WORKING GROUP FOR THE CELTIC SEAS ECOREGION (WGCSE)

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Contents

i Executive summary

The Working Group for the Celtic Seas Ecoregion (WGCSE) performs stock assessments on demersal stocks in Rockall, West of Scotland, Irish Sea, West of Ireland, Western English Channel, Bristol Channel, Celtic Sea and Southwest of Ireland. The working group provides updated fisheries data and reviews for ten *Nephrops* stocks, four sole and plaice stocks, three cod and whiting stocks, three haddock stocks, two megrim, one seabass, one anglerfish and one pollack stock. For most of the stocks, advice is drafted in May for June release. Advice for *Nephrops*, anglerfish and Rockall megrim are not issued until autumn to take account of the 2021 survey information.

For a number of stocks (bss.27.6a7bj, cod.27.6b, ple.27.7bc, sol.27.7bc, whg.27.7a, nop.27.6a, whg.27.6b, nep.27.6aoutFU, nep.27.7outFU) no new advice was provided this year.

Two stocks have gone through a benchmark procedure in the past year; cod.27.7a, ple.27.7f-g. the results of which were presented to the group. Analytical assessments using age-structured models were conducted for 12 of the fish stocks. Surplus-production models, without age or length structure, were used to assess lez.27.4a6a and lez.27.6b, and a Depletion-Corrected Average Catch model to assess pol.27.67.

In 2022 the state of the five fish stocks for which no analytical assessment could be performed were inferred from application of Data-Limited Methods, using survey or biomass indices as indicators of stock development along with indications of stock status inferred from length indicators.

UWTV survey-based assessments were conducted for ten *Nephrops* stocks. Overall the stock status across the ecoregion show a decline in abundance to last year, with a reduction of *circa* 8 800 tonnes in finfish advice (mostly owing to reduction in Celtic sea haddock [had.27.7.b-k]; down 4,045 tonnes, and Celtic sea whiting [whg.27.7.b,c,e-k]; down 2737 tonnes), in the order of a 14% reduction on 2021 advice. Of the 22 assessed fish stocks, five stocks were fished above F_{MSY}, ten below and seven stocks had unknown status relative to F_{MSY}; 8 were above MSY B_{lim}, and seven below B_{lim}, with the status of seven unknown.

Of the eleven *Nephrops* stocks, catch advice saw an increase of *circa* 2 800 tonnes on 2021 advice (approximately 8%), with a range of Functional Unit increases and decreases.

ii Expert group information

Expert group name	Working Group for the Celtic Seas Ecoregion (WGCSE)
Expert group cycle	Annual
Year cycle started	2022
Reporting year in cycle	1/1
Chairs	Matt Lundy, United Kingdom
	Jonathan White, Ireland
Meeting venues and dates	4–13 May 2022, Online meeting, 29 participants 13–15 September 2022, Online meeting, 15 participants

1 Introduction

The Introductory section will be completed in autumn when the WGCSE 2021 report is finalised.

1.1 Terms of reference

1.1.1 Generic ToRs for Regional and Species Working Groups

2021/2/FRSG01 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 on the following for the fisheries relevant to the working group:

   i) descriptions of ecosystem impacts on fisheries;

   ii) descriptions of developments and recent changes to the fisheries;

   iii) mixed fisheries considerations; and

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

c) Conduct an assessment on the stock(s) to be addressed in 2022 using the method (assessment, forecast or trends indicators) as described in the stock annex; - complete and document an audit of the calculations and results; and produce a **brief** report of the work carried out regarding the stock, providing summaries of the following where relevant:

   i) Input data and examination of data quality; in the event of missing or inconsistent survey or catch information refer to the ACOM document for dealing with COVID-19 pandemic disruption and the linked template that formulates how deviations from the stock annex are to be reported.

   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 Regulatory Area), estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2021.

   iv) For category 3 and 4 stocks requiring new advice in 2022, implement the methods recommended by WKLIFE X (e.g. SPiCT, rfb, chr, rb rules) to replace the former 2 over 3 advice rule (2 over 5 for elasmobranchs). MSY reference points or proxies for the category 3 and 4 stocks.

   v) Evaluate spawning–stock biomass, total stock biomass, fishing mortality, catches (projected landings and discards) using the method described in the stock annex;

      1. for category 1 and 2 stocks, in addition to the other relevant model diagnostics, the recommendations and decision tree formulated by WKFORBIAS

(see Annex 2 of https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2020/WKFORBIAS_2019.pdf) should be considered as guidance to determine whether an assessment remains sufficiently robust for providing advice.

2. If the assessment is deemed no longer suitable as basis for advice, consider whether it is possible and feasible to resolve the issue through an inter-benchmark. If this is not possible, consider providing advice using an appropriate Category 2 to 5 approach;

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

Consistent with ACOMs 2020 decision, the basis for F_{pa} should be $F_{p.05}$.

1. Where Fp.05 for the current set of reference points is reported in the relevant benchmark report, replace the value and basis of Fpa with the information relevant for Fp.05.
2. Where Fp.05 for the current set of reference points is not reported in the relevant benchmark report, compute the Fp.05 that is consistent with the current set of reference points and use as Fpa. A review/audit of the computations will be organized.
3. Where Fp.05 for the current set of reference points is not reported and cannot be computed, retain the existing basis for Fpa.

vii) Catch scenarios for the year(s) beyond the terminal year of the data for the stocks for which ICES has been requested to provide advice on fishing opportunities;

viii) Historical and analytical performance of the assessment and catch options with a succinct description of associated quality issues. For the analytical performance of category 1 and 2 age-structured assessments, report the mean Mohn's rho (assessment retrospective bias analysis) values for time-series of recruitment, spawning–stock biomass, and fishing mortality rate. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose.

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

i. In the section 'Basis for the assessment' under input data match the survey names with the relevant "SurveyCode" listed ICES survey naming convention *(restricted access)* and add the "SurveyCode" to the advice sheet.

e) Review progress on benchmark issues and processes of relevance to the Expert Group.

i. update the benchmark issues lists for the individual stocks in SID;

ii. review progress on benchmark issues and identify potential benchmarks to be initiated in 2023 for conclusion in 2024;

iii. determine the prioritization score for benchmarks proposed for 2023–2024;

iv. as necessary, document generic issues to be addressed by the Benchmark Oversight Group (BOG).

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

g) Identify research needs of relevance to the work of the Expert Group.

h) Review and update information regarding operational issues and research priorities on the Fisheries Resources Steering Group SharePoint site.

i) If not completed in 2020, complete the audit spread sheet 'Monitor and alert for changes in ecosystem/fisheries productivity' for the new assessments and data used for the stocks. Also note in the benchmark report how productivity, species interactions, habitat and distributional changes, including those related to climate-change, could be considered in the advice.

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

1.1.2 Specific ToRs

2021/2/FRSG10 The Working Group for the Celtic Seas Ecoregion (WGCSE), chaired by Mathieu Lundy, UK and Jonathan White*, Ireland will meet virtually 3–13 May 2022 and by correspondence September / October 2022 to:

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

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

Material and data relevant for the meeting must be available to the group on the dates specified in the 2021 ICES data call.

WGCSE will report by 25 May 2022 for the attention of ACOM, and by 1 October 2022 for *Nephrops* stocks, anglerfish and megrim in Rockall.

Only experts appointed by national Delegates or appointed in consultation with the national Delegates of the expert's country can attend this Expert Group.

1.2 Participation

Due to the COVID-19 pandemic and uncertainties in Europe owing to the Russian invasion of Ukraine, the decision was taken in mid-March to hold the meeting remotely in order to give participants certainty in the meeting process. An adequate participation was achieved with representation of the different institutes generally involved.

1.3 Methods

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

Category 1 age-based assessments and forecasts were conducted for bss.27.4bc7ad–h, cod.27.7.e–k, had.27.7.a, had.27.7.b–k, had.27.6a, ple.27.7.a, sol.27.7.a, sol.27.7.e, sol.27.7.fg, whg.27.6.a and whg.27.7.b–ce–k; cod 27.7.a went through benchmark in 2022 (WGNSCS, ICES 2022), and is now assessed as a Category 1 assessment.

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

Category 1: UWTV survey based assessments and advice will be 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 2: Lez.27.6b The stock has a SPICT assessment to determine stock status and a short-term catch forecast;

Category 3: Several stocks are now assessed as Data-Limited following the guidelines of WKLIFEIX and X, (ICES, 2019; 2020) following the "rfb" approach, implementing trends from combined biomass index and length-based indicators as the basis for advice. These include: ple.27.7.e; ple.27.7fg; ple.27.7h–k with trends from combined biomass index. Further, assessed in the autumn were anf.27.3a46 and had.27.6.b,

Ple.27.7fg went through a benchmarked process in 2022 (WKNSCS ICES, 2022). The resulting assessment and basis for providing forecast catch advice was approved. During WGCSE however, a number of issues became apparent with the assessment from which it was decided to revert the advice basis to the data-limited, Category 3 "rfb" approach. These are detailed in the Report Section on ple.27.7fg, and may be summarised as:

- A lack of justification or objectivity in choice of natural mortality (m) levels.
- Smooth trend in Fishing pressure resulting from no correlation process implemented across m age classes (F-at-age lognormal random walks were not correlated across ages).
- When correlations were introduced they produced a less smooth F trend over time, and strong model retrospective patterns in R, SSB and F (-0.19, 0.53 and -0.36 respectively) outside recommended limits.
- This also resulted in substantial changes in SSB and F in recent years.
- Recruitment in the assessment was modelled as a constant mean, removing this to enable recruitment to be calculated for each year from the data resulted in slight changes in SSB, F and R.

Category 4: Depletion corrected average catch was used for pol.27.67;

Category 5: sol.27.7h–k.

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

1.4 Data issues

Data were generally submitted in a timely fashion through the InterCatch database for landings and discards data, and through the accessions database for other sources of data.

1.5 Transparent Assessment Framework (TAF)

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

1.6 Internal auditing and external reviews

As in previous years the WG carried out its own internal audit process using the standard ICES template. Given the workload of many of the scientists at WGCSE (sometimes with one scientist responsible for two or more stocks), many of the reports were not finalized until after the WG meeting. Audits were therefore typically carried out by correspondence after the WG and not completed for some stocks. All stocks for which advice was provided in June and October 2022 were audited by the WG and audit reports were produced for most of these. Issues discovered during the audit process were corrected in the WG report.

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

Stocks recommended for next round(s) of benchmarks:

Listed for 2022–2023 Benchmark	Requested from 2023–2024 Benchmark
pol.27.67	pok.27.7–10
bss.27.4bc7ad–h	ple.27.7e
cod 27.6a	lez.27.4a–6a
	ple.27.7fg
Requested for 2022–2023 Benchmark	sole 7a
had.27.6b	whg.27.7b–ce–k
	lez.27.4a–6a

pol.27.67 and pok.27.7–10 were recommended for benchmark in 2020.
Currently, pol.27.67 is categorized as category 4 data-limited and the DCAC method is applied to provide advice. As the DCAC method only uses long time-series of official landings, it may not reflect recent stock fluctuations or changes in the fisheries, smoothed by the length of the time-series. As a result, new computations of DCAC are always very close to the previous year's results even if recruitment or SSB highly fluctuate. Therefore, it is relevant to explore new assessment models. No assessment or advice has been provided for the pok.27.7–10 stock, as a benchmark should establish if the DCAC approach can be improved upon.

had.27.6b was recommended for benchmark in 2020.
At-sea observer sampling for discards remains sparse for had.27.6b, which leads to uncertainty in fishery selectivity patterns and catch estimates data used in the assessment. The assessment model used (FLXSA) assumes catch is measured with no uncertainty and so does not account for this sampling issue. The estimates of SSB are consistently being overestimated and F is consistently being underestimated, therefore it is recommended to address this in a benchmark.

Atlantic seabass stocks were recommended for benchmark in 2020.
There was a joint recommendation with the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) to evaluate the stock identity of the Atlantic seabass stocks. The Working Groups recognized the complexity and considered that a stock identity workshop might be convened to allow relevant experts to consider relevant studies (data storage tags, conventional tags, genetics, otolith microchemistry and larval dispersion models) and advise whether the existing stock boundaries remain appropriate. This work should be proceeding towards a benchmark in the next stage. The aim should be to explore and peer-review all available information on recreational catches. There is also 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. Estimates of discards are available only from the early 2000s, but do not cover all fisheries, are imprecise, and are only included for some fleets in the assessment. Discard rates are expected to increase in the short term as fishers adjust to take account of the management measures, such as the increase in minimum conservation reference

size from 36 cm to 42 cm. The difference in perception between the modelled discards and the observed, should also be addressed. The benchmark should evaluate if sampling is currently sufficient to support continued application of Stock Synthesis fitting selection parameters to fishery composition data.

In 2022 WGCSE recommend the following stocks to be benchmarked

ple.27.7e: A SAM assessment has been developed and is ready for critique and review.

whg.27.7b–ce–k: Following application in WGCSE the model has high retrospective patterns which are evidenced in Mohn's rho values from recruitment, SSB and fishing pressure. The assessment needs to be investigated and developed to improve its internal consistency and improve retrospective convergence.

lez.27.4a–6a: The present modelling approach is built on ageing IT architecture and more user-friendly applications are now available. A SPiCT model and SS3 should be explored as alternatives to the present labour-intensive approach.

ple.27.7fg: The SAM assessment developed in WKNSCS (ICES, 2022) should be reviewed, with qualification for natural mortality levels detailed and correlation linkages across age classes implemented to assess potential relative to retrospective patterns. A SPiCT model may also be appropriate.

had.27.6b: While catch and survey data are presently available their processing needs to be reviewed as the approached are currently not visible. For 2022 a survey based DLS approach was advised by WGCSE, while a winter–spring data review and model development benchmark would provide grounds to provide a Category 1 based assessment for 2023.

Every year a prioritization exercise for the stocks that need to be benchmarked is done. The sum of the weighting scores (1–5) for each of the five criteria will determine the urgency for a benchmark. Those criteria are related to the quality of the previous assessments, the opportunity to improve the assessment, the management importance, the perceived stock status and the time since the previous benchmark. To have an overview of this information, an issue list is requested for every stock.

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

Assessment in 2022

The last benchmark for this stock was carried out in February 2018 (ICES, 2018) where it was agreed to provide advice on the basis of the procedure for category 3.2.0 of ICES RGLIFE data-limited stock (DLS) methods as set out in the stock annex. However, in 2022, based on the recommendations of the WKLIFE workshop, ICES decided that this method should no longer be used and future advice should be provided following the *rfb* rule (ICES, 2021).

ICES advice applicable to 2021 and 2022

ICES advice for 2021

ICES advises that when the precautionary approach is applied, catches in 2021 should be no more than 17 645 tonnes.

ICES advice for 2022

ICES advises that when the Precautionary approach is applied, catches in 2022 should be no more than 14 116 tonnes.

2.1 General

Stock description and management units

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

Management applicable to 2021 and 2022

Council Regulation (EU) 2021/92 of 28 January 2021 fixing for 2021 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	**Anglerfish** **Lophiidae**	**Zone:**	**United Kingdom and Union waters of 4;** **United Kingdom waters of 2a** **(ANF/2AC4-C)**
Belgium	312 (1) (2)		
Denmark	688 (1) (2)		
Germany	336 (1) (2)		
France	64 (1) (2)		
The Netherlands	236 (1) (2)		
Sweden	8 (1) (2)		
United Kingdom	10 328 (1) (2)		
Union	1 644 (1) (2)		
TAC	11 972		Precautionary TAC

(1) Special condition: of which up to 30% may be fished in United Kingdom, Union and international waters of 6a north of 58°30′N (ANF/*6AN58).

(2) Special condition: of which up to 10 % may be fished in United Kingdom waters of 6a south of 58°30′N; United Kingdom and international waters of 5b; International waters of 12 and 14 (ANF/*56-14).

Species	Anglerfish Lophiidae	Zone:	Norwegian waters of 4 (ANF/04-N.)
Belgium	37	Precautionary TAC	
Denmark	935	Article 3 of Regulation (EC) No 847/96 shall not apply	
Germany	15	Article 4 of Regulation (EC) No 847/96 shall not apply	
The Netherlands	13		
Union	1100		
TAC	Not relevant		

Species	Anglerfish Lophiidae	Zone:	6; Union and international waters of 5.b; international waters of 12 and 14 (ANF/56-14)
Belgium	202 (1)		
Germany	230 (1)		
Spain	216 (1)		
France	2 485 (1)		
Ireland	562 (1)		
The Netherlands	194 (1)		
United Kingdom	2 488 (1)		
Union	3 889 (1)		
TAC	6377		Precautionary TAC

(1) Special condition: of which up to 20 % may be fished in: United Kingdom and Union waters of 2a and 4 (ANF/*2AC4C).

According to the 'agreed record', the following TACs have been agreed between the EU and UK for 2022. The allocations are as per the EU-UK Trade and Cooperation Agreement (TCA).

ICES areas	TAC	UK allocation	EU allocation
UK & EU waters of 4; UK waters of 2a.	9 014	7 849[1,2]	1 165[1,2]
6; UK & international waters of 5b; international waters of 12 & 14	5 102	2 060[3]	3 042[3]

1) Special condition: of which up to 30% may be fished in United Kingdom, European Union and international waters of 6a north of 58'30'' (ANF/*6AN58).

(2) Special condition: of which up to 10% may be fished in United Kingdom waters of 6a south of 58'30''; European Union and international waters of 5b; International waters of 12 and 14 (ANF/*56-14)

3: Special condition: of which up to 20% may be fished in United Kingdom and European Union waters of 2a and 4 (ANF/*2AC4C).

Species	Anglerfish Lophiidae	Zone:	Norwegian waters of 4 (ANF/04-N.)
Belgium	37	Precautionary TAC Article 3 of Regulation (EC) No 847/96 shall not apply Article 4 of Regulation (EC) No 847/96 shall not apply	
Denmark	935		
Germany	15		
The Netherlands	13		
Union	1000		
TAC	Not relevant		

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 for 2003 onwards.

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).

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. Total officially reported landings of anglerfish from the Northern Shelf are shown in Figure 4.1.

Trends in nominal international fishing effort in the North Sea and Eastern Channel and the West of Scotland collated by STECF for the Evaluation of Fishing Effort Regimes in European Waters are shown in Figure 4.2. Since 2014, there have been slight increases in TR effort in both the North Sea and West of Scotland, with effort across all gears in the North Sea stable or reducing since 2012 and in the West of Scotland increasing from 2014 driven by marked increases in trawl fisheries. Data for 2017 have not yet been released by STECF although a significant change in the overall observed trend of anglerfish fleets is not anticipated with the introduction of 2017 data.

The fishery in 2021

Official landings in 2021 for subareas 6 and 4 were 19 154 t (5992 t and 13 162 t respectively), giving a 17.5% undershoot of the combined TAC of 22 056 t (81% and 83% TAC uptake respectively). In Subarea 6 Belgium (0%), the Netherlands (0%) and France (37%) had noticeably low uptakes. Belgium was also observed to significantly undertake their quota in Subarea 4 (44%). Denmark (58%) and Germany (65%) both decreased their Subarea 4 uptakes in comparison to 2019, while the United Kingdom increased its uptake (70%). The UK exceeded its quota in Subarea 6 (by 52%), a decrease of 24% compared to 2019. Over quota landings by individual states are most likely due to countries obtaining additional quota from other EU member states, or carrying forward unutilised quota from 2019 and using a flexibility allowance whereby 10% of Subarea 4 TAC can be utilised to reattribute landings from Subarea 6.

Uptake of EC quota in 2021, 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	202	-	0%	37	312	349	290	83%
Denmark	-	-	-	935	688	1623	1 462	90%
France	2 485	1326	53%	-	64	166	108	65%
Germany	230	157	68%	15	336	893	228	65%
Ireland	562	684	122%	-	-	-	-	-
Netherlands	194	-	0%	13	236	249	376	151%
Norway	-	-	-	-	-	-	982	-
Russia	-	-	-	-	-	-	-	-
Spain	216	282	131%	-	-	-	-	-
Sweden	-	-	-	-	8	8	113	1 412%
UK (total)	2 488	3539	142%	-	10 328	10 328	9 604	93%
Total	6 377	6434	101%	1 000	11 972	13 616	13 162	97%

Based on data submitted to ICES, the fishery was principally prosecuted by vessels using demersal trawls (Table 4.6), targeting either white fish (83% of total landings by weight) or *Nephrops* (5%). Alongside these fleets there was also a significant gillnet fishery (11%), 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 (1%). Gillnets accounted for smaller proportion of total landings across gear types in 2021 in comparison to 2020.

UK (Scottish) vessels accounted for the majority of reported anglerfish landings from the combined Northern Shelf area, taking approximately 65% of the landings overall. Scottish, Danish and Norwegian vessels took 73%, 11% and 7%, respectively, of the North Sea (Divisions 4.a–4.c) landings. Scottish, French and Irish vessels took 59%, 22% and 11%, respectively, of the West Coast (Subarea 6) landings.

Landings in Division 3.a are not regulated: Table 4.5 shows the official landings which fluctuated between 400–500 t from 2005–2015, but have more than doubled since then. Official landings in 2021 were 912 t, slightly higher than 2020.

2.2 Data

Landings

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

Due to restrictive TACs, the likelihood of misreporting and underreporting of anglerfish landings in the past is considered to have been high, particularly during the period 2003–2005. During the benchmark at WKROUND (ICES, 2013), it was agreed that recent landings are likely to be more accurate from 2006 due to, i) less restrictive TACs, ii) the introduction of buyers and sellers legislation in the UK and Ireland and iii) the offshore gillnet fishery for anglerfish historically conducted by Spanish flagged vessels and thought to under-report landings, being much reduced. Anecdotal reports from fisheries officers and catch sampling staff suggest that towards the end of 2016 and into 2017 the high abundance of anglerfish on the grounds, and the restrictive quota were leading to an increase in suspected misreporting, discarding and black landings. There was no new information in 2021 to suggest that these suspected practices continued into 2018, 2019 or 2020, and the lower quota uptake during these years may indicate that the incentives for this behaviour are no longer prevalent. During the period 2005–2010, landings data were not provided to the Working Group by some of the major nations exploiting the fishery; however, the recent data call for the WKAngler benchmark (2018) has meant that WG estimates of subarea 6 and 4 landings have now been calculated for this period.

Discards

Prior to the recent WKAngler benchmark (2018) discard estimates have only been available within InterCatch since 2012. Following the WKAngler data call discard information are now available for some fleets since 2002; however, discard information from UK (Scotland) is not available before 2008. The discard estimates that are available from other nations for the 2002–2007 period are substantially higher than the later UK (Scottish) rates. Given that these (non-Scottish) fleets represent proportionally less of the landings, the discards pre-2008 are considered to be non-representative of the overall fishery (WKAngler 2018).

The breakdown of landings and discards by main gear group and area for 2020 and 2021 is given in Table 4.6. Landings and discards over time are shown in Figure 4.13. Discard data indicate that discarding in this fishery is relatively low due to high market value and no MCRS. Overall discarding was 2.4% of total catch in 2021. Demersal TR2 trawlers had the highest discard rate due to more restrictive quota share, 10.49% in 2021, similar to the value for 2020 (12.7%), but a substantial reduction from 2017 (20.9%) and 2016 (43.9%). In comparison TR1 trawlers, gillnets and miscellaneous gear types typically tend to have much lower discard rates (<2%).

Figures 4.3 (a–c) show the percentage of landed weight by fleet, country and area. Length–frequency samples for catch in 2021 were submitted by Belgium, Denmark, France, Germany, Ireland, Norway, UK (England & Wales) and the UK (Scotland). There was good coverage of both the demersal TR1 and TR2 fleets in Subarea 4 and Division 6.a. There were no samples from UK-flagged gillnet vessels (operating in Subarea 4) which alone accounted for approximately 11% of all landings (Figure 4.3a).

Length compositions

There is now a time-series of commercial catch-at-length data for 2002–2021 (Figure 4.4). The spread of lengths in the landings distributions are wider during the period 2012–2014 after which the distributions are steeper and unimodal. In 2015 the strong 2013 cohort entered the fishery producing a markedly different catch composition of lengths with the bulk of landings being between 30 and 50 cm in length with steep tails either side. Discard rates are lower from 2015 onwards however the landings of <30 cm fish were also lower, suggesting this reduction could be a combination of catch composition and the increase in quota availability. The distribution of lengths in the landings in 2020 and 2021 have narrowed when compared to 2018 and 2019 with low numbers of landings of fish >75cm notable in 2021.

Biological Data

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

Research vessel surveys

The SIAMISS (Scottish Irish Anglerfish Megrim Industry Science Survey) is a dedicated anglerfish survey. It covers much of the known distribution of the northern shelf anglerfish (ICES divisions 4a, 6a and 6b), with the exception of the central and southern parts of Subarea 4 and the Skagerrak and Kattegat (Division 3a). The survey area has been stratified based on knowledge from fishermen with sampling effort within each stratum allocated roughly according to its expected biomass. Given the large spatial coverage of the survey, it is typically carried out by multiple vessels including commercial fishing vessels and both Irish and Scottish research vessels using a standard gear. Abundance and biomass estimates are worked up on the basis of swept-area and account for herding by the trawl doors and sweeps, ii) escapes under the footrope and iii) anglerfish abundance and biomass in the southern part of Division 6a were not covered in 2005, 2008 and 2010. Further details regarding the survey design and work up can be found in the stock annex and working document for 2021 (see Barreto *et al*., 2021).

The survey began in 2005 and is carried out on an annual basis (usually in spring, but sometimes in November). In 2020, however, the Scottish component of the SIAMISS survey (covering the northern North Sea, the north of divisions 6a and 6b) was cancelled due to the COVID-19 pandemic. While the Irish part of the survey did go-ahead (covering the southern part of Division 6a), historical densities and stock trends suggest that extrapolation of this component of the survey to the wider stock area would be inappropriate. Therefore, there is no abundance/biomass estimate from SIAMISS for 2020. In 2022 the anglerfish multi-vessel survey took place from the 12th to 27th of April and involved two vessels: FRV Scotia – surveying Division 4a and Division 6a North of 58°N, and the Irish Marine Institute research vessel FRV Celtic Explorer, surveying Division 6a South of 58°N. One haul with the duration of 60 minutes was made at each sampling station (n=138). Due to a mechanical fault with FRV Scotia the SIAMISS survey did not include Division 6b (Rockall) in 2022.

Figures 4.14 and 4.15 show the 2022 survey haul locations and mean numbers and weight per km^2 caught at these locations. Larger numbers of anglerfish were caught along the shelf-edge below 58°N with large weights of fish being caught at the same locations. In previous years larger weights of fish have also been caught at Rockall, indicating that the fish at Rockall are larger than those caught on the shelf-edge. In 2022 there was no survey at Rockall so weights for this year are unknown.

Estimated total population numbers and biomass at length by area from the most recent survey in 2022 are shown in Figure 4.7 which show a much higher proportion of large fish in division 4a than in division 6a. In terms of numbers, area 4a has by far the highest value, when compared with areas 6a. Comparison of numbers-at-length and weight-at-length over time for all areas combined show a slight decrease in numbers but a slight increase in biomass compared to 2021. (Figures 4.8).

A time-series of total biomass is given in Table 4.7 and Figure 4.5. The total biomass estimate for the Northern Shelf in 2022, the most recent survey year was 55 423 t an increase of 14% compared to 2021. A large proportion of total population numbers consisted of individuals <40 cm in 2022, suggesting reasonably strong recruitment.

The breakdown of total numbers and biomass by area (Table 4.8 and Figure 4.6) shows that Division 6b has lower estimated population numbers with less variability over time than in either division 6a or 4a. Division 4a consistently has the highest total biomass of the three areas and shows similar temporal trends to Division 6a.

Estimates of the ratio of survey biomass between subareas 4 and 6 have fluctuated around 1:1, (time-series average of 47.5% in Subarea 4, Table 4.7). The proportion of biomass in Subarea 4 had been steadily increasing since 2013; however, 2017 saw a slight decrease followed by a marked decline in 2018 to a time-series low of 37% (Figure 4.9). 2022 has seen an increase in the proportion of biomass in Subarea 4 moving back towards a 1:1 split.

Additional survey indices were developed during the WKAngler 2018 benchmark after revisiting the anglerfish abundance of several surveys within the stock area (ICES, 2018). Mean weight per hour for both the SCW-IBTS Q1 and Q4 surveys declined in 2018 following time-series highs in 2017 and 2016 respectively (Figure 4.12) which reflects the SIAMISS-Q2 biomass trend (Figure 4.6). The Rockall index (Figure 4.12) has shown an increasing trend since 2005 with a significant peak in 2012 followed by a short period of decline before a continuation of the increasing trajectory from 2016 to 2018, a slight increase again in 2019 and a slight decline in 2020. Although the SIAMISS-Q2 biomass time-series for Division 6.b shows less year to year fluctuation than the Rockall index the increasing trend and magnitude of change for the 2005–2021 period are very similar. In Subarea 4 the NS-IBTS-Q1 and Q3 indices showed declining mean weights per hour until 2020, with a slight increase in 2021 (Figure 4.13).

