	2662	983	772	576	896	343	608	1164	567	443	482	297
9	1655	1683	669	594	429	714	186	436	865	395	309	322
+gp	5356	3904	3705	2940	2375	1672	2417	1066	953	1387	1246	942
TOTAL	35721	29912	25980	22098	19807	20409	20205	20397	19645	20404	19677	19239

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	6754	4671	5612	3132	5699	4459	3717	8620	4215	4477	4456	3441
2	4400	6111	4227	5078	2834	5157	4035	3363	7800	3814	4051	4032
3	3636	3365	4891	3638	4124	2261	4166	3195	2780	5671	3039	3329
4	2466	2264	2242	3022	2058	2821	1605	2663	1946	1859	3515	1930
5	961	1538	1473	1298	1619	1103	1717	881	1292	1135	1070	2131
6	1185	599	877	795	674	915	579	963	418	697	639	652
7	628	740	367	511	379	350	460	299	442	234	391	401
8	404	354	407	237	279	147	196	238	139	251	154	200
9	181	183	220	235	132	157	59	100	106	74	171	80
+gp	1111	1063	719	743	384	625	250	255	370	233	203	275
TOTAL	21726	20889	21033	18688	18182	17996	16784	20577	19508	18446	17688	16470

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	3317	4016	5423	6288	14756	8077	4324	6878	5214	5848	4975	3634
2	3114	3001	3634	4907	5690	13352	7308	3912	6223	4718	5292	4501
3	3368	2695	2547	3055	4253	4570	10444	5946	3513	5505	3816	4512
4	2261	1949	1453	1459	1878	2213	2727	7634	3987	2440	3149	2581
5	1043	1003	903	745	632	906	1353	1653	4813	2407	1365	1996
6	1106	545	504	437	392	303	590	811	868	2386	1332	752
7	321	543	275	217	233	219	217	305	497	360	1391	800
8	221	164	308	128	93	135	144	135	186	214	204	904
9	119	94	94	159	68	55	81	94	71	83	130	136
+gp	199	230	221	265	129	147	251	132	204	120	132	157
TOTAL	15070	14240	15364	17660	28124	29975	27440	27501	25576	24081	21785	19973

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	GMST 71-14
1	4409	9740	6815	1897	4581	6183	4422	1765	8587	7762	0	4802
2	3289	3989	8813	6167	1717	4145	5595	4001	1597	7770	7024	
3	3422	2657	3406	7397	5313	1435	3598	4648	3511	1364	6541	
4	2819	2274	1974	2641	5441	3844	1077	2243	3608	2410	827	
5	1656	1844	1525	1381	1682	3550	2499	648	1323	2443	1604	
6	1259	1047	1130	1051	920	1144	1968	1466	380	834	1580	
7	526	830	684	745	706	572	688	1122	917	211	521	
8	583	326	562	454	518	454	321	407	614	623	109	
9	648	389	223	411	299	342	281	214	237	444	428	
+gp	246	613	975	733	899	923	706	554	380	425	605	
TOTAL	18855	23709	26108	22877	22074	22593	21157	17068	21153	24287	19239	

Table 36.14 - Sol.27.7fg - Summary

	RECRUITS Age 1	SSB	BIOMASS	LANDINGS	FBAR 4-8	YIELD/SSB
1971	9356	7540	8974	1861	0.380	0.25
1972	4173	5939	7558	1278	0.281	0.22
1973	3312	4994	6295	1391	0.243	0.28
1974	3301	5266	6258	1105	0.245	0.21
1975	2928	4684	5518	919	0.208	0.2
1976	5154	4050	5061	1350	0.380	0.33
1977	4585	4417	5666	961	0.261	0.22
1978	5438	3511	4818	780	0.197	0.22
1979	3501	3629	4827	954	0.280	0.26
1980	5095	3783	4994	1314	0.303	0.35
1981	4839	3242	4409	1212	0.360	0.37
1982	4862	3350	4593	1128	0.346	0.34
1983	6754	3492	4962	1373	0.456	0.39
1984	4671	3750	5198	1266	0.411	0.34
1985	5612	3188	4660	1328	0.438	0.42
1986	3132	3240	4485	1600	0.543	0.49
1987	5699	2429	3636	1222	0.573	0.5
1988	4459	2599	3785	1146	0.564	0.44
1989	3717	2032	3161	992	0.536	0.49
1990	8620	2313	3789	1189	0.664	0.51
1991	4215	2031	3505	1107	0.487	0.55
1992	4477	2352	3767	981	0.402	0.42
1993	4456	2426	3792	928	0.458	0.38
1994	3441	2208	3224	1009	0.518	0.46
1995	3317	2125	3061	1157	0.641	0.54
1996	4016	2071	3051	995	0.552	0.48
1997	5423	1852	2998	927	0.633	0.5
1998	6288	1664	3089	875	0.618	0.53
1999	14756	1859	4279	1012	0.525	0.54
2000	8077	1966	3919	1091	0.335	0.55
2001	4324	3124	5412	1168	0.416	0.37
2002	6878	4043	5938	1345	0.448	0.33
2003	5214	3720	5585	1547	0.647	0.42
2004	5848	3277	4895	1398	0.456	0.43
2005	4975	3137	4823	1118	0.380	0.36
2006	3634	2687	4119	946	0.282	0.35
2007	4409	2806	3957	945	0.336	0.34
2008	9740	2529	4396	800	0.317	0.32
2009	6815	2857	5203	805	0.274	0.28
2010	1897	3098	4893	876	0.308	0.28
2011	4581	3290	4741	1029	0.328	0.31
2012	6183	3176	4509	1104	0.417	0.35
2013	4422	2735	4285	1093	0.406	0.4
2014	1765	2689	3839	1042	0.435	0.39
2015	8587	2561	4144	830	0.330	0.32
2016	7762	2525	4630	831	0.370	0.33
Arith. Mean	5320	3179	4624	1116	0.413	0.38
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 36.15 - Sol.27.7fg

Input for catch forecast and Fmsy analysis

Input: TAC constraint for 2017 (845 t)
Catch and stock weights are mean 14-16
Recruits age 1 in 2017,18 and 19 GM (71-14)

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	4802	0.42	WS1	0.090	0.39
N2	7024	0.49	WS2	0.138	0.19
N3	6541	0.26	WS3	0.188	0.03
N4	827	0.23	WS4	0.232	0.02
N5	1604	0.17	WS5	0.291	0.05
N6	1580	0.15	WS6	0.343	0.04
N7	521	0.15	WS7	0.399	0.05
N8	109	0.15	WS8	0.440	0.06
N9	428	0.14	WS9	0.486	0.05
N10	605	0.15	WS10	0.593	0.07
H.cons selectivity			Weight in the HC catch		
sH1	0.0000	0.00	WH1	0.112	0.30
sH2	0.0535	0.39	WH2	0.173	0.07
sH3	0.2766	0.45	WH3	0.206	0.03
sH4	0.3417	0.22	WH4	0.263	0.04
sH5	0.3773	0.14	WH5	0.326	0.11
sH6	0.4096	0.17	WH6	0.366	0.06
sH7	0.4508	0.32	WH7	0.443	0.04
sH8	0.3134	0.36	WH8	0.478	0.09
sH9	0.4152	0.33	WH9	0.481	0.10
sH10	0.4152	0.33	WH10	0.613	0.11
Natural mortality			Proportion mature		
M1	0.1	0.1	MT1	0	0
M2	0.1	0.1	MT2	0.14	0.1
M3	0.1	0.1	MT3	0.45	0.1
M4	0.1	0.1	MT4	0.88	0.1
M5	0.1	0.1	MT5	0.98	0.1
M6	0.1	0.1	MT6	1	0
M7	0.1	0.1	MT7	1	0
M8	0.1	0.1	MT8	1	0
M9	0.1	0.1	MT9	1	0
M10	0.1	0.1	MT10	1	0
Relative effort in HC fihery			Year effect for natural mortality		
HF17	1	0.1	K17	1	0.1
HF18	1	0.1	K18	1	0.1
HF19	1	0.1	K19	1	0.1
Recruitment in 2018 and 2019					
R18	4802	0.37			
R19	4802	0.37			

Table 36.16 - Sol.27.7fg - Management option table

TAC constraint for 2017 (845 t)
Catch and stock weights are mean 14-16
Recruits age 1 in 2017,18 and 19 GM (71-14)
Fbar age range: 4-8

2017 Biomass	SSB	FMult	FBar	Landings
4648	2678	0.7727	0.2925	845

2018				2019
SSB	FMult	FBar	Landings	SSB
3112	0.0000	0.0000	0	4310
3112	0.1000	0.0379	140	4175
3112	0.2000	0.0757	275	4044
3112	0.3000	0.1136	406	3918
3112	0.4000	0.1514	532	3796
3112	0.5000	0.1893	654	3678
3112	0.6000	0.2271	772	3565
3112	0.7000	0.2650	886	3455
3112	0.8000	0.3028	997	3350
3112	0.9000	0.3407	1103	3247
3112	1.0000	0.3786	1206	3149
3112	1.1000	0.4164	1305	3054
3112	1.2000	0.4543	1402	2962
3112	1.3000	0.4921	1495	2873
3112	1.4000	0.5300	1585	2787
3112	1.5000	0.5678	1672	2705
3112	1.6000	0.6057	1756	2625
3112	1.7000	0.6435	1837	2548
3112	1.8000	0.6814	1916	2473
3112	1.9000	0.7192	1992	2401
3112	2.0000	0.7571	2066	2331

Input units are thousands and kg - output in tonnes

2018			2019	2018-2019	2017-2018	
FMult	Landings	FBar	SSB	SSB change	TAC change	Basis
0.7133	901	0.27000	3441	10	10	msyapproach
0.7133	901	0.27000	3441	10	10	Fmsy
1.1069	1312	0.41900	3047	-2	55	Fmsy_upper
0.4068	541	0.15400	3788	22	-36	Fmsy_lower
0.6633	845	0.25110	3495	12	0	TACstable
0.7772	972	0.29421	3373	8	15	TACplus15
0.5537	718	0.20960	3617	16	-15	TACminus15
0.8982	1101	0.34000	3249	4	35	Fpa
1.268	1465	0.48000	2901	-7	79	Flim
0.7727	967	0.29250	3378	9	14	FInt
1.9014	1993	0.71975	2400	-23	136	Btrigger
3.1109	2741	1.17763	1700	-45	224	Blim

Table 36.17 - Sol.27.7fg - Detailed results

TAC constraint for 2017 (845 t)
Catch and stock weights are mean 14-16
Recruits age 1 in 2017,18 and 19 GM (71-14)
Fbar age range: 4-8

Year:	**2017**	F multiplier:	0.7727	Fbar:	0.2925		
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
1	0.000	0	0	4802	431	0	0
2	0.041	271	46.92	7024	967	983	135
3	0.214	1200	247.6	6541	1228	2943	552
4	0.264	183	48.14	827	192	728	169
5	0.292	387	126.1	1604	466	1571	457
6	0.317	409	149.71	1580	543	1580	543
7	0.348	146	64.86	521	208	521	208
8	0.242	22	10.64	109	48	109	48
9	0.321	112	53.88	428	208	428	208
10	0.321	159	97.16	605	359	605	359
Total	0.293	2889	845	24041	4650	9468	2679

Year:	**2018**	F multiplier:	1	Fbar:	0.3786		
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
1	0.000	0	0	4802	431	0	0
2	0.053	215	37.34	4345	598	608	84
3	0.277	1406	290.01	6098	1144	2744	515
4	0.342	1320	347.21	4780	1109	4206	976
5	0.377	172	56.21	575	167	563	164
6	0.410	348	127.33	1084	372	1084	372
7	0.451	361	160.11	1042	416	1042	416
8	0.313	85	40.83	333	146	333	146
9	0.415	25	12.02	77	37	77	37
10	0.415	220	134.91	678	402	678	402
Total	0.379	4152	1206	23814	4822	11335	3112

Year:	**2019**	F multiplier:	1	Fbar:	0.3786		
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
1	0.000	0	0	4802	431	0	0
2	0.053	215	37.34	4345	598	608	84
3	0.277	859	177.24	3727	699	1677	315
4	0.342	1156	303.97	4184	971	3682	854
5	0.377	922	300.55	3073	893	3012	875
6	0.410	114	41.89	357	122	357	122
7	0.451	226	100.07	651	260	651	260
8	0.313	154	73.69	601	264	601	264
9	0.415	71	34.34	220	107	220	107
10	0.415	146	89.75	451	267	451	267
Total	0.379	3863	1159	22411	4612	11259	3148

Input units are thousands and kg - output in tonnes

Figure 36.2 - Sol.27.7fg - Age composition of landings

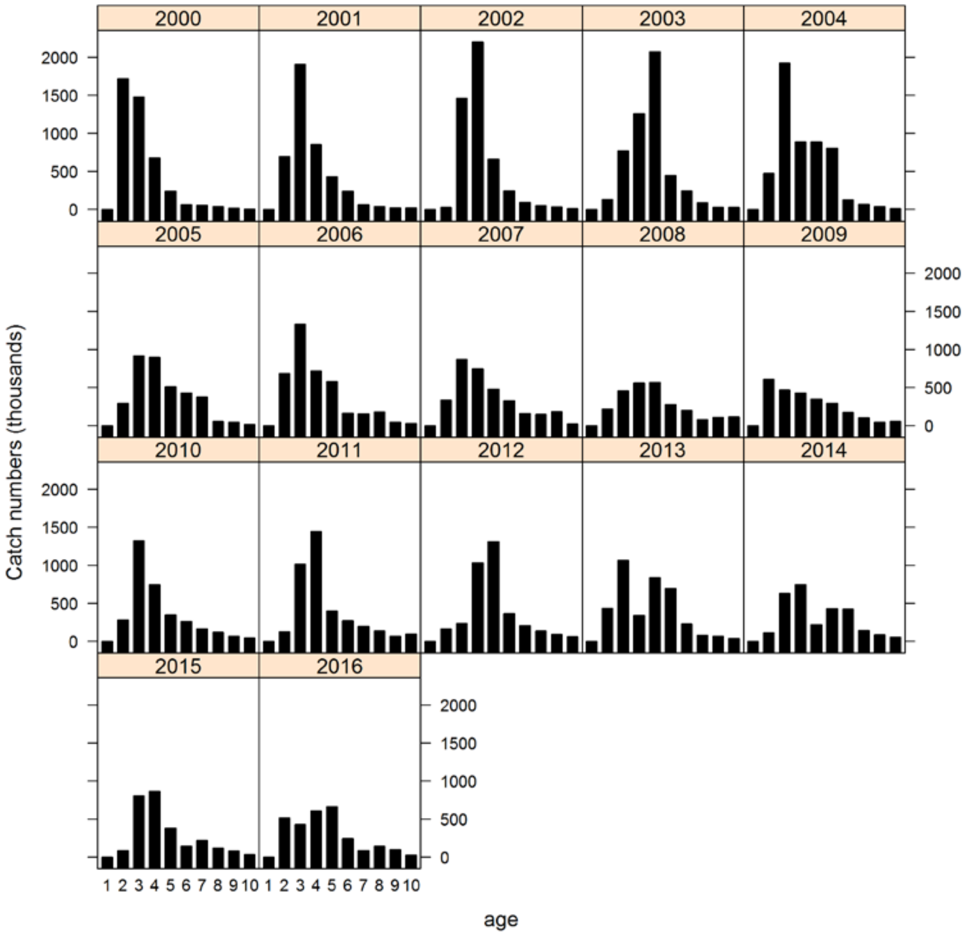


Figure 36.3 - Sol.27.7fg - Standardized catch proportion

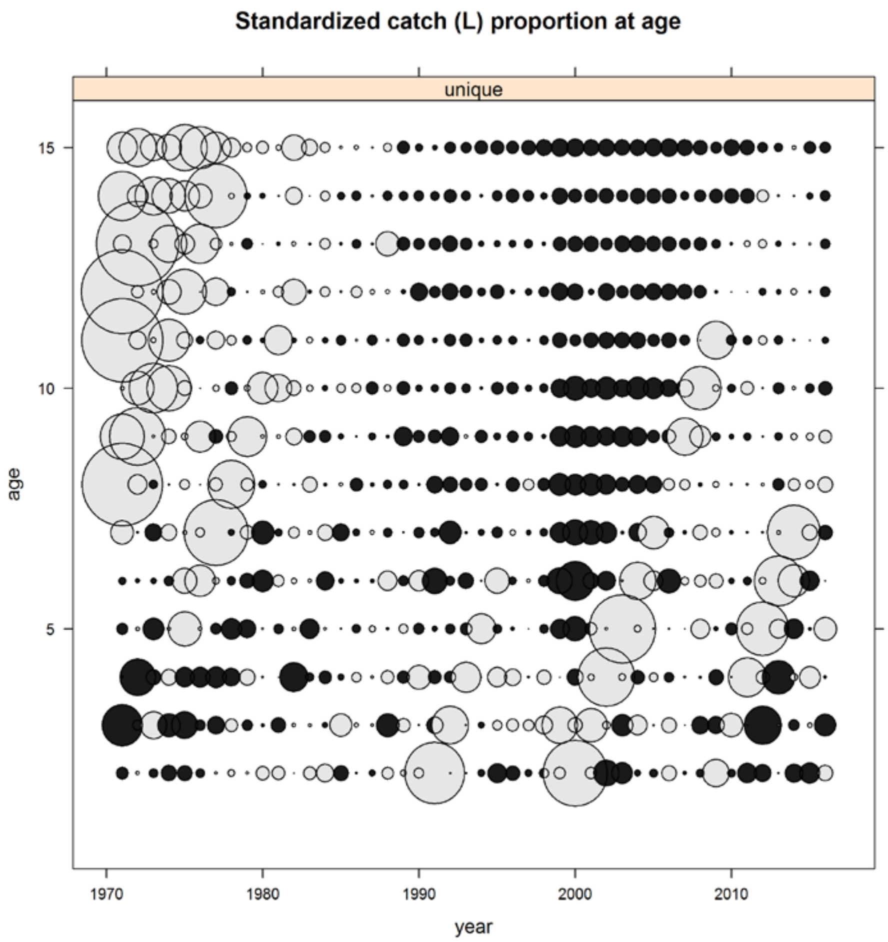


Figure 36.4a - Sol.27.7fg - Belgian length distributions of discarded and retained fish from discard sampling studies

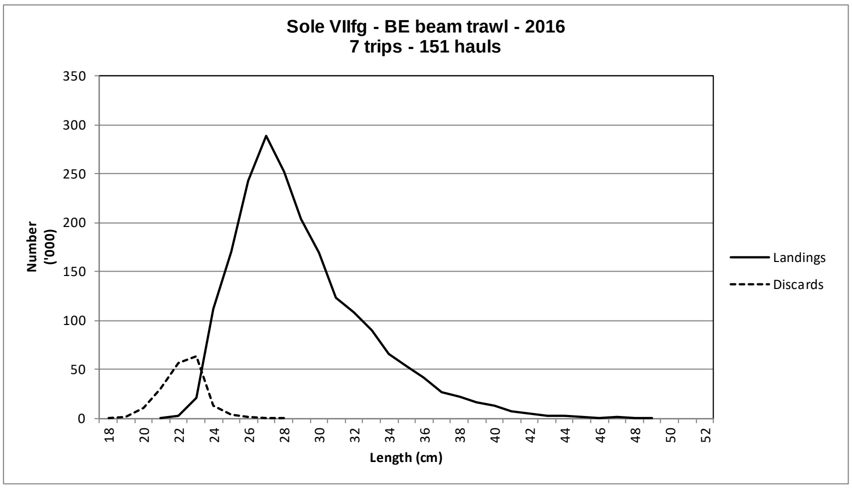
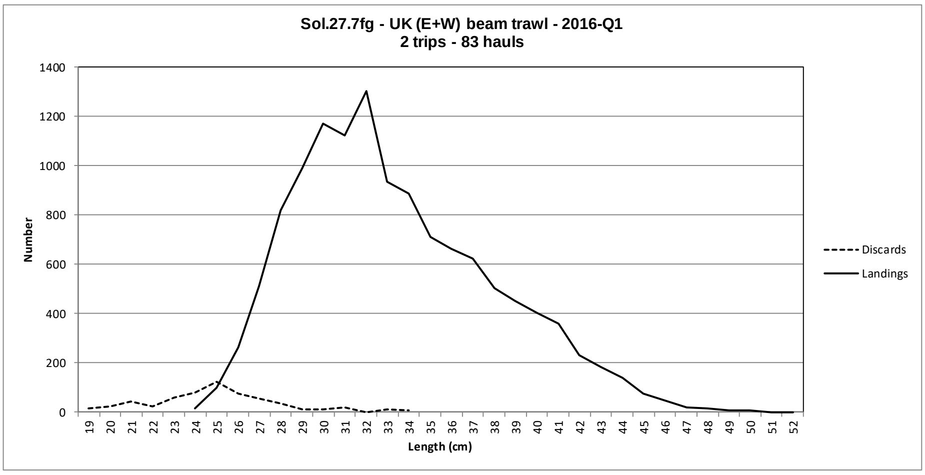
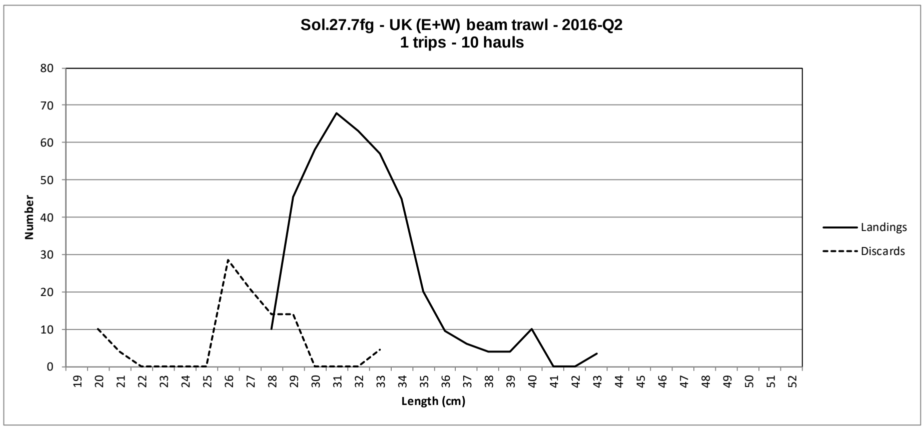


Figure 36.4b - Sol.27.7fg - UK (E+W) Length distributions of discarded and retained fish from discard sampling studies





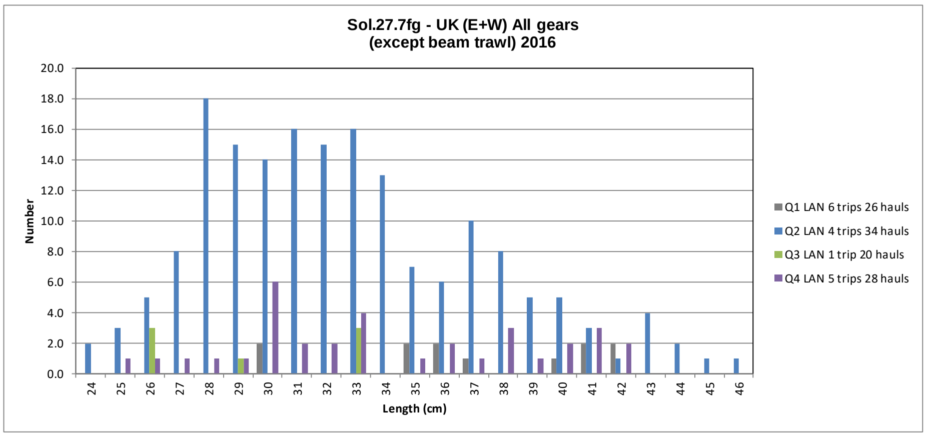
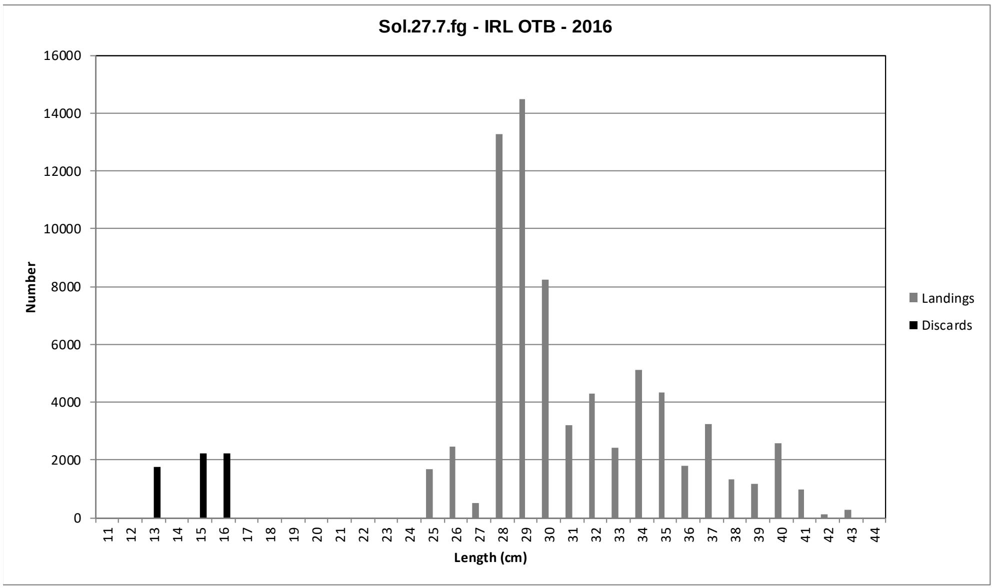


Figure 36.4c - Sol.27.7fg - Ireland Length distributions of discarded and retained fish from discard sampling studies



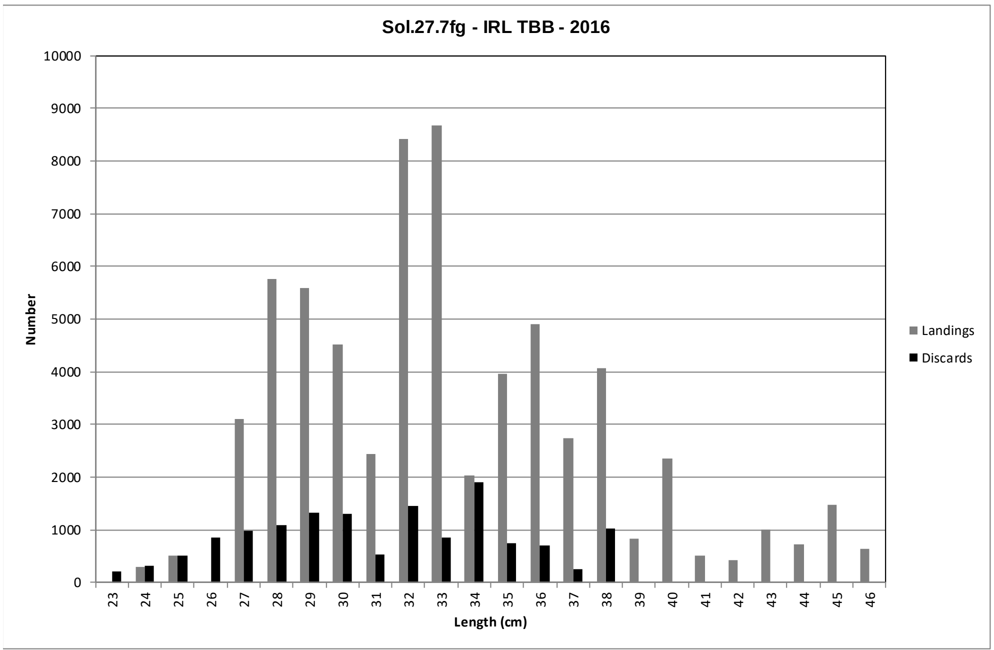


Figure 36.5a - Sol.27.7.fg - Mean-standardised indices

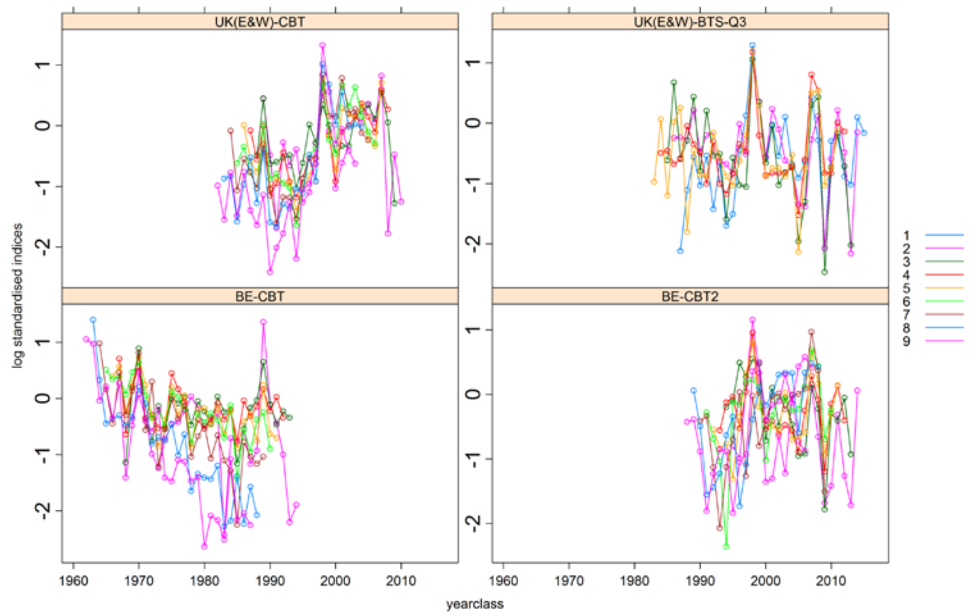


Figure 36.5b - Sol.27.7.fg - Mean-standardised indices

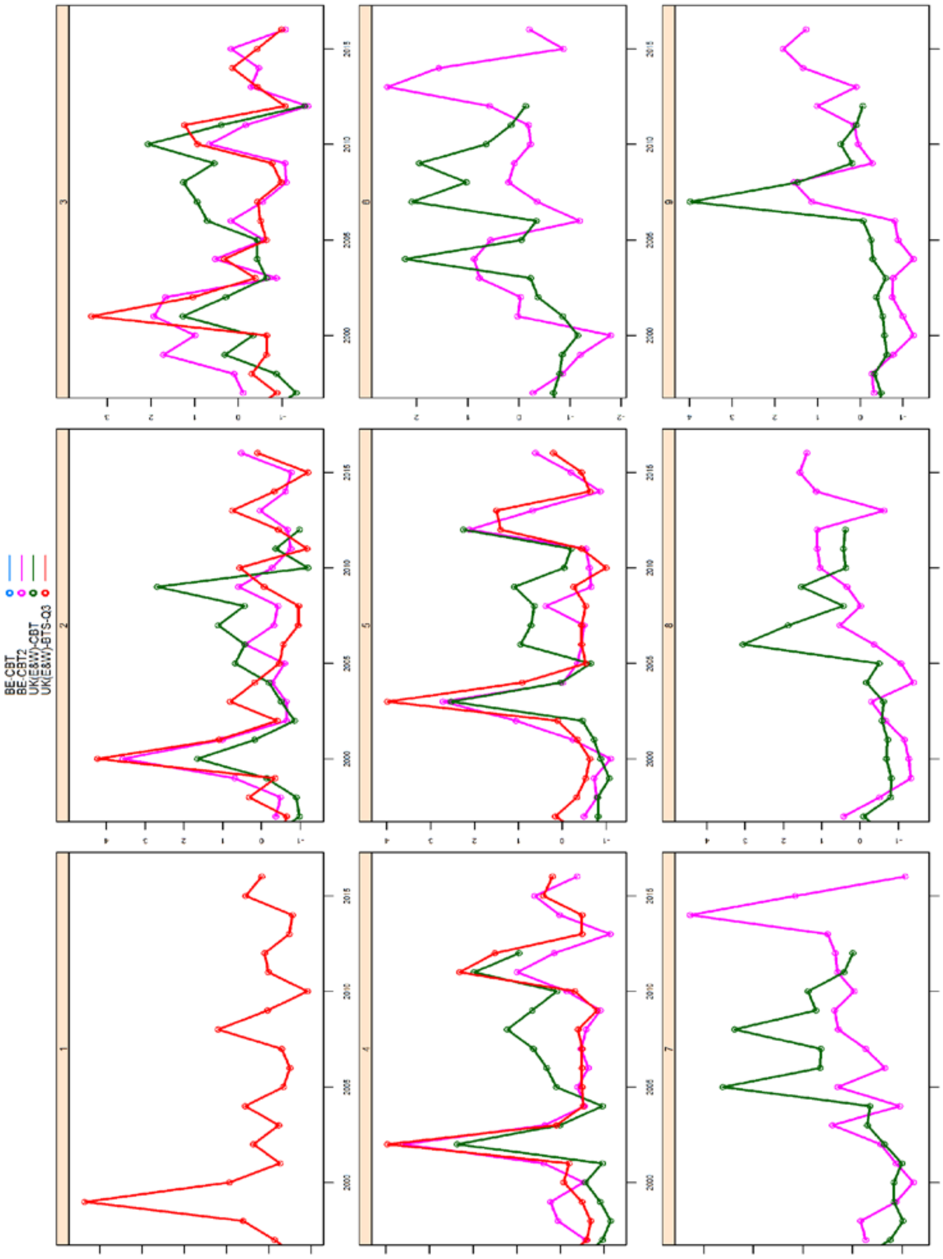


Figure 36.6 - Sol.27.7fg - Consistency plot UK(E&W)-BTS-Q3 survey

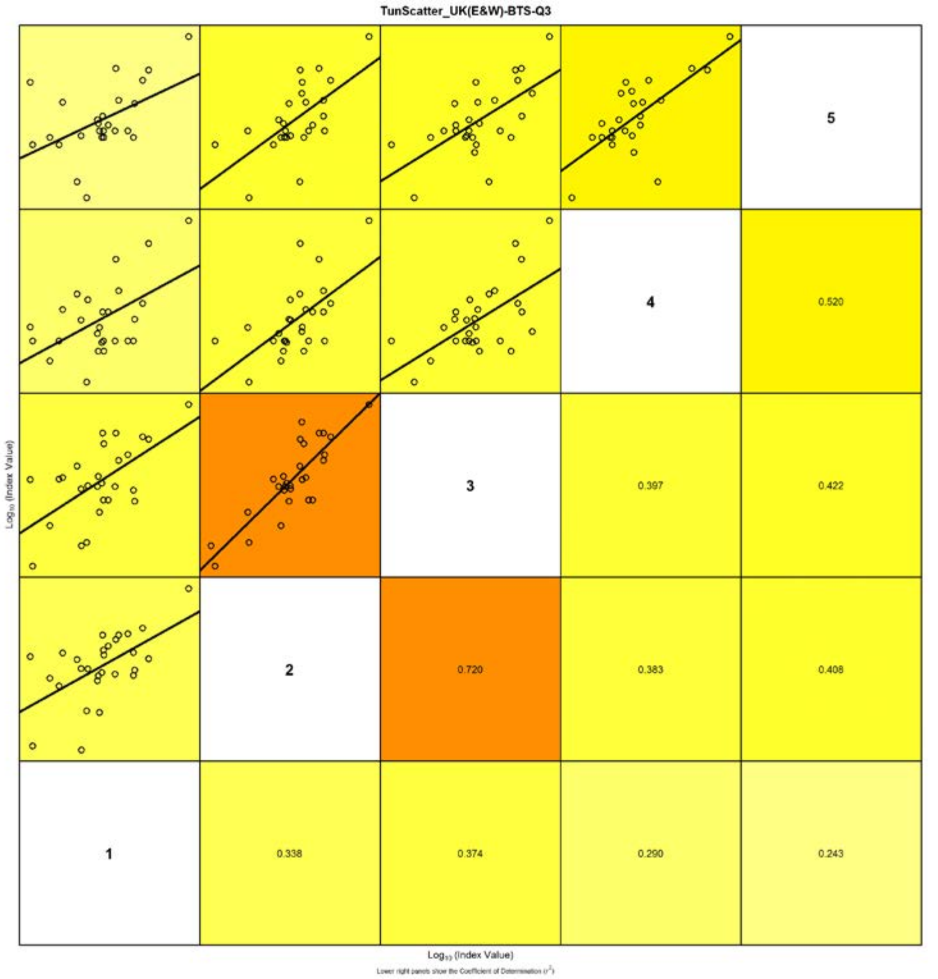
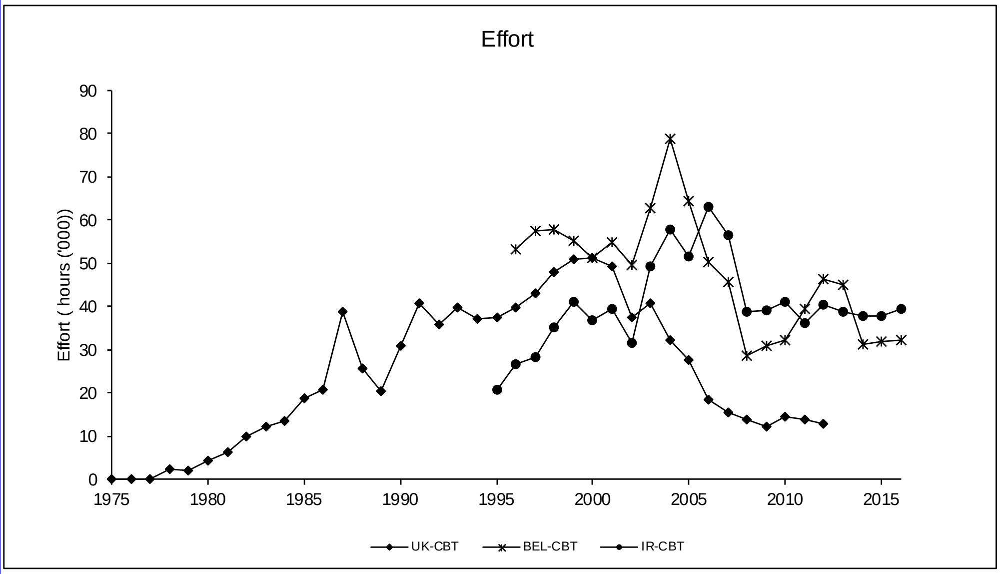


Figure 36.7 - Sol.27.7.fg - Effort (hours ('000) (BE-CBT and IR-CBT), hours ('000) GRT corrected (UK-CBT)) and LPUE (kg/hour (BE-CBT and IR-CBT), kg/hour GRT corrected (UK-CBT), kg/100km (UK-BTS-3Q))



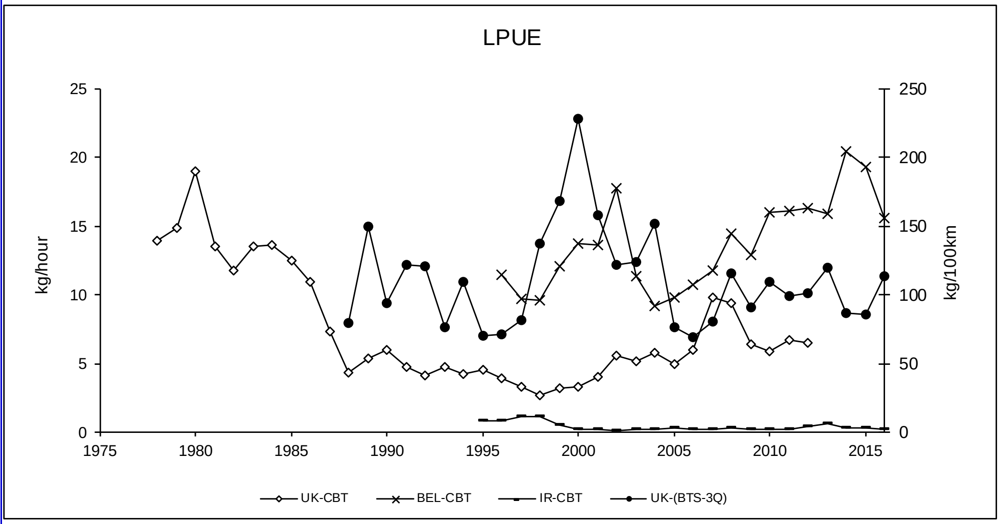


Figure 36.8 - Sol.27.7fg - Consistency plot UK(E&W) commercial beam trawl

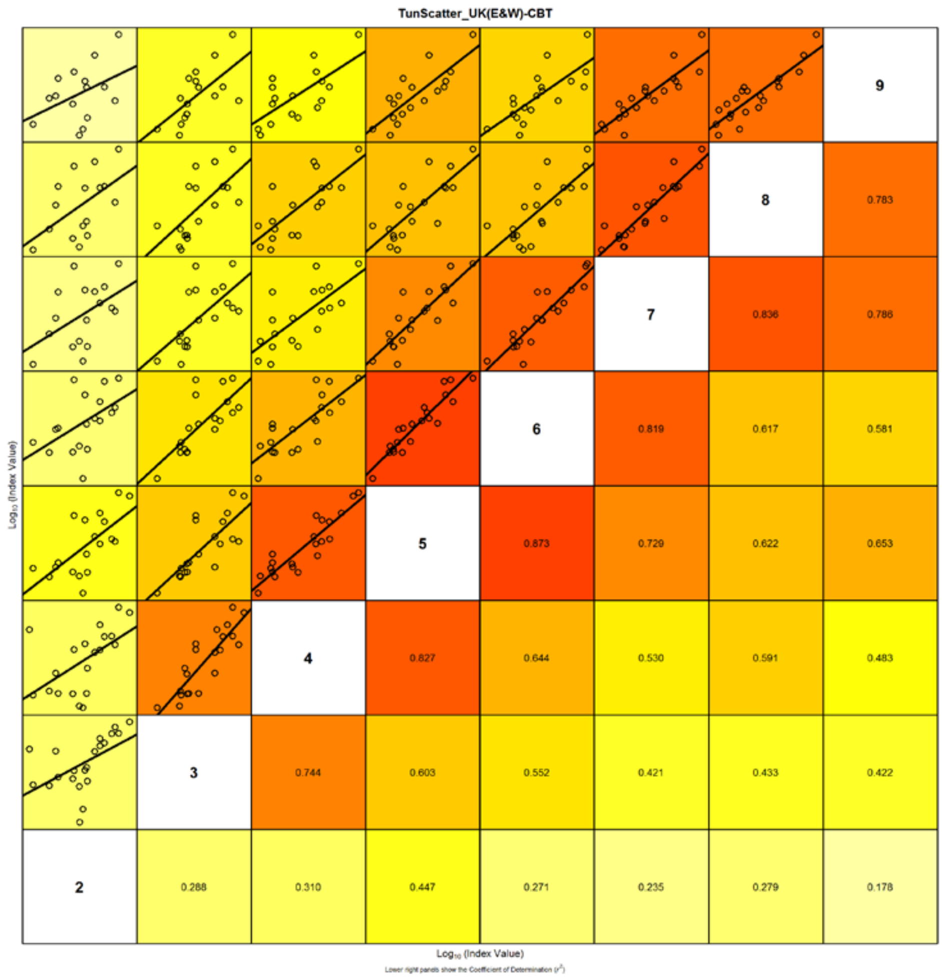


Figure 36.9a - Sol.27.7fg - Consistency plot commercial Belgian beam trawl
Years: 1971-1996

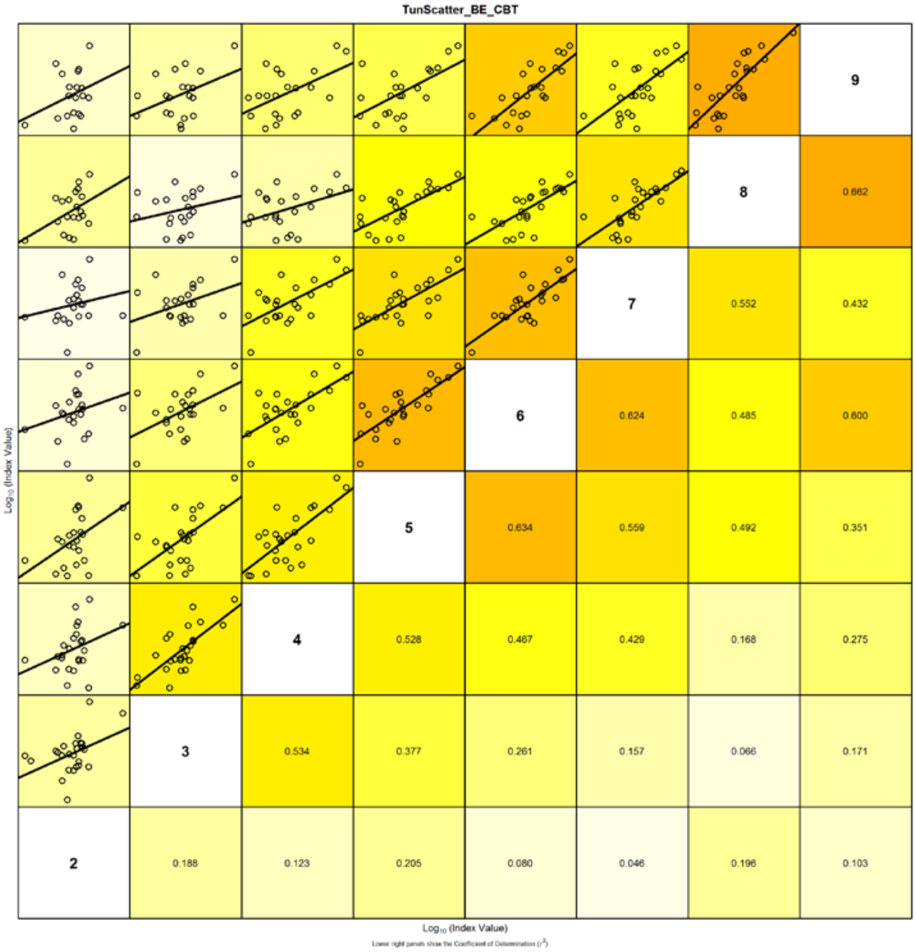


Figure 36.9b - Sol.27.7fg - Consistency plot commercial Belgian beam trawl
Years: 1997-2016

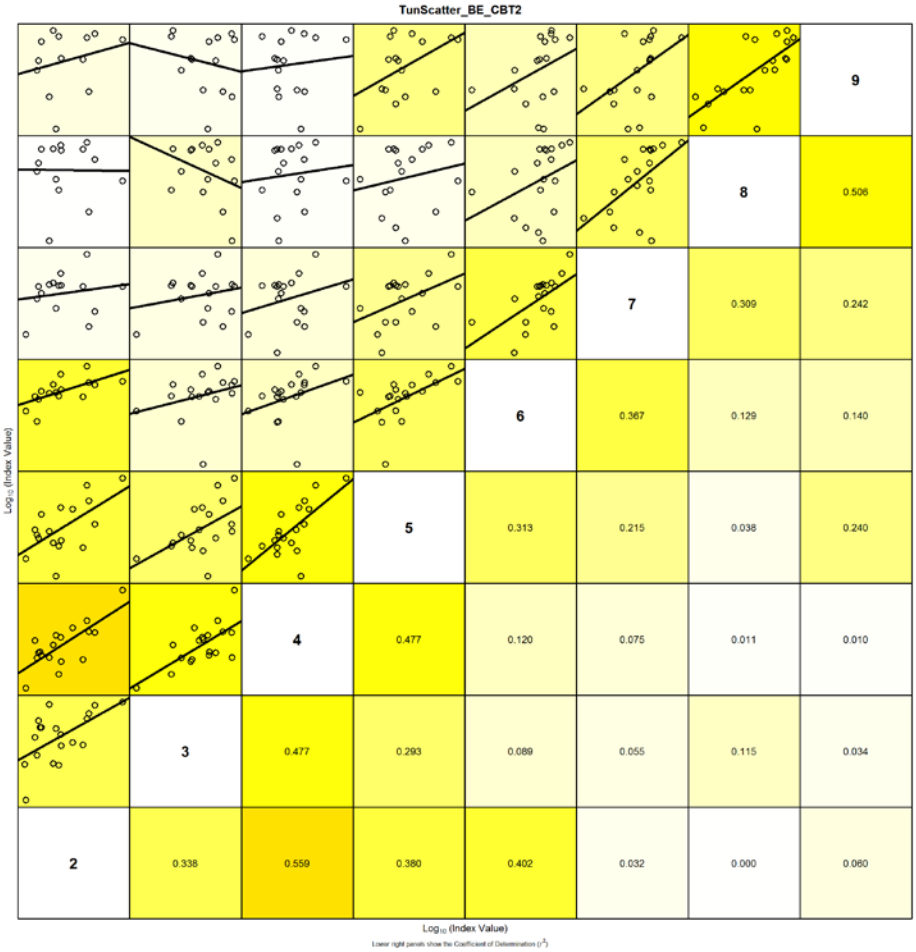


Figure 36.10 - Sol.27.7fg - Catchability residuals for the final XSA run

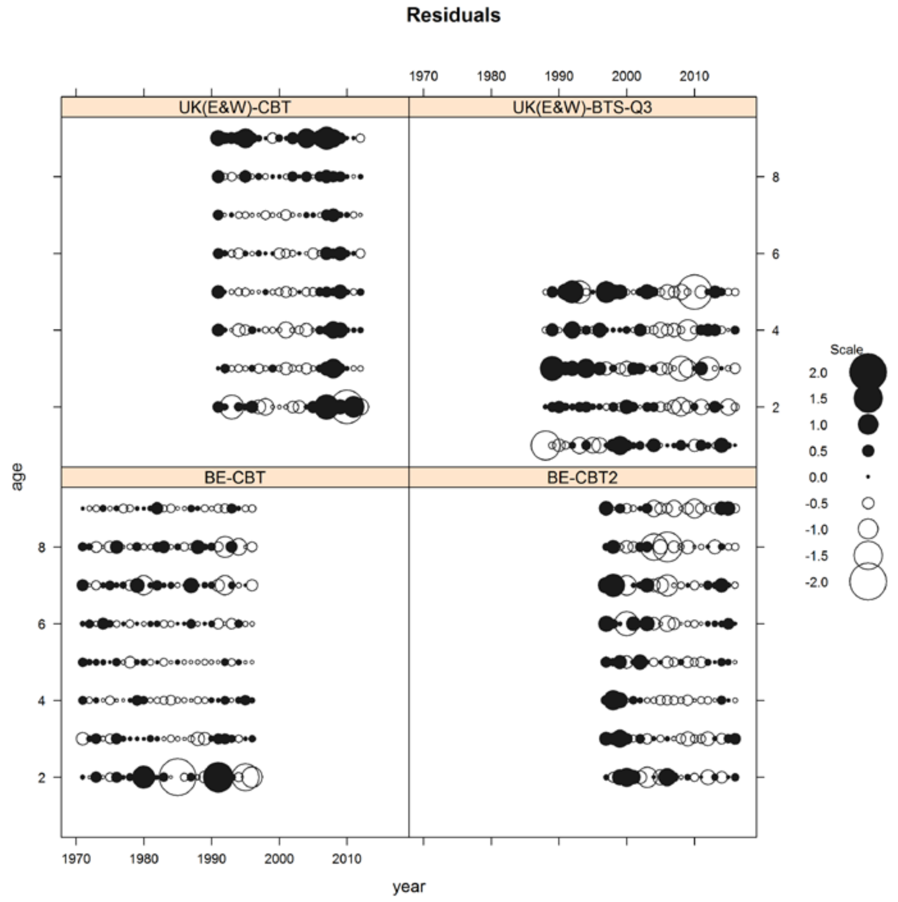


Figure 36.11 - Sol.27.7.fg - Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run

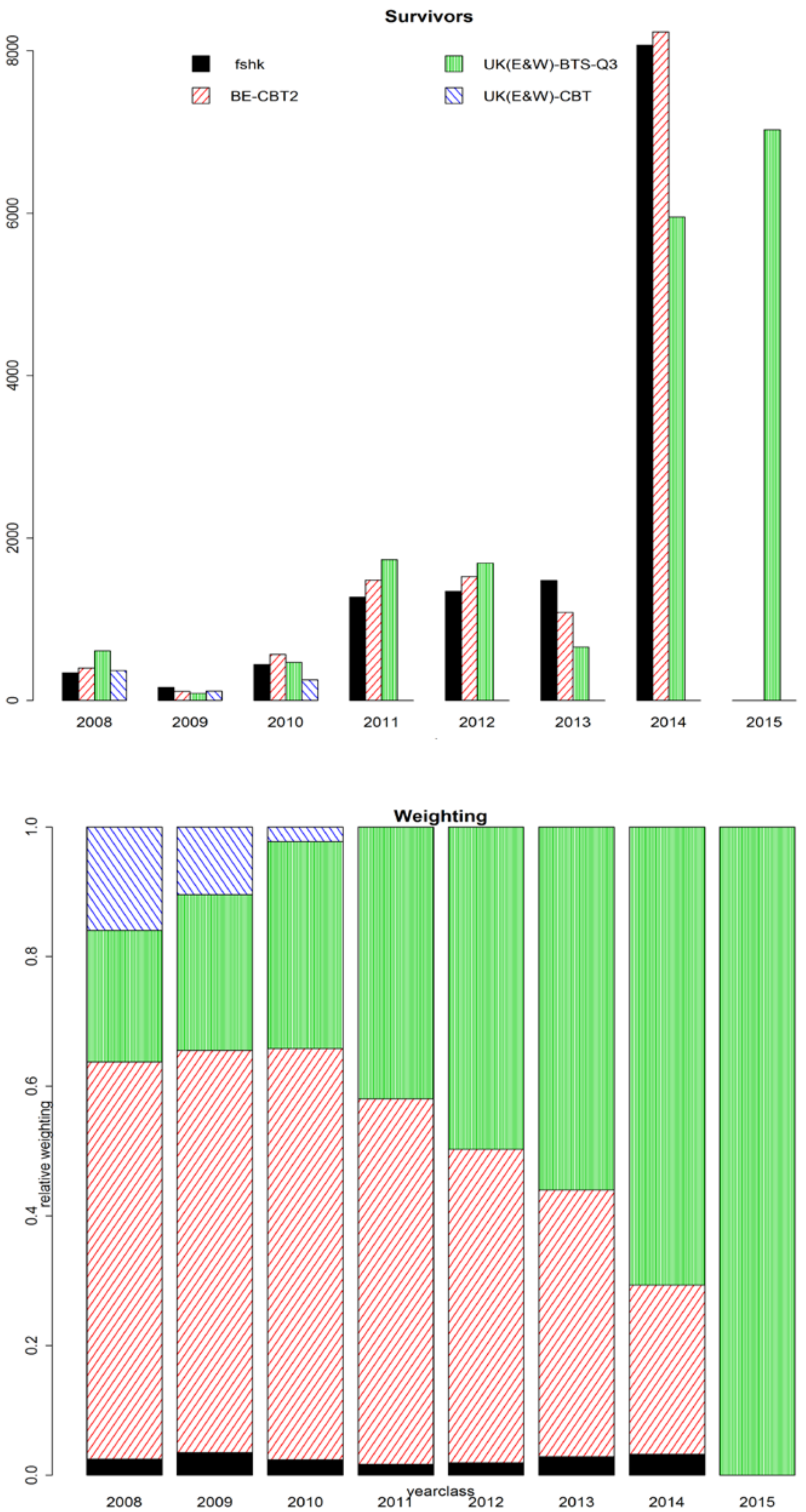


Figure 36.12 - Sol.27.7fg - Retrospective XSA analysis (shinkage SE=1.5)

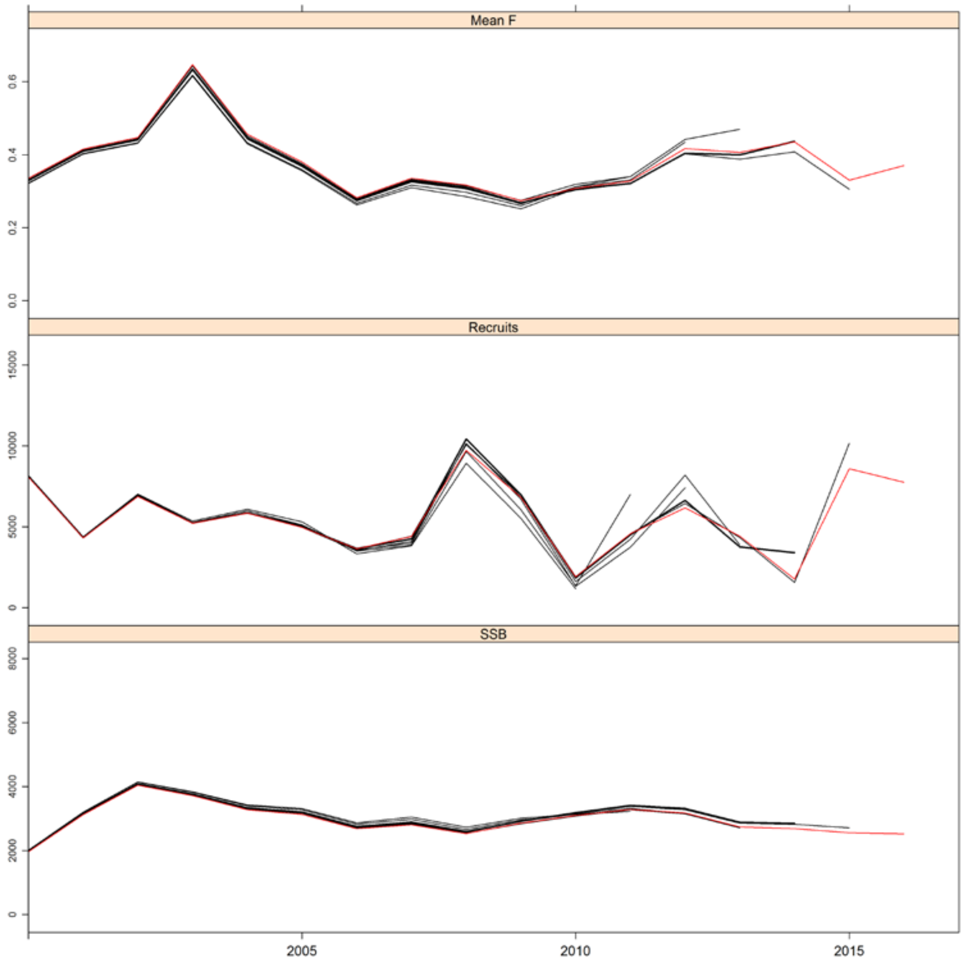


Figure 36.13 - Sol.27.7fg - Summary plots

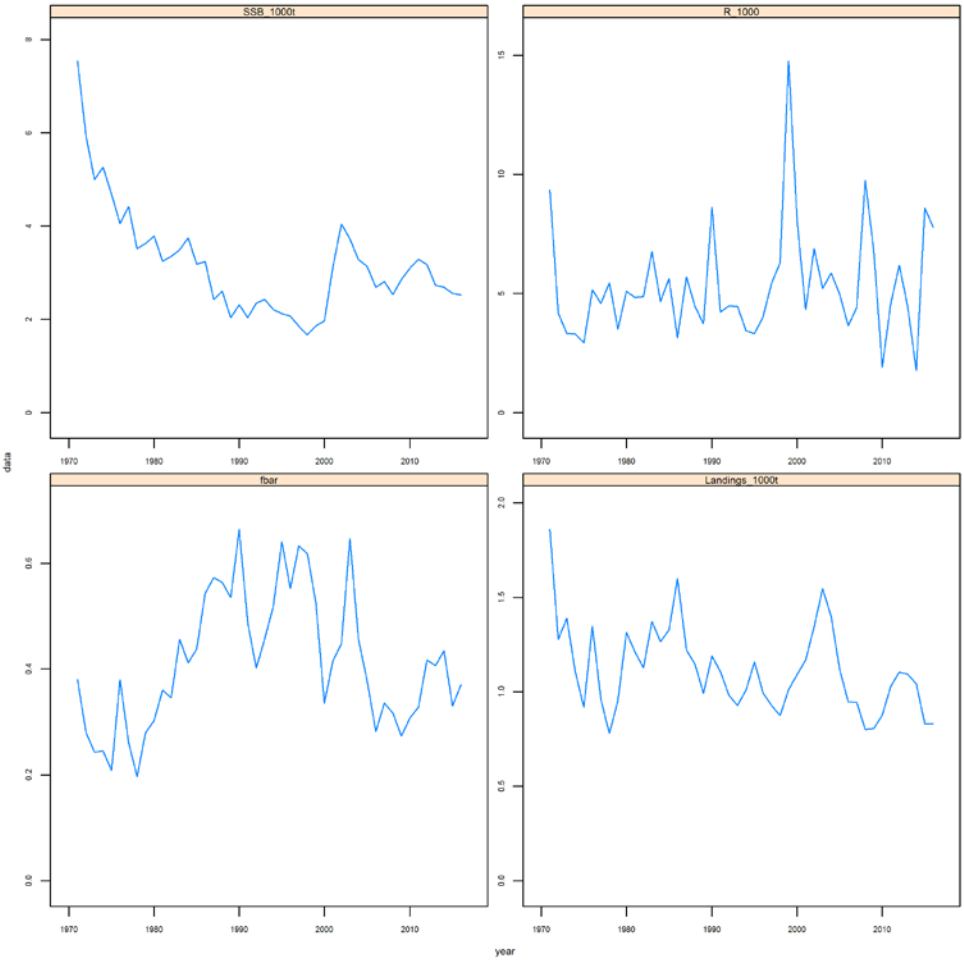


Figure 36.14 - Sol.27.7fg - Comparison with last year's assessment

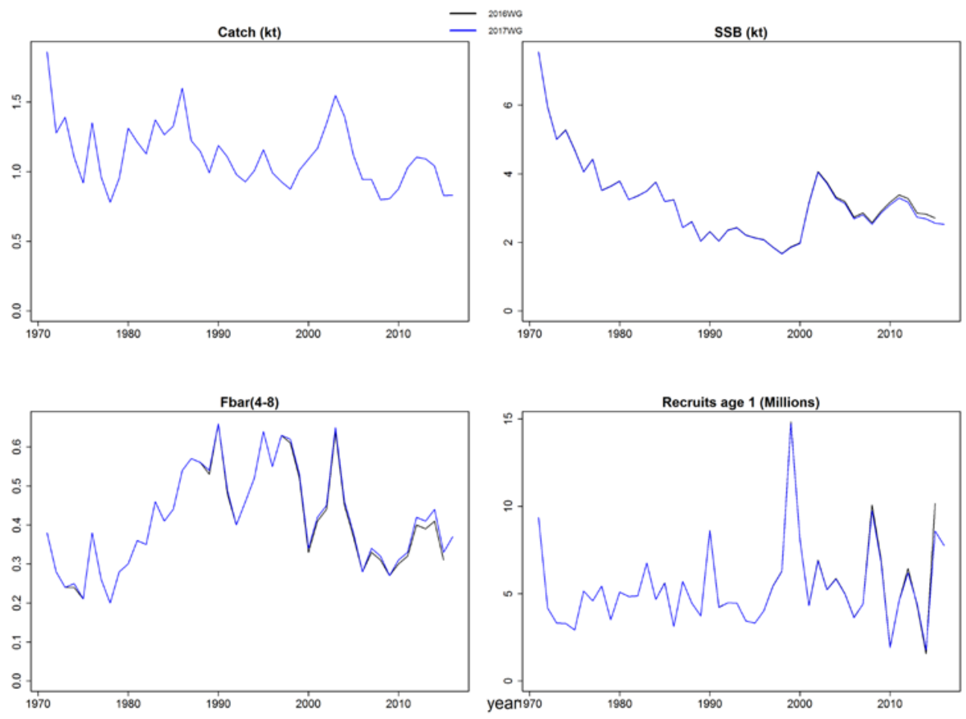


Figure 36.15 - Sol.27.7fg -
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

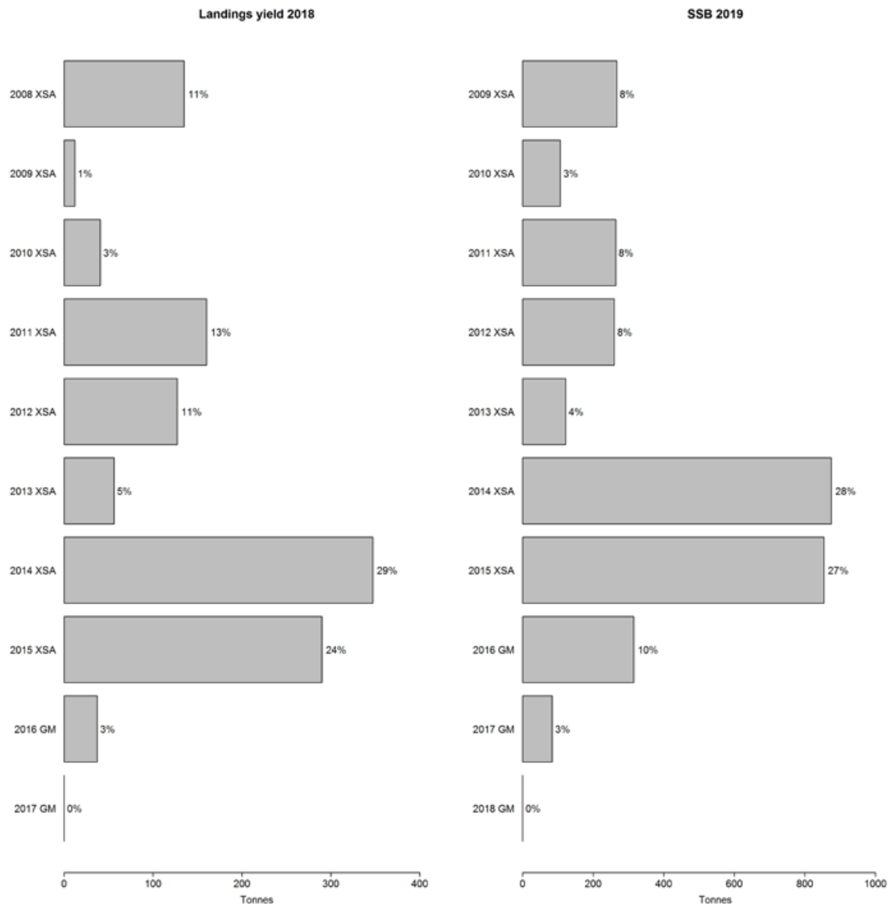


Figure 36.16 - Sol.27.7fg - Three year average exploitation pattern, standardised to Fbar (4-8)

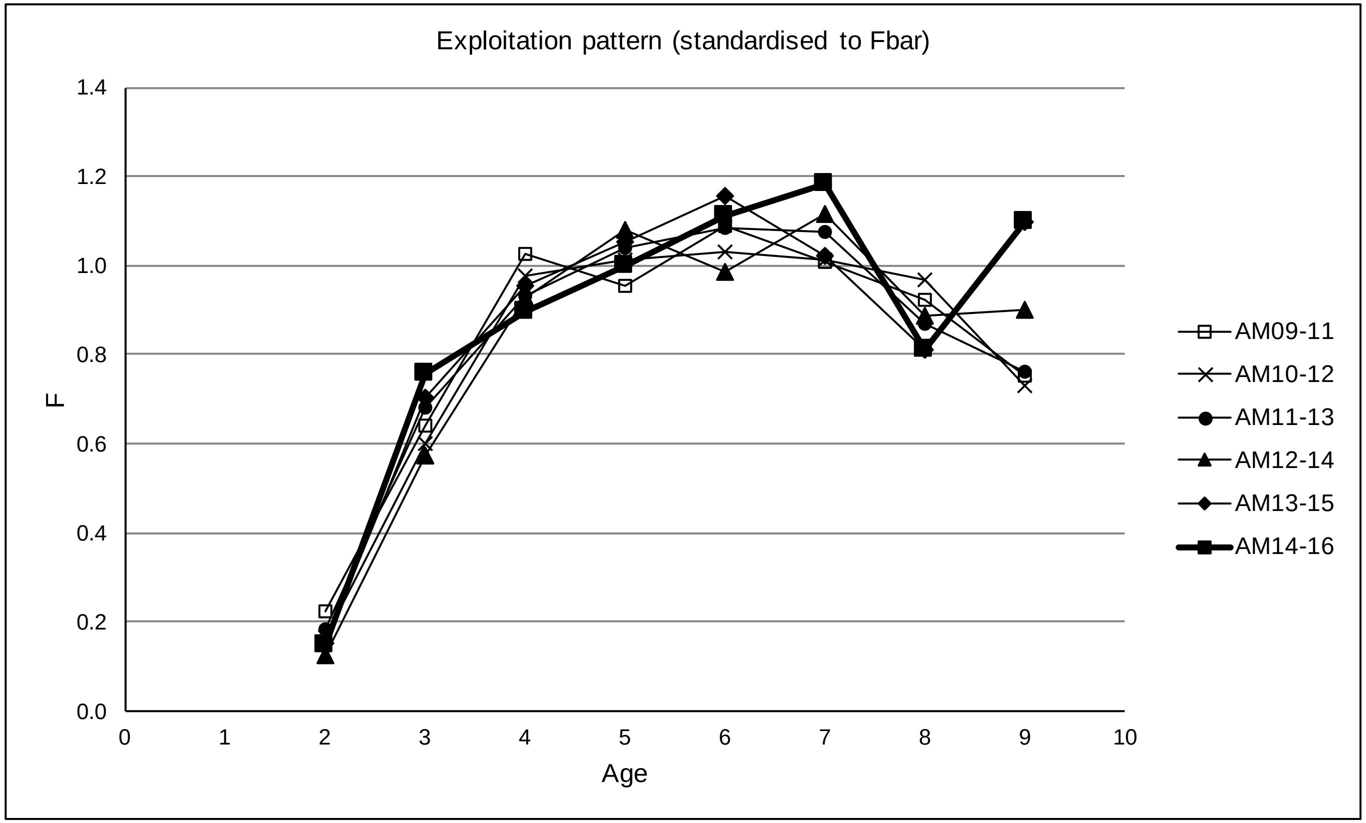
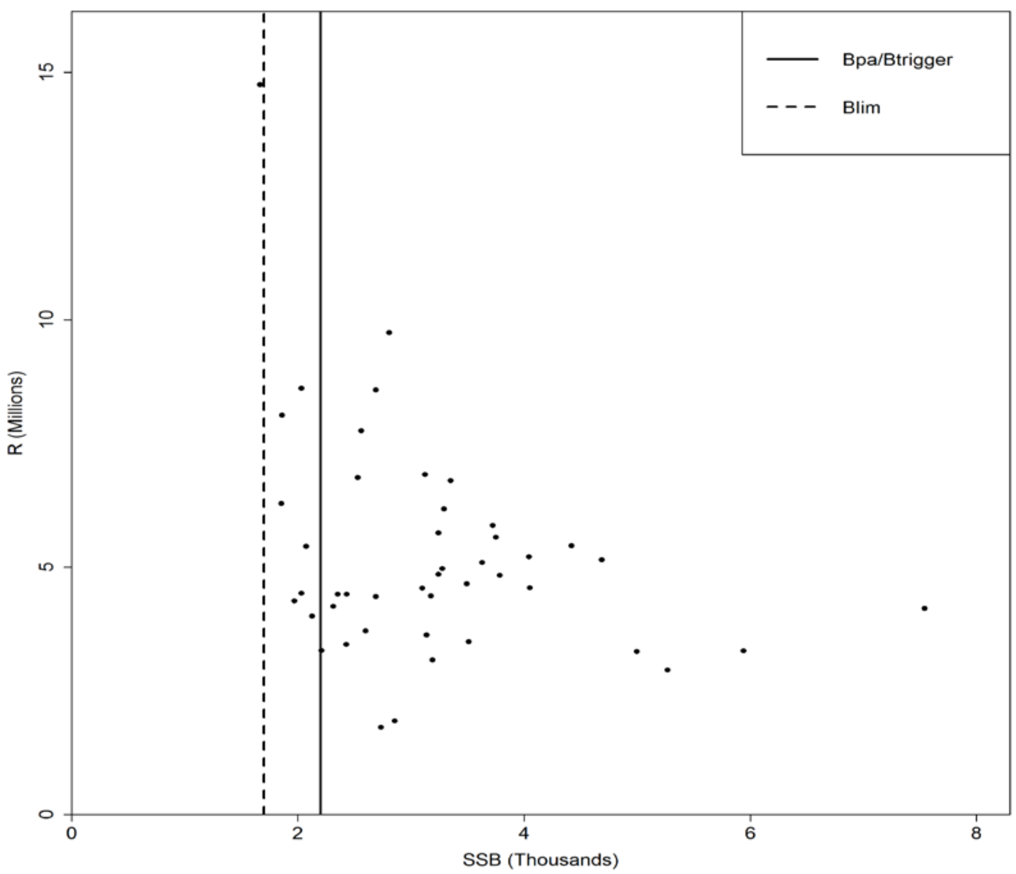


Figure 36.17 - Sol.27.7fg - Stock/recruitment plot



37 Sole in the Southwest of Ireland (ICES Divisions 7.h–k)

Type of assessment in 2017

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 2016

Based on ICES approach to data-limited stocks, ICES advises that catches should be no more than 205 t in 2016. All catches are assumed to be landed.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/sol-7h-k.pdf

ICES advice applicable to 2017

ICES advises that when the precautionary approach is applied, catches in 2017 should be no more than 223 tonnes.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/sol-7h-k.pdf

37.1 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 37.1). 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, because no age-disaggregated data are available for 7.h, the assessment is performed for 7.jk only.