2.3 Historical stock development

There has been no analytic assessment of Northern Shelf anglerfish since 2003, due to a combination of unreliable commercial data, landings misreporting, uncertain effort data and poor catchability of anglerfish in traditional research surveys. The Scottish Irish anglerfish and megrim industry science survey (SIAMISS-Q2) initiated by Marine Scotland Science in 2005, along with official logbook data and tally-book data schemes have addressed some of these issues, providing valuable information to fishery managers as well as minimum absolute abundance and biomass estimates annually. Between 2012-2021 assessment followed the ICES RGLIFE data-limited stock (DLS) 3.2.0 method of survey based indicative trends (ICES, 2012). Beginning in 2022 the assessment followed the rfb assessment method proposed by WKLIFE (ICES, 2021).

At the benchmark in 2018, it was agreed to use SIAMISS-Q2 survey as an indicator of historical stock development. During the first half of the time-series, the biomass index for the stock fluctuated around 40 kt. Between 2011 and 2017, the total biomass increased significantly (more than doubled) due to very strong recruitment which is first observed in the survey length frequency data in 2013 and can continue to be clearly tracked through these data until 2017. Between 2017 and 2019, the estimated total stock biomass decreased by more than 30% before increasing slightly in 2022.

Figure 4.10 and Table 4.9 shows mean standardised harvest rate (calculated as catch/survey index) by both weight and number of individuals. Whilst there are no reference levels to relate these harvest rates to, trends can still be useful. In terms of biomass, the harvest rate has shown an increasing trend since 2015 and in 2021 was estimated to be one of the highest values of the time-series. The harvest rate in number has shown a more gradual increase over this time. The marked fall in harvest rate by number from 2013–2014 is likely due to the influx of the substantial 2013 year class (i.e. large increase in survey numbers) and not a change in fishing behaviour. It may be more appropriate to use a harvest rate which is measured over a given length range of commercially exploitable fish.

2.4 Application of the rfb advice rule

Beginning in 2022 advice for this stock is given following the rfb assessment method (ICES, 2022) calculated as the previous year's advice multiplied by a) the index ratio (r) (the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B)); b) a ratio of observed mean length in the catch relative to the target mean length (f); c) a biomass safeguard (b) calculated as either the ratio of the last index value and the index trigger value or 1 where this is lower; and d) a precautionary multiplier (m) based on life history which is fixed over time.

Rfb values are calculated as follows (ICES, 2021):

Component	Definition	Description and use
r	$\frac{\sum_{i=y-2}^{y-1}(I_i/2)}{\sum_{i=y-5}^{y-3}(I_i/3)}$	The rate of change in the biomass index (I), based on the average of the two most recent years of data (y−2 to y−1) relative to the average of the three years prior to the most recent two (y−3 to y−5), and termed the "2 over 3" rule.
f	$\frac{\bar{L}_{y-1}}{L_{F=M}}$	The ratio of the mean length ($\bar{L}_{y-1}$) in the observed catch that is above the length of first capture relative to the target reference length (mean length/target reference length). The target reference length is $L_{F=M} = 0.75L_c + 0.25L_\infty$, where. L_c is defined as length at 50% of modal abundance (ICES, 2018b).
b	$\min\left\{1, \frac{I_{y-1}}{I_{\text{trigger}}}\right\}$	Biomass safeguard. Adjustment to reduce catch when the most recent index data I_{y-1} is less than $I_{trigger} = 1.4I_{loss}$ such that b is set equal to $I_{y-1}/I_{\text{trigger}}$. When the most recent index data I_{y-1} is greater than I_{trigger}, b is set equal to 1. I_{loss} is generally defined as the lowest observed index value for that stock.
m	[0,1]	Multiplier applied to the harvest control rule to maintain the probability of the biomass declining below B_{lim} to less than 5%. May range from 0 to 1.0.
Stability clause	$min\{max(0.7C_y, C_{y+1}), 1.2C_y\}$	Limits the amount the advised catch can change upwards or downwards between years. The recommended values are +20% and −30%; i.e. the catch would be limited to a 20% increase or a 30% decrease relative to the previous year's advised catch. The stability clause does not apply when b < 1.

Due to the lack of SIAMISS survey data in 2020, the procedure for calculating the index ratio could not be followed exactly. Instead, the rfb framework for category 3 stocks is applied with the 2020 index value treated as missing. This adds a degree of uncertainty as without 2020 data index B has been calculated as the mean of the previous two years (2018 and 2019) instead of three years. Consequently, the 3 over 2 rule was replaced with a 2 over 2 rule in 2022. Furthermore, in 2022 the SIAMISS-Q2 survey did not include division 6.b (Rockall) which in 2021 accounted for 7.9% of landings. The survey estimate for 2021 was used in place of the missing 2022 estimate for division 6.b. This adds a further degree of uncertainty to the assessment, but does not affect the advice as the reduction is capped.

The advice in 2022 is lower than in 2021 due to a decrease in the index ratio (Figure 4.5), an $F_{MSY\ Proxy}$ value lower than 1 (Figure 4.11) and a precautionary multiplier of 0.95. The mean catch length of fish in this stock has consistently been below the proxy length since at least 2011 (Figure 4.11). Although biomass has declined since 2017 it has remained above the index trigger value since 2014 (Figure 4.5). The stability clause was considered and applied to limit the reduction in catch advice to 30%.

Division 3a46 Anglerfish stock		
Previous catch advice A_y (advised catch for 2022)		14 116 tonnes
Stock biomass trend		
Index A (2021, 2022)		53 222 tonnes
Index B (2018, 2019; 2020 not available)		68 118 tonnes
r: stock biomass trend (index ratio A/B)		0.78
Fishing pressure proxy		
Mean catch length ($L_{mean} = L_{2021}$)		53 cm
MSY proxy length ($L_{F=M}$)		61 cm
f: Fishing pressure proxy relative to MSY proxy ($L_{2021}/L_{F=M}$)		0.87
Biomass safeguard		
Last index value (I_{2021})		55 423
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		46 554
b: Index relative to trigger value, min{$I_{2021}/I_{trigger}$, 1}		1
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.95
RFB calculation**		8 893 tonnes
Stability clause (+20%/-30% compared to A_y, only applied if b = 1)	Applied	0.70
Discard rate		1.2%
Catch advice for 2023 (A_y × stability clause)		9 881 tonnes
Projected landings corresponding to advice***		9 610 tonnes
% advice change^		−30%

*** The figures in the table are rounded. Calculations were made with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table.**

****$A_{y+1} = A_y \times r \times f \times b \times m$.**

***** [Advised catch for 2023] × [1 – discard rate].**

^ Advice value for 2023 relative to the advice value for 2022 (14 116 tonnes).

2.5 Biological reference points

Biological reference are calculated as follows:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	46 554	Biomass index trigger value ($I_{trigger}$), defined as $I_{trigger} = I_{loss} \times 1.4$, where I_{loss} is the lowest observed historical biomass index value (from 2011) from 2005-2022. Value in tonnes.	ICES (2022a, 2022b)
	$F_{MSY\ proxy}$	0.87	$L_{mean}/L_{F=M}$; Mean catch length divided by MSY proxy reference length ($L_{F=M}$ = 61 cm).	ICES (2022a, 2022b)
Precautionary approach	B_{lim}	Not defined		
	B_{pa}	Not defined		
	F_{lim}	Not defined		
	F_{pa}	Not defined		
Management plan	SSB_{mgt}	Not applicable		
	F_{mgt}	Not applicable		

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 Celtic Sea/Bay of Biscay stock has recently been benchmarked and an F_{MSY} of 0.28 was adopted (ICES, 2018a). In the case of *Nephrops* the technical basis for MSY $B_{trigger}$ is the bias-adjusted lowest observed UWTV survey estimate of abundance, however for anglerfish, whilst abundances from SIAMISS-Q2 were initially intended to be an absolute measure of abundance they are now considered to be only a relative index so this may not be appropriate.

2.6 Management plans

ICES is aware of the multiannual management plan (MAP) which has been adopted by the EU for this stock (EU, 2019) and which ICES considers to be precautionary. There is no agreed shared management plan with the UK for this stock, and ICES provides advice according to ICES precautionary approach.

2.7 Uncertainties and bias in assessment and forecast

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

Commercial data

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

- Accuracy of landings statistics due to species and area misreporting (historically an issue between 1998–2005 and anecdotally again in 2016).
- Lack of information on total catch and catch composition of gillnetters operating on the continental slope to the northwest of the British Isles (See the stock annex for further details of this fishery).

Survey data

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

Biological information

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

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

Stock structure

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

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

2.8 Recommendations for next Benchmark

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

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

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

2.9 Management considerations

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

The two TACs in this area do not match the stock unit. One TAC area covers Subarea 4 and Division 2.a (EC); the second covers Division 5.b (EC) and subareas 6, 12, and 14. There is no TAC for Division 3.a and landings from this area have increased significantly in recent years. As a result of this mismatch, there is a potential for catches to exceed advice. There is no TAC for the Norwegian fishery in Subarea 4.

The TACs in subareas 4 (including Norwegian waters) and 6 until 2010 were split 67:33%, since 2011 they have been split 64:36%. In 2018, 10% of the TAC for 4 and 2.a could be taken from Division 5.b, or subareas 6, 7 and 9. Over the survey time-series, the stock has been fairly evenly distributed between 4:6, the split has fluctuated around 50:50 (47% on average) (Table 4.7 and Figure 4.9) however in 2018 there was a significant decrease to 38% increasing to 40% in 2019 and 47% in 2021. 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.

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

YEAR	Catch corresponding to advice	BASIS	WEST OF SCOTLAND (Subarea 6)		NORTH SEA (Subarea 4)	
			TAC4)	WGCSE landings	TAC5)	WGCSE landings
2003	<6700[1)^]	Reduce F below F_{pa}	3180	3068	7000	8714
2004	<8800[2)^]	Reduce F below F_{pa} [2)]	3180	3130	7000	8532
2005	-	No effort increase[2)]	4686	3747	10 314	9696
2006	-	No effort increase[2)]	4686	3491	10 314	9564
2007	-	No effort increase[2)]	5155	4476	11 345	9823
2008	-	No effort increase[3)]	5155	4847	11 345	10 732
2009	-	No effort increase[3)]	5567	5192	11 345	9781
2010	-	No effort increase[3)]	5567	3912	11 345	7900
2011	-	Decrease effort	5456	4693	9643	7920
2012	-	Reduce catches	5183	4372	9161	6412
2013	-	Decrease catches by 20%[2)]	4924	4727	8703	6306
2014	10 231	Decrease catches by 20%[2)]	4432	5880	7833	8165
2015	14 702	Increase landings by 20%[2)]	5313	5008[(7)]	9390	10 243
2016	≤ 18 435	Increase recent advised catch by no more than 20%[2)]	6375	5966	11267	12 854
2017	≤ 22 007	Precautionary approach	7650	6460	13521	14 508
2018	≤ 26 408	Precautionary approach	9180	6356	16225	14 280
2019	≤ 31 690	Precautionary approach	11453	7912	20237	12674
2020	≤ 22 056	Precautionary approach	7971	6 601	14085	11 582
2021	≤ 17 645	Precautionary approach	6 377		11 972	
2022	≤ 14 116	Precautionary approach				

All values raised to nearest tonne.

^ Landings advice

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) pplies to 5.b(EC), 6, 7 and 14.

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

(7) Landings including raised discards.

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

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

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

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

	3.a	4.a	4.b	4.c	6.a	6.b	4	6	Total (3.A, 4,6)	WG Landings	WG Discards	
1997	776	23425	2172	160	5330	990	25757	6320	32853	32728	-	
1998	626	16859	2088	78	4506	1313	19026	5819	25471	25293	-	
1999	660	13344	1517	24	4284	1401	14885	5685	21230	21854	-	
2000	602	12338	1617	31	3311	1074	13986	4385	18973	19682	-	
2001	621	12861	1832	21	2660	1309	14714	3969	19304	19157	-	
2002	667	11048	1244	21	2280	718	12313	2998	15978	15067	-	
2003	478	8523	847	20	2493	643	9390	3136	13004	12008	-	
2004	519	8987	851	15	2453	671	9853	3124	13496	11976	-	
2005	458	8424	688	5	3019	958	9117	3982	13557	13728	-	
2006	426	10340	683	3	2785	915	11026	3700	15152	13292	-	
2007	433	10632	749	4	3353	1261	11384	4613	16430	14564	490	
2008	486	11038	769	5	3373	1246	11813	4619	16918	15878	903	
2009	478	10067	651	8	2984	1820	10726	4804	16008	15372	38	
2010	433	8190	615	11	3040	1606	8815	4645	13895	12136	69	
2011	405	7760	764	8	2871	1871	8532	4742	13679	12902	95	
2012	423	6459	714	4	2835	1831	7177	4666	12266	11143	590	
2013	407	6393	546	5	2667	2123	6944	4790	12141	11375	687	
2014	440	7633	820	27	2610	1754	8481	4365	13286	14406	448	
2015	478	9690	985	16	3290	1723	10691	5013	16182	15663	395	
2016	586	11680	1196	11	4638	1423	12887	6060	19533	19412	981	
2017	742	13620	1107	7	5024	1504	14733	6528	22023	21719	756	
2018	914	13438	823	11	4369	1932	14274	6303	21487	21572	326	
2019	1029	11155	1303	28	5030	2647	12486	7677	21192	21-	513	
2020*	886	10674	1066	24	4749	1685	11763	6434	19064	19 072	316	
2021*	912	11959	1184		19	4455	1537	13162	5992	20066	20143	249

*Preliminary.

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

Division 6.a (West of Scotland)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Belgium	3	2	9	6	5	-	5	2	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	1	3	4	5	10	4	1	2	1	+	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Faroe Is.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	3	2	1	2	4	1	-	-	-	+	1	-	-	-	-	-
France	1910	2308	2467	2382	2648	2899	2058	1634	1814	1132	943	739	1212	1191	1396	1314	1764	1746	1513	1206	1168	1166	1114	1098	1107	1734	1882	1287	1276	1281	1322
Germany	1	2	60	67	77	35	72	137	50	39	11	3	27	39	39	1	-	54	79	79	59	63	48	85	63	81	79	127	94	8	35
Ireland	250	403	428	303	720	717	625	749	617	515	475	304	322	219	356	392	470	295	328	510	488	346	336	410	446	581	579	596	897	698	517
NL	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	6	14	8	6	4	4	1	3	1	3	2	1	+	+	1	1	1	2	+	2	1	+	1	1	1	1	1	2	2	1	-
Spain	7	11	8	1	37	33	63	86	53	82	70	101	196	110	83	76	3	174	185	197	138	69	123	54	30	178	173	218	298	232	251
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			962	1643	2062	2311	2139	2463	2529	2330

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Total	5061	5479	5553	5273	6354	6408	5330	4506	4284	3311	2660	2280	2493	2453	3024	2785	3353	3373	2984	3040	2871	2835	2667	2610	3290	4638	5024	4369	5030	4749	4456
Unallocated	296	2638	3816	2766	5112	11148	7506	5234	3799	3114	2068	187	2	16	-8	-74	145	332	190	56	62	91	115	1595	68	-58	12	42	290	-6	4
As used by WG	5357	8117	9369	8039	11466	17556	12836	9740	8083	6425	4728	2467	2495	2469	3016	2711	3498	3705	3174	3096	2933	2926	2782	4205	3358	4580	5036	4411	5320	4743	4451

*Preliminary.

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

Division 6.b (Rockall)/ *Preliminary.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
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	-	-	-	17	23	4
Germany	-	-	103	73	83	78	177	132	144	119	67	35	64	66	77	72	222	93	132	87	90	79	88	66	139	177	167	266	340	221	122
Ireland	272	417	96	135	133	90	139	130	75	81	134	51	26	13	35	53	70	76	91	107	108	235	237	162	156	160	214	282	365	202	167
Norway	18	10	17	24	14	11	4	6	5	11	5	3	6	5	4	6	7	5	9	12	7	5	9	3	6	11	4	1	1	2	-
Portugal	-	-	-	132	128	-	91	413	429	20	18	8	4	19	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	2	4	1	1	35	-	-	-	-	-	1	2	-	2	-	1	3	-
Spain	333	263	178	214	296	196	171	252	291	149	327	128	59	43	34	36	12	85	57	32	29	36	-	27	119	56	118	43	60	32	31

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
UK(E,W&NI)	99	173	76	50	105	144	247	188	111	272	197	133	133	54	93	46	-	1	48	15	-	120	395	-	-	-	-	-	-	-	-
UK(Scot)	201	224	182	281	199	68	156	189	344	374	367	317	160	294	355	477	-	624	1141	1177	-	895	732	-	-	-	-	-	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	622	-	-	-	1129			1347	1081	1018	999	1340	1862	1202	1209
Total	923	1089	681	909	958	602	990	1313	1401	1074	1309	718	643	671	958	915	1261	1246	1820	1606	1871	1831	2123	1754	1723	1423	1504	1946	2632	1685	1533
Unallocated	-	-	-	-132	-128	-	-91	-413	-9	17	-178	210	70	10	227	136	282	104	-198	791	111	385	178	80	74	37	80	2	140	-115	-28
As used by WG	923	1089	681	777	830	602	899	900	1392	1091	1131	508	573	661	731	779	979	1142	2018	815	1760	1446	1945	1674	1649	1386	1424	1944	2492	1800	1561

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

Subarea 6 (West of Scotland and Rockall)

^ indicates landings assigned to subarea 6 but not to a division. /*Preliminary.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Belgium	3	2	9	6	5	-	5	2	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	--	-	-	-	-
Denmark	1	3	4	5	10	4	1	2	1	+	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Faroe Is.	-	2	-	-	-	15	4	2	2	-	1	-	-	2	2	3	2	2	6	12	1	5	-	1	+	1	+	-	-	-	-
France	191	230	2496	238	2648	2899	2059	1635	181	118	113	782	140	136	1689	153	209	207	185	137	167	162	177	124	132	173	188	128	1293	1	1326
Germany	1	2	163	140	160	113	249	269	194	158	78	38	91	105	116	73	222	146	211	166	149	142	136	151	201	258	246	394	434	2	157
Ireland	522	820	524	438	853	807	764	879	692	596	609	355	348	232	391	445	540	371	419	617	596	581	572	572	602	741	793	878	1262	8	684

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Nether-	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	24	24	25	30	18	15	5	9	6	14	7	4	6	5	5	7	8	7	9	14	7	6	10	4	8	12	5	4	2	1	-
Portugal	-	-	-	132	128	-	91	413	429	20	18	8	4	19	63	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	2	4	1	1	35	-	-	-	-	-	1	2	-	2	-	1	3	-
Spain	340	274	186	215	333	229	234	338	344	231	397	229	255	153	117^	112	15	259	242	229	167	105	123	81	149	234	290	261	358	2	282
UK(E,W&NI	369	524	299	420	425	345	403	307	171	316	237	165	164	84	113	70	188	6	60	-	-	132	401	-	-	-	-	-	-	-	-
UK(Scot)	281	260	2528	241	2732	2583	2478	1962	203	187	148	141	865	115	1482	145	154	172	200	-	-	207	177	-	-	-	-	-	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	223	214	220	217	231	272	308	331	347	4322	3	3539
Total	598	656	6234	618	7312	7010	6320	5819	568	438	396	299	313	312	3982	370	461	461	480	464	474	466	479	436	501	606	652	630	7652	6	5989
Unallo-	296	263	3816	263	4984	1114	7415	4821	379	313	189	22	68	6	235	209	137	228	388	733	49	294	63	151	5	94	68	-53	-160	-	-23
As used by WG	6280	9206	10050	8816	12296	18158	13735	10640	9475	7516	5859	2976	3068	3130	3747	3491	4476	4847	5192	3912	4693	4372	4727	5880	5008	5966	6460	6356	7812	65	6012

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

Northern North Sea (4.a)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
BE	2	9	3	3	2	8	4	1	5	12	-	8	1	-	-	-	-	-	-	-	-	-	+	-	-	-	1	-	-	-	-
DK	1245	1265	946	1157	732	1239	1155	1024	1128	1087	1289	1308	1523	1538	1379	1311	961	1071	1134	1143	841	821	854	801	962	1506	2002	1790	1669	1058	1140
Faroes	1	-	10	18	20	-	15	10	6	-	2	-	3	11	22	2	-	-	4	-	-	-	-	-	-	-	-	-	1	-	-
FR	124	151	69	28	18	7	7	3	18	8	9	8	8	8	4	7	13	13	20	23	20	14	15	27	26	35	91	141	185	124	108

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
DE	71	68	100	84	613	292	601	873	454	182	95	95	65	20	84	173	186	344	216	124	46	265	274	321	286	208	523	462	547	-	-
NL	23	44	78	38	13	25	12	-	15	12	3	8	9	38	13	14	14	12	5	8	5	5	-	16	-	21	28	68	68	40	10
NO	587	635	1224	1318	657	821	672	954	1219	1182	1212	928	769	999	880	1006	831	860	859	791	494	485	545	524	406	610	840	1230	1267	954	964
ES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-		-	-	-
SE	14	7	7	7	2	1	2	8	8	78	44	56	8	6	5	5	20	67	-	-	-	-	-	-	6	4	8	12	17	59	100
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 (Scot.)	7039	7887	9712	11683	15658	22344	18783	13318	9710	9559	10024	8539	6033	6284	6003	7722	8304	8658	7509	5730	-	4622	4154	-	-	-	-	-	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6353	4870	4704	5943	8005	9296	10127	9735	7401	8092	
Total	9235	10209	12309	14505	17891	25176	23425	16859	13344	12338	12861	11048	8523	8987	8424	10340	10632	11038	10067	8190	7760	6459	6393	7633	9690	11680	13620	13438	11155	11739	11959

***Preliminary.**

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

Central North Sea (4.b)

*** Preliminary**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Belgium	357	538	558	713	579	287	336	371	270	449	579	435	180	260	207	138	179	181	134	124	111	131	135	213	196	251	168	155	249	239	284

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Denmark	345	421	346	350	295	225	334	432	368	260	251	255	191	274	237	276	173	237	248	194	286	301	192	334	369	584	565	411	533	339	322
Faroes	-	-	2	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	-	1	-	2	-	-	-	-	-	-	-	-	-	+	-	+	+	-	3	6	2	+-	+-	1	+	+	-	+	-	2	-
Germany	4	2	13	15	10	9	18	19	9	14	9	17	11	11	9	14	12	22	17	21	17	10	10	17	23	18	14	26	27	16	22
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	285	356	467	510	335	159	237	223	141	141	123	62	42	25	31	33	61	58	36	46	53	61	41	72	88	120	166	111	310	226	354
Norway	17	4	3	11	15	29	6	13	17	9	15	10	12	22	16	12	24	15	21	10	11	11	26	8	9	16	41	36	22	42	17
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Sweden	-	-	-	3	2	1	3	3	4	3	2	9	2	1	4	4	6	9	-	-	-	-	-	-	3	7	10	12	19	14	13
UK(E, W&NI)	669	998	1285	1277	919	662	664	603	364	423	475	236	167	120	96	108	-	105	85	88	-	85	70	-	-	-	-	-	-	-	-
UK (Scotland)	845	733	469	564	472	475	574	424	344	318	378	210	241	138	88	98	-	142	108	125	-	115	72	-	-	-	-	-	-	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	293	-	-	-	284	200	142	175	297	201	143	72	144	189	172
Total	2522	3053	3143	3445	2627	1847	2172	2088	1517	1617	1832	1244	847	851	688	683	749	769	651	615	764	714	546	820	985	1196	1107	823	1303	1066	1184

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

Southern North Sea (4.c)

*** Preliminary.**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Belgium	13	12	34	37	26	28	17	17	11	15	15	16	9	5	4	3	3	4	6	7	6	2	2	4	5	2	1	1	1	2	5
Denmark	2	+	-	+	+	+	+	+	+	+	+	+	+	+		+	+	-	-	+	+	+	-	-	-	+	-	+	-	-	-
France	-	-	-	-	-	-	-	10	-	+	-	+	-	-	-	+	+	-	1	1	1	+	+	1	+	1	+	+	-	-	+
Germany	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	+	-	+	+	+	+	+	+	-	+	+
Netherlands	5	10	14	20	15	17	11	15	10	15	6	5	1	-	1	-	1	1	-	2	1	1	1	19	10	8	5	8	26	19	11
Norway	-	-	-	-	+	-	-	-	+	-		-	+	-	-	+	-	-	1	-	-	-	-	1	+	-	-	1	-	-	-
UK(E&W&NI)	6	17	18	136	361	256	131	36	3	1	-	-	10	3	-	+	-	+	1	1	-	-	1	-	-	-	-	-	-	-	-
UK (Scot-land)	+	+	+	17	+	3	1	+	+	+	-	-	-	7	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-+	-+	+	1	1	1	+	1	2	1	1	+	1	2	1	2
Total	26	39	66	210	402	304	160	78	24	31	21	21	20	15	5	3	4	5	8	11	8	4	5	27	16	11	7	11	29	22	19

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

Subarea 4 (North Sea)

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

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Belgium	372	559	595	753	607	323	357	389	286	476	594	459	190	265	211	141	181	185	140	131	116	133	137	217	200	253	169	156	249	243	290
Denmark	1599	1686	1293	1509	1027	1464	1489	1456	1496	1347	1540	1563	171	181	161	1587	1134	1308	1382	133	112	112	104	113	1331	2090	2567	2201	2202	1398	1462
Faroes	1	-	12	18	20	-	15	10	6	-	2	10	3	11	22	2	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
France	124	152	69	30	18	7	7	13	18	8	9	8	8	8	4	7	14	13	23	30	24	15	15	30	26	36	91	142	186	127	108
Germany	75	70	113	99	623	301	619	892	463	196	104	112	76	31	93	187	198	367	233	145	63	275	284	339	309	226	537	488	574	361	228
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	313	410	559	568	363	201	260	238	166	168	132	75	52	63	45	47	76	71	41	56	59	67	42	108	98	148	199	187	405	285	376
Norway	604	639	1227	1329	672	850	678	967	1236	1191	1227	938	781	102	896	1018	855	875	881	802	505	496	572	533	415	626	881	1267	1289	955	982
Sweden	14	7	7	10	4	2	5	11	12	81	46	65	10	7	9	10	26	76	-	-	-	-	-	-	10	11	18	25	36	72	112
UK(E&W&N	804	1158	1463	1582	1456	1357	2969	1307	1148	642	658	334	281	206	130	207	425	118	406	460	-	333	621	-	-	-	-	-	-	-	-
UK (Scot-	7884	8620	1018	1226	1613	2282	1935	1374	1005	9877	1040	8749	627	642	609	7820	8476	8800	7617	585	-	473	422	-	-	-	-	-	-	-	-
UK (Total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	663	506	484	612	8303	9498	1027	9808	7545	8282	9604
Total	11790	13301	15519	18162	20920	27327	25757	19026	14885	13986	14714	12313	9390	9853	9117	11026	11384	11813	10726	8815	8532	7177	6944	8481	10691	12887	14733	14274	12486	11763	13162
Unallocated	-1224	-1573	-2441	-2732	-5126	11087	-7540	-4999	-3166	-2422	-2037	600	676	1330	-579	1462	1561	1081	945	915	612	765	638	316	448	33	225	-6	-176	182	-6
WG estimate	10566	11728	13078	15430	15794	16240	18217	14027	11719	11564	12677	11713	8714	8523	9696	9564	9823	10732	9781	7900	7920	6412	6306	8165	10243	12854	14508	14280	12662	11581	13168

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

***Preliminary.**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Belgium	15	48	34	21	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	493	658	565	459	312	367	550	415	362	377	375	369	215	311	274	227	255	287	344	270	251	307	298	309	336	389	526	597	692	600	678
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	1	-	-	-	-
Germany	-	-	1	+	-	1	1	1	2	1	-	1	-	1	1	2	1	1	1	1	2	1	1	-	1	2	1-	2	1	1	1
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	3	4	4	3	1	3	-	5	-	-	-	4	9	17	16	16	47	66	46
Norway	64	170	154	263	440	309	186	177	260	197	200	242	189	130	100	139	132	144	134	158	153	115	108	127	90	124	118	204	189	129	116
Sweden	23	62	89	68	36	25	39	33	36	27	46	55	71	73	79	54	44	51	-	-	-	-	-	-	42	53	81	95	100	71	71
UK (Total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Total	595	938	843	811	823	702	776	626	660	602	621	667	478	519	458	426	433	486	478	433	405	423	407	440	478	586	742	914	1029	866	912
Unallocated	-	-	-	-	-	-	-	-	-	-	-	288	252	197	174	189	168	187	79	109	116	63	65	78	66	-5	-911	-22	-34	-22	-30
As used by WG	-	-	-	-	-	-	-	-	-	-	-	379	226	322	284	237	265	299	399	324	289	360	342	362	412	591	751	936	1063	888	942

Table 4.6. Breakdown of WG estimates of commercial catches for 2020 and 2021 by main gear group and area in tonnes.