Management applicable to 2016 and 2017

TAC table 2016

Species:	Common sole *Solea solea*	Zone:	VIIh, VIIj and VIIk (SOL/7HJK.)
Belgium	32		
France	64		
Ireland	171		
The Netherlands	51		
United Kingdom	64		
Union	382		
TAC	382		Analytical TAC Article 12(1) of this Regulation applies

TAC table 2017

Species:	Plaice *Pleuronectes platessa*	Zone:	VIIh, VIIj and VIIk (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(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 delegate regulation (EC, 2015) vessels where more than 5% of their landings using beam trawls were sole during the reference years (2013 & 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 for 2017.

37.2 Data

Landings and discards

The nominal landings are given in Table 37.1. 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 37.2 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. In 2014 less than 1% of the catch was discarded and in 2015 there were no observation of sole discards on three observer trips (Figure 37.2).

Landings numbers-at-age

Landings numbers-at-age are given in Table 37.2 and Figure 37.3. Figure 37.4 shows a bubble plot 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 37.5 gives the stock weights (which are the same as the landings weights).

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

Surveys and commercial tuning fleets

There is currently no survey index available for this stock (the Irish IBTS Q4 Groundfish Survey data are too noisy to be used). A commercial tuning index is available which use 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 37.6). Next the effort and landings of the OTB vessels inside the sole area was 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 (which is not the case further offshore).

The age composition of the Irish OTB fleet in 7.j was used for the tuning fleet (Table 37.4). Figure 37.7 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. Figure 37.8 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. With only two years of data this would not currently form a valid index for this fishery.

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.

37.3 Historical stock assessment development

Target category: 3.2.0.

Model used: XSA.

Software used: Lowestoft vpa95.exe and FLR with R version 3.3.2 and packages FLCore 2.6.0; FLEDA 2.5 and FLAssess 2.5.0.

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 catch numbers for ages 2–10+ for the years 1993–2016. The tuning fleet included ages 3–9 for the years 2006–2016.

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 37.5. Figure 37.9 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.

State of the stock

The summary table with a time-series of landings, recruitment, SSB and F is given in Table 37.6 and Figure 37.10. Recruitment is variable without a clear trend. The SSB has declined from nearly 800 tonnes 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 a slight revision upwards in 2016.

37.4 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, 2016 d) 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 following WKMSYREF4 guidelines is presented here. Details on this evaluation can be found in the working document in appendix xxx. 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 37.12 and 37.13 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).

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	$B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.20$	ICES (2017)
	F_{lim}	0.222	F with 50% probability of SSB< B_{lim}	ICES (2017)
	F_{pa}	0.161	$F_{lim} \times \exp(-1.645 \times \sigma)$; $\sigma = 0.20$	ICES (2017)
Management plan	SSB_{mgt}			
	F_{mgt}			

37.5 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 are 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.

37.6 Recommendations for the next benchmark

WGCSE recommend that this stock is upgraded to a Category 2 stock (ICES, 2012) where the previous advice is increased or decrease based on the results of the assessment and forecast for 7.j carried out by WGCSE. The reference points could be defined according to the procedures set out in WKMSYREF4 as is shown in Section 37.4. ACOM would need to decide if this requires a benchmark or whether an intersessional review of WGCSE's analysis is sufficient.

37.7 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 northeastern 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.

37.8 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 FMSY 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), 1993–2016, 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
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	0	0	61	0	10	94	2	0	0	0	223	106	329	339

Table 37.2. 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	34.6	121.2	147.1	126.4	45.2	52.0	20.3	18.7	12.9	1.2	7.1	0.8	0.0	0.8	12.2
2000	36.7	89.0	77.2	38.9	26.9	14.7	19.5	10.0	15.4	7.3	2.8	0.0	1.6	0.0	3.2
2001	61.7	109.5	50.2	46.9	36.0	21.4	20.8	13.7	8.8	3.5	1.9	5.0	2.8	1.6	3.2
2002	8.6	94.2	124.1	44.4	25.6	26.2	10.1	5.6	16.3	5.2	13.9	3.5	3.7	2.2	14.9
2003	1.4	36.5	63.0	87.0	51.8	30.6	12.5	2.7	3.7	6.1	9.3	0.0	1.8	0.6	3.6
2004	6.9	18.0	90.1	46.7	35.5	18.3	13.3	5.7	7.8	1.2	6.8	1.2	4.4	3.4	12.0
2005	9.4	34.1	47.4	64.9	17.2	38.4	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
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	24.9	66.7	47.4	33.6	33.5	13.8	8.6	8.6	7.8	7.1	4.5	2.3	1.0	8.6
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	8.8	30.6	69.9	60.9	32.2	17.9	14.2	7.5	4.0	4.4	2.6	2.2	2.4	3.5
2014	1.5	21.5	28.5	38.2	64.2	53.7	21.7	12.1	8.7	4.0	2.9	2.6	1.6	2.1	2.9
2015	2.1	28.7	50.0	27.0	32.2	41.2	31.1	16.9	7.9	7.2	3.4	2.6	1.6	1.7	3.1
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

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
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

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	2015															
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

Table 7.14.5. XSA diagnostics.

```
x
FLR XSA Diagnostics 2017-05-25 15:58:17

CPUE data from indices

Catch data for 24 years 1993 to 2016. 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      2016  <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   2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
   year
age   2007  2008  2009  2010  2011  2012  2013  2014  2015  2016
  2  0.003 0.003 0.000 0.007 0.002 0.002 0.000 0.002 0.003 0.002
  3  0.085 0.068 0.036 0.073 0.042 0.031 0.028 0.034 0.039 0.037
```

4 0.170 0.222 0.129 0.144 0.123 0.095 0.098 0.106 0.093 0.094
5 0.242 0.280 0.268 0.241 0.179 0.166 0.175 0.152 0.124 0.156
6 0.353 0.243 0.305 0.235 0.208 0.167 0.189 0.215 0.167 0.225
7 0.288 0.241 0.274 0.189 0.233 0.269 0.214 0.226 0.187 0.209
8 0.308 0.245 0.283 0.200 0.263 0.259 0.219 0.196 0.177 0.177
9 0.310 0.229 0.218 0.221 0.273 0.269 0.193 0.202 0.206 0.174
10 0.310 0.229 0.218 0.221 0.273 0.269 0.193 0.202 0.206 0.174

XSA population number (Thousand)
age
year 2 3 4 5 6 7 8 9 10
2007 436 569 240 147 157 178 81 63 108
2008 492 394 473 184 105 100 121 54 133
2009 798 444 333 343 126 74 71 85 123
2010 715 722 387 265 237 84 51 48 173
2011 437 643 607 303 188 170 63 38 175
2012 375 394 558 486 229 138 122 44 189
2013 751 339 346 459 372 176 96 85 159
2014 883 679 298 284 349 279 128 69 142
2015 656 798 594 243 221 254 201 95 155
2016 3009 591 695 490 194 169 191 152 246

Estimated population abundance at 1st Jan 2017
age
year 2 3 4 5 6 7 8 9 10
2017 0 2717 516 572 379 140 124 145 116

Fleet: IRL-VMS: nos per 1000 hours

Log catchability residuals.

year
age 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
2016
3 0.678 0.430 0.428 -0.320 0.240 -0.258 -0.636 -0.419 -0.265 0.128 -
0.006
4 0.179 0.149 0.634 -0.010 -0.055 -0.150 -0.485 -0.139 -0.103 0.031 -
0.050
5 -0.347 0.105 0.465 0.317 0.059 -0.168 -0.325 0.042 -0.136 -0.073
0.061
6 -0.331 0.324 0.166 0.288 -0.125 -0.180 -0.479 -0.037 0.048 0.058
0.266
7 -0.328 0.092 0.132 0.154 -0.370 -0.094 -0.032 0.060 0.074 0.146
0.166

8 -0.211 0.162 0.149 0.184 -0.317 0.030 -0.071 0.084 -0.074 0.097
0.001
9 -0.009 0.167 0.083 -0.080 -0.218 0.061 -0.028 -0.043 -0.043 0.243 -
0.018

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	-0.3002	0.6742	1.0727	1.2310	1.2582	1.2582	1.2582
S.E_Logq	0.2444	0.2444	0.2444	0.2444	0.2444	0.2444	0.2444

Terminal year survivor and F summaries:

,Age 2 Year class =2014

source	scaledWts	survivors	yrcls
fshk	1	2717	2014

,Age 3 Year class =2013

source	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.92	513	2013
fshk	0.08	552	2013

,Age 4 Year class =2012

source	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.962	544	2012
fshk	0.038	520	2012

,Age 5 Year class =2011

source	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.966	403	2011
fshk	0.034	370	2011

,Age 6 Year class =2010

source

```
                   scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours      0.96       183  2010
fshk                        0.04       170  2010

 ,Age 7 Year class =2009

source
                   scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.979       146  2009
fshk                       0.021       114  2009

 ,Age 8 Year class =2008

source
                   scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.979       145  2008
fshk                       0.021       112  2008

 ,Age 9 Year class =2007

source
                   scaledWts survivors yrcls
IRL-VMS: nos per 1000 hours     0.979       114  2007
fshk                       0.021       117  2007
```

Table 37.6. Summary table for sol 7.jk. Catch/landings in tonnes (7.jk only). Recruitment (age 3) in thousands. SSB in tonnes.

year	catch	recruit	fbar	ssb
1993	246	897	0.369	679
1994	178	546	0.224	775
1995	241	889	0.41	649
1996	166	378	0.266	625
1997	191	570	0.345	605
1998	219	530	0.41	561
1999	200	465	0.589	425
2000	109	437	0.314	367
2001	127	623	0.26	391
2002	144	418	0.26	501
2003	102	545	0.272	388
2004	85	321	0.198	421
2005	77	250	0.182	362
2006	61	296	0.156	343
2007	83	569	0.212	377
2008	77	394	0.203	388
2009	69	444	0.184	384
2010	82	722	0.174	473
2011	87	643	0.138	530
2012	94	394	0.115	600
2013	91	339	0.122	615
2014	87	679	0.127	578
2015	78	798	0.106	601
2016	106	591	0.128	846

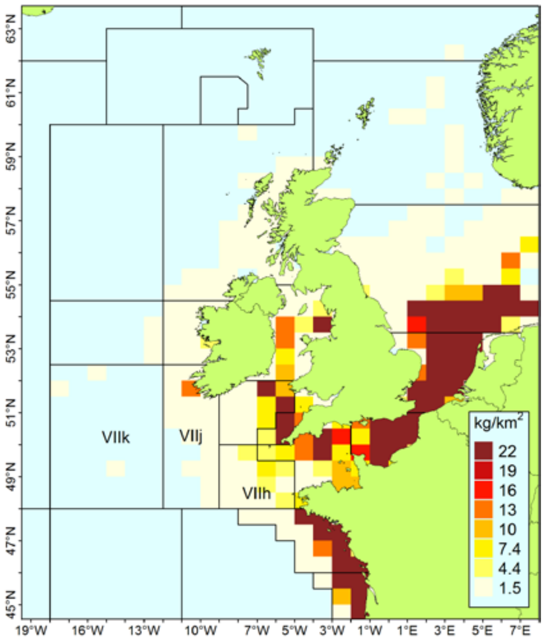


Figure 37.1. The spatial distribution of International landings of sole (2012 data, all gears combined; data from STECF).

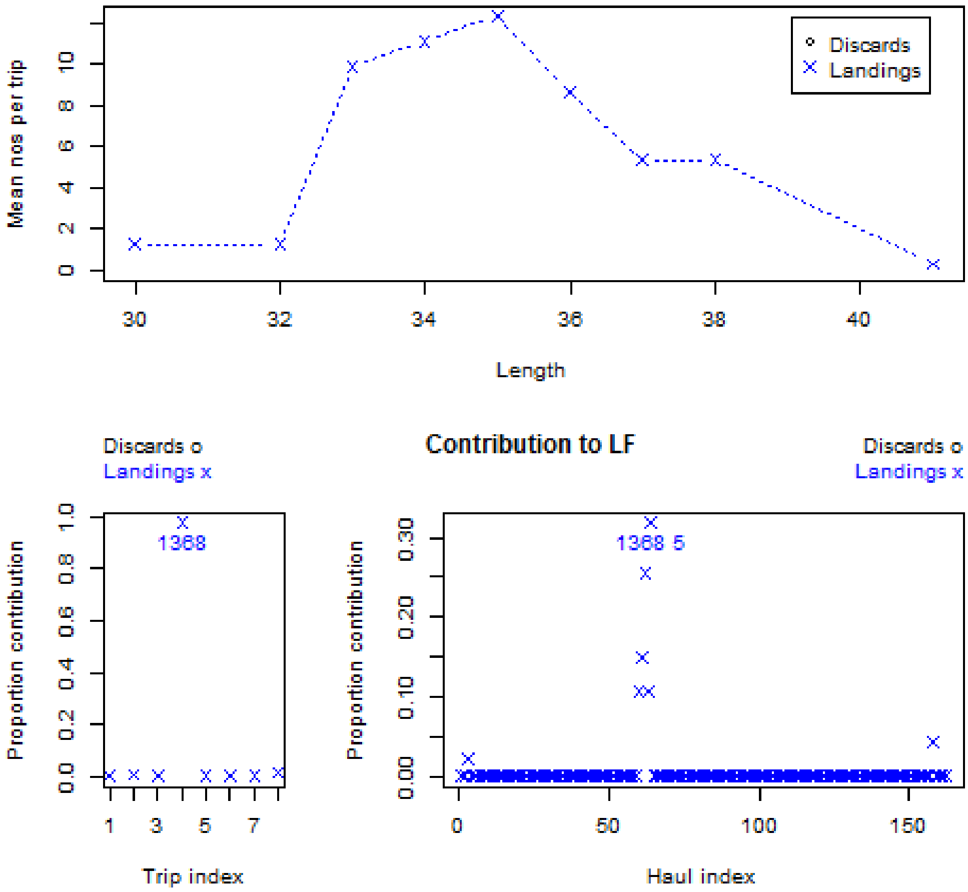


Figure 37.2. Irish OTB retained catches on observer trips in 7.j during 2016. Numbers raised to fleet level using fishing effort (hours fished). No discards observed during 2015.

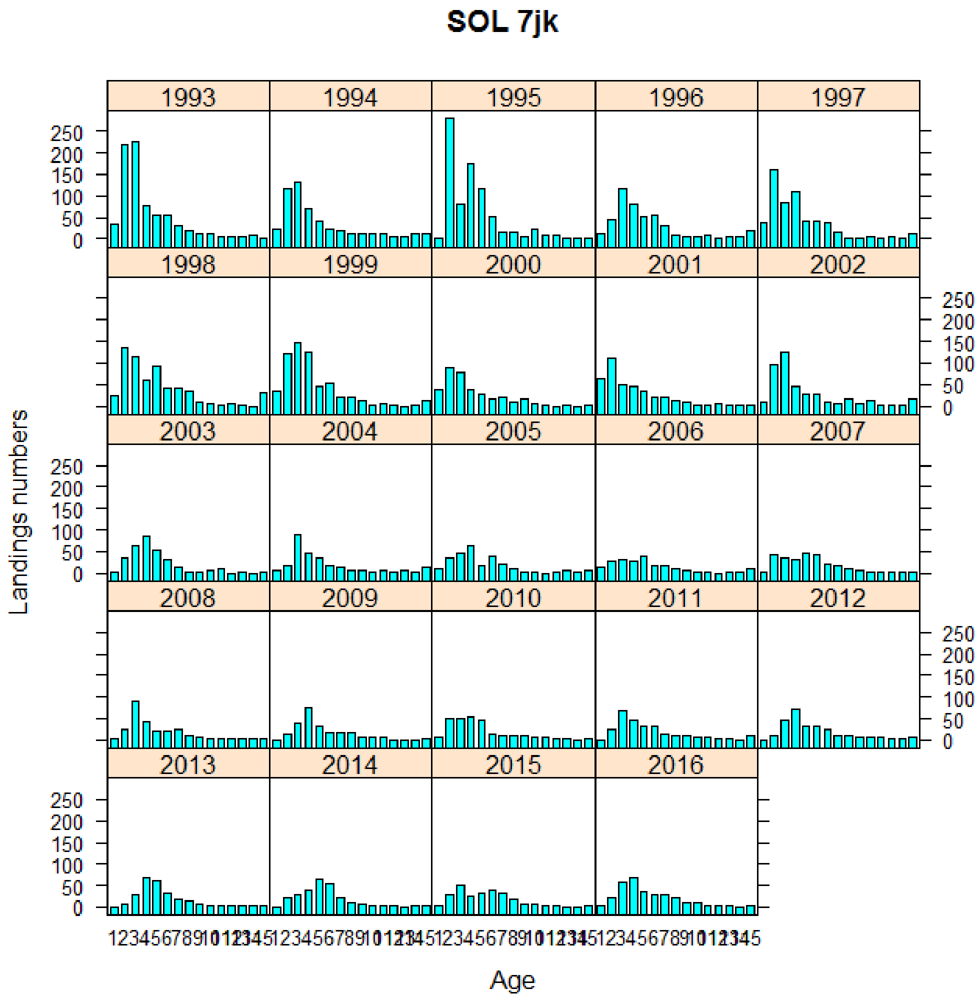


Figure 7.14.3. Age distribution of sole in 7.jk between 1993 and 2015. All gears and quarters combined.

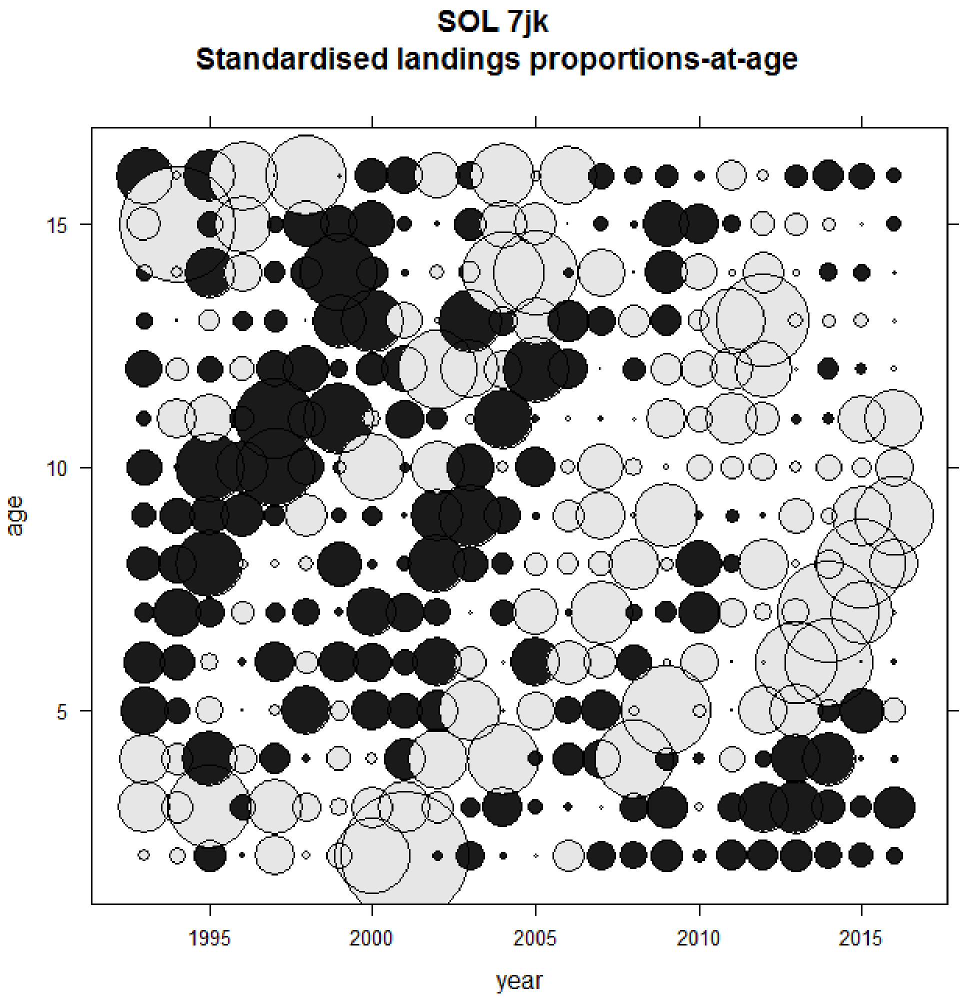


Figure 37.4. Standardised catch proportions-at-age for sole in 7.jk. Grey bubbles represent higher than average catch-at-age and black bubbles represent lower than average catch-at-age.

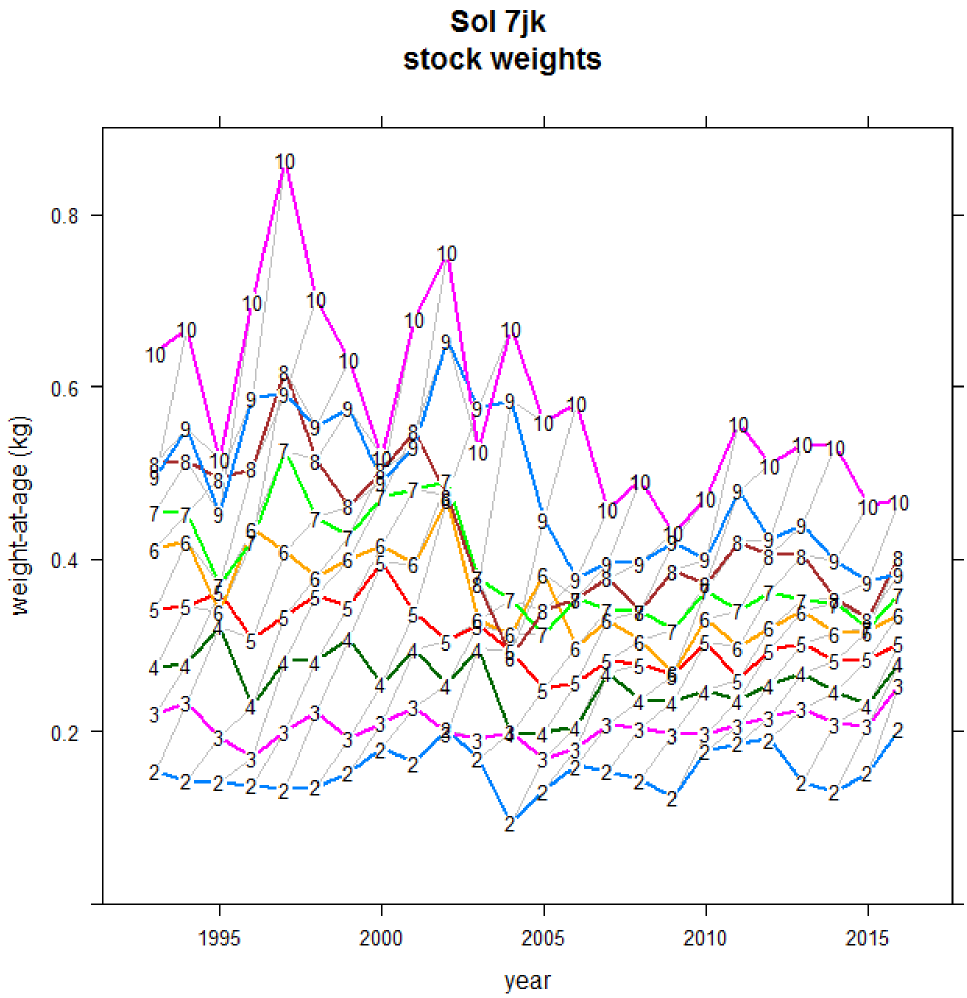


Figure 37.5. Catch weights/stock weights of sol7.jk.

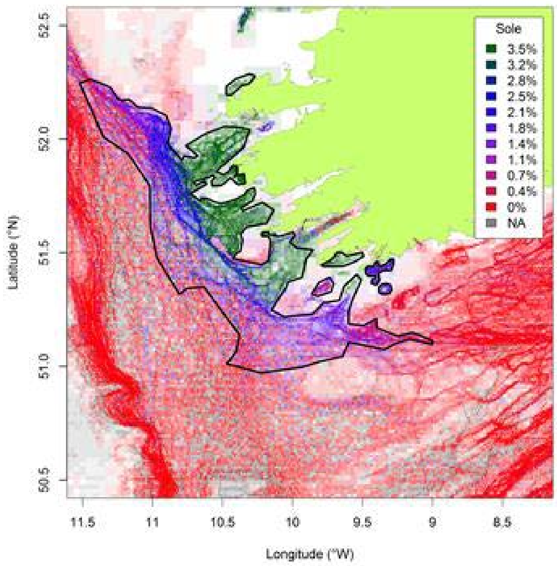


Figure 37.6. Top: the proportion of sole in landings of Irish vessels with VMS over the years 2006–2014. The black line indicates the polygon inside which sole are caught. Effort and landings from the VMS/logbooks data inside the polygon were used as a tuning index. Bottom: the VMS lpue index (black line) and the lpue of sole in the whole of 7.j.

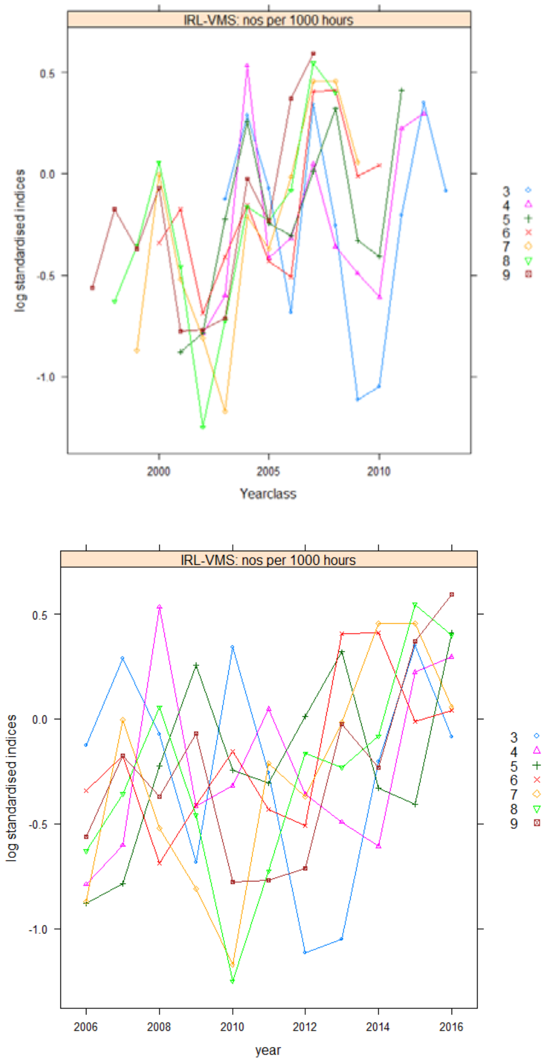


Figure 37.7. The log-standardised tuning index by year (top) and cohort (bottom). The cohorts are tracked quite well and no year effects are obvious.

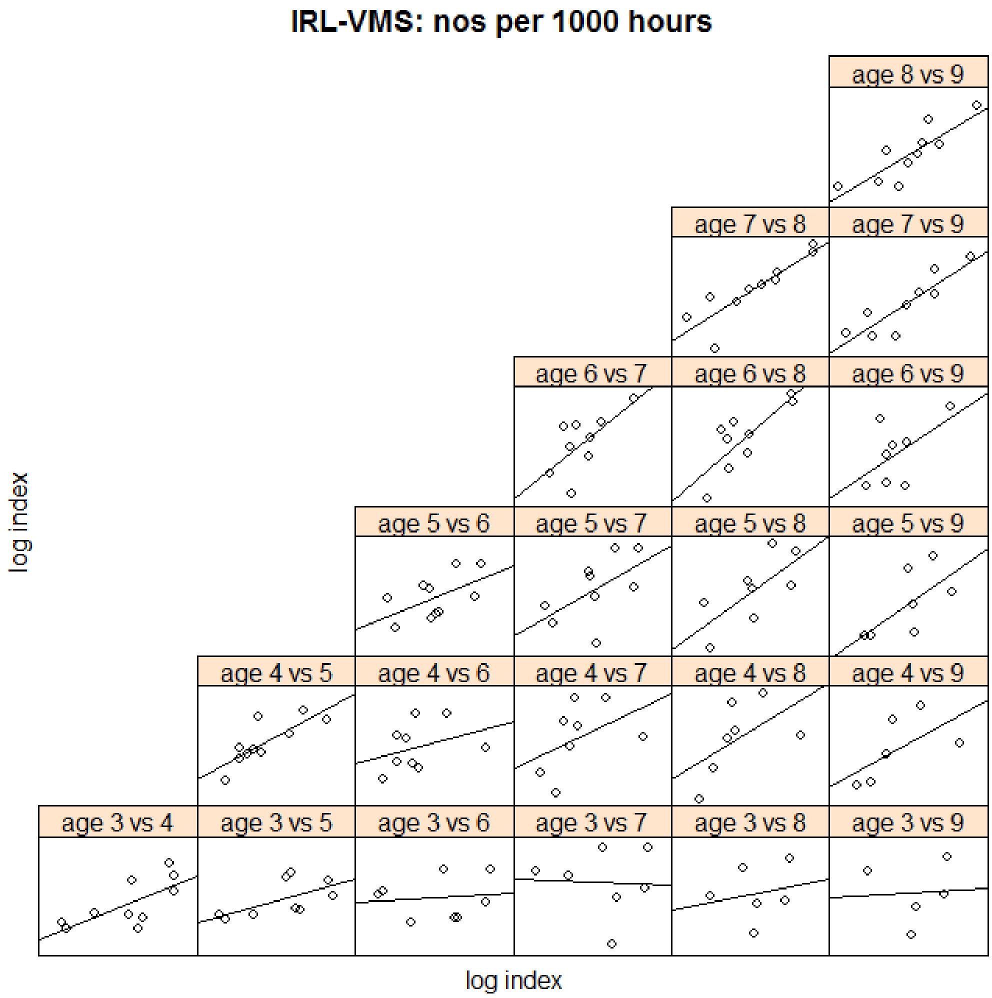


Figure 37.8. Internal consistency of the tuning fleet.

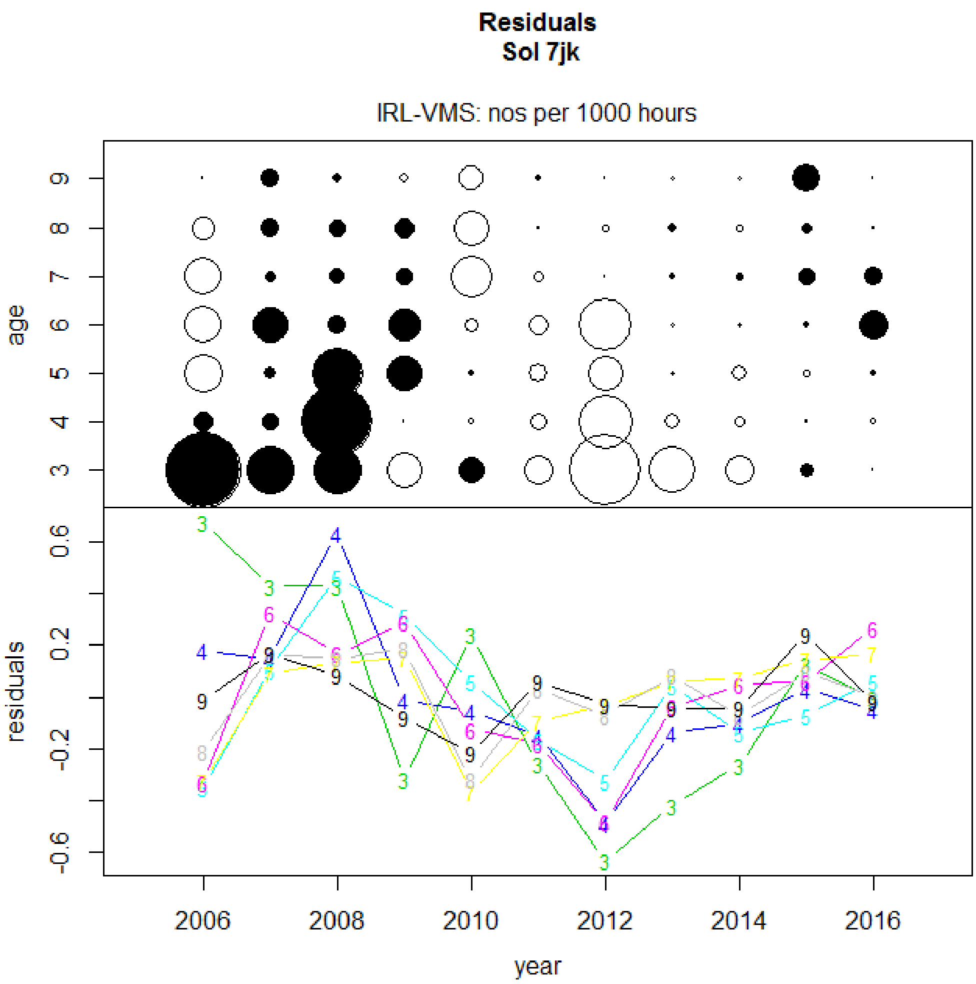


Figure 37.9. Residuals of the index fit.

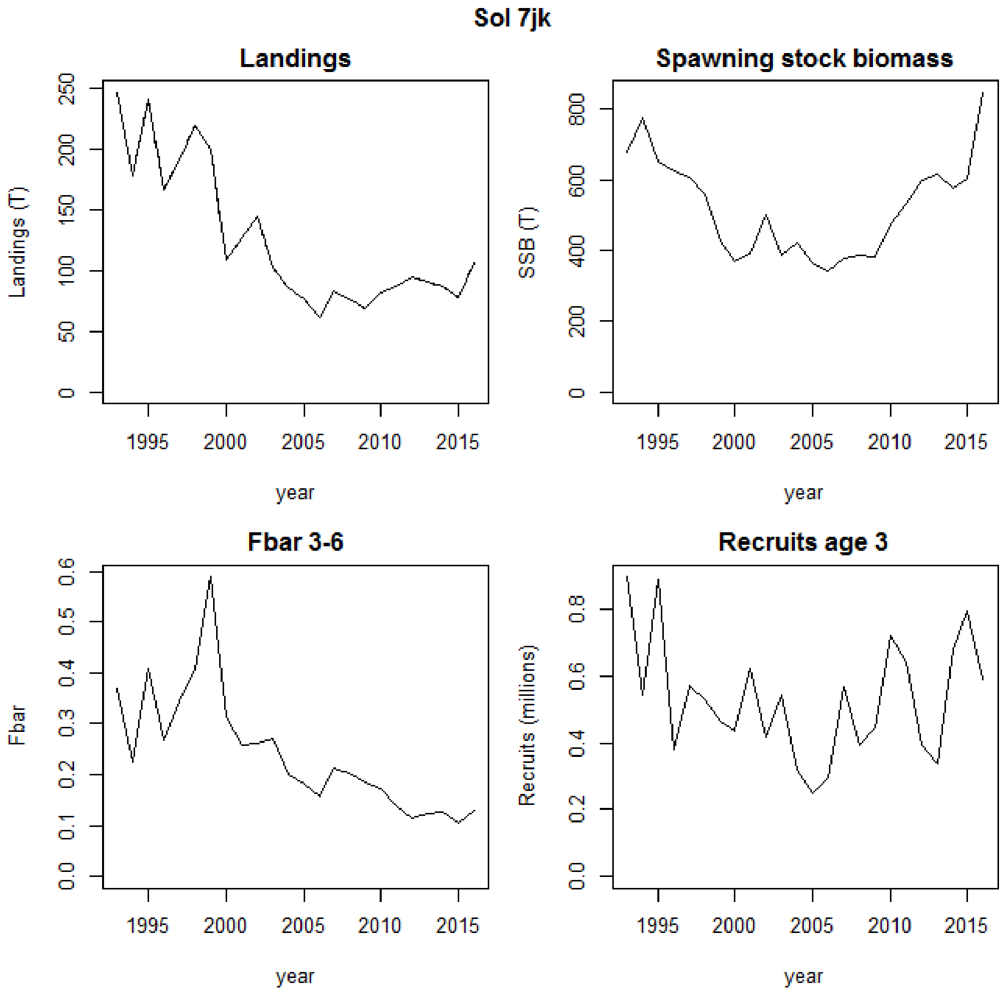


Figure 37.10. Stock summary plot.

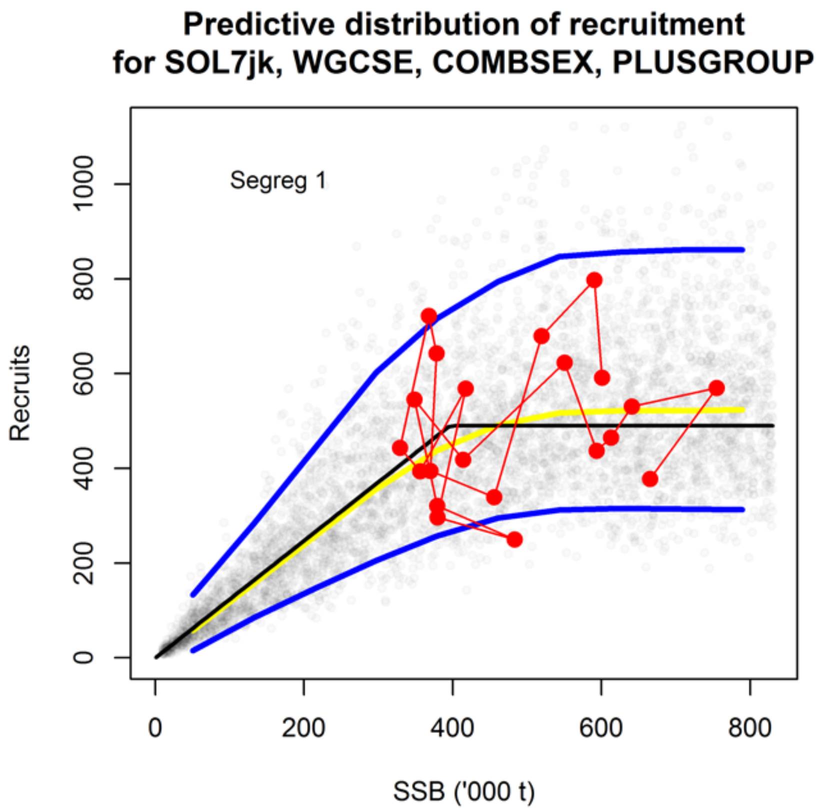


Figure 37.11. Sole 7jk stock–recruit plot. Because recruitment does not appear to be impaired at the lowest stock size, the inflection point of the segmented regression was chosen to be B_{loss}.

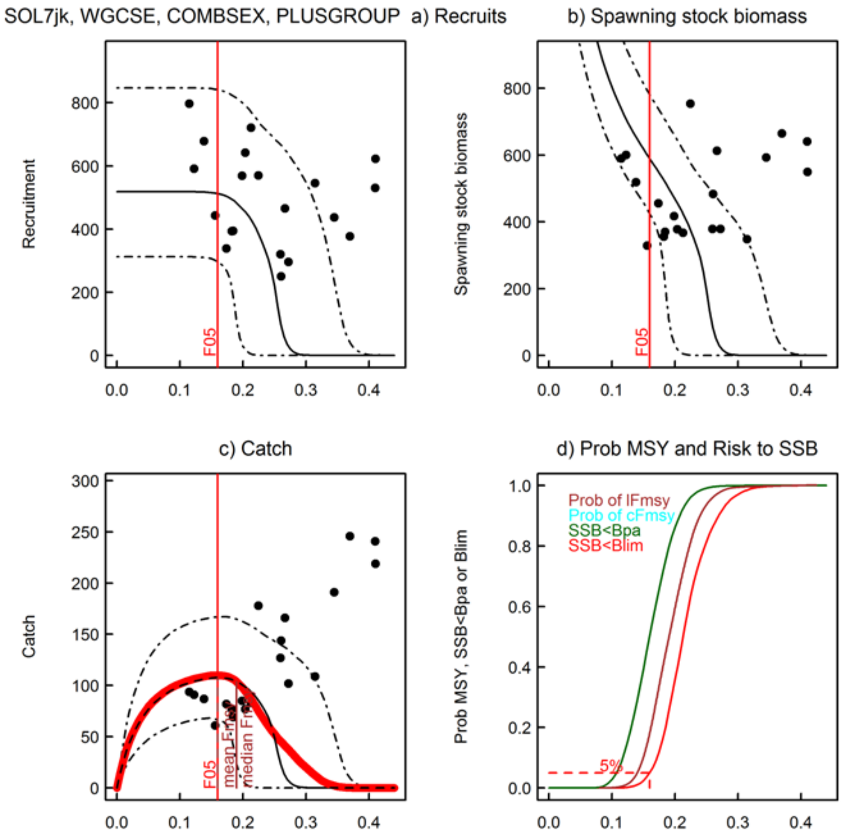


Figure 37.12. Sole 7.jk Summary of MSY evaluations (without $B_{trigger}$ harvest control rule), a) simulated andMarine2018 observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}.

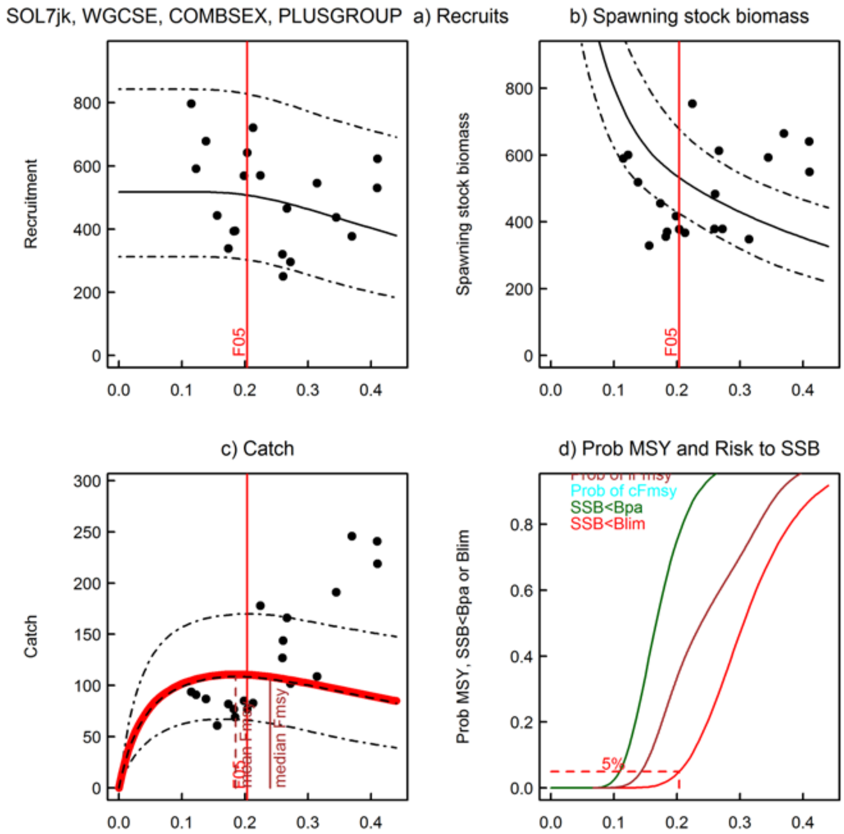


Figure 37.13. Sole 7.jk Summary of MSY evaluations (with $B_{trigger}$=B_{loss} harvest control rule), a) simulated and observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}.

37.9 Audit of sole in divisions 7. h-k

38 Whiting in Division 27.6.a

Type of assessment in 2017

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 2016

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

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/whg-scow.pdf

ICES advice applicable to 2017

ICES does not issue any advice in 2017. The recommendations made in 2016 hold in 2017. The next advice for this stock is scheduled for May 2018.

38.1 General

Stock description

General information is now located in the Stock Annex.

Management applicable to 2016 and 2017

The TAC for whiting (in tonnes) is set for ICES subareas 6, 12 and 14 and EU and international waters of ICES Division 27.5b, for 2016–2017 is shown below (unchanged for 2017):

TAC for 2016

Species:	Whiting *Merlangius merlangus*	**Zone:**	VI; Union and international waters of Vb; international waters of XII and XIV (WHG/56-14)
Germany	1		
France	26		
Ireland	64		
United Kingdom	122		
Union	213		
TAC	213		Analytical TAC

(Council Regulation (EU) 2016/72).

TAC for 2017

Species:	Whiting *Merlangius merlangus*	Zone:	VI; Union and international waters of Vb; international waters of XII and XIV (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) 2017/127).

The minimum landing size for whiting in Division 27.6.a is 27 cm.

Fishery in 2016

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. However, the recent low TACs combined with increased interest in bigger whiting (driven by good prices) has resulted in an increasing uptake of the whiting quota.

Total landings (nominal landings, ICES statistics) in 2016 were 232 t, up by 5% from 2015 (Table 38.1). These are the fifth lowest recorded landings in the time-series. The majority were landed by Scottish, Irish and Dutch vessels, and a smaller amount by French vessels. The UK landings in Division 27.6.a in 2016 constituted 81% of the UK quota, while Ireland exceeded its quota by 21%. Total landings in 2016 exceeded TAC for that year by 9%.

The total estimated international catch of ages 1 and older in 2016 was 1029 t of which 796 t were discards (Table 38.2). An additional 160 t were discarded as the 0-group. Of the discards, 57% 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 27.6.a in 2016. In terms of quantity, the discards in 2016 (ages 1 and older) were almost as high as those in 2015, and still above the average in the last decade. In terms of discard rate (discards as a proportion of catch), they were still high (the 4th highest in the time-series).

The general perception from fishermen is that large number of whiting are being discarded in the *Nephrops* fleet that the numbers of smaller whiting has exploded recently but mainly in inshore areas.

38.2 Data

Landings

Total landings, as officially reported to ICES in 1965–2016, 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) and 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 may mean 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. These 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. As in previous meetings, 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 27.6.a were available to the WG. In all surveys listed, the highest age represents a true age not a plus group.

- Scottish first-quarter west coast groundfish survey (ScoGFS-WIBTS-Q1): ages 1–7, years 1985–2010
- Scottish fourth-quarter west coast groundfish survey (ScoGFS-WIBTS-Q4): ages 0–7, 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 and as such 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 (UKSGFS-WIBTS-Q1): ages 1–7, years 2011–2017
- Scottish fourth-quarter west coast groundfish survey (UKSGFS-WIBTS-Q4): ages 0–7, year 2011–2016

(see the distribution of whiting cpue at age in the Q1 and Q4 surveys in 2014–2017, Figure 38.4). The Q4 survey in 2013 (not shown in Figure 38.4) was not complete due to adverse weather conditions; it covered only the northern half of Division 27.6.a and is therefore not used in the assessment. The Q1 survey in 2017 has recently been completed and processed. As a result, seven years of data are currently available in the time-series for the Q1 survey and five years of data for the Q4 survey (as valid indices). These data were made available this year's assessment.

The Irish groundfish survey:

- Irish fourth-quarter west coast groundfish survey (IGFS-WIBTS-Q4): ages 0–6, years 2003–2016

(see the distribution of whiting at age in the two Q4 surveys, UKSGFS-WIBTS-Q4, only the southern part, and IGFS-WIBTS-Q4, in 2013–2016, 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 survey was considered long enough to be used in the assessment of whiting in Division 27.6.a, giving useful additional indications of year-class strength.

Further descriptions of the above five surveys can be found in the last IBTSWG report (ICES, 2016a).

IBPWSRound 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 UKSGFS-WIBTS-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 although did not rule out revisiting this issue when a longer time-series of Scottish data became available. Ultimately, five survey time-series were used in the last year and present assessment.

The survey indices for the five surveys are shown in Table 38.9 with data used in the final assessment 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 (unchanged since 2011) 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 (UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-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.

38.3 Historical stock development

The final assessment of whiting in 27.6.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 1981–2015 (1995–2005 age structure only used),
- Discards, ages 1–7+, years 1981–2015 (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 2008–2016
- UKSGFS-WIBTS-Q1: ages 1–6, years 2011–2017
- UKSGFS-WIBTS-Q4: ages 1–6, years 2011–2012 and 2014–2016

The assessment of whiting in 27.6.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 UKSGFS-WIBTS-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), prediction errors 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 last year's assessment, greater care was taken to ensure that the model parameters were accurately chosen, which consequently improved the model's performance. This 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 last year.

IBPWSRound attempted TSA runs with and without a survey catchability trend 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 to the 2016 and present assessment.

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 their 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. No such increase could be seen in the new Scottish surveys.

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. 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 2016 = 0.052

SSB in 2017 = 17 023 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 and SSB) with the last year's assessment:

$F_{(2\text{-}4)}$ in 2015 = 0.057 (the present assessment: in 2015, 0.067)

SSB in 2016 = 16 247 t (the present assessment: in 2016, 15 907 t)

State of the stock

The spawning–stock biomass (SSB) has been increasing since 2006 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 very low. Recruitment is estimated to have been very low since 2002 but estimated to have increased in recent years.

38.4 Short-term projections

No short-term projection was conducted this year as the forecast for this stock is updated biennially starting from the last year. The next forecast is scheduled in 2018.

The last short-term projection followed the procedure outlined in the Stock Annex.

38.5 MSY explorations

The reference points for this stock were not updated in this assessment.

Last year, MSY reference points and ranges were calculated for the stock using the same procedure as that agreed at WKMSYREF4 (ICES, 2016b). The details of the analysis and the results are presented in Working Document 7 (ICES, 2016c).

38.6 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 stock–recruit function.
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 with B_{lim} as the breakpoint
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 F_{MSY}	36 600		

38.7 Management plans

There are no specific management objectives or a management plan for this stock, but a plan is under development.

38.8 Uncertainties and bias in the assessment and forecast

The most significant problem with assessment of this stock is with 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 for omission in the catch data during this period (1995–2005 uses only age structure data from the catch), which is why it was used here as 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 27.6.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 last year's 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 2008 onwards.

38.9 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 27.6.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 the abundance index between the two Q4 surveys, IGFS-WIBTS-Q4 and UKSGFS-WIBTS-Q4, should further be explored. With more years of data available (an additional 1–2 years), the analysis of catchability in the two surveys could be revisited 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 plots).

38.10 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 (2009, 2011, 2013 and 2014).

Whiting are caught in mixed fisheries with cod and haddock in Division 27.6.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 27.6.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.

38.11 References

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Table 38.1. Whiting in Division 27.6.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	1,315	977	1,200	1,377	1,192	1,213	1,448	1,182	977	952	1,121	793	764	577	568	356	172	196	56	69
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	1	-	1	2	+	-	2	-	-	-	-	-	-	-
UK (E, W & NI)	44	50	218	196	184	233	204	237	453	251	210	104	71	73	35	13	5	2	1	-
UK (Scot.)	6,109	4,819	5,135	4,330	5,224	4,149	4,263	5,021	4,638	3,369	3,046	2,258	1,654	1,064	751	444	103	178	424	-
UK (total)																				370
Total landings	7,669	6,026	6,908	6,010	6,751	5,786	6,278	6,642	6,178	4,657	4,677	3,203	2,543	1,735	1,365	819	289	383	488	441

Table 38.1. (continued).

Country	2009	2010	2011	2012	2013	2014	2015	2016*
Belgium	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-
Faroe Islands	-	+	1	1	-	-	-	-
France	1	3	+	+	1	1	+	5
Germany	-	-	-	-	-	-	-	-
Ireland	125	99	149	96	97	97	88	77
Netherlands	-	-	-	-	-	-	11	52
Norway	2	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-
UK (E, W & NI)	-	-	-	-	-	-	-	-
UK (Scot.)	-	-	-	-	-	-	-	-
UK (total)	354	247	80	204	116	83	122	98
Total landings	482	349	230	301	214	181	221	232

*** Preliminary.**

+ <0.5 t.

Table 38.2. Whiting in Division 27.6.a. Landings, discards and catch estimates 1978–2016, as used by the WG. Values are totals for fish over the ages 1 to 7+. Discard and catch values are revised 1978–2003 compared to previous assessments because of a revised method for raising discards.

Year	Weight (tonnes)			Numbers (thousands)		
	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
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

Table 38.2. (continued).

Year	Weight (tonnes)			Numbers (thousands)		
	Total	Human consumption	Discards	Total	Human consumption	Discards
2015	1060	227	833	9336	479	8857
2016	1029	233	796	7102	433	6669
Min	569	184	174	3085	408	1853
GM	5510	2552	2418	33928	7738	21260
AM	9728	5843	3885	52291	19949	32342
Max	23462	17081	13285	176734	61393	166616

Table 38.3. Whiting in Division 27.6a. 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
1992	2695	9440	4473	4782	396	373	106
1993	1051	10179	6293	2673	2738	163	147
1994	909	4889	9158	3607	712	715	69

	Age						
Year	1	2	3	4	5	6	7+
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

Table 38.3. (continued).

	Age						
Year	1	2	3	4	5	6	7+
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

Table 38.4. Whiting in Division 27.6.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
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

Table 38.4. (continued).

	Age						
Year	1	2	3	4	5	6	7+
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

Table 38.5. Whiting in Division 27.6.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

	Age						
YEAR	1	2	3	4	5	6	7+
1991	26505	16366	17401	1474	1627	342	51
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

Table 38.5. (continued).

	Age						
Year	1	2	3	4	5	6	7+
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

Table 38.6. Whiting in Division 27.6.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
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

Table 38.6. (continued).

	Age						
Year	1	2	3	4	5	6	7+
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

Table 38.7. Whiting in Division 27.6.a. Discard 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	0
1979	0.173	0.188	0.208	0.215	0.281	0	0
1980	0.14	0.179	0.208	0.22	0.271	0.386	0
1981	0.108	0.16	0.195	0.298	0.286	0.295	0
1982	0.096	0.18	0.209	0.243	0.283	0.44	0
1983	0.141	0.186	0.228	0.237	0.267	0.267	0
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	0	0
1988	0.076	0.143	0.203	0.227	0.262	0	0
1989	0.099	0.177	0.205	0.209	0.294	0.305	0
1990	0.124	0.171	0.214	0.219	0.237	0.264	0

	Age						
YEAR	1	2	3	4	5	6	7+
1991	0.085	0.169	0.205	0.223	0.226	0.281	0
1992	0.109	0.173	0.219	0.227	0	0	0
1993	0.118	0.197	0.225	0.242	0.256	0	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	0
2000	0.075	0.164	0.203	0.233	0.282	0.25	0
2001	0.094	0.154	0.196	0.203	0.381	0	0
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

Table 38.7. (continued).

	Age						
Year	1	2	3	4	5	6	7+
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	0
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	0	0
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	0
2016	0.073	0.216	0.282	0.292	0.310	0.261	0.384

Table 38.8. Whiting in Division 27.6.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
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

Table 38.8. Whiting in Division 27.6.a. Total catch weight-at-age (kg).

	Age						
Year	1	2	3	4	5	6	7+
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

Table 38.9. Whiting in Division 27.6.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 new design and ground gear.

ScoGFS-WIBTS-Q1: Scottish Groundfish Survey - Effort in hours - Numbers at age								
	Effort	Age						
Year	(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

ScoGFS-WIBTS-Q4: Scottish Groundfish Survey - Effort in hours - Numbers at age									
	Effort	Age							
Year	(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

Table 38.9. (continued).

IRGFS-WIBTS-Q4: Irish groundfish survey - Effort in minutes - Numbers at age								
	Effort	Age						
Year	(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

UKSGFS-WIBTS-Q1: Scottish Groundfish Survey - Effort in hours - Numbers at age								
	Effort	Age						
Year	(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

UKSGFS-WIBTS-Q4: Scottish Groundfish Survey - Effort in hours - Numbers at age									
	Effort	Age							
Year	(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

Table 38.10. Whiting in Division 27.6.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 1 in 1987, age 3 in 1991, age 1 in 2000, age 1 in 2013 Surveys: *ScoGFS-WIBTS-Q1* cvmult = 3 for age 5 in 1992, age 2 in 1993, age 1 in 2000, age 2 in 2000 cvmult = 5 for age 4 in 1992 *ScoGFS-WIBTS-Q4* cvmult = 3 for age 4 in 2007, 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 27.6.a. TSA parameter estimates for final assessment presented this year.

Parameter	Notation	Description	2015 WG	2016 WG	2017 WG
Initial fishing mortality	*F* (1, 1981)	Fishing mortality-at-age *a* in year *y*	0.10	0.09	0.09
	F (2, 1981)		0.12	0.11	0.11
	F (4, 1981)		0.37	0.32	0.32
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.10	0.00	0.01
	σ_U	Persistent changes in selection (age effect in F)	0.11	0.09	0.09
	σ_V	Transitory changes in the year effect in fishing mortality	0.09	0.00	0.00
	σ_Y	Persistent changes in the year effect in fishing mortality	0.30	0.27	0.28
Measurement CVs	$CV_{landings}$	CV of landings-at-age data	0.16	0.17	0.16
	$CV_{discards}$	CV of discards-at-age data	0.54	0.53	0.53
Recruitment		Hockey-stick parameter Recruitment value at change point	28.4	29.6	29.4
		Hockey-stick parameter SSB at change point	2.86	3.19	2.90
	CV_{rec}	Coefficient of variation of recruitment data	0.28	0.32	0.33
Discards	$\sigma_{logit\ p}$	Transitory trends in discarding	0.30	0.30	0.26
	$\sigma_{persistent}$	Persistent trends in discarding	0.20	0.22	0.22
Survey selectivities (ScoGFS-WIBTS-Q1)	$\Phi(1)$	Survey selectivity-at-age *a*	1.71	1.09	1.01
	$\Phi(2)$		1.80	1.12	1.05
	$\Phi(3)$		1.57	0.96	0.89
	$\Phi(4)$		1.40	0.81	0.75
	$\Phi(5)$		1.19	0.66	0.60
	$\Phi(6)$		0.91	0.58	0.53
	σ_{survey}	Standard error of survey data	0.41	0.44	0.45
	σ_η		0.10	0.10	0.10
Survey catchability standard deviations	σ_Ω	Transitory changes in survey catchability	0.06	0.18	0.22
	σ_β	Persistent changes in survey catchability	0.21	0.11	0.11

Parameter	Notation	Description	2015 WG	2016 WG	2017 WG
Survey selectivities (ScoGFS-WIBTS-Q4)	$\Phi(1)$	Survey selectivity-at-age *a*	3.63	3.23	3.15
	$\Phi(2)$		3.28	2.97	3.00
	$\Phi(3)$		2.57	2.33	2.33
	$\Phi(4)$		2.22	2.02	1.99
	$\Phi(5)$		3.15	2.70	2.67
	$\Phi(6)$		0.64	0.47	0.48
	σ_{survey}	Standard error of survey data	0.19	0.21	0.20
	σ_{η}		0.17	0.19	0.19
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	0.00	0.00	0.00
	σ_{β}	Persistent changes in survey catchability	0.16	0.15	0.14

Table 38.11. (continued)

Parameter	Notation	Description	2015 WG	2016 WG	2017 WG
Survey selectivities (IRGFS-WIBTS-Q4)	$\Phi(1)$		8.70	12.93	12.47
	$\Phi(2)$		8.31	10.99	11.60
	$\Phi(3)$		9.19	14.59	14.72
	$\Phi(4)$		7.63	10.48	10.26
	σ_{survey}	Standard error of survey data	0.27	0.28	0.27
	σ_{η}		0.40	0.51	0.47
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	0.16	0.10	0.08
	σ_{β}	Persistent changes in survey catchability	0.09	0.16	0.18
Survey selectivities (UKSGFS-WIBTS-Q1)	$\Phi(1)$		2.63	5.35	5.42
	$\Phi(2)$		2.34	6.00	6.40
	$\Phi(3)$		3.51	6.92	7.67
	$\Phi(4)$		2.50	6.07	6.32
	$\Phi(5)$		2.35	5.39	5.53
	$\Phi(6)$		2.49	6.64	6.30
	σ_{survey}	Standard error of survey data	0.43	0.43	0.36
	σ_{η}		0.23	0.11	0.16
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	0.31	0.02	0.01
	σ_{β}	Persistent changes in survey catchability	0.00	0.13	0.06

Parameter	Notation	Description	2015 WG	2016 WG	2017 WG
Survey selectivities (UKSGFS-WIBTS-Q4)	$\Phi(1)$		1.83	6.91	6.02
	$\Phi(2)$		6.88	11.10	10.36
	$\Phi(3)$		3.73	6.84	6.12
	$\Phi(4)$		4.38	8.24	7.89
	$\Phi(5)$		2.70	5.45	6.89
	$\Phi(6)$		3.61	7.95	8.09
	σ_{survey}	Standard error of survey data	0.33	0.28	0.26
	σ_{η}		0.05	0.06	0.01
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	0.00	0.01	0.13
	σ_{β}	Persistent changes in survey catchability	0.00	0.20	0.01
Misreporting		Transitory changes in misreporting	0.01	0.00	0.00
		Persistent changes in misreporting	0.19	0.18	0.16

Table 38.12. Whiting in Division 27.6.a. TSA population numbers-at-age (thousands).

	Age						
Year	1	2	3	4	5	6	7+
1981	199286	470622	85831	22394	7134	2107	907
1982	163930	79554	218417	38575	9429	3091	1333
1983	197890	63743	35579	94654	15977	4032	1926
1984	326424	72393	24228	12310	31706	5424	2088
1985	310390	115368	24418	7174	3385	9328	2229
1986	289433	111645	37585	5895	1339	646	2499
1987	405405	109638	40797	12080	1426	321	780
1988	106901	143420	37275	12460	3267	320	215
1989	325015	34852	42573	10786	2518	599	21
1990	176231	119683	10686	11544	2568	435	36
1991	245830	64206	46964	3832	3333	743	66
1992	338241	91076	23806	17180	1274	1052	245
1993	267856	127245	34886	8831	5972	457	470
1994	282810	101850	49449	12710	2718	1921	293
1995	303691	109629	41899	18800	4158	914	757
1996	195381	118044	43082	15527	5473	1199	475
1997	183810	68840	44242	14485	4040	1388	421
1998	244782	61772	23177	14108	3576	992	449
1999	181119	77645	18288	6648	3387	812	325
2000	280702	51935	20702	4450	1271	669	224
2001	115876	81827	14799	5665	847	253	180
2002	41087	32483	23868	4194	1094	155	83
2003	65060	9632	10837	7822	1117	304	67
2004	40280	16510	2913	3561	1847	276	94
2005	21810	9896	4800	836	861	414	87
2006	27266	7175	3806	1743	263	263	165
2007	14178	8959	2839	1473	579	90	149
2008	16126	4240	3725	1186	512	214	90
2009	24774	5013	1578	1530	382	163	102
2010	59876	8526	2037	622	555	138	96
2011	18600	20461	3809	903	234	227	94
2012	38328	7073	9570	1880	430	111	157
2013	19751	14392	3406	4722	918	216	138
2014	48210	7655	7025	1747	2410	485	191
2015	101689	19143	3818	3661	929	1317	377
2016	70431	41323	9563	1995	1966	513	954
2017*	138913	29185	20870	5063	1094	1109	849
2018*	181667	57377	14716	11020	2768	615	1127
GM(81−16)	104527	38752	15141	5707	1860	583	260

*** Estimates for 2017 and 2018 are TSA projections.**

Table 38.13. Whiting in Division 27.6.a. Standard errors on TSA population numbers-at-age (thousands).

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	19420	33253	7258	1919	708	252	217
1982	17182	7871	16079	3586	908	346	166
1983	18922	6886	3842	7838	1700	460	223
1984	26137	7084	3124	1640	3236	784	292
1985	23449	9321	2979	1148	618	1409	444
1986	21118	8783	3951	1070	430	268	791
1987	33364	8296	3929	1606	438	192	448
1988	11021	12312	3206	1427	604	174	225
1989	21607	3845	4437	1236	554	250	131
1990	18304	8236	1301	1707	501	244	143
1991	22963	6935	3349	516	722	236	159
1992	28486	8804	2690	1365	211	315	153
1993	23414	10997	3543	1080	591	89	171
1994	25775	9461	4836	1601	464	294	102
1995	24382	10795	4470	2373	733	221	182
1996	20128	10095	4808	1969	948	323	170
1997	22993	7791	4034	1828	631	336	169
1998	32489	9035	3211	1589	625	239	172
1999	28039	11915	3453	1082	504	208	125
2000	41148	9650	3785	978	244	133	79
2001	17401	13757	2755	938	179	51	46
2002	8709	5770	4339	805	222	48	27
2003	11896	2606	1737	1485	213	65	22
2004	7396	3697	638	547	352	61	25
2005	4074	2095	838	174	115	97	26
2006	2469	784	457	193	32	27	34
2007	1722	783	270	170	68	12	22
2008	1533	557	336	128	84	36	17
2009	1883	511	218	159	62	42	25
2010	5089	663	219	103	78	32	32
2011	1398	1869	306	110	52	43	32
2012	3759	548	905	159	58	29	37
2013	1980	1482	271	483	87	32	31
2014	7061	804	748	148	271	51	31
2015	9698	2915	408	408	83	157	43
2016	12888	4095	1485	223	227	48	109
2017*	44029	5450	2123	808	127	133	86
2018*	64931	18433	2787	1183	455	75	121
GM(81–16)	11214	4274	1745	721	289	123	87

*** Estimates for 2017 and 2018 are TSA projections.**

Table 38.14. Whiting in Division 27.6.a. TSA estimates for mortality-at-age.

	Age						
Year	1	2	3	4	5	6	7+
1981	0.1035	0.1240	0.2174	0.3283	0.3284	0.3284	0.3284
1982	0.1159	0.1532	0.2570	0.3428	0.3429	0.3431	0.3430
1983	0.1807	0.2678	0.4326	0.5530	0.5542	0.5538	0.5535
1984	0.2251	0.3812	0.5495	0.6856	0.6863	0.6858	0.6860
1985	0.2374	0.4461	0.6260	0.7908	0.7914	0.7914	0.7909
1986	0.1839	0.3633	0.4900	0.5878	0.5875	0.5876	0.5877
1987	0.2265	0.4433	0.5904	0.6968	0.6966	0.6974	0.6968
1988	0.2623	0.5219	0.6460	0.8654	0.8650	0.8650	0.8649
1989	0.2319	0.4504	0.5947	0.7592	0.7594	0.7597	0.7595
1990	0.1766	0.3111	0.4271	0.5587	0.5590	0.5586	0.5587
1991	0.1782	0.3324	0.4360	0.5539	0.5540	0.5539	0.5539
1992	0.1685	0.3159	0.4212	0.5385	0.5387	0.5388	0.5388
1993	0.1684	0.3065	0.4243	0.6160	0.6168	0.6161	0.6161
1994	0.1511	0.2606	0.3772	0.5568	0.5565	0.5572	0.5567
1995	0.1758	0.2952	0.4122	0.6336	0.6335	0.6338	0.6336
1996	0.2395	0.3728	0.5116	0.7781	0.7783	0.7780	0.7779
1997	0.2807	0.4353	0.5766	0.8202	0.8205	0.8196	0.8200
1998	0.3302	0.5078	0.6502	0.8971	0.8990	0.8984	0.8987
1999	0.4067	0.6283	0.7778	1.1093	1.1111	1.1107	1.1103
2000	0.4061	0.5899	0.7312	1.1348	1.1339	1.1361	1.1350
2001	0.3957	0.5419	0.6592	1.0682	1.0706	1.0704	1.0693
2002	0.3063	0.3988	0.4818	0.7652	0.7650	0.7655	0.7654
2003	0.3412	0.4070	0.4824	0.8382	0.8384	0.8389	0.8378
2004	0.3975	0.4280	0.5405	0.8564	0.8581	0.8574	0.8574
2005	0.3600	0.3499	0.4571	0.6710	0.6700	0.6707	0.6707
2006	0.3437	0.2870	0.3790	0.5781	0.5781	0.5789	0.5782
2007	0.3134	0.2286	0.2874	0.4762	0.4759	0.4763	0.4762
2008	0.3525	0.2599	0.3039	0.5335	0.5330	0.5337	0.5331
2009	0.3343	0.2265	0.2763	0.4402	0.4400	0.4399	0.4399
2010	0.2662	0.1661	0.2079	0.3267	0.3268	0.3266	0.3267
2011	0.1756	0.1055	0.1302	0.1964	0.1965	0.1963	0.1964
2012	0.1620	0.0890	0.1182	0.1773	0.1772	0.1771	0.1771
2013	0.1277	0.0677	0.0900	0.1284	0.1283	0.1284	0.1283
2014	0.0987	0.0515	0.0711	0.0935	0.0934	0.0935	0.0935
2015	0.0864	0.0475	0.0690	0.0842	0.0843	0.0842	0.0842
2016	0.0676	0.0371	0.0560	0.0631	0.0631	0.0631	0.0631
2017*	0.0706	0.0388	0.0585	0.0660	0.0660	0.0660	0.0660
2018*	0.0735	0.0404	0.0609	0.0687	0.0687	0.0687	0.0687
GM(81–16)	0.2158	0.2540	0.3405	0.4836	0.4837	0.4837	0.4836

*** Estimates for 2017 and 2018 are TSA projections.**

Table 38.15. Whiting in Division 27.6.a. Standard errors of TSA estimates for log mortality-at-age.