2020	3.a		4		6.a		6.b		Total		% of Total	
Fleet	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**
Demersal trawl	151	5	8296	86	4521	80	920	6	13888	178	73	56
Nephrops trawl	538	14	257	55	41	4	0	0	837	73	4	23
Gillnets	119	3	2434	40	32	1	817	5	3402	49	18	16
Other/Not specified	80	2	595	10	208	4	62	0	945	16	5	5
Total	888	22	11522	177	4763	88	1799	11	19072	316	100	100
2021												
Fleet	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**
Demersal trawl	116	4	10423	95	4361	12	910	14	15810	125	78	50
Nephrops trawl	647	25	363	48	34	0	0	0	1044	73	5	29
Gillnets	107	5	1767	23	35	0	648	9	2557	37	13	15
Other/Not specified	72	5	616	8	9	0	35	0	732	13	4	5
Total	942	39	13169	174	4439	12	1593	23	20143	249	100	100

Table 4.7. Total biomass estimates with confidence intervals and relative standard errors from the 2005–2021 SIAMISS-Q2 surveys.

Year	Number of hauls	Number measured	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	156	1569	50.392	43.676	57.108	6.8	56.62%
2008	167	2219	53.546	42.421	64.671	10.6	55.51%
2009	206	1643	38.060	32.987	43.133	6.8	44.82%
2010	168	1280	42.279	30.429	54.129	14.3	51.90%
2011	153	1037	33.254	24.846	41.662	12.9	44.96%
2012	169	1461	36.325	29.704	42.946	9.3	41.59%
2013	93	984	38.395	31.020	45.770	9.8	37.04%
2014	106	1568	52.884	42.769	62.999	5.2	40.25%
2015	117	2198	67.915	58.782	77.047	6.9	43.66%
2016	108	2025	77.946	66.831	89.060	7.275	56.39%
2017	153	3265	87.896	74.222	101.569	7.937	53.47%
2018	142	2714	77.661	66.258	89.064	7.491	37.80%
2019	128	1860	58.575	46.189	70.962	10.789	40.49%
2021	137	1524	48.355	37.233	59.476	11.734	46.71%
2022	65	687	55.423	40.068	70.779	14.136	54.58%

Table 4.8. Abundance and biomass estimates from the 2005–2021 SIAMISS-Q2 surveys by ICES subareas and divisions.

Year	Month	Numbers (millions)					Biomass (kt)				
		IVa	VIa	VIb	VI	Total	IVa	VIa	VIb	VI	Total
2005	November	11.168	10.866	1.800	12.666	23.834	18.642	14.096	5.879	19.975	38.617
2006	November	12.844	10.459	3.174	13.633	26.477	21.921	12.175	6.889	19.064	40.985
2007	November	15.304	7.956	4.000	11.956	27.26	28.534	11.072	10.786	21.858	50.392
2008	April	12.613	7.718	3.952	11.67	24.283	29.721	14.383	9.442	23.825	53.546
2009	April	8.279	5.144	3.688	8.832	17.111	17.058	8.150	12.852	21.002	38.060
2010	April	7.366	5.161	3.131	8.292	15.658	21.944	11.59	8.745	20.335	42.279
2011	April	5.150	6.057	3.669	9.726	14.876	14.949	9.330	8.974	18.304	33.253
2012	Abril	5.432	4.961	5.135	10.096	15.528	15.106	9.213	12.005	21.218	36.325
2013	October	8.470	8.461	4.885	13.346	21.816	14.369	10.801	13.626	24.427	38.796
2014	April	17.553	16.096	6.488	22.584	40.136	21.284	16.633	14.967	31.60	52.884
2015	April	18.266	28.604	5.496	34.100	52.366	29.653	24.047	14.215	38.262	67.915
2016	April	21.648	14.383	4.538	18.922	40.569	43.956	18.273	15.717	33.99	77.946
2017	April	23.691	16.332	4.360	20.683	44.374	46.995	29.297	11.604	40.901	87.896
2018	April	11.819	13.528	6.240	19.768	31.586	29.353	22.350	25.958	48.308	77.661
2019	April/May	14.606	21.032	3.592	24.624	39.231	23.719	18.864	15.992	34.856	58.575
2021	April	17.371	8.608	3.048	11.656	29.027	22.587	12.74	13.027	25.767	48.355

Year	Month	Numbers (millions)					Biomass (kt)				
		IVa	VIa	VIb	VI	Total	IVa	VIa	VIb	VI	Total
2022	April	13.259	10.283	3.048*	13.331**	26.591**	30.252	12.142	13.027*	25.170**	55.423**

***Value carried over from 2021 due to missing survey data in division 6b in 2022**

****Total includes value carried over from 2021 due to missing survey data in division 6b in 2022**

Table 4.9. Northern Shelf anglerfish mean standardised harvest rates of catch numbers and biomass 2008–2021.

Year	Mean standardised harvest rate – Number	Mean standardised harvest rate – Biomass
2007	1.019557	0.962803
2008	1.396944	1.010032
2009	1.117361	1.304825
2010	1.307811	0.930318
2011	1.08548	1.259594
2012	1.28022	1.041019
2013	1.058155	1.001878
2014	0.727179	0.938519
2015	0.62145	0.761601

Year	Mean standardised harvest rate – Number	Mean standardised harvest rate – Biomass
2016	0.861419	0.842697
2017	0.760659	0.824041
2018	0.908121	0.908698
2019	0.855643	1.213976
2021	0.855643	1.213976

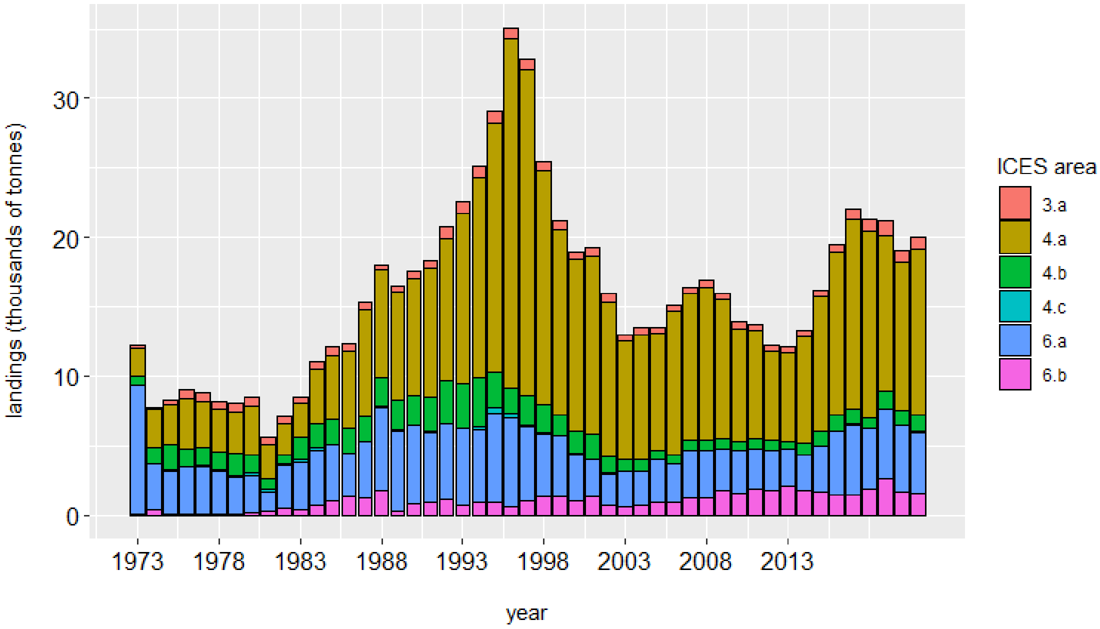

Figure 4.1. Northern Shelf anglerfish. Officially reported landings by ICES area (1973–2021).

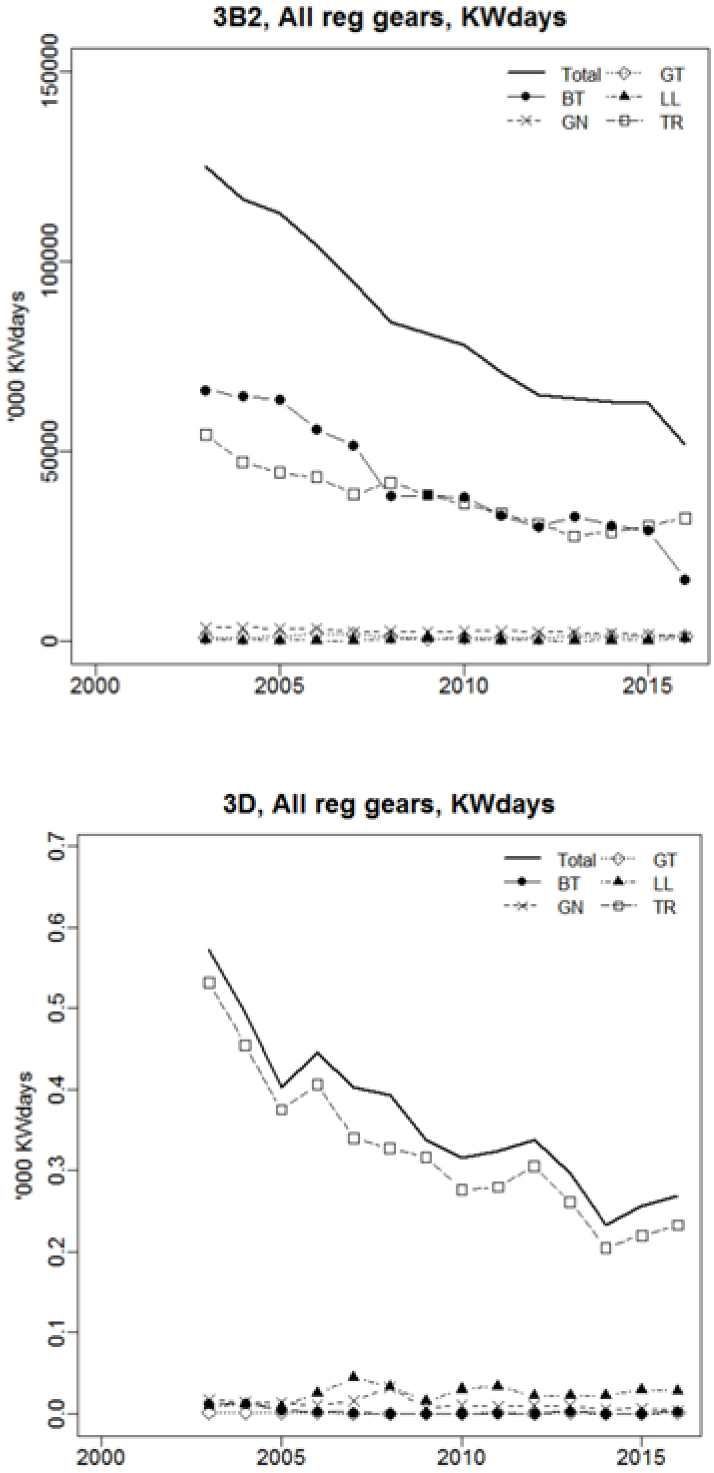

Figure 4.2. Trends in nominal international fishing effort (kW*days at sea) in North Sea and II (EU) (left) and West of Scotland (right) collated by STECF for the Evaluation of Fishing Effort Regimes in European Waters (STECF, 2017).

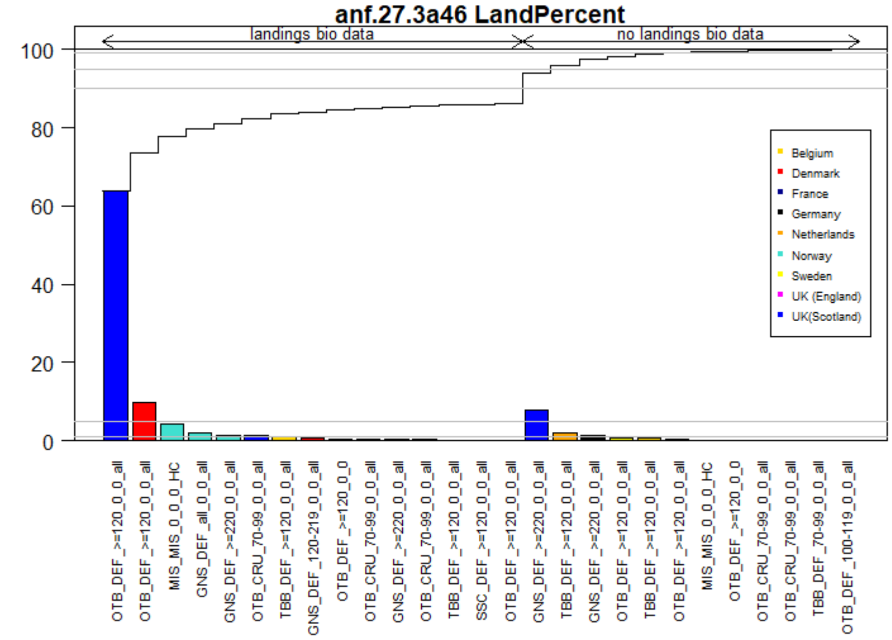

Figure 4.3a. Percentage of total landings weight by fleet and country in 2021; Subarea 4.

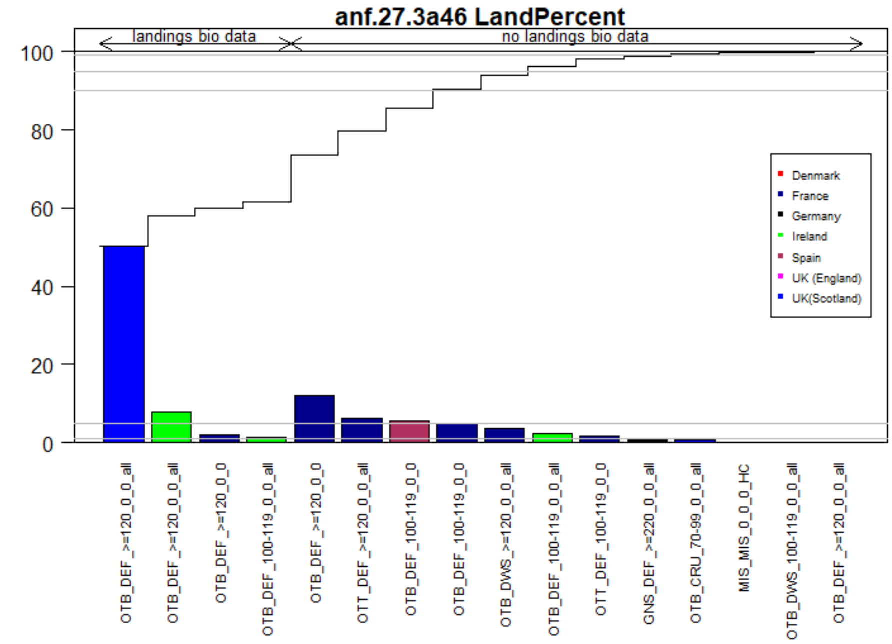

Figure 4.3b. Percentage of total landings weight by fleet and country in 2021; Division 6.a.

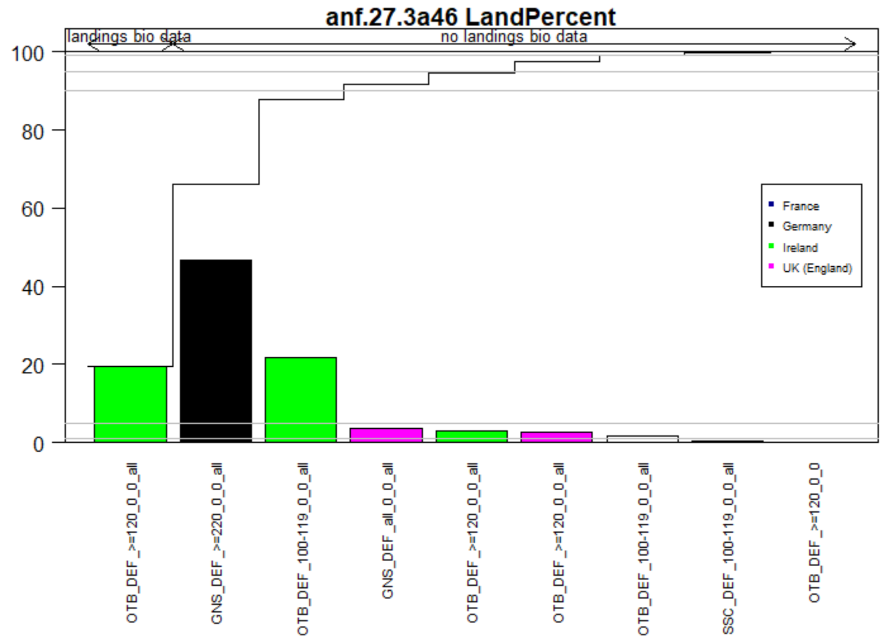

Figure 4.3c. Percentage of landings weight by fleet and country in 2021; Division 6.b.

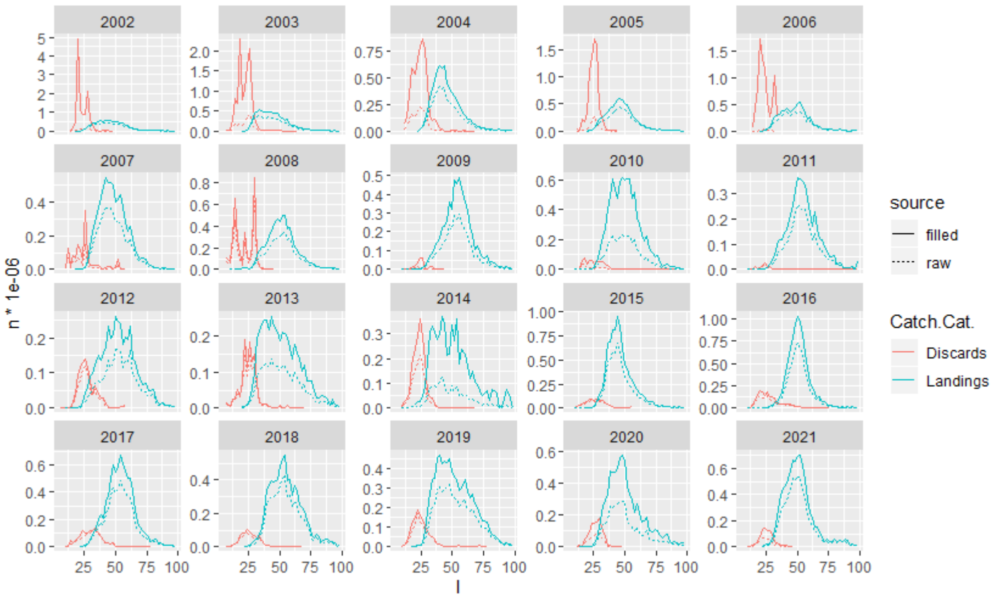

Figure 4.4. WGCSE Landed numbers ('00 thousands) at-length (cm) 2002–2021.

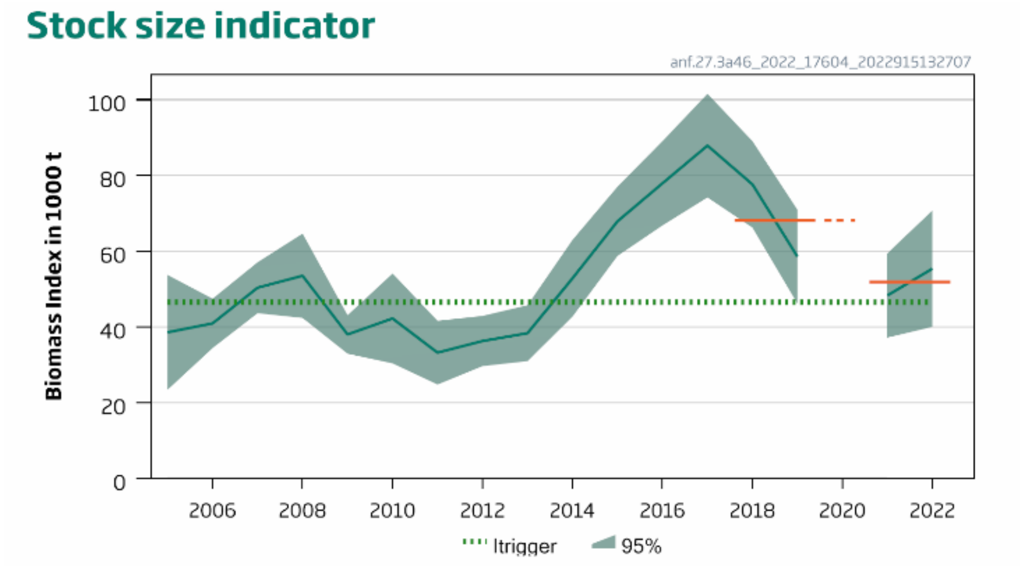

Figure 4.5. SIAMISS-Q2 estimates of total biomass with 95% confidence intervals for subareas 4 and 6 combined, 2005–2021. The horizontal orange lines indicate the average of the most recent two years, and the previous two years (with 2020 not available and hence excluded from the average). The dashed line represents the index trigger value.

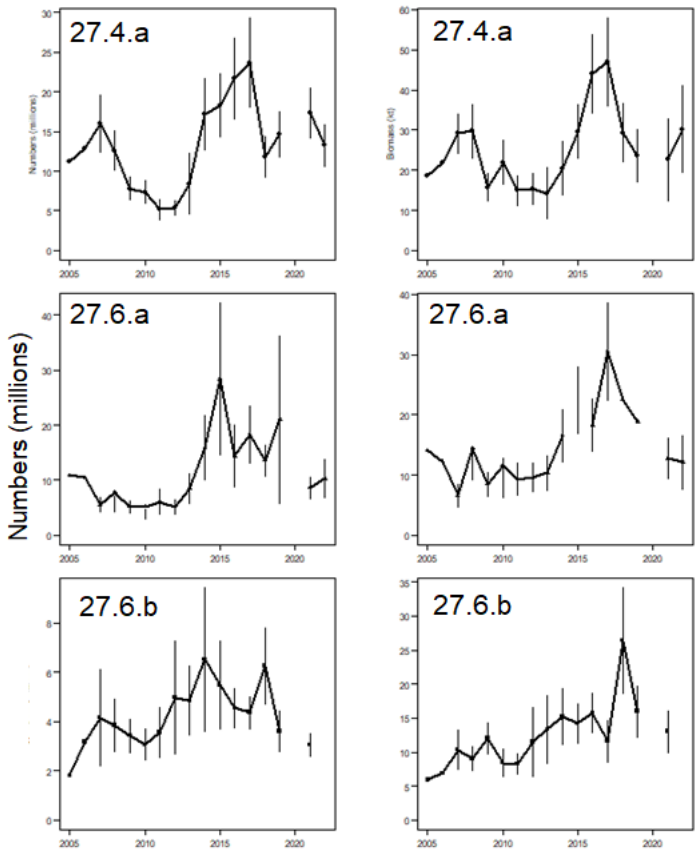

Figure 4.6. SIAMISS-Q2 estimates of total abundance (left) and biomass (right) of anglerfish for the Northern Shelf 2005–2022 provided for ICES Subarea 4a, Division 6.a and Division 6.b.

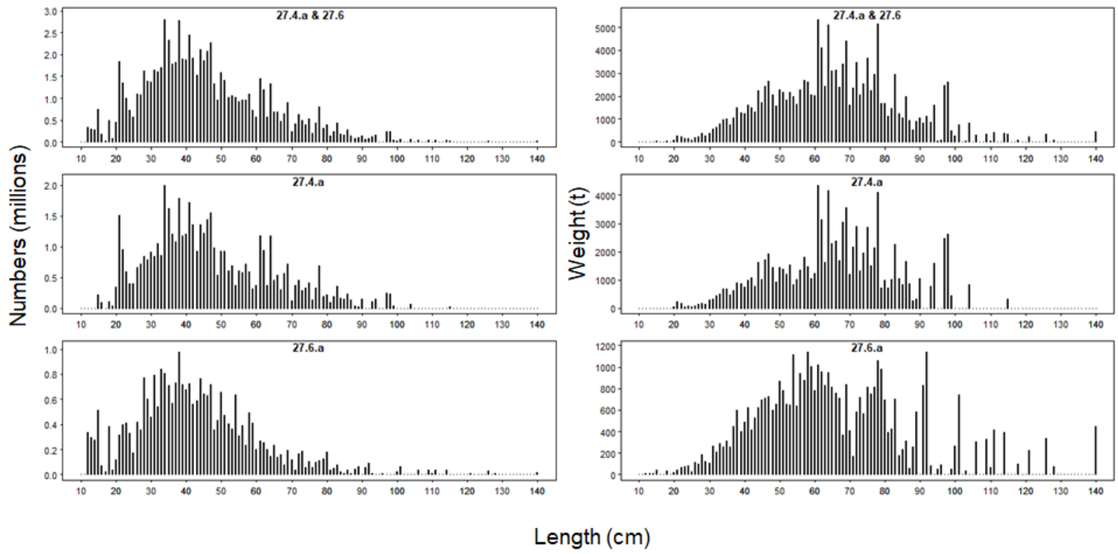

Figure 4.7. SIAMISS-Q2 estimates of total numbers (millions) and weight (t) at-length (cm) for subareas 4.a and 6.a, 2022.

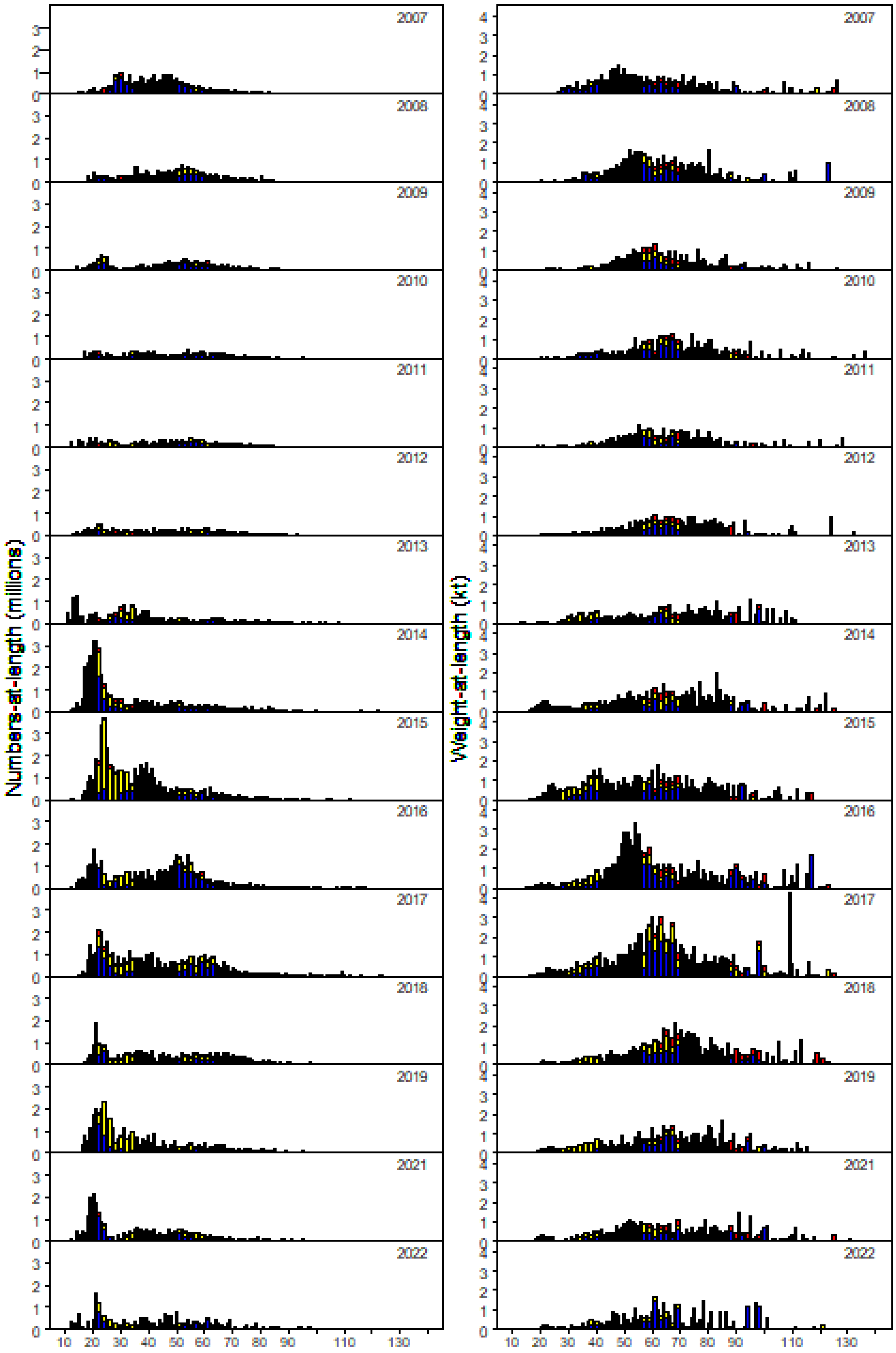

Figure 4.8. SIAMISS-Q2 estimates of total numbers (millions) at-length (cm) (left) and estimates of total biomass (kt) at-length (cm) (right) for subareas 4.a (blue)–c and 6.a (yellow)–b (red) combined, 2007–2022.

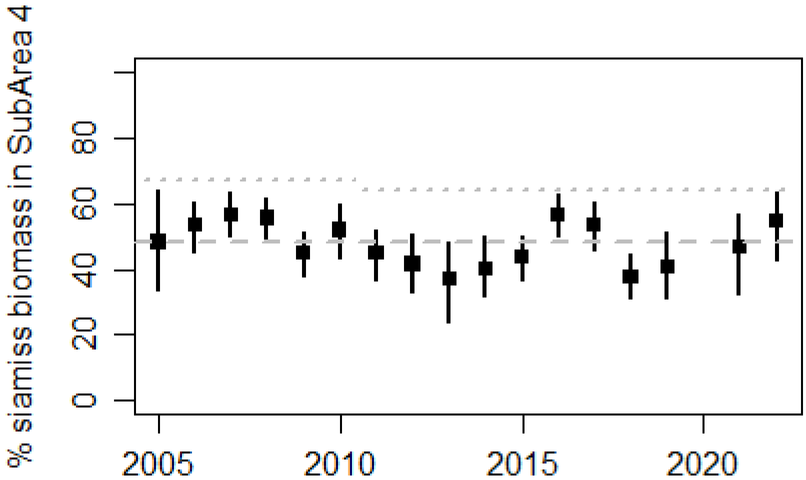

Figure 4.9. Percentage of SIAMISS-Q2 total biomass, with confidence intervals, estimated to be in subareas 4.a–c compared with subareas 4.a–c and 6.a–b combined. The full grey line represents the average of these percentages over the time-series (2005–2022) (48%). The dotted grey lines represent the 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 2011–2022).

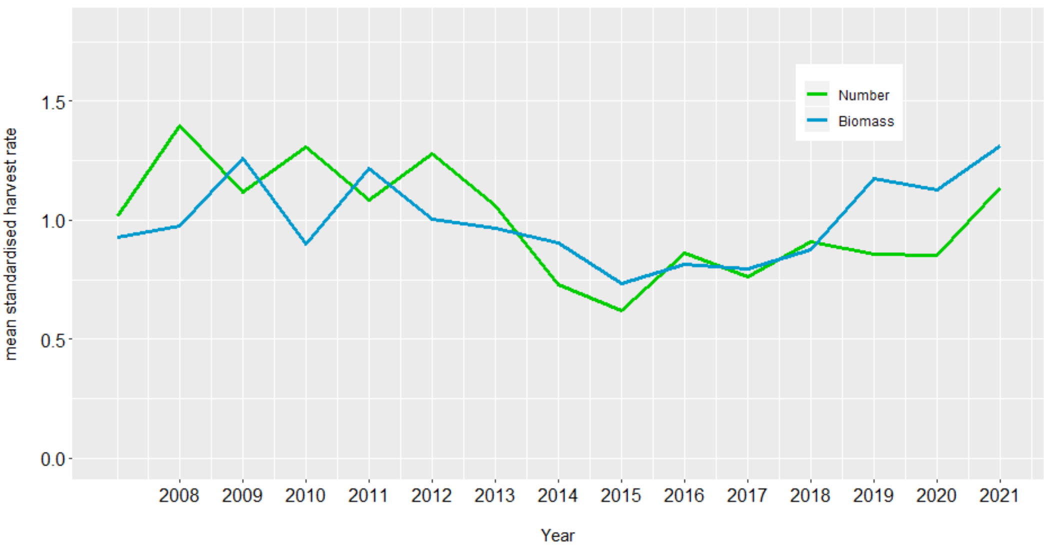

Figure 4.10. Northern Shelf anglerfish harvest rate 2008–2021 (mean standardised WG catch total numbers of biomass / SIAMISS-Q2 total numbers or biomass).

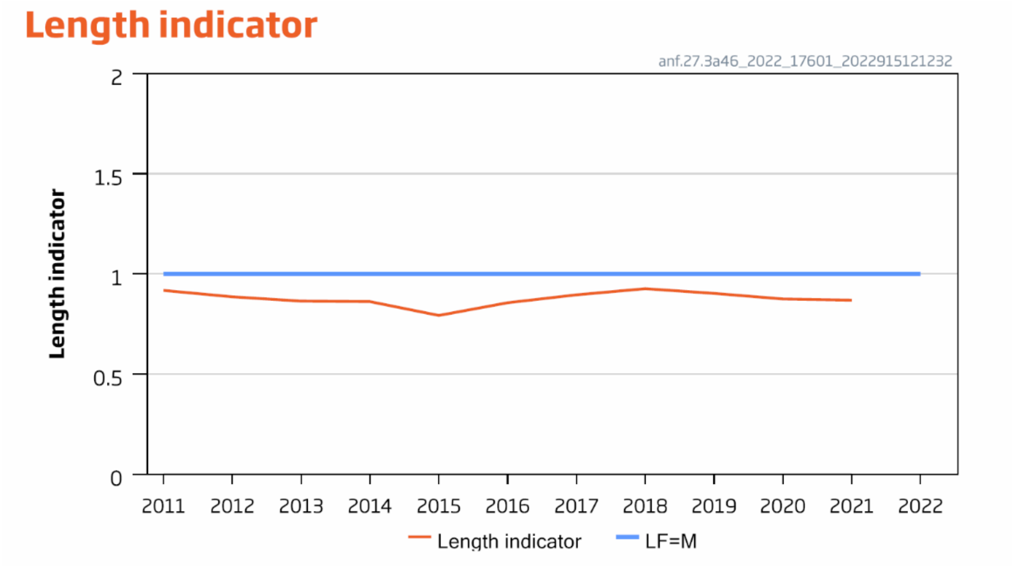

Figure 4.11. Anglerfish in subareas 4 and 6 and in Division 3.a. Length indicator (mean length of fish in the catch above the estimated length of first capture (Lc) normalised to the MSY proxy reference length LF = M.). The exploitation status is below FMSY proxy when the indicator ratio value is higher than 1 (shown by a blue line).

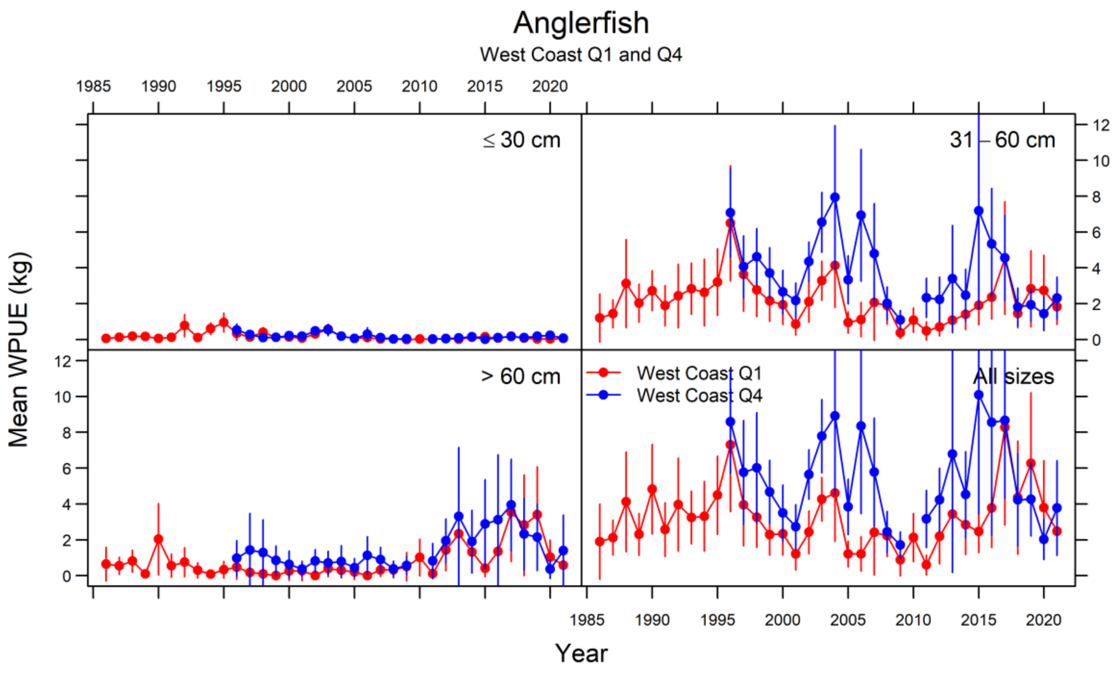

Figure 4.12. Survey indices of mean weight (g) per hour from SWC-IBTS-Q1 (blue) in 6.a, SWC-IBTS-Q4 (red) in 6.a and Rockall (red) in 6.b.

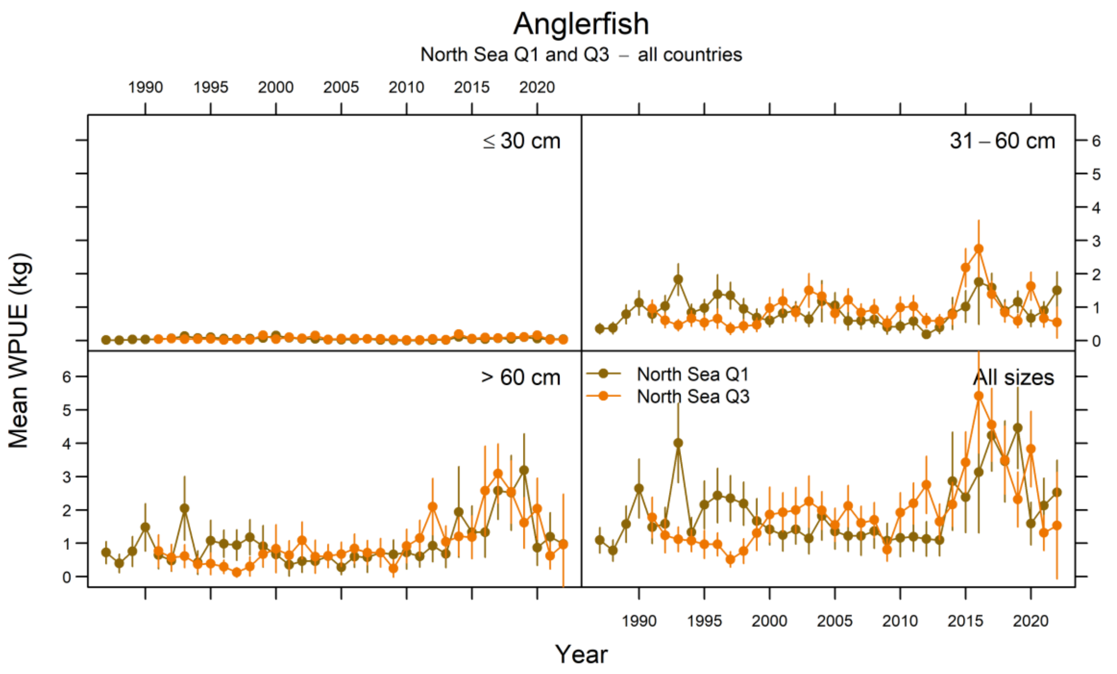

Figure 4.12. Survey indices of mean weight (g) per hour from NS-IBTS-Q1 (brown) and NS-IBTS-Q3 (orange).

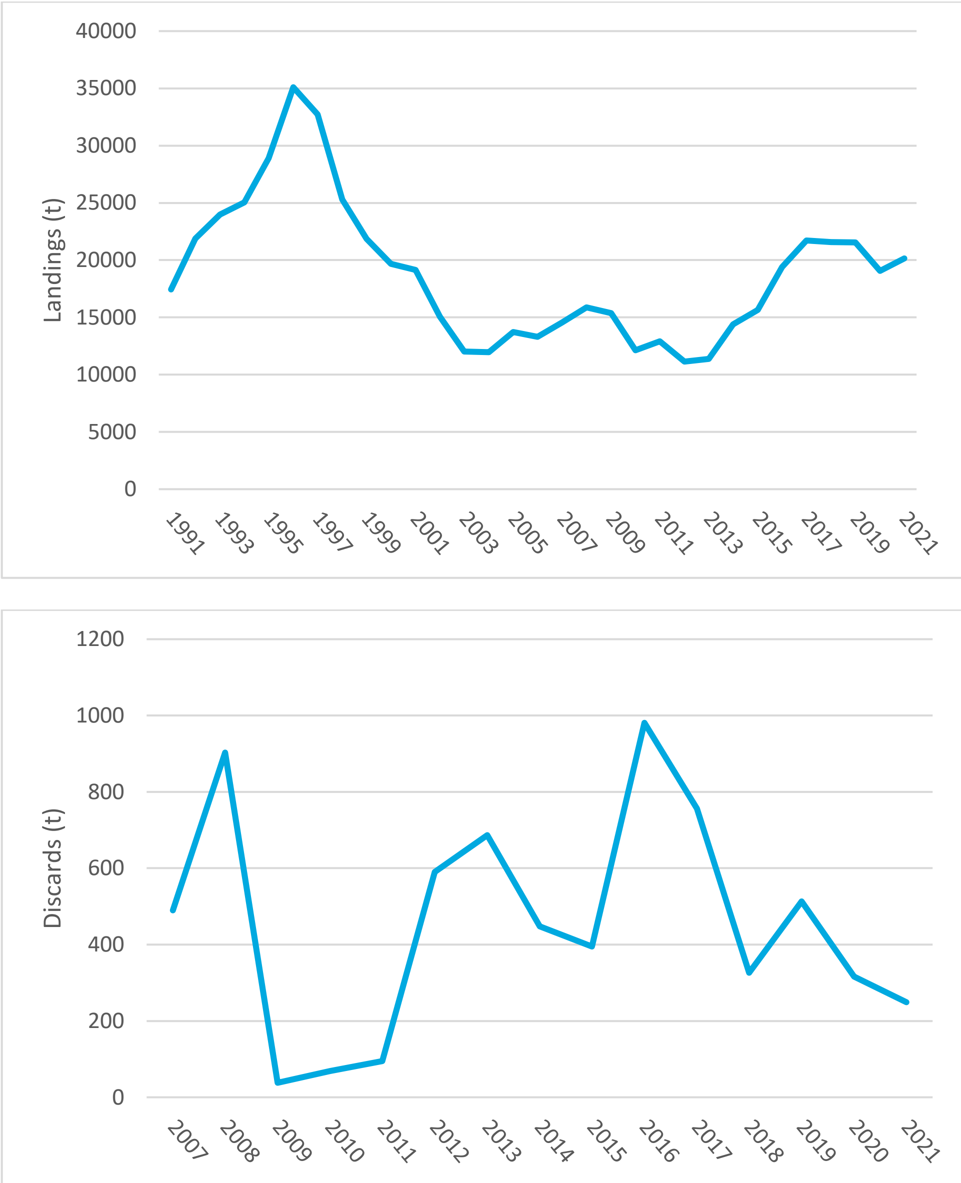

Figure 4.13. ICES landings of anglerfish 1991–2021 (top) and ICES discards of anglerfish 2007–2021 (bottom) in subareas 4 and 6 and in Division 3.a.

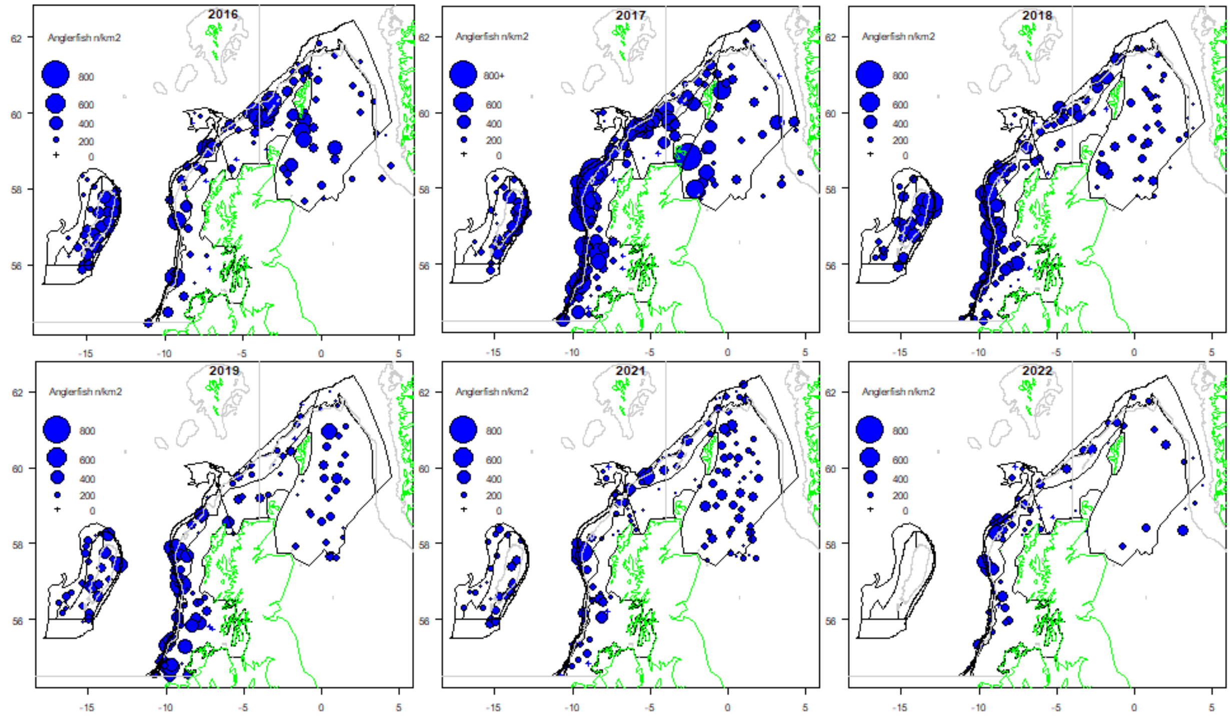

Figure 4.14. Numbers of anglerfish per km² observed by SIAMISS surveys 2016–2022.

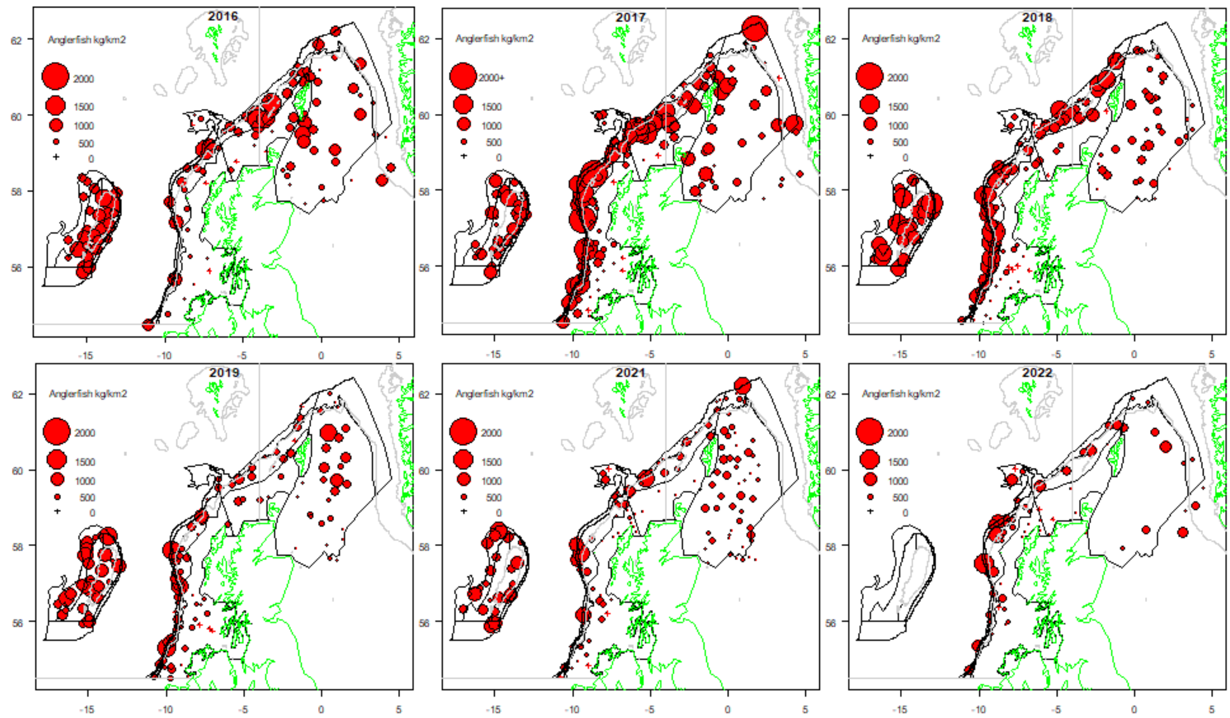

Figure 4.15. Weight of anglerfish (kg) per km² observed by SIAMISS surveys 2016–2022.

3 Cod in Division 6.a

3.1 Introduction

The last benchmark for this stock was carried out in February 2020 (ICES, 2020). This resulted in a change of assessment method (TSA to SAM), inclusion of revised catch data from 2003 onwards and updated biological parameters.

The assessment presented here contains a number of deviations associated with the catch estimation process and input data to the approaches agreed at the benchmark and documented in the Stock Annex:

Processed UK VMS data have not been submitted in accordance with the ICES VMS data call deadline and hence were not available ahead of WGCSE. Furthermore, data access issues between UK administrations mean that raw UK VMS data are not directly available for the estimation of Scottish area misreported landings. This applies to data from 2021. Therefore, instead of using these data to estimate area misreported landings (as agreed at WKDEM, ICES, 2020a), the WG has again had to make use of estimates provided by Marine Scotland Compliance (MS-C, which were used by the WG prior to the 2020 benchmark). VMS data for 2019 and 2020 became available just prior to the WG meeting and hence could not be used to revise the previously used MS-C estimates. The MS-C estimates are used for 2019–2021.

In 2021, Scottish observer sampling from the *Nephrops* trawl fleet (OTB_CRU) was extremely limited due to COVID-19 disruption. This has resulted in an underestimate of total discards and unreliable estimates of catch numbers and mean weights-at-ages 1 and 2 which as a consequence have been excluded from the assessment. Sensitivity analysis suggests this has had minimal impact on the assessment (See Section 3.3 & 5.4 for further details and sensitivity analysis).

Due to vessel breakdown in 2022, the Scottish Q1 West Coast survey could not be carried out and hence there was no intermediate year survey included in this year's assessment. Sensitivity analysis suggests this has had minimal impact on the assessment (See Section 3.3 & 5.4 for further details and sensitivity analysis).

3.2 General

3.2.1 Advice

This stock has had zero catch advice since 2004. In recent years, this advice has typically been issued on a biennial basis.

3.2.2 Stock definition and the management unit

The general conclusion from recent workshops on cod stock ID in Division 6.a and the neighbouring North Sea (WK6aCodID; ICES, 2022 & WKNSCODID; ICES, 2020b) was that the current assessment units are not consistent with the stock structure.

WK6aCodID concluded that the available evidence supported a hypothesis of multiple overlapping subpopulations in Division 6a related to the Dogger genetic lineage (with linkage between 4a and 6a) with a separate subpopulation in the Clyde, associated with the Celtic genetic lineage and for which evidence for a link to Division 7a was presented.

The non-Clyde part of Division 6a is considered likely to consist of separate inshore and offshore Dogger subpopulations, but given the very limited data from parts of Division 6a, there remains uncertainty regarding the spatial extent of these. Genetic evidence for a link with the North Sea Dogger unit was supported by tagging data showing mixing between the northern part of a and the northwestern part of 4a in the North Sea.

The Clyde population, genetically associated with the Celtic unit, is different to elsewhere in Division 6a in terms of otolith microchemistry and demographics (maturity and SSB trends). This is confirmed by tagging data showing Clyde cod to be largely resident within the Clyde, with no mixing with other 6a subpopulation and limited exchange with the Irish Sea.

WK6aCodID considered it highly unlikely that it would be possible to collate sufficient appropriately disaggregated data to enable a separate Clyde stock assessment to be conducted in the near future. However, given the currently very minor contribution of Clyde cod catches to the overall catches from Division 6a, the impact of retaining the Clyde cod within a meta-population stock assessment (as part of the Inshore Dogger subgroup within 6a) is likely to be minor and was therefore recommended as a practical way forward for the short to medium term.

Within the North Sea, WKNSCODID (ICES, 2020b) concluded that there were separate Viking (northeast North Sea) and Dogger (remaining North Sea) genetic populations (with boundaries agreed), with the northern offshore component of Division 6a considered likely to be part of the latter.

A process for developing a combined spatial assessment for North Sea and West of Scotland cod, accounting for the substock structure is underway, and will conclude in 2023.

The management unit is ICES Divisions 6.a plus EU and international waters of Division 5.b to the east of 12°00′W. Prior to 2009, the TAC was set for ICES subareas 6, 12 and 14 plus Subdivision 5.b.1.

Recent management

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

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

With the full implementation of the landing obligation in 2019 for fisheries catching cod, a bycatch TAC of 1735 t was set to allow mixed fisheries with a bycatch of cod to continue. In 2020, this TAC has been reduced to 1279 t. The agreed TAC has remained at this level in 2021 and 2022, although the quota share has changed (as agreed under the EU-UK Trade and Cooperation Agreement). A breakdown of these TACs by country can be found below.

TAC 2020

Species:	Cod *Gadus morhua*		Zone:	6a; Union and international waters of 5b east of 12°00′ W (COD/5BE6A)
Belgium	2	(1)	Analytical TAC	
Germany	19	(1)	Article 8 of this Regulation applies	
France	203	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply	
Ireland	284	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply	
United Kingdom	771	(1)		
Union	1 279	(1)		
TAC	1 279	(1)		

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

TAC 2021

Species:	Cod *Gadus morhua*		Zone:	6a; United Kingdom and international waters of 5b east of 12°00′ W (COD/5BE6A)
Belgium	2	(1)	Analytical TAC	
Germany	12	(1)		
France	130	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply	
Ireland	243	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply Article 9 of this Regulation applies	
Union	387	(1)		
United Kingdom	892	(1)		
TAC	1 279	(1)		

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

TAC 2022

Species:	Cod *Gadus morhua*		Zone	6a; United Kingdom and international waters of 5b east of 12° 00′ W (COD/5BE6A)
Belgium	2	(1)	Analytical TAC	
Germany	11	(1)	Article 9 of this Regulation applies	
France	117	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply	
Ireland	219	(1)		
Union	349	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply	
United Kingdom	930	(1)		
TAC	1 279	(1)		

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

Technical measures applicable to the West of Scotland, including those associated with the cod recovery plan in force up to 2008 (Council Regulation No. 423/2004), the cod long-term management plan in force from 2009 (Council Regulation No. 1342/2008) were amended by Council Regulation No. 1243/2012. The management plan was further amended in 2016 by Council

Regulation (EU) 2016/2094 to cover the transitional period in which preparations are ongoing towards multiannual plans for multispecies fisheries. In 2018, the cod management plan was discontinued. Cod in Division 6.a is not included as a named target species in the EU multiannual plan for Western Waters (Council Regulation (EU) 2019/472).

3.2.3 The fishery in 2021

The table of official landings statistics is given in Table 3.1 and Figure 3.1. Official landings increased in 2021 (1209 t) compared to 2020 (983 t). Note that updates to official landings data for 2019 associated with national GDPR clauses means that data for this year are now incomplete. In 2021, over 75% of the official landings were reported by UK vessels, approximately 15 % by France with smaller amounts declared by Ireland and Spain. The majority of reported cod landings in Division 6.a are now taken in the far north of the area. In 2021, officially reported BMS (below minimum size) landings of cod in Division 6.a were less than half a tonne.

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 believed to occur. The UK legislation introduced in 2006 is also believed to be responsible for a significant increase in discards starting in 2006. Following the full implementation of the landing obligation (2019 onwards) for fisheries catching cod and the availability of a bycatch TAC rather than a 1.5% bycatch allowance, discard rates have been much reduced since 2019 although area misreporting continues to occur (albeit at an apparently lower level in recent years).

3.3 Data

Catch data

Area-misreported landings by the Scottish fleet have been considered to represent a considerable proportion of the total landings. One of the main focuses of the 2020 benchmark was deriving an objective approach for estimating area misreported landings based on an analysis of VMS data linked to daily logbook landings (WD 4.4, ICES, 2020a) rather than using estimates provided by Marine Scotland Compliance (MS-C) based on fishery observations and expert judgement (as used by the WG prior to the 2020 benchmark). However, UK VMS data for 2019 onwards have not been submitted in accordance with the VMS data call deadline and hence have not been available prior to WGCSE. Therefore, as in 2020 and 2021, the WG again had to revert to making use of area misreported landings estimates provided by MS-C. Figure 3.2 and Table 3.2 shows the time-series of estimates of area misreported landings (which come from the UKS large mesh demersal trawl fleet) alongside reported landings for Division 6.a. Total estimated area misreported Division 6.a cod landings in 2021 are 49 t. This represents a decline both in total weight of area-misreported landings and also a reduction in the proportion relative to total landings remains similar (<5 %). These landings are largely reported into Division 4.a, but assumed to actually be taken in Division 6.a. It is not clear why this sharp reduction has taken place. The approaches to identify area-misreporting used by MS-C have not changed since 2020. One explanation could be that an increase in quota share for 6a (for the UK) coupled with a highly restrictive N Sea cod quota have meant that there is less need/opportunity to area misreport across the 4 degrees west line.