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	0.0133	0.0140	0.0237	0.0328	0.0328	0.0328	0.0328
1982	0.0171	0.0188	0.0295	0.0356	0.0356	0.0356	0.0357
1983	0.0294	0.0331	0.0495	0.0524	0.0526	0.0526	0.0527
1984	0.0385	0.0475	0.0627	0.0623	0.0624	0.0624	0.0625
1985	0.0417	0.0525	0.0688	0.0699	0.0700	0.0700	0.0701
1986	0.0338	0.0439	0.0555	0.0552	0.0552	0.0553	0.0553
1987	0.0422	0.0520	0.0637	0.0642	0.0643	0.0644	0.0644
1988	0.0487	0.0641	0.0693	0.0785	0.0786	0.0788	0.0788
1989	0.0438	0.0603	0.0650	0.0713	0.0714	0.0715	0.0716
1990	0.0338	0.0437	0.0512	0.0551	0.0552	0.0552	0.0552
1991	0.0341	0.0467	0.0514	0.0557	0.0557	0.0558	0.0558
1992	0.0325	0.0451	0.0503	0.0556	0.0556	0.0557	0.0557
1993	0.0333	0.0459	0.0523	0.0664	0.0666	0.0666	0.0666
1994	0.0305	0.0409	0.0483	0.0609	0.0610	0.0611	0.0611
1995	0.0368	0.0491	0.0572	0.0772	0.0773	0.0774	0.0774
1996	0.0509	0.0649	0.0736	0.0976	0.0976	0.0977	0.0977
1997	0.0597	0.0764	0.0813	0.1025	0.1026	0.1025	0.1026
1998	0.0685	0.0850	0.0862	0.1014	0.1017	0.1018	0.1019
1999	0.0825	0.0986	0.0982	0.1121	0.1123	0.1125	0.1125
2000	0.0830	0.0922	0.0923	0.1193	0.1192	0.1196	0.1196
2001	0.0810	0.0864	0.0876	0.1176	0.1179	0.1181	0.1180
2002	0.0649	0.0688	0.0677	0.0914	0.0914	0.0916	0.0916
2003	0.0739	0.0741	0.0712	0.0976	0.0977	0.0978	0.0978
2004	0.0910	0.0839	0.0889	0.1142	0.1144	0.1145	0.1145
2005	0.0878	0.0746	0.0836	0.1087	0.1085	0.1087	0.1087
2006	0.0709	0.0504	0.0495	0.0633	0.0633	0.0635	0.0634
2007	0.0651	0.0410	0.0398	0.0577	0.0577	0.0578	0.0578
2008	0.0736	0.0473	0.0422	0.0582	0.0582	0.0583	0.0583
2009	0.0709	0.0419	0.0388	0.0490	0.0490	0.0490	0.0490
2010	0.0572	0.0315	0.0298	0.0369	0.0370	0.0370	0.0370
2011	0.0393	0.0208	0.0196	0.0223	0.0224	0.0224	0.0224
2012	0.0380	0.0184	0.0187	0.0213	0.0213	0.0213	0.0213
2013	0.0318	0.0148	0.0153	0.0161	0.0161	0.0161	0.0162
2014	0.0254	0.0119	0.0129	0.0117	0.0117	0.0117	0.0117
2015	0.0235	0.0118	0.0137	0.0109	0.0109	0.0109	0.0109
2016	0.0201	0.0101	0.0129	0.0089	0.0089	0.0089	0.0090
2017*	0.0295	0.0156	0.0220	0.0219	0.0219	0.0219	0.0219
2018*	0.0377	0.0202	0.0294	0.0315	0.0315	0.0315	0.0315
GM(81–16)	0.0441	0.0415	0.0462	0.0535	0.0536	0.0536	0.0536

*** Estimates for 2017 and 2018 are TSA projections.**

Table 38.16. Whiting in Division 27.6.a. 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	11429	1257	2132	4568	931	14325	15997	1458	0.223	0.020	134374	7349	168638	8298	199286	19420
1982	13880	13028	1391	5485	4298	889	19366	17326	1621	0.251	0.022	91982	4860	109637	5360	163930	17182
1983	15962	16705	1534	6294	5342	933	22257	22047	2015	0.418	0.035	63151	3502	93075	4836	197890	18922
1984	16459	14423	1295	4017	5209	965	20476	19633	1879	0.539	0.043	46166	2835	81872	4360	326424	26137
1985	12879	11383	1094	4840	7308	1248	17719	18691	1809	0.621	0.047	42190	2643	78752	4082	310390	23449
1986	8458	7799	827	2669	5383	906	11127	13183	1314	0.480	0.039	38125	2426	71937	3694	289433	21118
1987	11542	9852	979	11918	8131	1371	23460	17982	1789	0.577	0.045	40521	2400	77561	4102	405405	33364
1988	11349	10537	992	8132	5568	1058	19481	16105	1512	0.678	0.052	41384	2503	50167	2879	106901	11021
1989	7523	6570	688	5876	6159	1054	13399	12729	1403	0.601	0.049	22598	1646	56536	3007	325015	21607
1990	5642	5129	547	4530	4998	908	10172	10126	1123	0.432	0.038	33375	2048	57588	3502	176231	18304
1991	6658	5617	545	4883	4073	741	11541	9690	1030	0.441	0.039	27425	1833	51803	3193	245830	22963
1992	6005	5512	511	9249	6153	1065	15253	11665	1288	0.425	0.039	30535	2117	68838	4267	338241	28486
1993	6872	6565	611	4759	7094	1175	11631	13659	1414	0.449	0.043	43537	3005	76411	4985	267856	23414
1994	5901	5811	549	3455	5174	805	9356	10986	1064	0.398	0.040	38416	2993	64419	4754	282810	25775
1995	6078	6756	998	5771	5879	1020	11849	12635	1755	0.447	0.051	38772	3484	61887	4836	303691	24382
1996	7158	7804	1265	7940	7701	1416	15098	15505	2368	0.554	0.067	42621	3663	61741	5122	195381	20128
1997	6290	7945	1163	5251	7173	1348	11542	15118	2210	0.611	0.073	34352	3152	55534	5252	183810	22993
1998	4627	6011	925	9216	8190	1613	13843	14201	2260	0.685	0.075	24978	2978	49408	5669	244782	32489
1999	4613	5436	963	3975	7353	1535	8588	12789	2237	0.838	0.083	23285	3318	39365	5298	181119	28039
2000	3011	4028	820	13285	7818	1715	16296	11846	2298	0.819	0.082	17871	2939	39034	5521	280702	41148
2001	2439	3590	708	4263	6188	1380	6702	9778	1902	0.756	0.079	20099	3111	31680	4512	115876	17401

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
2002	1767	2714	607	2851	2179	572	4618	4893	1085	0.549	0.062	13924	2242	16955	2727	41087	8709
2003	1355	2074	470	719	1836	518	2074	3910	909	0.576	0.067	8358	1425	13792	2251	65060	11896

Table 38.16. (continued).

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**
2004	811	1210	284	2159	1676	517	2970	2886	753	0.608	0.082	5952	1064	9432	1582	40280	7396
2005	341	710	172	629	823	249	970	1532	394	0.493	0.079	3778	567	5718	803	21810	4074
2006	380	546	53	946	615	110	1327	1161	139	0.415	0.041	3427	241	4721	297	27266	2469
2007	427	439	38	317	425	78	745	864	98	0.331	0.035	3378	201	4564	276	14178	1722
2008	445	416	39	314	504	93	759	920	114	0.366	0.037	2915	207	4148	270	16126	1533
2009	488	393	39	419	475	86	908	868	108	0.314	0.033	3264	247	4585	298	24774	1883
2010	307	293	32	893	530	101	1200	823	115	0.234	0.025	2671	188	4996	313	59876	5089
2011	230	244	26	339	310	58	569	554	71	0.144	0.016	5678	409	6236	427	18600	1398
2012	313	289	32	727	447	84	1039	736	97	0.128	0.015	5525	393	7720	515	38328	3759
2013	222	253	27	951	277	50	1173	530	64	0.095	0.012	6558	493	7372	533	19751	1980
2014	184	216	22	583	278	58	767	493	69	0.072	0.010	6434	496	8807	719	48210	7061
2015	227	217	22	835	587	131	1063	805	140	0.067	0.010	7713	779	15271	1268	101689	9698
2016	233	248	26	797	528	117	1030	776	130	0.052	0.009	15907	1409	21051	1975	70431	12888
2017*	NA	353	109	NA	732	283	NA	1084	368	0.054	0.018	17023	1808	26125	3752	138913	44029
2018*	NA	496	205	NA	1013	495	NA	1508	671	0.057	0.025	24387	4443	36291	6590	181667	64931
Min	184	216	22	314	277	50	569	493	64	0.052	0.009	2671	188	4148	270	14178	1398
GM	2199	2368	287	2373	2326	457	4954	4835	642	0.360	0.037	16877	1409	26728	2057	104527	11214
AM	5091	5061	599	3928	3924	747	9019	8985	1112	0.436	0.044	27534	2088	43924	3105	159680	16092
Max	16459	16705	1534	13285	8190	1715	23460	22047	2368	0.838	0.083	134374	7349	168638	8298	405405	41148

*** Estimates for 2017 and 2018 are TSA projections.**

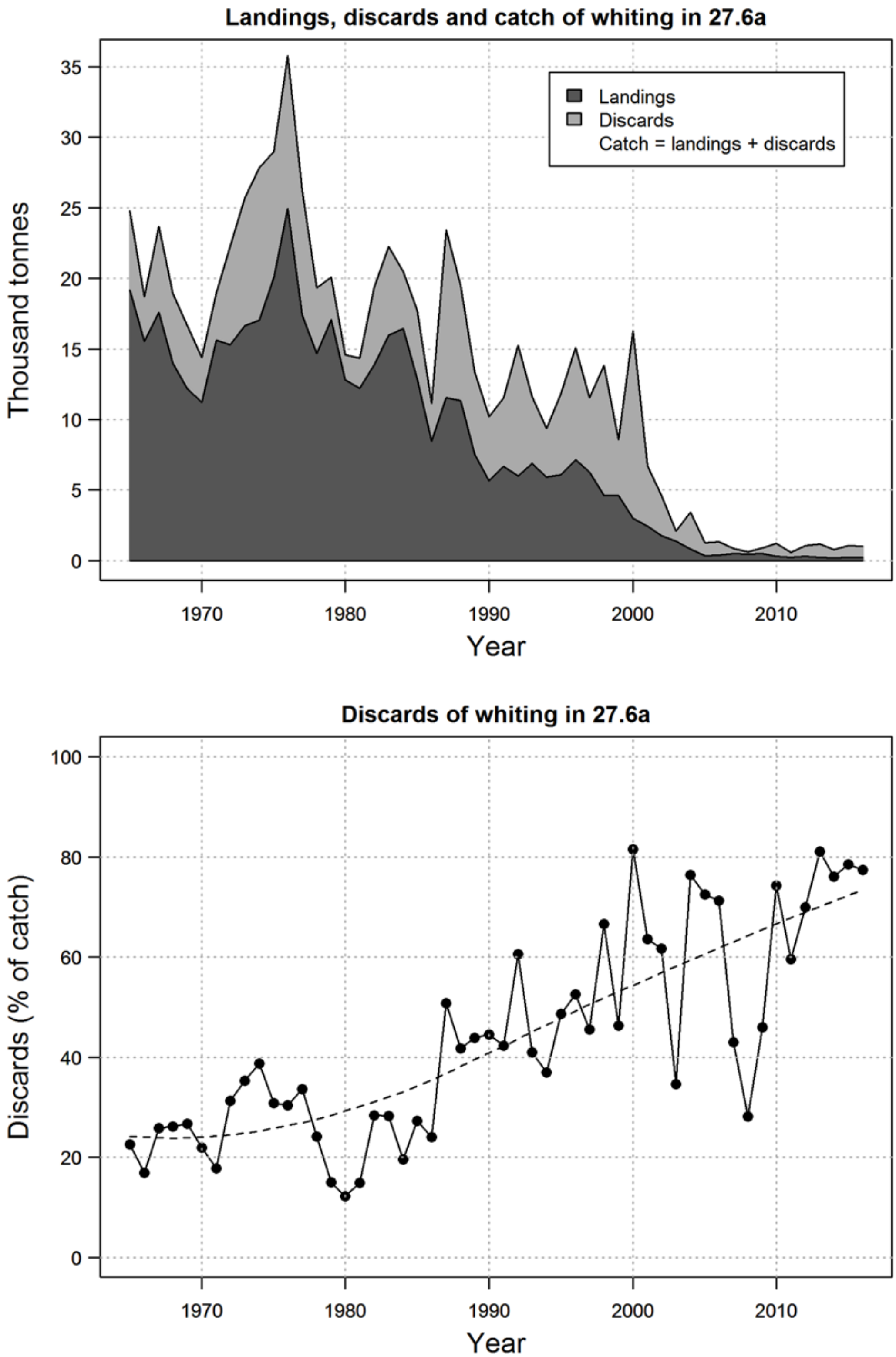


Figure 38.1. Whiting in Division 27.6.a. Landings, discards and catch (in tonnes, whiting at age 1 and older) as officially reported to ICES (upper panel) and discards (as % of catch, lower panel).

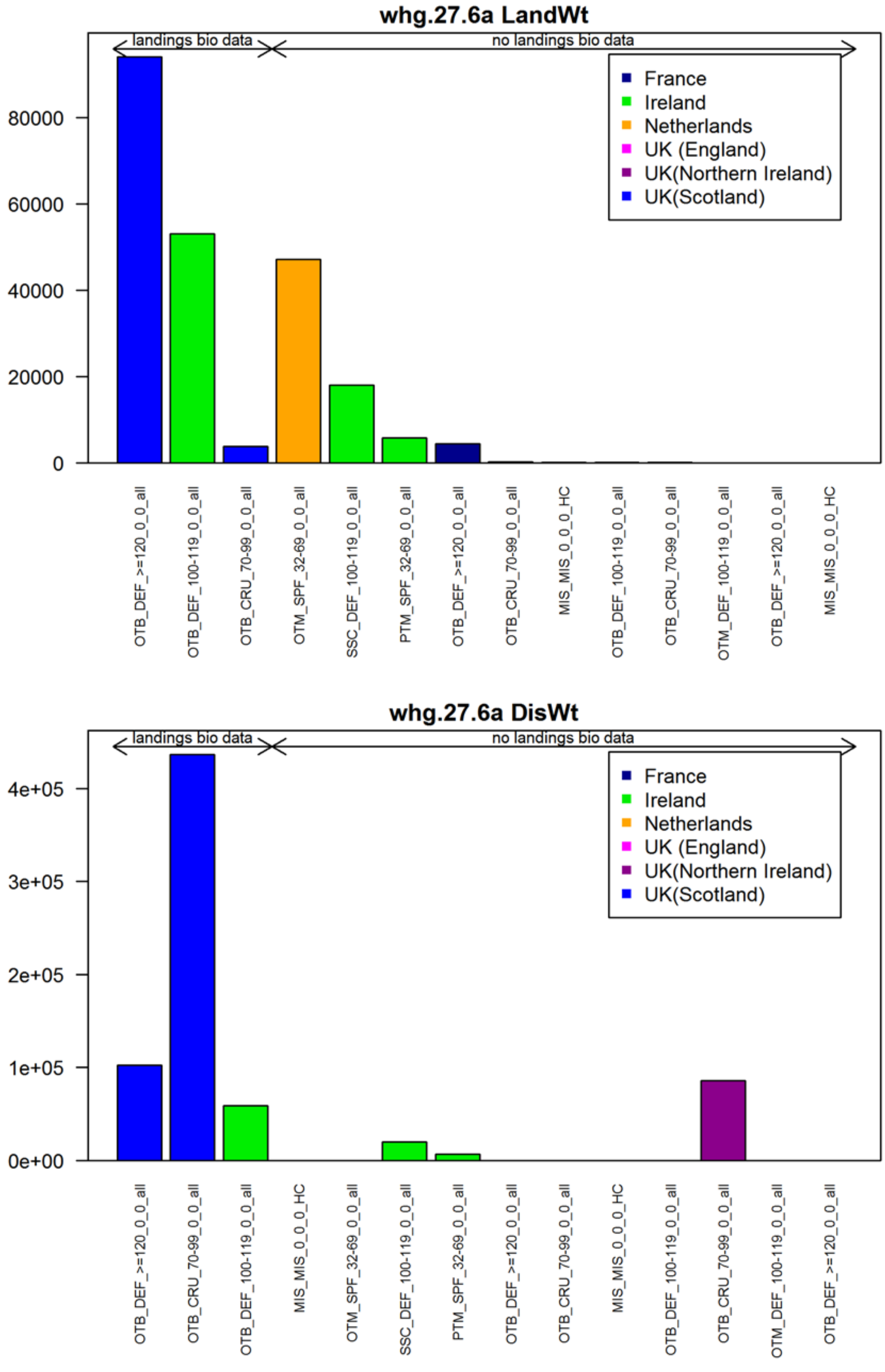
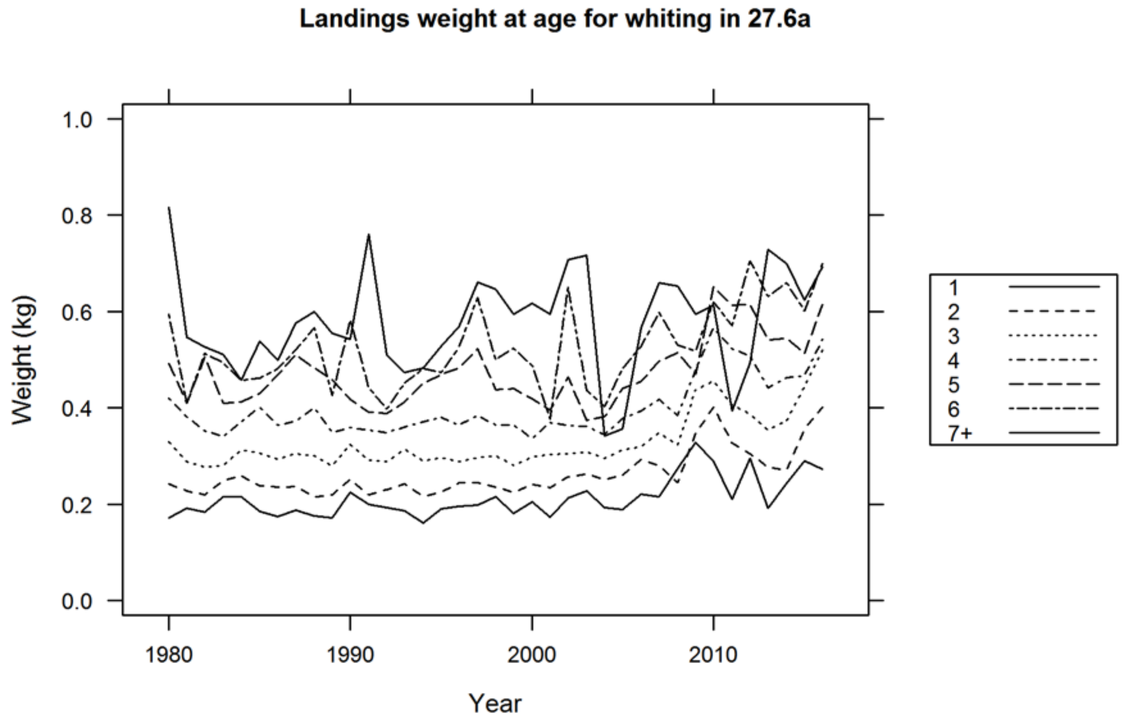


Figure 38.2. Whiting in Division 27.6.a. Landings (upper panel) and discards (all ages, lower panel) by métier (kg) in 2016 as entered into InterCatch.



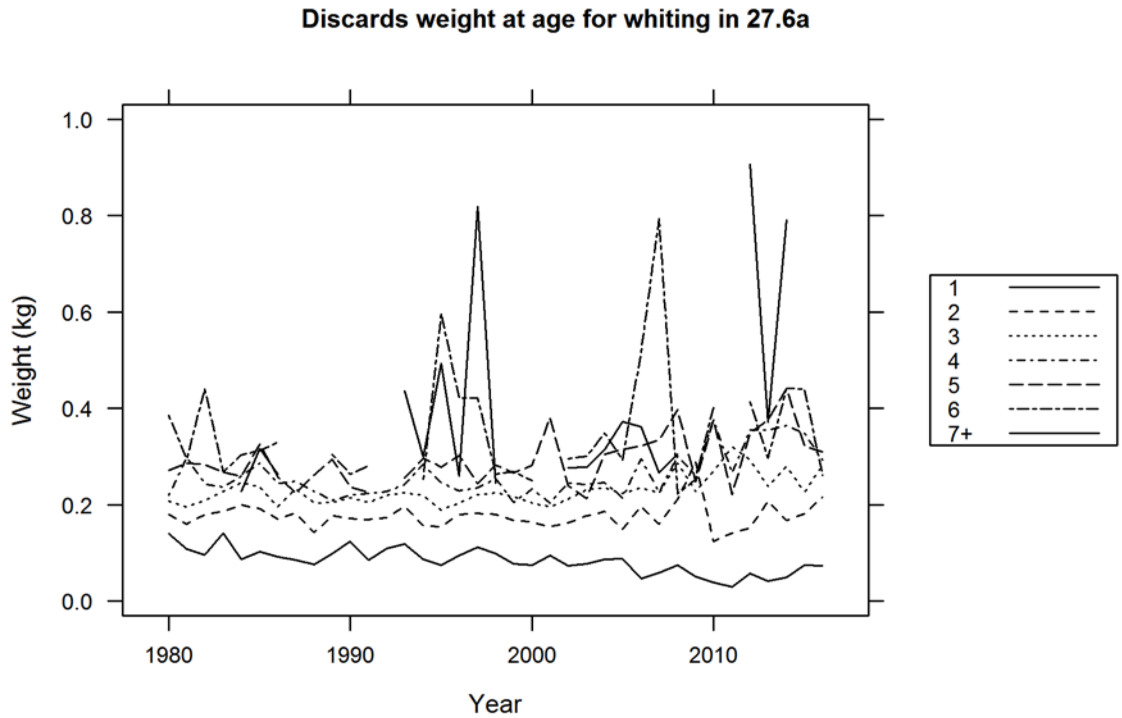


Figure 38.3. Whiting in Division 27.6.a. Mean weight-at-age in the landings (upper panel) and discards (lower panel).

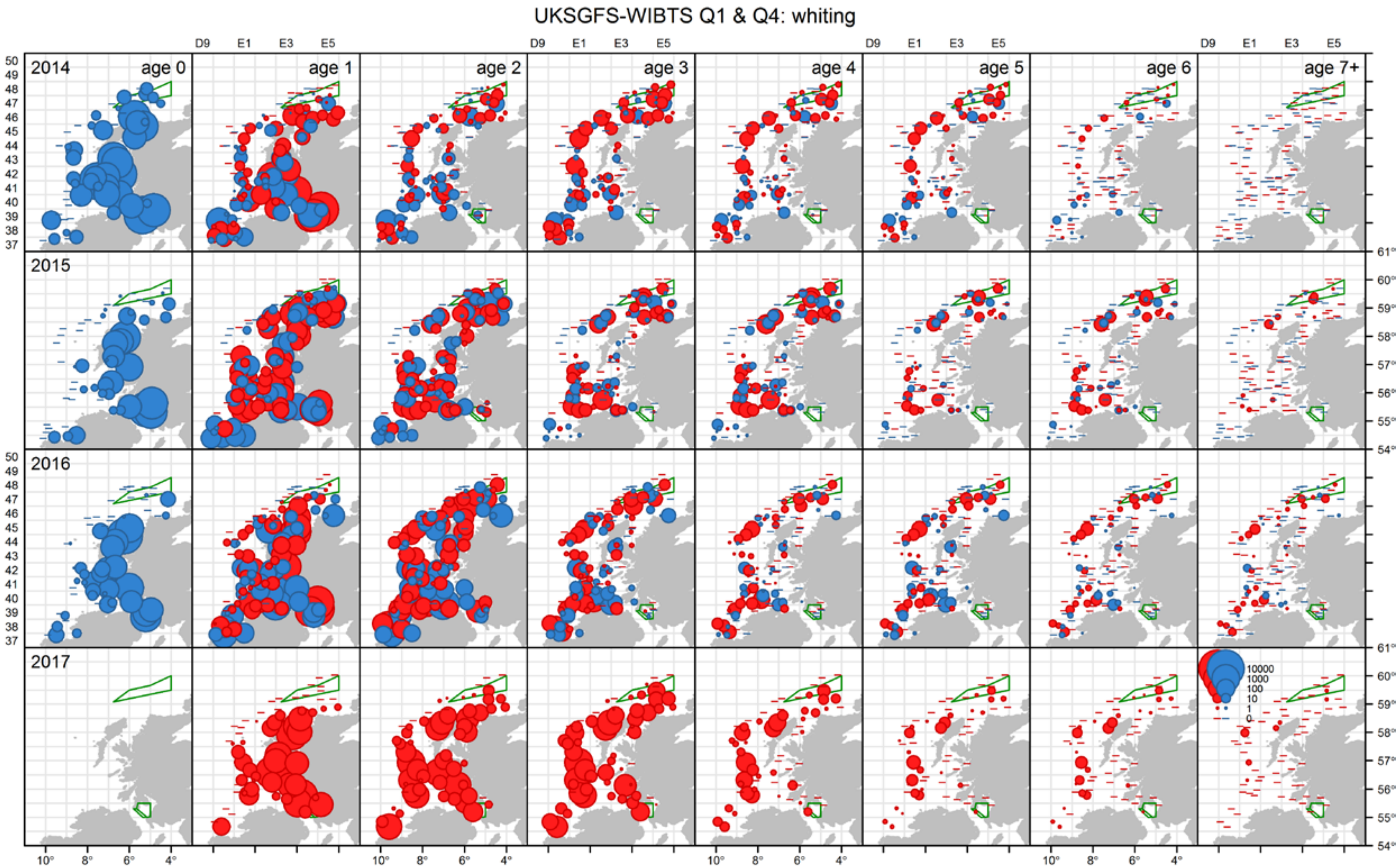


Figure 38.4. Whiting in Division 27.6.a. The catch of whiting per unit of effort during the Scottish first quarter west coast groundfish survey (UKSGFS-WIBTS-Q1, in red) and the Scottish fourth quarter groundfish survey (UKSGFS-WIBTS-Q4, in blue) in 2014–2017. Each circle shows the sample location and the size of the circle is proportional to the log number density (n/30 min fished), according to the legend. Two closed areas (the Windsock in the north and the Clyde in the south) are shown as green polygons.

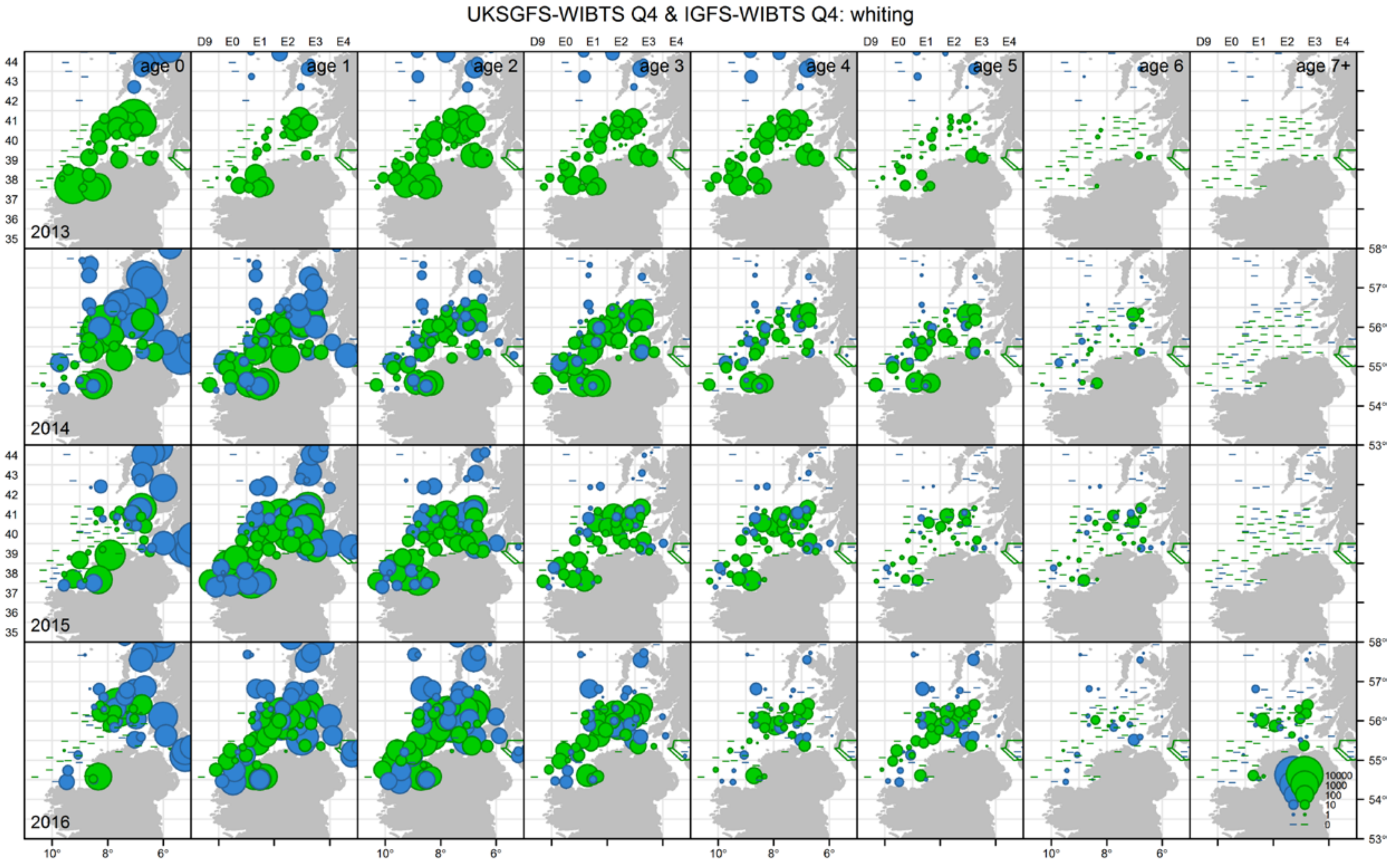


Figure 38.5. Whiting in Division 27.6.a. The catch of whiting per unit of effort during the Scottish fourth quarter west coast groundfish survey (UKSGFS-WIBTS-Q4, only the southern part of the survey area, in blue) and the Irish fourth quarter groundfish survey (IGFS-WIBTS-Q4, in green) in 2013–2016. Each circle shows the sample location and the size of the circle is proportional to the log number density (n/30 min fished), according to the legend. The Clyde closed area is shown as a green polygon.

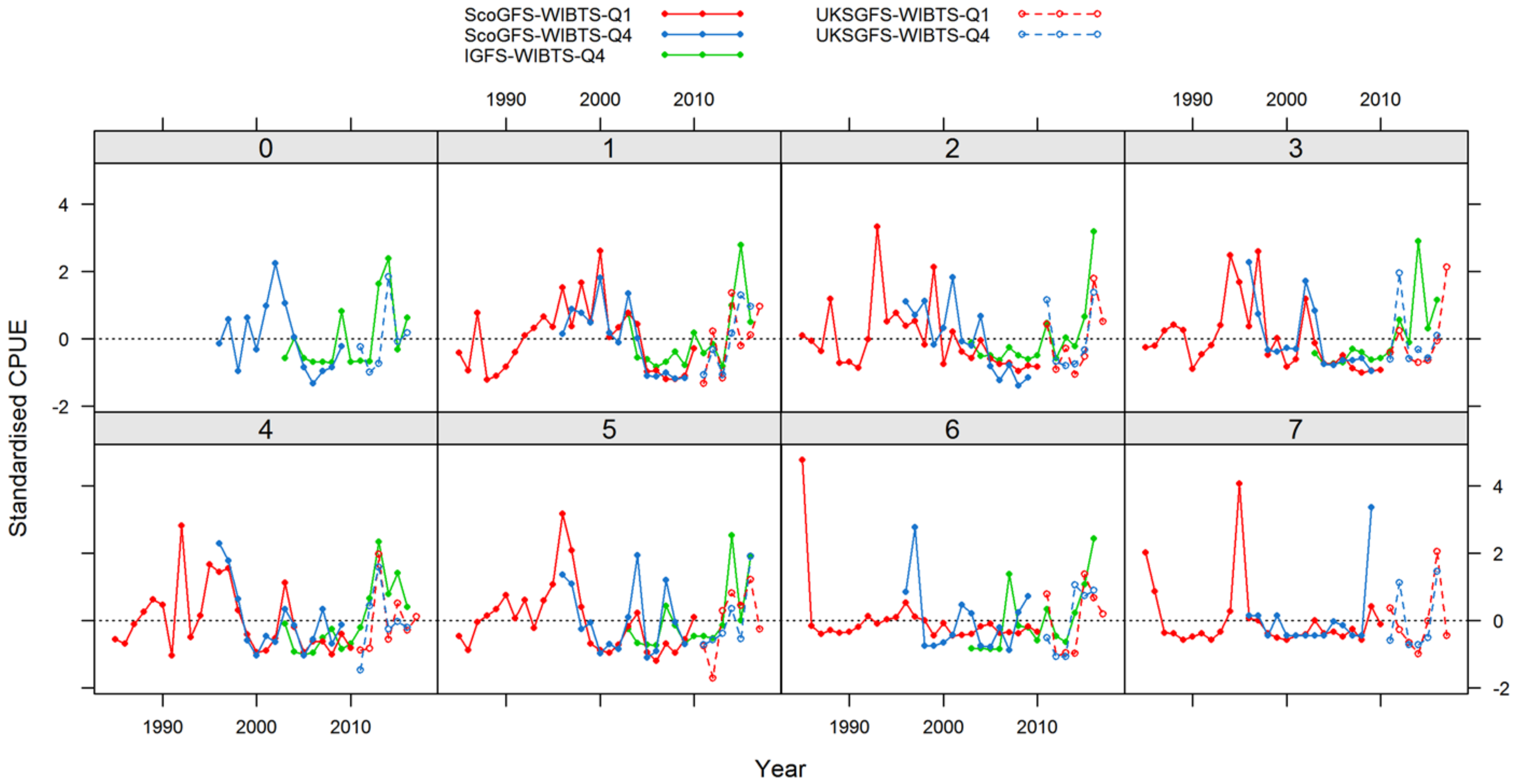


Figure 38.6. Whiting in Division 27.6.a. Scaled survey indices from ScoGFS-WIBTS-Q1, ScoGFS-WIBTS-Q4, IGFS-WIBTS-Q4, UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-Q4. The abundance index for IGFS-WIBTS-Q4 is shown only for ages 0–6.

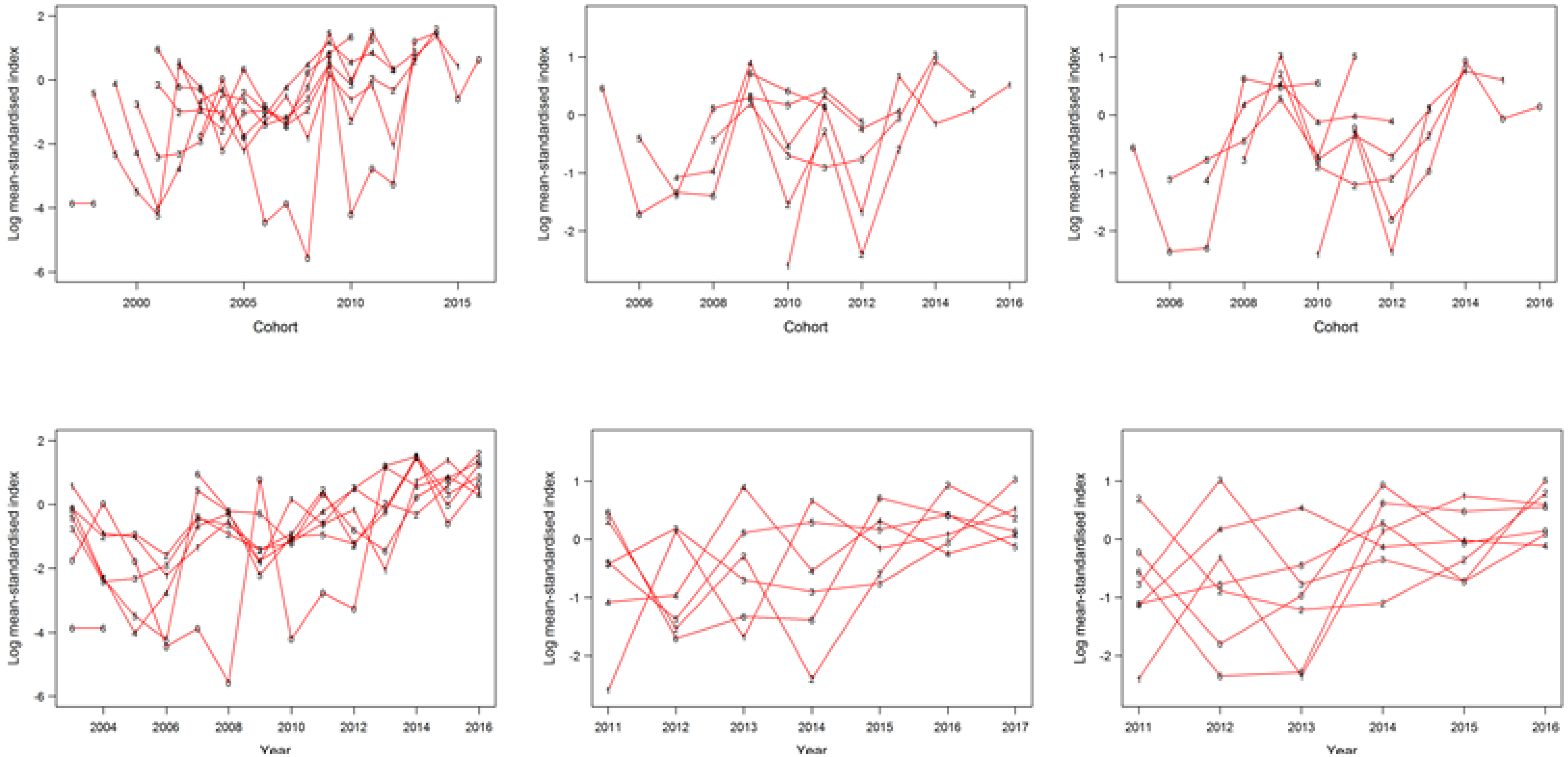


Figure 38.7. Whiting in Division 27.6.a. Log mean standardised survey index for each age by cohort (upper panels) and year (lower panels) in IGFS-WIBTS-Q4, UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-Q4, respectively.

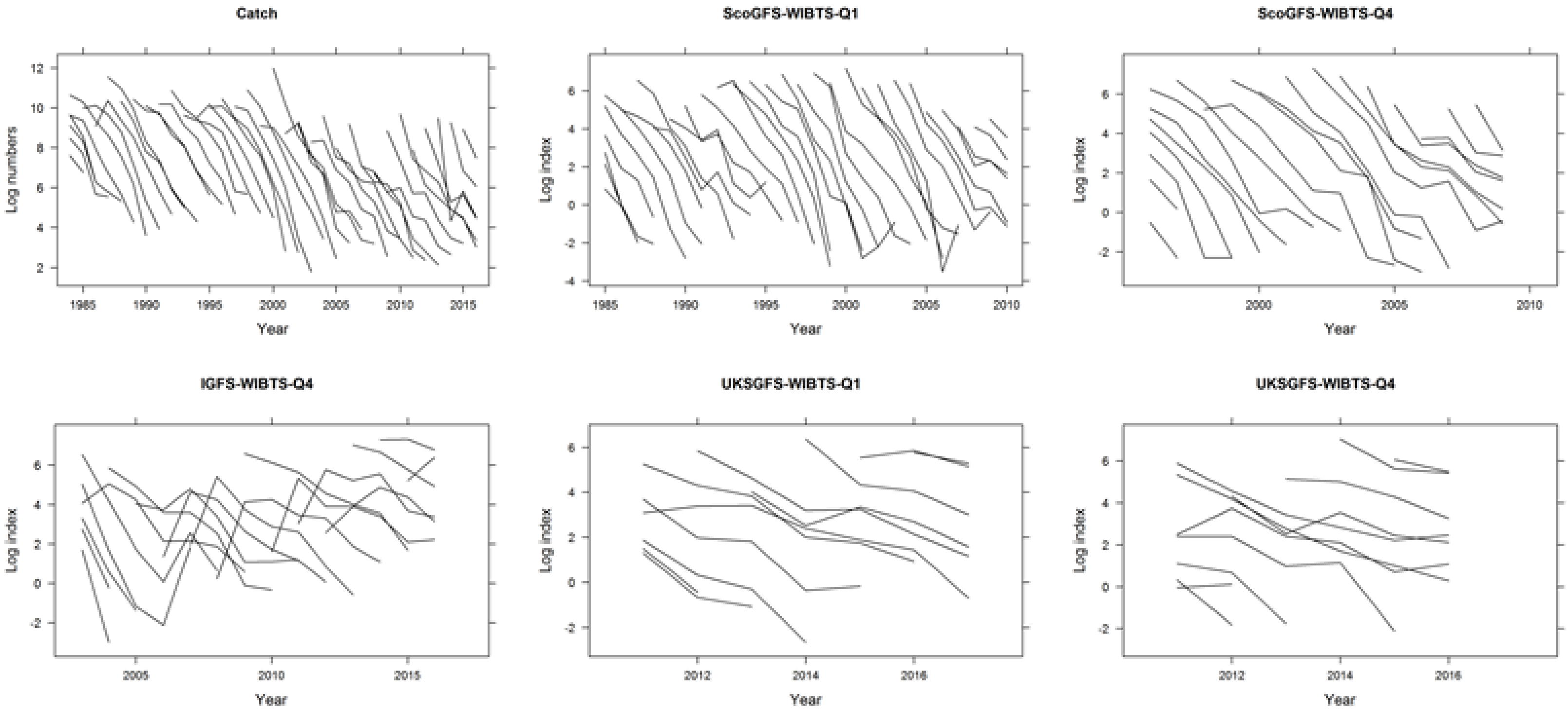


Figure 38.8. Whiting in Division 27.6.a. Log catch curves from the catch (ages 1–7) and from the five survey series (ages as specified in Table 38.9).

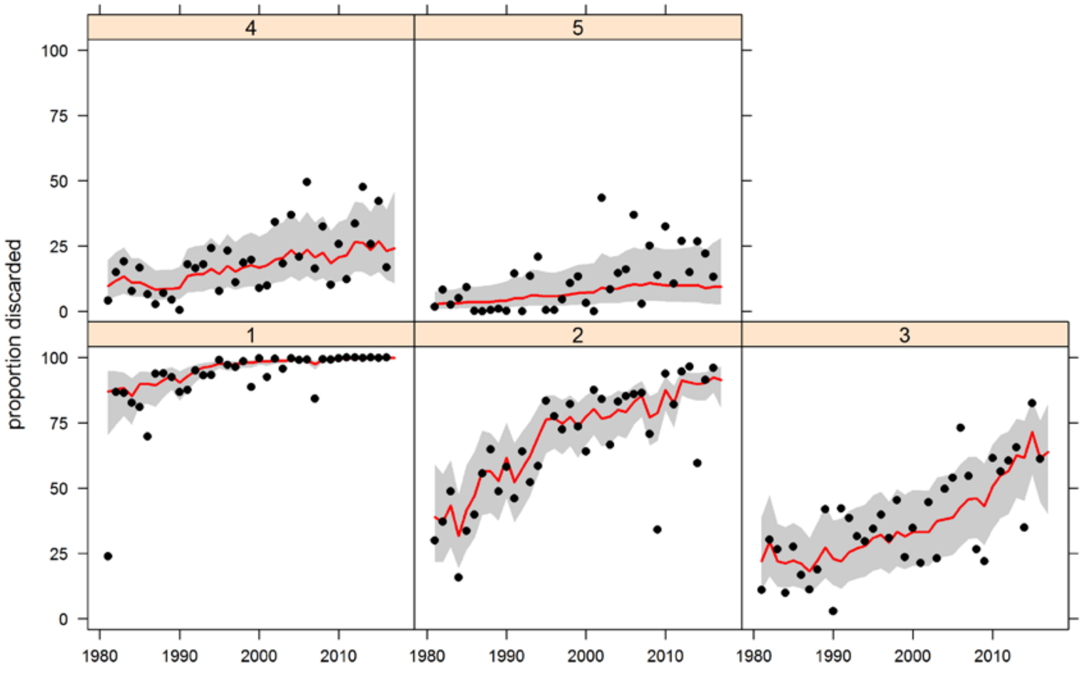


Figure 38.9. Whiting in Division 27.6.a. Proportion discarded at age from the final TSA run.

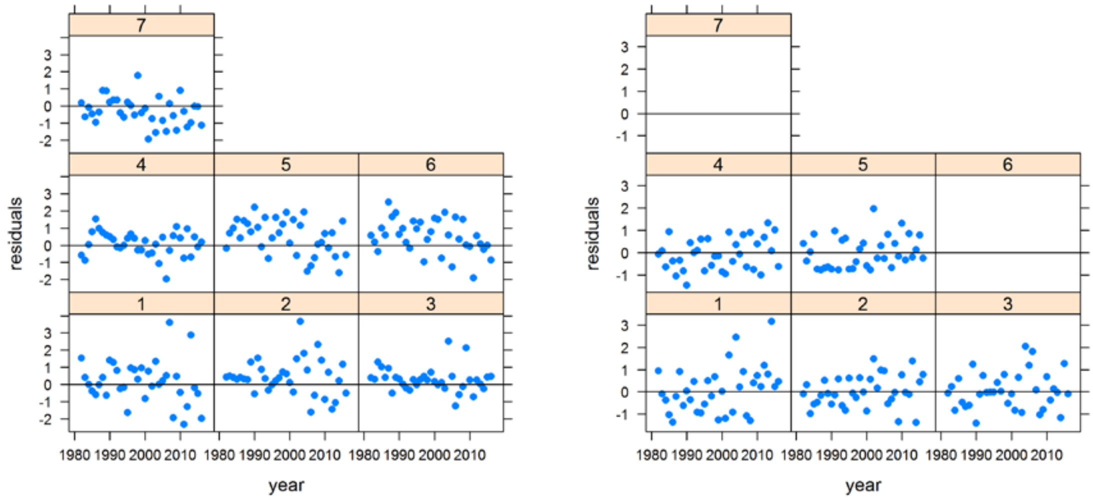


Figure 38.10. Whiting in Division 27.6.a. Standardised residuals for landings (left panel) and discards (right panel) from the final TSA run.

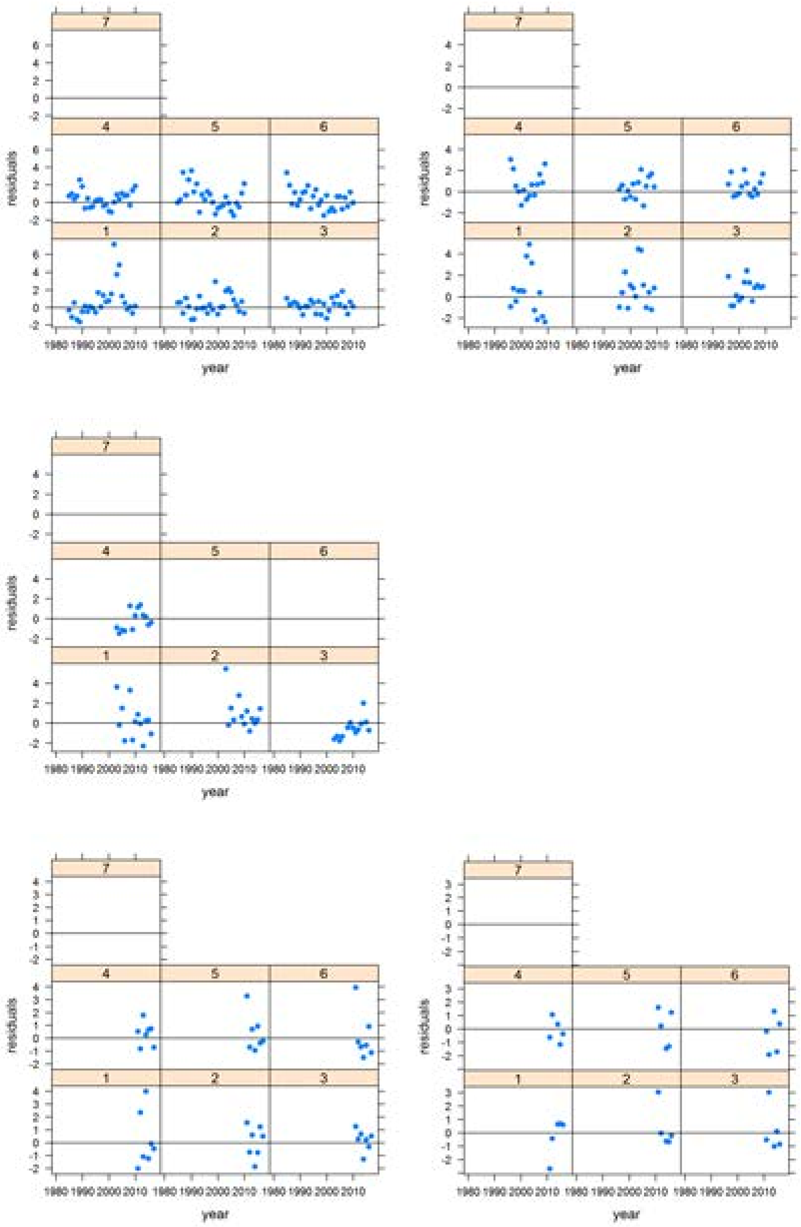


Figure 38.11. Whiting in Division 27.6.a. Standardised survey residuals from TSA in ScoGFS-WIBTS-Q1 (top left panel), ScoGFS-WIBTS-Q4 (top left panel), IGFS-WIBTS-Q4 (middle panel), UKSGFS-WIBTS-Q1 (bottom left panel) and UKSGFS-WIBTS-Q4 (bottom right panel), from the final TSA run.

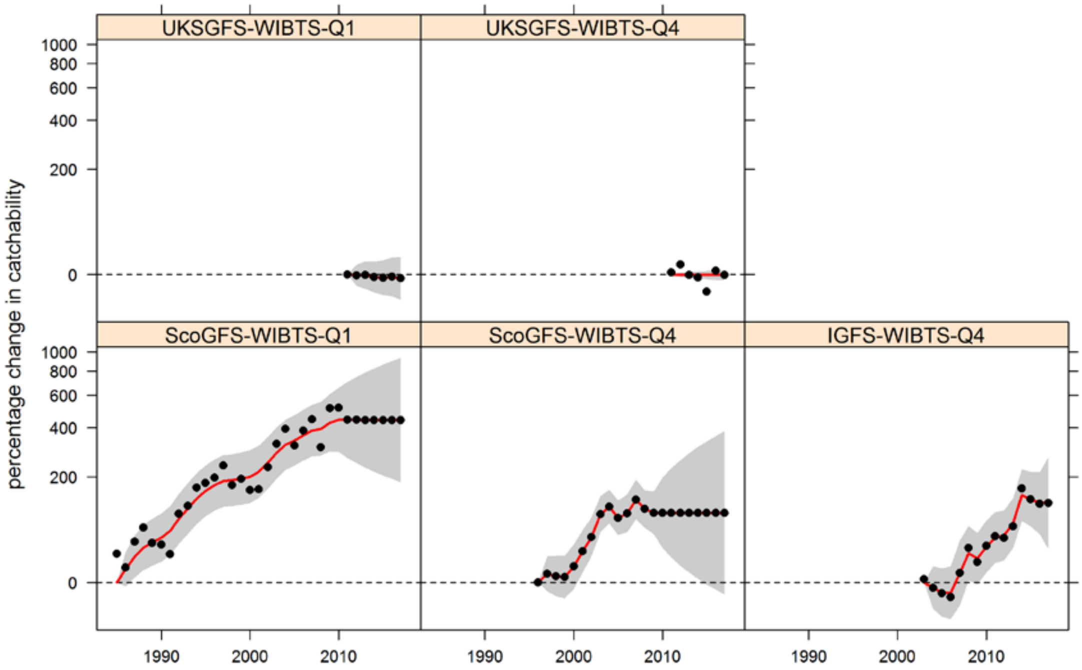


Figure 38.12. Whiting in Division 27.6.a. Percentage change in catchability from the final TSA run. Transient changes (points) and the persistent change (solid line) with uncertainty bounds.

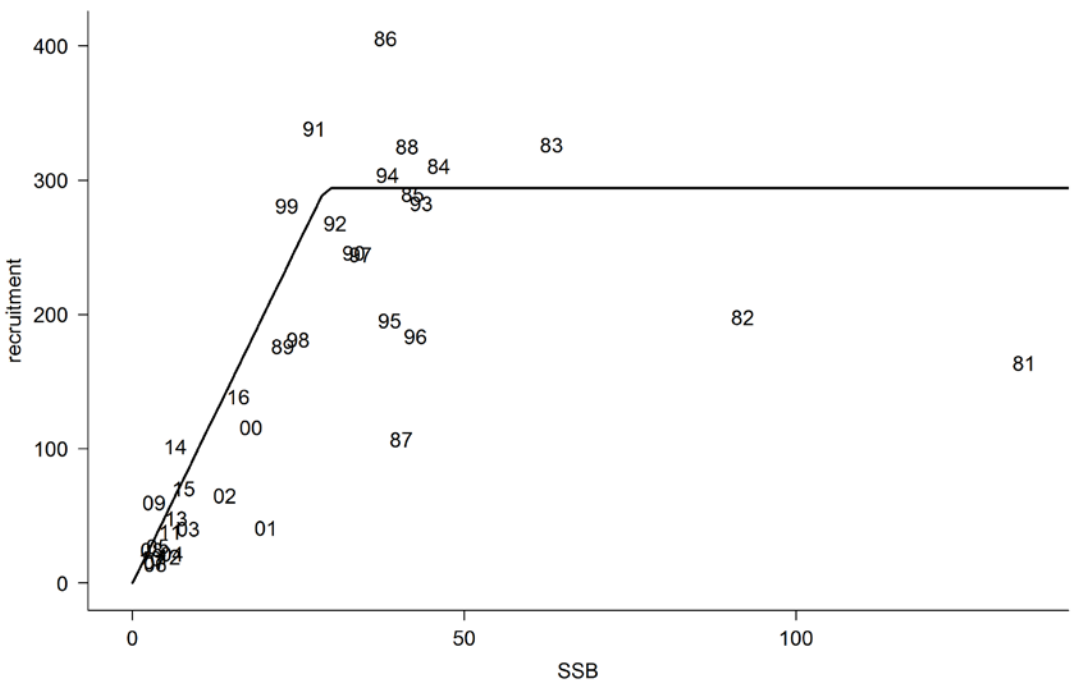


Figure 38.13. Whiting in Division 27.6.a. Stock–recruitment relationship (recruitment in millions, SSB in thousand tonnes) from the final TSA run, with points labelled as year classes, and fitted with a segmented-regression model ("hockey-stick", solid line).

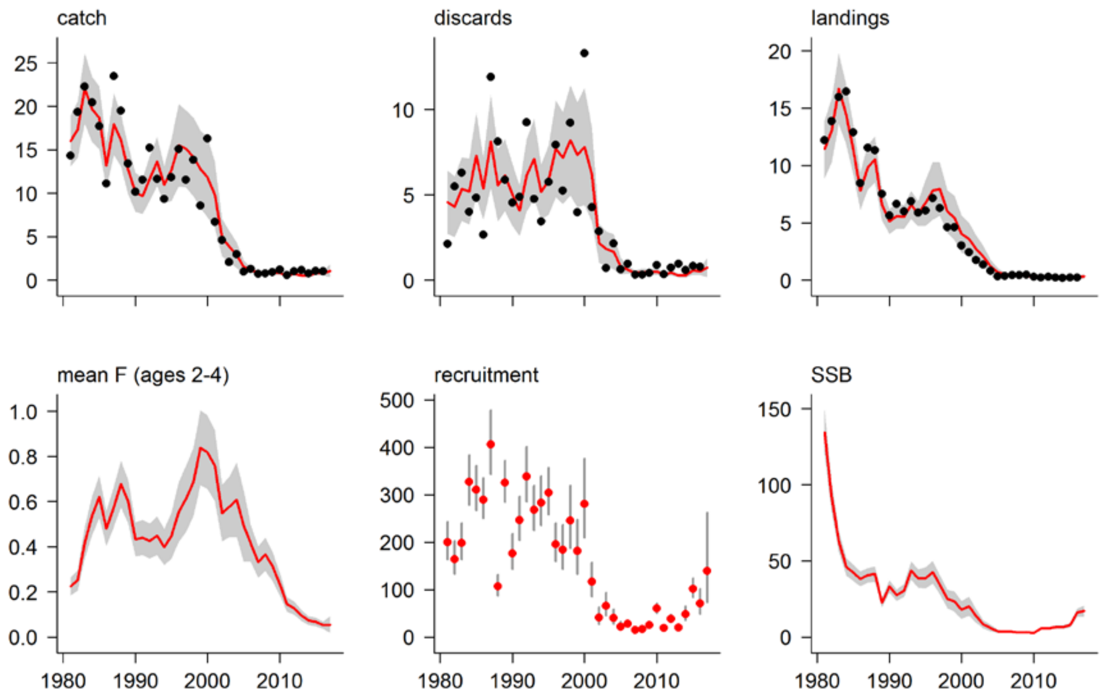


Figure 38.14. Whiting in Division 27.6.a. TSA stock summaries from the final TSA run. Catch, landings, discards and SSB in tonnes, recruitment in thousands. Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, landings and discards.

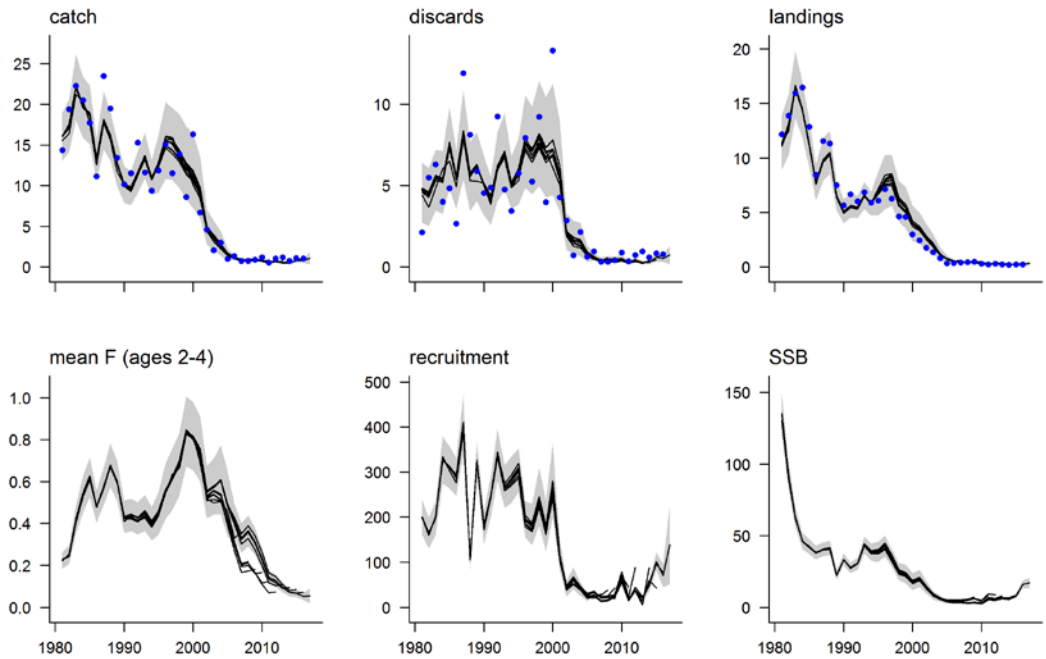


Figure 38.15. Whiting in Division 27.6.a. Retrospective plots of TSA run (the retro analysis for 2007–2016). Catch, landings, discards and SSB in tonnes, recruitment in thousands. Blue points show observed values, black lines show estimates in the respective years, grey bands show confidence intervals for the last estimate.

38.12 Audit of wgh-scow (Division 27.6.a)

The audit is not available.

39 Whiting in Division 27.6.b

Type of assessment in 2017

No assessment was performed in 2017.

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

39.1 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 27.6.a stock.

Management applicable to 2016 and 2017

The TAC for whiting is set for ICES Subareas 6, 12 and 14 and EU and international waters of ICES Division 27.5.b. The following TACs and quotas have been applicable in recent years:

TAC for 2016

Species:	Whiting *Merlangius merlangus*	**Zone:**	VI; Union and international waters of Vb; international waters of XII and XIV (WHG/56-14)
Germany	1		
France	26		
Ireland	64		
United Kingdom	122		
Union	213		
TAC	213		Analytical TAC

(Council Regulation (EU) 2016/72).

TAC for 2017

Species:	Whiting *Merlangius merlangus*	Zone:	VI; Union and international waters of Vb; international waters of XII and XIV (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) 2017/127).

Fishery in 2016

No specific information is available for 2016. Whiting at Rockall are taken as a by-catch in fisheries for other species such as haddock and anglerfish.

39.2 Data

Landings data for whiting in 27.6.b are shown by nation in Table 39.1 and Figure 39.1. Total officially reported landings were 33 t in 2016, of which 22 t were reported by the UK, 9 t by Ireland and 1 t by Norway (for the first time in the time-series). 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 2016 (Figure 39.2).

In addition, some landings and discards age compositions were also uploaded to InterCatch. About 67% of the total landings (22 t) are from the Scottish TR1 fleet which, based on two sampled trips has a 0% discard rate. The data available in InterCatch are shown below.

Country	Landings (t)	Discards (t)	Total (t)
Ireland	9.4	4.9	14.4
UK (Scotland)	22.2	0.1	22.2
Norway	1.5	0	1.5
Grand total	33.0	5.0	38.1

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.

39.3 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 27.6.b is likely to remain a category 6 stock.

39.4 Management considerations

Rockall whiting is managed under a TAC for the combined Divisions 27.6.a and 27.6.b and therefore cannot be effective in limiting catches in Rockall.

Table 39.1. Whiting in Division 27.6.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*
Faroe Islands	-	-	-	-	-	-	-	-	-	-
France	+	-	-	-	-	-	-	-	-	-
Ireland	16	23	4	2	3	-	+	6	6	9
Norway	-	-	-	-	-	-	-	-	-	1
Spain	-	-	-	-	-	-	-	-	-	-
UK (E, W & NI)	-	-	-	-	-	-	-	-		
UK (Scotland)	1	8	12	16	6	1	3	23		
UK (all)									46	22
Total	17	31	16	18	9	1	3	29	52	33

*** Preliminary.**

+ < 0.5 t.

Table 39.2. Whiting in Division 27.6.b. Survey data made available to the WG: Scottish Q3 groundfish survey (Rock-WIBTS-Q3). Catch rates are given as number per ten hours.

2011	2016							
1	1	0.66	0.75					
0	7							
10	0	0	0	0	0	0	0	0
10	33.279	0	0.358	0	0	0	0	0
10	6.687	1.924	0	0	0	0	0	0
10	17.425	3.426	0.838	0.307	0	0	0	0
10	8.853	0.559	0.559	0.55	0	0	0	0
10	250.012	0.782	0	0.223	0.447	0	0	0

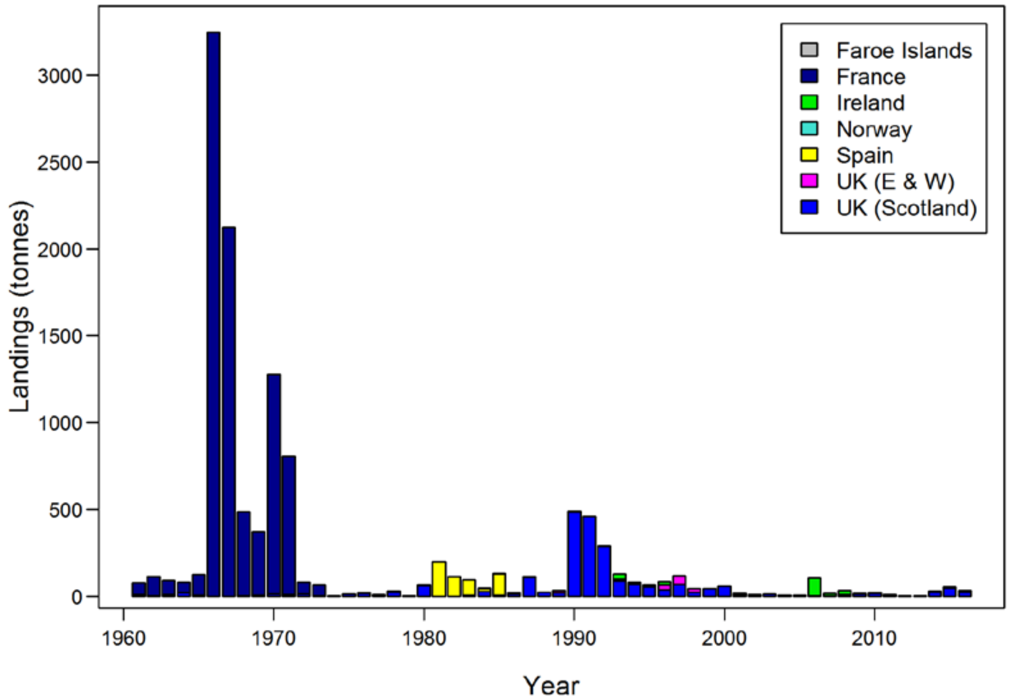


Figure 39.1. Whiting in Division 27.6.b. Official landings of whiting in 27.6.b by nation.

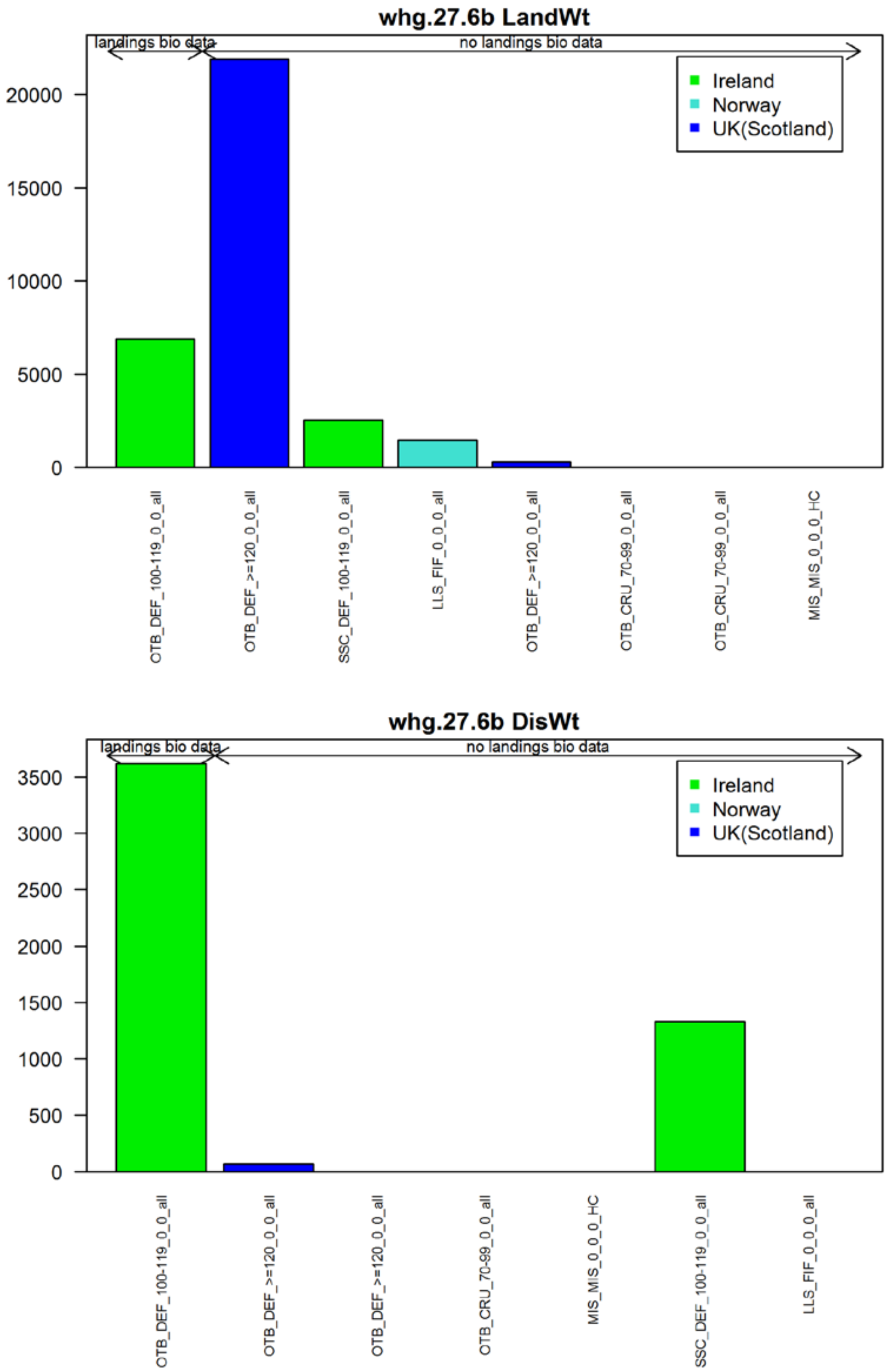


Figure 39.2. Whiting in Division 27.6.b. Landings (upper panel) and discards (all ages, lower panel) by métier (kg) in 2016 as entered into InterCatch.

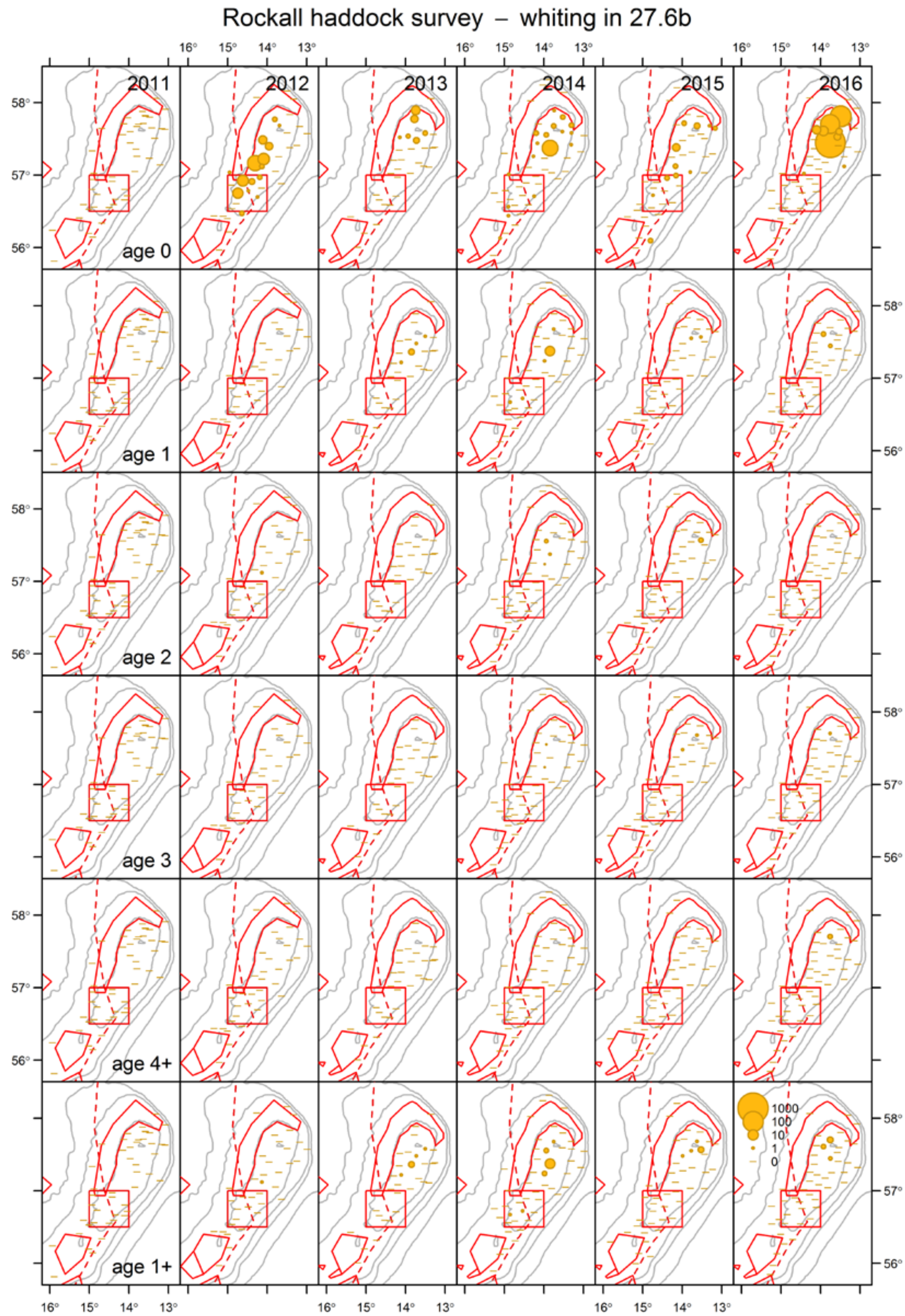


Figure 39.3. Whiting in Division 27.6.b. Whiting distribution by age on the Rockall Bank in 2011–2016 as observed in the Rockall Haddock survey. The densities (numbers of fish per 30 min) are represented by circles. The red polygons show the protected areas. The red rectangle in the centre shows the Haddock Box. The dashed line shows the NEAFC Regulatory Area.

39.1 Audit of whg-rock (Division 27.6b)

Date: 07/06/2017

Auditor: Claire Moore

General

- No assessment was preformed
- In 2015 this stock received three year multiannual advice, therefore there are no changes this year.

For single stock summary sheet advice

1) Assessment type: none

2) Assessment: Not applicable

3) Forecast: Not applicable

4) Assessment model: Not applicable

5) Data issues: No issues

6) Consistency: Not applicable

7) Stock status: Not applicable

8) Management Plan: None

General comments

Well written report, clear and concise

Technical comments

Report follows multiannual advice given in 2015

Conclusions

Report has been completed correctly given the data and advice available.