The landings uploaded into InterCatch are shown in Figure 3.3 by métier and country, and discard proportions by weight shown in Figure 3.4. The French OTB_DEF≥120 métier is the largest metier with unsampled landings and represents 9% of the total landings in 2021.

In 2021, fishery sampling continued to be disrupted by the COVID-19 pandemic. Sampling of both landings and discards from the main fleet (Scottish OTB_DEF) remained at around half the number of trips in pre-pandemic years. While the number of samples was lower for this fleet, samples were available from both sources (landings and discards) with reasonable seasonal coverage. The most significant impact of the reduced sampling was on the number of samples and seasonal coverage of discard samples from the *Nephrops* trawl fleet (Scottish OTB_CRU). The number of samples from this fleet was around 25% of typical levels (four trips). This fleet usually has a discard rate of almost 100%, but none of the sampled trips caught (and discarded) any cod. Given that there have been no changes in selectivity devices used in the fishery that would result in a reduction in discards, it was considered that these trips were unlikely to be representative of the fishery as a whole and the estimates of zero discards were not uploaded into InterCatch.

Following an analysis of Scottish catch sampling data conducted at WKDEM (ICES, 2020a), it was agreed that for the purposes of allocated age compositions and discard rates, the area-misreported landings should be considered as 'sampled' landings and treated as part of the Scottish demersal trawl fleet. This is in contrast to previous assessment WGs where the area-misreported component was considered un-sampled and were assumed to have zero discards and landings age compositions consistent with the total sampled landings (i.e. all countries).

Due to the lack of discard sampling from the OTB_CRU fleet in 2021, discard proportions and landings and discard age distributions for all unsampled fleets were assigned from the only sampled fleets (Scottish & Irish OTB_DEF fleets) within InterCatch (representing a deviation from the Stock Annex). Allocated discard rates using this approach are shown in Figure 3.5 and estimated total catch by metier in Figure 3.6. The final mix of numbers-at-age from sampled and unsampled landings and sampled and raised (un-sampled) discards is given in Figure 3.7. An extremely small amount (<0.5 t) of below minimum size (BMS) landings was also reported, but is not shown. There is a noticeable lack of age 1 fish in the catch in 2021. Figure 3.8 shows the breakdown of catch numbers-at-age by fleet (OTB_DEF/OTB_CRU) and catch category (landings/discard) in 2021 compared to 2018–2020 (note that 2018 is pre-LO). The OTB_CRU fleet typically catches younger individuals than the OTB_DEF fleet and a significant proportion of the catch numbers-at-age 1 (and to a lesser degree age 2) in 2018–2020 are taken by the OTB_CRU fleet (grey colour in Figure 3.8). These are absent from the data in 2021. As a result, the WG concluded that total discards and catch numbers-at-age 1 and 2 for 2021 were likely to be underestimated due to the lack of samples from the OTB_CRU fleet.

Sampling levels (number of trips) by country are given below and compared to 2019. A limited number of Northern Irish samples are also available in 2020 and 2021. Sampling of the Scottish OTB_DEF landings has been quite poor in the recent past. The small sample sizes (which include a few very large fish with high raising factors) can result in a very high sum of products (SOP, landings-at-age x weight-at-age) for this fleet in some years.

		Scotland			Ireland
	Year	Demersal trawl (OTB_DEF)	*Nephrops* trawl (OTB_CRU)	Total	Total
2019	Landings	19	1	20	21
	Observer	22	18	40	28
2020	Landings	9	1	10	24
	Observer	10	4	14	5
2021	Landings	11	0	11	28
	Observer	9	0^	9	10

^ Four trips sampled with zero discards. Not used due to low confidence in estimates due to low sample size.

The WG estimates of total landings and discards are given in Table 3.2 and shown in Figure 3.9. The total discard proportion by weight is shown in Figure 3.10, and while this has increased somewhat in 2021 (~35%) compared to 2019 (9%), it remains well below the previous 3-year average. (2016–2018) when the discard proportion was estimated to be in excess of 70% of the total catch.

In contrast to the period 2006 to 2018 when there was substantial highgrading and discarding occurring (to some degree) over all age classes, during the years 2019 to 2021, discarding is mostly limited to ages 1 and 2 (and to a lesser degree age 3) (Figures 3.11 and 3.12). In 2021, there is a reduction in discard proportion at age 1 compared the previous ten years. However, given the lack of *Nephrops* discard sampling data (and the underestimate of discards at age 1), it seems unlikely that this apparent reduction is a true indication of changes in the fishery.

Age-compositions and weights-at-age

Raised landings numbers-at-age and discard numbers-at-age are given in Tables 3.3 and 3.5 respectively and total catch numbers-at-age in Table 3.7.

Annual mean weights-at-age in landings, discards and catch are given in Tables 3.4, 3.6 and 3.8. Figure 3.13 shows the mean weights-at-age in the landings and discards. The mean weight of age two and three fish in the landings increased since the mid-2000s in line with the increase in highgrading which occurred at these ages. Other age classes show fluctuations with a long-term downward trend particularly for ages 5 and above. Values at older age are noisy, particularly in recent years (most likely due to low sampling levels). Mean weight-at-age in the discards shows no real trend between 2006 and 2018. In 2020, there is a decline in mean weight-at-age in both the landings and discards at age 1. While the 2020 estimates remain well within historical values (and are not extreme), the lower discard mean weight could potentially be due to the lack of discard samples from quarter 2 onwards (i.e. after individuals have grown) from the *Nephrops* fleet which is typically the most important fleet for age 1 discards. (See above for COVID-19 samples disruption). The reason for the decline in mean weight-at-age 1 in the landings is harder to explain and potentially is noise related to low sample sizes or increased retention of smaller fish (due to the LO). In 2021, there is a substantial increase in mean discard weight (and subsequently catch weight) at age 1 and 2. Closer inspection of mean discard weights-at-age by fleet (Scottish data), Figure 3.14, suggests that this may be due to a lack of samples from the OTB_CRU fleet as this fleet generally catches smaller individuals (at age) than the OTB_DEF fleet. In addition, a number of very large age 1 fish were recorded in 2021 OTB_DEF samples which contribute to the high value. The WG agreed that these discard (and catch) mean weights-at-age in 2021 are therefore likely to be biased estimates.

Biological data

Given the trends in observed mean weights, WKDEM proposed the use of a temporally varying natural mortality would be more appropriate. The catch weights show high interannual variability (Figure 3.13) and therefore it was agreed to use smoothed catch weights as stock weights and then use these with the Lorenzen (1996) function with the 'natural' parameters to obtain natural mortality (WD 4.3, ICES, 2020a).

To derive the stock weights, a GAM is fitted to mean catch weights-at-age (Figure 3.14). Refitting the GAM each year results in typically minor revisions to stock weights used to estimate SSB between assessment years (and also natural mortality, WD 4.3, ICES, 2020a). Including the biased estimates of mean catch weight-at-age 1 and 2 in 2021 in the GAM has a significant impact on the estimated stock weights-at-age. The WG therefore agreed that these values should be excluded from the smoothing process for estimating stock weights, and stock weights-at-age 1 and 2 for 2021 should be set equal to the estimated values for 2020.

The catch mean weight-at-age 2 in 2019 remains a substantial outlier. At WGCSE 2020, the sampling data for 2019 were scrutinized in detail and the estimate could not be attributed to a particularly anomalous or influential sample and therefore the datapoint was considered valid (See ICES, 2020 for further details).

At all ages there is a general downward trend in catch weights (and hence stock weights) over time although with an apparent recent increase at ages 3 and 4. This results in increases in natural mortality, although at most ages the scale of this increase is very small (Figure 3.15). Stock weights and natural mortality are given in Tables 3.9 and 3.10.

The maturity ogive was also updated at WKDEM. An analysis of Scottish survey data (following the approach advocated by ICES, 2008) indicated a proportion of individuals at age 1 to be mature, but no temporal trend in maturity. A new ogive was therefore used for the full time-series (WD 4.2, ICES, 2020a).

Age	1	2	3	4	5	6	7+
WGCSE 2019	0	0.52	0.86	1.0	1.0	1.0	1.0
WKDEM/WGCSE 2020 onwards	0.27	0.53	0.48	0.91	0.97	0.99	1.0

Survey data

All available survey data are given in Table 3.11, with the data used in the assessment highlighted in bold. Survey descriptions are given in the stock annex. Since the inter-benchmark in 2019 (IBPCod6.a), the assessment makes use of three quarter four surveys (one of which is no longer current) and two quarter one surveys (one of which is discontinued). Survey indices for the two current Scottish surveys (UK-SCOWCGFS- Q1 and UK-SCOWCGFS- Q4) are provided with an estimate of variance.

The CPUE by survey haul for recent years for the two Scottish surveys (UK-SCOWCGFS- Q1 and UK-SCOWCGFS- Q4) are shown in Figure 3.16. Both surveys show mostly zero returns over latitudes between 56 degrees N and 58.5 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 closed area although these seem to have reduced in recent years (coincidental with a reduction in the size of the area closed to fishing, Figure 3.16). South of 56 degrees N, the Q1 surveys catch mostly young cod in the Clyde region. Occasional very large hauls associated with apparent aggregations of older cod (typically age 3 and above) have a significant impact on the survey indices and their variance estimates. In 2017, the indices for age four, five and six cod in the quarter one survey show particularly high uncertainty due to a single very large haul (Figure 3.16) of large cod with most other stations having very low or zero values. In 2018 (in the same survey), there were no large hauls and therefore the estimated variance is low. In 2019, the quarter one survey shows very low catch rates of ages >1 across the survey area, but relatively high catch rates (compared to recent years) of age 1 fish.

The quarter four survey estimates also have substantial uncertainty. This is particularly apparent in the 2016 survey with a CV of over 70% at age 4, and to a lesser degree in the 2018 survey with two hauls catching large numbers of individuals aged 4 to 6 and very low catches elsewhere, resulting in CVs of around 60% for these ages in this year.

Due to vessel breakdown the Scottish Q1 survey was not carried out in 2022.

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

3.4 Stock assessment

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

Data screening

Log catch (landings + discards) numbers-at-age over time (Figure 3.17) show good tracking of strong and weak cohorts historically. These signals become less apparent and more noisy after 2010, potentially due to low sampling levels and/or ageing errors. There is however, a clear indication of increasing numbers of older fish appearing in the catch since this time, which would be consistent with a reduction in fishing mortality. Catch curves from commercial catch-at-age data are also shown in Figure 3.17. Although the data are noisy, there is some evidence of a flattening off of the catch curves in recent years compared to those of the cohorts spawned in the late 1990s. Figure 3.17 shows that the log catch numbers-at-age 1 are by far the lowest of the time-series which supports the view that these are potentially biased (due to lack of OTB_CRU discard sampling).

A plot of log catch curve gradients derived from commercial catch data over different age ranges is shown in Figure 3.18. Here too there is some evidence of a decreasing mortality in recent years. (Note that these exploratory catch data plots are based on reported landings and discards and will be influenced in part by underreporting of landings in the 1990s and early 2000s).

Figure 3.19 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 up to age 4.

More recently the data become rather noisy and since 2018, the proportion of the catch-at-age at age four and above are very high. These observations are not supported consistently by above average values at younger ages of the same cohort. Potentially this could be associated with a slight change in the distribution of the fishery and access to a previously closed area (illustrated in Figure 3.16) where a significant proportion of the older fish are located (Figure 3.16), however recent VMS data are unavailable and hence this hypothesis cannot be substantiated.

Figure 3.20 shows the log mean standardised indices from the ScoGFS-WIBTS-Q1 survey by year and by cohort. The early part of the time-series appears to track the cohorts relatively well with no obvious year effects. However, in later years the indices become noisier and there is some evidence of year effects in the survey. The survey ended in 2010. Figure 3.21 shows log catch curves for the ScoGFS-WIBTS-Q1 survey. It shows a strong "hook" at the younger ages (lower catchability), 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 3.22) 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 that would be consistent with a change in mortality (Figure 3.23) for any of the age ranges considered.

Figure 3.24 shows the log mean standardised indices by cohort and year from the ScoGFS-WIBTS-Q4 survey. The survey shows reasonable tracking of cohorts at ages one to three and no particular evidence of year effects. This is also evident in the survey scatterplots which show reasonable correlation at younger ages (Figure 3.25). This survey catches very few fish at ages five and above.

Figure 3.26 shows the log mean standardised indices by cohort and year from the IRGFS-WIBTS-Q4. The log mean standardised indices plot shows consistent signals at ages 1 and 2 early in the time-series with no obvious year effects. The scatterplots (Figure 3.28) also show reasonable consistency between ages one and two, but the tracking at older ages is less strong. The data cover too few age classes sufficiently well to give an indication of trend in mortality through catch curve gradients (Figure 3.27).

Figure 3.29 shows log mean standardised indices by cohort and year from the UK-SCOWCGFS-Q1. Cohorts tracking within this survey is inconsistent and there is some evidence of survey year effects (2015, 2017 and 2019, particularly for older ages). There appeared to be a general increase in the catch rates of older ages over time to 2017 (four and above), but no equivalent increase in the catch rates of younger ages (from the same cohort). These declined significantly in 2018 and 2019.

The log catch curves from the UK-SCOWCGFS- Q1 are also very noisy (Figure 3.30) 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) show weak positive correlation (Figure 3.31).

Figure 3.32 shows log mean standardised indices by cohort and year from the UK-SCOWCGFS-Q4. There is some evidence of cohort tracking, but this is not consistent over time or ages and this is also apparent in the survey scatterplots shown in Figure 3.34. Figure 3.33 shows the log catch curves from the UK-SCOWCGFS-Q4 which are noisy and difficult to interpret given the short time-series and missing year of survey data.

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

Figure 3.35 shows a comparison (between surveys) of log mean standardised survey indices at age over time (mean standardised over the common year range of all three surveys). The two

Scottish surveys show reasonable consistency over ages two to four, despite being noisy. The Irish survey also shows reasonable agreement at age two. At older ages (in the Scottish surveys), the general trends are similar, but show different interannual variations.

The inter-benchmark in 2019 agreed that all five surveys should be included in the final assessment (and this was followed at WKDEM in 2020), the basis being that the additional surveys show reasonable internal consistency and in addition, some between survey consistency. It was considered that the Irish survey could provide an additional indicator of year-class strength and could be useful as it covers the period during which there is a break in the Scottish survey indices. The lack of spatial coverage of this survey (only the southern part of Division 6.a) was deemed less important given the index is only being used to provide information on the younger ages.

Final assessment

The SAM configuration file for the final assessment model run is given in Table 3.12. To summarise the main features:

- Fishing mortality at ages 4 and above are assumed equal (See # Coupling of the fishing mortality states, Table 3.12).
- Survey catchabilities are mostly freely estimated for each age with the exception of the two oldest ages (i.e. no survey catchability plateau assumed). The exception to this is the WIBTS.Q1 for which all catchabilities are independently estimated.
- Catch observation variance parameters are allowed to differ for age 1 and age 7+ while other age groups are coupled (# Coupling of the variance parameters for the observations). To allow for greater uncertainty in the catch data for 2006 onwards (when the fishery changes from being a landings fishery to largely discards), the estimated catch observation error standard deviation is doubled for 2006 onwards (based on inspection of the one step ahead residuals).
- Survey observation variance parameters differ between surveys but are coupled for all age groups within a survey.
- Recruitment is modelled as a random walk.
- A catch scaling factor is estimated for 1995–2006 when underreporting of landings was considered significant.
- Fishing mortality across ages is modelled with AR(1) and process variance parameters coupled across all ages with the exception of age 1. Process variance in stock numbers-at-age were assumed coupled with the exception of age 1 (the age at recruitment).

Input data are derived as agreed at the 2020 benchmark with a number of exceptions:

- the use of MS-C estimates of area-misreported landings for 2019–2021 rather than estimates from VMS data (as per assessment WGs in 2020 and 2021). A comparison of VMS estimates and MS-C estimates carried out at WKDEM suggested VMS estimates were generally lower with some correlation between the two sets of estimates.
- The lack of an intermediate year survey (Q1 2022 data missing) due to vessel breakdown.
- The exclusion of age 1 and age 2 catch numbers-at-age due to concerns over bias (likely underestimated) due to lack of discard sampling from the OTB_CRU fleet.

Sensitivity analyses have been conducted to explore the potential impacts of the missing survey data and the exclusion of the catch data. (No further sensitivity analysis was carried out regarding the use of MS-C data since this approach has now been utilised at the past three assessment WGs).

Figure 3.36 shows a retrospective sensitivity analysis to the exclusion of the intermediate year data i.e. comparing previous years' assessments with and without these data included. While the intermediate year estimate of recruitment is sensitive to the inclusion (or not) of the intermediate year survey, the exclusion of the data does not result in major historical revisions to either recruitment, SSB or F. In addition, the analysis also suggests that the use of the intermediate year survey to estimate recruitment does not always provide a good estimate of recruitment (2020 value revised downwards) and that a resampled value (or GM) may in fact provide a better estimate.

The retrospective sensitivity analysis to the exclusion of the age 1 and age 2 catch in the final year also suggests that the assessment is relatively insensitive to the removal of these data in previous years (Figure 3.37) when compared to the assessment runs including all catch data (Intermediate year survey excluded from these assessment runs).

The fits of the model to observations (catch and survey indices on a log scale) are shown in Figures 3.38 to 3.43. The fits to the survey data appear better at younger ages while the model appears to follow the catch data better at ages 2 and above (age 1 observations are likely to be noisier due to uncertain discard estimates).

The standardised one step ahead residuals are shown in Figure 3.44. There are no major outliers in the residuals, with most lying within ±2. There are a few patterns apparent in the (discontinued) survey residuals which are rather similar to those observed in previous TSA assessments (ICES, 2019a & b) and at WKDEM (ICES, 2020): most notably some evidence of a tendency to more positive residuals in the latter half of the WCIBTS.Q1 (at age 1) and WCIBTS.Q4 (at age 2) and some year effects in most of the surveys (years with mostly positive or mostly negative residuals).

The model runs which leave out each survey index in turn are shown in Figure 3.45. With the exception of the period when total catches are excluded from the assessment (catch-scaling factor estimated for 1995–2006), the estimates of SSB and recruitment are relatively robust to the exclusion of the different survey series. Excluding the early Scottish Q4 survey (WCIBTS.Q4) results in higher estimates of SSB, recruitment and catch than the baseline run during this period (when catches area excluded) and excluding the early Scottish Q1 survey much lower estimates. When the WCIBTS.Q4 is excluded, estimates of mean F are lower than the baseline during the first part of this period (to 2000) and higher than the baseline after 2000 while excluding the WCIBTS.Q1 shows the opposite effect. The relative magnitude of the changes when each of these surveys are excluded suggests the WCIBTS.Q1 to be much more influential in the overall assessment of stock trends.

When the SCO.Q4 survey series is excluded there is a downward revision in the estimate of fishing mortality in the final year (although still within the confidence bounds of the estimate) while excluding either the SCO.Q1 or the Irish survey index appears to have little impact on the assessment results.

The retrospective analysis is shown in Figure 3.46. Although the Mohn's rho value for F is within the bounds advised by WKFORBIAS (ICES, 2020c), two of the peels lie outside the confidence intervals of the final assessment run. There appears to be some tendency to over-estimate F. The estimates of mean F appear to be substantially more noisy than SSB. The Mohn's rho values (as %) are as follows:

SSB	Mean F	Recruitment
-13.4	15.4	7.5

In contrast to previous assessments, the recruitment and SSB Mohn's rho do not include the intermediate year in each assessment peel (as this year's assessment does not include an intermediate year survey and hence SSB and R estimates are not available for this year from the assessment). The Mohn's rho in recruitment is therefore much lower than in previous years as the intermediate year estimate typically shows substantial revisions with the inclusion of additional years' data.

Final parameter estimates from the SAM run are given in Table 3.13. Table 3.14 gives the SAM population numbers-at-age and Table 3.15 the estimated F at-age. A full summary output is given in Table 3.16 (including model estimates of catch and catch scaling parameters).

Stock status

The summary plot including reference points is shown in Figure 3.47 and the stock–recruitment estimates are shown in Figure 3.48. The estimated SSB shows a steady downward trend until 2006, an increase to 2016 and then a further decline since then. Recruitment has been very low since 2001 and is extremely poor in 2016–2018 and also in 2021. Although fishing mortality declined between 2009 and 2016 to below F_{lim}, it has shown a slight increase since then and is estimated to be just above F_{lim} in 2020. It is not known whether, and to what extent, this increase is associated with the discontinuation of the days-at-sea regulation in 2017, which was part of the cod recovery plan.

Estimated SSB in the final year is well below B_{lim} (= 14 376 tonnes). Mean F is well above F_{MSY} and has been fluctuating around F_{lim} since 2013. Although the latest assessment shows a flattening off of F since 2013, there has been a clear decrease in mean F since 2009. The decline in mean F is proportionately similar (~50%) to the decline in STECF effort (large and small mesh demersal/crustacean trawl from both regulated and unregulated fleets), although the mean F does not start to decline until several years after the effort.

3.5 Short-term stock projections

Forecasting in SAM takes the form of short-term stochastic projections. A total of 10 000 samples are generated from the estimated distribution of survivors. These replicates are then simulated forward according to model and forecast assumptions (see below), using the usual exponential decay equations, but also incorporating the stochastic survival process (using the estimated survival standard deviation) and subject to different catch-options scenarios.

Some modification to the forecast assumptions has been necessary due to the data issues outlined above (lack of intermediate year survey in 2022 and unreliable catch data at age 1 and 2). Recruitment in the forecast has been resampled from the assessment estimates for 2016 to 2021. This choice was made due to an apparent further reduction in the level of recruitment in this period (usually a ten year window is chosen). The lack of an intermediate year (2022) recruitment estimate from the assessment (lack of intermediate year survey data) has meant a necessary change to the recruitment assumptions with the resampled recruitment also used for the intermediate year in this year's forecast.

Fishing mortality in the intermediate year (2022) was taken as a three-year average over 2019 to 2021 as an estimate of F status quo (given that there is no particular trend in mean F).

Cod in Division 6a has been fully under the landings obligation since 2019 when a bycatch TAC of 1735 t was set to allow mixed fisheries with a cod bycatch to continue (in contrast to a 0 t TAC with 1.5% bycatch regulation in previous years). For 2020 and 2021, the bycatch TAC was reduced to 1279 t. These increases in TAC (and the introduction of the LO) appear to have resulted in a significant change in discarding practices since 2019. The partition of catch into landing/discards components in the forecast is therefore based on a recent three-year average (2019–2021) with the exception of ages 1 and 2 for which the 2021 data are excluded due to the concerns regarding biases in the data for these ages due to lack of OTB_CRU discard samples. A similar approach is also taken for the derivation of forecast mean weights-at-age due to the likely biases in catch mean weights-at-age 1 and 2 in 2021 (See Section 3.3). A summary of the forecast assumptions is given in Table 3.17.

Under the forecast assumption of status quo F, landings in 2022 are predicted to be 1333 t and discards to be 540 t. The SSB in 2023 is forecast to be 2923 t which is well below B_{lim}. This value (2923 t) is similar to that forecast for 2023 from the assessment carried out in 2021 (3038 t) under fishing at F_{lim} (=0.73), similar to this year's 2022 intermediate year assumption.

The forecast under different catch scenarios for 2023 is shown in Table 3.18. Note that the values that appear in the catch scenarios are medians from the distributions that result from the stochastic forecast.

The forecast stock trajectory under the proposed advice for 2023 (shows an increase in SSB in 2024 (Figure 3.49). Figure 3.50 shows the contribution by recruitment year to SSB in 2024 and catch in 2023 (when fished at F_{MSY}). The assumption regarding recruitment in 2022 to 2024 contribute approximately 50% of SSB in 2024 and 15% of the 2023 catch. (Figure 3.50). These values are substantially higher than those reported last year due to the intermediate year recruitment being assumed (rather than an assessment estimate) in this year's forecast.

3.5.1 Reference points

Both MSY and precautionary reference points were reconsidered at WKDEM in February 2020 in accordance with ICES guidelines and are shown below (weights in tonnes). The estimate of F_{MSY} is derived from simulation based on segmented regression stock–recruitment only as both the Ricker and Beverton–Holt stock–recruitment relationships suggest peaks well outside the range of observed values. As in the estimates derived at IBPCOD.6A, yield is defined as catch above MCRS (estimated by assuming a historical discard rate prior to highgrading).

	WKMSYREF4	IBPCod.6a	WKDEM 2020	Rationale (WKDEM; ICES 2020a)
B_{lim}	14 000	14 000	14 376	Tonnes; SSB consistent with high probability of above average recruitment (SSB in 1992 as estimated by WKDEM)
B_{pa}	20 000	20 000	20 126	Tonnes; 1.4 x B_{lim}
F_{lim}	0.82	0.77	0.73	F with 50% probability of SSB<B_{lim}
F_{pa}	0.59	0.55	0.57^	Fp.05; the F that leads to SSB ≥ B_{lim} with 95% probability with ICES AR^
F_{MSY}	0.167	0.29	0.30	Based on simulation using a segmented regression stock–recruitment relationship (EqSim)
MSY $B_{trigger}$	20 000	20 000	20 126	B_{pa}
F_{MSY} upper	0.254	0.41	0.49	F at 95% MSY (above F_{MSY})
F_{MSY} lower	0.108	0.20	0.18	F at 95 % MSY (below F_{MSY})

^ Updated at WGCSE 2021 following guidance issued by ACOM. Fp.05 value derived at WKDEM 2020.

3.5.2 Management plans

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

3.6 Quality of the assessment

Figure 3.51 shows a comparison between this year's and previous year's assessments. The revised estimates of recruitment and SSB compared to pre-2020 assessments are largely the result of the inclusion of the updated historical catch data at WKDEM (ICES, 2020a). The benchmark changes to the assessment had only minor impact on the perception of the stock.

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 the five years, 2014–2018, area misreported landings accounted for over 50% of the total landings although that has reduced to around 20% in more recent years (and <5% in 2021). The misreporting estimates for 2019–2021have been provided by Marine Scotland Compliance based on intelligence and consideration of VMS data (i.e. vessel activity) due to a lack of access to UK VMS data for these years (See Sections 3.1 and 3.3). Estimates for earlier years are derived from VMS data analysis conducted at WKDEM (ICES, 2020a) and these are somewhat lower than MS-C estimates for those years.

Discards

Although discards have reduced significantly in recent years due to the availability of a bycatch TAC and the implementation of the LO, over the last three years discarding accounts for around 20% of the total catch. Despite an increase in sampling levels, discard estimates are still very uncertain (approximate CV = 50% for Scottish large mesh demersal fleet in 2017) contributing to uncertainty in the estimates of mean F.

In 2020 and 2021, discard sampling, and to a lesser extent landings sampling, has been disrupted due to the COVID-19 pandemic, with the most significant impact on the number of samples and seasonal coverage of discard samples from the *Nephrops* trawl fleet. Due to the lack of *Nephrops* fishery discard samples in 2021, total discards and catch numbers-at-age 1 and 2 are considered to be underestimated and not included in the assessment. This is likely to result in increased uncertainty in the estimates of recruitment in 2021.

Biological factors

Cod consumption by seals (derived from diet composition studies and seal abundance estimates) is estimated to be 7632 tonnes (95% CI: 3542–13 937) in 2010 (Hammond and Wilson, 2016) compared to a TSB estimate of just under 6000 tonnes from the SAM assessment and it has been suggested that seals may be impairing the recovery of this stock. However, there is uncertainty as to whether the seals are actually exploiting the same population as the fishery. Seal foraging mostly occurs on the continental shelf (Russell *et al*., 2017) including rocky areas which are unsuitable for trawl fishing and are not surveyed on RV trips, while most of the cod landings are taken along the continental shelf edge in the north of Division 6a (STECF, 2016) and thus the seals and fishery are largely operating in different areas. Given the complex stock structure and the presence of coastal cod populations, it is clear there is potential for the seals and fishery to be exploiting different substocks.

The final SAM assessment assumes natural mortality to be a function of stock weight-at-age (Lorenzen, 1996) which are in turn derived from smoothed catch weights-at-age. Natural mortality clearly remains a major source of uncertainty in this assessment and incorrect assumptions regarding its trend and magnitude can have a significant impact on estimates of stock status.

Stock structure

Stock structure is complex and a number of different subpopulations are known to occur within this area (WK6aCodID; ICES, 2022). The stock assessment therefore represents an assessment of multiple substocks with the northern component accounting for most of the landings since the mid-2000s. 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 closed area) bordering Division 4.a. A process is underway within ICES to develop a spatial assessment for Northern Shelf cod (North Sea plus Division 6a) which accounts more appropriately for this substock structure.

Assessment method

The benchmark agreed on the final SAM model configuration by comparing model residuals, AIC and retrospective patterns. There remain some patterns in the residuals particularly in the later surveys which are very noisy and the various sensitivity analyses conducted at WKDEM had little impact on these. Other assessment models also show similar problems. The retrospective analysis in the SAM shows overestimation of fishing mortality during the initial years of decline in mean F (although not persistent across all years of the retrospective analysis), which may suggest the model reacts slowly to changes in fishing mortality.

The input data for this cod assessment are particularly uncertain (both survey indices and commercial data) and as a result, the data can be interpreted in different ways by different assessment methods. The assessment presented by Cook (2019) and a number of exploratory assessments presented at WKDEM show a stock which by 2016 had recovered to levels consistent with those of the 1990s (although with a subsequent decline since then) while the SAM assessment shows little sign of SSB recovery. In this respect, the SAM assessment is very similar to the previous TSA and exploratory a4a assessments considered at the benchmark (ICES, 2020a). The key differences between the Cook (2019) model and the ICES assessment appears to be in the estimates of fishery selectivity and survey catchability and these result in substantial differences in stock trends. An extensive discussion on the plausibility of the estimates can be found in Section 4.3 of ICES (2020a).

Given these model uncertainties, estimates of uncertainty from the final SAM assessment are therefore unlikely to adequately reflect the true uncertainty in the estimates of stock biomass and fishing mortality for this stock.

3.6.1 Recommendation for next Benchmark

problem	solution	expertise necessary[1]	suggested time
Stock identity – multiple substocks within 6a and linkage with northern North Sea	Evaluate a possible merge between northern North Sea and 6.a cod stocks. Or as an alternative, split area 6.a in two areas North and South. Requires development of spatial SAM (or alternative) plus derivation of appropriate substock data sets as necessary (catch, survey & biological)	Scientists from MSS, Cefas & DTUAqua	Next benchmark although would need collaboration with WGNSSK.
Noisy survey data	Explore modelled indices using e.g. delta-logN approach and also modelled ALKs.	Scientists from MSS	Ahead of next benchmark.
Fishery selectivity pattern	Flat-topped & dome-shaped selectivity pattern both plausible – modelling the main fleets separately may help. Implement multifleet SAM assessment.	Scientists from MSS	Fleet-disaggregated data now available in InterCatch for 2003 onwards. Exploratory assessment to be put together ahead of next benchmark.
Assessment model uncertainty – different models with the same assumptions result in quite different stock status	Application of a multiple model approach.	Scientists from MSS	Could be explored as part of WKENSEMBLE. In preparation for next benchmark.

[1] MSS = Marine Scotland Science.

3.6.2 Management considerations

The fisheries for cod have been fully under the landing obligation from 2019 onwards. In the past they have been managed by a combination of landings limits, area closures and technical measures. The measures taken thus far have not recovered the stock. Although fishing mortality declined between 2009 and 2016, it has shown an increase since then. It is not known whether, and to what extent, this increase is associated with the discontinuation of the days-at-sea regulation in 2017, which was part of the cod recovery plan.

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

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

Although the UK ‘Buyers and Sellers’ and Irish ‘Sales Notes’ legislation is considered to have reduced underreporting from 2006, discard data showed increased discards at-ages one and two and a change in discard practices such that fish are discarded at older ages from 2006–2018 (i.e. such that the discards were largely highgrading). With the full implementation of the landing obligation in 2019 for fisheries catching cod, a bycatch TAC of 1735 t was set to allow mixed fisheries with a bycatch of cod to continue. The fishery has responded to this by reducing discards, particularly at older ages. The forecast assumes that this discarding behaviour will continue in future. The bycatch TAC has been reduced to 1279 t for 2020 and 2021.

Estimates of area misreporting (landings believed to be taken in Division 6.a and reported elsewhere) imply ICES landings estimates that are in excess of TAC. Area misreported landings accounted for around 20% of the total landings in 2019–2021 which is a reduction on previous years.

Cod is taken in mixed demersal fisheries, and in Division 6.a is a bycatch species. To greatly reduce cod catch would likely result in having to greatly reduce harvesting of other stocks such as haddock, whiting and anglerfish. It is also important the bycatch from the *Nephrops* fleet is closely monitored (including discard observations). Typically, large trawl gear vessels targeting finfish are responsible for around 90% of cod catches in Division 6.a, the *Nephrops* fleet take approximately 4% and the remainder are taken by other gears, including longliners and gillnets. (Note that data for 2021 are unreliable due to lack of OTB_CRU discard sampling).

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).

Cod to the west of Scotland (6a.) are believed to comprise of at least two subpopulations and potentially linked to cod in the North Sea (4a). The current assessments and management do not capture this dynamic as they are treated independently.

3.7 References

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Table 3.1. Cod.27.6a. ICES official catch statistics.

Country	Belgium	Denmark	Faroe Islands	France	Germany	Greenland	Ireland	Netherlands	Norway	Spain	UK (E, W, N.I.)	UK (Scotland)	UK	Official BMS	Total
1985	48	-	-	7411	66	-	2564	-	204	28	260	8032	-		18613
1986	88	-	-	5096	53	-	1704	-	174	-	160	4251	-		11526
1987	33	4	-	5044	12	-	2442	-	77	-	444	11143	-		19199
1988	44	1	11	7669	25	-	2551	-	186	-	230	8465	-		19182
1989	28	3	26	3640	281	-	1642	-	207	85	278	9236	-		15426
1990	-	2	-	2220	586	-	1200	-	150	-	230	7389	-		11777
1991	6	2	-	2503	60	-	761	-	40	-	511	6751	-		10634
1992	-	3	-	1957	5	-	761	-	171	-	577	5543	-		9017
1993	22	2	-	3047	94	-	645	-	72	-	524	6069	-		10475
1994	1	+	-	2488	100	-	825	-	51	-	419	5247	-		9131
1995	2	4	-	2533	18	-	1054	-	61	16	450	5522	-		9660
1996	+	2	-	2253	63	-	1286	-	137	+	457	5382	-		9580
1997	11	-	-	956	5	-	708	2	36	6	779	4489	-		6992
1998	1	-	-	714	6	-	478	1	36	42	474	3919	-		5671
1999	+	+	-	842	8	-	223	-	79	45	381	2711	-		4289
2000	+	-	-	236	6	-	357	-	114	14	280	2057	-		3064
2001	2	-	-	391	4	-	319	-	39	3	138	1544	-		2440
2002	+	-	-	208	+	-	210	-	88	11	195	1519	-		2231
2003	-	-	-	172	+	-	120	-	45	3	79	879	-		1298
2004	-	-	2	91	-	-	34	-	10	-	46	413	-		596
2005	-	-	-	107	-	-	28	-	17	-	25	243	-		420
2006	-	-	1	108	2	-	18	-	30	-	14	318	-		491
2007	-	-	12	92	2	-	70	-	30	-	21	260	-		487
2008	-	-	1	82	1	-	58	-	65	-	6	232	-		445
2009	-	-		74	-	-	24	-	18	-	14	104	-		234
2010	-	-	-	60	-	-	49	-	21	-	4	115	-		249

Country	Belgium	Denmark	Faroe Islands	France	Germany	Greenland	Ireland	Netherlands	Norway	Spain	UK (E, W, N.I.)	UK (Scotland)	UK	Official BMS	Total
2011	-	-	-	49	-	-	41	-	8	-	3	107	-		208
2012	-	-	-	4	-	-	18	-	2	-	2	135	-		161
2013	-	-	-	3	-	-	14	-	24	-	1	130	-		172
2014	-	-	-	5	-	-	12	-	13	-	9	121	-		160
2015	-	-	-	11	-	-	17	-	59	-	-	-	168		256
2016	-	11	-	86	-	1	28	-	39	-	-	-	183		348
2017	-	1	-	119	-	-	19	-	14	-	-	-	200		352
2018	-	+	+	101	-	-	12	-	37	-	-	-	217		367
2019	-	-	-	142	-	-	^	-	47	31	-	-	1224	+	1443^
2020*	-	-	-	139	-	3	65	-	4	32	-	-	738	2	983
2021*	-	-	-	162	-	-	98	-	-	27	-	-	923	+	1209

*** Preliminary.**

+ < 0.5 tonnes.

^Incomplete/missing due to part of the data being unavailable under national GDPR clauses.

Table 3.2. Cod.27.6a. Landings (reported into 6a and area misreported), discards, BMS and catch (tonnes) estimates, as used by the WG (caton from InterCatch).

Year	Landings		Discards	BMS	Catch
	reported	misreported			
1981	23865		303		24168
1982	21511		571		22082
1983	21305		197		21503
1984	21272		329		21601
1985	18607		963		19570
1986	11820		263		12083
1987	18971		2388		21358
1988	20413		368		20781
1989	17169		2076		19246
1990	12175		571		12746
1991	10927		622		11549
1992	9086		1779		10865
1993	10314		139		10453
1994	8928		661		9588
1995	9439		141		9580
1996	9427		63		9489
1997	7034		499		7533
1998	5714		538		6252
1999	4201		69		4270
2000	2977		821		3798
2001	2347		92		2439
2002	2243		480		2722
2003	1292		60		1353
2004	573		78		651
2005	516		54		570
2006	470	34	461		965

Year	Landings		Discards	BMS	Catch
	reported	misreported			
2007	485	30	1651		2166
2008	460	102	1037		1598
2009	231	54	1287		1572
2010	239	119	1575		1933
2011	211	130	3867		4208
2012	162	65	1914		2141
2013	172	93	1870		2136
2014	161	234	3369		3764
2015	258	270	2498		3026
2016	336	272	1499		2108
2017	355	320	3519		4195
2018	378	613	2429		3419
2019	1489	571	204		2264
2020	941	332	307	2.5	1583
2021	1215	49	642	+	1907

+ < 0.5 tonnes.

Table 3.3. Cod.27.6a. Landings-at-age (thousands). Values for 2006 onwards include an adjustment for area misreporting.

	1	2	3	4	5	6	7+
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	53	487	93	120	7	2	2
2004	45	99	90	12	27	3	1
2005	37	124	46	40	7	6	0
2006	18	97	78	23	14	2	1
2007	7	170	53	28	2	3	2
2008	0	20	106	21	13	1	2
2009	1	9	10	40	6	1	0
2010	6	80	26	20	11	1	1
2011	0	29	51	18	4	6	1
2012	1	1	18	24	3	2	2
2013	0	8	7	39	9	2	1
2014	0	5	73	34	25	2	0
2015	0	44	40	29	21	19	1
2016	1	17	82	52	17	9	11

	1	2	3	4	5	6	7+
2017	0	13	52	47	46	13	3
2018	2	10	28	78	51	32	11
2019	9	21	129	89	142	57	13
2020	7	75	9	55	44	53	30
2021	1	29	228	49	47	8	12

Table 3.4. Cod.27.6a. Mean weight-at-age in landings (kg).

	1	2	3	4	5	6	7+
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	0.659	1.046	2.272	3.82	5.932	8.022	8.681
2004	0.605	1.026	2.191	4.398	6.033	8.242	9.84
2005	0.75	1.109	2.425	3.969	4.775	6.616	10.214
2006	0.659	1.176	2.239	3.813	6.16	7.759	11.041
2007	0.728	1.127	2.592	4.322	6.503	7.738	8.83
2008	0.556	1.157	3.067	4.843	6.283	7.964	8.487
2009	0.974	2.038	2.861	4.781	6.004	8.327	9.137
2010	0.936	1.468	2.918	4.064	5.785	9.158	10.275
2011	0	1.804	2.811	4.51	5.842	6.528	9.837
2012	0.661	1.797	3.118	5.331	6.428	7.617	8.695
2013	0.957	1.368	2.933	4.075	6.135	7.144	9.842
2014	1.028	1.6	2.097	3.051	4.693	5.503	7.207
2015	0.914	2.406	2.958	3.844	5.455	5.558	9.158
2016	0.713	1.429	2.367	3.917	5.137	6.596	7.622
2017	0.902	1.229	2.063	4.533	5.616	5.081	9.243

	1	2	3	4	5	6	7+
2018	0.871	1.686	2.761	4.163	5.427	6.427	8.575
2019	0.857	1.159	2.962	4.242	5.461	7.045	8.841
2020	0.618	1.310	2.308	4.763	5.957	6.362	6.448
2021	0.908	1.207	2.760	3.518	5.443	7.316	7.377

Table 3.5. Cod.27.6a. Discard numbers-at-age (thousands).

	1	2	3	4	5	6	7+
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	124	27	7	0	0	0	0
2004	238	23	0	0	0	0	0
2005	127	22	0	0	0	0	0
2006	1058	45	25	2	3	1	0
2007	283	1321	46	35	2	3	0
2008	64	151	416	3	1	0	0
2009	590	157	116	146	8	7	0
2010	410	810	150	17	7	0	0
2011	303	579	1255	102	1	4	0
2012	1029	180	605	78	0	0	0
2013	2175	346	220	167	24	0	3
2014	913	948	644	116	45	2	0
2015	264	571	620	72	18	2	0
2016	1253	377	189	94	13	0	0
2017	240	429	912	223	43	5	0

	1	2	3	4	5	6	7+
2018	87	447	206	300	54	18	6
2019	248	112	49	6	1	0	0
2020	304	173	16	10	0	0	0
2021	6	174	131	1	6	0	0

Table 3.6. Cod.27.6a. Mean weight-at-age in discards (kg).

	1	2	3	4	5	6	7+
1981	0.135	0.326					
1982	0.314	0.392					
1983	0.223	0.374					
1984	0.298	0.435					
1985	0.178	0.346					
1986	0.267	0.305					
1987	0.166	0.37					
1988	0.296	0.283					
1989	0.332	0.59					
1990	0.132	0.454					
1991	0.245	0.351					
1992	0.22	1.03	2.382				
1993	0.239	0.812	3.723				
1994	0.24	0.365					
1995	0.203	0.256					
1996	0.226	0.389					
1997	0.321	0.328					
1998	0.23	0.367	0.59				
1999	0.294	0.299					
2000	0.28	0.421					
2001	0.248	0.417					
2002	0.263	1.021					
2003	0.311	0.6	0.388				
2004	0.261	0.576					
2005	0.242	0.483	0.803				
2006	0.276	1.346	2.786	3.501	6.242	5.581	11.151
2007	0.196	0.948	3.014	4.457	4.985	10.635	
2008	0.224	0.999	2.049	3.853	5.216		
2009	0.264	1.333	2.296	3.834	6.051	6.985	9.119
2010	0.273	1.274	2.268	3.218	3.245		
2011	0.266	1.072	2.213	2.993	4.891	4.168	
2012	0.142	1.118	2.179	3.222			
2013	0.125	1.155	2.11	3.05	5.029		6.269
2014	0.15	1.21	2.39	3.066	3.998	4.349	
2015	0.404	1.063	2.33	3.428	4.414	6.103	
2016	0.205	1.096	2.212	3.759	4.435		
2017	0.262	1.048	2.183	3.473	4.397	7.714	

	1	2	3	4	5	6	7+
2018	0.217	1.046	2.219	3.649	5.3	4.98	2.117
2019	0.226	0.548	1.397	2.318	3.516		
2020	0.167	0.922	3.199	4.763			
2021	0.708	1.348	2.821	4.309	5.175		

Table 3.7. Cod.27.6a. Total catch-at-age (thousands).

	1	2	3	4	5	6	7+
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	176	514	100	120	7	2	2
2004	282	122	90	12	27	3	1
2005	163	146	46	40	7	6	0
2006	1076	143	104	25	17	3	1
2007	290	1492	100	64	5	6	2
2008	64	171	522	24	15	1	2
2009	591	166	126	186	14	8	1
2010	416	889	175	37	17	1	1
2011	303	608	1307	120	5	10	1
2012	1030	181	623	101	3	2	2
2013	2175	355	228	206	33	2	4
2014	913	953	717	149	70	4	0
2015	264	615	660	102	39	21	1
2016	1254	394	271	146	30	9	11
2017	240	442	963	270	89	18	3

	1	2	3	4	5	6	7+
2018	88	457	235	378	105	49	16
2019	256	132	178	95	142	57	13
2020	311	248	26	65	44	53	30
2021	6	203	359	50	53	8	12

Table 3.8. Cod.27.6a. Mean weight-at-age (kg) in total catch.

	1	2	3	4	5	6	7+
1981	0.506	1.07	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	1.26	2.995	4.398	6.305	8.084	9.744
1984	0.588	1.398	3.168	5.375	6.601	8.606	10.35
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	1.31	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	7.52	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	6.19	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	4.71	6.389	8.423	8.409
1995	0.423	1.13	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	9.63
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	0.94	2.679	4.568	5.86	7.741	9.386
2002	0.361	1.096	2.33	4.841	6.175	7.192	9.548
2003	0.415	1.023	2.14	3.82	5.932	8.022	8.681
2004	0.316	0.943	2.191	4.398	6.033	8.242	9.84
2005	0.356	1.014	2.425	3.969	4.775	6.616	10.214
2006	0.282	1.23	2.373	3.789	6.175	7.002	11.046
2007	0.209	0.969	2.788	4.397	5.726	9.174	8.83
2008	0.224	1.018	2.256	4.715	6.189	7.964	8.487
2009	0.266	1.372	2.342	4.039	6.03	7.222	9.111
2010	0.282	1.291	2.363	3.683	4.784	9.158	10.275
2011	0.266	1.107	2.237	3.221	5.722	5.507	9.837
2012	0.142	1.12	2.205	3.713	6.428	7.617	8.695
2013	0.125	1.16	2.137	3.243	5.336	7.144	7.145
2014	0.15	1.212	2.36	3.063	4.245	4.984	7.207
2015	0.405	1.159	2.368	3.548	4.964	5.612	9.158
2016	0.206	1.11	2.259	3.815	4.834	6.596	7.622
2017	0.263	1.053	2.177	3.656	5.032	5.746	9.243

	1	2	3	4	5	6	7+
2018	0.229	1.06	2.285	3.755	5.362	5.909	6.304
2019	0.248	0.644	2.532	4.112	5.450	7.045	8.841
2020	0.178	1.039	2.873	4.763	5.957	6.362	6.448
2021	0.730	1.327	2.782	3.534	5.413	7.316	7.377

Table 3.9. Cod.27.6a. Mean weight-at-age (kg) in stock.

	1	2	3	4	5	6	7
1981	0.496	1.262	2.888	4.854	6.932	8.447	10.100
1982	0.488	1.256	2.874	4.838	6.891	8.421	10.077
1983	0.480	1.250	2.859	4.821	6.849	8.394	10.054
1984	0.473	1.244	2.844	4.803	6.807	8.367	10.030
1985	0.465	1.238	2.827	4.783	6.766	8.340	10.008
1986	0.457	1.232	2.810	4.761	6.724	8.314	9.985
1987	0.450	1.225	2.793	4.738	6.682	8.287	9.961
1988	0.442	1.219	2.776	4.716	6.641	8.260	9.937
1989	0.434	1.213	2.760	4.696	6.599	8.232	9.912
1990	0.427	1.207	2.745	4.681	6.557	8.203	9.885
1991	0.419	1.201	2.729	4.671	6.514	8.173	9.857
1992	0.411	1.195	2.712	4.666	6.472	8.142	9.827
1993	0.404	1.188	2.691	4.665	6.429	8.109	9.796
1994	0.396	1.182	2.666	4.664	6.386	8.075	9.764
1995	0.388	1.176	2.636	4.660	6.342	8.038	9.731
1996	0.380	1.170	2.602	4.649	6.298	7.999	9.698
1997	0.373	1.164	2.564	4.628	6.254	7.957	9.664
1998	0.365	1.158	2.526	4.596	6.210	7.913	9.628
1999	0.357	1.152	2.489	4.553	6.165	7.866	9.591
2000	0.350	1.145	2.455	4.500	6.120	7.816	9.551
2001	0.342	1.139	2.426	4.440	6.075	7.764	9.509
2002	0.334	1.133	2.401	4.377	6.029	7.708	9.463
2003	0.327	1.127	2.381	4.310	5.983	7.650	9.412
2004	0.319	1.121	2.364	4.242	5.937	7.588	9.356
2005	0.311	1.115	2.350	4.172	5.891	7.524	9.294
2006	0.304	1.108	2.338	4.099	5.845	7.457	9.225
2007	0.296	1.102	2.326	4.023	5.799	7.387	9.147

	1	2	3	4	5	6	7
2008	0.288	1.096	2.315	3.944	5.752	7.313	9.061
2009	0.281	1.090	2.305	3.865	5.706	7.237	8.967
2010	0.273	1.084	2.298	3.790	5.660	7.159	8.865
2011	0.265	1.078	2.294	3.726	5.613	7.079	8.755
2012	0.258	1.072	2.295	3.678	5.567	6.997	8.640
2013	0.250	1.065	2.302	3.649	5.521	6.915	8.519
2014	0.242	1.059	2.317	3.643	5.475	6.834	8.395
2015	0.235	1.053	2.340	3.657	5.429	6.753	8.267
2016	0.227	1.047	2.373	3.690	5.383	6.673	8.137
2017	0.219	1.041	2.414	3.736	5.338	6.595	8.004
2018	0.212	1.035	2.462	3.791	5.292	6.518	7.870
2019	0.204	1.028	2.516	3.850	5.247	6.442	7.735
2020	0.196	1.022	2.574	3.912	5.202	6.367	7.599
2021	0.196	1.022	2.633	3.974	5.156	6.292	7.463

Table 3.10. Cod.27.6a. Natural mortality.

	1	2	3	4	5	6	7
1981	0.496	0.378	0.298	0.256	0.231	0.218	0.207
1982	0.498	0.379	0.298	0.256	0.231	0.218	0.207
1983	0.501	0.379	0.298	0.256	0.232	0.218	0.207
1984	0.503	0.380	0.299	0.257	0.232	0.219	0.207
1985	0.505	0.380	0.299	0.257	0.232	0.219	0.208
1986	0.508	0.381	0.300	0.257	0.233	0.219	0.208
1987	0.510	0.382	0.300	0.258	0.233	0.219	0.208
1988	0.513	0.382	0.301	0.258	0.234	0.219	0.208
1989	0.515	0.383	0.301	0.258	0.234	0.220	0.208
1990	0.518	0.383	0.302	0.259	0.235	0.220	0.208
1991	0.521	0.384	0.302	0.259	0.235	0.220	0.208
1992	0.524	0.384	0.303	0.259	0.235	0.220	0.209
1993	0.527	0.385	0.304	0.259	0.236	0.221	0.209
1994	0.529	0.386	0.305	0.259	0.236	0.221	0.209
1995	0.532	0.386	0.306	0.259	0.237	0.221	0.209
1996	0.536	0.387	0.307	0.259	0.237	0.221	0.209
1997	0.539	0.387	0.308	0.260	0.238	0.222	0.210
1998	0.542	0.388	0.309	0.260	0.238	0.222	0.210
1999	0.545	0.388	0.311	0.261	0.239	0.223	0.210
2000	0.549	0.389	0.312	0.262	0.239	0.223	0.210
2001	0.552	0.390	0.313	0.263	0.240	0.223	0.211
2002	0.556	0.390	0.314	0.264	0.240	0.224	0.211
2003	0.560	0.391	0.315	0.265	0.241	0.224	0.211
2004	0.564	0.392	0.315	0.266	0.241	0.225	0.212
2005	0.568	0.392	0.316	0.267	0.242	0.225	0.212
2006	0.572	0.393	0.316	0.269	0.243	0.226	0.212
2007	0.576	0.393	0.317	0.270	0.243	0.227	0.213

	1	2	3	4	5	6	7
2008	0.580	0.394	0.317	0.272	0.244	0.227	0.214
2009	0.585	0.395	0.318	0.273	0.244	0.228	0.214
2010	0.590	0.395	0.318	0.275	0.245	0.229	0.215
2011	0.595	0.396	0.318	0.276	0.245	0.229	0.216
2012	0.600	0.397	0.318	0.277	0.246	0.230	0.217
2013	0.605	0.397	0.318	0.278	0.247	0.231	0.217
2014	0.610	0.398	0.317	0.278	0.247	0.232	0.218
2015	0.616	0.399	0.316	0.278	0.248	0.233	0.219
2016	0.622	0.399	0.315	0.277	0.248	0.233	0.220
2017	0.628	0.400	0.313	0.276	0.249	0.234	0.221
2018	0.635	0.401	0.312	0.275	0.250	0.235	0.222
2019	0.642	0.401	0.310	0.274	0.250	0.236	0.224
2020	0.649	0.402	0.308	0.272	0.251	0.237	0.225
2021	0.649	0.402	0.306	0.271	0.252	0.237	0.226

Table 3.11. Cod.27.6a. 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 (ages 1–6 used)**

Effort (Hrs)	1	2	3	4	5	6	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 3.11. Continued. Cod.27.6a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

UK-SCOWCGFS-Q1 (index) (ages 1–6 used)

Effort (Hrs)	1	2	3	4	5	6	7	8
10	0.52	32.95	21.07	0.93	0.98	0.74	0.00	2011
10	13.99	27.30	22.72	4.58	3.50	2.20	4.20	2012
10	20.03	40.26	26.38	36.95	7.76	0.30	0.00	2013
10	11.40	41.73	13.44	5.12	4.31	0.75	0.00	2014
10	8.16	36.40	70.70	37.74	23.25	13.00	2.47	2015
10	4.73	56.07	65.41	44.56	5.67	2.36	2.29	2016
10	2.92	33.49	50.58	49.58	156.64	10.71	24.89	2017
10	1.728	20.375	7.199	19.765	9.98	2.261	1.092	2018
10	9.924	4.173	6.888	2.031	3.181	0.318	0.318	2019
10	14.433	28.978	11.516	9.782	1.176	0.646	0.0	2020
10	1.175	12.137	22.988	2.946	2.519	1.236	0.0	2021

UK-SCOWCGFS-Q1 (variance)

Effort (Hrs)	1	2	3	4	5	6	7	8
10	0.09	78.37	24.06	0.22	0.49	0.30	0.00	2011
10	44.18	120.08	33.73	2.31	8.34	4.83	13.02	2012
10	118.35	151.04	136.89	240.05	6.47	0.09	0.00	2013
10	20.17	383.27	12.23	3.04	5.47	0.28	0.00	2014
10	14.35	112.82	1264.73	602.27	289.82	98.91	5.48	2015
10	1.81	214.42	607.48	319.21	5.02	1.60	1.85	2016
10	1.43	155.67	498.57	1061.90	20475.95	84.79	287.62	2017
10	1	24.03	2.21	20.09	7.46	0.5	0.25	2018
10	6.79	2.03	6.12	0.6	1.98	0.1	0	2019
10	121.47	65.29	14.48	24.01	0.46	0.22	0	2020
10	1.03	10.19	31.36	1.35	0.92	0.37	0.13	2021

Table 3.11. Continued. Cod.27.6a. 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**				
Effort (Hrs)	0	1	2	3	
1849	0.0	312.0	49.0	13.0	1993
1610	20.0	999.0	56.0	13.0	1994
1826	78.0	169.0	142.0	69.0	1995
1765	0.0	214.0	89.0	18.0	1996
1581	6.0	565.0	31.0	10.0	1997
1639	0.0	83.0	53.0	6.0	1998
1564	0.0	24.0	14.0	3.0	1999
1556	0.0	124.0	4.0	1.0	2000
755	3.0	82.0	28.0	2.0	2001
798	0.0	50.6	2.2	1.2	2002

ScoGFS-WIBTS-Q4: **Quarter 4 Scottish ground fish survey (ages 1x4 used)**

1996	**2010**									
Effort (Hrs)	0	1	2	3	4	5	6	7	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 3.11. Cont. Cod.27.6a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

UK-SCOWCGFS-Q4 (index) (ages 1–6 used)

Effort (Hrs)	0	1	2	3	4	5	6	7	8	
10	0.60	9.71	31.54	10.88	0.93	1.70	2.38	0.00	0.00	2011
10	0.75	19.78	7.12	15.43	13.60	1.02	0.68	0.34	0.00	2012
Survey not completed due to mechanical issues										2013
10	1.67	23.65	28.06	15.63	5.57	6.63	1.37	0.00	0.00	2014
10	3.64	28.17	52.53	34.22	10.58	4.24	5.27	1.18	0.59	2015
10	0.374	6.162	34.941	45.443	118.92	14.893	5.773	3.176	0	2016
10	2.127	10.024	6.221	24.427	10.881	8.538	0.767	0.511	0	2017
10	0	4.569	15.945	4.809	39.902	29.022	10.887	0.829	0	2018
10	0.351	17.65	1.402	3.246	3.457	1.814	0.627	0.363	0	2019
10	0.601	15.988	24.873	3.472	4.936	1.35	0.783	0.392	0	2020
10	0.863	9.348	89.12	14.769	0.392	1.822	1.158	0.256	0	2021

UK-SCOWCGFS-Q4 (variance)