40 Whiting in 7.a

2017 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 WKIRISH 2 (ICES, 2017). A full analytical assessment procedure was developed during WKIRISH 3 (ICES, 2017) using ASAP. Reference points were also estimated during WKIRISH 3. WGCSE 2017 updated the assessment with 2016 data.

Type of assessment

SPALY update of ASAP assessment.

ICES advice applicable to 2017 and 2016

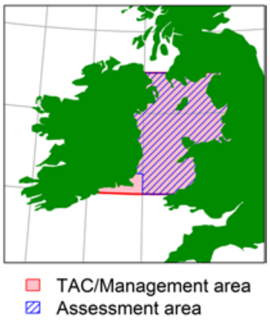
ICES advises that when the precautionary approach is applied, there should zero catch in 2017.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/whg-iris.pdf

40.1 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 2016 and 2017

The minimum landing size of whiting is 27 cm. The 2017 TAC for whiting 7.a was 80 t, the same as 2016. Overall official landings in 2016 were below the TAC but some countries landings were close to their quotas. This stock is not yet under the landings obligation (EU) 2016/2375.

2016	2016 Quota	2016 Officially reported Landings
Belgium	0	1
France	3	<0.5
Ireland	46	49
The Netherlands	0	-
United Kingdom	31	8

Note for Ireland, 40 t were reallocated from rectangles 33E2 & 33E3.

TAC 2016

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 2017

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

Fishery in 2016

The characteristics of the fishery are described in the stock annex.

The fishery in 2016 was prosecuted by the same fleets and gears as in recent years.

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 (762 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 2016 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 2016 catches by main gear types is presented below.

Catch (2016)	Landings				Discards	
780 t	fin-fish trawls	*Nephrops* directed otter trawl	Beam trawlers	Other gears	*Nephrops* directed otter trawls	Other gears
	58%	31%	0%	11%	78%	22%
	15 t				765 t	

40.2 Information from the Industry

There was no information on the whiting stock from the industry.

40.3 Data

Data were provided by all countries according to the data call.

For WGCSE (2017) all data have been updated. Furthermore, to allow an age-based assessment, catch numbers-at-age, catch weights-at-age, stock weights-at-age have all be constructed since 2003. 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 Belgium and the UK(E&W). 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. This 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. Data from other UK and Belgium were available from 2012–2016. 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 2016 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 WKIRISH, 2 and investigated during WKIRISH, 3. 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 WKIRISH, 3. 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.

40.4 Historical stock development

Model used: ASAP; (XSA is also carried out for comparison)

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 WKIRISH, 3. 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.

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 40.11.

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} for since the early 1990s.

40.5 Short-term predictions

Short-term projections were performed using FLR libraries. Recruitment for 2017–2019 was estimated at 117 107 (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 2018 landings and 2019 SSB are shown in Figure 40.12. The 2014 year-class estimates from ASAP accounts for 60% projected landings in 2018. The 2017 GM assumption contributes considerably to the estimated SSB in 2019.

40.6 Medium-term projection

There is no analytical assessment for this stock.

40.7 MSY evaluations and Biological Reference Points

ICES carried out and evaluation of MSY and PA reference points for this stock at WKIRISH 3. The results are summarized below:

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	16 300 t	Bpa
Approach	F_{MSY}	0.22	Median point estimates of EqSim with combined SR
	B_{lim}	10 000 t	Below 10 000 t recruitment is impaired
Precautionary	B_{pa}	16 300 t	B_{lim} combined with the assessment error
Approach	F_{lim}	0.37	F with 50% probability of SSB less than B_{lim}
	F_{pa}	0.22	F_{lim} combined with the assessment error

40.8 Management plans

No management plan has been agreed or proposed.

40.9 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. Figure 40.10 shows a comparison between the final ASAP run and an XSA run. Both models with different structural assumptions show a consistent picture of stock trends.

Stock status classification relative to MSY proxies is given below.

	Fishing pressure				Stock size			
		2015	2016	2017		2015	2016	2017
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
Qualitative evaluation	-	↘	↘	↗ Increasing	-	↘	↗	↗ Increasing

40.10 Recommendations for next benchmark assessment

This stock was benchmarked in 2017 as part of the WKIRSH 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 two). 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.

40.11 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 ca. 1000 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 landing size (≥27 cm), whiting now mature well below this MLS.

40.12 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, 1988–2016, 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

Year	Belgium	France	Ireland	Netherlands	UK(NI, Engl. & Wales)	Spain	UK (Isle of Man)	UK (Scotland)	UK	Total human consumption
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
2016*	1	<0.5	44		5		<0.1			50

* Preliminary

Table 40.2. ICES estimates of discards, landings and catch of whiting in Division 7.a, 1988–2016.

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

[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

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	0	4239	2567	1795	87
1998	0	329	0	3287	4727	888	0
1999	1	341	0	2806	2607	741	0
2000	0	319	0	1364	1002	299	0
2001	0	111	0	1189	1006	171	0
2002	0	67	0	748	0	1480	376
2003	0	89	0	1051	606	0	199
2004	0	0	0	17	0	117	0
2005	0	0	0	101	0	216	0
2006	0	34	0	41	0	88	0
2007	0	24	0	41	0	32	0
2008	0	38	0	66	0	25	0
2009	0	65	0	44	0	22	0
2010	0	18	0	83	0	11	0
2011	0	1	0	17	0	59	0
2012	0	4	0	29	0	80	0
2013	8	81	0	36	0	20	0
2014	0	2	0	25	0	24	0
2015	0	0	0	9	0	44	0
2016	0	0	0	6	0	21	0

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

Table 40.6. Whiting in 7.a. Survey data available to WGCSE 2017.

NIGFS-WIBTS-Q1: Northern Ireland March Groundfish Survey

1993	2017						
1	1	0.21	0.25				
0	6						
1	665.6	710.3	81.2	11.7	4	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	373.3	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	3	0.1	2005
1	959.8	235.6	30.3	6.0	0	0.1	2006
1	905.0	158.6	14.9	2.7	0	0.0	2007
1	756.7	347.0	45.0	2.8	0	0.4	2008
1	1062.3	281.1	36.4	1.8	0.2	0.1	2009
1	739.4	545.8	51.6	4.7	6	0.0	2010
1	586.4	156.5	36.0	3.9	1	0.0	2011
1	972.2	354.4	42.3	5.9	1	0.0	2012
1	629.6	649.3	66.7	3.5	1	0.0	2013
1	922.1	367.6	67.0	4.3	0	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	0.0	2016
1	888.1	831.8	142.2	11.2	0.7	0.1	2017

Table 40.6. Whiting in 7.a. Survey data available to WGCSE 2017.

NIGFS-WIBTS-Q1: Northern Ireland October Groundfish Survey

1993	2016							
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	0.0	2016

Table 40.6. Whiting in 7.a. Survey data available to WGCSE 2017.

UK (E&W)-BTS-Q3: Corystes Irish Sea Beam-Trawl Survey - Prime stations only - Effort and numbers-at-age (per km towed).

1988	2015		
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

Table 40.6. Whiting in 7.a. Survey data available to WGCSE 2017.

NIMIK: Northern Ireland MIK Net Survey

1994	2015	
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

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
# Irish Sea Whiting
#
# ASAP GUI 15 AUG 2012
#
# Number of Years
37
# First Year
1980
# Number of Ages
7
# Number of Fleets
1
# Number of Sensitivity Blocks
2
# Number of Available Survey Indices
5
# Natural Mortality
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
1.078  0.803  0.718  0.608  0.554  0.518  0.518
# Fecundity Option
0
# Fraction of year that elapses prior to SSB calculation (0=Jan-1)
0
# Maturity
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
```

```
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
0  0  1  1  1  1  1
# Number of Weights-at-age Matrices
2
# Weight Matrix - 1
0.034   0.11    0.235   0.363   0.529   0.63    0.772
0.04    0.118   0.24    0.364   0.529   0.63    0.888
0.031   0.135   0.265   0.365   0.533   0.63    0.736
0.033   0.146   0.256   0.397   0.491   0.605   0.655
0.032   0.125   0.244   0.403   0.55    0.7     0.745
0.021   0.107   0.245   0.333   0.478   0.567   0.642
0.025   0.1     0.217   0.342   0.512   0.709   0.94
0.024   0.101   0.217   0.363   0.535   0.72    0.933
0.021   0.088   0.201   0.33    0.547   0.763   1.005
0.026   0.111   0.193   0.269   0.433   0.68    1.079
0.036   0.094   0.204   0.31    0.436   0.676   0.8
0.031   0.077   0.194   0.263   0.352   0.453   0.692
0.014   0.063   0.17    0.272   0.361   0.513   1.007
0.029   0.067   0.142   0.228   0.331   0.454   0.892
0.03    0.074   0.183   0.221   0.301   0.378   0.496
0.031   0.063   0.179   0.257   0.326   0.551   1.32
0.027   0.057   0.159   0.23    0.284   0.364   0.715
0.026   0.044   0.153   0.222   0.287   0.396   0.679
0.017   0.035   0.156   0.228   0.268   0.35    0.421
0.028   0.044   0.161   0.246   0.324   0.351   0.325
0.024   0.038   0.127   0.218   0.291   0.347   0.31
0.017   0.036   0.132   0.301   0.338   0.538   0.337
0.016   0.033   0.124   0.253   0.339   0.449   0.425
0.02    0.048   0.232   0.295   0.259   0.000   0
0.017   0.034   0.131   0.324   0.509   0.466   0
0.017   0.037   0.148   0.263   0.363   0.36    0.32
0.017   0.069   0.152   0.268   0.361   0.36    0.32
0.023   0.042   0.122   0.295   0.434   0.624   1.26
0.022   0.044   0.118   0.262   0.374   0.834   1.354
0.023   0.039   0.094   0.34    0.323   0.543   0.000
0.02    0.048   0.125   0.256   0.401   0.375   0.000
0.018   0.044   0.104   0.196   0.405   0.462   0.799
0.023   0.035   0.109   0.275   0.398   0.41    0.305
0.03    0.052   0.112   0.24    0.346   0.28    0.38
0.03    0.042   0.133   0.226   0.425   0.659   1.012
0.022   0.044   0.127   0.291   0.448   0.298   0.482
0.022   0.035   0.085   0.195   0.341   0.466   0.882
# Weight Matrix - 2
0   0.0733  0.1733  0.2992  0.446   0.5795  0.7203
0   0.0785  0.1797  0.3003  0.4468  0.5795  0.7143
0   0.084   0.1873  0.311   0.4408  0.576   0.6948
```

```
0   0.085   0.194   0.321   0.45    0.5813  0.6668
0   0.079   0.1918  0.3163  0.4473  0.5743  0.6628
0   0.0697  0.1807  0.3038  0.4455  0.5825  0.6998
0   0.0643  0.1685  0.2907  0.4338  0.5893  0.7485
0   0.0598  0.1572  0.2857  0.4387  0.6195  0.8123
0   0.0617  0.15    0.2662  0.425   0.6262  0.8682
0   0.0607  0.1497  0.2533  0.3963  0.6057  0.8412
0   0.0608  0.1473  0.24    0.355   0.5375  0.7817
0   0.0545  0.1417  0.2393  0.3318  0.4772  0.718
0   0.048   0.1233  0.2218  0.3148  0.4282  0.7055
0   0.0463  0.117   0.2045  0.2927  0.3982  0.6358
0   0.0462  0.118   0.2002  0.2798  0.396   0.6755
0   0.0473  0.1208  0.202   0.2695  0.3752  0.6523
0   0.042   0.1142  0.205   0.2675  0.3703  0.6678
0   0.0367  0.1053  0.1952  0.258   0.3345  0.521
0   0.0322  0.101   0.194   0.2598  0.3227  0.4225
0   0.0313  0.0945  0.1937  0.2632  0.3212  0.3588
0   0.0312  0.0895  0.2015  0.2742  0.3532  0.3367
0   0.0293  0.0835  0.1987  0.2888  0.3812  0.3847
0   0.029   0.0992  0.2054  0.2847  0.4021  0.4114
0   0.0281  0.1007  0.2267  0.3261  0.3847  0.4357
0   0.0288  0.1045  0.2282  0.3338  0.3984  0.4062
0   0.0323  0.0918  0.2277  0.3525  0.3862  0.3827
0   0.0331  0.0939  0.2097  0.3355  0.4296  0.5145
0   0.0352  0.0901  0.2082  0.3326  0.4961  0.7133
0   0.0311  0.0815  0.2152  0.3261  0.5283  0.9183
0   0.0331  0.077   0.1989  0.3325  0.4804  0.9181
0   0.0326  0.0756  0.1883  0.3311  0.4127  0.784
0   0.0313  0.078   0.175   0.3326  0.3957  0.5933
0   0.032   0.0753  0.1748  0.3127  0.3924  0.455
0   0.0334  0.0808  0.1777  0.3134  0.4162  0.4746
0   0.0369  0.0836  0.1851  0.3267  0.4009  0.5369
0   0.0339  0.0805  0.1806  0.3283  0.4403  0.6021
0   0.0328  0.0745  0.1862  0.3264  0.4092  0.5803
# 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
2
2
2
2
2
2
2
2
2
2
2
2
2
2
```

```
2
2
2
2
2
2
2
2
# Selectivity Options for each block 1=by age, 2=logisitic, 3=double logistic
2  2
# Selectivity Block #1 Data
0    1  0   0.25
0.5  1  0   0.25
0.9  1  0   0.25
1   -1  0   0.25
1   -1  0   0.25
1   -1  0   0.25
1   -1  0   0.25
3    1  0   1
0.5  1  0   1
0   0   0   0
0   0   0   0
0   0   0   0
0   0   0   0
# Selectivity Block #2 Data
0.2  1   0   0.5
1   -1   0   0
1   -1   0   0
1   -1   0   0
1   -1   0   0
1   -1   0   0
1   -1   0   0
2    1   0   1
0.5  1   0   1
0    0   0   0
0    0   0   0
0    0   0   0
0    0   0   0
# Fleet Start Age
1
# Fleet End Age
7
# Age Range for Average F
2  4
# Average F report option (1=unweighted, 2=Nweighted, 3=Bweighted)
1
# Use Likelihood constants? (1=yes)
1
# Release Mortality by Fleet
1
# Catch Data
# Fleet-1 Catch Data
12786   46838   28699   6533    2574    350     621     16737
9865    36138   38173   16166   2622    821     339     21331
4088    13916   18658   19359   6108    813     400     17969
23847   12214   11979   9109    4530    1165    321     12405
26394   52154   14250   5268    2571    1045    402     14999
12380   42001   37183   8696    996     675     372     18169
28364   27417   18303   10842   1877    285     270     12129
16594   50747   23438   6968    1943    242     111     14270
6922    24941   27708   6989    1513    396     197     11856
17247   32346   16505   13037   3645    490     177     13408
4216    41312   20957   4806    1477    318     128     10656
20451   36760   22229   5975    994     311     84      9946
1497    69831   32311   8056    1374    462     93      12791
12677   16721   39175   7753    937     135     27      9230
3731    15308   8795    20211   1830    208     50      7936
7118    18737   17110   3512    4678    233     21      7044
12861   41299   14330   9408    1344    1082    135     7966
8163    26107   9591    3256    1936    87      79      4205
6096    27460   5580    5277    932     261     95      3533
```

```
20852   8018    4923    2835    776     161     121     2762
7321    39242   5758    1566    354     115     25      2880
16940   12742   4338    1108    181     53      20      1745
8538    13480   2336    1710    408     48      42      1487
12389   4685    1252    606     199     0       0   996
19699   14938   362     176     150     17      0   1038
643     5797    448     232     98      21      3   397
15764   20624   654     109     39      9       1   1837
17436   24343   787     82      10      3       0   1547
10645   20032   742     41      5       1       0   1206
6622    27513   1220    22      4       1       0   1360
3946    15120   2894    75      4       0       0   1184
25982   8198    675     373     15      3       0   977
6637    31023   819     116     61      12      1   1399
8501    12026   649     24      5       1       1   981
13467   27555   2450    284     21      1       1   1974
3883    23595   2613    267     15      1       1   1549
4504    5773    4802    307     21      2       0   780
# 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   0   0   0   0
0   0   0   0   0   0   0   0
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   0   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  2  2  2
# Age Proportion Index Units
2  2  2  2  2
# Weight-at-age Matrix
1  1  1  1  1
# Index Month
3  10  5  9  5
# Index Selectivity Link to Fleet
-1  -1  -1  -1  -1
# Index Selectivity Options 1=by age, 2=logisitic, 3=double logistic
1  1  1  1  2
# Index Start Age
2  1  1  1  2
# Index End Age
7  7  1  2  7
# Estimate Proportion (Yes=1)
1  1  0  0  0
# Use Index (Yes=1)
1  1  1  0  0
# Index-1 Selectivity Data
0    -1   0   0
0.5  1    0   0.5
1    -1   0   0
1    -1   0   0
1    -1   0   0
1    -1   0   0
1    -1   0   0
2     1   0   1
0.5  1    0   1
0     0   0   0
0     0   0   0
0     0   0   0
0     0   0   0
# Index-2 Selectivity Data
0.2  1    0   0.5
0.5  1    0   0.5
1    -1   0   0
1    -1   0   0
1    -1   0   0
1    -1   0   0
1    -1   0   0
2     1   0   1
0.5  1    0   1
0     0   0   0
0     0   0   0
0     0   0   0
```

```
0    0   0   0
# Index-3 Selectivity Data
1   -1   0   0
0   -1   0   0
0   -1   0   0
0   -1   0   0
0   -1   0   0
0   -1   0   0
0   -1   0   0
0   0   0   0
0   0   0   0
0   0   0   0
0   0   0   0
0   0   0   0
0   0   0   0
# Index-4 Selectivity Data
1   -1      0   1
1   -1      0   0
1   -1      0   0
1   -1      0   0
1   -1      0   0
1   -1      0   0
1   -1      0   0
0   0   0   0
0   0   0   0
0   0   0   0
0   0   0   0
0   0   0   0
0   0   0   0
# Index-5 Selectivity 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
4   1   0   1
0.5     1   0   1
0   0   0   0
0   0   0   0
0   0   0   0
0   0   0   0
# Index-1 Data
1980  0   0   0   0   0   0   0   0   0   0
1981  0   0   0   0   0   0   0   0   0   0
1982  0   0   0   0   0   0   0   0   0   0
1983  0   0   0   0   0   0   0   0   0   0
1984  0   0   0   0   0   0   0   0   0   0
1985  0   0   0   0   0   0   0   0   0   0
1986  0   0   0   0   0   0   0   0   0   0
1987  0   0   0   0   0   0   0   0   0   0
1988  0   0   0   0   0   0   0   0   0   0
1989  0   0   0   0   0   0   0   0   0   0
1990  0   0   0   0   0   0   0   0   0   0
1991  0   0   0   0   0   0   0   0   0   0
1992  0   0   0   0   0   0   0   0   0   0
1993  1474    0.3     0   0.452   0.482   0.055   0.008   0.003   0.001
50
1994  2431    0.3     0   0.742   0.108   0.123   0.018   0.005   0.003
50
1995  2615    0.3     0   0.646   0.243   0.067   0.034   0.008   0.002
50
1996  2093    0.3     0   0.702   0.16    0.102   0.017   0.018   0.003
50
1997  3169    0.3     0   0.444   0.485   0.049   0.017   0.001   0.004
50
1998  2694    0.3     0   0.551   0.28    0.154   0.011   0.003   0.001
50
1999  1900    0.3     0   0.721   0.196   0.059   0.022   0.002   0.001
50
```

```
2000  2925    0.3     0   0.787   0.14    0.062   0.009   0.001   0
50
2001  1909    0.3     0   0.558   0.365   0.065   0.007   0.003   0.001
50
2002  3235    0.3     0   0.713   0.212   0.054   0.016   0.003   0
50
2003  2543    0.3     0   0.588   0.356   0.051   0.004   0.001   0
50
2004  1907    0.3     0   0.844   0.121   0.032   0.001   0.001   0
50
2005  857     0.3     0   0.804   0.145   0.033   0.014   0.003   0
50
2006  1232    0.3     0   0.779   0.191   0.025   0.005   0       0
50
2007  1081    0.3     0   0.837   0.147   0.014   0.002   0       0
50
2008  1152    0.3     0   0.657   0.301   0.039   0.002   0       0
50
2009  1382    0.3     0   0.769   0.203   0.026   0.001   0       0
50
2010  1348    0.3     0   0.549   0.405   0.038   0.003   0.005   0
50
2011  783     0.3     0   0.749   0.2     0.046   0.005   0.001   0
50
2012  1376    0.3     0   0.707   0.258   0.031   0.004   0.001   0
50
2013  1350    0.3     0   0.466   0.481   0.049   0.003   0       0
50
2014  1361    0.3     0   0.677   0.27    0.049   0.003   0       0
50
2015  3288    0.3     0   0.851   0.143   0.006   0.001   0       0
50
2016  2374    0.3     0   0.594   0.39    1E-06   0.016   0.001   0
50
# Index-2 Data
1980  0   0   0   0   0   0   0   0   0   0
1981  0   0   0   0   0   0   0   0   0   0
1982  0   0   0   0   0   0   0   0   0   0
1983  0   0   0   0   0   0   0   0   0   0
1984  0   0   0   0   0   0   0   0   0   0
1985  0   0   0   0   0   0   0   0   0   0
1986  0   0   0   0   0   0   0   0   0   0
1987  0   0   0   0   0   0   0   0   0   0
1988  0   0   0   0   0   0   0   0   0   0
1989  0   0   0   0   0   0   0   0   0   0
1990  0   0   0   0   0   0   0   0   0   0
1991  0   0   0   0   0   0   0   0   0   0
1992  0   0   0   0   0   0   0   0   0   0
1993  2309    0.3     0.309   0.451   0.206   0.029   0.004   0.001   0
50
1994  2829    0.3     0.393   0.467   0.074   0.053   0.012   0.001   0
50
1995  3841    0.3     0.813   0.124   0.043   0.008   0.009   0.001   0
50
1996  3103    0.3     0.743   0.191   0.043   0.017   0.003   0.002   0
50
1997  3889    0.3     0.675   0.174   0.128   0.016   0.005   0.001
0.001  50
1998  3566    0.3     0.803   0.131   0.043   0.02    0.002   0.001   0
50
1999  3851    0.3     0.644   0.28    0.05    0.013   0.011   0.001   0
50
2000  3631    0.3     0.654   0.299   0.035   0.006   0.005   0.002
0.001  50
2001  7322    0.3     0.868   0.09    0.037   0.004   0.001   0       0
50
2002  4331    0.3     0.622   0.305   0.062   0.01    0.001   0       0
50
2003  7017    0.3     0.631   0.224   0.131   0.011   0.002   0       0
50
2004  5545    0.3     0.804   0.126   0.048   0.021   0.001   0       0
50
```

```
2005  3066   0.3    0.775   0.159   0.06    0.005   0       0       0
50
2006  3050   0.3    0.934   0.047   0.015   0.003   0.001   0       0
50
2007  3296   0.3    0.656   0.291   0.045   0.005   0.001   0.001   0
50
2008  6315   0.3    0.773   0.208   0.018   0.001   0       0       0
50
2009  2838   0.3    0.791   0.18    0.025   0.003   0.001   0       0
50
2010  2855   0.3    0.797   0.109   0.091   0.003   0       0       0
50
2011  4053   0.3    0.872   0.086   0.034   0.006   0.001   0       0
50
2012  1894   0.3    0.703   0.213   0.071   0.01    0.003   0       0
50
2013  7680   0.3    0.929   0.046   0.02    0.004   0       0       0
50
2014  5157   0.3    0.873   0.098   0.026   0.002   0       0       0
50
2015  3816   0.3    0.734   0.234   0.03    0.002   0       0       0
50
2016  3817   0.3    0.712   0.225   0.053   0.008   0       0       0
50
# Index-3 Data
1980  0   0   0   0   0   0   0   0   0   0
1981  0   0   0   0   0   0   0   0   0   0
1982  0   0   0   0   0   0   0   0   0   0
1983  0   0   0   0   0   0   0   0   0   0
1984  0   0   0   0   0   0   0   0   0   0
1985  0   0   0   0   0   0   0   0   0   0
1986  0   0   0   0   0   0   0   0   0   0
1987  0   0   0   0   0   0   0   0   0   0
1988  0   0   0   0   0   0   0   0   0   0
1989  0   0   0   0   0   0   0   0   0   0
1990  0   0   0   0   0   0   0   0   0   0
1991  0   0   0   0   0   0   0   0   0   0
1992  0   0   0   0   0   0   0   0   0   0
1993  0   0   0   0   0   0   0   0   0   0
1994  778     0.5    0   0   0   0   0   0   0   0
1995  225     0.5    0   0   0   0   0   0   0   0
1996  397     0.5    0   0   0   0   0   0   0   0
1997  205     0.5    0   0   0   0   0   0   0   0
1998  59      0.5    0   0   0   0   0   0   0   0
1999  91      0.5    0   0   0   0   0   0   0   0
2000  40      0.5    0   0   0   0   0   0   0   0
2001  167     0.5    0   0   0   0   0   0   0   0
2002  19      0.5    0   0   0   0   0   0   0   0
2003  148     0.5    0   0   0   0   0   0   0   0
2004  101     0.5    0   0   0   0   0   0   0   0
2005  135     0.5    0   0   0   0   0   0   0   0
2006  118     0.5    0   0   0   0   0   0   0   0
2007  82      0.5    0   0   0   0   0   0   0   0
2008  99      0.5    0   0   0   0   0   0   0   0
2009  173     0.5    0   0   0   0   0   0   0   0
2010  78      0.5    0   0   0   0   0   0   0   0
2011  122.2   0.5    0   0   0   0   0   0   0   0
2012  123.9   0.5    0   0   0   0   0   0   0   0
2013  197.6   0.5    0   0   0   0   0   0   0   0
2014  54.9    0.5    0   0   0   0   0   0   0   0
2015  59.5    0.5    0   0   0   0   0   0   0   0
2016  6.7     0.5    0   0   0   0   0   0   0   0
# Index-4 Data
1980  0   0   0   0   0   0   0   0   0   0
1981  0   0   0   0   0   0   0   0   0   0
1982  0   0   0   0   0   0   0   0   0   0
1983  0   0   0   0   0   0   0   0   0   0
1984  0   0   0   0   0   0   0   0   0   0
1985  0   0   0   0   0   0   0   0   0   0
1986  0   0   0   0   0   0   0   0   0   0
1987  0   0   0   0   0   0   0   0   0   0
1988  96      0.5    0   0   0   0   0   0   0   0
```

```
1989  93      0.5     0   0   0   0   0   0   0   0
1990  99      0.5     0   0   0   0   0   0   0   0
1991  216     0.5     0   0   0   0   0   0   0   0
1992  405     0.5     0   0   0   0   0   0   0   0
1993  253     0.5     0   0   0   0   0   0   0   0
1994  205     0.5     0   0   0   0   0   0   0   0
1995  1949    0.5     0   0   0   0   0   0   0   0
1996  169     0.5     0   0   0   0   0   0   0   0
1997  409     0.5     0   0   0   0   0   0   0   0
1998  893     0.5     0   0   0   0   0   0   0   0
1999  550     0.5     0   0   0   0   0   0   0   0
2000  320     0.5     0   0   0   0   0   0   0   0
2001  585     0.5     0   0   0   0   0   0   0   0
2002  280     0.5     0   0   0   0   0   0   0   0
2003  456     0.5     0   0   0   0   0   0   0   0
2004  917     0.5     0   0   0   0   0   0   0   0
2005  849     0.5     0   0   0   0   0   0   0   0
2006  1010    0.5     0   0   0   0   0   0   0   0
2007  339     0.5     0   0   0   0   0   0   0   0
2008  780     0.5     0   0   0   0   0   0   0   0
2009  389     0.5     0   0   0   0   0   0   0   0
2010  324     0.5     0   0   0   0   0   0   0   0
2011  1002    0.5     0   0   0   0   0   0   0   0
2012  442     0.5     0   0   0   0   0   0   0   0
2013  1535    0.5     0   0   0   0   0   0   0   0
2014  261     0.5     0   0   0   0   0   0   0   0
2015  211     0.5     0   0   0   0   0   0   0   0
2016  666     0.5     0   0   0   0   0   0   0   0
# Index-5 Data
1980  0   0   0   0   0   0   0   0   0   0
1981  0   0   0   0   0   0   0   0   0   0
1982  0   0   0   0   0   0   0   0   0   0
1983  0   0   0   0   0   0   0   0   0   0
1984  0   0   0   0   0   0   0   0   0   0
1985  0   0   0   0   0   0   0   0   0   0
1986  0   0   0   0   0   0   0   0   0   0
1987  0   0   0   0   0   0   0   0   0   0
1988  0   0   0   0   0   0   0   0   0   0
1989  0   0   0   0   0   0   0   0   0   0
1990  0   0   0   0   0   0   0   0   0   0
1991  0   0   0   0   0   0   0   0   0   0
1992  0   0   0   0   0   0   0   0   0   0
1993  0   0   0   0   0   0   0   0   0   0
1994  0   0   0   0   0   0   0   0   0   0
1995  0   0   0   0   0   0   0   0   0   0
1996  0   0   0   0   0   0   0   0   0   0
1997  0   0   0   0   0   0   0   0   0   0
1998  0   0   0   0   0   0   0   0   0   0
1999  0   0   0   0   0   0   0   0   0   0
2000  0   0   0   0   0   0   0   0   0   0
2001  0   0   0   0   0   0   0   0   0   0
2002  0   0   0   0   0   0   0   0   0   0
2003  0   0   0   0   0   0   0   0   0   0
2004  0   0   0   0   0   0   0   0   0   0
2005  38.66   0.5     0   0   0   0   0   0   0   0
2006  72.953  0.5     0   0   0   0   0   0   0   0
2007  21.87   0.5     0   0   0   0   0   0   0   0
2008  25.23   0.5     0   0   0   0   0   0   0   0
2009  164.82  0.5     0   0   0   0   0   0   0   0
2010  111.12  0.5     0   0   0   0   0   0   0   0
2011  48.6    0.5     0   0   0   0   0   0   0   0
2012  139.25  0.5     0   0   0   0   0   0   0   0
2013  82.85   0.5     0   0   0   0   0   0   0   0
2014  0   0   0   0   0   0   0   0   0   0
2015  0   0   0   0   0   0   0   0   0   0
2016  0   0   0   0   0   0   0   0   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
2
# Phase for Catchability Deviations
-5
# Phase for Stock Recruitment Relationship
3
# 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
1
1
1
1
1
1
1
1
1
1
1
# Lambdas by Index
1  1  1  1  1
# Lambda for Total Catch in Weight by Fleet
1
# Lambda for Total Discards at Age by Fleet
0
# Catch Total CV by Year and Fleet
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
```

```
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
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
0
0
0
0
0
0
0
0
0
0
0
# Catch Effective Sample Size by Year and Fleet
10
10
10
10
10
10
10
10
10
10
10
10
```

```
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
# 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
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
0.9
# Lambda for F Mult Deviations by Fleet
0
# CV for F Mult Deviations by Fleet
0.9
# Lambda for N in 1st Year Deviations
```

```
0
# CV for N in 1st Year Deviations
.9
# Lambda for Recruitment Deviations
.1
# Lambda for Catchability in First year by Index
0  0  0  0  0
# CV for Catchability in First year by Index
0.9  0.9  0.9  0.9  .9
# Lambda for Catchability Deviations by Index
0  0  0  0  0
# CV for Catchability Deviations by Index
.9  .9  .9  .9  .9
# Lambda for Deviation from Initial Steepness
0
# CV for Deviation from Initial Steepness
.9
# Lambda for Deviation from Unexploited Stock Size
0
# CV for Deviation from Unexploited Stock Size
.9
# NAA Deviations Flag
1
# Initial Numbers-at-age in 1st Year
1000000  500000  250000  125000  60000  30000  10000
# Initial F Mult in 1st Year by Fleet
1
# Initial Catchabilty by Index
.001  .001  .001  .001  0.001
# 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
2017
# Projection Data by Year
2017 -1     3 -99    1
# Do MCMC (Yes=1)
0
# MCMC Year Option
1
# MCMC Iterations
0
# MCMC Thinning Factor
0
# MCMC Random Seed
0
# Agepro R Option
-1
# Agepro R Option Start Year
0
# Agepro R Option End Year
0
# Export R Flag
1
# Test Value
-23456
######
###### FINIS ######
# Fleet Names
#$All
```