Effort (Hrs)	0	1	2	3	4	5	6	7	8	
10	0.21	31.08	38.07	5.78	0.19	1.56	4.79	0.00	0.00	2011
10	0.14	41.72	2.79	11.37	48.79	1.05	0.46	0.12	0.00	2012
Survey not completed due to mechanical issues										2013
10	0.68	132.97	56.62	44.17	3.87	4.79	0.39	0.00	0.00	2014
10	5.55	98.78	316.23	51.22	8.60	4.43	4.61	0.34	0.12	2015
10	0.14	7.394	419.36	716.38	7654.82	118.64	24.30	6.08	0	2016
10	3.215	11.252	3.816	76.154	14.262	8.928	0.207	0.063	0	2017
10	0	3.71	28.22	8.46	532.1	271.49	44.45	0.39	0	2018
10	0.03	88.63	0.43	1.86	2.6	0.67	0.39	0.13	0	2019
10	0.36	14.8	16.12	1.84	6.76	0.71	0.61	0.15	0	2020
10	0.25	9.38	4509.27	50.26	0.15	0.28	0.26	0.07	0	2021

Table 3.11. Continued. Cod.27.6a. 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. (ages 1–3 used)

Effort (Hrs)	0	1	2	3	4	
1127	0	10	11	0	0	2003
1200	0	24	10	1	0	2004
960	63	13	7	0	2	2005
1510	0	95	12	0	0	2006
1173	0	161	12	0	1	2007
1135	0	23	24	4	0	2008
1378	1	75	4	5	0	2009
1291	0	70	31	4	3	2010
1287	1	26	26	4	0	2011
1230	0	74	7	3	0	2012
1295	0	92	11	0	0	2013
1200	0	113	20	2	0	2014
1213	0	15	11	3	0	2015
962	0	27	23	2	0	2016
1196	0	2	17	7	2	2017
966	1	21	3	0	1	2018
1291	0	36	1	0	0	2019
805	6	4	6	2	0	2020
1015	0	15	14	18	4	2021

Table 3.12. Cod.27.6a. SAM configuration file.

```
# Where a matrix is specified rows corresponds to fleets and columns to ages.
# Same number indicates same parameter used
# Numbers (integers) starts from zero and must be consecutive
#
$minAge
# The minimium age class in the assessment
 1

$maxAge
# The maximum age class in the assessment
 7

$maxAgePlusGroup
# Is last age group considered a plus group for each fleet (1 yes, or 0 no).
 1 0 0 0 0 0

$keyLogFsta
# Coupling of the fishing mortality states (nomally only first row is used).
  0  1  2  3  3  3  3
 -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

$corFlag
# Correlation of fishing mortality across ages (0 independent, 1 compound symmetry, 2 AR(1), 3 separable AR(1).
 2

$keyLogFpar
# Coupling of the survey catchability parameters (normally first row is not used, as that is covered by fishing mortality).
 -1 -1 -1 -1 -1 -1 -1
  0  1  2  3  4  5 -1
  6  7  7 -1 -1 -1 -1
  8  9 10 10 -1 -1 -1
 11 12 13 14 15 15 -1
 16 17 18 19 20 20 -1

$keyQpow
# Density dependent catchability power parameters (if any).
 -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 -1 -1 -1 -1 -1

$keyVarF
# Coupling of process variance parameters for log(F)-process (normally only first row is used)
  0  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 -1 -1 -1 -1

$keyVarLogN
# Coupling of process variance parameters for log(N)-process
 0 1 1 1 1 1 1

$keyVarObs
# Coupling of the variance parameters for the observations.
  0  1  1  1  1  1  2
  3  3  3  3  3  3 -1
  4  4  4 -1 -1 -1 -1
  5  5  5  5 -1 -1 -1
  6  6  6  6  6  6 -1
  7  7  7  7  7  7 -1

$obsCorStruct
# Covariance structure for each fleet ("ID" independent, "AR" AR(1), or "US" for unstructured). | Possible values are: "ID" "AR" "US"
 "ID" "ID" "ID" "ID" "ID" "ID"

$keyCorObs
# Coupling of correlation parameters can only be specified if the AR(1) structure is chosen above.
# NA's indicate where correlation parameters can be specified (-1 where they cannot).
#1-2 2-3 3-4 4-5 5-6 6-7
 NA NA NA NA NA NA
 NA NA NA NA NA -1
 NA NA -1 -1 -1 -1
 NA NA NA -1 -1 -1
 NA NA NA NA NA -1
 NA NA NA NA NA -1

$stockRecruitmentModelCode
# Stock recruitment code (0 for plain random walk, 1 for Ricker, 2 for Beverton–Holt, and 3 piece-wise constant).
 0

$noScaledYears
# Number of years where catch scaling is applied.
 12

$keyScaledYears
# A vector of the years where catch scaling is applied.
 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006

$keyParScaledYA
# A matrix specifying the couplings of scale parameters (nrow = no scaled years, ncols = no ages).
 0  0  0  0  0  0  0
 1  1  1  1  1  1  1
```

2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9
10	10	10	10	10	10	10
11	11	11	11	11	11	11

$fbarRange
lowest and higest age included in Fbar
2 5

$keyBiomassTreat
To be defined only if a biomass survey is used (0 SSB index, 1 catch index, 2 FSB index, 3 total catch, 4 total landings and 5 TSB index).
-1 -1 -1 -1 -1 -1

$obsLikelihoodFlag
Option for observational likelihood | Possible values are: "LN" "ALN"
"LN" "LN" "LN" "LN" "LN" "LN"

$fixVarToWeight
If weight attribute is supplied for observations this option sets the treatment (0 relative weight, 1 fix variance to weight).
0

$fracMixF
The fraction of t(3) distribution used in logF increment distribution
0

$fracMixN
The fraction of t(3) distribution used in logN increment distribution
0

$fracMixObs
A vector with same length as number of fleets, where each element is the fraction of t(3) distribution used in the distribution of that fleet
0 0 0 0 0 0

$constRecBreaks
Vector of break years between which recruitment is at constant level. The break year is included in the left interval. (This option is only used in combination with stock–recruitment code 3)

Table 3.13. Cod.27.6a. SAM estimated model parameters.

	par	sd(par)	exp(par)	Low	High
logFpar_0	-9.82627	0.15868	0.00005	0.00004	0.00007
logFpar_1	-7.97290	0.15238	0.00034	0.00025	0.00047
logFpar_2	-7.09241	0.15248	0.00083	0.00061	0.00113
logFpar_3	-6.64846	0.15466	0.00130	0.00095	0.00177
logFpar_4	-6.17816	0.16649	0.00207	0.00149	0.00289
logFpar_5	-5.77349	0.17573	0.00311	0.00219	0.00442
logFpar_6	-11.07638	0.20538	0.00002	0.00001	0.00002
logFpar_7	-11.32750	0.16446	0.00001	0.00001	0.00002
logFpar_8	-8.21779	0.23178	0.00027	0.00017	0.00043
logFpar_9	-7.16734	0.23223	0.00077	0.00048	0.00123
logFpar_10	-6.87243	0.18456	0.00104	0.00072	0.00150
logFpar_11	-8.50034	0.22149	0.00020	0.00013	0.00032
logFpar_12	-6.33104	0.16249	0.00178	0.00129	0.00246
logFpar_13	-5.87522	0.16068	0.00281	0.00204	0.00387
logFpar_14	-5.46087	0.20059	0.00425	0.00285	0.00635
logFpar_15	-4.93287	0.20523	0.00721	0.00478	0.01086
logFpar_16	-6.96448	0.18865	0.00094	0.00065	0.00138
logFpar_17	-6.13471	0.14544	0.00217	0.00162	0.00290
logFpar_18	-5.52082	0.15834	0.00400	0.00292	0.00549
logFpar_19	-4.73993	0.20667	0.00874	0.00578	0.01321
logFpar_20	-4.14112	0.22248	0.01590	0.01019	0.02482
logSdLogFsta_0	-2.22062	0.73436	0.10854	0.02499	0.47148
logSdLogFsta_1	-2.37973	0.20440	0.09258	0.06151	0.13933
logSdLogN_0	-0.13522	0.12237	0.87353	0.68389	1.11575
logSdLogN_1	-2.53454	0.53318	0.07930	0.02730	0.23034
logSdLogObs_0	-0.54157	0.13520	0.58183	0.44398	0.76248
logSdLogObs_1	-1.51650	0.07853	0.21948	0.18758	0.25681

	par	sd(par)	exp(par)	Low	High
logSdLogObs_2	-0.82221	0.12909	0.43946	0.33947	0.56891
logSdLogObs_3	-0.35243	0.06670	0.70298	0.61519	0.80329
logSdLogObs_4	-0.16578	0.10534	0.84723	0.68629	1.04592
logSdLogObs_5	-0.24846	0.11147	0.78000	0.62412	0.97481
logSdLogObs_6	0.45734	0.09121	1.57987	1.31642	1.89604
logSdLogObs_7	0.28239	0.10186	1.32629	1.08183	1.62598
itrans_rho_0	0.90870	0.40524	2.48110	1.10320	5.57998
logScale_0	0.02550	0.15205	1.02582	0.75685	1.39039
logScale_1	-0.16192	0.17277	0.85051	0.60203	1.20155
logScale_2	-0.10723	0.18484	0.89832	0.62070	1.30011
logScale_3	0.13244	0.19076	1.14161	0.77951	1.67190
logScale_4	0.18771	0.19398	1.20648	0.81853	1.77831
logScale_5	0.36493	0.19735	1.44041	0.97066	2.13750
logScale_6	0.70711	0.20145	2.02812	1.35556	3.03437
logScale_7	0.60486	0.20010	1.83100	1.22711	2.73206
logScale_8	1.12059	0.19596	3.06666	2.07231	4.53812
logScale_9	1.36555	0.18682	3.91786	2.69638	5.69268
logScale_10	1.20026	0.17694	3.32099	2.33120	4.73103
logScale_11	0.68888	0.23380	1.99148	1.24767	3.17872

Table 3.14. Cod.27.6a. SAM estimates of population numbers-at-age (thousands).

	1	2	3	4	5	6	7
1981	10776	19502	7001	1981	475	63	51
1982	24158	5364	7788	2593	728	184	44
1983	14133	11850	2224	2780	896	258	82
1984	24070	6612	4627	775	877	293	112
1985	10610	11370	2454	1467	227	254	121
1986	21633	4729	4108	749	379	63	102
1987	42929	10267	1766	1300	214	108	49
1988	7360	18877	3724	538	351	61	45
1989	21585	3157	6256	1139	155	100	31
1990	7974	9495	1079	1729	320	44	37
1991	11762	3384	3321	352	492	100	26
1992	21848	5012	1089	1004	108	140	38
1993	7886	9524	1693	310	289	33	55
1994	13771	3512	3297	490	91	85	27
1995	10200	6004	1244	1006	139	27	33
1996	4222	4471	1926	365	294	41	18
1997	17062	1829	1408	513	105	86	17
1998	5413	7413	548	369	144	30	30
1999	4314	2212	2164	141	105	43	18
2000	14621	1808	642	563	39	30	18
2001	4137	6079	558	173	160	11	14
2002	6975	1700	1860	150	45	43	7
2003	2303	2806	494	499	41	12	13
2004	3243	908	791	120	130	11	7
2005	2204	1274	262	196	30	31	4
2006	7212	887	409	62	45	7	9
2007	2419	3051	293	106	13	11	4

	1	2	3	4	5	6	7
2008	1751	980	1066	75	25	3	3
2009	5474	734	345	264	16	6	2
2010	6453	2365	270	84	54	3	2
2011	2450	2828	904	69	18	12	1
2012	4188	1082	1162	241	15	4	3
2013	7473	1843	487	383	63	4	2
2014	6372	3357	811	174	115	18	2
2015	5925	2875	1548	292	57	39	7
2016	2226	2763	1338	593	97	20	16
2017	2012	994	1338	534	201	34	13
2018	924	922	442	514	176	67	16
2019	4183	396	411	163	153	55	26
2020	2876	1863	181	155	48	46	25
2021	1974	1264	878	70	46	14	22

Table 3.15. Cod.27.6a. SAM estimates for fishing mortality-at-age.

	1	2	3	4	5	6	7
1981	0.217	0.517	0.689	0.750	0.750	0.750	0.750
1982	0.226	0.531	0.722	0.811	0.811	0.811	0.811
1983	0.245	0.568	0.778	0.894	0.894	0.894	0.894
1984	0.264	0.607	0.844	0.988	0.988	0.988	0.988
1985	0.285	0.643	0.894	1.061	1.061	1.061	1.061
1986	0.279	0.624	0.859	1.010	1.010	1.010	1.010
1987	0.302	0.664	0.896	1.031	1.031	1.031	1.031
1988	0.315	0.690	0.909	1.015	1.015	1.015	1.015
1989	0.323	0.704	0.933	1.032	1.032	1.032	1.032
1990	0.317	0.684	0.873	0.956	0.956	0.956	0.956
1991	0.324	0.715	0.911	0.976	0.976	0.976	0.976
1992	0.313	0.706	0.921	0.974	0.974	0.974	0.974
1993	0.298	0.691	0.918	0.978	0.978	0.978	0.978
1994	0.293	0.690	0.912	0.979	0.979	0.979	0.979
1995	0.301	0.728	0.943	0.978	0.978	0.978	0.978
1996	0.312	0.771	0.994	0.998	0.998	0.998	0.998
1997	0.326	0.814	1.032	1.007	1.007	1.007	1.007
1998	0.336	0.836	1.037	0.995	0.995	0.995	0.995
1999	0.334	0.827	1.030	1.012	1.012	1.012	1.012
2000	0.334	0.809	1.011	1.025	1.025	1.025	1.025
2001	0.340	0.813	1.021	1.059	1.059	1.059	1.059
2002	0.352	0.830	1.035	1.068	1.068	1.068	1.068
2003	0.360	0.841	1.077	1.102	1.102	1.102	1.102
2004	0.352	0.814	1.095	1.160	1.160	1.160	1.160
2005	0.329	0.759	1.098	1.205	1.205	1.205	1.205
2006	0.303	0.699	1.064	1.216	1.216	1.216	1.216
2007	0.284	0.653	1.044	1.204	1.204	1.204	1.204

	1	2	3	4	5	6	7
2008	0.269	0.618	1.050	1.230	1.230	1.230	1.230
2009	0.260	0.599	1.076	1.301	1.301	1.301	1.301
2010	0.243	0.554	1.020	1.234	1.234	1.234	1.234
2011	0.229	0.513	0.968	1.198	1.198	1.198	1.198
2012	0.206	0.450	0.830	1.047	1.047	1.047	1.047
2013	0.193	0.415	0.749	0.951	0.951	0.951	0.951
2014	0.183	0.390	0.691	0.865	0.865	0.865	0.865
2015	0.173	0.367	0.641	0.816	0.816	0.816	0.816
2016	0.171	0.359	0.618	0.801	0.801	0.801	0.801
2017	0.179	0.380	0.653	0.861	0.861	0.861	0.861
2018	0.182	0.390	0.676	0.921	0.921	0.921	0.921
2019	0.179	0.384	0.675	0.965	0.965	0.965	0.965
2020	0.171	0.362	0.642	0.957	0.957	0.957	0.957

Table 3.16. Cod.27.6a. SAM summary table. ('Catch' refers to model estimate).

Year	Recruitment Age 1			SSB			TSB			Catch			Esti-mated catch scaling factor	Fishing mortality Ages 2–5		
	Value	Low	High	Value	Low	High	Value	Low	High	Value	Low	High		Value	Low	High
1981	10776	7807	14874	43252	37639	49703	64140	55761	73777	23538	19296	28712		0.676	0.583	0.785
1982	24158	18021	32385	42471	37367	48273	60463	53440	68408	23619	20156	27678		0.719	0.636	0.812
1983	14133	10568	18900	35762	31720	40320	50490	44906	56769	20932	18149	24142		0.784	0.701	0.876
1984	24070	18038	32119	30414	27051	34196	46017	40823	51872	21318	18390	24712		0.857	0.769	0.955
1985	10610	7966	14131	25388	22611	28505	37829	33525	42684	16365	14129	18955		0.915	0.818	1.023
1986	21633	15806	29608	22021	19475	24899	34921	30561	39904	14256	12210	16643		0.876	0.786	0.976
1987	42929	30989	59470	24089	21365	27161	45783	39160	53525	15739	13382	18511		0.906	0.814	1.007
1988	7360	5432	9974	26656	23062	30811	42426	36220	49695	18976	15915	22627		0.907	0.817	1.008
1989	21585	15987	29143	25011	21701	28826	37972	33126	43527	16265	13707	19300		0.925	0.831	1.03
1990	7974	5803	10959	19427	17139	22020	28743	25318	32630	12787	10918	14975		0.867	0.777	0.968
1991	11762	8745	15821	16219	14331	18356	23972	21194	27115	10464	8975	12200		0.894	0.804	0.995
1992	21848	16244	29386	14351	12777	16120	24827	21626	28502	9253	7979	10730		0.894	0.8	0.999
1993	7886	5717	10879	14335	12438	16522	23169	19832	27068	10983	9255	13034		0.891	0.788	1.008
1994	13771	9656	19640	14118	11784	16916	22213	18387	26836	10065	8410	12045		0.89	0.776	1.021
1995	10200	7016	14828	13032	10213	16629	20413	15894	26217	9419	7337	12092	1.026	0.907	0.792	1.038

Year	Recruitment Age 1			SSB			TSB			Catch			Estimated catch scaling factor	Fishing mortality Ages 2–5		
	Value	Low	High	Value	Low	High	Value	Low	High	Value	Low	High		Value	Low	High
1996	4222	2845	6265	10962	8264	14540	15907	11972	21137	8359	6200	11270	0.850	0.94	0.819	1.079
1997	17062	11434	25460	9311	6899	12567	15990	11744	21771	7087	5119	9812	0.898	0.965	0.838	1.112
1998	5413	3586	8172	9098	6591	12560	15061	10845	20916	6095	4302	8635	1.142	0.966	0.842	1.109
1999	4314	2846	6539	7685	5527	10687	11274	8140	15614	5285	3727	7495	1.206	0.97	0.847	1.112
2000	14621	9627	22205	6650	4792	9228	11941	8533	16710	4822	3371	6897	1.440	0.967	0.845	1.107
2001	4137	2711	6313	6966	4971	9763	11651	8278	16400	5057	3497	7314	2.028	0.988	0.863	1.132
2002	6975	4583	10613	6387	4591	8885	10048	7249	13927	4756	3289	6878	1.831	1	0.872	1.147
2003	2303	1531	3466	5208	3811	7115	7704	5643	10517	3649	2566	5190	3.067	1.031	0.896	1.186
2004	3243	2202	4777	3632	2726	4839	5347	4038	7079	2570	1853	3564	3.918	1.058	0.917	1.22
2005	2204	1480	3284	2609	2012	3382	3994	3093	5158	1870	1387	2522	3.321	1.066	0.924	1.23
2006	7212	4920	10572	2476	1981	3095	4779	3748	6093	1856	1401	2458	1.991	1.049	0.909	1.21
2007	2419	1617	3617	3083	2431	3909	5378	4184	6912	2185	1650	2893		1.026	0.893	1.179
2008	1751	1192	2573	3091	2422	3946	4539	3598	5727	2193	1652	2913		1.032	0.897	1.187
2009	5474	3843	7799	2534	2084	3080	4302	3536	5233	1908	1502	2424		1.07	0.922	1.24
2010	6453	4594	9064	2940	2435	3549	5605	4582	6856	2144	1647	2791		1.011	0.874	1.169
2011	2450	1708	3515	3838	3159	4664	6229	5121	7577	2514	1964	3217		0.969	0.831	1.13

Year	Recruitment Age 1			SSB			TSB			Catch			Estimated catch scaling factor	Fishing mortality Ages 2–5		
	Value	Low	High	Value	Low	High	Value	Low	High	Value	Low	High		Value	Low	High
2012	4188	2986	5873	3931	3248	4759	5933	4948	7114	2330	1842	2946		0.843	0.723	0.984
2013	7473	5312	10512	4074	3441	4824	6744	5662	8032	2102	1702	2595		0.767	0.653	0.901
2014	6372	4546	8932	5094	4281	6061	8383	6995	10046	2635	2082	3336		0.702	0.595	0.829
2015	5925	4201	8356	6395	5343	7652	9738	8152	11632	3454	2732	4367		0.66	0.554	0.786
2016	2226	1590	3117	6902	5770	8255	9543	8001	11381	3508	2813	4374		0.645	0.538	0.772
2017	2012	1437	2817	6366	5284	7671	8099	6764	9698	3256	2627	4034		0.689	0.585	0.812
2018	924	638	1338	4634	3825	5613	5672	4732	6798	2540	2054	3142		0.727	0.617	0.857
2019	4183	2964	5902	3158	2611	3820	4284	3598	5102	1827	1489	2240		0.747	0.627	0.889
2020	2876	1758	4705	2795	2313	3378	4269	3509	5195	1583	1289	1944		0.73	0.598	0.89
2021	1974	928	4198	3326	2600	4255	4758	3683	6148	2050	1551	2710		0.747	0.584	0.954

Table 3.17. Cod.27.6a. Intermediate year assumptions based on the SAM assessment. Units are tonnes (SSB, landings, discards and catch) or thousands (recruitment).

Variable	Value	Notes
$F_{ages\ 2–5}$ (2022)	0.74	$F_{average\ (2019–2021)}$
SSB (2023)	2923	Short-term forecast; in tonnes.
$R_{age\ 1}$ (2022, 2023 and 2024)	2226	Median recruitment resampled from the years 2016–2021; in thousands.
Total catch (2022)	1873	Short-term forecast; in tonnes.
Projected landings (2022)	1333	Short-term forecast assuming average landing pattern (2019–2021)^; in tonnes.
Projected discards (2022)	540	Short-term forecast assuming average discard pattern (2019–2021)^; in tonnes.

^ Due to inadequate discard sampling coverage of the fishery in 2021, average landings and discards proportions from 2019–2020 are used for ages 1 and 2.

Table 3.18. Cod.27.6a. Catch scenarios based on the SAM assessment and assuming F status quo in the intermediate year. Units are tonnes (SSB, landings, discards and catch) or thousands (recruitment).

Basis	Cat	Lan	Dis	Ftot	Flan	Fdis	SSB	SSB	TAC
MSY approach: F_MSY	809	594	215	0.3	0.23	0.069	3757	29%	-37%
Precautionary approach: Fpa	1359	985	374	0.57	0.44	0.13	3099	6.00%	6.30%
FMSY upper	1210	881	329	0.49	0.38	0.112	3278	12.10%	-5.40%
FMSY lower	514	380	134	0.18	0.139	0.041	4113	41%	-60%
F = 0	0	0	0	0	0	0	4728	62%	-100%
Fpa	1359	985	374	0.57	0.44	0.13	3099	6.00%	6.30%
F = Flim	1625	1169	456	0.73	0.56	0.167	2781	-4.90%	27%
Fsq	1642	1181	461	0.74	0.57	0.17	2760	-5.60%	28%
zero TAC advice - haddock Fmult	2562	1779	783	1.6	1.23	0.37	1650	-44%	100%
zero TAC advice - saith Fmult	1642	1181	461	0.74	0.57	0.17	2760	-5.60%	28%
0.05*Fsq	114	85	29	0.037	0.029	0.008	4590	57%	-91%
0.25*Fsq	527	390	137	0.185	0.143	0.042	4095	40%	-59%
0.5*Fsq	966	708	258	0.37	0.29	0.085	3568	22%	-24%
0.75*Fsq	1333	967	366	0.56	0.43	0.127	3130	7.10%	4.20%
2022F=Fsq then Fmsy HCR	133	99	34	0.043	0.033	0.01	4569	56%	-90%
2022F=Fsq then Fmsy HCR lower	80	60	20	0.026	0.02	0.006	4632	58%	-94%
2022F=Fsq then Fmsy HCR upper	214	159	55	0.071	0.055	0.016	4472	53%	-83%
2022F=Fsq then 0% SSB increase	1507	1088	419	0.66	0.51	0.15	2923	0.00%	17.80%
2022F=Fsq then 10% SSB increase	1263	918	345	0.52	0.4	0.119	3215	10.00%	-1.25%
2022F=Fsq then 20% SSB increase	1019	745	274	0.4	0.3	0.09	3508	20%	-20%
2022F=Fsq then 30% SSB increase	773	569	204	0.28	0.22	0.065	3800	30%	-40%
2022F=Fsq then 40% SSB increase	530	392	138	0.186	0.144	0.042	4092	40%	-59%
2022F=Fsq then 50% SSB increase	286	212	74	0.096	0.074	0.022	4385	50%	-78%
2022F=Fsq then prev.TAC*0.25	320	237	83	0.108	0.083	0.025	4347	49%	-75%
2022F=Fsq then prev.TAC*0.5	640	472	168	0.23	0.177	0.052	3961	36%	-50%
2022F=Fsq then prev.TAC*0.75	959	703	256	0.37	0.28	0.084	3577	22%	-25%
2022F=Fsq then prev.TAC*1	1279	929	350	0.53	0.41	0.12	3196	9.30%	0.00%

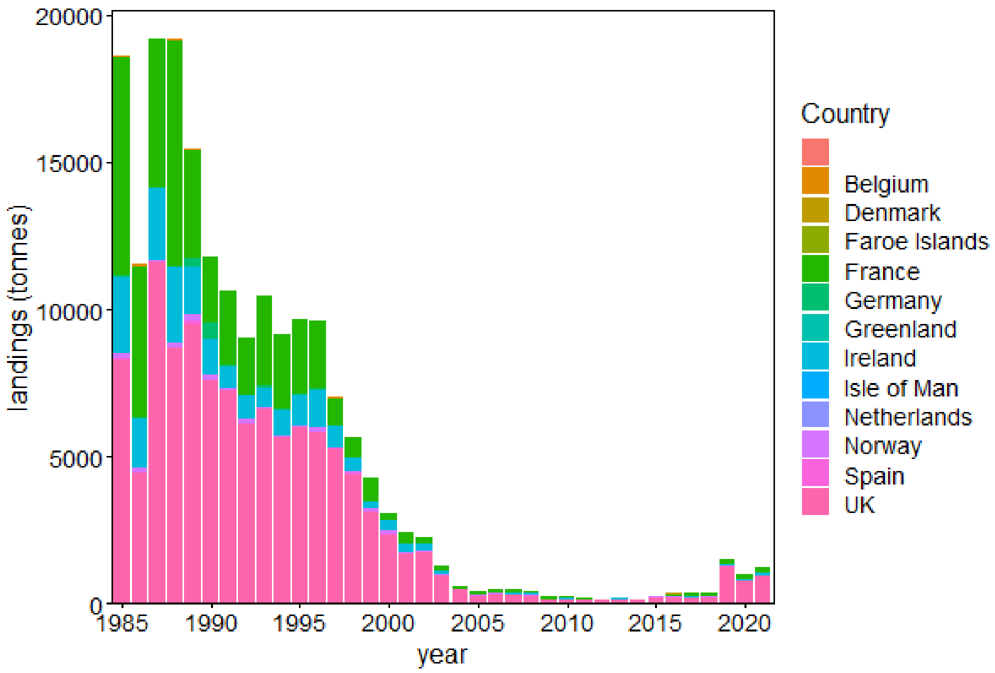


Figure 3.1. Cod.27.6a. ICES official landings by country.

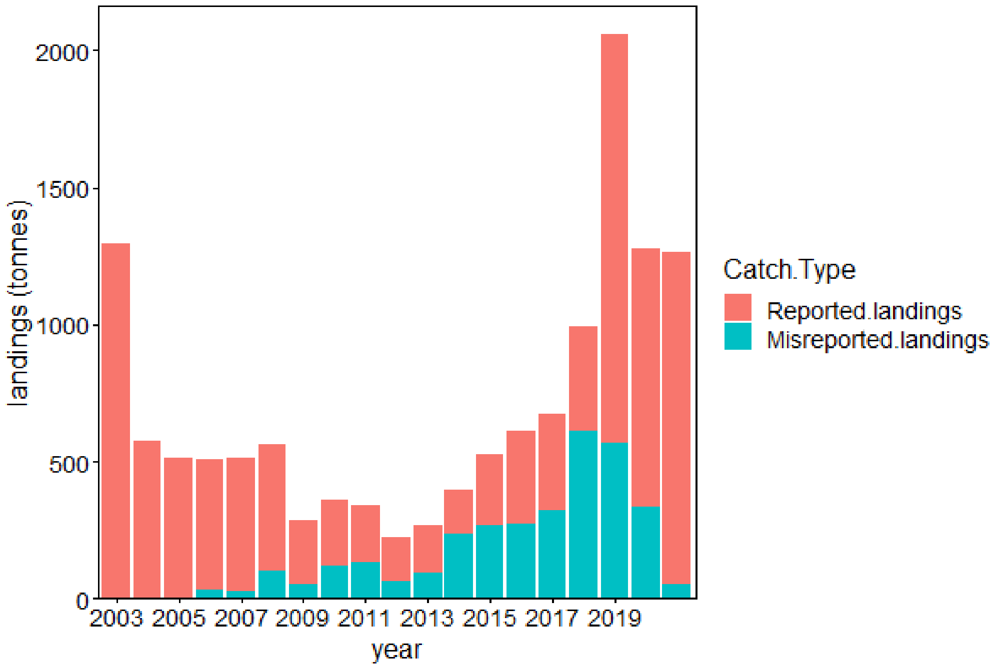


Figure 3.2. Cod.27.6a. ICES estimates of reported (red) and area misreported landings (blue) of cod caught in ICES Division 6.a.