```
# Survey Names
#$NI-Q1
#$NI_Q2
#$NI-MIK
#$UK-BTS
#$UK-FSP
#
```

Table 40.8. Whiting 7.a. Selectivity of the catches and indices.

Age	Catch	NI-Q1	NI-Q4	NI-MIK
0	0.124	0.000	0.667	1.000
1	0.862	0.568	0.755	0.000
2	0.996	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	0.026	0.173	0.431	0.513	0.524	0.525	0.526
1981	0.032	0.207	0.516	0.614	0.627	0.629	0.629
1982	0.035	0.229	0.57	0.679	0.693	0.695	0.695
1983	0.036	0.233	0.579	0.69	0.704	0.706	0.706
1984	0.044	0.286	0.71	0.846	0.863	0.865	0.866
1985	0.053	0.347	0.862	1.027	1.048	1.05	1.051
1986	0.041	0.27	0.671	0.799	0.816	0.818	0.818
1987	0.044	0.286	0.713	0.848	0.866	0.868	0.868
1988	0.037	0.243	0.604	0.719	0.734	0.735	0.735
1989	0.052	0.34	0.847	1.008	1.029	1.031	1.032
1990	0.044	0.289	0.718	0.855	0.873	0.875	0.875
1991	0.044	0.289	0.72	0.857	0.875	0.877	0.877
1992	0.071	0.468	1.164	1.386	1.415	1.418	1.419
1993	0.057	0.371	0.923	1.099	1.122	1.124	1.124
1994	0.059	0.384	0.955	1.137	1.161	1.163	1.164
1995	0.105	0.73	0.843	0.846	0.846	0.846	0.846
1996	0.114	0.797	0.921	0.924	0.924	0.924	0.924
1997	0.1	0.694	0.802	0.805	0.805	0.805	0.805
1998	0.139	0.968	1.119	1.123	1.123	1.123	1.123
1999	0.11	0.765	0.884	0.887	0.887	0.887	0.887
2000	0.143	0.999	1.155	1.159	1.159	1.159	1.159
2001	0.116	0.81	0.936	0.939	0.939	0.939	0.939
2002	0.158	1.103	1.274	1.279	1.279	1.279	1.279
2003	0.079	0.549	0.634	0.636	0.636	0.636	0.636
2004	0.217	1.513	1.749	1.755	1.755	1.755	1.755
2005	0.057	0.397	0.458	0.46	0.46	0.46	0.46
2006	0.194	1.353	1.563	1.569	1.569	1.569	1.569
2007	0.153	1.065	1.23	1.235	1.235	1.235	1.235
2008	0.123	0.86	0.994	0.998	0.998	0.998	0.998
2009	0.14	0.977	1.129	1.133	1.133	1.133	1.133
2010	0.145	1.013	1.171	1.175	1.175	1.175	1.175
2011	0.109	0.762	0.881	0.884	0.884	0.884	0.884
2012	0.144	1.004	1.16	1.164	1.164	1.164	1.164
2013	0.083	0.577	0.667	0.669	0.669	0.669	0.669
2014	0.186	1.298	1.5	1.505	1.505	1.505	1.505
2015	0.117	0.815	0.941	0.945	0.945	0.945	0.945
2016	0.074	0.513	0.593	0.595	0.595	0.595	0.595

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	634875	387588	123018	20634	7315	1005	1793
1981	322564	210395	145994	38980	6722	2489	986
1982	285178	106342	76594	42499	11480	2063	1104
1983	880701	93704	37878	21119	11733	3298	942
1984	630674	289221	33255	10350	5768	3334	1247
1985	513723	205458	97383	7972	2419	1398	1148
1986	870583	165806	65079	20053	1555	487	530
1987	474957	284290	56706	16218	4908	395	268
1988	488278	154708	95634	13562	3780	1186	166
1989	601748	160113	54375	25508	3599	1043	386
1990	523266	194402	51036	11373	5068	739	303
1991	686554	170386	65252	12139	2634	1217	259
1992	229804	223533	57154	15496	2805	631	366
1993	214792	72810	62714	8703	2110	392	144
1994	184671	69069	22510	12157	1580	395	104
1995	343300	59265	21077	4225	2123	284	93
1996	204896	105204	12798	4424	987	523	96
1997	172204	62190	21247	2486	956	225	147
1998	168308	53039	13912	4645	605	246	99
1999	209650	49842	9022	2216	823	113	67
2000	109785	63920	10387	1817	497	195	44
2001	193639	32367	10542	1597	311	90	45
2002	80493	58659	6449	2016	340	70	31
2003	121095	23381	8722	879	306	54	17
2004	95987	38086	6051	2257	253	93	22
2005	106343	26286	3756	513	212	25	12
2006	155909	34184	7920	1158	177	77	14
2007	104358	43690	3958	809	131	21	11
2008	149762	30479	6748	564	128	22	6
2009	93394	45042	5776	1218	113	27	6
2010	93123	27623	7597	911	214	21	6
2011	152628	27399	4491	1149	153	38	5
2012	79945	46555	5727	908	258	36	11
2013	160974	23555	7645	876	154	46	9
2014	202376	50421	5924	1914	244	45	17
2015	111405	57162	6168	645	231	31	8
2016	73818	33726	11338	1174	136	52	9
2017	117107	23335	9043	3056	352	43	20

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	16687.64	61039.66	32629.44	0.327925	634875.4	0.325387	0.372722	0.322519
1981	18267	3064	21331	21129.98	59606.34	43090.35	0.245206	322563.9	0.42311	0.446001	0.293789
1982	17167	801	17969	17946	43511.25	34578.53	0.266949	285177.6	0.443759	0.492886	0.329732
1983	10577	1829	12405	12366.03	29917.51	21952.64	0.344642	880700.7	0.252594	0.500751	0.388257
1984	11619	3380	14999	14738.96	37821.26	14972.78	0.411413	630673.8	0.313125	0.61383	0.355033
1985	15525	2644	18169	17965.82	37034.95	22714.54	0.293134	513722.7	0.343337	0.745188	0.325287
1986	10063	2066	12129	12084.56	28815.08	18153.78	0.321255	870583.4	0.261595	0.580289	0.350309
1987	10411	3859	14270	14068.29	33163.48	16162.93	0.336758	474957.3	0.345989	0.615815	0.325033
1988	10245	1611	11856	11797.72	29994.02	20448.57	0.27866	488278.1	0.322398	0.521575	0.327604
1989	11305	2103	13408	13406.66	26702.97	16984.09	0.306192	601747.5	0.266623	0.731667	0.323508
1990	8212	2444	10656	10637.54	24500.52	12680.86	0.327651	523266.1	0.249663	0.620573	0.30836
1991	7348	2598	9946	9918.658	23077.41	13791.4	0.261504	686553.7	0.16746	0.621965	0.255336
1992	8588	4203	12791	12552.23	22624.92	11895.34	0.208485	229804.5	0.152229	1.006027	0.186953
1993	6523	2707	9230	6907.15	13353.19	9982.075	0.152894	214792	0.130685	0.797363	0.171076
1994	6763	1173	7936	5074.371	8949.334	5758.361	0.163857	184670.7	0.137223	0.825295	0.17784
1995	4893	2151	7044	4585.322	6942.186	4138.936	0.166379	343300.4	0.118564	0.806319	0.172512
1996	4335	3631	7966	4417.117	7309.3	2890.724	0.18824	204896.3	0.128812	0.880345	0.149828
1997	2277	1928	4205	3030.9	5403.375	3121.015	0.1527	172203.5	0.139538	0.767375	0.167845
1998	2229	1304	3533	2907.449	4292.339	2584.476	0.161166	168307.7	0.130493	1.069987	0.168909
1999	1670	1092	2762	2270.118	3118.85	1558.802	0.198781	209649.7	0.127885	0.845638	0.179119
2000	762	2118	2880	2372.386	3510.023	1515.725	0.191011	109784.6	0.139391	1.10422	0.154797
2001	733	1012	1745	1641.008	2286.874	1338.526	0.173713	193638.9	0.130625	0.895241	0.184889
2002	747	740	1487	1899.731	2892.649	1191.53	0.194397	80492.75	0.136273	1.218762	0.161237
2003	517	480	996	1277.829	1862.462	1205.466	0.173136	121095	0.149346	0.606273	0.238655
2004	133	905	1038	2085.752	2374.888	1278.009	0.196704	95986.93	0.125111	1.672411	0.175214
2005	125	272	397	500.1733	1399.921	550.8759	0.266067	106343.1	0.138711	0.438244	0.280962
2006	64	1773	1837	2601.818	2217.654	1086.157	0.218679	155908.8	0.126074	1.495156	0.184161
2007	35	1512	1547	1540.226	2125.135	587.2439	0.272323	104358	0.13103	1.176623	0.171414
2008	37	1169	1206	1288.862	1677.813	729.914	0.210066	149762.2	0.124771	0.95073	0.194535
2009	39	1321	1360	1505.441	2234.113	743.2255	0.214228	93394.39	0.133541	1.079439	0.177648
2010	30	1154	1184	1455.614	1730.781	830.2582	0.193554	93122.57	0.128358	1.1199	0.19216
2011	31	946	977	988.2198	1477.868	620.2893	0.232569	152628.2	0.125678	0.842261	0.199523
2012	60	1339	1399	1439.404	2179.637	689.8764	0.214981	79944.65	0.135581	1.108899	0.175336
2013	33	948	981	1035.754	1632.012	845.2731	0.201059	160974.5	0.140252	0.637902	0.223498
2014	23	1951	1974	2632.195	2817.076	956.5321	0.21211	202375.9	0.1221	1.434274	0.188249
2015	28	1521	1549	1689.851	2645.404	707.6253	0.263233	111404.7	0.159114	0.900314	0.217968
2016	15	765	780	833.5219	2240.35	1134.145	0.231567	73817.9	0.248598	0.56715	0.313215
2017*	NA	NA	NA	NA	NA	1426.148	NA	117107	NA	0.967246	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.

2017										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	117107	1.078	0	0	0	0	0	0.092	0.126	0.025
1	23335	0.803	0	0	0	0.035	0.103	0.128	0.772	0.04
2	9043	0.718	1	0	0	0.08	0.477	0.277	0.535	0.114
3	3056	0.608	1	0	0	0.184	0.795	0.374	0.22	0.225
4	352	0.554	1	0	0	0.327	0.958	0.46	0.057	0.401
5	43	0.518	1	0	0	0.417	1.007	0.477	0.008	0.155
6	20	0.518	1	0	0	0.573	1.002	0.796	0.013	0

2018										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	117107	1.078	0	0	0	0	0	0.092	0.126	0.025
1	35145	0.803	0	0	0	0.035	0.103	0.128	0.772	0.04
2	4356	0.718	1	0	0	0.08	0.477	0.277	0.535	0.114
3	1604	0.608	1	0	0	0.184	0.795	0.374	0.22	0.225
4	603	0.554	1	0	0	0.327	0.958	0.46	0.057	0.401
5	73	0.518	1	0	0	0.417	1.007	0.477	0.008	0.155
6	14	0.518	1	0	0	0.573	1.002	0.796	0.013	0

2019										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	117107	1.078	0	0	0	0	0	0.092	0.126	0.025
1	35145	0.803	0	0	0	0.035	0.103	0.128	0.772	0.04
2	6561	0.718	1	0	0	0.08	0.477	0.277	0.535	0.114
3	773	0.608	1	0	0	0.184	0.795	0.374	0.22	0.225
4	317	0.554	1	0	0	0.327	0.958	0.46	0.057	0.401
5	126	0.518	1	0	0	0.417	1.007	0.477	0.008	0.155
6	19	0.518	1	0	0	0.573	1.002	0.796	0.013	0

Table 40.13. Whiting7.a .Single-option output of the short-term forecast (F = mean $F_{2014-2016}$). Numbers in thousands, weights in tonnes.

2017										
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.126	8553	211	117107	0	0	0
1	0.103	0	0	0.772	9898	399	23335	806	0	0
2	0.477	22	6	0.535	4329	493	9043	719	9043	719
3	0.795	163	61	0.22	1371	309	3056	562	3056	562
4	0.958	112	51	0.057	69	28	352	115	352	115
5	1.007	22	11	0.008	0	0	43	18	43	18
6	1.002	10	8	0.013	0	0	20	11	20	11
Total	0.458	329	137	0.509	24220	1440	152956	2231	12514	1425

2018										
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.126	8553	211	117107	0	0	0
1	0.103	0	0	0.772	14908	601	35145	1214	0	0
2	0.477	10	3	0.535	2085	238	4356	346	4356	346
3	0.795	85	32	0.22	720	162	1604	295	1604	295
4	0.958	191	88	0.057	118	47	603	197	603	197
5	1.007	38	18	0.008	0	0	73	31	73	31
6	1.002	7	6	0.013	0	0	14	8	14	8
Total	0.458	331	147	0.509	26384	1259	158902	2091	6650	877

2019										
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.126	8553	211	117107	0	0	0
1	0.103	0	0	0.772	14908	601	35145	1214	0	0
2	0.477	16	4	0.535	3141	358	6561	522	6561	522
3	0.795	41	15	0.22	347	78	773	142	773	142
4	0.958	100	46	0.057	62	25	317	104	317	104
5	1.007	65	31	0.008	0	0	126	52	126	52
6	1.002	10	8	0.013	0	0	19	11	19	11
Total	0.458	232	104	0.509	27011	1273	160048	2045	7796	831

Table 40.14. Whiting7.a. Management options table. Weights in tonnes.

Fmult	Catch18	Land18	Dis18	Basis	FCatch18	FLand18	FDis18	SSB19	dSSB	dTac
0	0	0	0		0	NA	NA	2103	139.80%	-100%
0.1	190	21	169		0.09672	0.00376	0.09297	1916	118.47%	-73.75%
0.2	366	41	326		0.19345	0.00752	0.18593	1746	99.09%	-48.75%
0.3	530	58	472		0.29017	0.01128	0.2789	1591	81.41%	-27.50%
0.4	683	75	608		0.3869	0.01504	0.37186	1449	65.22%	-6.25%
0.5	825	90	735		0.48362	0.0188	0.46483	1321	50.63%	12.50%
0.6	957	103	854		0.58035	0.02256	0.55779	1204	37.29%	28.75%
0.7	1081	115	965		0.67707	0.02632	0.65076	1097	25.09%	43.75%
0.8	1196	127	1070		0.7738	0.03008	0.74372	1000	14.03%	58.75%
0.9	1305	137	1167		0.87052	0.03384	0.83669	911	3.88%	71.25%
1	1406	147	1259		0.96725	0.0376	0.92965	831	-5.25%	83.75%
1.1	1501	155	1345		1.06397	0.04136	1.02262	757	-13.68%	93.75%
1.2	1590	163	1427		1.1607	0.04511	1.11558	690	-21.32%	103.75%
1.3	1674	171	1503		1.25742	0.04887	1.20855	629	-28.28%	113.75%
1.4	1753	178	1576		1.35414	0.05263	1.30151	574	-34.55%	122.50%
1.5	1828	184	1644		1.45087	0.05639	1.39448	523	-40.37%	130%
1.6	1898	189	1709		1.54759	0.06015	1.48744	477	-45.61%	136.25%
1.7	1965	195	1770		1.64432	0.06391	1.58041	435	-50.40%	143.75%
1.8	2028	200	1828		1.74104	0.06767	1.67337	396	-54.85%	150%
1.9	2088	204	1884		1.83777	0.07143	1.76634	361	-58.84%	155%
2	2144	208	1936		1.93449	0.07519	1.8593	330	-62.37%	160%
2.1	2198	212	1986		2.03122	0.07895	1.95227	301	-65.68%	165%
2.2	2250	215	2034		2.12794	0.08271	2.04523	274	-68.76%	168.75%
2.3	2299	219	2080		2.22467	0.08647	2.1382	250	-71.49%	173.75%
2.4	2346	222	2124		2.32139	0.09023	2.23116	228	-74.00%	177.50%
2.5	2390	225	2166		2.41812	0.09399	2.32413	208	-76.28%	181.25%

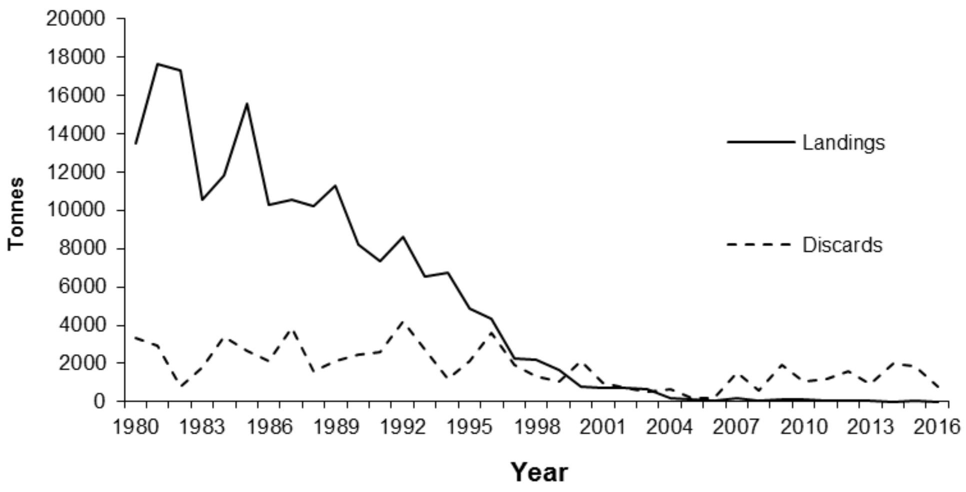


Figure 40.1. Whiting 7.a. Working group estimates of International landings and discards between 1980–2016.

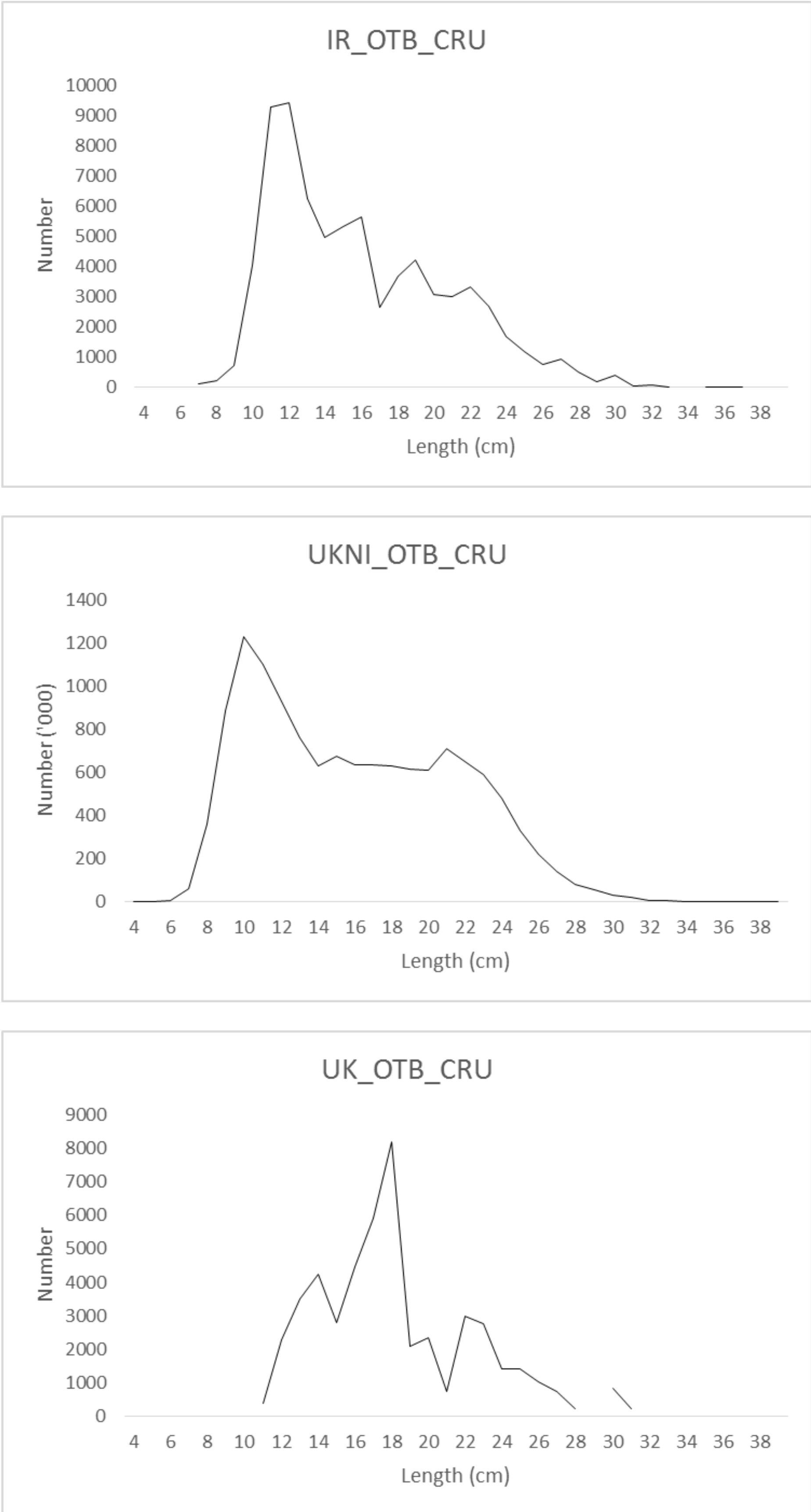


Figure 40.2. 7.a Whiting discard length–frequency by national fleets in 2016 for the OTB_CRU metier. Note due to low levels of retained catch, and hence low sampling, these data are not presented.

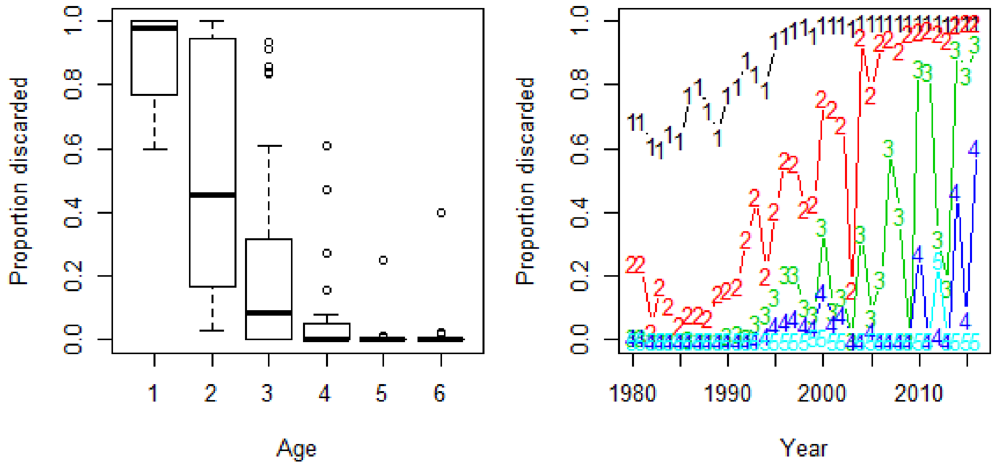


Figure 40.3. Whiting 7.a Proportion of discards by age (left) and year (right).

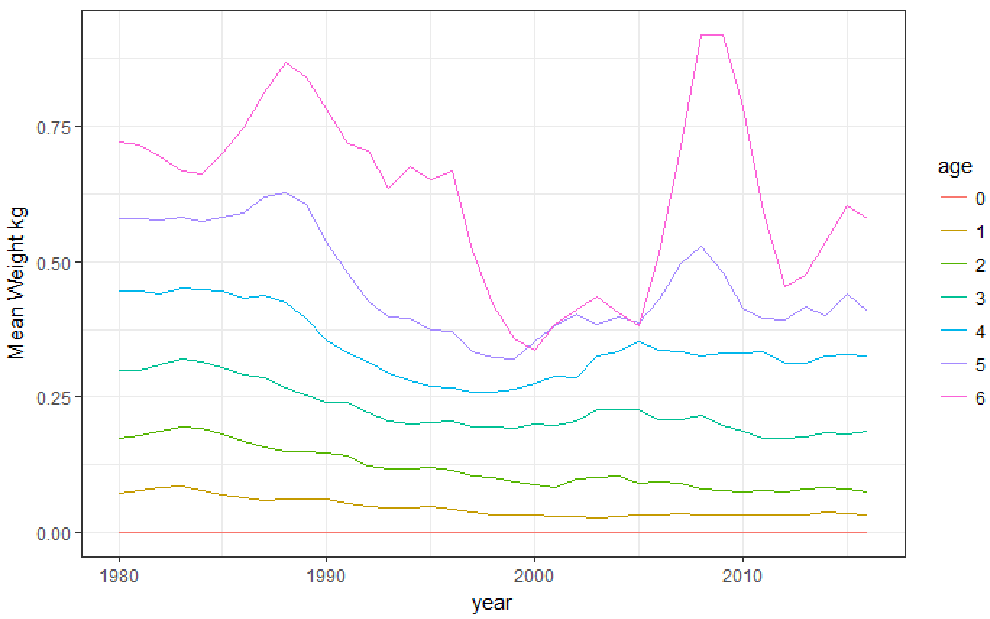


Figure 40.4. Whiting 7.a Smoothed Stock Weights (Three year running average).

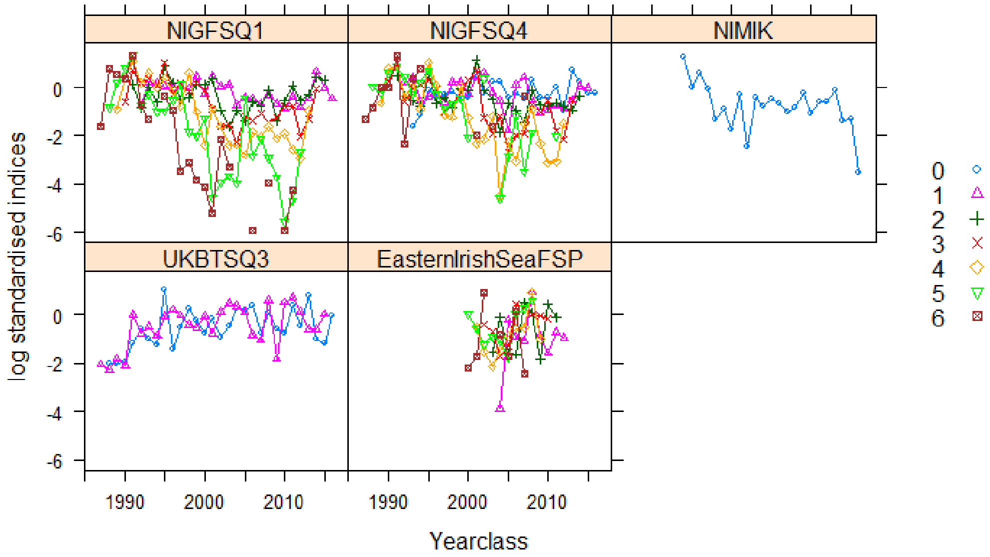


Figure 40.5. Whiting 7.a. Log Standardized indices of tuning fleets by cohort.

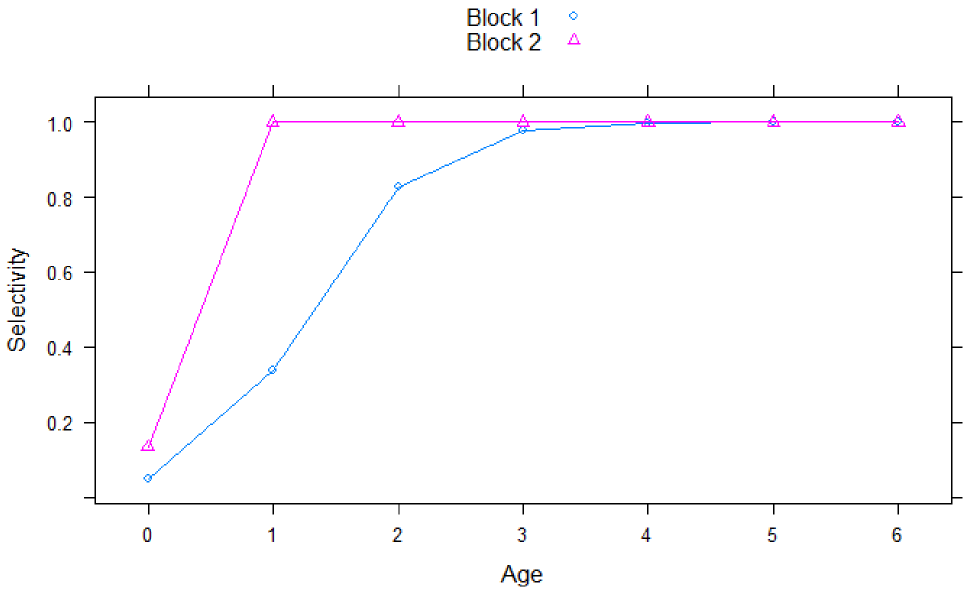


Figure 40.6. Whiting 7.a. Selectivity-at-age in the Catch.

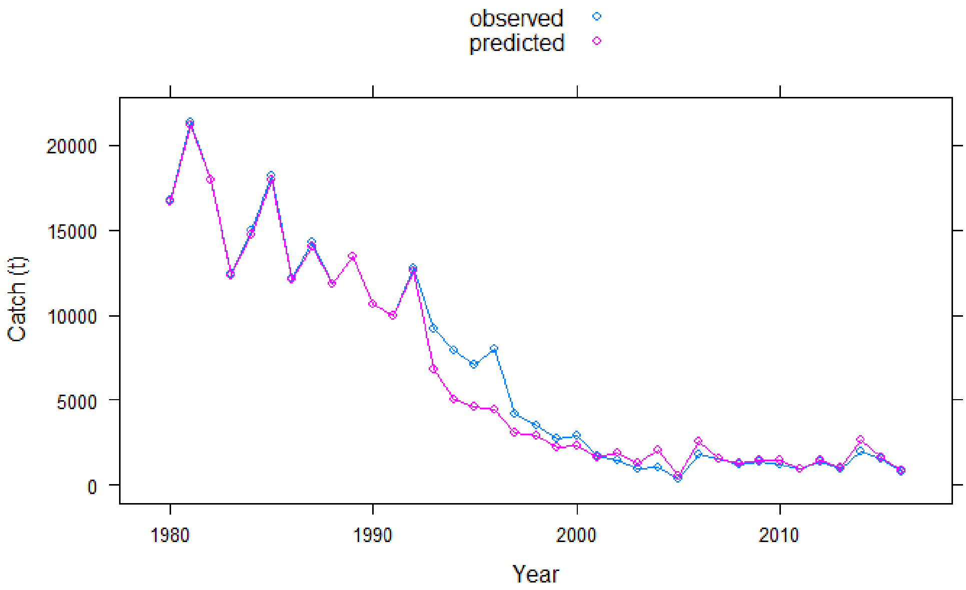


Figure 40.7. Whiting 7.a. Observed and Predicted Catches.

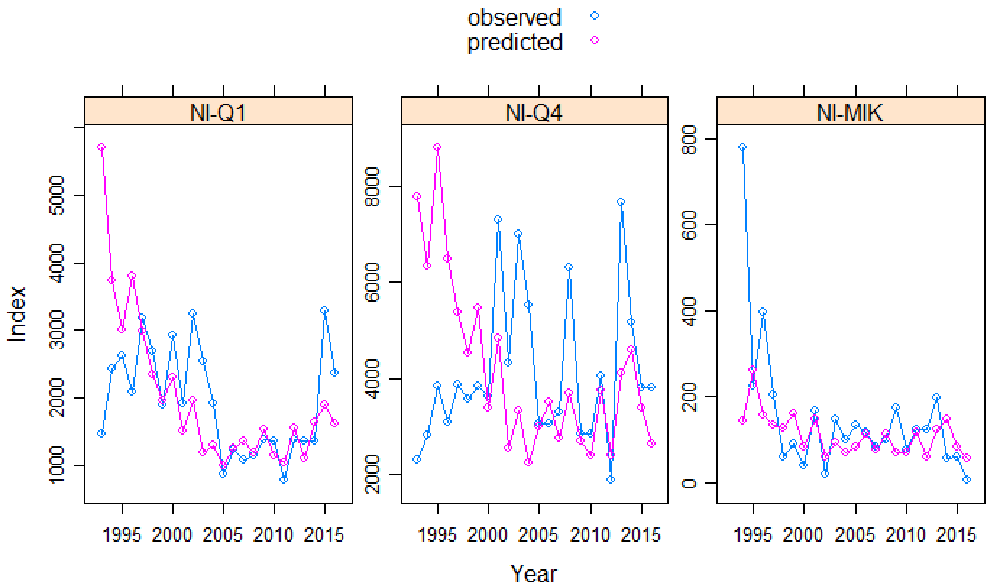


Figure 40.8. Whiting 7.a. Observed and Predicted index cpue.

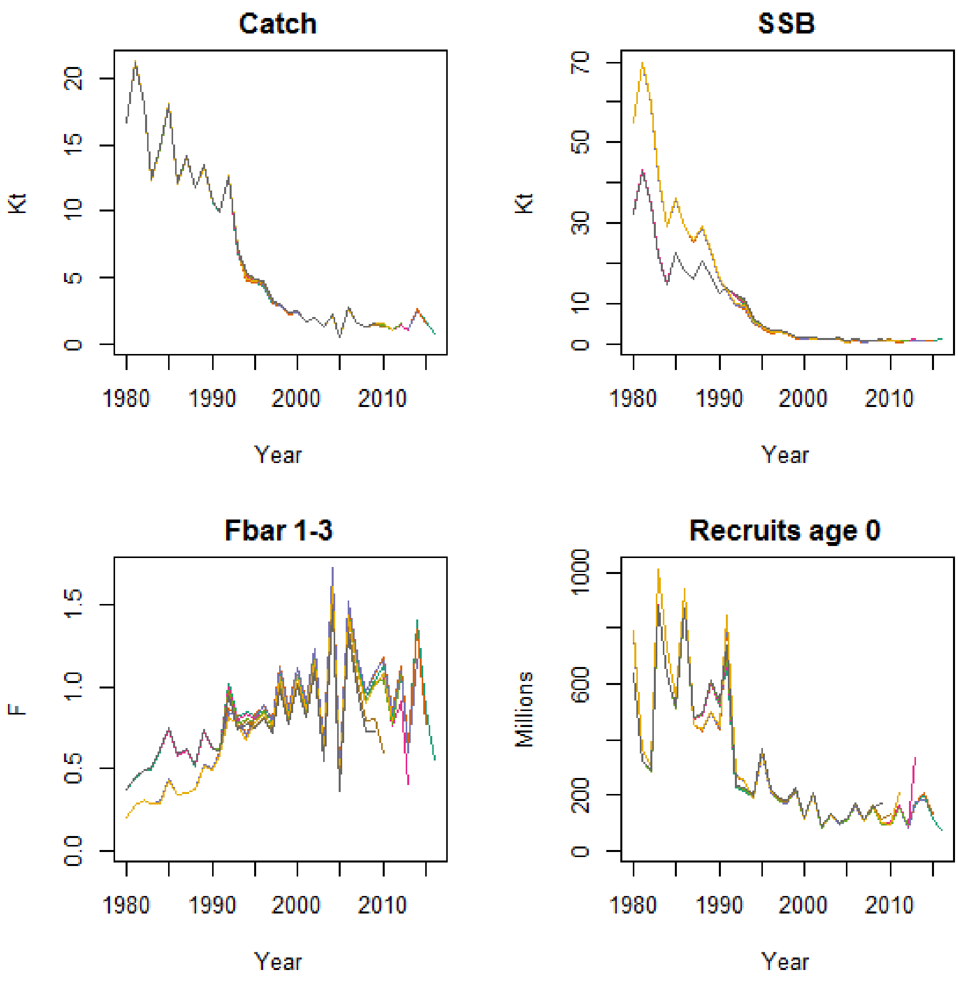


Figure 40.9. Whiting 7.a. Retrospective analysis of the final ASAP run.

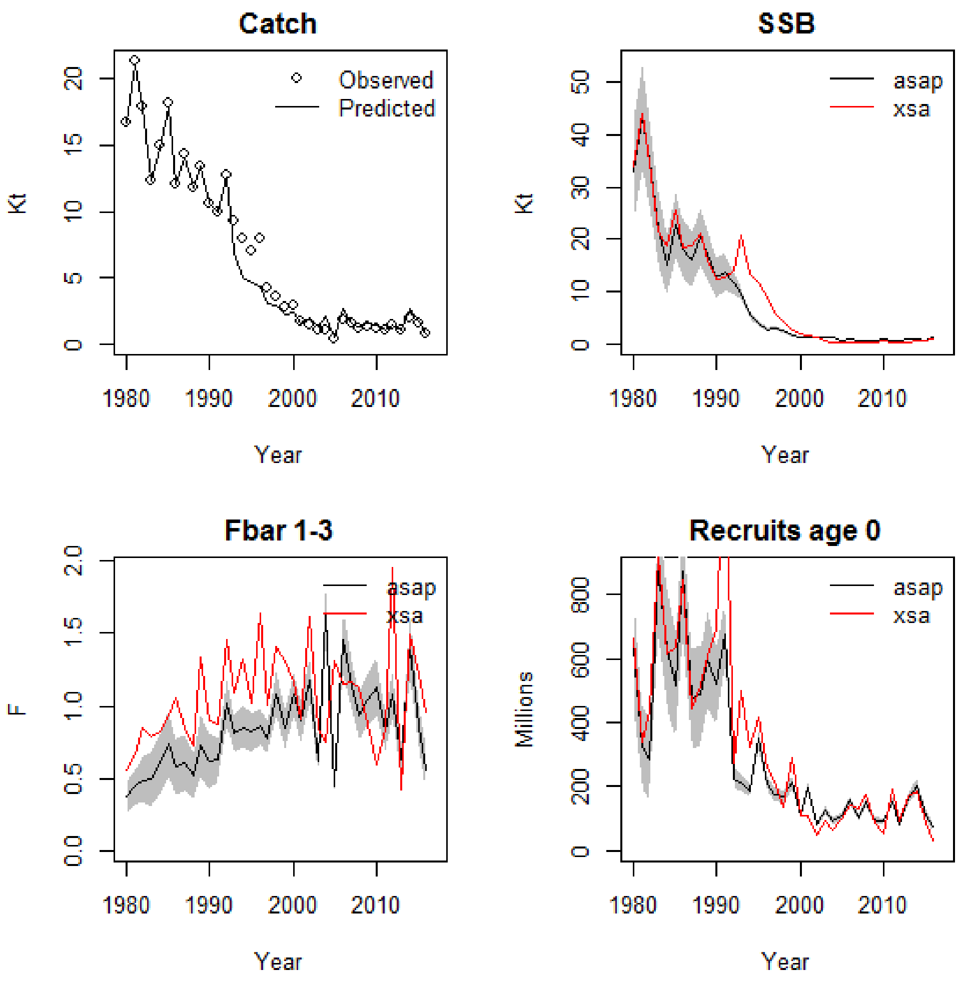


Figure 40.10. Whiting 7.a. Comparison of the ASAP assessment and XSA run.

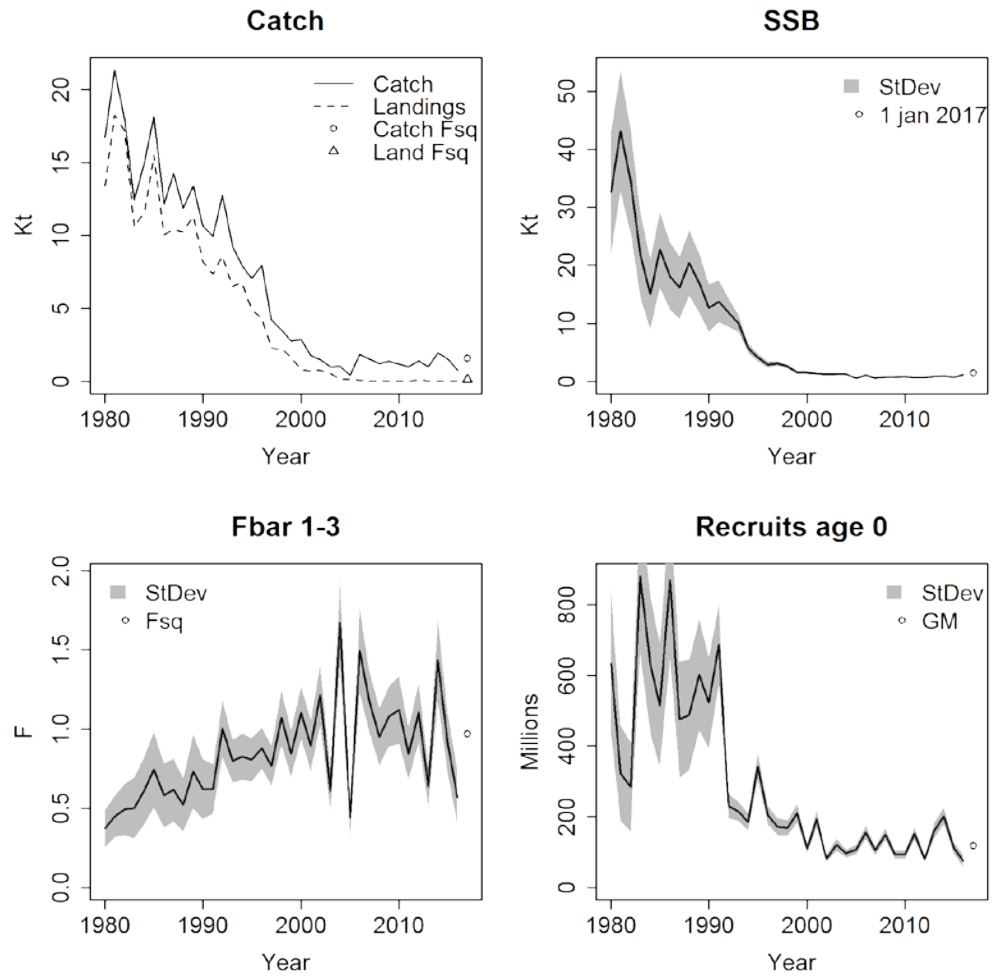


Figure 40.11. Whiting 7.a. Stock Summery Plot. The thick black line represents the ASAP assessment standard deviations from ASAP are shaded grey. The forecast/ assumed values are given by open circles. The thick black line in the catch plot represents the predicted catch from ASAP. The dotted line in the SSSB, F_{bar} and recruitment plots represents the XSA assessment with the same input data.

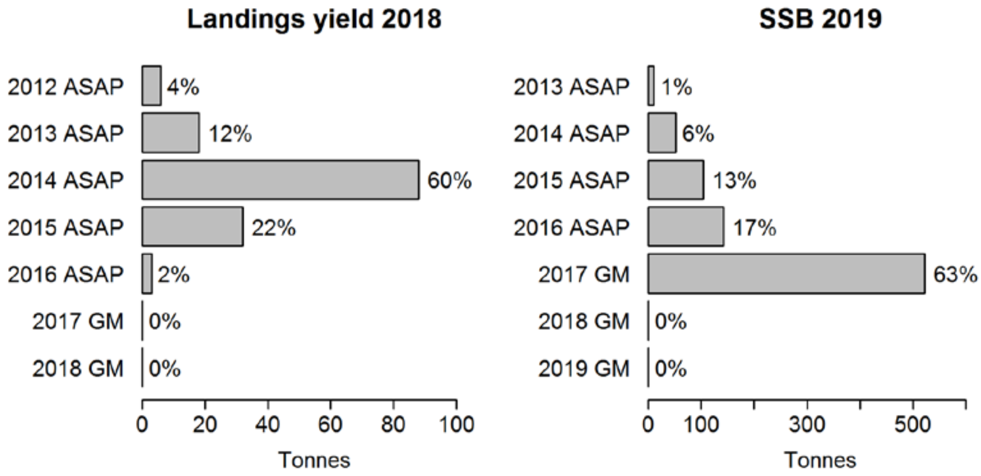


Figure 40.12. Whiting 7.a. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

41 Whiting in Division 7.b, c, e–k

Type of assessment in 2017

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, 2016) are included also.

ICES advice applicable to 2017

ICES advises that when the MSY approach is applied, catches in 2017 should be no more than 25 125 tonnes.

Since this stock is only partially under the EU landing obligation, ICES is not in a position to advise on landings corresponding to the advised catch.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/whg-7e–k.pdf

ICES advice applicable to 2016

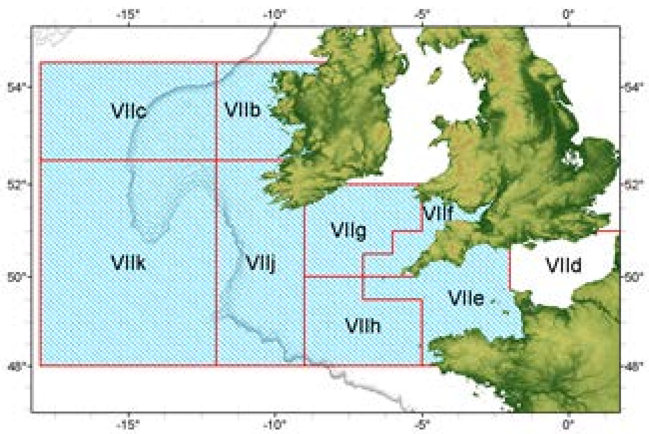
ICES advises based on the MSY approach that catches in 2016 should be no more than 19 076 tonnes. If discards rates do not change from the average of the last three years this implies landings of no more than 15 395 tonnes.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/whg-7e–k.pdf

41.1 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, Whiting in 7.b,c are now assessed as part of 7.bc, e–k, while whiting in 7.d are included in 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 2016 TAC for whiting 7.bc, e–k increased from 17 742 t (2015) to 22 778 t (2016) and increased again to 27 500 t for 2017. ICES official landings for whiting 7.bc, e–k in 2016 are 15 053 t. Thus the current TAC for whiting catches in the 7.bk stock area is not restrictive regarding landings in the 7.bc, e–k assessment area.

TAC in 2016

Species:	Whiting *Merlangius merlangus*	**Zone:**	VIIb, VIIc, VIId, VIIe, VIIf, VIIg, VIIh, VIIj and VIIk (WHG/7X7A-C)
Belgium	222		
France	13 668		
Ireland	6 333		
The Netherlands	111		
United Kingdom	2 444		
Union	22 778		
TAC	22 778		Analytical TAC Article 12(1) of this Regulation applies Article 7(2) of this Regulation applies

Landings obligation

In 2016 the landings obligation applied to this stock for the first time in accordance with Delegate Regulation (EC, 2015). Vessels where more than 25% of total landings from trawls and seines in the reference years (2013 & 2014) were specified gadoids (cod, haddock, whiting and saithe) were covered by the Landings Obligation. These vessels remain subject to the updated Delegated Regulation (EU) 2016/2375 where the reference fleet is modified to 2014–2015 and total landings consisted of more than 20% cod, haddock, whiting and saithe combined.

This implies that all catches of whiting in the Celtic Sea and Western Channel by those vessels must be landed. However a 7% *de minimus* still applies, meaning that these vessels can discard up to 7% of the whiting they catch up to 2017, reducing to 6% in 2018. It is difficult to assess how this might impact on the fishery, the stock, the scientific data and the advice given for 2018 at this stage.

41.2 The fishery in 2016

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, 2015).

The spatial distributions of landings by Irish and UK fleets in 2014 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 focused within rectangles 29E5 and 29E6.

41.3 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_AllCountries	GNS_IRL&UK
2	TBB_BEL&UK	TBB_UK
3	TBB_VIIj_IRL	TBB_VIIg_IRL
4	SSC&SDN_AllAreas_AllCountries	SDN_VIIeg_FRA
5	OTB_MIS_VIIbc_AllCountries	OTB_VIIb_IRL
6	OTB_MIS_VIIjk_AllCountries	OTB _VIIjk_IRL
7	OTB_MIS_VIIeh_FRA	OTB_VIIeg_ FRA
8	OTB_MIS_VIIeh_UKBELNED	OTB _VIIe_UK
9	OTB_MIS_VIIeh_IRLNISCO	OTB _VIIg_IRL
10	GTR_VIIeh_FRA	OTB_VIIgeh_FRA

Sample allocation scheme

Strata	Unsampled	Sampled
1	GNS_DIS _ALL	GNS_DIS_ALL
2	GNS_LAN_ALL	GNS_LAN_ALL
3	SSC&SDN_LAN _ALL	SSC_LAN_ALL
4	TBB_DIS _ALL	TBB_DIS_ALL
5	TBB_LAN _ALL	TBB_LAN_ALL
6	OTB&SSC&Others_DIS_All *	OTB&Others_DIS_All
7	OTB&SSC&Others_LAN_All	OTB&MIS_LAN_All

NB: Everything has been weighted by CATON.

*** SSC included in this group as no SSC specific sampled discards available.**

Age sampling allocation scheme

The length compositions for 2016 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.

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 has remained similar over time with the exception of periods where strong year classes pass through older ages. Older ages (3+) were proportionally higher in the 2016 catch than in most of the preceding time-series. Age group 0 was included in the assessment data to allow inclusion of 0-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 (Table 5 and Table 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. There is some indication of an increasing trend in weights for ages 6 and 7 since 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 2016 as available in InterCatch is presented in Table 7. Discarded whiting length distributions from 2016 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, catch and stock indicating that while there is a lot of 2–3 year olds in the stock and a lot of 1–2 year olds in the catch it is the 2 year olds that seem to suffer from discarding disproportionately higher than the stock.

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-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 and year (Figure 7). The index is quite noisy and shows a number of year affects for some ages.

Commercial lpue

Commercial lpue, from 2000 to 2013, were evaluated at WKCELT 2014 and have been omitted from the assessment due to catchability trends.

41.4 Historical stock development

An XSA assessment was carried out for this stock applying the same settings as last year, using a truncated time-series 1999–2015 of combined landings and discards data. The settings previously used were applied again this year and are detailed within the stock annex.

Data screening & 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	1999–2015
	Ages	0–7+
Fbar Age Range:		2–5
Assessment Method:		XSA
Survey Tuning-series:		
IGFS-EVHOE	Yrs	2003–2015
	Ages	0–5
Time taper:		No
Q plateau age:		5
F shrinkage S.E:		1.0
	Num yrs	5
	Num ages	3
Fleet S.E:		0.5

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.

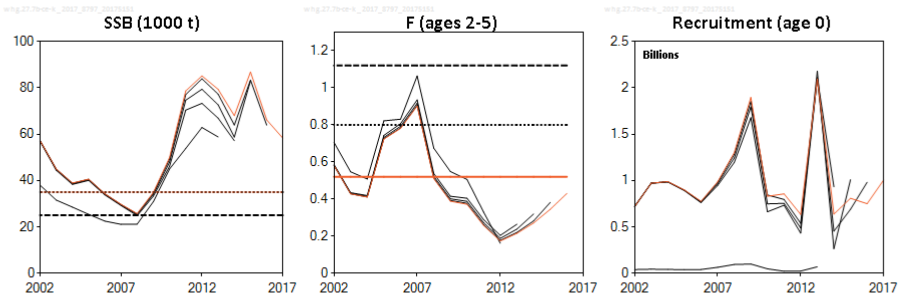
The log-catchability residuals from the XSA fit are plotted for the tuning-series in Figure 8. The residual patterns for the survey index does not show significant trends. Some year effects however are apparent 2005 and 2011.

The retrospective pattern is shown in Figure 9. A retrospective bias in F and SSB appears to be developing in this assessment with F being revised down and SSB being revised up. This year the WG scaled F to F_{2016} to address this retrospective trend.

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 and recruitment in 2013 remains the second highest in the time-series (Figure 11).

Comparison with previous assessments

The current assessment is consistent with last year as shown in the historical stock summary retrospective below.



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 declined since 2007, but is now increasing possibly in response to recent increased SSB and F_{bar} increasing to achieve F_{MSY}. SSB is well within precautionary limits for this stock while F_{bar} is approaching F_{MSY}.

There has been two above average recruitments (2008 and 2009) entering the fishery in recent years prior to the 2013 cohort, estimated to be the second highest in the time-series. Notwithstanding a downward revision of the 2013 year-class F and catch-at-age suggest significant numbers of two year olds in the 2015 fishery.

41.5 Short-term projections

The short-term projection settings were as described in the stock annex with the following exceptions. The GM period was 1999–2015 (full time-series minus the last year).

Table 13 gives the management option table. Fishing at F_{MSY} = 0.52 in 2018 implies catches of 19 548 t and landings of 13 841 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 2013–2015, 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 2013–2015. Stock numbers-at-age in 2015 for ages 0 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. The assumptions of $GM_{1999\text{-}2015}$ recruitment for 2016 and 2017 are predicted to contribute c.2% to the landings in 2017 and <1% to SSB in 2017–2018. Yield is still heavily reliant on the XSA estimate 2013 year class which is estimated at 57%.

41.6 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}	0.524	Segmented regression with B_{lim} as the breakpoint Range = 0.32–0.67	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}	0.800	F_{lim}/1.4	2016a
Management plan	SSB_{MGT}	Undefined		
	F_{MGT}	Undefined		

41.7 Management plans

No management plan has been agreed or proposed.

41.8 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 are invariably <1%, 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.

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 Figure 5 and Figure 10).

Surveys

The surveys for whiting are prone to year effects. However, cohort tracking for the 1+ fish is quite consistent for the combined tuning index.

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.

41.9 Recommendation for next benchmark

Overall, WGCSE recommend that cod, haddock and whiting in the Celtic Sea should be benchmarked together in 2018. The focus of the benchmark should be on streamlining data compilation procedures for fishery-dependent and survey data. This would give improved transparency for diagnostics surrounding commercial tuning fleets and surveys. The benchmark should also relook at 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.

For whiting, specifically:

- Further develop and evaluate statistical Catch at Age models such as SAM first conducted during WKCELT.
- Simplification of the complexity of métiers and the raising process in InterCatch. This is error prone and places a significant onus on the stock co-ordinator as the last stage in the data raising process in the narrow window before the assessment.
- Mapping of survey indices by age show significant recruitment data available outside the current combined index area which could potentially be utilised to improve the 0-grp estimates.

41.10 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 second highest in the time-series. These will be contributing to catches and SSB in the short term but the upturn in catches and SSB is likely to be short lived as recent recruitment is episodic and F appears to be increasing.

Discarding of 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 from the stock 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.

Whiting are caught in directed gadoid trips and as part of mixed fisheries 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 MLS 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.

41.11 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.

41.12 Tables

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	4711	4570	413	129	9951	291	9660	12031	21691	25440	
2007	127	3575	4864	575	87	9227	140	9087	8456	17543	20934	19900
2008	122	3072	2406	618	36	6254	394	5860	2880	8740	11933	19900
2009	87	2815	2798	828	25	6554	41	6513	4101	10614	17183	16950
2010	101	3464	4331	792	93	8778	190	8588	3008	11596	17729	14407
2011	100	4311	4752	739	174	10076	592	9484	1954	11438	16902	16658
2012	170	3709	5842	763	142	10626	438	10188	2449	12630	16234	19053
2013	226	4007	6887	906	92	12118	187	11931	2512	14796	18700	24500
2014	222	4927	6873	1057	38	13117	158	12847	3977	16742	19954	19162
2015	152	5640	6437	819	97	13145	-29	13174	6101	19275	19954	17742
2016[a]	186	6294	7644	890	39	15053	-126	15179	7278	22457	26187	22778

[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	25	5202	4132	359	3	9720	74%
SSC	7	97	2042	0	156	2300	17%
TBB	123	0	24	66	0	212	2%
Other	0	449	272	176	44	941	7%
	155	5748	6469	601	202	13174	100%

Table 3. Whiting in Divisions 7.b,c,e–k. Length distributions for Landings (LAN) and Discards (DIS) for 2016 by country and main fleet (Numbers in '000s). Nos raised to the Catch.

CatchCat	Lngt	GNS_IRL	OTB_FRA	OTB_IRL	OTB_UK	OTT_FRA	TBB_BEL	TBB_IRL	TBB_UK
DIS	6	0	0	0	0	0	0	0	0
DIS	7	0	0	1	1	0	0	0	0
DIS	8	0	0	1	1	0	0	0	0
DIS	9	0	0	1	1	0	0	0	0
DIS	10	0	0	1	0	1	0	0	0
DIS	11	0	0	1	0	1	3	0	0
DIS	12	0	0	0	0	0	9	0	1
DIS	13	0	0	1	2	4	38	0	0
DIS	14	0	0	6	4	0	91	0	0
DIS	15	0	11	9	3	2	92	0	0
DIS	16	0	4	31	3	6	106	0	0
DIS	17	0	42	31	0	4	71	0	3
DIS	18	0	14	21	2	4	55	0	0
DIS	19	0	16	21	3	2	68	0	5
DIS	20	0	69	21	3	2	62	0	11
DIS	21	0	147	29	14	2	102	0	13
DIS	22	0	162	27	13	22	130	0	7
DIS	23	0	190	85	75	20	183	0	25
DIS	24	0	161	136	207	13	215	0	27
DIS	25	0	110	119	166	15	207	0	24
DIS	26	0	188	228	228	61	289	1	63
DIS	27	0	254	248	214	53	277	1	59
DIS	28	0	259	270	172	59	339	2	96
DIS	29	0	240	238	183	46	280	2	94
DIS	30	0	256	125	114	67	241	2	135
DIS	31	0	181	102	82	100	282	2	172
DIS	32	0	132	86	72	91	229	2	143
DIS	33	0	103	60	55	39	153	2	109
DIS	34	0	55	36	29	20	140	2	76
DIS	35	0	44	26	30	6	77	1	47
DIS	36	0	27	17	16	12	88	1	44
DIS	37	0	22	9	7	12	41	1	16
DIS	38	0	2	9	5	22	56	1	23
DIS	39	0	3	5	1	20	19	1	5
DIS	40	0	5	2	2	1	4	0	4
DIS	41	0	0	2	1	15	1	0	2
DIS	42	0	5	1	0	0	6	0	3
DIS	43	0	1	0	0	0	0	0	0
DIS	44	0	8	1	0	0	0	0	0
DIS	45	0	2	0	0	0	0	0	0
DIS	46	0	0	0	1	0	1	0	0

CatchCat	Lngt	GNS_IRL	OTB_FRA	OTB_IRL	OTB_UK	OTT_FRA	TBB_BEL	TBB_IRL	TBB_UK
DIS	47	0	0	0	5	0	0	0	0
DIS	48	0	1	0	0	0	0	0	0
DIS	49	0	0	0	1	0	0	0	0
DIS	50	0	0	0	0	0	0	0	0
DIS	51	0	0	0	0	0	0	0	0
DIS	52	0	0	0	0	0	0	0	0
DIS	53	0	0	0	0	0	0	0	0
DIS	54	0	0	0	0	0	0	0	0
DIS	55	0	0	0	0	0	0	0	2
DIS	56	0	0	0	0	0	0	0	0
DIS	57	0	0	0	0	0	0	0	0
DIS	58	0	0	0	0	0	0	0	0
DIS	59	0	0	0	0	0	0	0	0
DIS	60	0	0	0	0	0	0	0	0
DIS	61	0	0	0	0	0	0	0	0
DIS	62	0	0	0	0	0	0	0	0
DIS	63	0	0	0	0	0	0	0	0
DIS	64	0	0	0	0	0	0	0	0
DIS	65	0	0	0	0	0	0	0	0
DIS	66	0	0	0	0	0	0	0	0
DIS	69	0	0	0	0	0	0	0	0
LAN	6	0	0	0	0	0	0	0	0
LAN	7	0	0	0	0	0	0	0	0
LAN	8	0	0	0	0	0	0	0	0
LAN	9	0	0	0	0	0	0	0	0
LAN	10	0	0	0	0	0	0	0	0
LAN	11	0	0	0	0	0	0	0	0
LAN	12	0	0	0	0	0	0	0	0
LAN	13	0	0	0	0	0	0	0	0
LAN	14	0	0	0	0	0	0	0	0
LAN	15	0	0	0	0	0	0	0	0
LAN	16	0	0	0	0	0	0	0	0
LAN	17	0	0	0	0	0	0	0	0
LAN	18	0	0	34	0	0	0	0	0
LAN	19	0	0	0	0	0	0	0	0
LAN	20	0	0	0	0	0	0	0	0
LAN	21	0	0	0	0	0	0	0	0
LAN	22	0	0	0	0	0	0	0	0
LAN	23	0	0	0	0	0	0	0	0
LAN	24	0	16	0	0	0	0	0	0
LAN	25	0	12	0	0	0	0	0	0
LAN	26	0	13	0	1	0	0	0	0
LAN	27	0	95	0	9	0	0	0	1
LAN	28	0	33	16	24	1	2	0	0

CatchCat	Lngt	GNS_IRL	OTB_FRA	OTB_IRL	OTB_UK	OTT_FRA	TBB_BEL	TBB_IRL	TBB_UK
LAN	29	0	301	47	48	0	2	0	3
LAN	30	0	240	119	80	1	6	0	4
LAN	31	0	550	154	138	1	9	0	8
LAN	32	0	392	211	145	2	14	0	10
LAN	33	0	479	293	147	8	17	0	12
LAN	34	0	614	345	129	6	17	0	10
LAN	35	23	526	370	127	6	20	0	10
LAN	36	85	484	350	118	6	19	0	6
LAN	37	0	415	291	86	11	23	0	10
LAN	38	19	407	251	78	9	25	0	11
LAN	39	19	402	128	62	9	18	0	10
LAN	40	0	521	114	58	4	20	0	15
LAN	41	0	479	116	52	7	15	0	15
LAN	42	0	445	115	39	7	10	0	3
LAN	43	0	332	127	42	6	11	0	11
LAN	44	0	248	116	36	8	8	0	9
LAN	45	0	174	183	27	7	6	0	4
LAN	46	0	192	144	19	9	2	0	7
LAN	47	0	96	170	19	4	3	0	6
LAN	48	0	91	102	19	4	2	0	5
LAN	49	0	81	99	16	4	1	0	3
LAN	50	0	120	66	10	7	0	0	2
LAN	51	0	72	62	7	6	0	0	2
LAN	52	0	48	40	9	5	0	0	2
LAN	53	0	35	28	6	3	1	0	0
LAN	54	0	27	29	7	1	0	0	0
LAN	55	0	13	2	2	1	0	0	2
LAN	56	0	7	10	5	1	0	0	0
LAN	57	0	11	10	2	1	0	0	0
LAN	58	0	7	5	2	0	0	0	0
LAN	59	0	1	3	0	0	0	0	0
LAN	60	0	1	2	1	0	0	0	0
LAN	61	0	0	2	1	0	0	0	0
LAN	62	0	1	0	1	0	0	0	0
LAN	63	0	0	0	0	0	0	0	0
LAN	64	0	1	0	0	0	0	0	0
LAN	65	0	0	0	0	0	0	0	0
LAN	66	0	0	0	0	0	0	0	0
LAN	69	0	1	0	0	0	0	0	0

Table 4. Whiting in Divisions 7.bc,e–k. The strong 1999 year class is distinct in both the catch and landings data, with some evidence of the strong 2009 year class appearing at older ages. Catch numbers-at-age ('000).

CATCH

1999	2016						
0	7						
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

LANDINGS							
1999	2016						
0	7						
0.0	3939.1	10139.7	12589.4	8597.8	8987.8	6670.2	1498.7
4.3	3176.7	9988.7	10773.9	6030.5	2605.9	2100.9	2424.3
0.0	297.8	11793.6	11628.2	5251.1	2049.0	763.1	627.3
6.6	926.4	6034.6	20341.6	5877.2	1057.6	291.6	111.0
0.0	306.5	3246.5	8574.3	12482.4	1640.7	227.8	58.1
39.8	1310.2	4358.2	5703.4	7213.9	6212.0	573.2	81.2
1.1	725.5	5991.0	8258.9	4968.9	4819.8	3717.7	155.1
0.1	868.2	6238.5	8187.4	3880.2	1750.4	1181.6	579.4
0.0	781.8	5142.0	8760.9	5248.7	1407.4	345.4	325.7
3.1	661.8	3555.5	5235.7	3272.8	858.5	214.8	68.4
0.1	462.5	4562.4	6267.2	2640.7	770.3	192.4	201.5
0.0	399.6	3571.3	7713.8	4293.1	1201.0	260.9	101.4
0.0	297.4	3214.7	6618.5	5316.3	1738.5	355.4	84.5
0.0	91.4	1191.7	7728.3	5276.9	1725.5	505.5	116.1
0.0	241.6	1713.2	3635.9	9299.9	3915.7	897.1	208.2
0.0	1664.3	1722.4	4551.1	4918.3	6829.7	1680.8	311.9
0.0	257.3	5835.8	3865.9	5308.7	2489.2	2887.0	802.9
3.3	592.7	2296.4	14067.9	4504.8	2833.3	996.3	1735.4

Table 5. Whiting in Divisions 7.bc,e–k. Catch weights-at-age (kg).

	Age							
	0	1	2	3	4	5	6	7+
1999	0.027	0.133	0.222	0.341	0.427	0.440	0.496	0.623
2000	0.031	0.069	0.220	0.396	0.505	0.563	0.580	0.587
2001	0.032	0.112	0.185	0.378	0.529	0.633	0.760	0.777
2002	0.027	0.097	0.197	0.351	0.532	0.707	0.825	1.013
2003	0.029	0.094	0.211	0.360	0.452	0.629	0.831	1.087
2004	0.040	0.155	0.227	0.361	0.432	0.491	0.537	0.785
2005	0.020	0.105	0.195	0.361	0.501	0.504	0.487	0.674
2006	0.033	0.124	0.210	0.385	0.538	0.588	0.544	0.675
2007	0.042	0.121	0.201	0.364	0.497	0.642	0.609	0.638
2008	0.028	0.109	0.214	0.386	0.524	0.626	0.780	0.830
2009	0.026	0.117	0.206	0.395	0.549	0.653	0.689	0.951
2010	0.034	0.119	0.228	0.420	0.560	0.679	0.815	0.836
2011	0.024	0.126	0.239	0.444	0.613	0.811	0.954	1.211
2012	0.039	0.096	0.225	0.461	0.649	0.808	0.967	1.088
2013	0.053	0.130	0.209	0.358	0.600	0.704	0.915	0.864
2014	0.038	0.142	0.254	0.397	0.554	0.662	0.759	1.007
2015	0.018	0.102	0.220	0.375	0.573	0.778	0.671	0.929
2016	0.052	0.149	0.217	0.358	0.577	0.685	0.746	0.784

Table 6. Whiting in Divisions 7.bc,e–k. Q1 Stock weights-at-age (kg) from Rivard corrected annual mean catch weights.

	Age							
	0	1	2	3	4	5	6	7+
1999	0.0170	0.1034	0.1659	0.2804	0.3724	0.3834	0.4674	0.6230
2000	0.0167	0.0432	0.1713	0.2960	0.4152	0.4905	0.5055	0.5868
2001	0.0180	0.0592	0.1131	0.2886	0.4575	0.5658	0.6541	0.7775
2002	0.0146	0.0551	0.1481	0.2549	0.4481	0.6117	0.7229	1.0133
2003	0.0125	0.0507	0.1428	0.2662	0.3981	0.5782	0.7663	1.0873
2004	0.0248	0.0671	0.1463	0.2763	0.3946	0.4711	0.5810	0.7846
2005	0.0079	0.0648	0.1741	0.2859	0.4254	0.4666	0.4889	0.6744
2006	0.0174	0.0494	0.1484	0.2742	0.4405	0.5427	0.5237	0.6750
2007	0.0259	0.0636	0.1577	0.2768	0.4379	0.5877	0.5982	0.6382
2008	0.0139	0.0677	0.1612	0.2788	0.4370	0.5582	0.7076	0.8298
2009	0.0119	0.0575	0.1502	0.2908	0.4604	0.5850	0.6571	0.9506
2010	0.0180	0.0553	0.1631	0.2946	0.4704	0.6108	0.7296	0.8356
2011	0.0123	0.0659	0.1688	0.3179	0.5077	0.6739	0.8049	1.2106
2012	0.0211	0.0482	0.1684	0.3320	0.5366	0.7040	0.8856	1.0881
2013	0.0327	0.0710	0.1412	0.2835	0.5258	0.6762	0.8599	0.8644
2014	0.0232	0.0870	0.1820	0.2877	0.4449	0.6304	0.7310	1.0072
2015	0.0063	0.0622	0.1767	0.3090	0.4767	0.6562	0.6666	0.9295
2016	0.0516	0.0518	0.1486	0.2807	0.4655	0.6261	0.7615	0.7836

Table 7. Whiting in Divisions 7.e–k. Summary of landings and discard data in 2015 provided to the Working Group.

	WEIGHT IN TONNES									
DISCARDS	**COUNTRY**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**	**GRAND TOTAL**
	Belgium	0.1	92.7	108.5	265.5	17.1	4.3	7.6	2.3	498.1
	France	22.5	412.7	432.0	838.4	53.1	12.7	15.6	20.7	1807.7
	Ireland	39.0	663.2	1003.3	2146.6	184.6	85.7	41.2	59.3	4222.9
	UK (England)	0.5	119.2	150.5	399.5	17.8	3.5	5.5	2.6	699.0
	Other	0.4	8.5	11.7	26.3	1.8	0.7	0.4	0.5	50.2
	Total	62.6	1296.2	1706.0	3676.3	274.4	106.8	70.1	85.4	7277.9
Landings	Belgium	0.0	2.5	8.7	114.1	24.8	9.4	16.4	10.1	186.0
	France	0.7	142.9	464.0	2907.8	1130.0	572.6	332.0	777.2	6327.2
	Ireland	0.0	15.7	331.1	3431.5	1574.0	1411.6	381.6	592.9	7738.4
	UK (England)	0.0	14.9	50.3	518.3	86.5	30.9	59.0	39.6	799.6
	Other	0.0	0.5	6.0	57.1	25.9	22.2	6.4	9.5	127.7
	Total	0.7	176.6	860.1	7028.8	2841.1	2046.8	795.4	1429.3	15178.8

Number in 000's										
Discards	Country	0	1	2	3	4	5	6	7	Grand Total
	Belgium	2.1	787.3	874.2	1096.9	42.0	9.2	16.8	5.7	2834.3
	France	138.9	2051.6	1741.5	2952.2	125.5	31.3	29.3	38.0	7108.3
	Ireland	1055.4	5535.8	5907.0	10027.6	675.9	261.5	105.4	146.8	23715.4
	UK (England)	15.1	863.1	945.2	1611.8	43.0	7.9	12.0	5.9	3504.0
	Other	8.9	60.7	63.2	113.9	5.9	2.1	0.9	1.3	256.9
	Total	1220.4	9298.6	9531.1	15802.4	892.4	312.0	164.4	197.6	37418.8
Landings	Belgium	0.0	10.4	28.5	260.1	42.1	13.5	18.0	14.1	386.7
	France	3.3	462.6	1235.3	5655.0	1794.0	789.5	444.2	969.3	11353.2
	Ireland	0.0	53.1	842.2	6859.5	2484.3	1960.8	457.1	688.9	13345.9
	UK (England)	0.0	64.7	174.2	1180.2	144.0	39.1	69.4	51.4	1723.0
	Other	0.0	1.8	16.2	113.1	40.5	30.5	7.6	11.6	221.3
	Total	3.3	592.7	2296.4	14067.9	4504.8	2833.3	996.3	1735.4	27030.1

Table 8. Whiting in Divisions 7.bc,e–k. Combined survey abundance indices of age groups 0–5.

	IGFSEVHOE No/Hr					
	Age					
	0	1	2	3	4	5
2003	207.826	201.071	73.602	26.557	13.911	0.658
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	0.689
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

Table 9. Whiting in Divisions 7.bc,e–k. XSA Diagnostics.

Run 1

FLR XSA Diagnostics 2017-05-15 15:48:58

CPUE data from indices

Catch data for 18 years 1999 to 2016. Ages 0 to 7.

	fleet	first age	last age	first year	last year	alpha	beta
1	IGFSEVHOENo/Hr	0	5	2003	2016	<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

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.105	0.045	0.033	0.011	0.030	0.033	0.009	0.033	0.035	0.066
2	0.774	0.236	0.281	0.117	0.050	0.096	0.097	0.106	0.149	0.239
3	0.783	0.456	0.333	0.340	0.157	0.117	0.214	0.210	0.356	0.410
4	1.071	0.710	0.483	0.474	0.412	0.202	0.240	0.407	0.493	0.557
5	0.976	0.636	0.456	0.555	0.408	0.279	0.309	0.359	0.380	0.513
6	0.633	0.467	0.348	0.341	0.392	0.244	0.299	0.285	0.429	0.360
7	0.633	0.467	0.348	0.341	0.392	0.244	0.299	0.285	0.429	0.360

XSA population number (Thousand)

year \ age	0	1	2	3	4	5	6	7
2007	986692	228997	92809	28979	9993	2758	890	818
2008	1301691	291301	87281	22341	8029	2229	697	217
2009	1897256	384298	117887	35973	8586	2569	791	814
2010	829944	560127	157387	46485	15642	3445	1091	417
2011	855666	245024	234420	73066	20072	6335	1326	310

2012	634499	252618	100633	116434	37868	8650	2823	640
2013	2097669	187323	103386	47722	62828	20134	4385	997
2014	637380	619295	78568	49001	23368	32151	9911	1695
2015	808397	188174	253528	36878	24084	10119	15050	2736
2016	749497	238663	76917	113987	15669	9574	4638	7592

Estimated population abundance at 1st Jan 2017

age year	0	1	2	3	4	5	6	7
2017	0	221277	94560	31609	45874	5840	3842	2212

Fleet: IGFSEVHOENo/Hr

Log catchability residuals.

year age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
0	-0.558	0.637	-0.541	0.460	0.887	0.098	0.063	-1.048	0.301	0.099	0.450	-0.748	-0.100	0.000
1	0.528	0.203	-0.635	0.056	-0.008	0.161	0.167	-0.172	0.350	-0.010	-0.217	-0.149	-0.126	-0.149
2	0.519	0.452	-0.845	0.342	-0.216	0.096	-0.349	0.062	0.158	0.181	-0.162	-0.404	-0.208	0.377
3	-0.007	0.432	-0.333	0.252	-0.101	0.185	-0.317	0.220	0.593	0.175	-0.204	-0.247	-0.383	-0.265
4	-0.196	-0.251	0.099	0.845	-0.418	0.418	-0.188	-0.293	0.570	-0.519	-0.032	-0.025	-0.379	0.370
5	-0.719	-0.283	0.538	0.440	-0.087	0.376	0.002	0.005	0.079	-0.718	-0.096	-0.141	0.463	0.140

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	-6.8746	-6.6929	-6.5974	-6.9712	-7.1275	-7.0606
S.E_Logq	0.3864	0.3864	0.3864	0.3864	0.3864	0.3864

Terminal year survivor and F summaries:

,Age 0 Year class =2016

source	scaledWts	survivors	yrcls
IGFSEVHOENo/Hr	1	221277	2016

,Age 1 Year class =2015

source	scaledWts	survivors	yrcls
IGFSEVHOENo/Hr	0.789	81489	2015
fshk	0.211	219486	2015

,Age 2 Year class =2014

source	scaledWts	survivors	yrcls
IGFSEVHOENo/Hr	0.759	46070	2014
fshk	0.241	79708	2014

,Age 3 Year class =2013

source	scaledWts	survivors	yrcls
IGFSEVHOENo/Hr	0.726	35208	2013
fshk	0.274	97215	2013

,Age 4 Year class =2012

source

	scaledWts	survivors	yrcls
IGFSEVHOENo/Hr	0.696	8456	2012
fshk	0.304	10160	2012

,Age 5 Year class =2011

source

	scaledWts	survivors	yrcls
IGFSEVHOENo/Hr	0.705	4418	2011
fshk	0.295	6095	2011

,Age 6 Year class =2010

source

	scaledWts	survivors	yrcls
fshk	1	1473	2010

Table 1. Whiting in Divisions 7.b, c, e–k. Fishing mortality (F)-at-age. F_{bar} range is 2–5.

	0	1	2	3	4	5	6	7+	F_{BAR}2–5
2007	0.000	0.105	0.774	0.783	1.071	0.976	0.633	0.633	0.901
2008	0.000	0.045	0.236	0.456	0.710	0.636	0.467	0.467	0.510
2009	0.000	0.033	0.281	0.333	0.483	0.456	0.348	0.348	0.388
2010	0.000	0.011	0.117	0.340	0.474	0.555	0.341	0.341	0.372
2011	0.000	0.030	0.050	0.157	0.412	0.408	0.392	0.392	0.257
2012	0.000	0.033	0.096	0.117	0.202	0.279	0.244	0.244	0.174
2013	0.000	0.009	0.097	0.214	0.240	0.309	0.299	0.299	0.215
2014	0.000	0.033	0.106	0.210	0.407	0.359	0.285	0.285	0.271
2015	0.000	0.035	0.149	0.356	0.493	0.380	0.429	0.429	0.345
2016	0.000	0.066	0.239	0.410	0.557	0.513	0.360	0.360	0.430

Table 11. Whiting in Divisions 7.b, c, e–k. Stock number-at-age ('000).

YEAR	0	1	2	3	4	5	6	7
2007	986692	228997	92809	28979	9993	2758	890	818
2008	1301691	291301	87281	22341	8029	2229	697	217
2009	1897256	384298	117887	35973	8586	2569	791	814
2010	829944	560127	157387	46485	15642	3445	1091	417
2011	855666	245024	234420	73066	20072	6335	1326	310
2012	634499	252618	100633	116434	37868	8650	2823	640
2013	2097669	187323	103386	47722	62828	20134	4385	997
2014	637380	619295	78568	49001	23368	32151	9911	1695
2015	808397	188174	253528	36878	24084	10119	15050	2736
2016	749497	238663	76917	113987	15669	9574	4638	7592

Table 12. Whiting in Divisions 7.b, c, e–k. Summary table.

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	F_{BAR} 2–5
1999	2295542	120208	50345	20180	0.508	0.719
2000	1357759	94357	42405	15644	0.473	0.703
2001	623570	85535	50581	13196	0.456	0.781
2002	717424	77903	57285	13640	0.366	0.581
2003	971252	67854	44974	11098	0.326	0.428
2004	988436	82673	38920	10188	0.428	0.410
2005	897849	66603	40600	12207	0.466	0.723
2006	775656	60904	34313	9660	0.632	0.781
2007	986692	69829	29709	9086	0.590	0.901
2008	1301691	63539	25724	5859	0.340	0.510
2009	1897256	79592	34918	6572	0.306	0.388
2010	829944	95885	49971	8514	0.231	0.371
2011	855666	105371	78700	9498	0.146	0.257
2012	634499	110772	85208	9812	0.144	0.173
2013	2097669	161303	79409	12402	0.188	0.215
2014	637380	136679	68013	12847	0.247	0.271
2015	808397	103688	86890	13174	0.222	0.344
2016	749497	117231	66195	15179	0.339	0.430
Geomean	1005.961					
Mean	1098.628	94440	53565	11598	0.356	0.499
0 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
0	0	0	0	0	NA	NA	63499
0.1	1956	1422	534	0.043	0.030	0.013	61778
0.2	3840	2785	1055	0.086	0.059	0.027	60126
0.3	5653	4091	1563	0.129	0.089	0.040	58540
0.4	7400	5342	2058	0.172	0.118	0.053	57017
0.5	9084	6542	2542	0.215	0.148	0.067	55554
0.6	10706	7692	3015	0.258	0.178	0.080	54149
0.7	12271	8795	3476	0.301	0.207	0.094	52799
0.8	13779	9853	3927	0.344	0.237	0.107	51502
0.9	15235	10868	4367	0.387	0.267	0.120	50254
1	16640	11842	4798	0.430	0.296	0.134	49055
1.1	17995	12777	5219	0.473	0.326	0.147	47901
1.2	19305	13674	5630	0.516	0.355	0.160	46790
1.3	20569	14536	6033	0.559	0.385	0.174	45722
1.4	21791	15364	6427	0.602	0.415	0.187	44693
1.5	22972	16160	6812	0.645	0.444	0.200	43702
1.6	24114	16924	7190	0.688	0.474	0.214	42748
1.7	25219	17659	7560	0.731	0.504	0.227	41828
1.8	26287	18366	7922	0.774	0.533	0.241	40942
1.9	27321	19045	8276	0.817	0.563	0.254	40087
2	28322	19699	8624	0.860	0.592	0.267	39263

Additional Catch Options							
Basis18	Catch18	Land18	Dis	FCatch18	FLand18	FDis18	SSB19
FMSY	19548	13841	5707	0.524	0.361	0.163	46584
F = 0	0	0	0	0.000	NA	NA	63499
F = Fpa	26923	18784	8139	0.800	0.551	0.249	40416
F = Flim	33753	23165	10589	1.120	0.772	0.348	34852
Blim	46510	30624	15886	2.004	1.381	0.623	25000
Bpa	33569	23050	10520	1.110	0.765	0.345	35000
Btrigger	33569	23050	10520	1.110	0.765	0.345	35000
F = F2017	16640	11842	4798	0.430	0.296	0.134	49055
Min FMSY	13053	9344	3709	0.323	0.223	0.100	52126
Max FMSY	23647	16612	7035	0.670	0.462	0.208	43138
Stable SSB	16982	12078	4903	0.441	0.304	0.137	48763
-15% TAC	34090	23375	10715	1.138	0.784	0.354	34582

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 2017, COMBSEX

F_{bar} age range: 2–5

nyears +1

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	1005961	1.22	0	0	0	0.027	0	0.098	0	0.036
1	221274	0.86	0	0	0	0.067	0.003	0.265	0.041	0.119
2	94559	0.65	1	0	0	0.169	0.041	0.369	0.124	0.187
3	31609	0.5	1	0	0	0.292	0.238	0.506	0.087	0.245
4	45873	0.43	1	0	0	0.462	0.453	0.651	0.033	0.297
5	5840	0.4	1	0	0	0.638	0.408	0.742	0.009	0.396
6	3842	0.38	1	0	0	0.72	0.344	0.826	0.014	0.376
7	5906	0.36	1	0	0	0.907	0.353	0.948	0.005	0.505

nyears +2

AGE	N	M	MAT	PF	PM	SWT	SEL	CWT	DSEL	DCWT
0	1005961	1.22	0	0	0	0.027	0	0.098	0	0.036
1	296990	0.86	0	0	0	0.067	0.003	0.265	0.041	0.119
2	88629	0.65	1	0	0	0.169	0.041	0.369	0.124	0.187
3	40269	0.5	1	0	0	0.292	0.238	0.506	0.087	0.245
4	12830	0.43	1	0	0	0.462	0.453	0.651	0.033	0.297
5	16392	0.4	1	0	0	0.638	0.408	0.742	0.009	0.396
6	2339	0.38	1	0	0	0.72	0.344	0.826	0.014	0.376
7	4337	0.36	1	0	0	0.907	0.353	0.948	0.005	0.505

nyears +3

AGE	N	M	MAT	PF	PM	SWT	SEL	CWT	DSEL	DCWT
0	1005961	1.22	0	0	0	0.027	0	0.098	0	0.036
1	296990	0.86	0	0	0	0.067	0.003	0.265	0.041	0.119
2	118956	0.65	1	0	0	0.169	0.041	0.369	0.124	0.187
3	37744	0.5	1	0	0	0.292	0.238	0.506	0.087	0.245
4	16345	0.43	1	0	0	0.462	0.453	0.651	0.033	0.297
5	4584	0.4	1	0	0	0.638	0.408	0.742	0.009	0.396
6	6565	0.38	1	0	0	0.72	0.344	0.826	0.014	0.376
7	2972	0.36	1	0	0	0.907	0.353	0.948	0.005	0.505

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
0	0	0	0	0	0	0	981125	19884	0	0
1	0.004	573	137	0.027	3587	386	203425	14938	0	0
2	0.031	1235	448	0.096	3521	636	53879	8980	53879	8980
3	0.188	12287	6105	0.108	10953	2707	113887	33426	113887	33426
4	0.347	2536	1663	0.055	710	218	11877	5733	11877	5733
5	0.323	1791	1341	0.029	196	80	8024	5249	8024	5249
6	0.329	998	866	0.026	225	107	4872	3666	4872	3666
7	0.336	1762	2051	0.018	97	42	7344	6854	7344	6854
Total	0.222	21182	12611	0.072	19289	4176	1384433	98730	199883	63908

NYears+2

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0	0	0	981125	19884	0	0
1	0.004	816	195	0.027	5108	550	289658	21271	0	0
2	0.031	1914	694	0.096	5454	985	83463	13910	83463	13910
3	0.188	2673	1328	0.108	2383	589	24774	7271	24774	7271
4	0.347	10970	7192	0.055	3073	942	51381	24802	51381	24802
5	0.323	1153	863	0.029	126	52	5165	3379	5165	3379
6	0.329	774	672	0.026	175	83	3781	2845	3781	2845
7	0.336	1423	1657	0.018	79	34	5934	5538	5934	5538
Total	0.222	19723	12601	0.072	16398	3235	1445281	98900	174498	57745

NYears+3

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0	0	0	981125	19884	0	0
1	0.004	816	195	0.027	5108	550	289658	21271	0	0
2	0.031	2725	988	0.096	7765	1403	118843	19807	118843	19807
3	0.188	4140	2057	0.108	3691	912	38376	11263	38376	11263
4	0.347	2386	1565	0.055	668	205	11177	5395	11177	5395
5	0.323	4987	3735	0.029	545	224	22344	14617	22344	14617
6	0.329	498	433	0.026	112	53	2434	1831	2434	1831
7	0.336	1132	1318	0.018	63	27	4720	4405	4720	4405
Total	0.222	16684	10291	0.072	17952	3374	1468677	98473	197894	57318

41.13 Figures

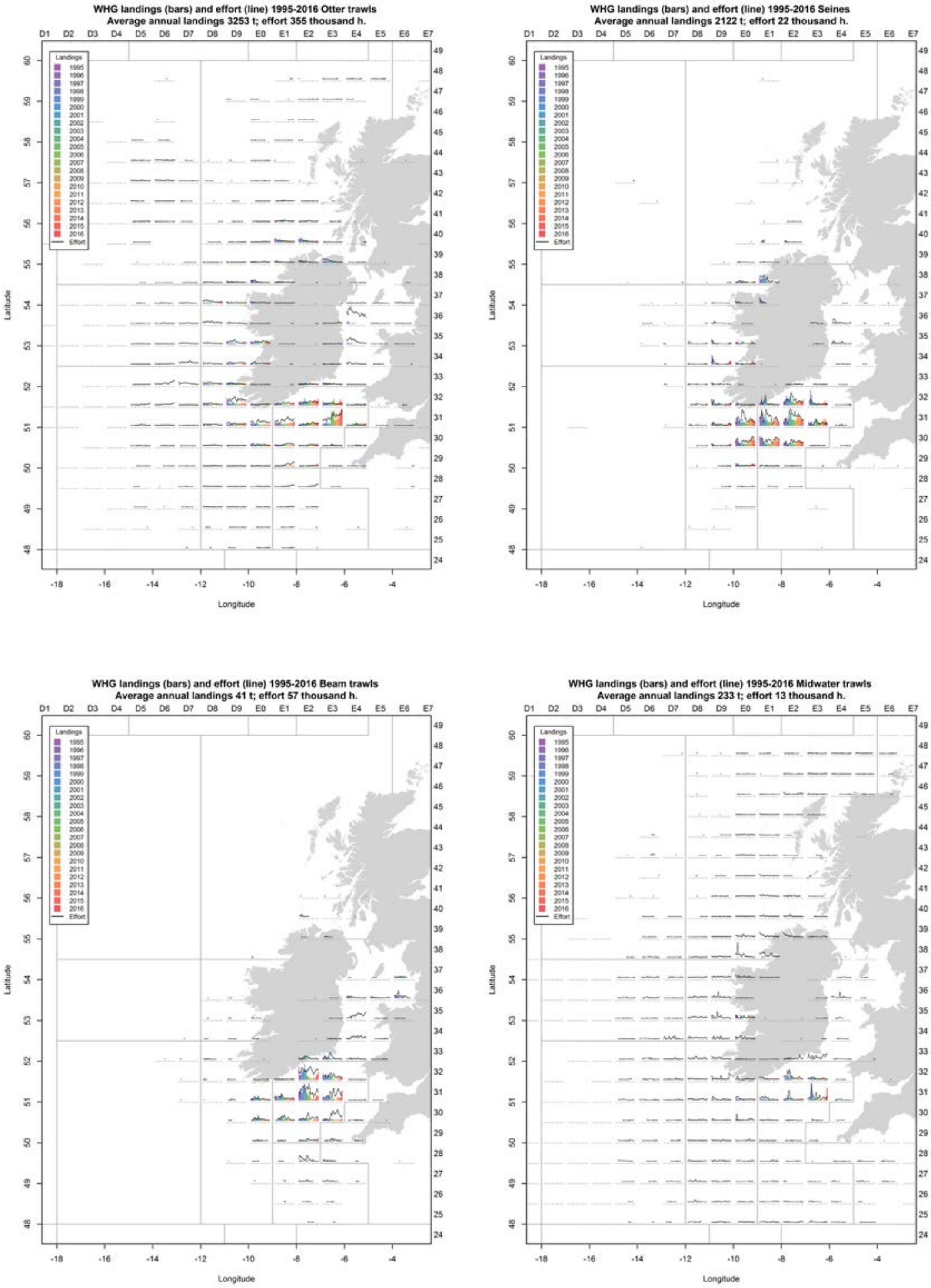
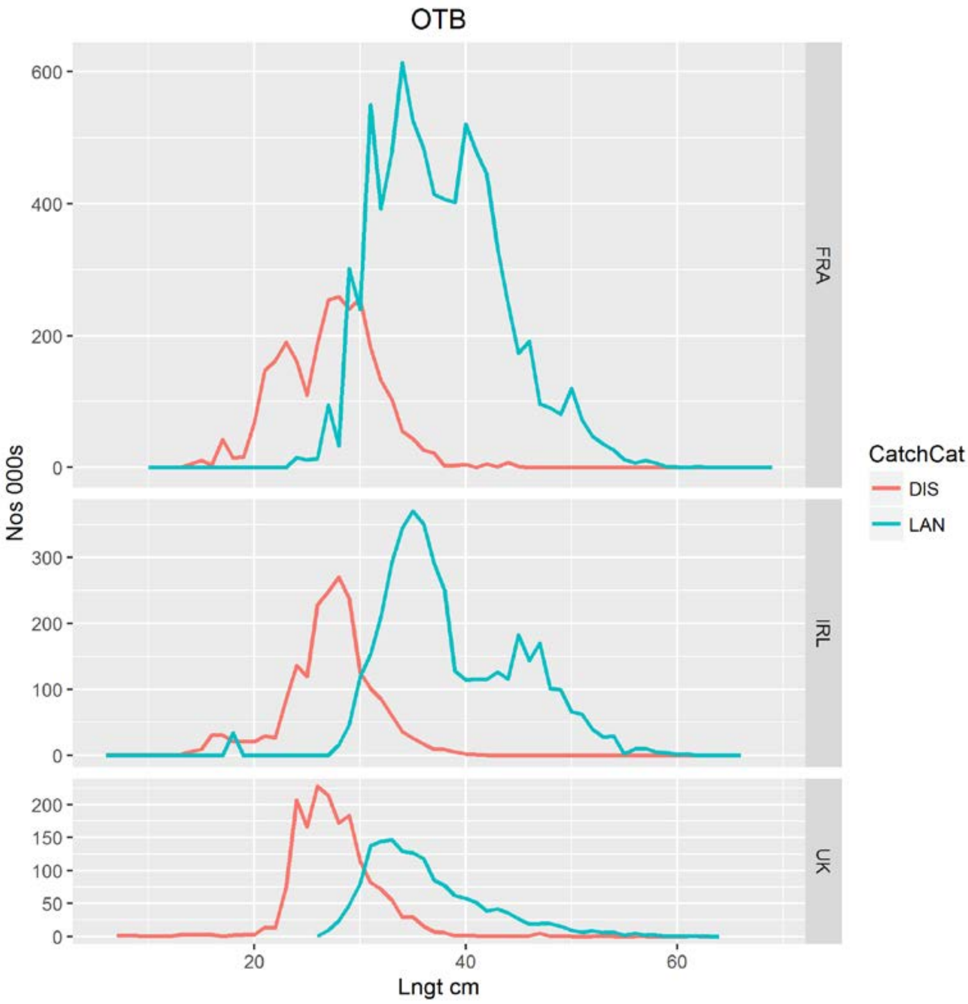
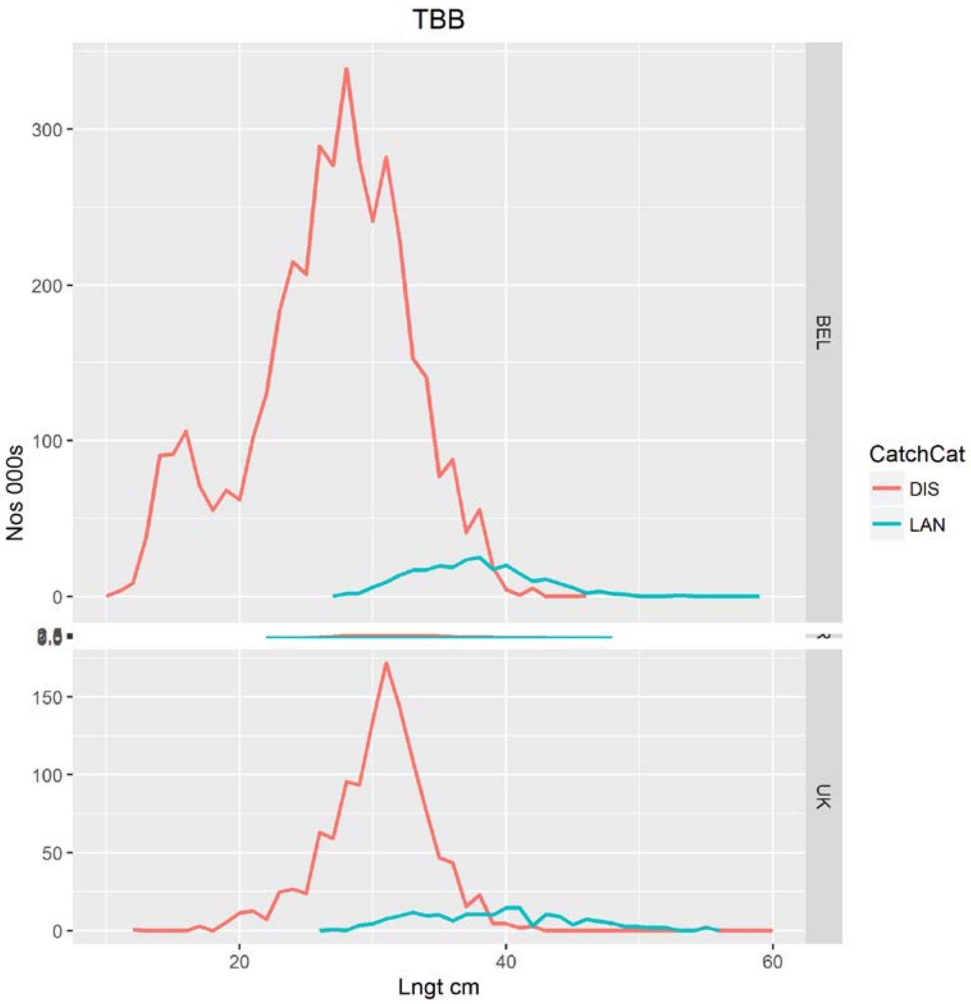


Figure 1. Irish landings for the main gear types in 1995–2015, along with annual average between 1995–2012.



OTB
Nos 000s
Lngt cm
FRA
IRL
UK
CatchCat
DIS
LAN
600
400
200
0
300
200
100
0
200
150
100
50
0
20
40
60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UK
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40
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Lngt cm
CatchCat
DIS
LAN

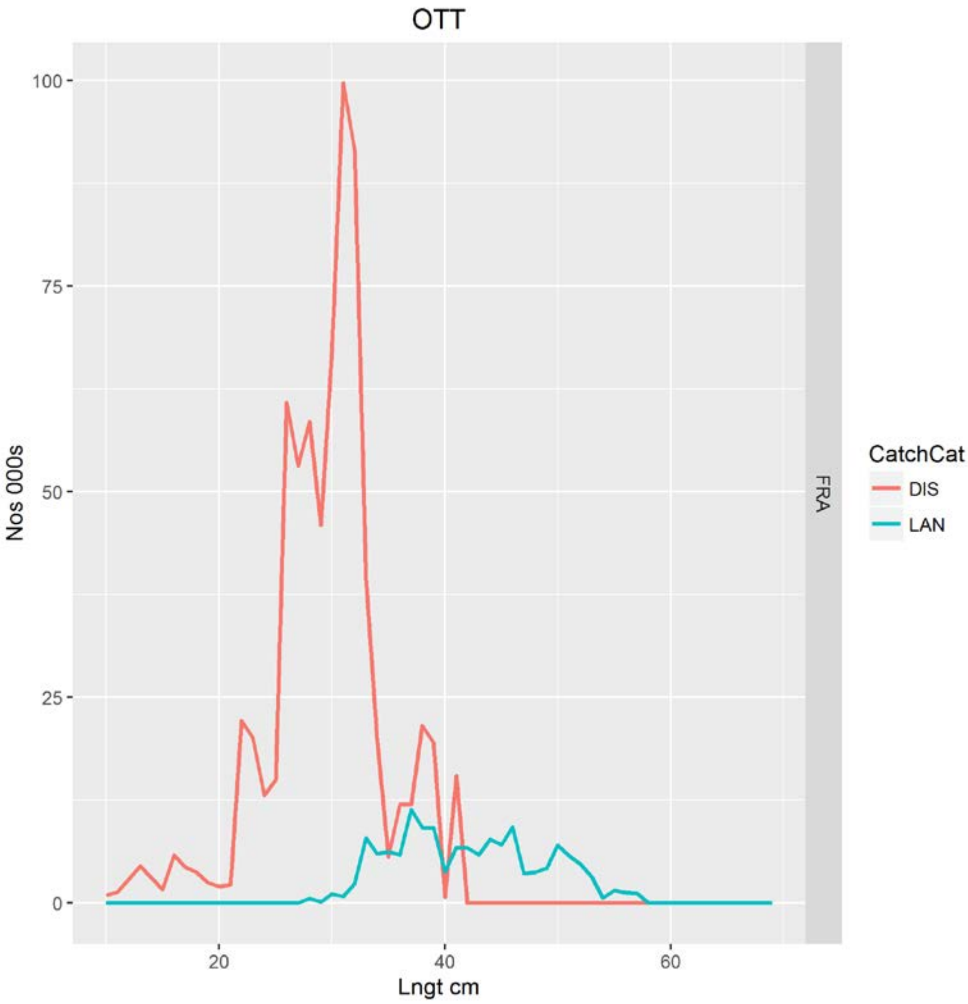

Figure 2. Whiting in 7.b, c, e–k (Celtic Sea). 2016 length compositions (raised numbers 000's) of French, UK and Irish Landings (LAN) and Discards (DIS) for the main fleets.

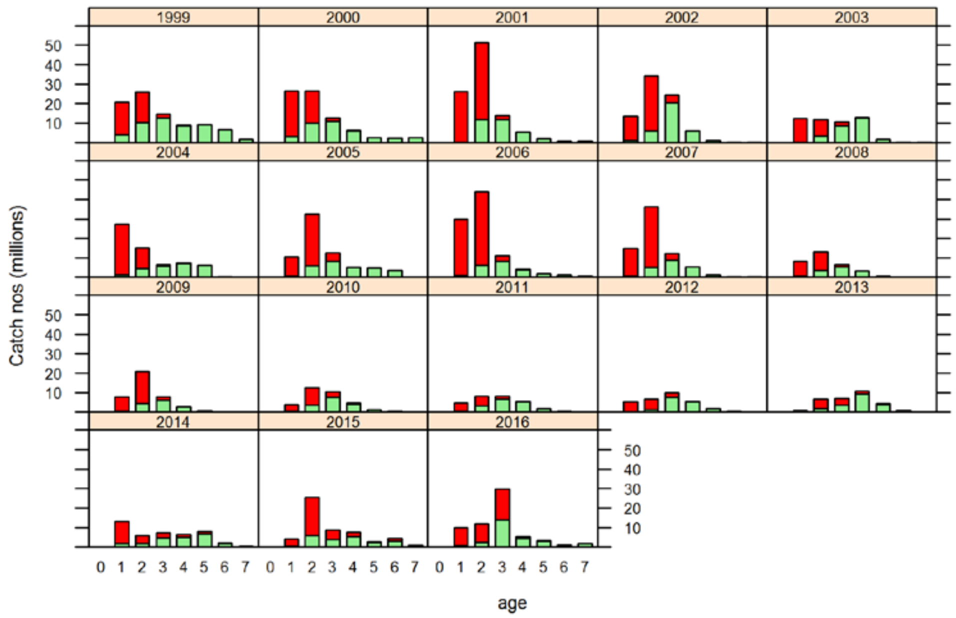

Figure 3. Whiting in 7.b, c, e–k (Celtic Sea), annual Landings (green) and Discards (red) by age composition.

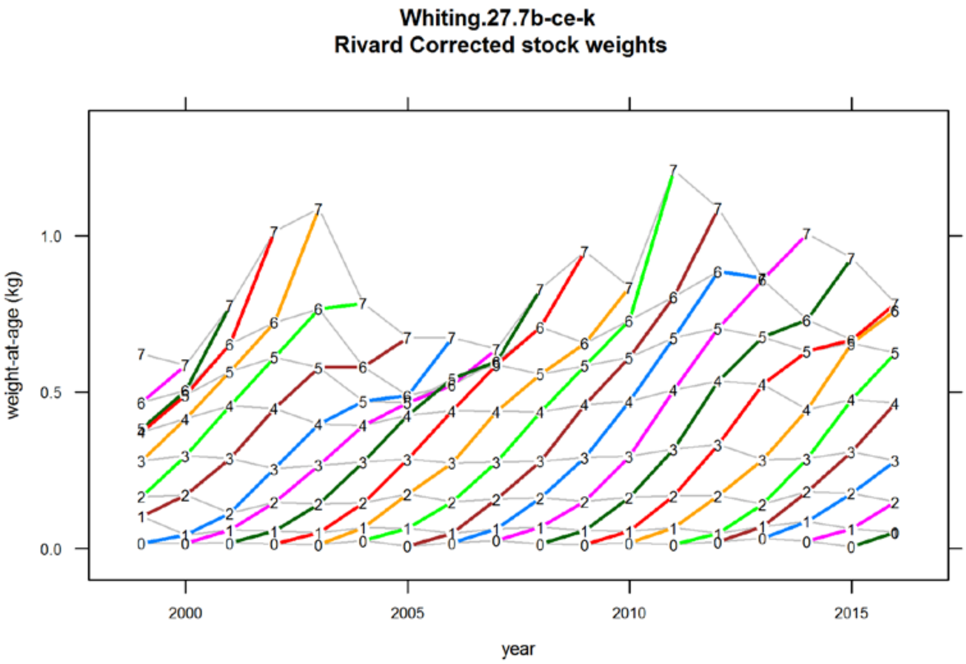

Figure 4. Whiting in 7.b, c, e–k (Celtic Sea). Rivard corrected stock weights-at-age.

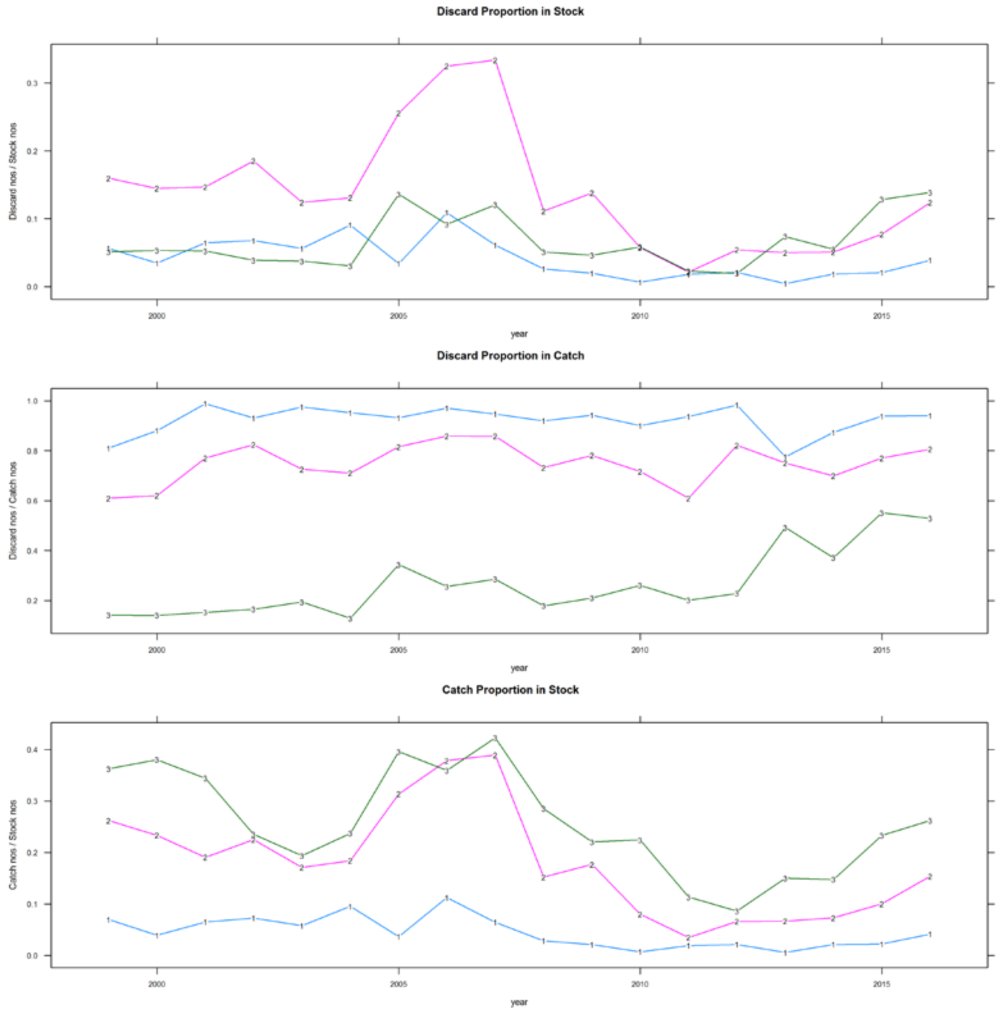

Figure 5. 2016 Annual proportions-at-age of Discard Nos in the Stock (above); Discard Nos in the Catch (middle) and Catch Nos in the Stock (below) from the assessment.

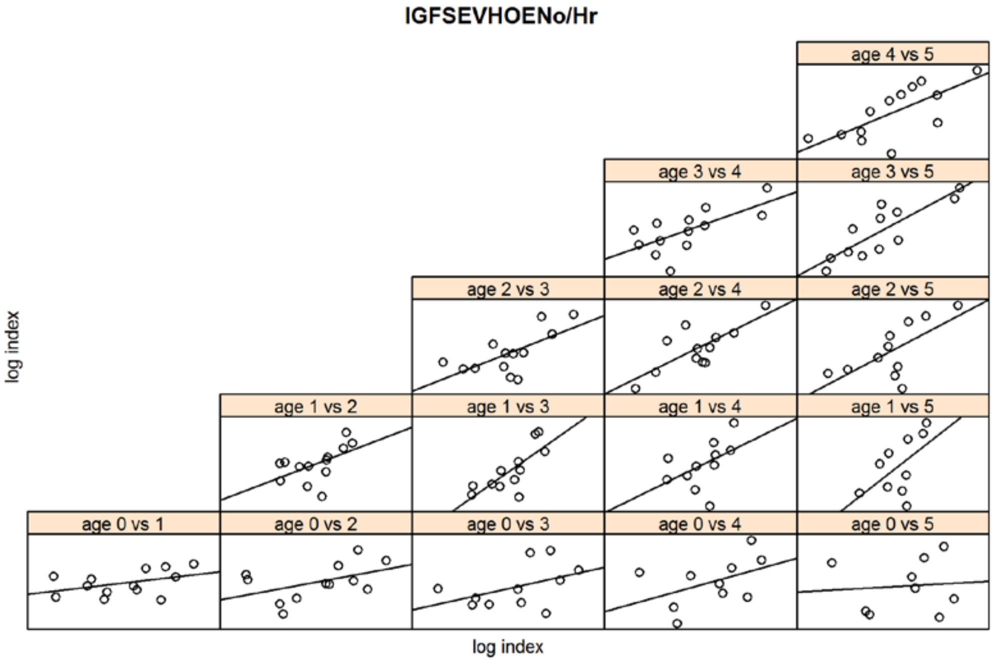

Figure 6. Whiting in 7.b, c, e–k (Celtic Sea). Pairwise scatterplots for the log numbers-at-age for the IGFS-EVHOE combined survey index.

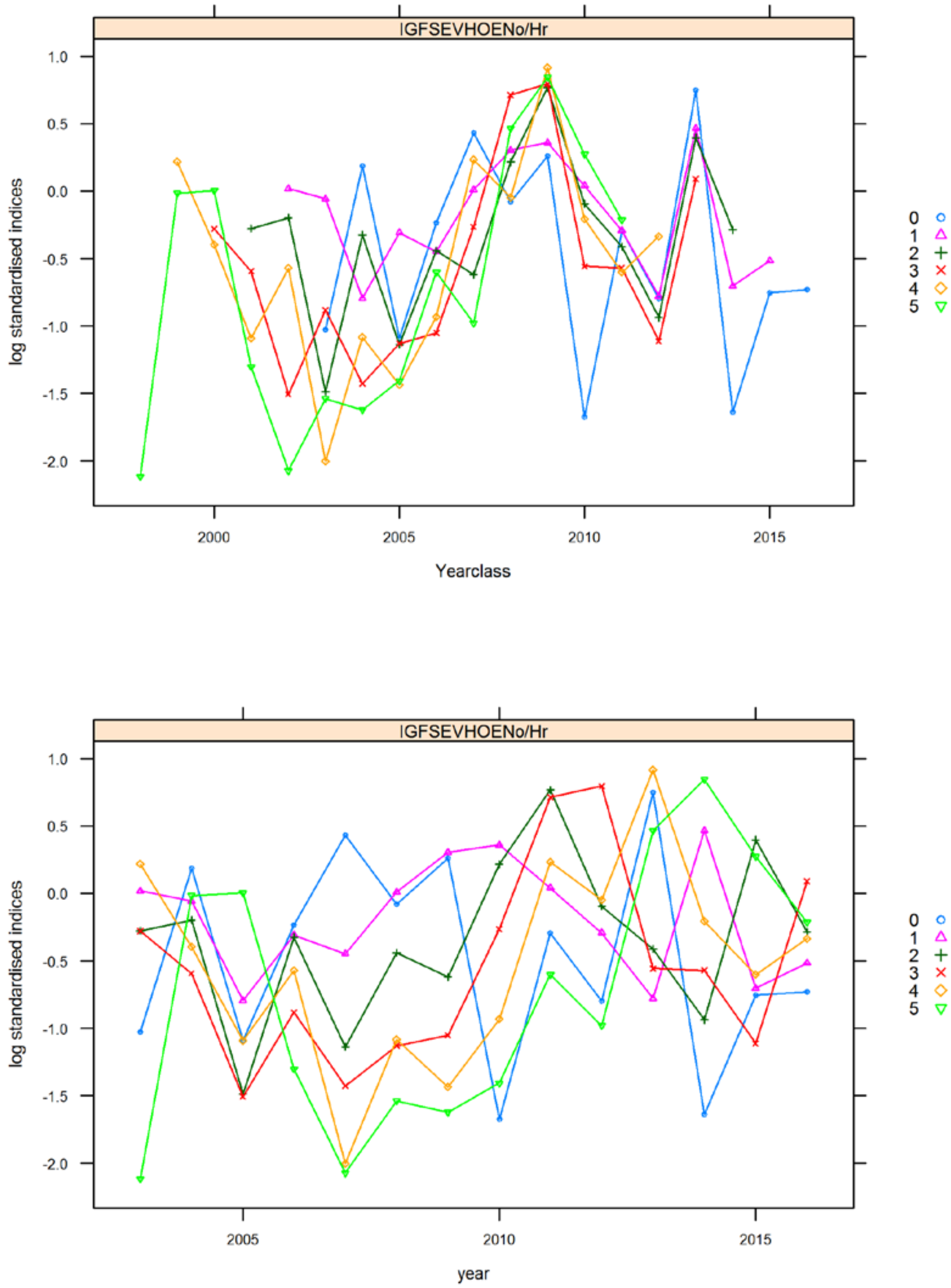

Figure 7. Whiting in 7.e–k (Celtic Sea). Mean log standardized plots of indices by year class (top panel) and by year (lower panel).

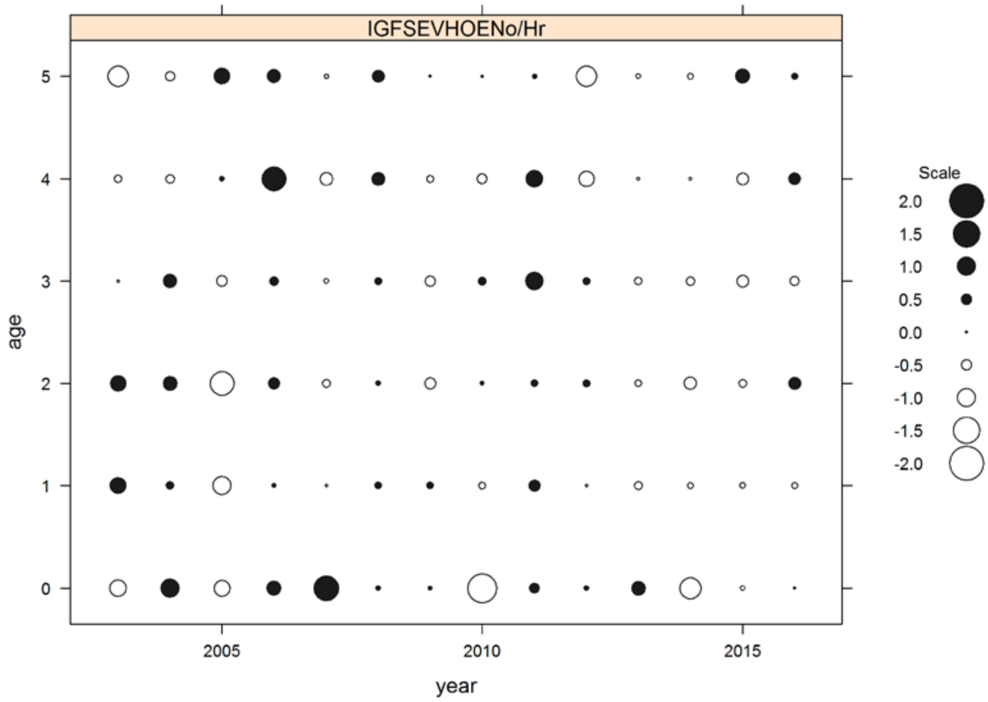

Figure 8. Whiting in 7.b, c, e–k (Celtic Sea). Log fleet catchability residuals bubble plots.

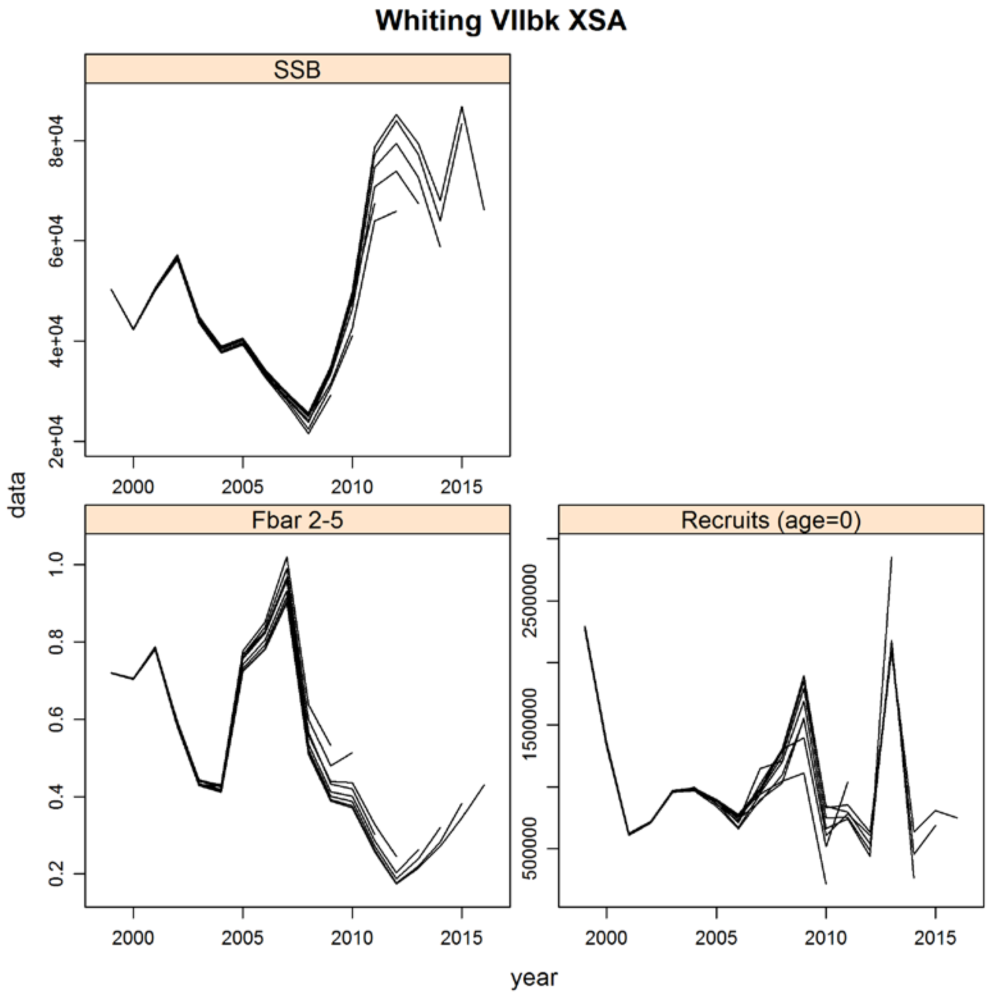

Figure 9. Whiting in 7.b, c, e–k (Celtic Sea). Retrospective analysis.

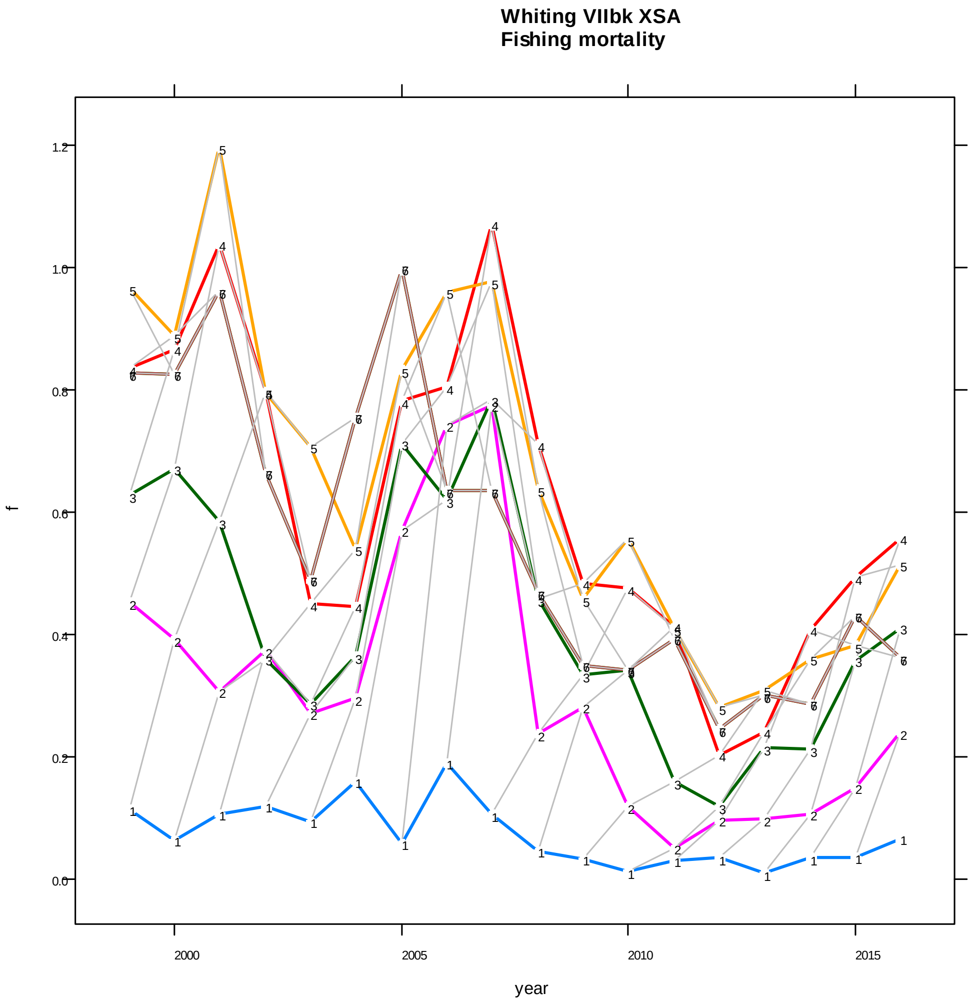

Figure 10. Whiting in 7.b, c, e–k (Celtic Sea). Fishing mortality-at-age.

Figure 11. Whiting in 7.b, c, e–k (Celtic Sea). Stock summary.

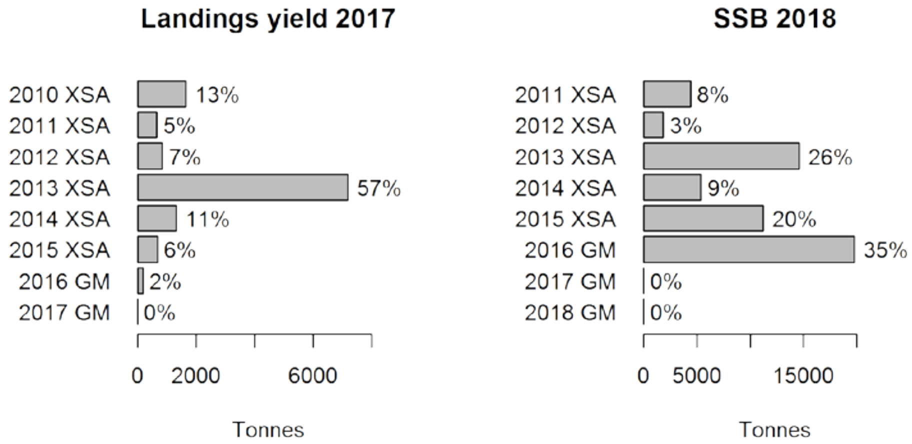

Figure 12. Whiting in Divisions 7.b, c, e–k. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

41.14 Audit of Whiting (*Merlangius merlangus*) in Divisions 7.b, c, and e–k (Southern Celtic seas and Eastern English Channel)

Date: 1st June 2017

Auditor: Lisa Readdy

General

- Whiting are caught in directed gadoid trips and as part of mixed fisheries throughout the Celtic Sea, as well as bycatch within *Nephrops* fisheries.
- This stock is only partially under the landings obligation.
- The assessment area does not correspond to the TAC management area as whiting in 7.d is assessed as part of the North Sea stock.
- ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 19 548 tonnes.
- Since 2010 below average recruitment with the exception of the 2013 year class, recent catches rely on this year class.

For single stock summary sheet advice

- Assessment type: update
- Assessment: Analytical
- Forecast: Presented
- Assessment model: XSA
- Data issues:
- Consistency: XSA as last year
- Stock status: Spawning–stock biomass has been well above MSY $B_{trigger}$ since 2009 and Fishing mortality has declined to below F_{MSY} since 2008, since 2012 it has been steadily increasing towards F_{MSY}. Recruitment has been below average since 2010 with the exception of the 2013 year class, estimated to be the second highest in the series.
- Management Plan: None

General comments

Well written report, clear and concise.

Technical comments

- Minor errors to text and references to tables and figures, which have subsequently been corrected.
- No explicit method on how the wanted and unwanted catches have been calculated from the forecasted catches.

Conclusions

The assessment has been performed according to the stock annex.

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? No management plan.
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes. F_{bar} was scaled to F_{2016}
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

Annex 2: WGCSE 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)	May 2013	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)	May 2015	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 2016	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)	March 2017	Haddock 7.a
had.27.6b	Haddock (*Melanogrammus aeglefinus*) in Division 6.b (Rockall)	May 2017	Haddock 6.b

Stock ID	Stock name	Last updated	Link
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
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 2015	*Nephrops* FU14
nep.fu.15	Norway lobster (*Nephrops norvegicus*) in Division 7.a, Functional Unit 15 (Irish Sea, West)	March 2009	*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 southwest of Ireland)	May 2017	*Nephrops* FU19

Stock ID	Stock name	Last updated	Link
nep.fu.2021	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h, functional units 20 and 21 (Celtic Sea)	May 2017	*Nephrops* FU2021
nep.fu.22	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.f, Functional Unit 22 (Celtic Sea, Bristol Channel)	May 2015	*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 2017	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 2017	Plaice 7.a
sol.27.7bc	Sole (*Solea solea*) in divisions 7.b and 7.c (West of Ireland)	April 2013	Sole 7.bc
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 2017	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 2017	Sole 7.a

Stock ID	Stock name	Last updated	Link
whg.27.7b–ce–k	Whiting (*Merlangius merlangus*) in divisions 7.b –c and 7.e–k (southern Celtic Seas and eastern English Channel)	February 2014	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 presented to WGCSE 2017

The following four working documents were presented to WGCSE in 2017. They are found below on the following pages:

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.27.3a-46)

Helen Holah, Marine Scotland Science

Introduction

Following on from the method development work of WKLIFE V in 2015 (ICES, 2016a) and the WKPROXY workshop in 2016 (ICES, 2016b), ICES has decided that stock status in relation to MSY reference points should be established for all category 3 and 4 stocks with update assessments in 2017 (see ACOM ToRs 2017). The suggested methods for exploration are outlined in the “ICES technical guidance for providing reference points for stocks in categories 3-4” (ICES, 2017).

This document presents the input data, results and interpretation of the Length Based Indicators (LBI) and Stock Production in Continuous Time (SPiCT) model and justification as to why the other suggested methods were not appropriate for this stock.

LBI

Input data

LBI can be used to provide a perception of stock status and direct further exploration using suitable methodologies. All input data are listed in Table 1. Catch Length frequencies and weight at-length data were available for both the landed and discarded components of the catches for 2012 onwards. Length frequencies available from earlier years were not included as the discard component was insufficiently sampled. The length frequencies show clear modes/peaks in 2013-2015, however 2012 has a slightly plateaued distribution and in 2016 there is evidence of a second smaller recruitment driven mode (Fig. 1). The fishery for anglerfish may have a dome-shaped selectivity pattern. Larger or mature fish are suspected to move from the continental shelf into deeper waters making them less available to the fishery (Laurenson *et al*., 2001). Mature females are also known to deposit their ribbon-like eggs higher in the water column, occasionally being caught in the pelagic fisheries (Hislop *et al*., 2000; Bjelland et al.,, 2006). Length-at-age plots from the SCO-IV-VI-AMISS-Q2 survey show anglerfish exhibit a near linear growth pattern which is not well modelled by the Von Bertalanffy growth curve (Fig. 2). However other studies have estimated VB parameters e.g. Quincoces *et al* (1998) and Landa *et al* (2001) who estimated Linf to be 150 and 140.5 for females and 100 and 110.5 for males respectively. In the absence of a model estimated $L_{inf,}$ a value of 146 cm was used, the length of the largest fish recorded in the catches of the last 10 years, associated *K* and equivalent M and M/*K* values are unknown.

Table 1: LBI Input data

Data type	Source	Years/value	Comment
Length frequency data	Intercatch	2012-2016	4 cm grouping
Weight-at-length data	Intercatch	2012-2016	4 cm grouping
L_{mat}	L50 maturity for females (Laurenson *et al*., 2008)*	102.4 cm	Males and females modelled together.
L_{inf}	Maximum observed length in the last decade (ICES, 2016a).	146 cm	

*for reference 58.3 cm for males.

Outputs

The results are compared to the suggested reference points in Table 2. Where a cell is highlighted green, the indicator suggests the stock is in a good condition relative to the reference, and red a poor condition. Across all parameters where the size composition is compared to L_{inf} and L_{mat} the stock appears to be in a bad state, particularly for the presence of mega spawners (P_{mega}). The MSY reference points suggest that the stock is being exploited above MSY, which can be seen in the graphical representation of the results (Fig. 3).

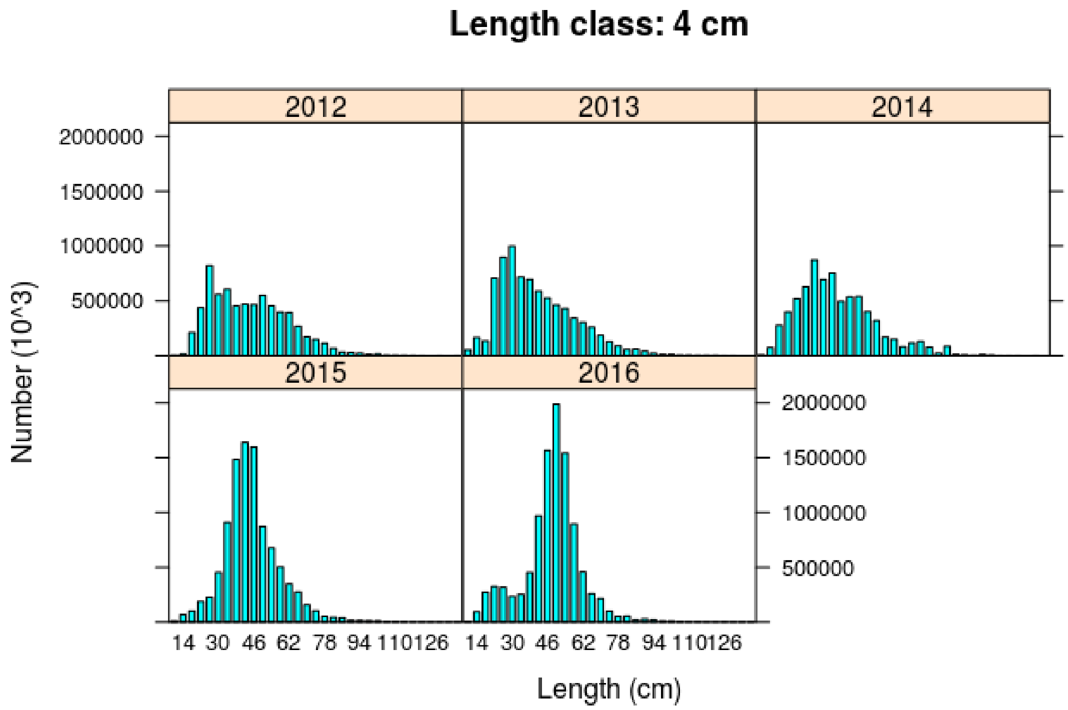

Figure 1: Length distribution from the commercial northern shelf anglerfish fishery.

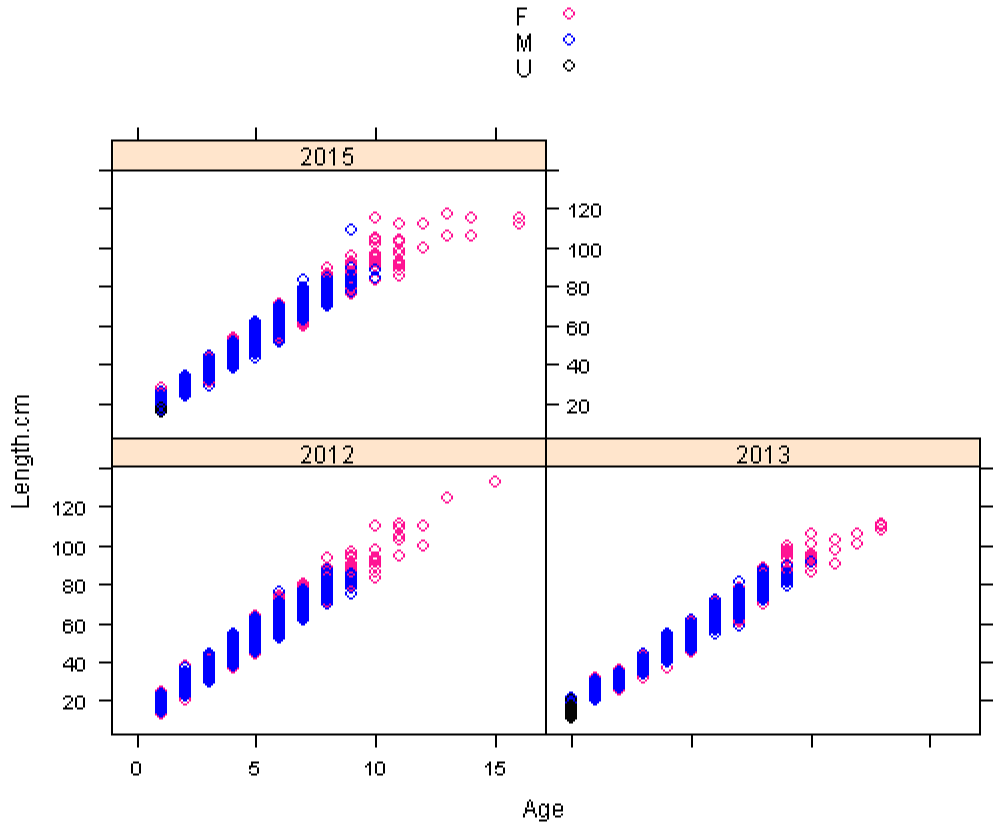

Figure 2: Length-at-age of anglerfish *(Lophius piscatorius* and *L. budegassa*) by sex from the SCO-IV-VI-AMISS-Q2 survey for years 2012, 2013 & 2015.

Table 2: table with LBI derived indicators of stock status compared to reference points.

	Conservation				Optimising Yield	MSY
Year	L_c/L_{mat}	L_{25}/L_{mat}	L_{max5}/L_{inf}	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
Reference	>1	>1	>0.8	>30%	~1 (>0.9)	≥ 1
2012	0.21	0.29	0.59	0	0.47	0.87
2013	0.14	0.28	0.58	0	0.43	0.89
2014	0.25	0.31	0.61	0	0.49	0.85
2015	0.33	0.37	0.54	0	0.49	0.78
2016	0.18	0.42	0.53	0	0.50	0.98

L_c : Length at first catch (length at 50% of mode).

L_{25} : 25th percentile of length distribution.

L_{max5} : Mean length of largest 5%.

P_{mega} : Proportion of individuals above L_{opt} + 10%.

L_{mean} : Mean length of individuals larger than L_c.

L_{opt} : Length of optimal yield (=2/3 * L_{inf}).

$L_{F=M}$: Length based proxy for MSY, = 0.75* L_c +0.25* L_{inf} .

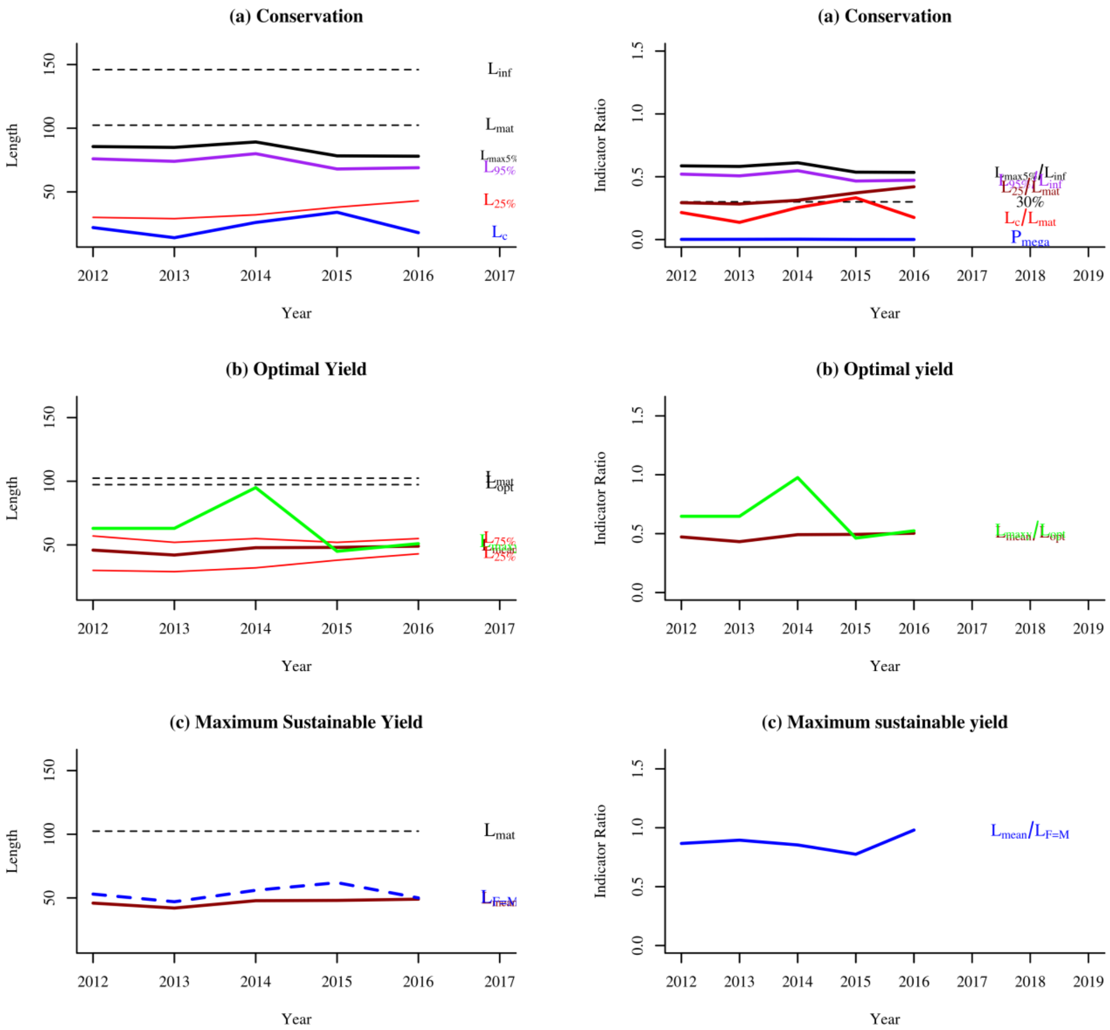

Figure 3: Development over time of the stock indicators in relation to suggested reference points.

Conclusion

The length based indicators suggest that the bulk of the catch is small and immature individuals, L_c, $L_{95\%}$ and $L_{max5\%}$ are all lower than L_{mat}. $L_{max5\%}$ is also below L_{inf} suggesting a poor conservation of large fish in the catches. This high exploitation pattern of juveniles leaves the stock vulnerable to overexploitation. However, literature concerning the biology and life history traits of anglerfish shows some consensus with larger fish migrating out of the fishery. In these situations the use of length based indicators are likely to be much less useful in terms of providing an indication of status in terms of conservation and optimising yield as they assume the (fully selected) catch length composition to be representative of the population length composition. However, it remains a concern that these fish are not represented in either the survey or commercial catches and therefore changes in their abundance cannot be observed or monitored. The linear nature of growth exhibited by anglerfish (Fig. 2) led to the approximation of a value for L_{inf} providing a further reason for treating the related indicators (L_{opt}, P_{mega}, $L_{F=M}$) with caution. Given the characteristics of the anglerfish stock and fishery, this method appears unlikely to be useful for the provision of advice on stock status.

MLZ

Comment

The mean length-z model assumes that Von Bertalanffy growth parameters L_{inf} and *K* can be estimated for the stock and that the selectivity of the fishery is knife-edged above the length of full selectivity (L_c) at which point 100% of individuals are vulnerable to capture. As these assumptions cannot be adequately met for this stock this method was not explored further.

LB-SPR

Comment

The length based spawner per recruit model also assumes Von Bertalanffy growth parameters L_{inf} and *K* are known for the stock and that the ratio of natural mortality and the Von Bertalanffy coefficient can be estimated. In addition the length structure observed in the catch should be representative of the stock. Again this stock does not meet the required assumptions for this method.

SPiCT model

Input data

The surplus production model in continuous-time (SPiCT) provides model diagnostics along with reference points for both biomass and fishing mortality and relative values respectively. All available input data are shown in Table 3 and Fig. 4. A single survey was included in the SPiCT model (the Scottish and Irish anglerfish and megrim industry/science survey SCO-IV-VI-AMISS-Q2) a targeted survey covering ICES Subareas 27.4 and 27.6. This was used as a relative or exploitable biomass index input. Landings data is available from 1973 however there are uncertainties associated with the catches between 1998-2006 after the introduction of a Total Allowable Catch (TAC) in 1998 and prior to the registration of fish sellers and buyers and designation of auction sites (Scotland) regulations of 2005. Landings during this period are assumed to be unreliable due to high levels of suspected area misreporting and possible black landings under a restrictive TAC. An effort series for Scottish demersal trawls (TR1) in Subarea 27.4 and 27.6 was available from 2000 to present. The recording of Scottish hours fished data is not mandatory in log sheets and the data are incomplete therefore Scottish otter-trawl fleet effort data are provided in units of kWdays.

Exploration

The SPiCT model was applied to relative biomass index as a proxy for exploitable biomass and landings as a proxy for catches. SPiCT allows for fixing the noise parameters on data series, due to the short time-series the parameters of observation error of the landings (β) and survey biomass (α) were not estimated in the model therefore fixed values of $\beta=0.65$ and $\alpha=0.85$ were adopted from the WKPROXY report (ICES, 2016b). No priors were used. The method exploration conducted at WKPROXY discounted the survey years where the survey was not conducted in April (November, 2005-2007, 2013) however SPiCT allows for the time at which the observation was made and the intervals between observation to be specified so these years were included (Fig. 4) in all model runs reported here.

Several trials were run (5 shown here) using various lengths and combinations of the available time-series (Table 3) as inputs.

Table 3: Input data available to the SPiCT model.

Data type	Source	Years/value	Comment
Survey time-series	SCO-IV-VI-AMISS-Q2	2005-2016	Conducted in November (rather than April) in 2005-2007 and

			2013.
Landings time-series	ICES; Historical Nominal Catches 1950-2010, Official Nominal Catches 2006-2014 and preliminary catch statistics 2015-2016.	1973-2016	Uncertainty surrounding reliability of landings 1998-2006.
Effort time-series	Scottish otter-trawl kWdays	2000-2016	

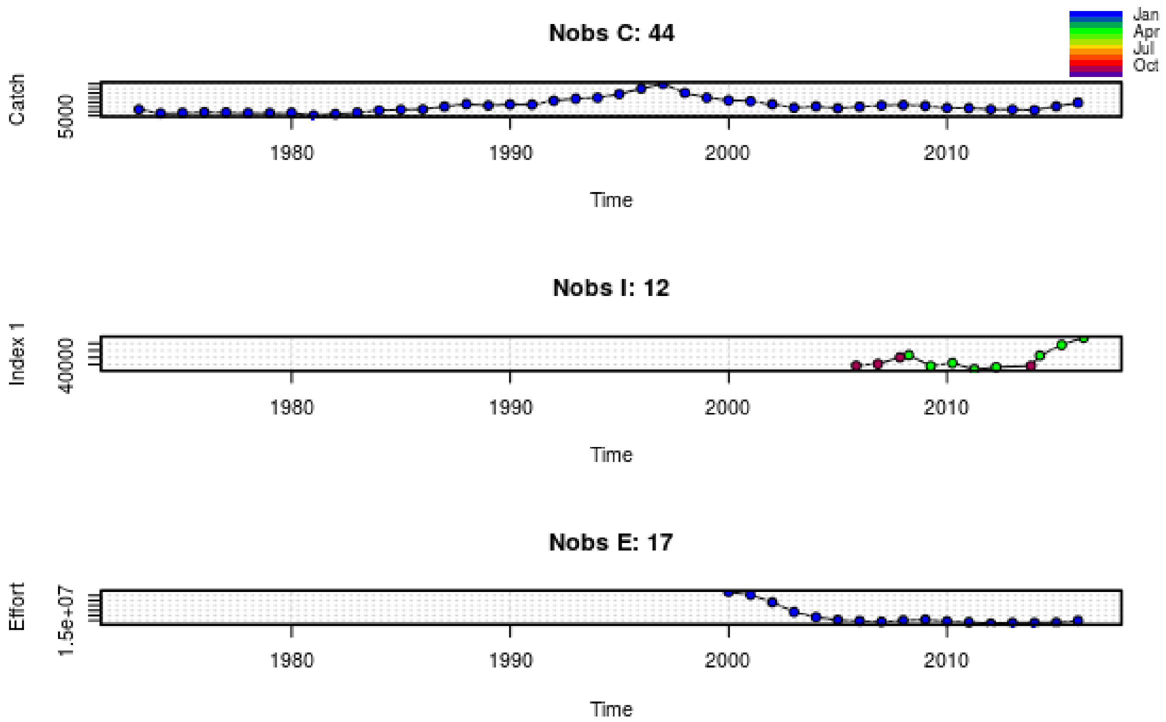

Figure 4: Input data available to the SPiCT model. Top: Landings as collated by ICES. Middle: SCO-IV-VI-AMISS-Q2 estimates of relative biomass. Bottom: Effort in kW days of the Scottish otter trawl fleet.

Output

Reference points and stock status can be found in the respective output tables for each trial (Tables 4-8). The output includes both stochastic and deterministic reference points. Both are shown but if a suitable model was agreed upon for the approximation of reference points then the more conservative of the two would likely be chosen. The graphical output of the runs can be seen in figures 5-19.

Discussion

Run 1

Exploration started with a model using the landings 2006-2016 and the biomass index 2005-2016 (run 1). This was a similar model to that available on the www.stockassessment.org portal as used by the WKPROXY workshop with an update to include the most recent years of landings (2015 and 2016), the most recent year of biomass index (2016) and the inclusion of the years in which the SCO-IV-VI-AMISS survey was conducted in November (2005-2007 and 2013). With the inclusion of the most recent data the model output gave a significantly poorer outlook of stock state (Fig. 5) with the biomass index below B_{MSY} for the whole time-series and the landings above F_{MSY} for all years excluding 2015, also reflected in the stock development plot. The uncertainties associated with the absolute and relative B_{MSY} and F_{MSY} reference points are very high. The values estimated (Table 4) for F_{MSY} are quite high and the F for 2016 is unrealistically high (0.75). The model diagnostics appear ok for all the runs, however the retrospective plot for run 1 (Fig. 7) fails to converge and appears to be highly sensitive to the removal of data points.

Run 2

For run 2 the biomass index and catch time-series used as model input remained the same as run 1, but an effort time-series was added to the model from 2006-2016 (Table 5). The effort data changes the outlook of the model dramatically, with the absolute and relative biomass values over the time-series all above B_{MSY} and similarly the fishing mortality values are well below F_{MSY}. The stock development plot now shows a healthy and highly productive stock (Fig. 8). Despite the stock appearing to be in a healthy state the uncertainties surrounding the reference points in run 2 are much greater. The model predicted stochastic MSY of 31 796 t is very high, as is the B_{2016} estimate of 119751 t with the F_{2016} of 0.166 unrealistically low for an anglerfish stock. Whist adding the effort series to the model improves the perceived condition of the stock the failure in the retrospective convergence suggests that the model is still highly unstable (Fig. 10).

Run 3

For run 3 the catch time-series was extended back to 1998, the first year of TAC management and the effort series extended back to its earliest year (2000) (Table 6). The model uncertainties in run 3 are much lower than in runs 1 and 2. The model shows the stock to have been below B_{MSY} between 1999-2004 and also above F_{MSY} from 1998-2002. This change over time is also seen in the stock development plot (Fig. 11). The model summary produces a slightly low B_{MSY} 36677 t and similarly slightly high F_{MSY} 0.628 although the estimates for MSY (23 022 t), B_{2016} (71 589) and F_{2016} (0.275) are all sensible. Whilst the retrospective fits of run 3 converged there is still instability appearing to come from the last two years of data (Fig. 13) suggesting that the model is fitting poorly to the steep increases observed in both the biomass and catch since 2014.

Run 4 and 5

For run 4 the landings time-series was extended back to 1973 with the biomass and effort series remaining the same as run 3. As with run 3 the uncertainties around the reference points are low however there appear to be much larger uncertainty bounds surroundings the absolute biomass of the first year (1973) which also looks unusual on the production curve plot (Fig. 14). The model suggests the stock has been exploited sustainably for the majority of the time series excluding the years of very high catch during the late 1990s (Fig. 14). There also appears to be a switch in the catch residuals from mainly positive to mainly negative around 1998, the model may be expecting more catches than were observed, which could be a result of the misreporting suspected to have begun at this time (Fig. 15). The model estimated reference points (Table 7) appear to be more realistic than those of the previous runs. The retrospective models successfully converge and appear to show pretty good fits and an indication of stability (Fig. 16). However due to the unusual way the model was responding to the first year of landings data (1973), predicting an unrealistically high absolute biomass run 5 was a rerun of run 4 with the exclusion of the first landings value for 1973. The impact of removing this single year on the model predictions of stock biomass and fishing morality is marked. The absolute biomass is now estimated to be below B_{MSY} until 1998 and in fact appears to increase from almost zero at the start of the time series. The estimates for fishing mortality also appear rather strange: fishing mortality is estimated to be well above F_{MSY} at the start of the time series when it was a relatively low value, by-catch species. The uncertainty margins increase towards the present day for the biomass estimates and decrease for the fishing mortality. The relative biomass shows an exaggerated-increasing trend (Fig. 17) in recent years. The model predicts unfeasible estimates of B_{MSY} (74 713 t) and B_{2016} (144 144 t). The retrospective fits again failed to fully converge and show very large variation (Fig. 19).

Overall conclusion

Whilst the inclusion of an effort time-series and additional years of landings data have made the model predictions more representative of existing knowledge of this stock's exploitation the model retrospective fits in almost all instances only partially converge and show significant differences between the retrospective fits demonstrating a lack of robustness in the SPICT model estimates.

The survey biomass index used in the SPiCT assessment is too short to inform production parameters, despite having a long time-series of landings available; using the two together is not advisable as it creates a large mismatch in the series for which the model is making assumptions. The reported landings since 1998 have been driven by quota limitations and are therefore not reflective of stock size. In addition, there is considerable uncertainty around the reported landings during the period 1998 to 2006 – a period when underreporting is known to have occurred. The analysis conducted here supports the conclusions of the WKPROXY experts and external reviewers that given the currently available data, SPiCT does not provide a reliable indication of stock status or associated MSY reference points.

Anglerfish will receive update advice in October 2017 at which point the presence or absence of MSY reference points will be considered when deciding whether or not the 20% precautionary buffer should be applied. Given that the exploitable biomass of this stock has increased significantly over the past 5 years and that the ratio of the most recent two to the previous three years biomass is 1.71 this stock has good grounds for an exemption in applying the PA buffer. There is a plan to benchmark this stock in 2018 and it is envisaged that this process will result in an analytical stock assessment and associated reference points.

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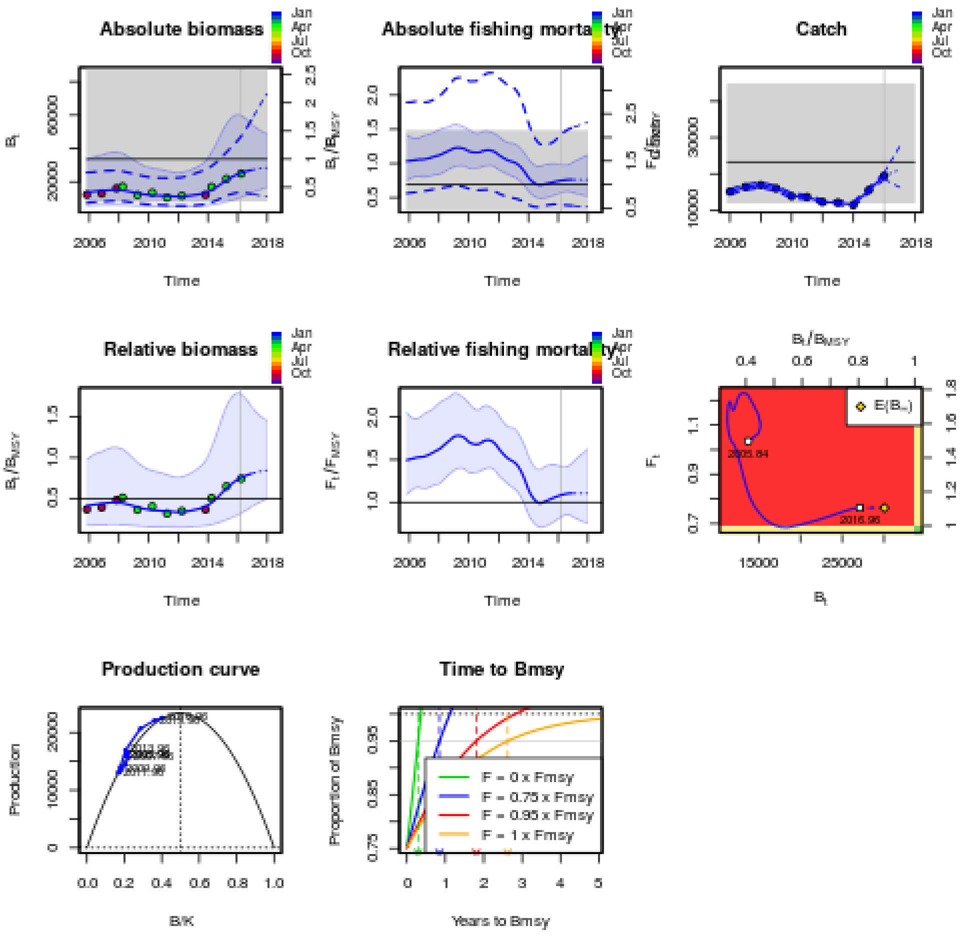

Figure 5: Output from the SPiCT run 1.

Table 4: Model estimated reference points run 1

Run 1	Parameter	Type	Value
Landings: 2006-2016 Index: 2005-2016	B_{MSY}	S	33667 t
		D	33747 t
	F_{MSY}	S	0.691
		D	0.692
	MSY	S	23264 t
		D	23337 t
	B_{2016}	-	25305
	F_{2016}	-	0.750
	B_{2016}/B_{MSY}	S	0.752
	F_{2016}/F_{MSY}	S	1.086

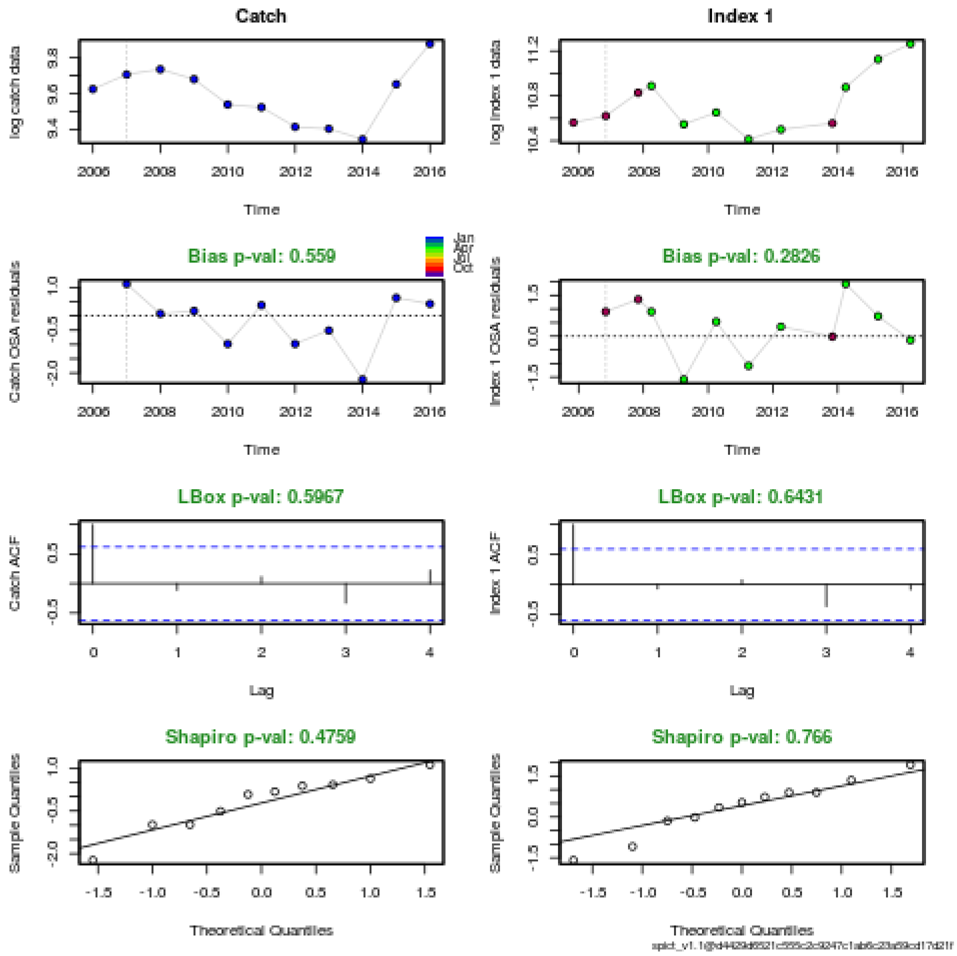

Figure 6: Model diagnostics from the SPiCT model run 1.

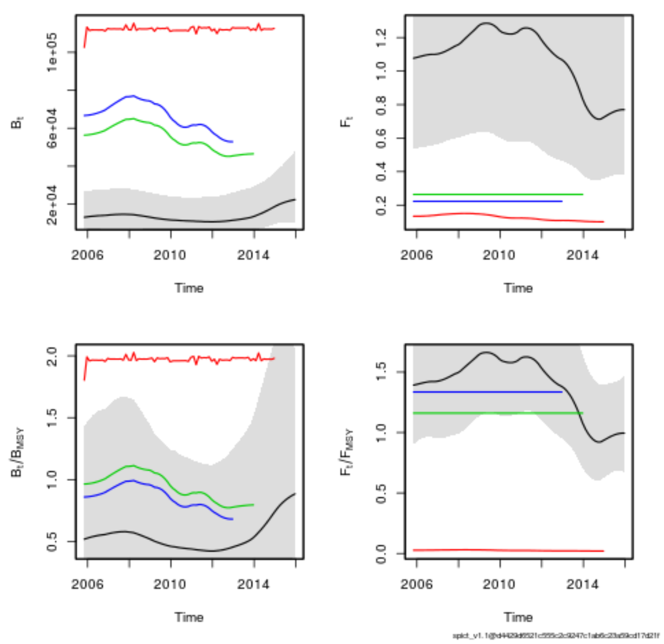

Figure 7: 4-year retrospective of SPiCT run 1.

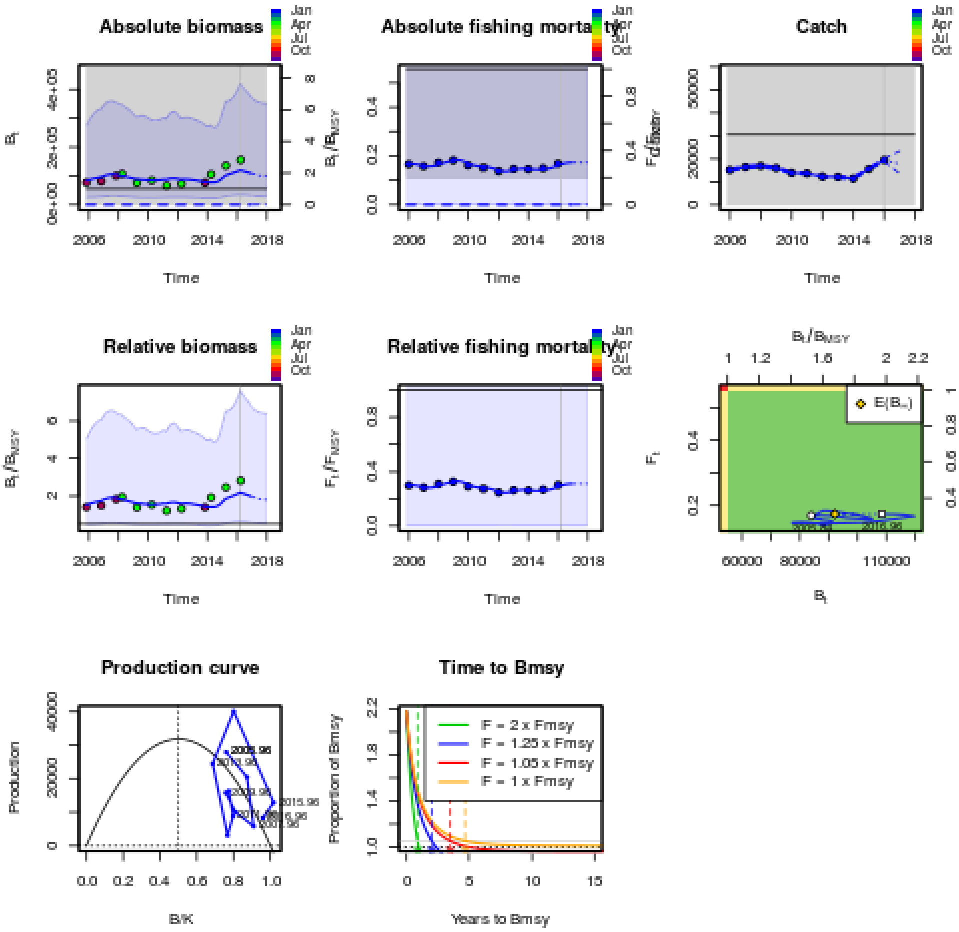

Figure 8: Output from the SPiCT run 2.

Table 5: Model estimated reference points run 2

Run 2	Parameter	Type	Value
Landings: 2006-2016 Index: 2005-2016 Effort: 2006-2016	B_{MSY}	S	54952 t
		D	56513 t
	F_{MSY}	S	0.556
		D	0.563
	MSY	S	31796 t
		D	30534 t
	B_{2016}	-	119751
	F_{2016}	-	0.166
	B_{2016}/B_{MSY}	S	2.179
	F_{2016}/F_{MSY}	S	2.990

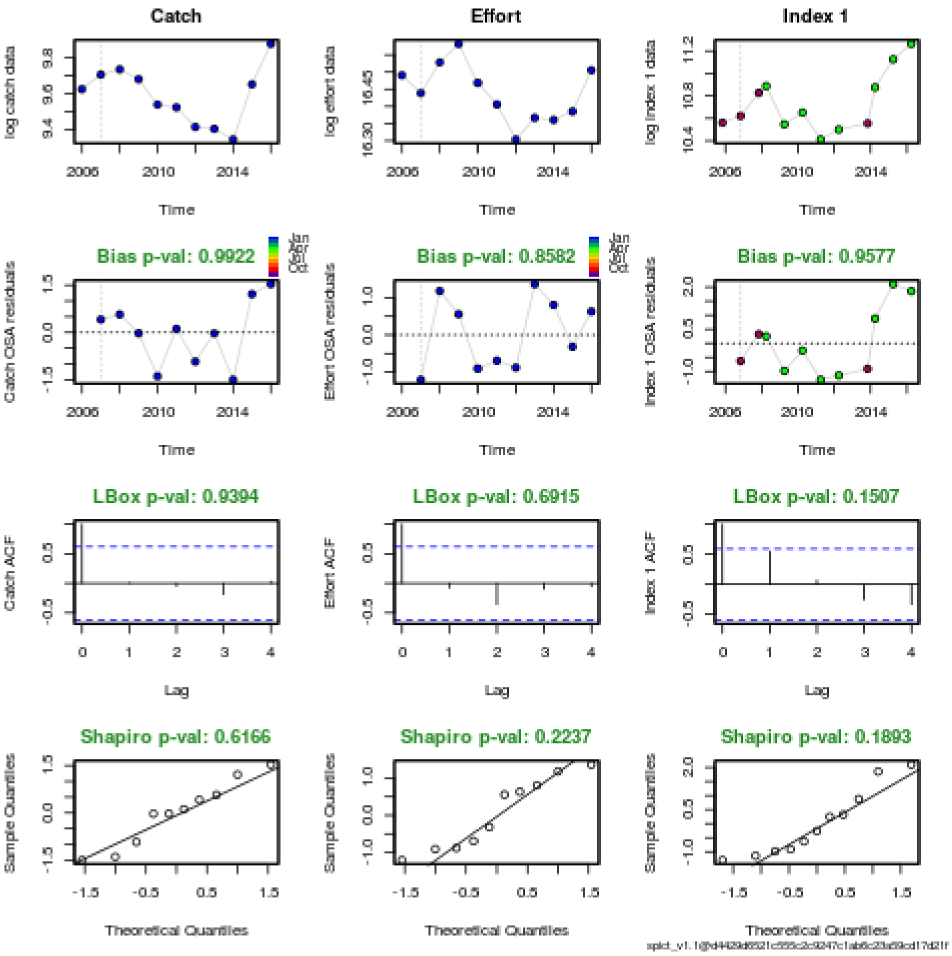

Figure 9: Model diagnostics from the SPiCT model run 2.

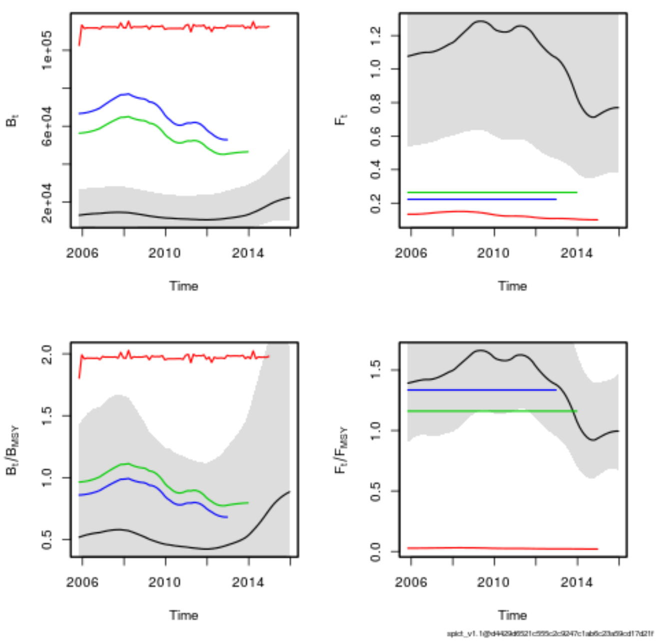

Figure 10: 4-year retrospective of SPiCT run 2.

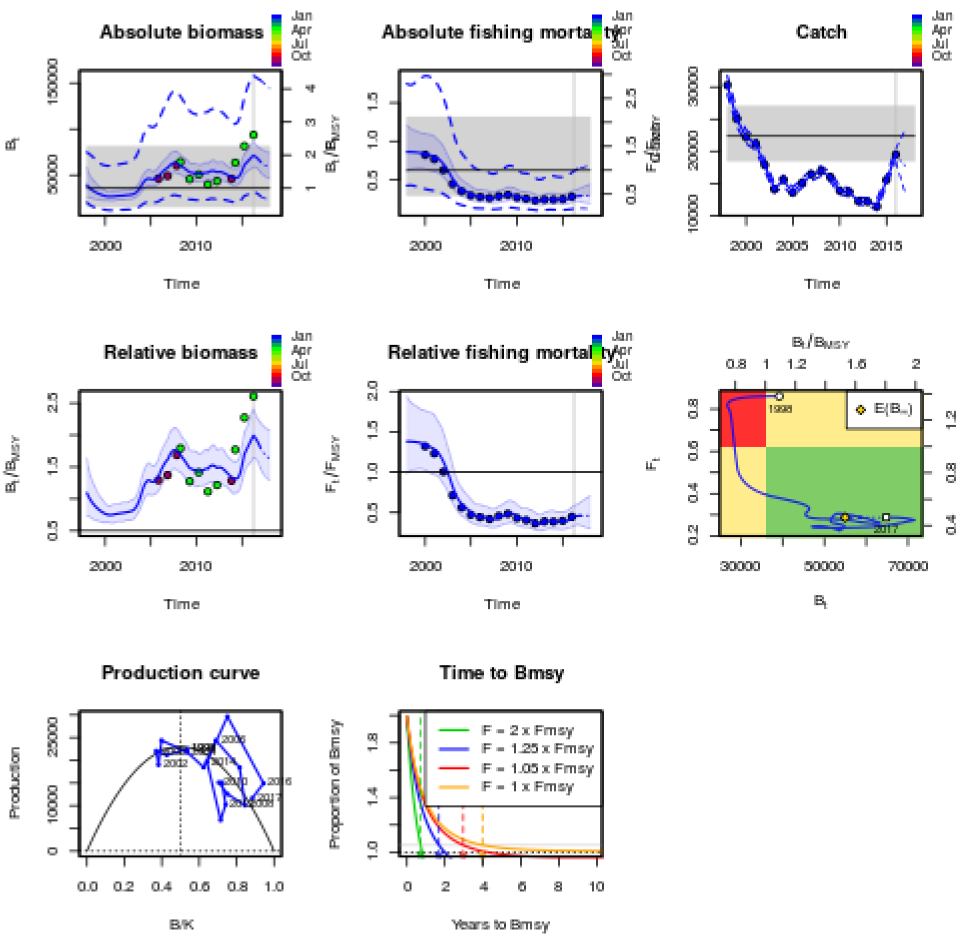

Figure 11: Output from the SPiCT run 3.

Table 6: Model estimated reference points run 3

Run 3	Parameter	Type	Value
Landings: 1998-2016 Index: 2005-2016 Effort: 2000-2016	B_{MSY}	S	35923 t
		D	36677 t
	F_{MSY}	S	0.623
		D	0.628
	MSY	S	22372 t
		D	23022 t
	B_{2016}	-	71589
	F_{2016}	-	0.275
	B_{2016}/B_{MSY}	S	1.993
	F_{2016}/F_{MSY}	S	0.442

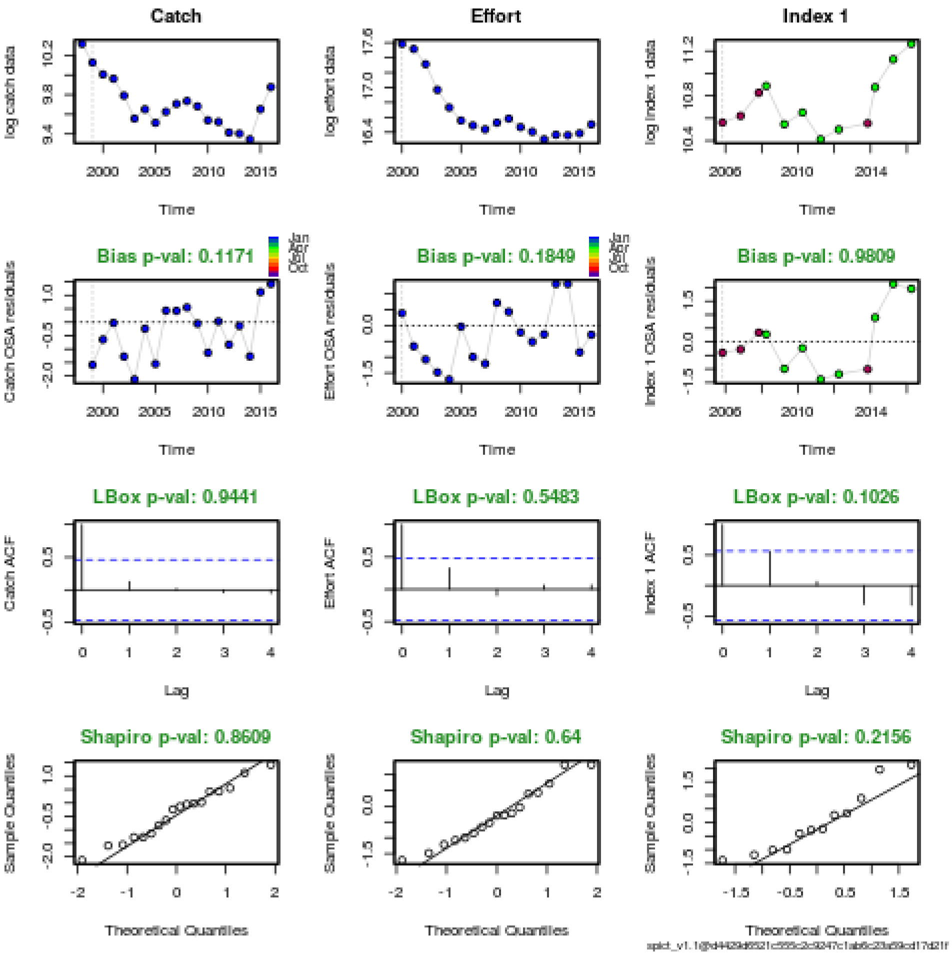

Figure 12: Model diagnostics from the SPiCT model run 3.

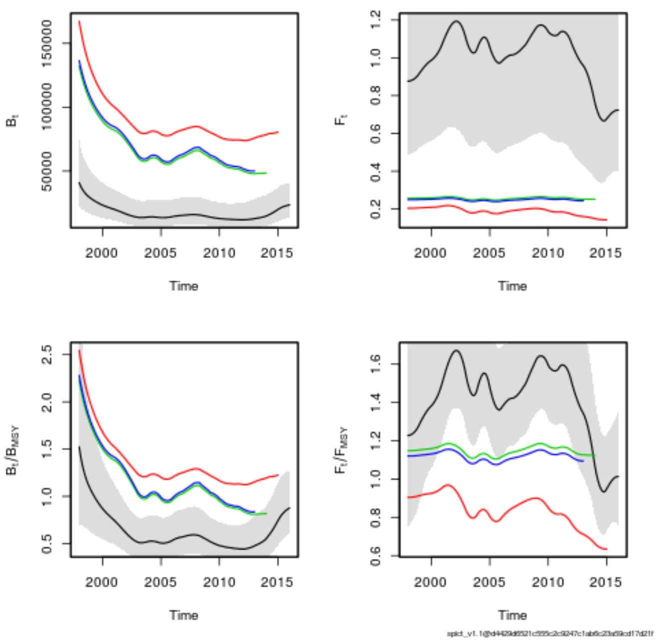

Figure 13: 4-year retrospective of SPiCT run 3.

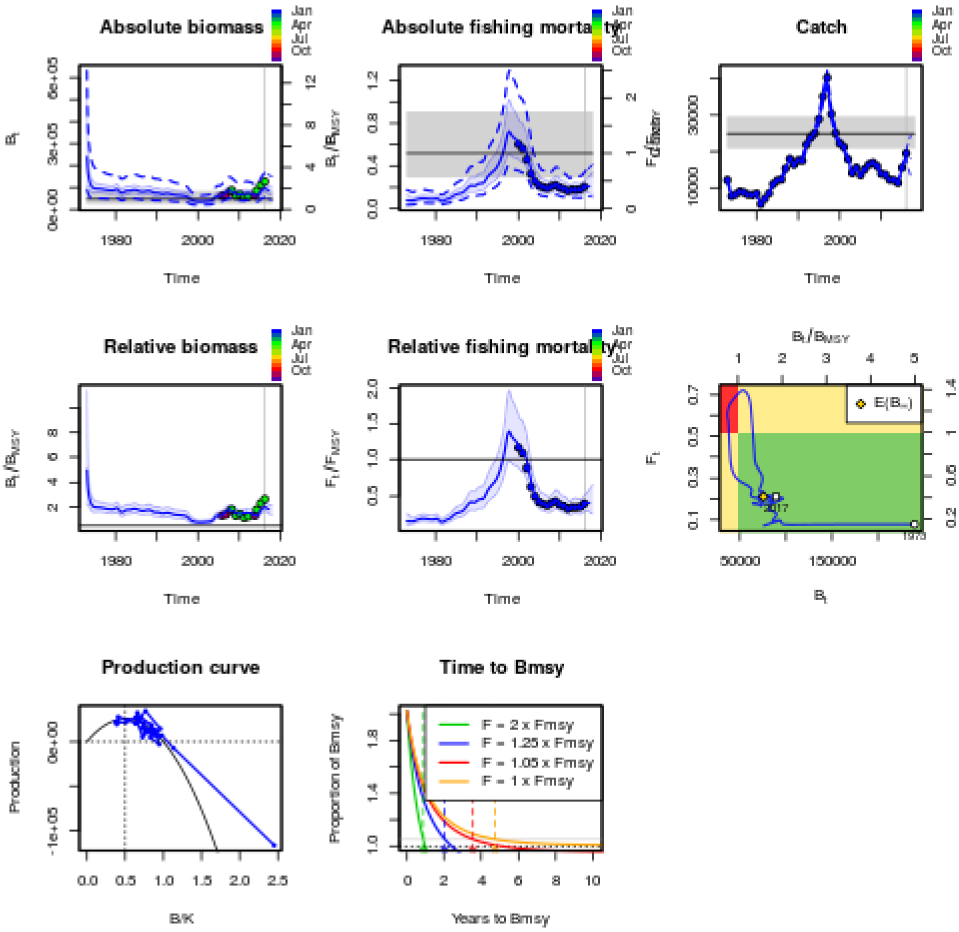

Figure 14: Output from the SPiCT run 4.

Table 7: Model estimated reference points run 4

Run 4	Parameter	Type	Value
Landings: 1973-2016 Index: 2005-2016 Effort: 2000-2016	B_{MSY}	S	47987 t
		D	48918 t
	F_{MSY}	S	0.518
		D	0.523
	MSY	S	24861 t
		D	25579 t
	B_{2016}	-	97086
	F_{2016}	-	0.202
	B_{2016}/B_{MSY}	S	2.023
	F_{2016}/F_{MSY}	S	0.390

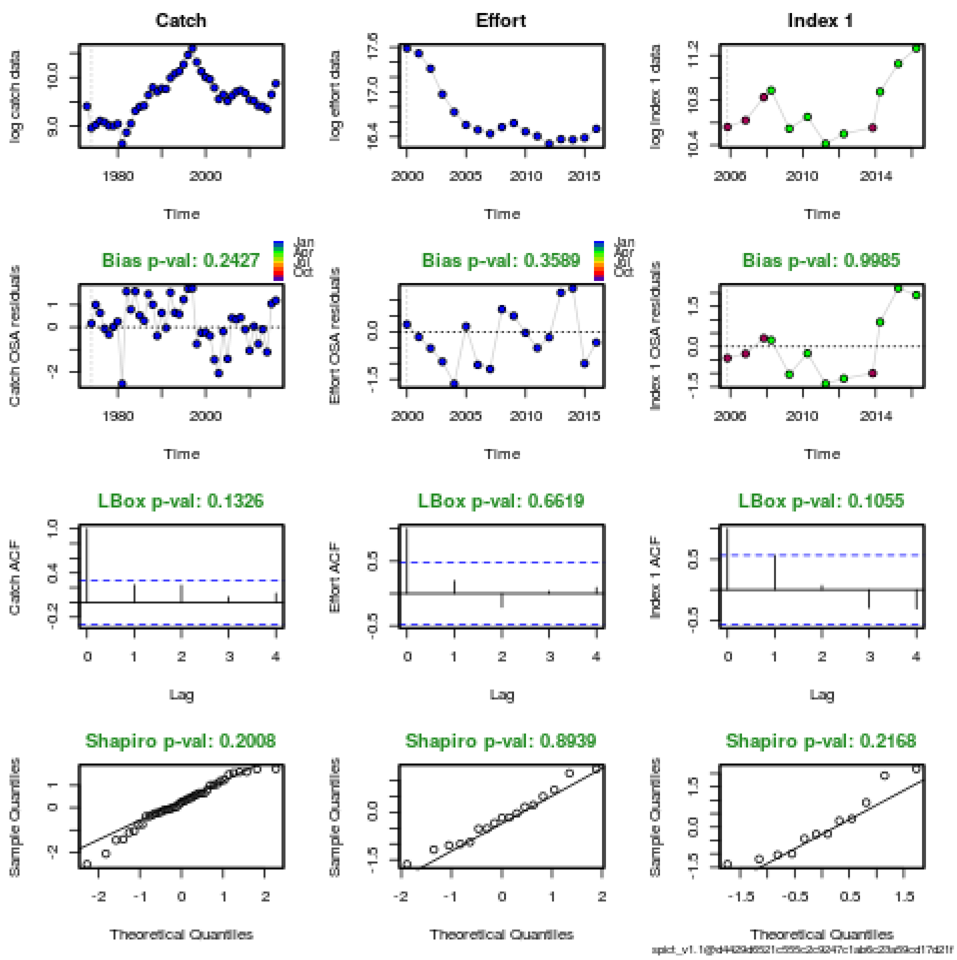

Figure 15: Model diagnostics from the SPiCT model run 4.

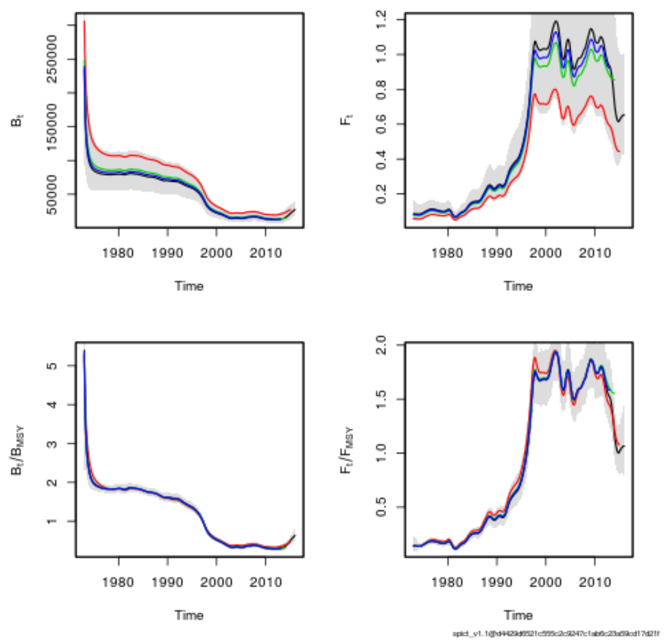

Figure 16: 4-year retrospective of SPiCT run 4.

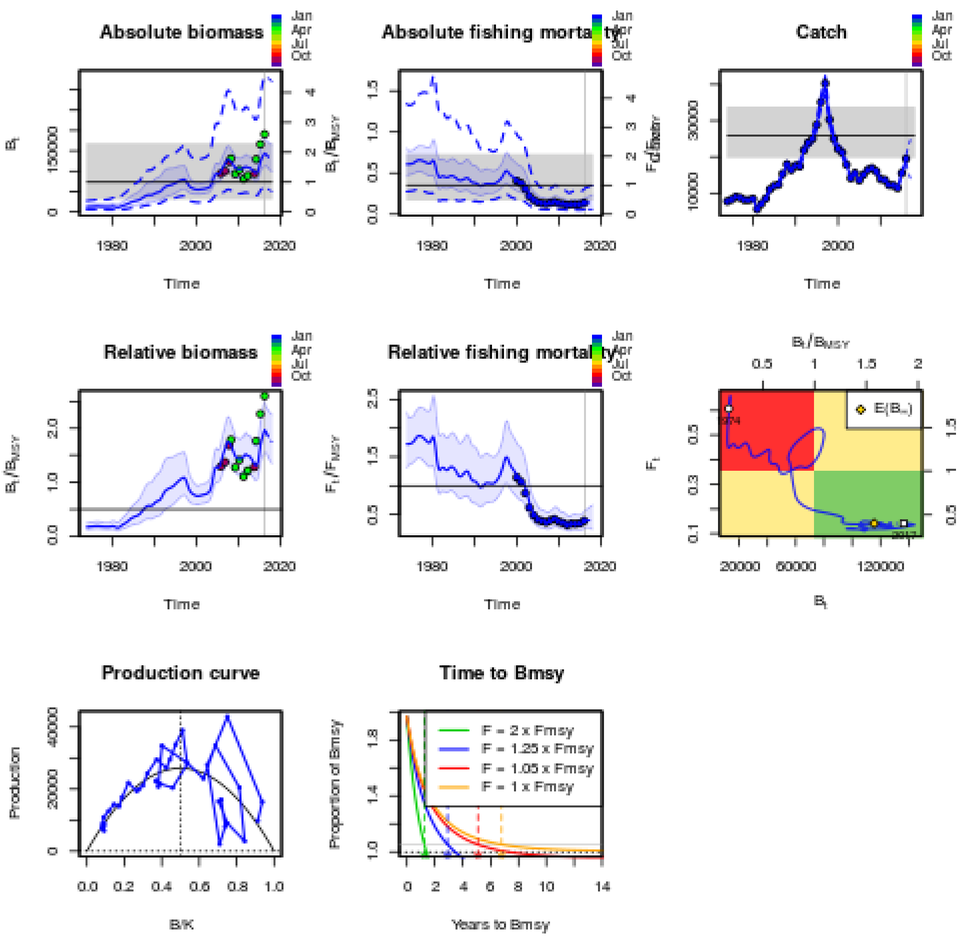

Figure 17: Output from the SPiCT run 5.

Table 8: Model estimated reference points run 5

Run 5	Parameter	Type	Value
Landings: 1974-2016 Index: 2005-2016 Effort: 2000-2016	B_{MSY}	S	73284 t
		D	74713 t
	F_{MSY}	S	0.353
		D	0.357
	MSY	S	25852 t
		D	26690 t
	B_{2016}	-	144144
	F_{2016}	-	0.136
	B_{2016}/B_{MSY}	S	1.967
	F_{2015}/F_{MSY}	S	0.384

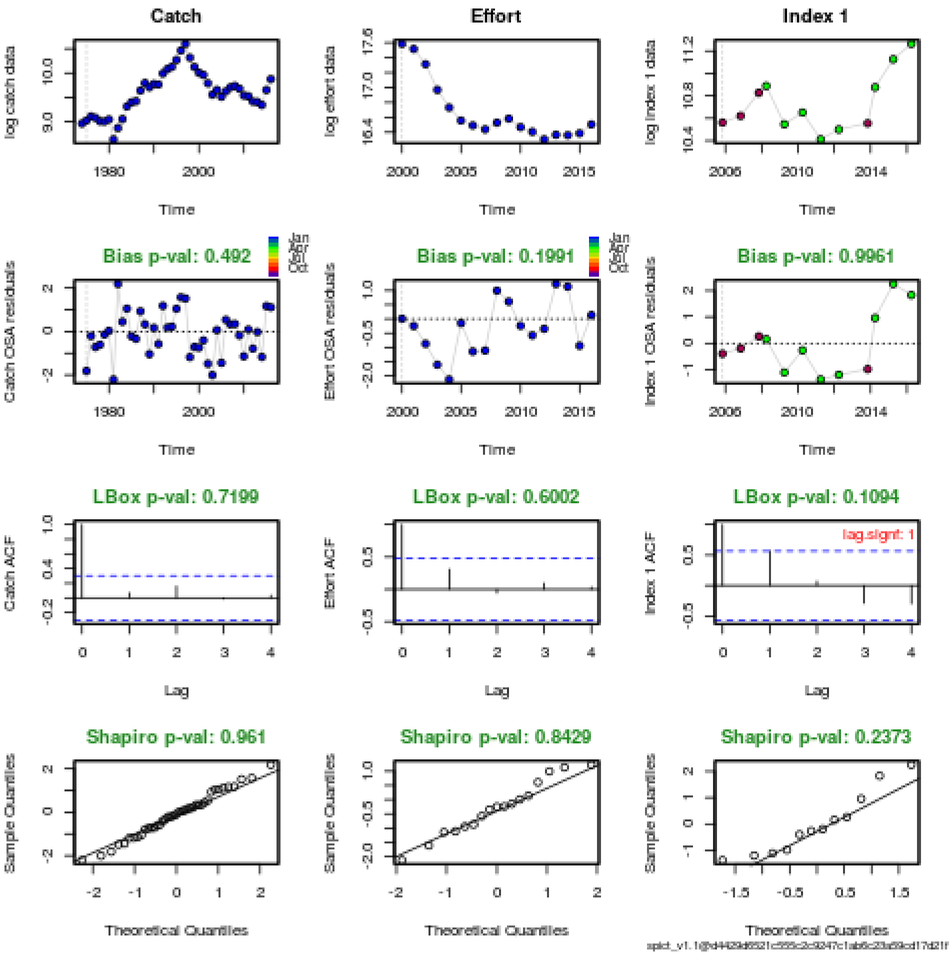

Figure 18: Model diagnostics from the SPiCT model run 5.

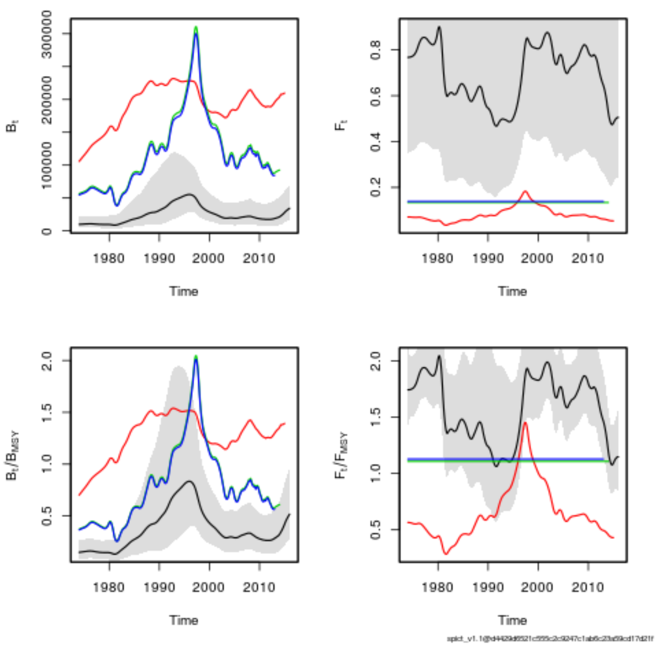

Figure 19: 4-year retrospective of SPiCT run 5.

Appendix 1: SPiCT input data.

Year	Landings (t)	Index (t)	Effort (kW/days)
1973	12189		
1974	7801		
1975	8299		
1976	9021		
1977	8774		
1978	8172		
1979	8123		
1980	8485		
1981	5623		
1982	7104		
1983	8542		
1984	11075		
1985	12078		
1986	12343		
1987	15377		
1988	17973		
1989	16451		
1990	17605		
1991	17441		
1992	21879		
1993	23966		
1994	25049		
1995	28897		
1996	35102		
1997	40258		
1998	30293		
1999	25026		
2000	22185		43410630
2001	21238		40520601
2002	17868		33034289
2003	14141		23411493
2004	15551		18454206
2005	13552	38617	15515821
2006	15150	40985	14518615
2007	16431	50392	13779921
2008	16918	53546	15070471
2009	16011	38060	15905442
2010	13896	42279	14198734
2011	13680	33254	13330728
2012	12265	36325	12036662
2013	12139	38395	12819808
2014	11438	52884	12743584
2015	15562	67915	13064499
2016	19505	77946	14729181

<u>Working Document for WGCSE (2017)</u>

Review of the UK (E&W)-BTS-Q3 abundance index for Irish Sea plaice (ple-iris, plaice 7a)

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26/04/2017

Introduction

The UK(E&W)-BTS-Q3 beam trawl survey provides an abundance index by age class for plaice in the Irish sea 7a since 1993. The index is calculated from 4 sampling strata: Irish Sea North (ISN), Irish Sea East (ISE), Irish Sea West (ISW), St George's Channel (SGC) (Figure 1).

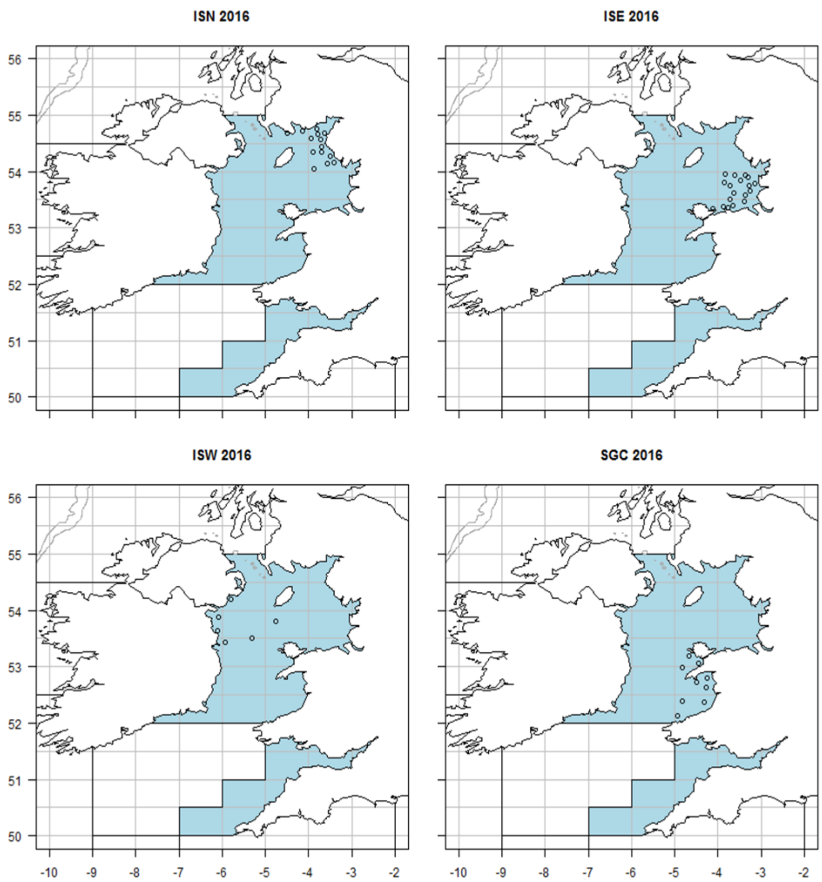


Figure 1. Locations of hauls (white circles) with plaice taken for age sampling in the Irish Sea during 2016.

For each age (0 – 9+), the index is calculated according to Figure 2. The initial combination of the values between Irish Sea North (ISN) and Irish Sea East (ISE) and between Irish Sea West (ISW), St George's Channel (SGC) is based on similarities in the growth function.

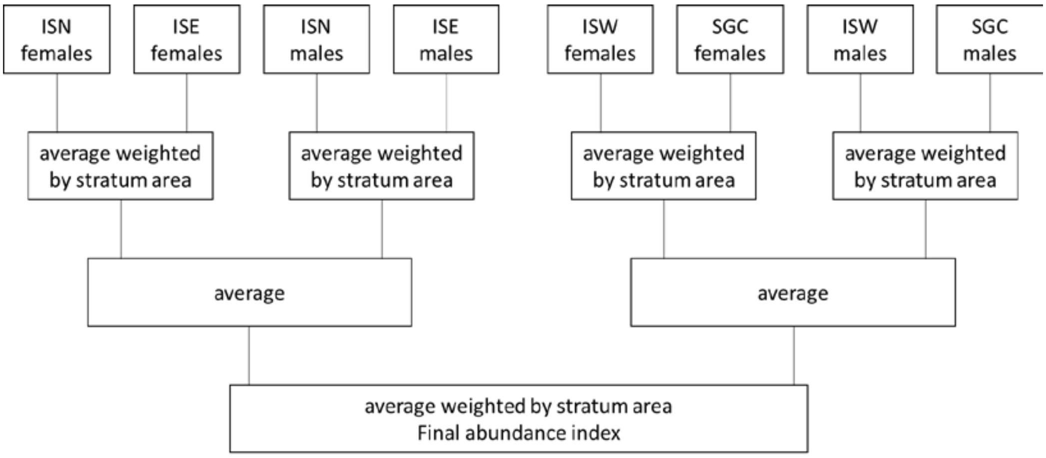


Figure 2. Flow chart resuming the methodological approach for the calculation of the biomass index from the UK(E&W)-BTS-Q3 beam trawl survey.

Review of the index

Here we provide a revision of the index to correct for few miscalculations present in the data set (Figure 3). No significant change in the index has been found for the ages used to run the stock assessment (ages 1 – 7). Ages 0, 8 and 9+ show the most significant changes with respect to the previous calculations (Figure 3). However, these last age classes do not influence the mean age value, which is calculated considering only age classes between 1 and 6. The effect of the new values for the age classes 0, 8 and 9+ on the total abundance index (obtained, for each year, by summing the abundance index across all ages) is also very limited (Figure 3).

Comparisons of the SAM model's outputs between the "old" and the "new" abundance index showed a difference in the SSB estimate with a higher value when using the revised index (SSB = 22686 t) with respect to the old one (SSB = 20504 t) (Figure 4). The estimation of the catchability also varied with the new revised index (highest catchability for age 1 vs age 2 with the previous index) as well as the recruitment (Figure 5 and Figure 6).

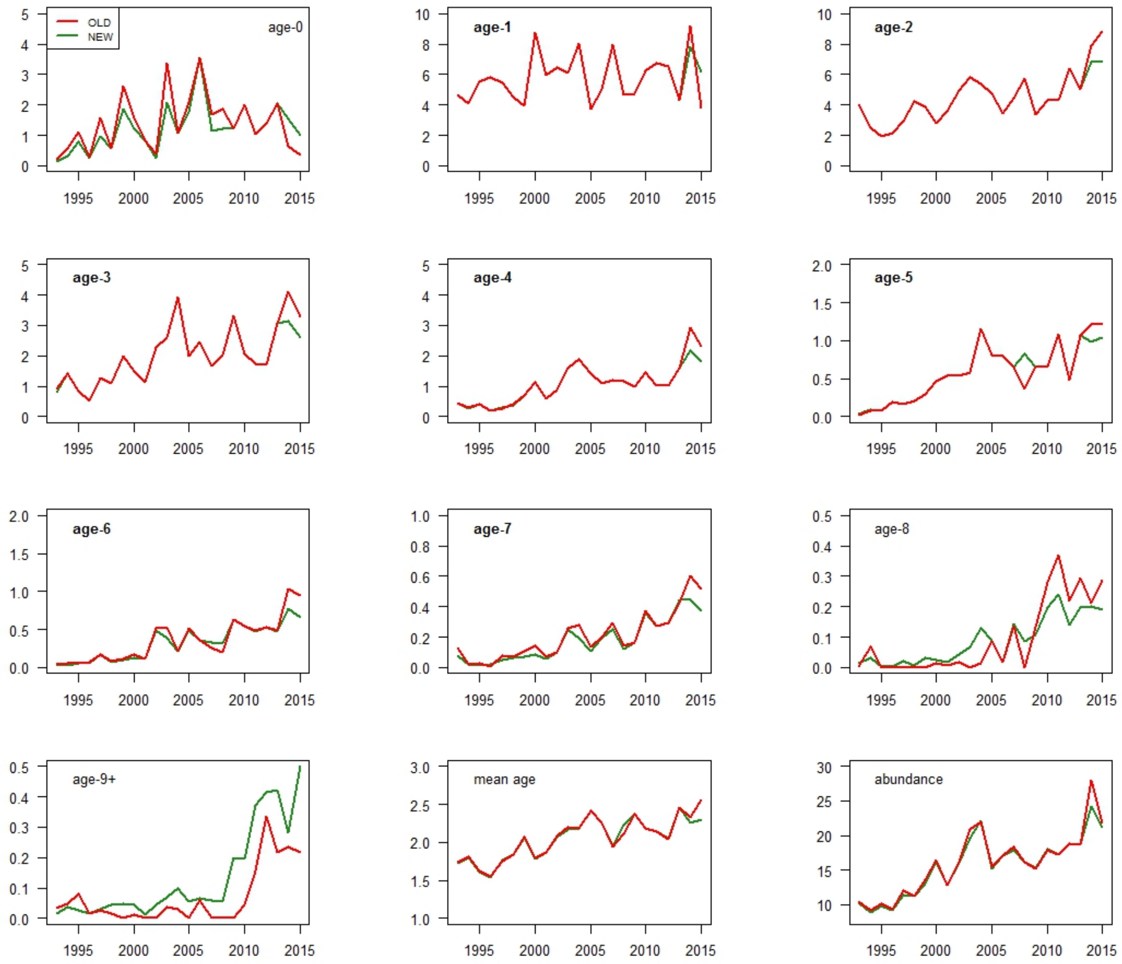


Figure 3. Comparison of the abundance index between the old (red line) and the new (green line) revised data set. Ages 1 – 7 (in bold) represent the ages used to run the stock assessment.

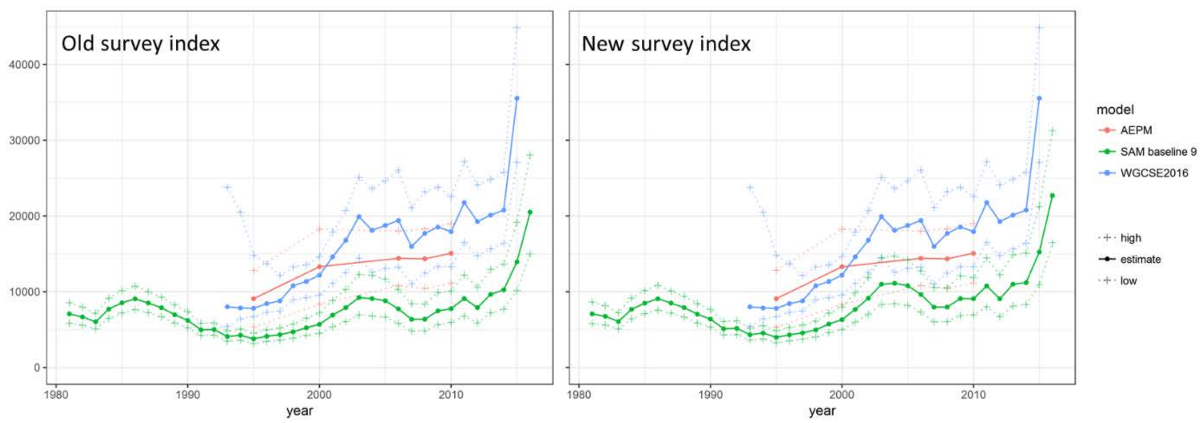


Figure 4. Comparison of the SSB estimate with SAM model the old and the new UK survey index of abundance.

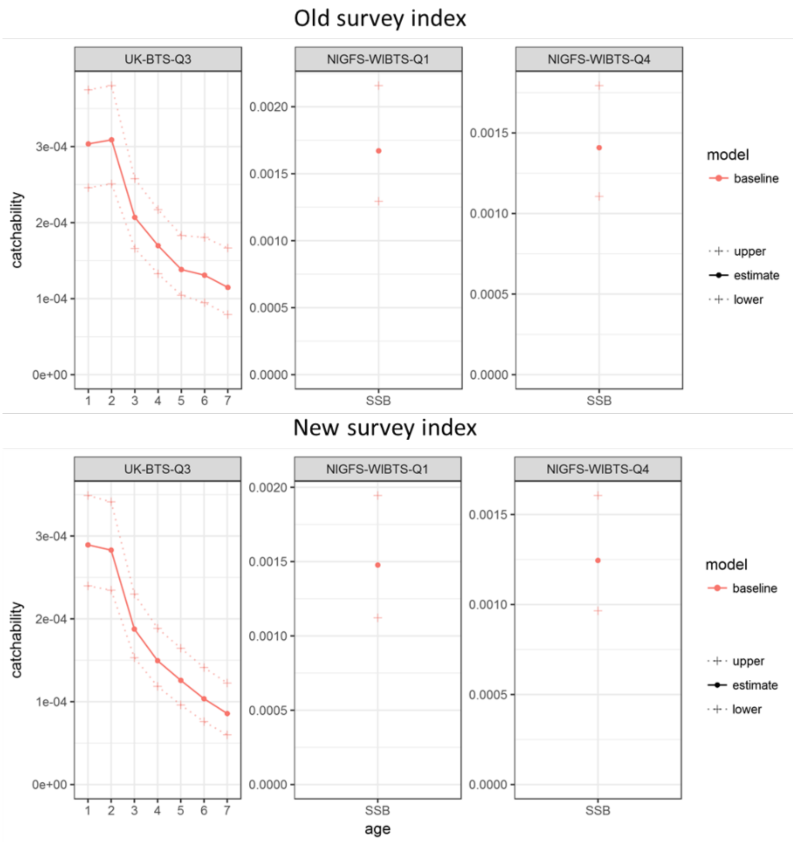


Figure 5. Comparison of the catchability estimate with SAM model the old and the new UK survey index of abundance.

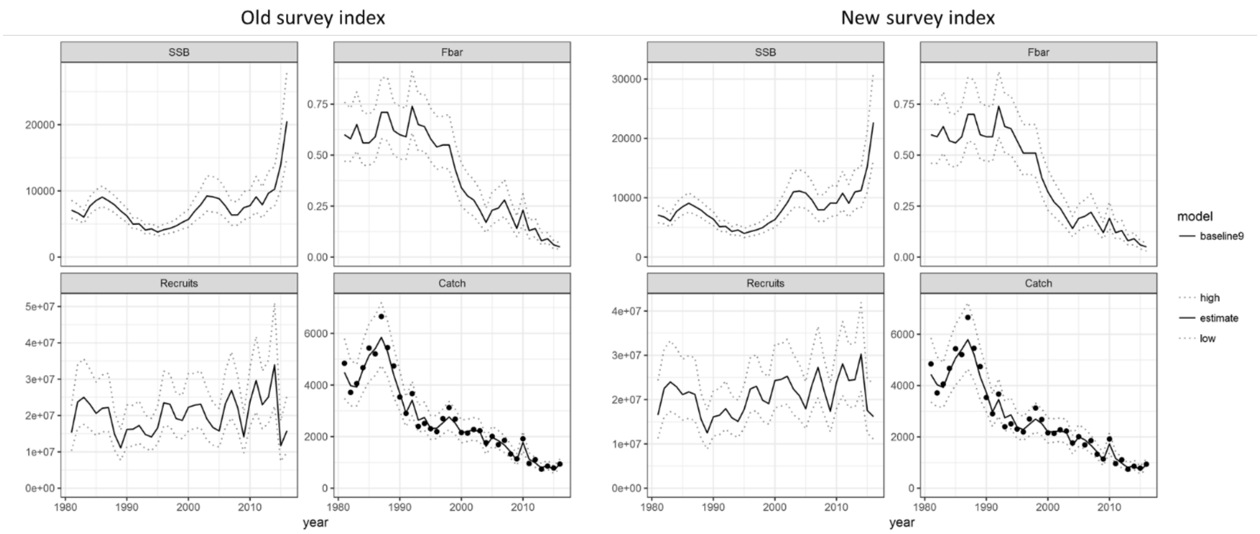


Figure 5. Comparison of the SAM model outputs with the old and the new UK survey index of abundance.

Note on french LPUE for WGCSE 2017. Seabass

Alain Laurec, Mickael Drogou

Feedback on almost zero catches from log books

Daily catch histograms per year, integrating all boats, every month all squares are presented in Figure 1 taking into account all the years (2000-2016).

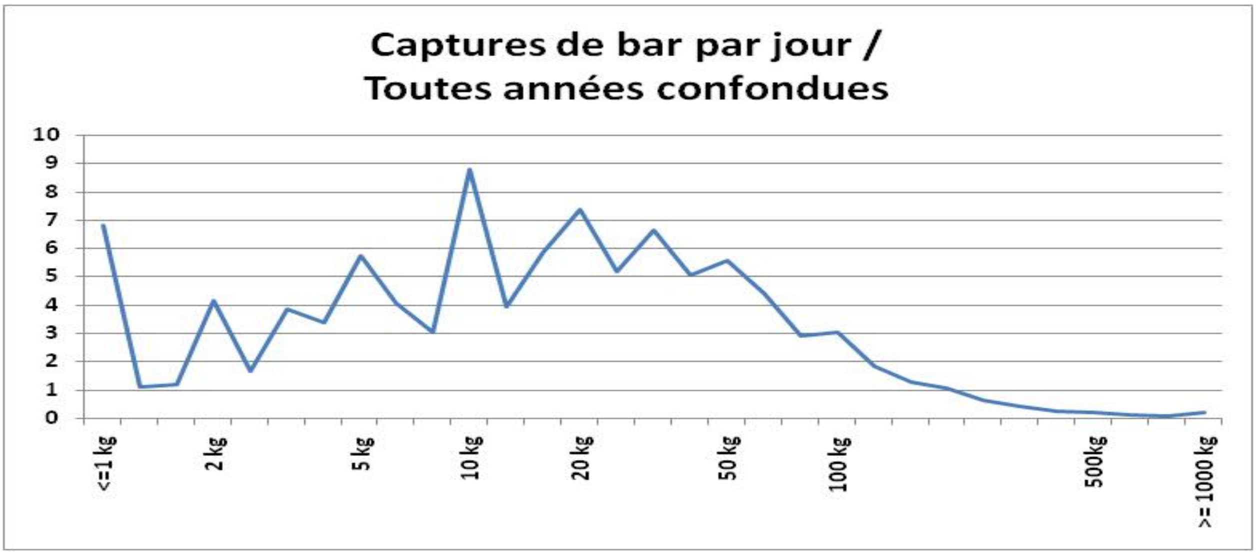


Figure 1 : seabass landings pear day (all years included)

The important element is the very low values, in this case with catches less than or equal to 1 kg. They are well isolated from the global mode (a few tens of kg). The frequency varies especially as it was already noted from year to year with a break in 2009 (figure 2).

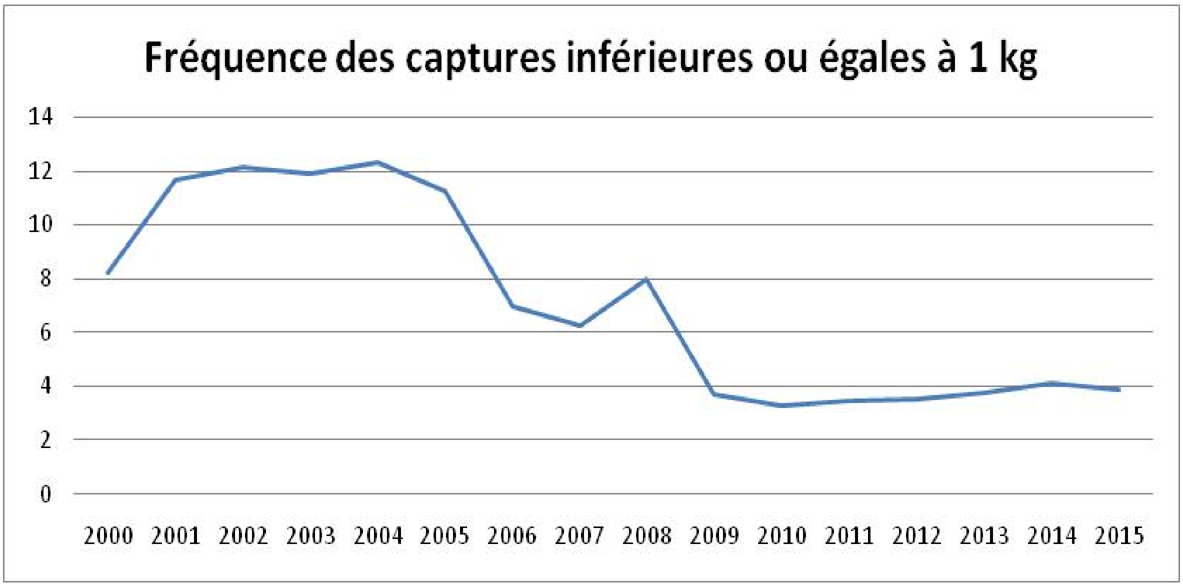


Figure 2 : fréquences of landings <=1kg

There is indeed a heterogeneity with a cut between 2008 and 2009. It is feared that many of the very low catches (many are declared at 0.1 kg) are false positives. In order to homogenize the whole, vessels may be selected which, even before 2009, have very few very low values, but it has been preferred finally for WGCSE 2017 to exclude values of less than 1 kg for all vessels and all years. This leads to the multi-year trends described in figure 3 (NB took 2009 as reference year).

Intégration of 2016

Like before, previous options are retained: elimination of catches of less than 1 kg, and elimination of MWT and purse seiners, (choice of 2009 as reference). For seasonal patterns the additional year does not change much. The graph below (Figure 3) shows the multiannual trends from 2000 to 2016.

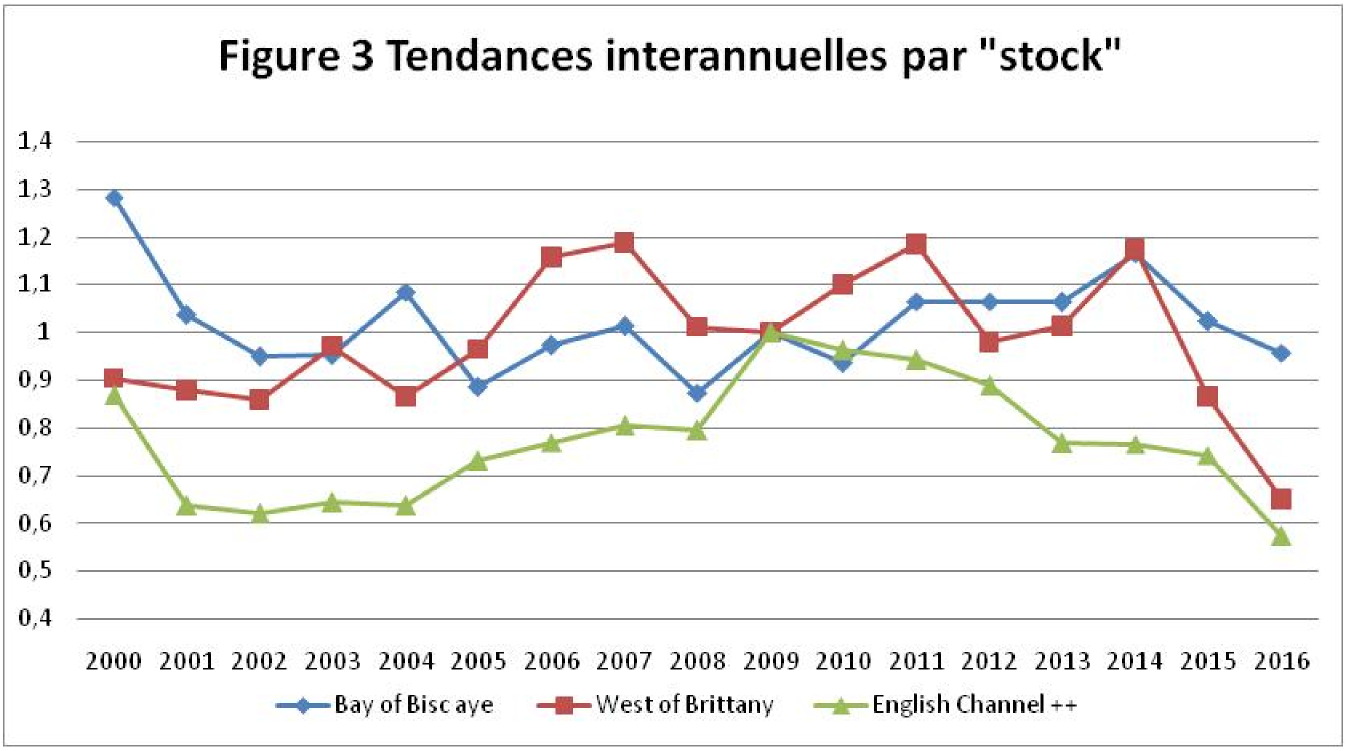


Figure 3 : annual trends per « stock »

To evaluate the reliability of these results 500 bootstrap have been made. The syntheses also include a basic estimate, average over 500 copies (average boot), maximum (boot) and minimum (boot) values on the 500 prints, the upper limits (B.sup.) And lower (B.inf) confidence intervals of the 5% confidence intervals (constructed on the basis of the normal approximation) and the standard deviation of the 500 simulations and the number of prints (<= 500) Which allowed a complete calculation.

Figures 4-a to 4-5 show the estimated annual effects (compared to 2009) for the three "stocks".

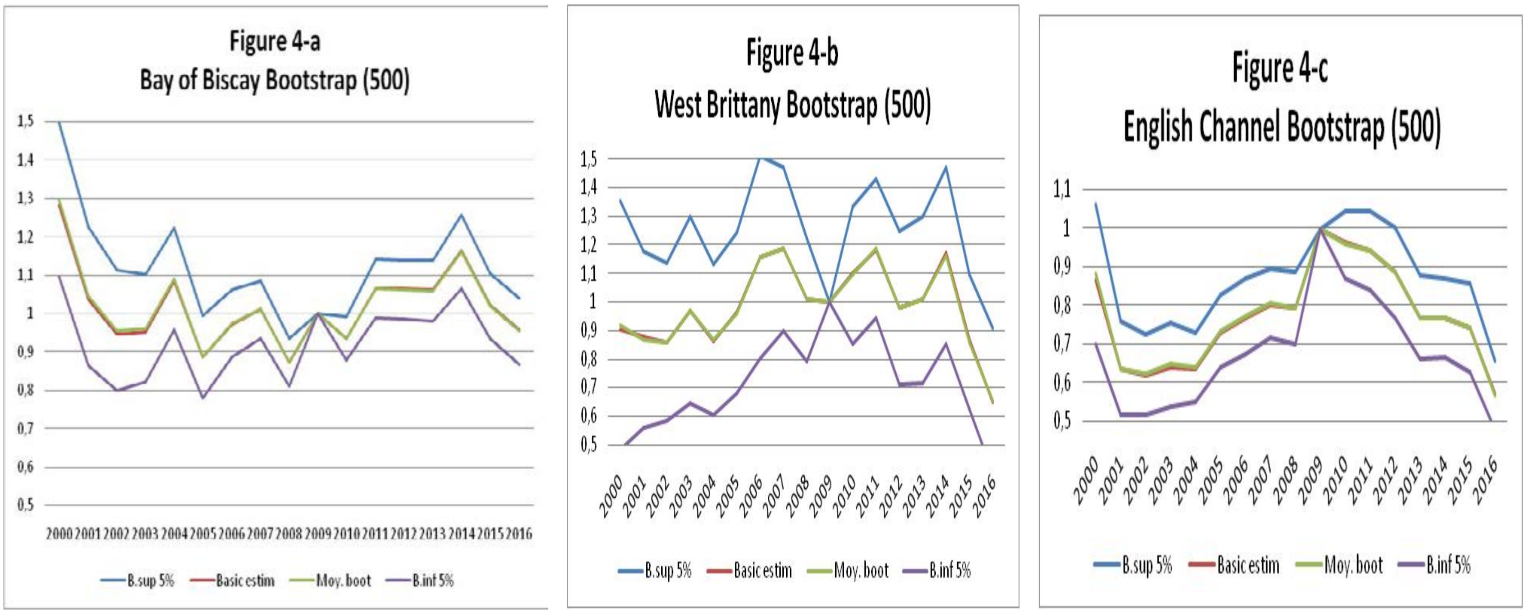


Figure 4 : LPUE indices with confidence intervals

In all cases, the mean of the simulations is very close to the mean of the simulations, which suggests that the so-called Laurent correction sometimes evoked by purists has no impact.

For the Bay of Biscay the increase from 2009 to 2014 is "significant", and at least 8%. In the Channel the decrease since 2009 is significant since 2013, and is in 2016 by at least 30%, and may reach 50%. Special calculations have been made of the apparent decreases since 2014. The confidence intervals for the 2014-2015, 2015-2016 and 2014-2016 ratios are shown in the table below.

"Stock"	Gascogne	Gascogne	Gascogne	Manche	Manche	Manche
Couple	Ratio 14-15	Ratio 15-16	Ratio 14-16	Ratio 14-15	Ratio 15-16	Ratio 14-16
Base	1.18	1.11	1.26	1.08	1.35	1.39
B.inf 5%	1.13	1.05	1.18	1	1.22	1.26
B.Sup 5%	1.24	1.18	1.35	1.17	1.49	1.53

This suggests for example that in the Bay of Biscay the decrease from 2014 to 2016 would be at least 18% and could go up to 35%. The corresponding reduction would be at least 26% and could reach 53%.

Estimating MSY reference Points for Sol 27.7.h-k

Colm Lordan

9 June 2017

Introduction

This Markdown document outlines the steps involved in estimating PA and MSY reference points for Sole 7.h-j at WGCSE 2017. The objective is to have a reproducible document that transparently outlines the process, settings and decisions.

The ICES **technical guidelines document** establishes the procedures to be followed.

These have been developed based on the experiences and approach applied at **WKMSYREF4** which estimated PA reference points and Fmsy and MSY ranges for category 1 stocks in western waters and **WKMSYREF3** which estimated Fmsy and MSY ranges for North Sea stocks.

For typical age-based assessments the preferred ICES approach used the EqSim methodology. This is available from the developmental repository for the 'msy package' which is located on github, more specifically on github.com/ices-tools-prod/msy.

The MSY evaluation used the stock object for the update assessment carried out at WGCSE 2017.

Overview of stock

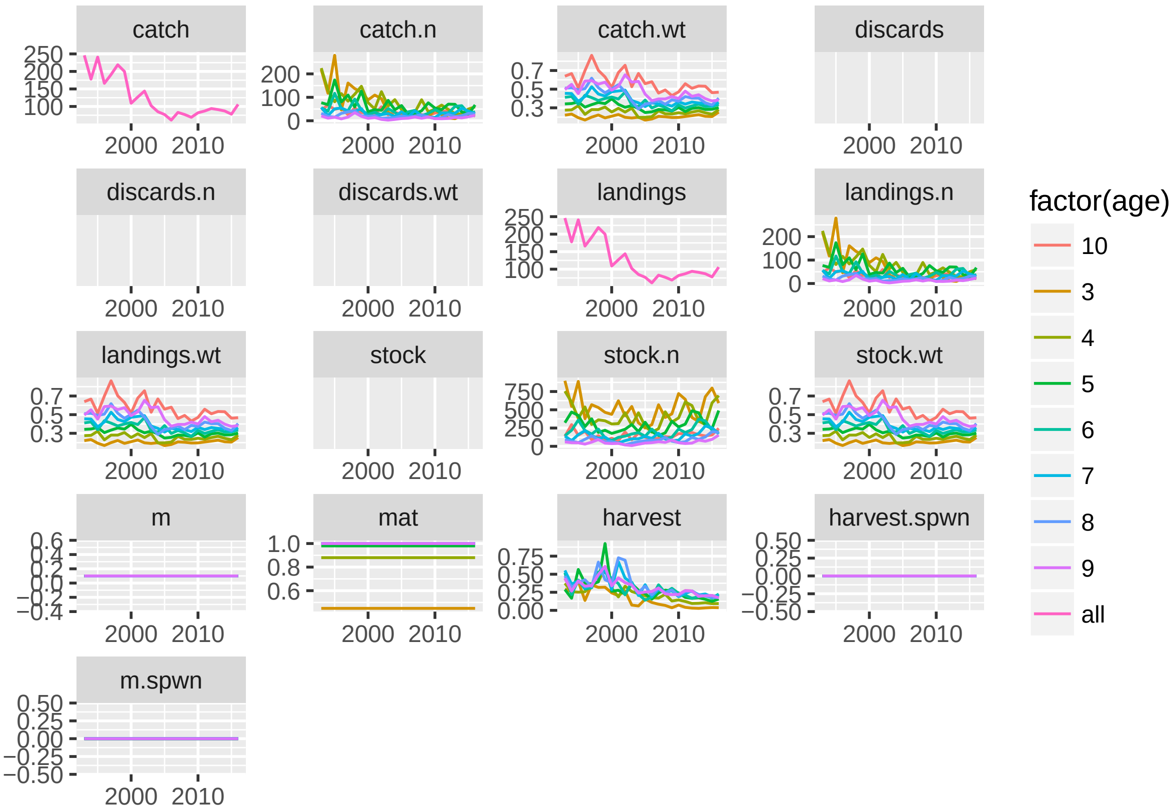
First we plot the stock object to see what the input data to Eqsim look like. The mean weights and stock weights declined in the mid to late 2000s. A fixed maturity vector is used throughtout time. The F pattern-at-age looks resonably stable over the last decaed. Strong cohorts are apparent in the stock numbers-at-age.

The stock summary plot shows some indication of auto-correlation in recruitment which is typicall in sole stocks. F shows a decling trend and SSB shows and increasing trend over time.

```
stock <- trim(stock, age = 3:10) # Need this as SOL only mature at age 3
stock@range['minfbar'] <- 3
stock@range['maxfbar'] <- 6
set.seed(196788)  # to ensure repeatable results

ggplot(data = stock, aes(year, data)) + geom_line(aes(group = age,
      colour = factor(age))) + facet_wrap(~slot, scales = "free",
      nrow = 5) + labs(x = "", y = "")
```

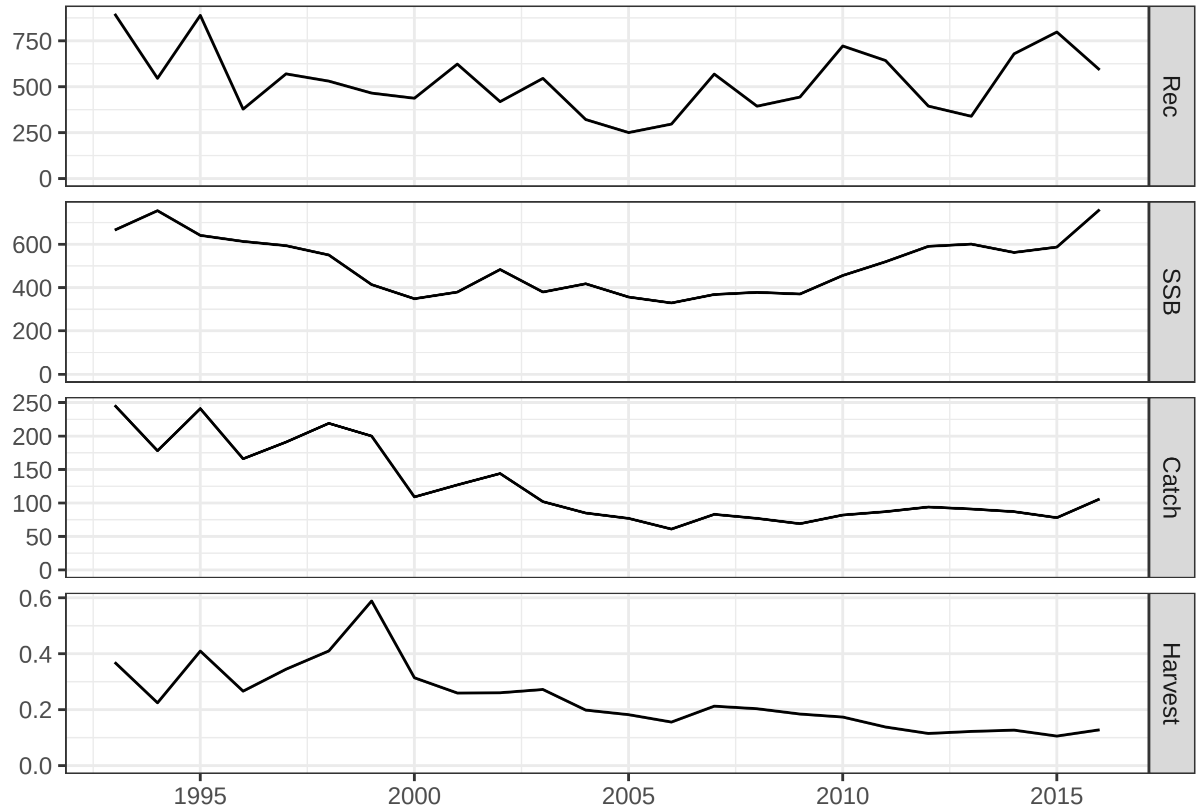
```
## Warning: Removed 24 rows containing missing values (geom_path).
```




```r
ggsave("Summary_of_stock_object.png", device="png")
```

```
## Warning: Removed 24 rows containing missing values (geom_path).
```

```r
plot(stock) + theme_bw()
```




```
ggsave("Stock_summary_plot.png", device="png")
```

Plotting the SR relationship

Next we have an inital look at the stock and recruit plot. Recruitment is age 3 so there needs to be an off set.

```
ssb <-as.data.frame(ssb(stock))
ssb$var <- "SSB"
rec <-as.data.frame(rec(stock))
rec$year <- rec$year-rec$age
rec$var <- "Recruitment"
sr <- left_join(ssb,rec, by="year")[,c(2,7,14)]
names(sr) <- c("year", "SSB", "Recruitment")
ggplot(sr, aes(SSB, Recruitment)) + geom_point() +
  geom_text(aes(label=year), hjust=-0.1) + theme_bw() +
  xlim(0, max(sr$SSB)*1.05) + ylim(0, max(sr$Recruitment)*1.05) +
  geom_path(aes(colour = year), arrow = arrow(angle = 30, length = unit(0.15, "inches")))
```

```
## Warning: Removed 3 rows containing missing values (geom_point).

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## Warning: Removed 3 rows containing missing values (geom_path).
```
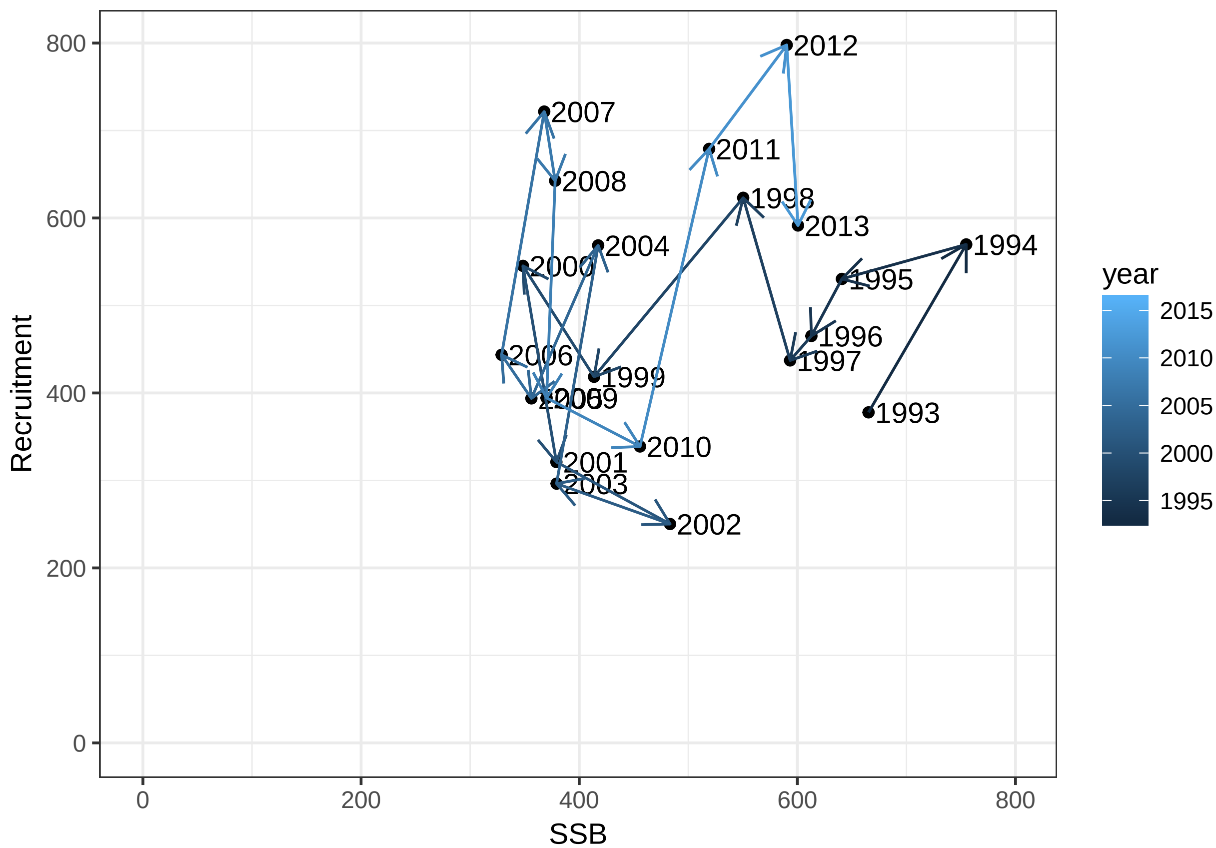




```
ggsave("sr_summary_plot.png", device="png")
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
## Warning: Removed 3 rows containing missing values (geom_text).
## Warning: Removed 3 rows containing missing values (geom_path).
```

Shift function

This is a function to shift ages in eqsim.

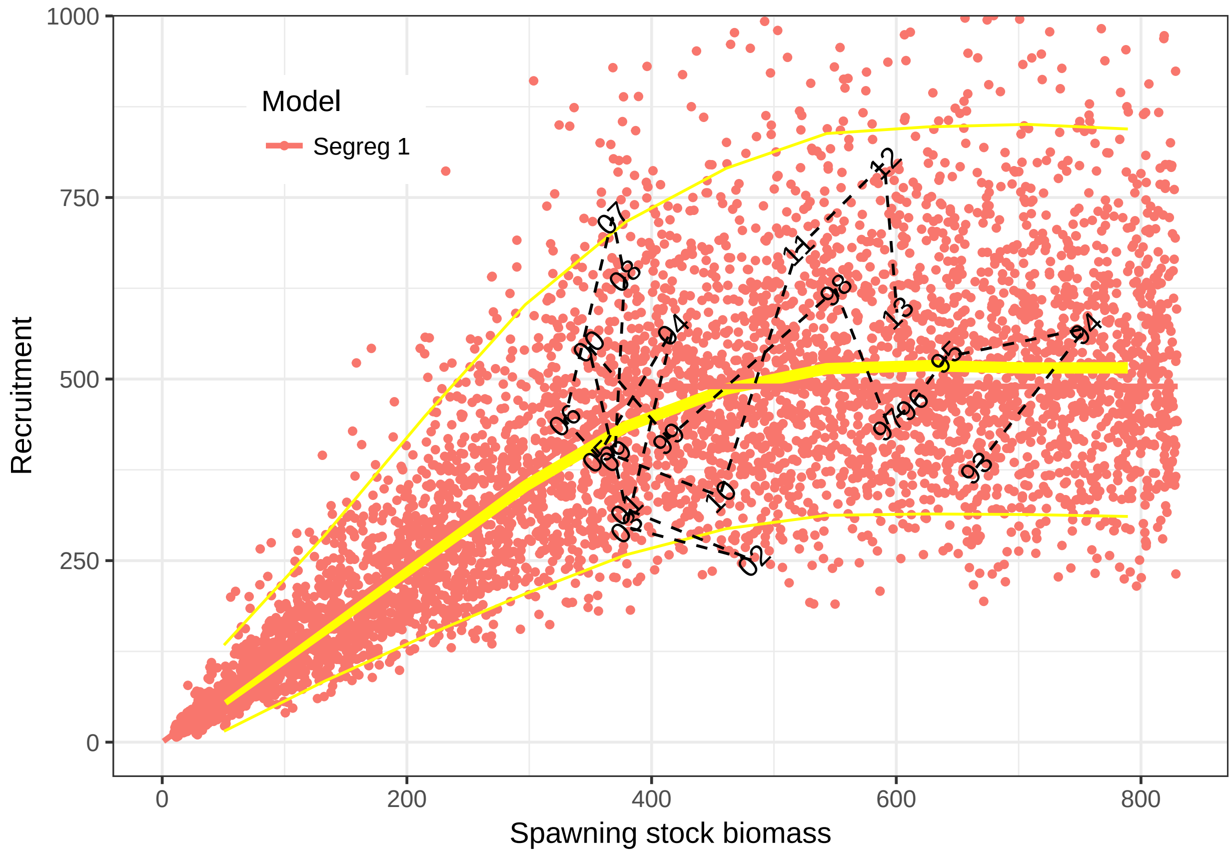
```
eqsr_fit_shift <-
  function (stk, nsamp = 5000, models = c("Ricker", "Segreg", "Bevholt"),
            method = "Buckland", id.sr = NULL, remove.years = NULL, delta = 1.3,
            nburn = 10000, rshift = 3) {
    dms <- FLCore::dims(stk)
    rage <- dms$min
    if (rage == 0) {
      x = FLCore::stock.n(stk)[1, drop = TRUE]
    }
    else {
      x = c(FLCore::stock.n(stk)[1, -seq(rage), drop = TRUE],
            rep(NA, rage))
    }
    if (rshift > 0){
      x = c(FLCore::stock.n(stk)[1, -seq(rshift), drop = TRUE],
```

```
          rep(NA, rshift))

  } else { NULL }
  rby <- data.frame(year = with(dms, minyear:maxyear), rec = x,
                    ssb = FLCore::ssb(stk)[drop = TRUE], fbar = FLCore::fbar(stk)[drop = TRUE],
                    landings = FLCore::landings(stk)[drop = TRUE], catch = FLCore::catch(stk)[drop = T
  # print(rby)
  row.names(rby) <- NULL
  rby <- rby[!is.na(rby$rec), ]
  data <- rby[, 1:3]
  if (!is.null(remove.years)) {
    data$ssb[data$year %in% remove.years] <- NA
  }
  data <- data[complete.cases(data), ]
  if (is.null(id.sr))
    id.sr <- FLCore::name(stk)
  method <- match.arg(method, c("Buckland", "Simmonds", "King", "Cadigan"))
  if (!is.character(models))
    stop("models arg should be character vector giving names of stock recruit models")
  if (method == "Buckland") {
    return(c(eqsr_Buckland(data, nsamp, models), list(stk = stk,
                                                      rby = rby, id.sr = id.sr)))
  }
  else {
    cat("The", method, "is not ready yet!  Working on it!\n")
  }
}
```

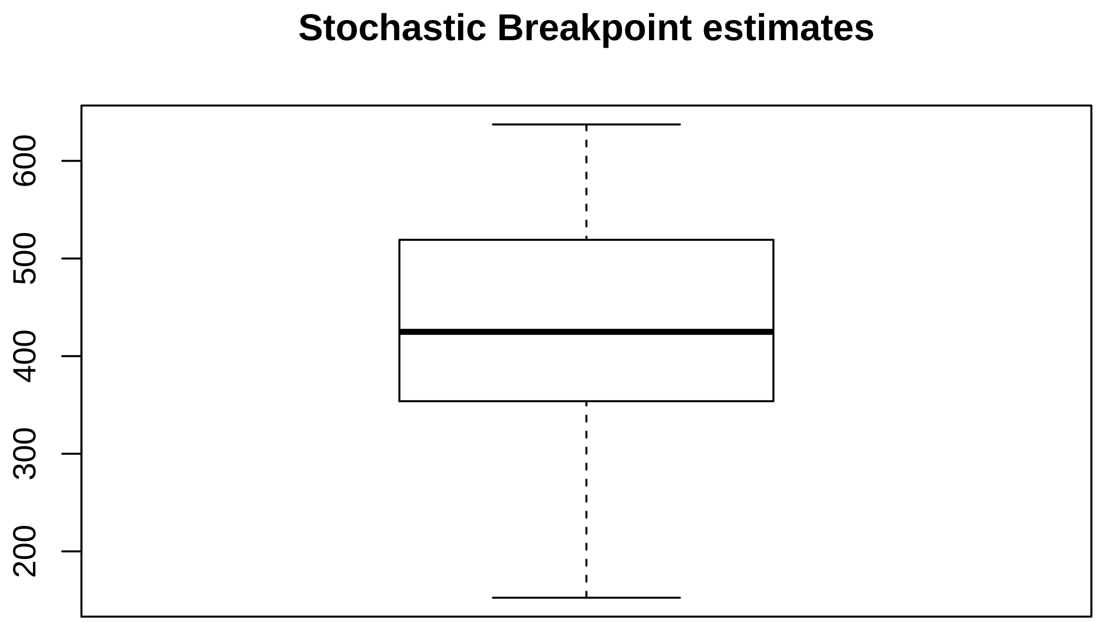
Fitting a Segmented regression

This stock can arguably be classified as Type 2 - Stocks with a wide dynamic range of SSB, and evidence that recruitment is or has been impaired. For these types of stock Blim is set to the change point in segmented regression.

```
fit <- eqsr_fit_shift(stock, nsamp = 1000, models = c("Segreg"), rshift = 3)
eqsr_plot(fit,ggPlot=T)
```




```r
boxplot(fit$sr.sto$b.b, main="Stochastic Breakpoint estimates")
```




```
Blim <- median(fit$sr.sto$b.b)
Bpa <- Bpa(Blim, 0.2)
```

Based on the segmented regression above Blim = 424.8830039 and Bpa= 590.4080134.

Running the simulation with and without errors and advice rules

The function below originally writen by Einar Hjorleifsson. It is a very handy way of getting results for the various types of simulation in one place to avoid confusion.

```
do_the_whole_thing <- function(stockSetup) {
  results <- within(stockSetup, {
    fit <- eqsr_fit_shift(stock, nsamp=1000, model="Segreg", method="Buckland", id.sr=NULL, remove.years
    ## Simulate a stock to equilibrium and continue simulating for some years
    ## 1) simulation with no error
    sim_noError <- eqsim_run(fit, Fscan=Fscan, verbose=verbose,
                         extreme.trim=extreme.trim,
                         bio.years=bio.years, sel.years=sel.years,
                         bio.const=TRUE, sel.const=TRUE,
                         Fcv=0, Fphi=0,
                         Blim=Blim, Bpa = Bpa)
    ## 2) simulation with age error
    sim_ageError <- eqsim_run(fit, Fscan=Fscan, verbose=verbose,
                          extreme.trim=extreme.trim,
                          bio.years=bio.years, sel.years=sel.years,
                          bio.const=FALSE, sel.const=FALSE,
```

```
                              Fcv=0, Fphi=0,
                              Blim=Blim, Bpa = Bpa)
    ## 3) simulation of base data
    sim_base <- eqsim_run(fit, Fscan=Fscan, verbose=verbose,
                          extreme.trim=extreme.trim,
                          bio.years=bio.years, sel.years=sel.years,
                          bio.const=FALSE, sel.const=FALSE,
                          Fcv=Fcv, Fphi=Fphi,
                          Blim=Blim, Bpa = Bpa)
    ## 4 ) simulation incudling Btrigger harvest control rule
    sim_trigger <- eqsim_run(fit, Fscan=Fscan, verbose=verbose,
                             extreme.trim=extreme.trim,
                             bio.years=bio.years, sel.years=sel.years,
                             bio.const=FALSE, sel.const=FALSE,
                             Fcv=Fcv, Fphi=Fphi,
                             Blim=Blim, Bpa = Bpa,
                             Btrigger=Bpa)
  })
  return(results)
}
```

Running Eqsim

The setup for the simulation is fairly standard. Ten years for biologicals and selection. The Fscan range is limted to 0.44 with a percision of 0.005 to get very percise estimates. The FCV and Fphi are the standard ones advised by WKMSYREF4.

```
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)
)

out <- do_the_whole_thing(stocksetup)
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Output from eqsim analysis

The tables below gives the estimates for FMSY with and without Btrigger.

```
knitr::kable(t(out$sim_base$Refs2), digits=c(3,3,0,0,0,0))
```

	catF	lanF	catch	landings	catB	lanB
F05	0.160	NA	108	NA	590	NA
F10	0.171	NA	107	NA	557	NA
F50	0.213	NA	94	NA	425	NA
medianMSY	NA	0.162	NA	108	NA	585
meanMSY	0.160	0.160	108	108	589	589
Medlower	NA	0.113	NA	102	NA	745
Meanlower	NA	0.112	NA	105	NA	NA
Medupper	NA	0.194	NA	103	NA	487
Meanupper	NA	0.188	NA	105	NA	NA

```r
knitr::kable(t(out$sim_trigger$Refs2), digits=c(3,3,0,0,0,0))
```

	catF	lanF	catch	landings	catB	lanB
F05	0.204	NA	108	NA	532	NA
F10	0.223	NA	107	NA	508	NA
F50	0.306	NA	100	NA	425	NA
medianMSY	NA	0.185	NA	109	NA	560
meanMSY	0.185	0.185	109	109	559	559
Medlower	NA	0.120	NA	103	NA	719
Meanlower	NA	0.117	NA	105	NA	NA
Medupper	NA	0.271	NA	103	NA	456
Meanupper	NA	0.272	NA	105	NA	NA

```r
#FMSY base
refs <- round(t(out$sim_base$refs_interval),3)
fmsy_base <- refs[4,]
f05_base <- refs[7,]

#FMSY trig
refs <- round(t(out$sim_trigger$refs_interval),3)
fmsy_trigger <- refs[4,]
f05_trigger <- refs[7,]
```

The Fmsy without the ICES advice rule is 0.161. The F0.05 without the ICES advice rule is 0.16. The Fmsy range is 0.115, 0.161, 0.192.

The Fmsy with the ICES advice rule is 0.181. The F0.05 with the ICES advice rule is 0.204. The Fmsy range is 0.122, 0.181, 0.27.

Visulatisation of MSY reference points

Below we produce the standard plots used to evaluate the fits etc.

```r
png('stock-recruit.png',4.5,4.5,'in',10,res=600)
eqsr_plot(out$fit)
dev.off()
```

```
## pdf
##   2
```

```r
png('yield_base.png',4.5,4.5,'in',10,res=600)
eqsim_plot(out$sim_base, catch = TRUE)
dev.off()
```

```
## pdf
##   2
```

```r
png('yield_trigger.png',4.5,4.5,'in',10,res=600)
eqsim_plot(out$sim_trigger, catch = TRUE)
dev.off()
```

```
## pdf
##   2
```

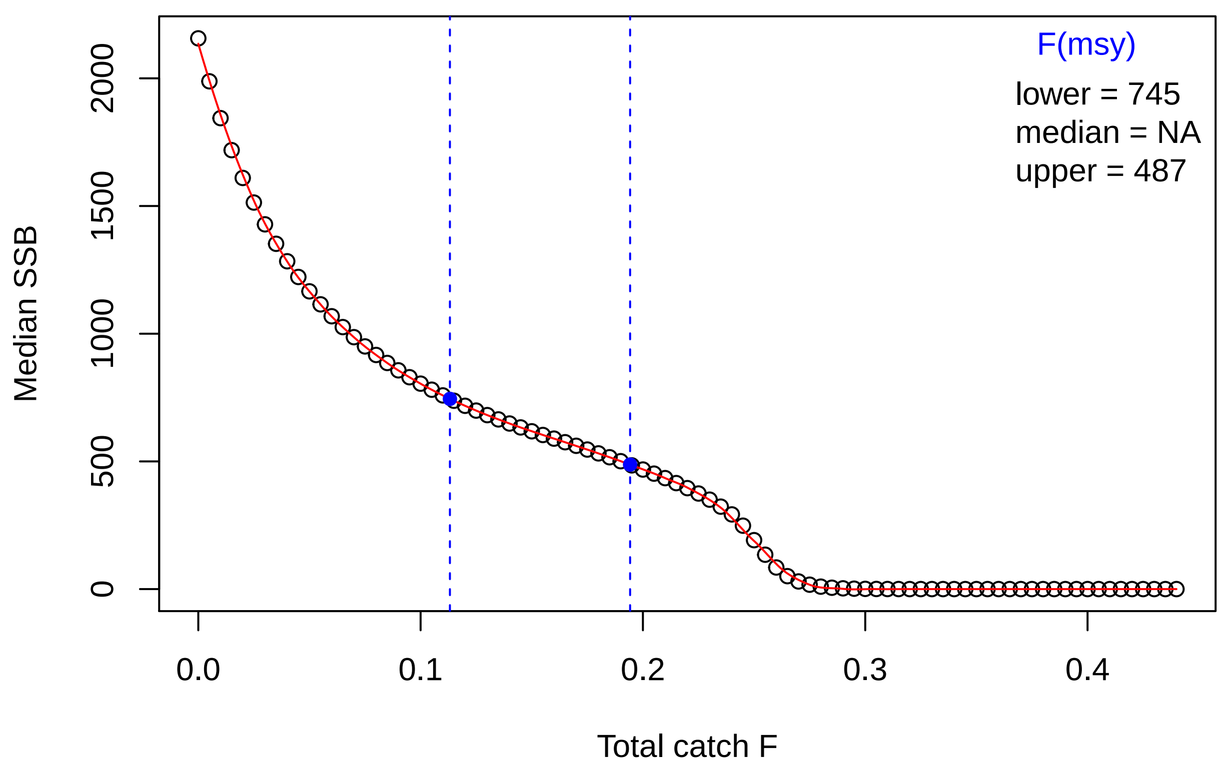
```r
png('msy_base.png',4.5,4.5,'in',10,res=600)
eqsim_plot_range(out$sim_base, type="median")
dev.off()
```

```
## pdf
##   2
```

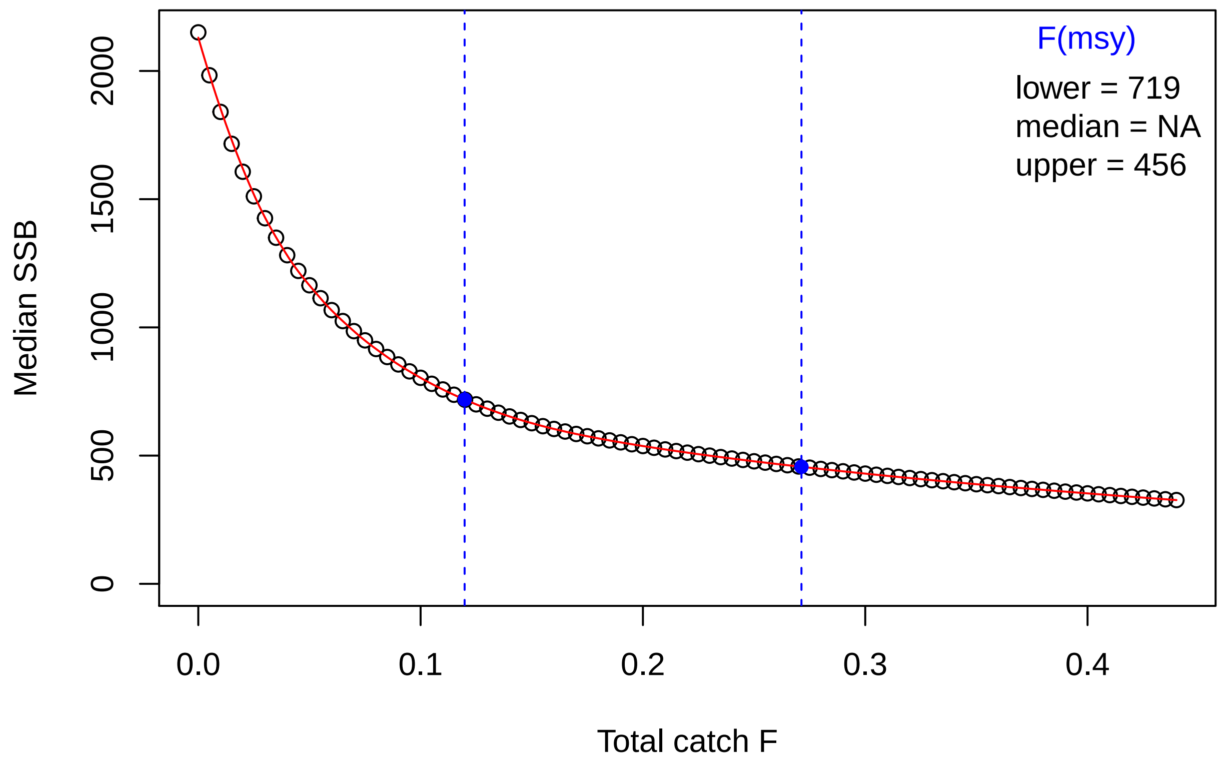
```r
png('msy_trigger.png',4.5,4.5,'in',10,res=600)
eqsim_plot_range(out$sim_trigger, type="median")
dev.off()
```

```
## pdf
##   2
```

```r
eqsim_plot_range(out$sim_base, type="ssb")
```



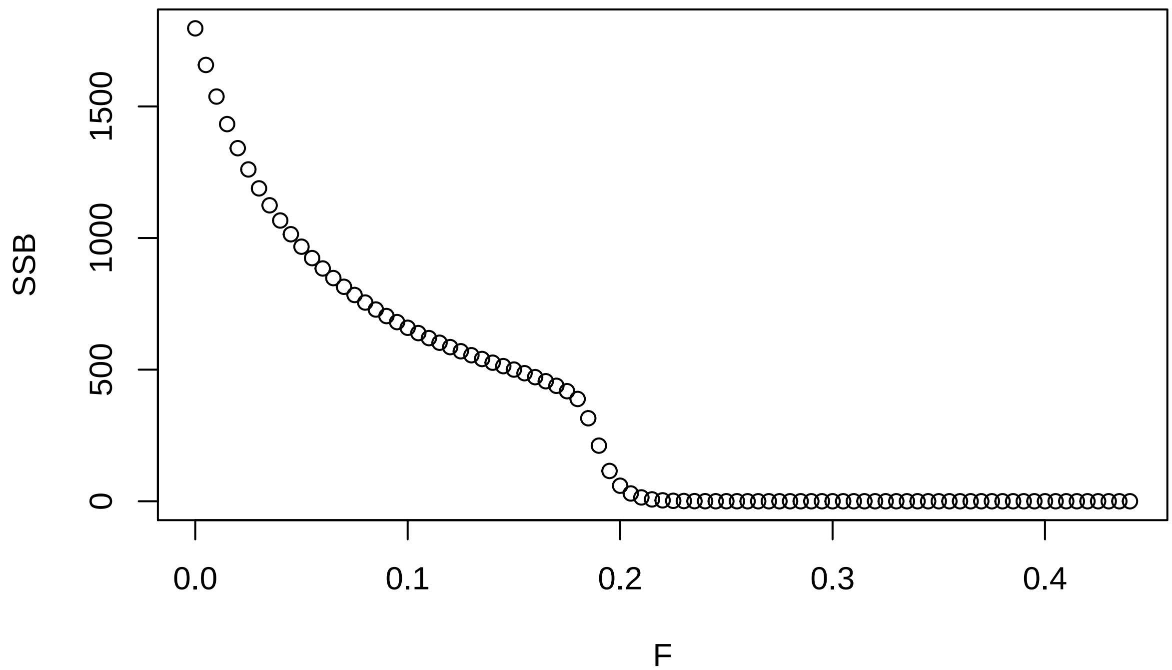

```r
eqsim_plot_range(out$sim_trigger, type="ssb")
```



Estimating Flim and Fpa

Eqsim is run with no error to estimate Flim and the MSY Btrigger you would get from the analysis. There a a few different approaches to estimating the Flim point. Here we use a loess smoother to predict the F that has a 50% probability of bringing the stock to Blim. A similar approach is used to estimate the MSY Btrigger you would get from the analysis to test if this is higher than Bpa.

```
data.95 <- out$sim_noError$rbp
x.95 <- data.95[data.95$variable == "Spawning stock biomass", ]$Ftarget
b.95 <- data.95[data.95$variable == "Spawning stock biomass", ]$p50
#plot(b.95~x.95, ylab="SSB", xlab="F")
b.lm <- loess(x.95 ~ b.95, span = 0.3)
flim<- round(predict(b.lm, Blim), 3)
fpa<- round(Fpa(flim, 0.2),3)
###BTrigger
data.05 <- out$sim_noError$rbp
x.05 <- data.05[data.05$variable == "Spawning stock biomass", ]$Ftarget
b.05 <- data.05[data.05$variable == "Spawning stock biomass", ]$p05
plot(b.05~x.05, ylab="SSB", xlab="F")
```




```
b.lm <- loess(b.05 ~ x.05, span = 0.3)
msybtrig <- predict(b.lm, fmsy_base)


save(out,file='msy_output.Rdata')
```

Summary of the results

For this stock the estimated Fmsy is very close to F0.05 and Fpa.

Table 2. Summary of reference ploints

Reference point	Value	Technical basis
MSY Btrigger	590.40801343849 t	Bpa
FMSY	0.161	Median point estimates of EqSim with segmented regression SR
Blim	424.883003902523 t	Break point segmented regression S-R relationship
Bpa	590.40801343849 t	Blim $\times$ exp(1.645 $\times$ sigma) sigma = 0.20
Flim	0.222	F with 50% probability of SSB less than Blim
Fpa	0.16	Flim combined with the assessment error

Annex 4: Technical Minutes of the Review Group for the Review Group of Celtic Sea Stocks (RGCS)

- RGCS
- By correspondence 25 May–2 June 2017
- Reviewers: Brooke Wright (chair), Steve Cadrin (chair), Gavin Fay (chair), Nicholas Calabrese, Alexander Hansell, Amanda Hart, Lauren Horton, Judith Rosellon-Druker, Ashley Weston, Robert Wildermuth, and Megan Winton; University of Massachusetts Dartmouth, School for Marine Science & Technology, Fairhaven, Massachusetts, USA.
- Review of ICES Working Group for the Celtic Sea Ecoregion (WGCSE) Report 2017

Review Process - The ICES advisory service quality assurance program requested that a team of graduate students and their professors serve as a review group, as specified in Guidelines for Review Groups (RG; ICES, 2009). The group initially met on 24 May 2017 to review the ICES advisory process, RG guidelines, and to assign two WGCSE report sections to each reviewer. RG members reviewed WG report sections independently, and presented their summaries and reviews to the group in a series of meetings from 30 May 2017 to 1 June 2017. A RG template (Appendix A) was provided to each reviewer so that the information needed for RG discussions and conclusions could be compiled and efficiently reported. At these meetings, reviewers provided a summary of their report, focusing on changes to methodology, stock status or basis for advice. At the close of each presentation the RG discussed and finalized recommendations for each stock. Reviews were collated and finalized by the chairs, which included verifying the data provided in each review and resolving any outstanding questions raised by reviewers.

Sixteen stock assessment reports (i.e. WGCSE report sections) were reviewed (Table 1). The WG reports were generally informative, and WG decisions about data, model choice, and specification were clearly explained and justified. In general, the RG concludes that most reports are technically correct, and agrees with the WG interpretations and recommendations, with only a few exceptions.

General comments

WGCSE report sections were downloaded 25–29 May 2017. Some report sections were still in ‘track changes’ mode, so we accepted all changes and reviewed the revised document, unless otherwise noted in each review section. UMass Dartmouth has formed a RG annually since 2008, and the efficiency of the review process improves each year.

Most update assessments applied the benchmark methods. There were a few exceptions, and most of these were well justified. The RG recommends that the benchmark method should be applied whenever possible, so that the results and diagnostics of any proposed alternative methods can be reviewed. The RG supported the conclusions of the WGCSE and supported their assessments as a reliable basis for advice. One exception was that the RG could not determine if the updated assessment for plaice in Division 7.a (ple.27.7.a) was consistent with the benchmark method or if it is a valid basis for advice because of the lack of detail on data and model decisions in the annex and the apparent inconsistencies between the WG report and the annex.

Table 1. Stocks reviewed by RGCS.

Stock	Full Stock Description
cod.27.6.a	Cod (*Gadus morhua*) in Division 6.a (West of Scotland)
cod.27.7.a	Cod (*Gadus morhua*) in Division 7.a (Irish Sea)
cod.27.7.e–k	Cod (*Gadus morhua*) in divisions 7.e–k (eastern English Channel and southern Celtic Seas)
had.27.7.a	Haddock (*Melanogrammus aeglefinus*) in Division 7.a (Irish Sea)
had.27.7b–k	Haddock (*Melanogrammus aeglefinus*) in divisions 7.b–k (southern Celtic Seas and English Channel)
ple.27.7.a	Plaice (*Pleuronectes platessa*) in Division 7.a (Irish Sea)
ple.27.7.e	Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel)
ple.27.7.fg	Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)
ple.27.7.h–k	Plaice (*Pleuronectes platessa*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)
sol.27.7.e	Sole (*Solea solea*) in Division 7.e (western English Channel)
sol.27.7.fg	Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)
sol.27.7.h–k	Sole (*Solea solea*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)
whg.27.7.a	Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea)
whg.27.7.b–ce–k	Whiting (*Merlangius merlangus*) in divisions 7.b–c and 7.e–k (southern Celtic Seas and eastern English Channel)

Some RG comments apply to several assessment sections:

- The UMassD RG previously reviewed WGCSE stock assessments in 2009 and 2012. The RG was impressed with several trends toward data improvements and modelling advancements. For example, discards are being monitored and included in many stock assessments in the region. Continued monitoring and integration of discards into stock assessments is encouraged to improve the basis of ICES advice, particularly as the landings obligation begins to affect more fisheries. The transition from calibrated Virtual Population Analysis (e.g. eXtended Survivor Analysis, XSA) toward statistical catch-at-age (e.g. Age-Structured Assessment Program, ASAP; State–space Assessment Model, SAM) is considered to be a systematic improvement. The RG encourages WGCSE to continue the transition by adopting a fleet-based approach to modelling fishery catch. Applications of ICES recent advances for data-limited stock assessments, Maximum Sustainable Yield (MSY) reference points and MSY proxy reference points are also positive developments.
- Several benchmark ASAP applications were revised to remove the likelihood constant from the recruitment likelihood component. Although most assessments are not sensitive to the revision, removal of the likelihood constant is considered to be 'best practice' to avoid biased estimates. For example, update assessments of New England groundfish all made the same revision from benchmark methods (NEFSC, 2015).
- The RG used the same terminology for retrospective patterns as the WG. However, the RG notes that the phrases 'revised upward' and 'revised downward' are more appropriate than 'underestimated', 'overestimated' or 'bias', because simulation studies have demonstrated that the direction and magnitude of retrospective inconsistency is not a measure of bias. The terminology and implied meanings are important for considering practices like retrospective adjustment.
- Several reported values imply a false sense of precision (e.g. fishing mortality values to five digits).
- The RG thanks WGCSE Chair and Assessment authors for timely responses to RG questions. The RG notes that some assessment authors included assessment model data and output files as part of the reports; these aided in diagnosing RG questions and/or inconsistencies during the review process.

References

ICES. 2009. Guidelines for Review Groups. ACOM 2009.

Northeast Fisheries Science Center. 2015. Operational Assessment of 20 Northeast Groundfish Stocks, Updated Through 2014. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 15–24; 251 p.

Review of the Working Group for the Celtic Seas Ecoregion Report (WGCSE)

cod.27.6.a [WGCSE Section 05: Cod (*Gadus morhua*) in Division 6.a (West of Scotland)]

1) Assessment Type: Update including commercial landings and survey data through 2016 (Benchmarked in 2012 and Inter-Benchmarked in 2015).

2) Assessment: Analytical (Category 1.20)

3) Forecast:

- Short-term: Age-structured model using *status quo* F (0.79), 2017 recruitment from TSA and a 10-year geometric mean recruitment for 2018. Catch in 2017 is predicted to be 1627, and SSB in 2018 is predicted to be 2835 t. Catch in 2018 and SSB in 2019 were not predicted due to sensitivity to recruitment assumptions.
- Medium-term: None
- Long-term: None

4) **Assessment method**: The assessment was conducted using a time-series analysis (TSA). Commercial data included landings and discards. Survey data included Scottish West Coast Groundfish Survey cpue index ScoGFS-WIBTS-Q1 (1985–2010) and UKSGFS-WIBTS-Q1 cpue index (2011–2017).

5) Consistency:

- The update is consistent with the annex with some changes.
- Misreported landings are treated as a separate fleet instead of applying landings-at-age of the Scottish fishery. The annex provides for flexibility in the method of accounting for misreported landings, and the WG documented that misreported catch has different age composition than the Scottish fleet. The RG agrees that the revised method appears to be reasonable, but the change may influence the results because of the large contribution of misreported landings to the total catch.
- Landing-at-age 7+ are allowed to have higher variance in the model due to inconsistencies in the age composition of 2016 landings. The RG agrees that this change also seems reasonable.
- Overall retrospective bias is small with a slight overestimation of F in recent years but is not apparent in earlier years of the assessment.
- Stock status is consistent with previous years.
- A forecast was not provided because of sensitivity to recruitment assumptions.

6) Stock Status:

- Historical trends show as steady decline in SSB with minor increases in recent years. F has fluctuated with no trend but remains above F_{lim} (0.82)
- SSB_{2016} (2741 t) $<B_{pa}$ (20 000 t); increased risk
- F_{pa} (0.59) $<F_{lim}$ (0.82) $<F_{2016}$(0.94); harvested unsustainably
- F_{2016} (0.94) $>F_{MSY}$ (0.17); overfished
- B_{2016} (2741 t) $< B_{lim}$ (14 000 t) $< B_{trigger}$ (20 000 t); reduced reproductive capacity
- Recruitment in 2016 and 2017 are estimated to be higher than average, but high F will result in small increases in SSB.

7) Management Plan:

- There is no new management plan for cod in Division 6.a.
- Following the MSY approach, the TAC will remain at zero with a bycatch allowance of 1.5% the total live weight of catch on board the vessel. Identical with the previous year.
- Under current management plan, 2017 F (0.79) will drop below F_{lim} (0.82). However, 2018 SSB (2835 t) will remain well below B_{lim} (14 000 t)
- The WG believes the current regulations encourage the increased catches of other species, which has led to increased landings of cod in recent years.

General comments

- The WG report is well written and concise. The WG did follow the Stock Annex with some changes.
- Misreported landings are treated as a separate fleet instead of applying landings-at-age of the Scottish fishery.
- Landing-at-age 7+ are allowed to have higher variance in the model due to inconsistencies in the age composition of 2016 landings.

Technical comments

- The WG Report and advice documents were downloaded on 5/28/17. All track changes for advice were accepted.
- Inconsistent documentation within the annex on ScoGFS-WIBTS-Q4 survey. Listed as data used, but absent from model.
- Management plan references Section XXX.

Conclusions

The assessment was consistent with the Stock Annex with some changes that appear to be well justified. The RG agrees with the WG decision to continue with the current management strategy. The RG also agrees with WG concern that current regulations could increase harvest of other species thus increasing cod landings as seen in recent years, as well as the need for more information on seal predation. The RG agrees the updated assessment is suitable for advice.

cod.27.7.a [WGCSE Section 07: Cod (*Gadus morhua*) in Division 7.a (Irish Sea)]

1) Assessment Type: New assessment including commercial catch through 2016, including discards data, and survey index data through 2016 (benchmarked in 2017).

2) Assessment: Analytical assessment (Category 1.2)

3) Forecast:

a) Short-term: The WG assumed status quo F (three-year average from 2014–2016 with retrospective correction) and geometric mean recruitment from 2005–2014 to forecast 2017 and 2018 values. At this fishing and recruitment rate, the WG estimates SSB_{2017} as 10 299 t and total catch in 2017 as 591 t. There is no benchmark method for forecasts in the Stock Annex.

b) Medium-term: None.

c) Long-term: None.

4) **Assessment method**: Age-structured assessment program (ASAP)

a) Input data: commercial catch and discards from InterCatch at four time intervals (1968–1990, 1991–1999, 2000–2005, 2006–2016), numbers- and weights-at-age of catch from 1982–2016, survey indices (NIGFS-WIBTS-Q1 from 1993–2016, NIGFS-WIBTS-Q4 from 1993–2016, UK-FSP from 2005–2016 except 2014, and NIMIK from 1994–2016), maturity-at-age applied to NIGFS-WIBTS-Q1 data, and Lorenzen mortality.

b) Landings from ICES rectangles 33E2 and 33E3 have been transferred from Division 7a to 7e–k for the years 2004–2016.

c) Discards were included in catch totals as follows:

i) 2007–2016: Discards reported by the EU Data Collection Framework.

ii) 2003–2006: Discards were estimated as the mean from 2007-2015.

iii) 2000–2003: Discard data from observer programs in Ireland, UK (NI, E&W), and Belgium were applied to fleet/métier levels.

iv) Mid-1990s–2000: Discards from the Northern Ireland *Nephrops* fleet were raised to international *Nephrops* fleet.

v) 1968–mid-1990s: The mean *Nephrops* fleet/métier bycatch level for ages 0 and 1 was applied to international *Nephrops* fleet.

5) Consistency:

- The update is not consistent with the annex (file “cod.27.7a_SA.docx”).
- According to the WG Report text, some ages were excluded (age 5 in the NIGFS-WIBTS-Q1 survey and age 1 in the UK-FSP survey) while one additional age was included (age 6 in the UK-FSP survey). According to the WG Report text, NIGFS-WIBTS-Q4 data from 1993–2016 were used in the model although the annex called for the inclusion of year 1992. However, based on the figures and ASAP files, it appears that NIGFS-WIBTS-Q4 survey data from 1991–2016 were used and that age 6 was not included from the UK-FSP survey. It is, therefore, not entirely clear what changes were made, and no justification was provided for the changes.
- There are retrospective patterns in average F ages 2–4 (corrected upwards) and SSB (corrected downwards).

- Stock status changed from last year's stock size for both MSY and precautionary approaches. The stock is now above B_{lim}, but it is not clear to the RG if the change in perception of stock status is a result of the revised method or if the benchmark method also indicates a change in status. Fishing pressure remains consistent with the 2015 status with F below all reference points. The ASAP model and catch-at-age data suggest a slight recovery of older aged fish.

6) **Stock Status**: (reference values listed in the WG Report and annex draft "COD Stock Annex Update 1405.docx")

- There has been no directed fishery on Division 7.a cod in recent years and most catch results from bycatch and discards in beam trawls and *Nephrops* fleets.
- A relatively large recruitment in 2013 has led to a recent increasing trend in SSB, and TAC has been reduced by 15–25% annually since 2006, leading to a substantial decrease in F.
- SSB_{2016} (7173 t) <B_{pa} (8161 t); increased risk
- F_{lim} (0.61) >F_{pa} (0.44) > F_{2016}(0.03); acceptable
- F_{2016} (0.03) <F_{MSY} (0.31); below target
- $B_{trigger}$ (8161 t) >B_{2016} (7173 t) >B_{lim} (6000 t); increased risk
- Recruitment-at-age 0 in 2016 (49 t) is a historically low estimate.

7) Management Plan:

- The plan in Council Regulation (EC) 1342/2008 was determined to be not consistent with the ICES Precautionary Approach, according to the evaluation adopted in AGCREMP 2008.
- The TAC has been reduced by 25% annually since 2009, with most recent TAC levels set to 146 t for 2016 and 2017.
- According to WKROUND2, the Division 7a stock likely consists of local substocks, which are not expected to replenish each other so maintenance of these local substocks is important for the overall stock.
- If *status quo* fishing mortality for ages 2–4 and geometric mean recruitment are observed in 2017, the biomass (B_{2017} (10 299) >$B_{trigger}$ (8161 t)) will be acceptable and fishing mortality (F_{2017} (0.11) <F_{MSY} (0.31)) will be below target.
- Based on an MSY approach to determine advice for 2018, fishing at F_{2018} = 0.31 corresponds to a total catch of 1035 t and SSB_{2019} = 9337 t. Alternatively, fishing at *status quo* (F_{2018} = 0.11) corresponds to a catch of 400 t and SSB_{2019} = 10 366 t.

General comments

- The WG report is well written and concise. The WG did not follow the Stock Annex.
- The WG updated the maturity ogive using the 2016 NIGFS-Q1 data.
- The residuals for proportions-at-age in catch (Figure 6.9) were positive for age-3, which is not mentioned in the text.
- The advice document lists B_{pa} and $B_{trigger}$ as 8616 t rather than 8161 t, as in the Stock Annex. These values do not equal the value derived from the Technical Basis calculation in the draft advice.

Technical comments

- The Stock Annex (cod.27.7a_SA.docx), the WG Report, and Advice documents were downloaded May 25, 2017. Track changes in the Advice document were accepted before review.
- The annex update (COD Stock Annex Update 1405.docx) was downloaded May 25, 2017 because no values had been entered in the biological reference points table in the Stock Annex.
- Including the ASAP model file is helpful.
- There are a few grammatical errors in the text.
- The WG Report lists Cod 7.a (Irish Sea) as Section 6 instead of 7, as is referred to on the SharePoint 2017 Report.
- The name of the model description file should be updated in 6.1.3.
- References to Figures 6.4–6.6 do not match the figures file.
- The size and y-axis scale of age-level figures (Figures 6.1, 6.11, 6.12) should be increased to help viewing.

Conclusions

The Cod 7.a working group assessment is not consistent with the Stock Annex, with the changes made to data included in the model. The RG recommends caution when interpreting spawning biomass with respect to the defined precautionary limits. The finding that $B_{trigger}$ (8161 t) > B_{2016} (7173 t) > B_{lim} (6000 t) largely depends on the model's fit to the 2013 recruitment cohort. The WG discussed the uncertainty in the estimate of this cohort: 1) 2014 data are missing for one index (UK-FSP), 2) these estimates were formed with surveys with low estimates of selectivity (NIGFS-WIBTS-Q1, UK-FSP) 3) the assessment model estimates positively biased catch residuals for age 3 cod (the age of the 2013 cohort in 2016), and 4) the model shows a retrospective pattern, overestimating SSB for the most recent years. Along with few samples and high uncertainty about ages 5 and 6+, the RG recommends interpreting results from this assessment with precaution. The benchmark method is a valid basis for advice.

cod.27.7.e–k [WGCSE Section 09: Cod (*Gadus morhua*) in Division 7.e–k (Celtic Sea)]

1) Assessment Type: Update including data from the at-sea observer program (obsmer), landings to determine numbers-at-age, as well as two surveys FR-EVHOE (EVHOE-WIBTS-Q4 (1997–2016) survey and the IrGFS(IGFS-WIBTS-Q4 survey (2003–2016) that were combined to form IBTS Q4. The historical time-series of age structure from OTDEF French fleet Q1, 2, and 3 are used for the commercial tuning index. The benchmark assessment occurred in 2012.

2) **Assessment**: XSA (Category 1).

3) Forecast:

a) Short-term: Under the forecast assumption, landings in 2017 are predicted to be 3323 t. SSB in 2017 is 7140 t. SSB is 8755 t in 2018

b) Medium-term: None.

c) Long-term: None.

4) **Assessment method**: The WG used an XSA model as designated in the benchmark assessment using landings to determine numbers-at-age, as well as two surveys FR-EVHOE (EVHOE-WIBTS-Q4 (1997–2016) survey and the IrGFS(IGFS-WIBTS-Q4 survey (2003–2016) that were combined to form IBTS Q4. The historical time-series of age structure from OTDEF French fleet Q1, 2, and 3 are used for the commercial tuning index. The forecast model was age-structured using an initial stock size with 1) the survivors at age 2+ from the XSA assessment and N at age 1 = long-term geometric mean omitting the last two years. Maturity was the ogive as in the assessment, F and M = 0 before spawning (all ages and years), weight-at-age in the stock was the average stock and catch rates over the preceding three years. A three year average of F (age 2–5) was scaled using the last year F, following an alternative plan stated by the Annex.

5) Consistency:

- The update is consistent with the annex.
- There are slight retrospective trends, likely due to infrequent, large year classes
- Stock status is consistent with last year.

6) Stock Status:

- SSB has been below B_{pa} since 2014 and is slowly increasing. F was estimated lower than F_{pa}, but well above F_{MSY}. SSB shows a slight positive trend while F has fluctuated with downward trends before and after sharp increases in 2011 and 2014.
- SSB_{2016} (7043 t) < B_{lim} (7300 t); Reduced Reproductive Capacity
- F_{lim} (0.807) >F_{pa} (0.576) >F_{2016} (0.439); Harvested Sustainably
- F_{2016} (0.439) > F_{MSY} (0.353); Overfished
- Recruitment is highly variable with occasional high recruitments followed by several years of low recruitment. The 2015 year class is slightly lower than average.

7) Management Plan:

- There are no specific management plans or objectives.

- ICES advice has been based on MSY.

General comments

- The WG report is thorough and concise and follows the Stock Annex.
- The RG recommends using two significant figures for stock estimates and forecasts to avoid implying a false level of precision.
- Effort from the UK/Welsh fishery dropped to 0 in 2016 (confirmed by the WG).

Technical comments

- The WG report was downloaded 5/27.
- The Advice document appears unfinished.
- The WGCSE is incorrectly labelled (year).
- There are frequent grammatical errors.
- There are a few minor aesthetic errors in table labels.
- There are occasional typographical errors.
- There are minor rounding errors.
- The reference points from the WG and the Annex are essentially the same values (with occasional rounding differences), but they are cited from different sources.

Conclusions

The WGCSE Report is consistent with the Stock Annex procedure and is a valid basis for advice. The RG agrees with the WG that the retrospective pattern implies uncertainty in the F value. The WG notes that the large increase in the F revision from last year's assessment implies that that the stock has never been fished at F_{MSY} resulting in low SSB. Alternately, including a measure of discards (not currently included in the assessment) in F may account for the poorly forecasted SSB, resulting in a stock that is still above MSY $B_{trigger}$ since most discards are age-1 fish and the F value for pre-spawners = 0.

had.27.7.a [WGCSE Section 11: Haddock (*Melanogrammus aeglefinus*) in Division7.a (Irish Sea)]

1) Assessment Type: New assessment method derived at the most recent Benchmark (WKIRISH3, 2017).

2) **Assessment**: The stock assessment was advanced from a category 3 stock (trend-based assessment) to a category 1 stock (analytical assessment) in the 2017 Benchmark.

3) Forecast:

a) Short-term: Provided, as specified in the stock annex. Recruitment for 2017–2019 was estimated at 337 738. F used in the forecast was derived as the F related to TAC for 2017 which changed considerably compared to previous years, due to the introduction of the ASAP model.

b) Medium-term: None.

c) Long-term: None.

4) **Assessment method**: Age-structured assessment model using Age-Structured Assessment Program (ASAP). Assessment includes landings and discard data from commercial fishery through 2016. Quarterly landings are provided by the UK(E&W), UK(Scotland), UK(IOM), Belgium and France. Discards are estimated from the following sources: Northern Ireland self-sampling scheme for *Nephrops* (first time used in this assessment due to unreliability of the data), Northern Ireland observer sampling, and Irish otter trawl fleet (IR-OTB). Discards and landings are supplied together to the model. Four different surveys are used in this model; NIGFS-WIBTS-Q1 (age classes 1 to 5, years 1992–2016). NIGFS-WIBTS-Q4 (age classes 0 to 3; years 1991 to 2016). NI-MIK (age 0; years 1994–2016). UKFspW (age classes 2 to 5, years 1992–2016).

5) Consistency:

- The introduction of the ASAP model to provide advice for 2017 with a MSY approach was performed as established by the Benchmark and as outlined by the annex.
- The predicted catch, recruitment or fishing pressure shows no obvious retrospective pattern. However, there is a slight retrospective pattern of underestimating SSB.
- WG stated that "there is a close agreement with the stock trends of the current and previous assessment"
- ICES advice applicable to 2016 and 2017 are different because MSY approach is applied instead of the precautionary approach. ICES advises that catch in 2017 and 2018 should be no more than 3016 and 3479 t, respectively. These values are different compared with the advice of 1072 t in 2016.

6) Stock Status:

- SSB is currently at the highest levels observed in the time-series and is above MSY $B_{trigger}$. Fishing mortality has been below F_{MSY} since 2012.
- MSY $B_{trigger} = B_{pa}$
- SSB_{2017} (18 974 t) $>B_{pa}$ (3093 t) Above Trigger and Full Reproductive Capacity.
- F_{2017} (0.26) $<F_{MSY}$ (0.27) Below Target or Appropriate.

- Recent recruitment has been above the time-series average, with the second largest recruitment event in the time-series in 2013. Recruitment has been highly variable throughout the time-series.

7) Management Plan:

- There is no management plan for haddock in this area.
- MSY approach is now the basis of the advice.
- The TAC increased from 1654 t for 2016 to 2615 t for 2017.
- A large proportion of the TAC is taken as bycatch by the *Nephrops* fishery.
- Fishing mortality is expected to increase, and the spawning–stock biomass is expected to decline after 2017 as the 2013 cohort is exploited by the fishery.
- Landings have been adjusted since 2003 to exclude landings taken from the southern rectangles (33E2 and 33E3) in the Irish Sea as they are not believed to be part of this stock. This should be considered when setting TACs for the two management areas for haddock in divisions 7.a and 7.b–k. The RG notes that some recent recruitment episodes appear to be asynchronous between the two adjacent stocks.
- Vessels actively targeting haddock have been subject to the EU landing obligation since 2016.
- Regulations affecting haddock are linked to those implemented under the cod management plan (bycatch issues).

General comments

- The WG report is well written and concise. The WG followed the stock annex.
- The major changes in assessment and basis advice resulted from the 2017 Benchmark methods.

Technical comments

- Draft advice was reviewed as a marked-up document (downloaded on 05/26/17).
- In WG report: Figure 11.9 is missing; Figure 11.10 does not contain a legend. Table 7.4.9 is mislabelled; Management options output table is mislabelled as "Table xx.xx"

Conclusions

The WG report was consistent with the stock annex and provides a valid basis for advice. The WG raised some important concerns associated with the new methods used for this stock: 1) Discard rates are very variable between fleet and uncertain in some years (e.g. 2003–2007), 2) recruitment is highly variable, 3) estimation of age 5+ abundance is uncertain, but that might change as the 2013 exceptionally strong year class fully matures. The uncertainty in abundance of older ages is especially relevant to the use of specified selectivity blocks with partial selectivity for older ages. This RG agrees with the WG that model performance needs to be closely inspected in annual update assessments, because all these uncertainties may require deviations from the Benchmark method.

had.27.7.b–k [WGCSE Section 12: Haddock in divisions 7.b–k (southern Celtic Seas and English Channel]

1) Assessment Type: Update including commercial catch data (landings plus estimated discards), survey data, and one commercial tuning fleet through 2016. The stock was last benchmarked in 2012.

2) **Assessment**: Analytical (Category 1.00)

3) Forecast:

a) Short-term: Multifleet Deterministic Projection. Landings and discards are modelled as separate fleets. Under current exploitation patterns (average F 2014–2016), SSB in 2017, 2018, and 2019 are projected to be 32 937 t, 20 256 t, and 22 218 t, respectively.

b) Medium-term: None.

c) Long-term: None.

4) **Assessment method**: Age-structured assessment program (ASAP) with an Extended Survivors Analysis (XSA) also used for quality control purposes

a) Input data: commercial landings from 1993–2016 (catch-at-age, weight-at-age, and estimated discards-at-age); survey indices (FR-IRL-IBTS index, which is a combined index from the French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS surveys from 2003–2016); and one commercial tuning fleet (IR-GAD from 1995–2016). Age-specific natural mortality and the age at maturity were estimated and assumed to be constant over the time-series.

5) Consistency:

- The assessment is an update and is consistent with the stock annex, with a few apparently minor exceptions.
- The predicted catch and recruitment time-series did not have any clear retrospective patterns (Figure 7.4.15). SSB tended to increase as years of data were added, and F decreased with additional years. These retrospective patterns are likely due to the influence of the strong 2009 cohort, which caused conflict between catch data and the commercial tuning index (IRL-GAD).
- Stock status is consistent with last year.

6) Stock Status:

- Decreasing trend in SSB
- Increasing trend in F
- SSB_{2016} (28 251 t) >B_{pa} (10 000 t) >B_{lim} (6700 t); full reproductive capacity
- SSB_{2016} (28 251 t) >MSY $B_{trigger}$ (10 000 t); acceptable,
- F_{2016} (0.674) <F_{pa} (0.89) <F_{lim} (1.41); harvested sustainably
- F_{2016} (0.674) >F_{MSY} (0.40); overfished
- F has been above F_{MSY} for the entire time-series but shows a declining trend.
- Recent recruitment has varied around the average, following three years of below-average recruitment after the very strong 2009 year class.

7) Management Plan:

- There is no management plan for this stock.
- Since 2015, advice for this stock has been based on the MSY approach.
- The agreed TAC for 2017 is slightly higher (7751 t) than that for 2016 (7258 t).

- Under the MSY approach, catches in 2018 should not exceed 8393 t and F_{2018}=0.40, which will result in an increase in SSB in 2019 (SSB_{2019} = 24 919 t, remains above MSY $B_{trigger}$) and a decrease in the TAC (-23.42%).
- Landings have been adjusted since 2003 to exclude landings taken from the southern rectangles (33E2 and 33E3) in the Irish Sea as they are not believed to be part of this stock. This should be considered when setting TACs for the two management areas for haddock in divisions 7.a and 7.b–k.

General comments

- The WG report is generally well written and thorough.
- The WG followed the Stock Annex, with a few exceptions.
- The allocation rules applied to unsampled catches allocated age compositions from the combined annual landings and discards of all countries using the same gear type. This differed slightly from the Stock Annex, which specified country-gear combinations for allocating unsampled catches after 2013. The RG recognizes that the majority of the catch is unaffected by the change in allocation rules, but the justification for this minor change was unclear to the RG. A table indicating the specific fleets/areas used in the assessment vs. those used to characterize lpue would be helpful. In several instances, the WG presented lpue information from fleets that were not included in the assessment as auxiliary information; it was difficult for the RG to assess whether or not that data should have been included in the assessment as it was presented in both the Stock Annex and the WG report. Ensuring that the acronyms used to refer to each fleet are consistent both within and between the WG report and the Stock Annex would also be helpful.
- Direct inclusion of the ASAP input data table (Table 7.4.4) was very helpful. However, there were two changes from the benchmark method:
  - The input file indicates that likelihood constants were not used, though they were specified in the Stock Annex. The RG recognizes this change reflects current 'best practice' in ASAP applications to avoid biased estimates. For example, update assessments of New England groundfish all made the same revision from benchmark methods (NEFSC, 2015).
  - The catch total CV value used for 1993 is 0.2, but should be 0.3 according to the Stock Annex. No justification for the change was provided by the WG.
- The Stock Annex indicates that, in addition to ASAP, an XSA should be applied for quality control purposes. The XSA appears to have been last conducted in 2011.
- Discards for short-term projections were based on the proportions of the catch that were discarded over the full-time-series, rather than the benchmark method of averaging over the last three years. The WG justified this change, because the relatively low discards estimated over the last four years are unlikely to persist. The RG agrees that the revised approach to projected discards is reasonable.

Technical comments

- The TAC listed for 2016 in Table 7.4.1.a is the 2017 TAC.
- Figure 7.4.5a is difficult to interpret at its current size/colour scheme.

- Figure 7.4.5b is referred to as a time-series of discard ogives, but the plots appear to show the probability that a fish of a given size is retained, rather than discarded.
- Figure 7.4.9a is cluttered and difficult to interpret.
- Documents were initially downloaded on 5/26/17, but had not been updated with the current year's advice. The updated files were downloaded on 5/29/17.
- More specific language regarding the methods used (rather than just referring the 'historic approach' provided in the Stock Annex) would be helpful to the RG for evaluating consistency with the Stock Annex.

Conclusions

The assessment was carried out as specified in the Stock Annex with a few apparently minor exceptions. Although there were several changes to the data protocol, model settings, and forecast assumptions from the approved benchmark method, the revised method appears suitable as the basis for advice. The RG agrees that the recommended catch in the Draft Advice is appropriate given the stock status. The RG agrees that potential shifts in selectivity in response to gear changes should continue to be considered in future assessments (despite limited evidence of selectivity shifts since mesh regulations changed in 2012). The RG encourages further evaluation of an assessment that includes discards separately (given the high degree of uncertainty in discard estimates) at a future benchmark.

ple-27-7.a [WGCSE Section 25: Plaice (*Pleuronectes platessa*) in Division7.a (Irish Sea)]

1) Assessment Type: New assessment including landings, discards, and survey data from the extended UK (E&W)-BTS-Q3, NIGFS-WIBTS-Q1, and NIGFS-WIBTS-Q4 surveys. Benchmarked in 2017.

2) **Assessment**: Analytical (ICES data category 1.00)

3) Forecast:

a) Short-term: FLR projection.

b) Medium-term: none.

c) Long-term: none.

4) **Assessment method**: The assessment was conducted using an age-based analytical assessment (SAM model). Data used in the assessment include commercial landings numbers-at-age and discard numbers-at-age. Discards were reconstruction before 2004. Only dead fraction of discards (0.6) accounted for. Three survey indices including extended UK(E&W)-BTS-Q3 (1993–2016), NGFS-WIBTS-Q1 (1993–2016), and NIGFS-WIBTS-Q4 (1993–2016) were used. Fixed maturity ogive. Natural mortality is age specific and constant over time.

5) Consistency:

- The update is not entirely consistent with the annex.
- The WG report reference points (F_{MSY}, B_{lim} and B_{pa}) are not consistent with the stock annex.
- Projected catches in forecast are split according to average landings fractions at age from the last ten years; Annex specifies using the last three years.
- There is a lack of clarity in the Stock Annex about data usage and assessment model configurations making it difficult to tell if the WG report is correct.
- No retrospective trends.
- Stock status is consistent with last year.

6) Stock Status:

- Increasing trend in SSB and decreasing trend in F.
- Relative SSB_{2016} (22 686 t) > B_{pa} (7900 t); full reproductive capacity
- F_{lim} (0.48) >F_{pa} (0.25) >relative F_{2016} (0.05); acceptable
- F_{2016} (0.05) <F_{MSY} (0.15) below target
- Relative B_{2016} (22 686 t) >(10 400 t), B_{lim} (4200); acceptable
- These reference points (F_{MSY} and B_{pa}) are from the annex, but the WG report has different values.
- No trend in recruitment.

7) Management Plan:

- There is no explicit management plan for Irish Sea plaice, but there is a TAC and minimum landing size.
- The TAC for 2017 (1098 t) was the same as that for 2016.
- The WG report states that under a precautionary approach:
  - 2017 catches should not exceed 1493 t.

- If the stock is not under the EU landings obligation in 2017 and discards stay at the average of the last three years, then landings should not exceed 436 t.
- Assuming F_{MSY} = 0.154, total catch for 2018 is 3254 t and SSB in 2019 is 23 013 t.

General Comments

- The WG report is well written and concise.
- The WG did not follow the Stock Annex for reference points, the assumed values for selectivity in the forecast, and possibly some data and model decisions.
- The Stock Annex provides no information on usage of landings data and discards weight-at-age, so it is not clear if the WG followed the Annex.
- There were numerous references to supplemental explanations such as weight-at-age, numbers-at-age, and data screening to be provided in the Stock Annex throughout the WG report, but those explanations were not provided in the Annex.
- There was no information in the Stock Annex in sections on “Survey design and analysis” or “Survey data used”. It is unclear if the WG followed the Annex in this regard.

Technical comments

- The WG report, advice, and annex were downloaded on 5/30/17.
- The annex does not appear to be complete because there are headings with blank sections and no references.
- Some tables are referenced incorrectly and some tables are difficult to interpret.
- Header title of the report is “ICES WGCSE REPORT 2015”; the year should be 2017.

Conclusions

The WG report is well written and concise, but the assessment is not entirely consistent with the Stock Annex. There were discrepancies in reference point values between the Annex and the Report/Advice. A lack of clarity and information in the Stock Annex made it difficult to interpret consistency. The RG could not determine if the updated assessment was consistent with the benchmark method or is a valid basis for advice because of the lack of detail on data and model decisions in the annex and the apparent inconsistencies between the WG report and the annex.

ple.27.7e [WGCSE Section 27: Plaice (*Pleuronectes platessa*) in Division 7.e (Western English Channel)]

1) Assessment Type: Update including survey and fisheries data through 2016, as well as exploration of proxy MSY points (requested by WKMSY 2017) (Benchmarked in 2010, Inter-Benchmarked in 2015, Benchmark extended in 2016).

2) **Assessment**: Survey Based Trends (Category 3.2)

3) Forecast:

- Short-term: Projection of landings is based on recent trends in SSB. A ratio of the two previous years' average SSB (2015–2016) to the previous three years' average SSB (2012–2014) is applied to the 2017 advised catch (2714 t). This ratio suggested more than a 20% increase, but the allowed increase is constrained to an uncertainty limit of 1.2. This results in a 2018 advised catch of 3257 t.
- Medium-Term: None
- Long-term: None (Annex says it took place from 2012–2014, but stopped at the 2015 Inter-Benchmark)

4) **Assessment method**: This assessment was completed using an extended survivor analysis (XSA) including commercial landings-at-age (2–10+) (1980–2016) adjusted for migration, the UK Fisheries Science Partnership Survey UK-FSP: Cefas-UK industry cooperative project (2003–2016), and the UK Southwest Beam Trawl Survey Q1SWBeam (2006–2016).

5) Consistency:

- The update is consistent with the annex with some changes.
- Discard rate is not estimated in the Annex, but was estimated and applied to the advised catch by the WG in 2016 and 2017.
- The method of estimating discard rate was changed from average by métier for 2016 to international average for 2017, because the previous estimate was biased low. Métiers with low discard rates only contributed a small amount to total landings.
- Length-based indicators and a SPiCt model were explored to produce proxy MSY reference points (requested by WKMSY 2017). The length-based indicators and SPiCt methods of producing proxy MSY reference points were rejected on the basis of unrealistic results, and inability to track the dynamics of the stock.
- The retrospective patterns experiences in past assessments did not persist in the 2017 assessment.

6) Stock Status:

- Stock status is reported as relative values described previously. With the 2016 SSB showing an increase with respect to 2015 (2.461 ratio) and F showing a decrease (0.47 ratio).
- Relative recruitment has decreased from previous years (0.73 ratio)

7) Management p**lan:**

- There is no management plan in place for this stock.
- The TAC for this stock includes portions of bordering stocks and does not directly reflect changes in this stock.

- The TAC for 2017 (10 022 t) decreased from 2016 (12 446 t).
- The advised catch for the Division 7.e Plaice stock increased from 2262 t in 2016 to 2714 t in 2017.

General comments

- The WG report is well written, concise, and follows the annex with some changes.
- There were no data changes from the Inter-Benchmark in 2015
- The WG explored two methods of producing proxy MSY reference points, but both were rejected.
- The WG requests that more work should be done to reduce uncertainty regarding the migration rate correction factor.
- The WG advises that without discard information being included in the model, results are likely to be optimistic.

Technical comments

- The WG Report and advice documents were downloaded on 5/28/17. All track changes for advice were accepted.
- 'Error Reference Source Not Found' in Stock Status Section
- Multiple grammatical errors.

Conclusions

The assessment was consistent with the Stock Annex. The RG agrees with the WG conclusion that advised catch should increase. The RG also agrees that the assessment could benefit from improved estimates of migration rates and the inclusion of discard data. The RG notes that the positive trends indicated by surveys are supported by the exploratory XSA. The RG agrees that the assessment could be considered for a new benchmark review when a longer series of discard estimates and possibly movement information is available. The RG agrees the updated assessment is suitable for advice.

ple.27.7.fg [WGCSE Section 28: Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)]

1) Assessment Type: Revised analytical technique including landing data and survey data (benchmarked in 2011).

2) **Assessment**: Survey trends based (Category 3.2)

3) Forecast:

- **Short term**: Projection of the model for the year 2017 forecasts B > B_{MSY} and F< F_{MSY} within 95% confidence intervals. There is no benchmark method for forecasts.
- **Medium term:** None
- **Long term:** None

4) **Assessment method**: biomass dynamic model (SPiCT – Stochastic Production model in Continuous Time) with two survey indices (UK(E&W)-BTS-Q3) 1995–2016, (IGFS-WIBTS-Q4) 2003–2016, two commercial fleet indices (UK(E+W) BT 7F and UK OTB 7F) 1989–2010, commercial landings and discards. The SPiCT model was not included in the benchmark method.

5) Consistency:

- The update is not consistent with the annex.
- WKFLAT (2011) agreed to use the AP model (Aarts and Poos, 2009) as a temporary basis for advice. 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).
- The annex also states, "As the dataseries are extended a final model selection can be then determined".
- The stock annex outlines the use of an AP (Aarts and Poos) model to provide advice for this stock. In 2013, the AP model failed to converge. In 2015 & 2016 advice was based on research surveys due to unreliability of the AP model.
- In 2017, the WG decided to use the SPiCT model. Output from the SPiCT was consistent with trends in abundance of commercial-sized fish aged 3+ as represented by data of research surveys. The SPiCT model was first explored in 2015 by WKLIFE.
- The SPiCT estimates MSY reference points, but they were not reviewed by the benchmark.
- There are no retrospective trends.
- Stock status is consistent with last year.

6) Stock Status:

- Increasing trend in SSB and decreasing trend in F
- B_{2016} (15 634 t), B_{pa} (not defined)
- F_{lim} (not defined), F_{2016}(0.067), F_{pa} (not defined)
- F_{2016} (0.067) < F_{MSY} (0.28), Below Target
- B_{2016} (15 634 t) >B_{MSY} (9100 t) >$B_{trigger}$ (4550 t), B_{lim} (not defined); Acceptable

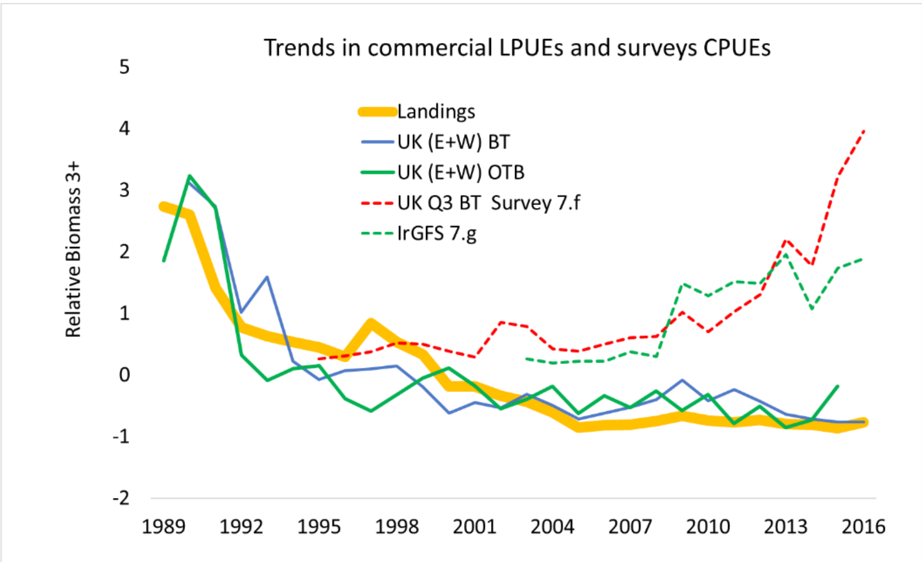
7) Management Plan:

- There is no management plan.
- ICES advice has been based on a general precautionary approach.

- TAC decreased from 2016 (420 t) to 405 t for 2017.

General comments

- The WG report is concise and organized.
- The WG did not follow the annex.
- The WG did a good job explaining recent difficulties in the analysis of this stock.
- There is limited background information on the SPiCT model in the WG report or annex. A further explanation and discussion of this technique is recommended.
- There is no information provided on how the short-term forecast was conducted.
- Plaice in areas 7f and g are discarded at a high rate. The discard mortality is assumed to be 100%. Survival of discards might be worth investigating for future assessments.
- The RG notes that there are different trends in commercial lpue and survey cpue time-series. The RG recommends the WG discuss some of the possible causes for these differences and encourages a larger overall discussion on their implication for the assessment model.



Technical comments

- There are different styles of font used within the document.
- There are two "Figure 28.8", the RG suggests changing the one in the text to a table.
- Figure 28.1a, 28.3 and 28.8 are small, making them difficult to interrupt.

Conclusions

The WG does a good job describing recent difficulties that have complicated the analysis of this stock, and the RG understands the WG's motivation for exploring a new analytical technique that has been reviewed by ICES, WKLIFE. The RG recommends further background information be provided on the SPiCT model, as no information on this technique is provided in the stock annex. Although MSY reference points are now available, the RG agrees with the WG that a precautionary approach should be applied because of remaining uncertainties in the assessment. The RG also recommends that this stock might be worth investigating for an inter-benchmark or benchmark assessment.

ple.27.7.h–k [WGCSE Section 29: Plaice (*Pleuronectes platessa*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)]

1) Assessment Type: Update XSA assessment for the 7.j,k component of the landings through 2016.

2) **Assessment**: Category 3 stock (trend-based assessment).

3) Forecast:

- No forecast presented.

4) **Assessment method**: Age-based analytical assessment (XSA) is indicative of stock trends. Input data include commercial Irish landings from divisions 7.j and 7.k (1993–present) and a commercial tuning index (IRL-VMS-OTB 2006–present). Discards are high but cannot be reliably quantified.

5) Consistency:

- The update is not consistent with the annex.
- The WG performed exploratory assessments carried out by means of a separable VPA and XSA. VPA was used to explore choices of reference age, F, and S.
- The WG also relied on methods used by WKProxy (ICES, 2016a) and the WKMSYREF4 (ICES, 2016b) to perform MSY evaluations. F_{MSY}= 0.25 was proposed based on $F_{0.1}$ from a Thomson-Bell yield-per-recruit analysis of the landing numbers-at-age.
- The RG notes that the new proxy F_{MSY} is substantially less from the F_{MSY}= 0.43 defined by the annex.
- The WG recommends that B_{lim} be estimated as the lowest SSB that generated high recruitment (354 t in 1999) and B_{PA} = 1.4*B_{lim}= 496 t. These methods resulted in an F_{MSY}=0.27 without a $B_{trigger}$ harvest control rule and F_{MSY}= 0.30 with a $B_{trigger}$ harvest control rule.
- The WG did not clarify if these estimates for reference points change the perception of the stock status. The RG tried to compare the advice from 2016 and 2017. However, recruitment, SSB, and F were listed as "relative" values in the 2016 advice and cannot be compared to the values provided in 2017. Landings in 2014 (148 t) and 2015 (107 t) were the same in both Advice documents.
- No consistent retrospective pattern (from the XSA).

6) Stock Status:

- Recruitment declined in 2015 and increased again in 2016. The SSB has declined from around 400 t in 1993 to around 100 t in recent years to a low of 44 t in 2015. F has been quite variable throughout the time-series but shows no clear trend.
- The summary table (29.10) with a time-series of landings, recruitment, SSB and F does not present values for 2016.
- Not all values for reference points provided in the Draft Advice are consistent with the previous or new values provided in the WG report.
- SSB_{2016} (94 t) <B_{pa} (282 t)
- F_{lim} (0.471) < F_{2016}(1.359) < F_{pa} (reported as 2639 in the draft advice)
- F_{2016} (1.359) > F_{MSY} (0.289)
- B_{2016} (94 t) < $B_{trigger}$ (282 t), B_{lim} (203t)

7) Management Plan:

- No management plan for plaice in this area
- ICES advised that landings should be no more than 86 t in 2017.

General comments

- The WG report was downloaded 05/28/17 and checked again on 05/30/17 and 06/05/17 and was still in a draft format.
- Several errors and omissions were found in the WG report and the Draft Advice.
- It was extremely difficult for this RG to provide further suggestions to the WG, since key information was missing (e.g. SSB, F, R in 2016).

Technical comments

- Several editing comments are still present in the WG report.
- Figures 7.11.7, 7.11.12, 7.11.13 are referenced but not present in the WG report.
- Table 29.10 is incomplete.

Conclusions

The WG report is not consistent with the annex. The WG relied on methods and analyses performed by the WKProxy (ICES, 2016a) and the WKMSYREF4 (ICES, 2016b) to provide the basis for advice. This RG recognizes that the revised reference points are based on the ICES initiative to provide MSY advice for data-limited stocks. The WG recommended upgrading this stock to a category 2, but the RG suggests that the uncertainties in discard estimates and XSA need to be considered in a Benchmark review. For example, there is strong evidence reported in the annex that the stock structure is incorrectly defined. The RG notes that if the absolute estimates from XSA are correct, the current F is more than two times greater than F_{lim}. The RG agrees that the annual Irish Beam-trawl Ecosystem Survey (IBES) may be included in the future as another tuning index once more years of this survey become available. The RG agrees with the WG statement that management of this stock should focus on reducing discards because discards are very high.

sol.27.7.e [WGCSE Section 35: Sole (*Solea solea*) in Division 7.e (Western English Channel)]

1) Assessment Type: Update including commercial landings and survey data through 2016 (benchmarked in 2012 and inter-benchmarked in 2015).

2) **Assessment**: Analytical (Category 1.00)

3) Forecast:

- Short-term: Recruitment was forecast using a long-term geometric mean (1969–2016) and F was rescaled by average $F_{14–16}$.
- Medium-term: None.
- Long-term: None.

4) **Assessment method**: Extended Survivors Analysis (XSA) with catch numbers-at-age excluding discards.

- **Input data:** four tuning fleets (two fishery-independent surveys: UK-FSP (2003–2016) and Q1SWBeam (2006–2016); and two commercial lpue time-series (1988–2016): UK-CBT-late (1988–2016); and UK-COT (1988–2016)).

5) Consistency:

- The update is consistent with the annex.
- Minor retrospective patterns have begun to emerge. Spawning–stock biomass seems to be slightly overestimated.
- Stock status is consistent with last year.
- In 2016, a European Union landings obligation was applied to this stock for the first time. Given the low discards observed in the fishery the landings obligation is unlikely to have a significant impact on this stock or the advice.
- UK-COT reported zero effort in 2016 and therefore a lpue value for 2016 for this fleet does not exist.

6) Stock Status:

- Increasing trend in SSB and increasing trend in F
- SSB_{2016} (4522 t) > B_{pa} (2855 t); Full Reproductive Capacity
- F_{lim} (0.44) > F_{2016} (0.22) < F_{pa} (0.32); Acceptable
- F_{2016} (0.22) < F_{MSY} (0.29); Below Target
- SSB_{2016} (4522) > $B_{trigger}$ (2826), B_{lim} (2039); Acceptable
- Recruitment in 2016 (3520) is lower than 2015 (4598). Since 1969 recruitment has varied without an overall trend.

7) Management Plan:

- Council Regulation (EC) No 509/2007 establishes a multiannual plan for the sustainable exploitation of sole in Division 7.e. The long-term management target (F_{MGT} = 0.27) is precautionary in the sense that it ensures there is a less than 5% chance of SSB declining below previously observed levels, as well as maintaining yield within 10% of MSY.
- The TAC increased from 979 t for 2016 to 1178 t for 2017. Landings in 2017 are projected to be 932 t, 246 t (-21%) less than the TAC in 2017.
- Projections based off of F_{MGT} = 0.27 project SSB_{2019} (4150 t) >$B_{trigger}$ (2826 t).

General comments

- The WG report is well written, organized and concise.

- The WG did follow the Stock Annex.
- The WG does a good job explaining possible causes for retrospective patterns.
- The WG does a good job discussing the driving factors behind the reduction in effort in the UK-COT fleets.
- Discard data are available from 2012. Even though discards are minimal the use of this time-series could be worth investigating at the next benchmark.

Technical comments

- The WG report and advice were downloaded on May 25, 2017. All track changes for advice were accepted at that time.
- There were minor track changes in the stock annex.
- The RG recommends in the future that documents be labelled consistently (e.g. the WG document was labelled "echw" while the annex and advice report is labelled 7.e).
- Table 35.6 is not in the same format as other tables, making it difficult to interpret.
- Minor spacing issues with figures.
- There are capitalization inconsistencies in the use of cpue and lpue throughout the document.

Conclusions

The assessment was in accordance with the Stock Annex. The RG agrees with the WG that retrospective patterns should be re-examined if they continue to be observed in future assessments. The RG also agrees with the WG that if effort of the UK-COT fleet continues to be non-existent, the next benchmark should investigate the removal of this commercial tuning information from the assessment. The RG agrees the updated assessment is suitable for advice.

sol.27.7.fg [WGCSE Section 36: Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)]

1) Assessment Type: Update includes international commercial landings and UK Beam-trawl survey (UK(E&W)-BTS-Q3) through 2016. Benchmarked in 2017.

2) **Assessment**: Analytical (ICES data category 1.00)

3) Forecast:

- The short-term forecast assumed a TAC for 2017 of 845 t which implies a fishing mortality of 0.29. Resulting SSB is 3112 t in 2018 and 3149 t in 2019.
- No medium-term or long-term forecasts presented.

4) **Assessment method**: The assessment was conducted using an XSA. Data included the UK(E&W)-BTS-Q3 survey index (1988–2016), and two commercial lpue tuning series indices; BEL-CBT (1971–1996) changed to BEL-CBT2 (1997–2016) and UK-CBT (1991–2012; not used since 2012). Commercial data include international landings numbers-at-age and weights-at-age from catch sampled by métier. Discards are not accounted for within the assessment.

5) Consistency:

- The update using an XSA model is consistent with the annex.
- There are no major retrospective patterns in estimates of SSB and F. In recent years, F was slightly underestimated and SSB was slightly overestimated.
- Stock status is consistent with last year; above $B_{trigger}$.

6) Stock Status:

- SSB has historically declined, but has been consistently above $B_{trigger}$ since 2001. F has been above F_{MSY} since 2009; it exceeded F_{pa} in 2016.
- SSB_{2016} (2525 t) > B_{pa} (2380 t); full reproductive capacity
- F_{lim} (0.49) > F_{2016} (0.37) > F_{pa} (0.35); increased risk
- F_{2016} (0.37) > F_{MSY} (0.27); overfished
- B_{2016} (2525 t) < $B_{trigger}$ (2380 t); acceptable
- Recruitments in 2015 and 2016 are estimated to be well above average.

7) Management Plan:

- There is no explicit management plan for Celtic Sea sole, but a TAC has been in place since 1983. Technical measures include minimum mesh size and minimum landing size. National authorities can impose additional management measures.
- The agreed TAC increased from 779 t for 2016 to 845 t for 2017.
- The above average recruitments in 2012, 2014, and 2015 are predicted to keep SSB just above $B_{trigger}$.
- If 2018 F = F_{pa}, SSB is expected to be 3227 t in 2019.

General comments

- The WG report is very well written and concise.
- The WG followed the Stock Annex, which was updated this year.
- The UK-CBT tuning series was excluded again in 2017 (as in the benchmark method) due to effort reporting issues.

- The WG raises concerns that the UK-BTS-Q3 survey is the only source of information for age 1 recruitment. Previously, estimates of the magnitude of strong year classes have sometimes been revised downward causing bias in forecasts.

Technical comments

- The WG Report and advice documents were downloaded on 5/24/17. All "track changes" for advice were accepted.
- Most figures and tables were located in supplemental file folders.

Conclusions

The assessment was performed correctly and in accordance with the stock annex. The RG agrees with the WG that catches in 2017/2018 should only slightly increase due to strong recruitment and SSB being above $B_{trigger}$, but there has been a recent increase in fishing mortality. The RG also agrees with the WG concern that recruitment estimates are only informed by a single series, and past recruitment estimates have been uncertain, which should be considered in the perception of recent above average recruitment and projections. The RG agrees that the updated assessment is a valid basis for advice.

sol.27.7.h–k [WGCSE Section 37: Sole (*Solea solea*) in divisions 7.h–k Celtic Sea South, southwest of Ireland]

1) Assessment Type: Update commercial landings in divisions 7.j–k, Irish age-composition for catch, commercial tuning index (IRL-VMS-OTB).

2) **Assessment**: Age-based analytical assessment (XSA) indicative of stock trends (Category 3.2)

3) Forecast:

- Short-term: None
- Medium-term: None
- Long-term: None

4) **Assessment method**: XSA performed for divisions 7.jk using catch numbers for age 2–10+ from 1993–2016. The tuning fleet of Irish VMS-based lpue (IRL-VMS-OTB) included age composition data from Division 7.j for age 3–9 from 2006–2016. Belgian landings from 7.j are excluded from total landings due to concerns over misreporting. Irish landings occur mainly in 7.jk, therefore the assessment occurs in this area. An exploratory VPA investigated year and age range for use in a separable VPA and choices of reference age, final F and S. Exploratory XSA investigated q-age, F-shrinkage and minimum SE threshold. The exploratory analysis is not used as the basis of advice for this assessment.

5) Consistency:

- The update is consistent with the annex
- Stock status is consistent with last year.

6) Stock Status:

- SSB declined from 800 t to 400 t between 2000–2009, but has been increasing since 2010 and recently recovered to nearly 800 t. F slowly declined in recent years and has been below F_{MSY} since 2012, and slightly increased in 2016. Biomass has been above MSY $B_{trigger}$ since 2015.
- F_{2016} (0.128) < F_{MSY} (0.25); appropriate
- Recruitment has been variable with no clear trend.

7) Management Plan:

- There is no management plan for sole in this area, a TAC is specified for divisions 7.h–7.k. and was set at 382 t in both 2016 and 2017. A precautionary TAC regulation applies (Article 12(1)) which closes Porcupine Bank in May and July.
- Landings obligations began in 2016 for divisions 7.b–c,f–k for beam-trawl vessels for which sole landings made up more than 5% of landings in 2013 and 2014. Landings obligations also took effect for all trammelnet and gill-net sole fisheries. Vessels are permitted to discard up to 3% of sole they catch in 2017.
- The assessment considers divisions 7.j–k but Division 7.h landings are accounted for when producing catch advice. Sole in Division 7.h are likely a part of stocks in 7.e,f,g.
- If the precautionary approach is applied, catch in 2018 should not exceed 268 t.

General comments

- The WG report is well written and concise.
- The WG report followed the stock annex.
- The Irish Beam-trawl Ecosystem Survey (IBES) began in 2016 and could someday be used as a tuning index, but currently is too short.
- The tuning index that is currently used is still short, but the WG believes it is long enough to inform trends. There are no obvious year effects in the tuning fleet. There were small year effects in XSA results from the tuning fleet lpue estimate.
- The WG noted that landings-at-age data problems between 1999 and 2003 may have resulted in erratic estimates of F, and the inclusion of a commercial tuning fleet may introduce bias if fleet efficiency changes over the time-series which may be avoided by limiting the index to only include areas where sole is caught.
- The TAC for sole in this area is currently not restrictive but quota may be restrictive in some countries, and the WG notes that restricting effort may be more effective than limiting landings.
- The WG noted that the landings obligation is unlikely to significantly impact advice for 2017 due to low discards in the fishery.
- A proposed F_{MSY} reference point proposed by WKProxy of F = 0.17 was based on $F_{0.1}$ and represents a data-limited approach, but is not directly comparable with XSA results due to differences in input data.
- An exploratory MSY evaluation was conducted but not used as a basis for advice (B_{lim}=B_{loss}=355 t, B_{pa}=1.4*B_{lim}=497 t, F_{MSY} = 0.20 with no $B_{trigger,}$ F_{MSY}=0.25 with $B_{trigger}$=B_{pa}).
- Some reference points in the draft advice are not reported in the annex or the WG report (SSB_{2016} (846 t) > B_{pa} (590 t) >B_{lim} (425 t); Full Reproductive Capacity; F_{lim} (0.222) > F_{pa} (0.161); Acceptable).

Technical comments

- WG report downloaded on 5/29/17, advice and stock annex downloaded 5/30/17. The RG last checked for updates on 6/5/17.
- ICES advice sections of the WG report and draft advice document appear to contain incorrect information, although current advice is contained later in both reports.
- Page headings do not reflect the current assessment year
- The final paragraph of the Management Considerations section is repetitive.
- The MSY Evaluation section is highlighted.
- The annex does not report the date of the most recent benchmark review.
- In the draft advice, there were two copies of Table 7 and several marked changes.

Conclusions

The assessment was performed according to the stock annex. The RG agrees that this assessment provides a valid basis for advice. The WG recommends that a benchmark or intersessional review be conducted to upgrade the stock to Category 2 next year. Potential methods for estimating reference points were explored in this assessment but are not currently used as the basis for advice. The short tuning index, lack of survey index, and potential problems in landings data from 1999–2003 which impact F estimates may limit accuracy of forecasts needed for Category 2 assessments. The RG recommends that a new benchmark review may be appropriate when a sufficient time-series of survey data are available.

whg.27.7.a [WGCSE Section 40: Whiting (*Merlangius merlangus*) in Division 7.a]

1) Assessment Type: New assessment commercial catch through 2016, including discards data, and survey index data through 2016 (benchmarked in 2017).

2) **Assessment**: Analytical assessment (Category 1)

3) Forecast:

- Short-term: FLAssess using R software packages using a three-year moving average for F and a geometric mean of recruitment from 2000–2016. The WG concluded that the recruitment assumption has a considerable effect on estimates of SSB for 2019.
- Medium-term: None.
- Long-term: None.

4) **Assessment method**: SPALY update of Age-structured assessment program (ASAP)

- Input data: commercial catch (1980–2016), numbers- and weights-at-age of catch (2003–2016), survey indices (NIGFS-WIBTS-Q1 from 1993–2016, NIGFS-WIBTS-Q4 from 1993–2016, and NIMIK from 1994–2016), knife-edge maturity-at-age 2, and Lorenzen mortality.
- Stock annual weights-at-age are calculated as a three-year moving average of catch weights-at-age.
- Landings from ICES rectangles 33E2 and 33E3 have been transferred from Division 7.a to 7.b,c,e–k for the years 2003–2016.
- Recent landings (since 2003) have not been corrected for misreporting.
- Discard estimates from Ireland and Northern Ireland were included with minor discards from Belgium and UK(E&W).
- XSA assessment was carried out for comparison, and the FLR package FLEDA was used for data screening.

5) Consistency:

- The update is consistent with the annex. There are no retrospective patterns for recent estimates of SSB, though some deviations occur prior to the mid-1990s, likely due to the addition of the survey. Slight retrospective patterns are present for F and recruitment.
- Stock status is consistent with last year.

6) Stock Status:

- Recruitment and SSB have been low since the 1990s, and F has been high with large variations in recent years.
- SSB_{2016} (1134 t) < B_{pa} (16 300 t); increased risk
- F_{2016}(0.57) > F_{lim} (0.37) > F_{pa} (0.22); harvested unsustainably
- F_{2016} (0.57) > F_{MSY} (0.22); overfished
- $B_{trigger}$ (16 300 t) > B_{lim} (10 000 t) > B_{2016} (1134 t); reduced reproductive capacity
- Recruitment has been low with no trend in recent years.

7) Management Plan:

- No management plan has been agreed or proposed.

- The TAC for 2017 is the same as for 2016 (80 t). The ICES advice from the precautionary approach advised zero catch in 2017.
- Advice from an MSY approach corresponds to no directed fisheries and minimized catch in 2018.
- If total catch is reduced to zero (F = 0) as advised by the MSY approach, SSB in 2019 is estimated to be 2103 t.
- Assuming a three-year moving average for F and a geometric mean of recruitment from 2000–2016. At these rates, the WG estimates SSB_{2017} as 877 t.
- Decreasing maturity-at-age means whiting now mature well below the minimum landing size (27 cm) and variable weight-at-age has potential to affect mortality-at-age estimates.
- This stock is not yet under the landings obligation.
- Due to the high bycatch rate of undersize whiting in the *Nephrops* fleet and low TAC, the WG expressed concern that the 7.a whiting stock may become a major "choke species."

General comments

- The WG report is well written and concise. The WG followed the Stock Annex.
- A considerable portion (765 t of 780 t in 2016) of the catch is derived from discards, mostly (78%) from bycatch in the *Nephrops* fleet.
- Landings-at-age data have declined in quality recently due to reduced sample numbers consistent with declining landings
- The value for F_{pa} (0.22) does not equal the value derived from the Technical Basis calculation in the draft advice.
- The model does not fit survey trends before the mid-1990s well.

Technical comments

- The annex and advice documents were downloaded May 30, 2017; the assessment was downloaded May 31, 2017.
- Track changes in the Advice document were accepted before review.
- Including the ASAP model input is helpful, though uploading it as a separate file would improve readability of the report.
- There are few grammatical errors in the text.

Conclusions

The whiting 7.a WG Report is consistent with the Stock Annex. The RG agrees with the WG's advice that all catches should be minimized in 2017 and 2018 due to high estimates of F and low estimates of SSB and the persistent truncation of the age distribution. The RG recommends that future benchmark reviews should consider modelling catch components (landings and discards) as separate fleets (e.g. white fish fleet, *Nephrops* fleet). The RG considers the WG assessment as a valid basis for advice.

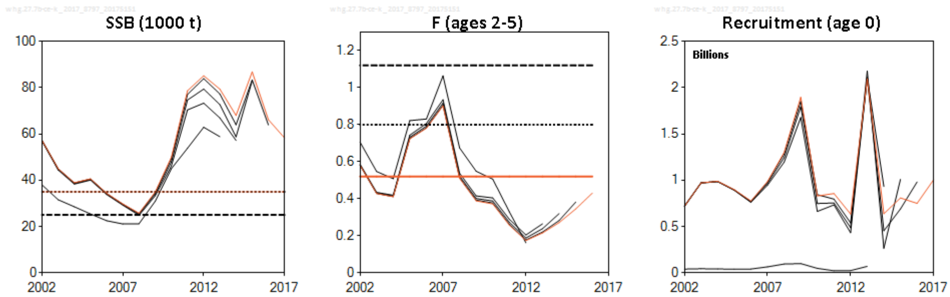
whg.27.7.b-ce-k [WGCSE Section 41: Whiting (*Merlangius merlangus*) in divisions 7.b-c and 7.e-k (southern Celtic Seas and eastern English Channel)]

1) Assessment Type: Update including catch, landings, discards, and numbers-at-age (benchmarked in 2014). Landings and numbers-at-age data drawn from updated InterCatch.
2) **Assessment**: Analytical (Category 1.0)
3) Forecast:

- Short-term: Multi Fleet Deterministic Projection with Numbers-at-age 0 replaced with the geometric mean of full time-series minus last year (1999–2015), F-at-age and catch weight-at-age were calculated as mean values from 2013–2015, stock numbers-at-age for age 0+ obtained from XSA.
- Medium-term: None
- Long-term: Multi Fleet Yield-per-recruit using same input information as short-term forecast

4) **Assessment method**: XSA that uses catch-at-age. Inputs include commercial landings, estimated discards, age composition of catch and the IGFS-EVHOE survey index (2003–2016) which contains data for age 0–5 and is used as a tuning index. It is a combined survey including data from the Q4 IBTS survey index for Irish Groundfish (IGFS) in divisions 7.b,g,j and the French EVHOE survey in divisions 7.e,h,j. Maturity and natural mortality are set in accordance with the stock annex. Landings and discard data are included for the full time-series (1999–2016).
5) Consistency:

- The WG report has some inconsistencies with the annex.
- Stock status is consistent with last year.
- Retrospective patterns appear to be developing with F revised downward, and SSB revised upward. WG chose to "scale F to F2016" in this assessment to account for the retrospective pattern. This decision is not in accordance with the stock annex. The RG notes that the magnitude of retrospective inconsistency is small, there is only a three-year pattern, and the brief pattern may result from revised perception of the 2013 recruitment event (see figure). The retrospective adjustment does not influence the stock status determination.
- It is unclear whether discards are being raised according to the stock annex since the WG report states that "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 time-series." No further explanation is provided to identify the extent to which this assessment may deviate from the stock annex when more accurate data are available.



6) Stock Status:

- SSB has been well above MSY $B_{trigger}$ since 2009 and F has been below F_{MSY} since 2008 but has shown a recent increasing trend
- SSB peaks in 2012 and 2015 correspond to peak recruitment events in 2009 and 2013 respectively.
- SSB_{2016} (66 195 t) > B_{pa} (21 000 t) Full Reproductive Capacity
- F_{lim} (1.18) > F_{pa} (0.72) > F_{2016}(0.43 retrospective adjusted); Acceptable
- F_{2016} (0.43 retrospective adjusted) < F_{MSY} (0.524) Acceptable
- B_{2016} (117 231 t) > $B_{trigger}$ (35 000 t) > B_{lim} (15 000 t); Acceptable
- Recruitment has been below average since 2010 with the exception of a very strong year class in 2013 which was the highest in the time-series.

7) Management Plan:

- There is no management plan for whiting in this area, a TAC is specified for divisions 7.b–7.k. and increased from 22 778 t in 2016 to 27 500 in 2017.
- There is a mismatch between assessment area and TAC area since Division 7.d is assessed separately. Rectangles 33E2 and 33E3 from Division 7.a have been reallocated to this stock and since 2005 no fishing is allowed in rectangles 30E4, 31E4, 32E3 from February 1 through March 31 to protect cod stocks.
- Beginning in 2016 landings obligations for vessels with whiting landings of greater than 25% total landings in 2013 and 2014 took effect. Vessels are permitted to discard up to 7% of whiting they catch in 2017 and 6% in 2018. The WG noted that the impacts of this allowable discard are still unknown.
- Assuming 2017 F = 0.52, the 2018 projected catch and landings are 19 548 t and 13 841 t respectively.

General comments

- The WG report generally produced advice in accordance with the stock annex with only minor deviations as follows: 1) WG chose to scale F to F_{2016} in this assessment to account for the retrospective pattern, and 2) discards may not be raised in accordance with the stock annex when more accurate discard data are available, but the accuracy of discard data used in this assessment was not discussed further. The RG does not understand the justification for retrospective adjustment of F, but notes that the adjustment is small and does not affect stock status. Further explanation of the revised discard data would also help to justify the change.

- The WG noted that the impacts of landings obligations are still unknown as fleets in which whiting is a bycatch species are not subject to landings obligations, but significant landings occurred in midwater herring fisheries in 2016 as a result of these obligations. Discards above the 27 cm MLS occurred across fleets, with some fleets discarding fish larger than 40 cm.
- The WG raised concerns that surveys are prone to year effects, but cohort tracking for age 1+ fish appear consistent for the combined tuning index. Age 3+ fish were proportionally higher in the 2016 catch than in most of the preceding time-series.
- The WG noted that increased SSB is likely related to strong year classes, and unlikely to persist in the long term.
- Discards also appeared variable depending on gear type and year-class strength, and age distribution was similar over the time-series, except when large year classes pass though older ages (1999, 2009, 2013). The WG reported "a recent upward trend in discarding of all ages in the catch and stock".
- Mean weight-at-age apparently declined from 2005–2008 when fishing effort and landings were high. There is some indication that age 6 and age 7 weights may be increasing since 2008, but the WG notes that weights of older fish have been more variable over the whole time-series.
- Square-mesh panels introduced to all trawl fisheries in divisions 7.fg in 2012 to reduce F-at-age do not appear to be effective and the WG suggests that additional measures may be necessary.

Technical comments

- WG report downloaded on 5/29/17, advice and stock annex downloaded 5/30/17
- The description of catch weights-at-age used in projections is not clear in the annex.
- The advice document had highlighted sections and appeared to be missing information from predicted catch and landings corresponding to advice in Table 7.
- ICES advice sections of the WG report appear to contain incorrect information, although current advice is contained later in the report.
- Section 41.2 in the WG report is empty.
- Figures numbers included in the text of the WG report do not always align with the corresponding figure included at the end of this report and should be double-checked and figure labels are not always sufficient to interpret without assistance from the WG report text.
- Page headings do not reflect the current assessment year
- Time-series range has not been updated to reflect addition of 2016 data in Historical stock development section.

Conclusions

Stock status is consistent with the previous year, but deviations from the stock annex were not fully justified. However, the effect of these inconsistencies is small, so the RG concludes that this assessment is similar to the benchmark method and is a valid basis for advice. The RG suggests that further justification be provided for the deviations from the stock annex. The WG recommended that cod, haddock, and whiting in the Celtic Sea be benchmarked together in 2018 with emphasis placed on streamlining the compilation of fishery-dependent and survey data and the exploration of statistical catch-at-age models like SAM. The RG supports this recommendation, especially given the WG's concerns about recent retrospective patterns observed in F and SSB.

Appendix A. Review Group template for section reviews

stock-code [WG Section #: Common name (*Genus species*) in Division# or Subarea#]

1) Assessment Type: Update including this dataset and this dataset (benchmarked in 20xx).

2) Assessment: Analytical

3) Forecast:

- Short-term:
- Medium-term:
- Long-term:

4) **Assessment method**: What type of model, which data (give the long names of dataseries).

5) Consistency:

- The update is/is not consistent with the annex. What changes were made?
- Are there retrospective trends?
- Stock status is/is not consistent with last year. If it changed, how so?

6) Stock Status:

- Increasing/Decreasing trend in SSB and Increasing/Decreasing trend in F
- $SSB_{2016/7}$ (number) >,<,= B_{pa} (number)
- F_{lim} (number) >,<,= F_{2016}(number) >,<,= F_{pa} (number); acceptable, increased risk, or harvested unsustainably
- F_{2016} (number) >,<,= F_{MSY} (number) below target, appropriate , or overfished
- $B_{2016/7}$ (number) >,<,= $B_{trigger}$ (number), B_{lim} (number); acceptable, increased risk, or reduced reproductive capacity
- Recruitment

7) Management Plan:

- Brief description of plan.
- This year's advice relative to last year's advice (e.g. The TAC for 2016 (___t) increased/decreased to ____ t in 2017.)
- What is projected to happen to F and B (relative to reference points) if this year's advice is followed?
- Other relevant management plan information

General comments

- The WG did/did not follow the Stock Annex.
- Data changes.
- Changes from Annex method.
- Other comments.

Technical comments

- Anything technically inaccurate that doesn't affect interpretation of the document.
- Spelling, grammar, punctuation

- Figure and table labels (size)
- typographical errors

Conclusions

Briefly summarize the assessment review, noting any deviations from the Stock Annex procedure. Note whether the RG agrees or disagrees with the (WG's) decision(s) and any recommendations. Is the assessment a valid basis for advice?