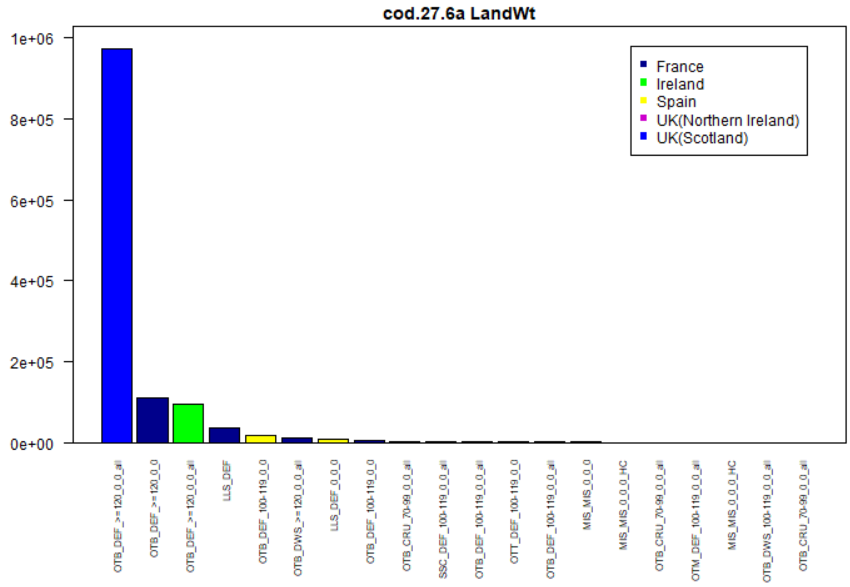


Figure 3.3. Cod.27.6a. Amounts landed by métier (kg) in 2021 as submitted to InterCatch.

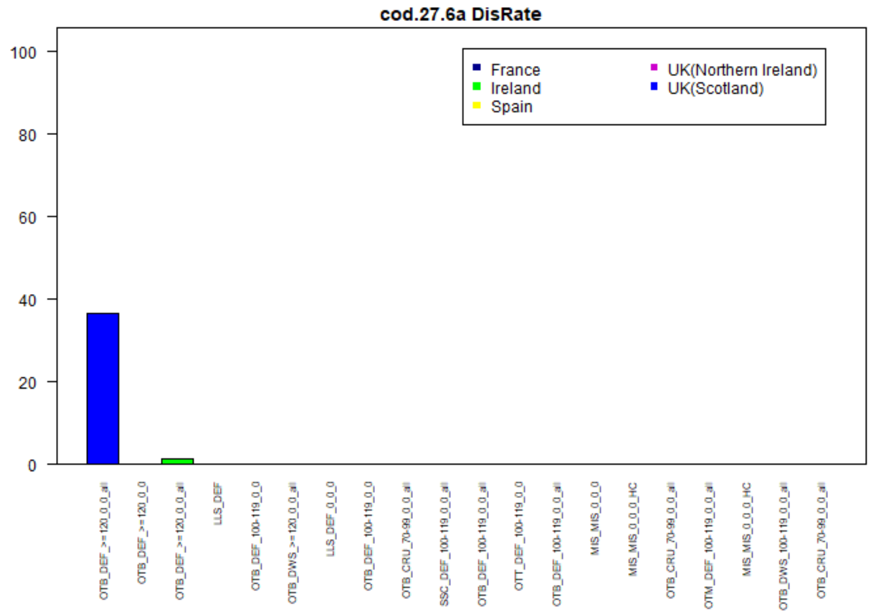


Figure 3.4. Cod.27.6a. Discard rates by weight by métier in 2021 as submitted to InterCatch.

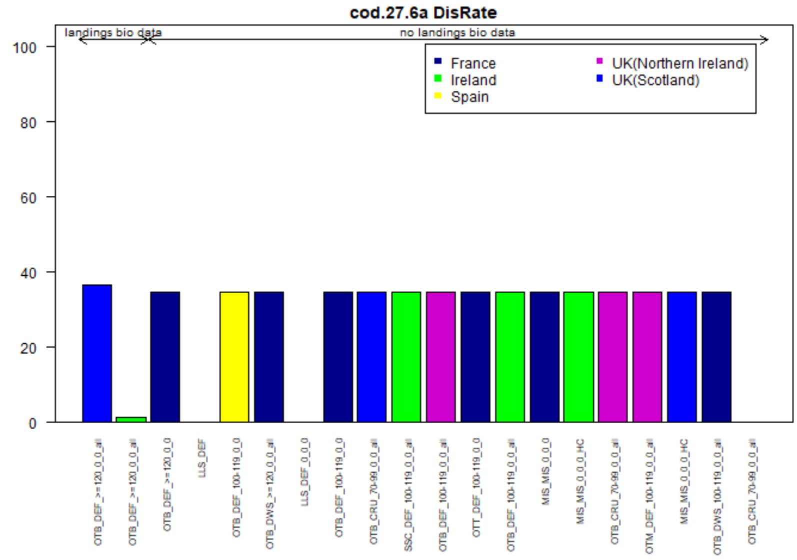


Figure 3.5. Cod.27.6a. Discard rates after allocations within InterCatch.

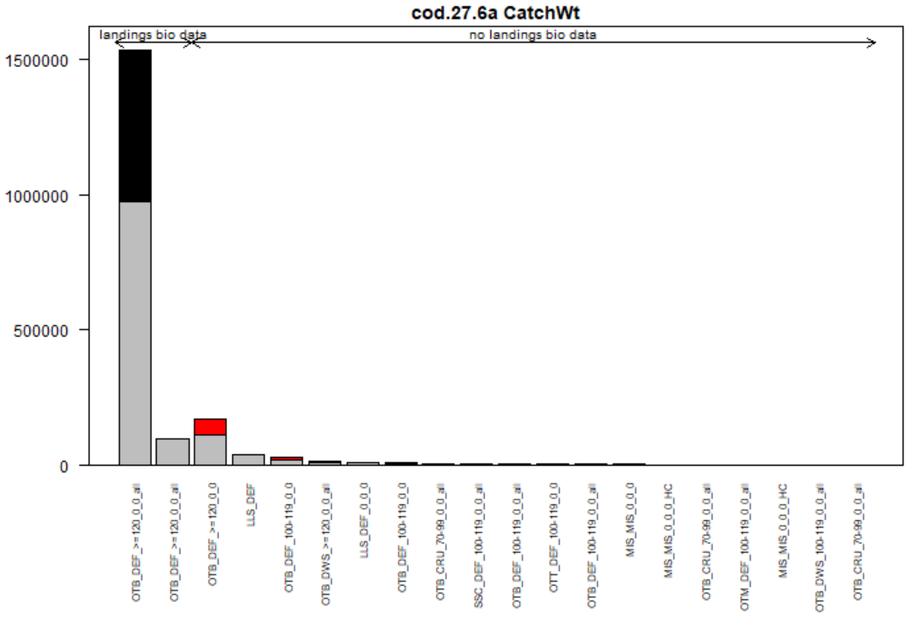


Figure 3.6. Cod.27.6a. Landings (grey), imported (black) and raised (red, but so small so not visible) discards of all fleets after allocations within InterCatch.

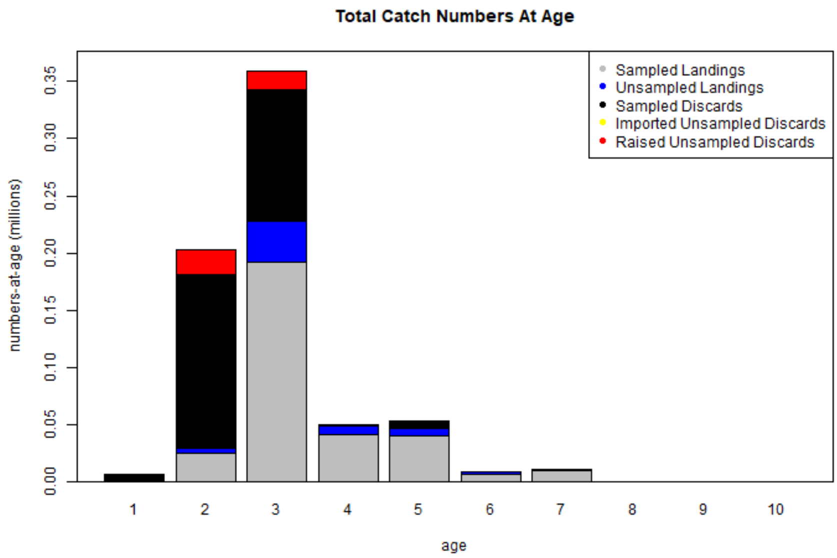


Figure 3.7. Cod.27.6a. Catch numbers-at-age by sampled and unsampled landings and sampled and raised (unsampled) discards, after allocations within InterCatch.

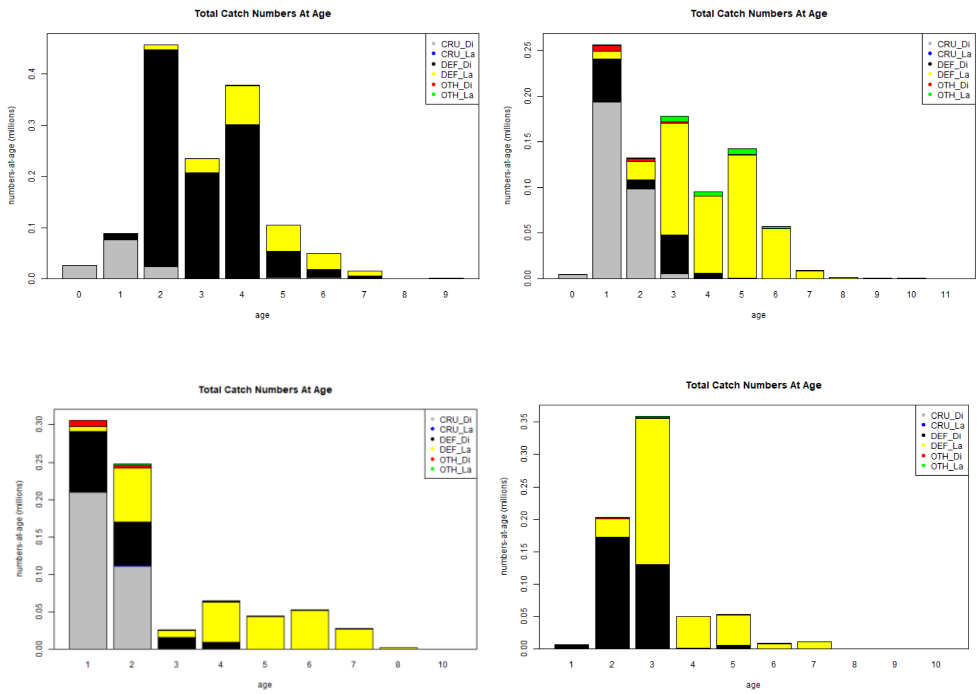


Figure 3.8. Cod.27.6a. Catch numbers-at-age by fleet/catch category after allocations within InterCatch, 2018 (top left) to 2021 (bottom right).

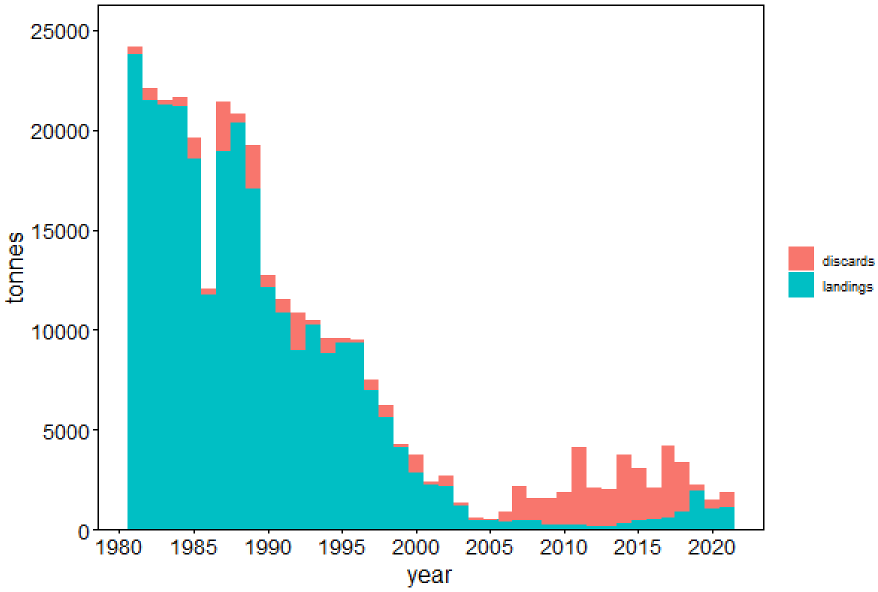


Figure 3.9. Cod.27.6a. Landings and discards estimates by weight, as used by the WG.

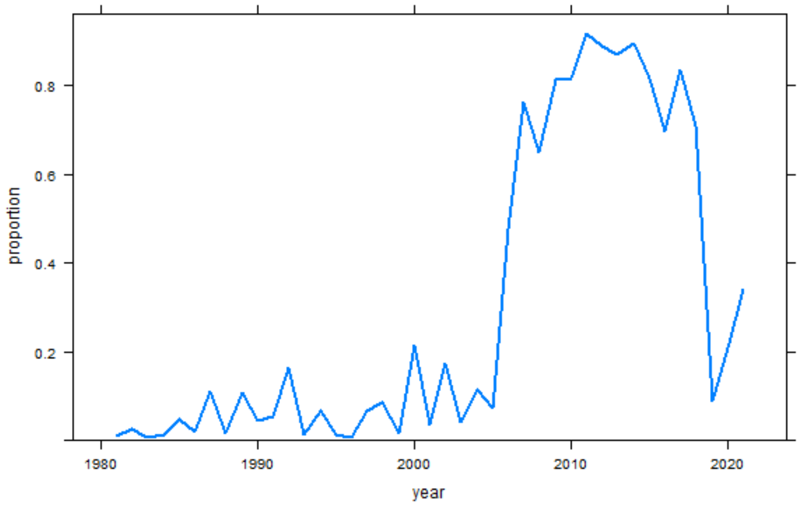


Figure 3.10. Cod.27.6a. Discard proportion (of total catch) by weight.

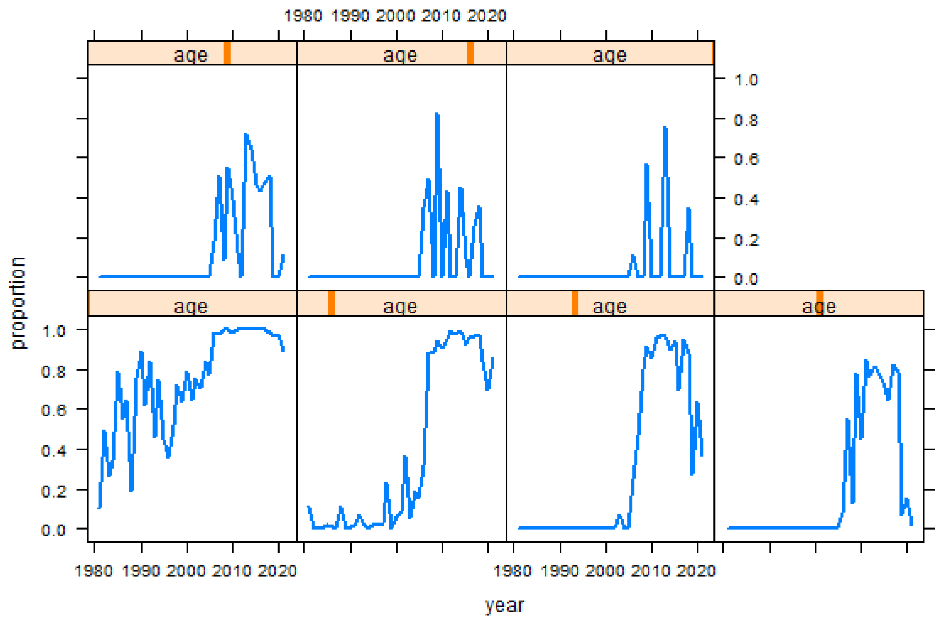


Figure 3.11. Cod.27.6a. Discard proportion by number by age.

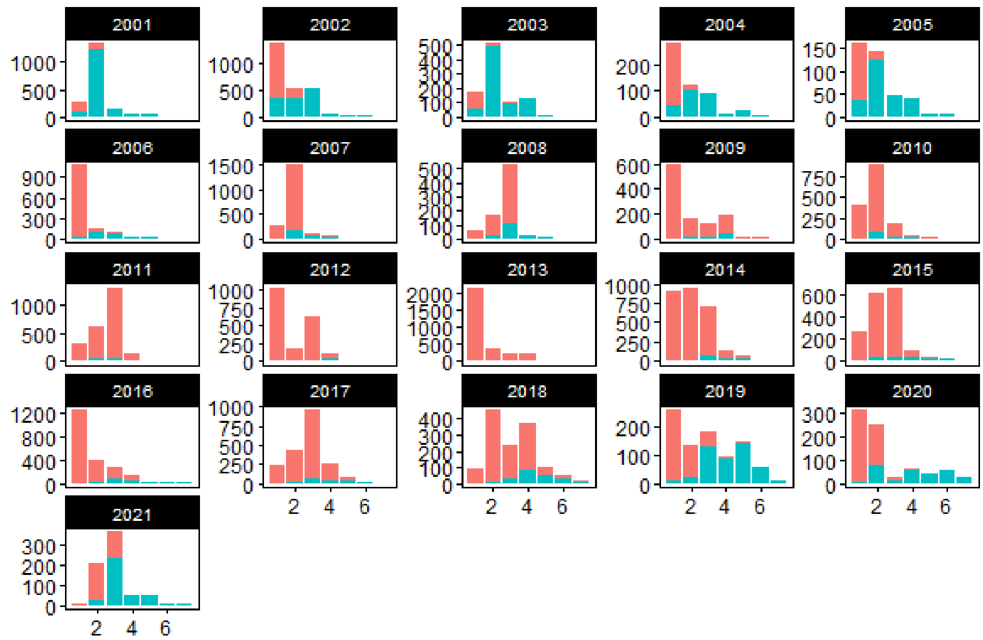


Figure 3.12. Cod.27.6a. Catch-at-age in numbers by year. Red: discards, blue: landings.

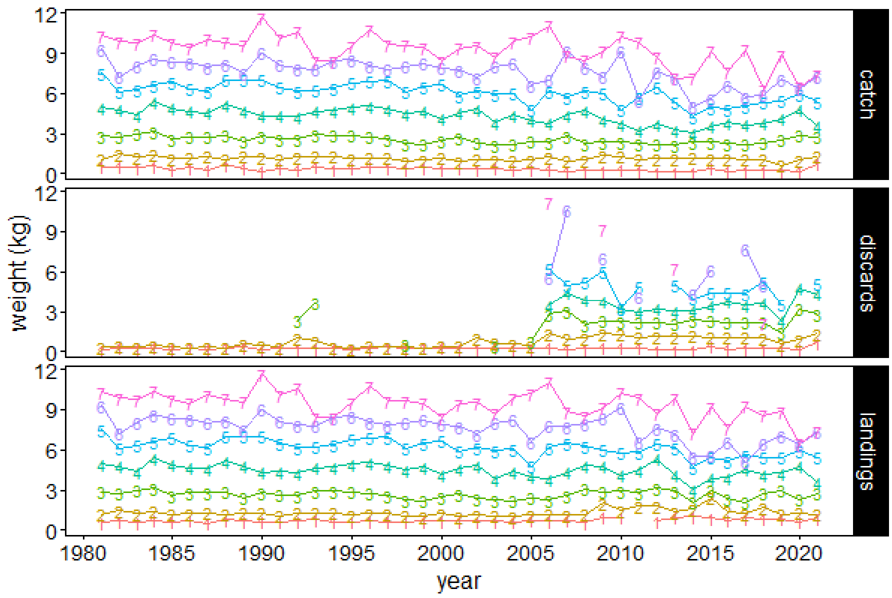


Figure 3.13. Cod.27.6a. Mean weights-at-age in landings and discards.

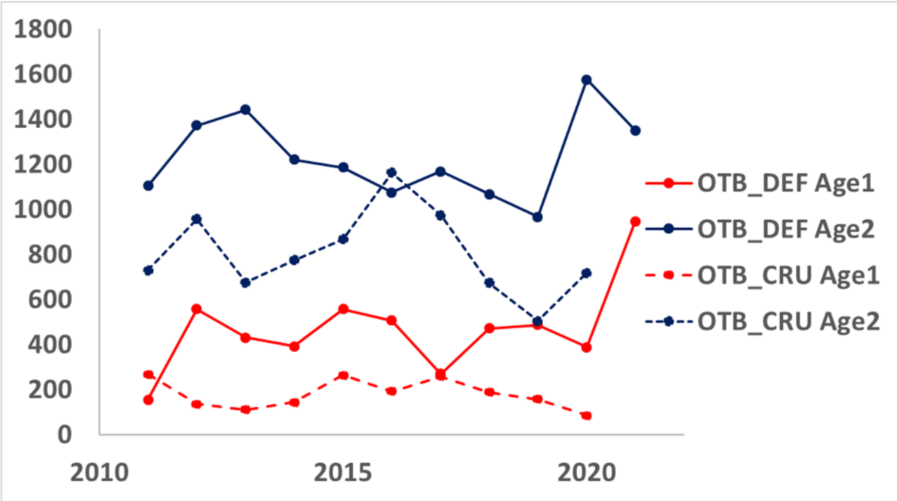


Figure 3.14. Cod.27.6a. Mean discard weights-at-age from Scottish sampling.

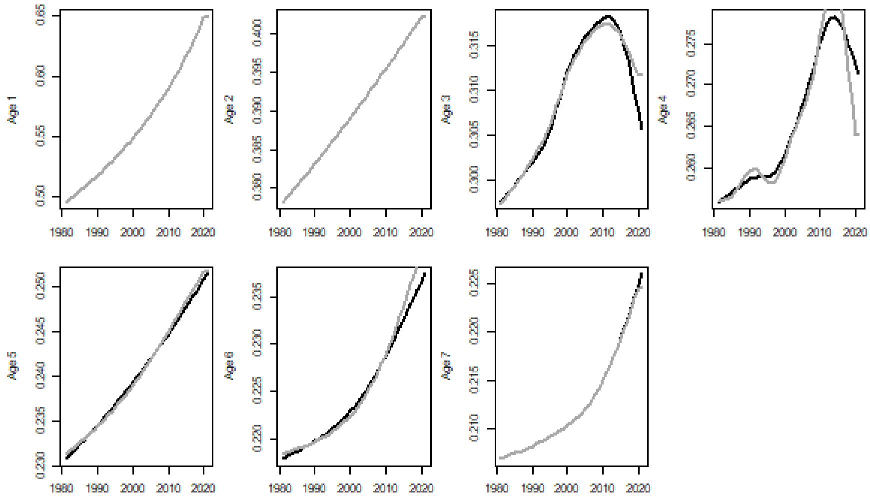


Figure 3.15. Cod.27.6a. Natural mortality-at-age based on stock weight-at-age and mortality–weight relationship (Lorenzen, 1996). (Age 1 bottom left, Age 7+ top right). Black: 2021, Grey: 2020.

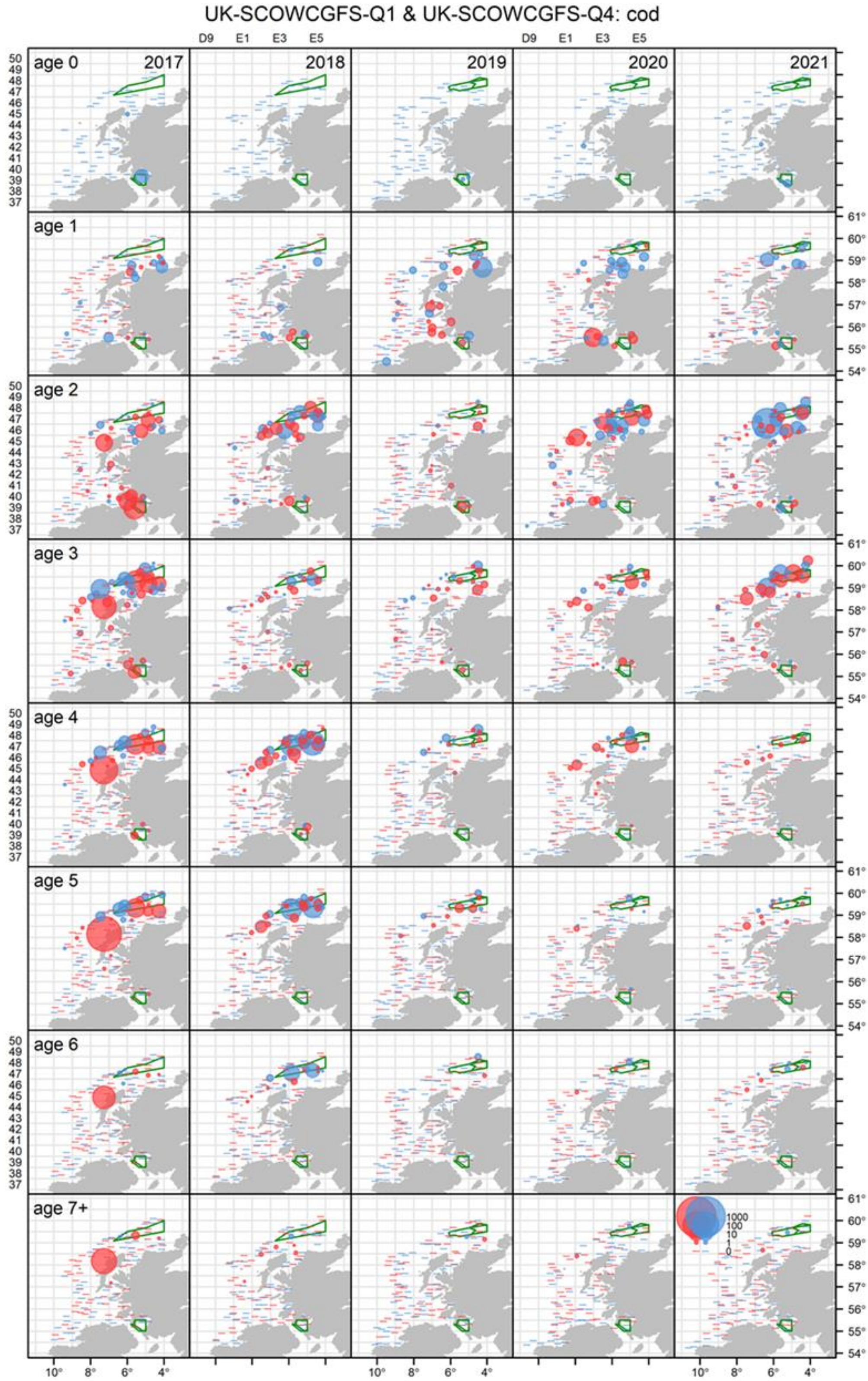
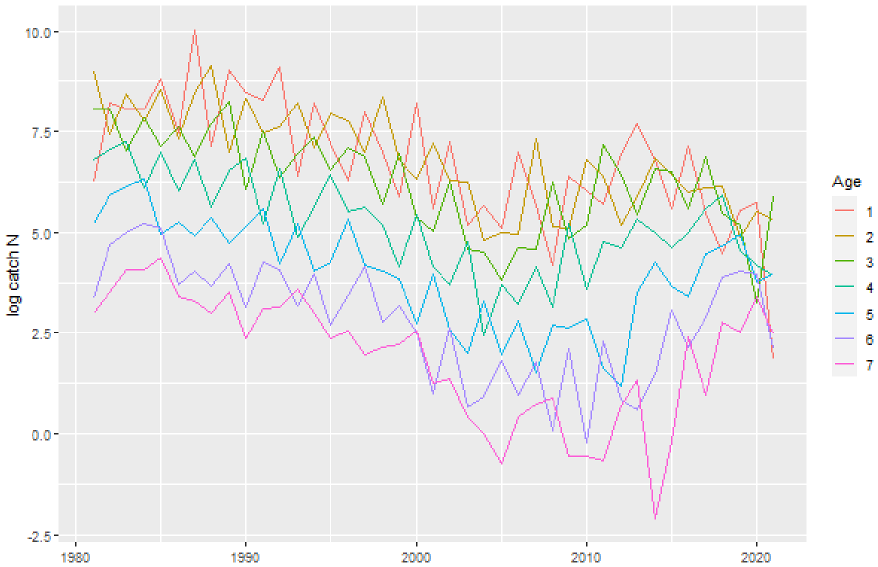


Figure 3.16. Cod.27.6a. CPUE numbers for fish aged at 1+ per tow resulting from Scottish quarter one survey (UK-SCOWCGFS-Q1) in red and (UK-SCOWCGFS-Q4) in blue. Numbers are standardised to 30 minutes towing. Green polygons are areas closed to fishing.



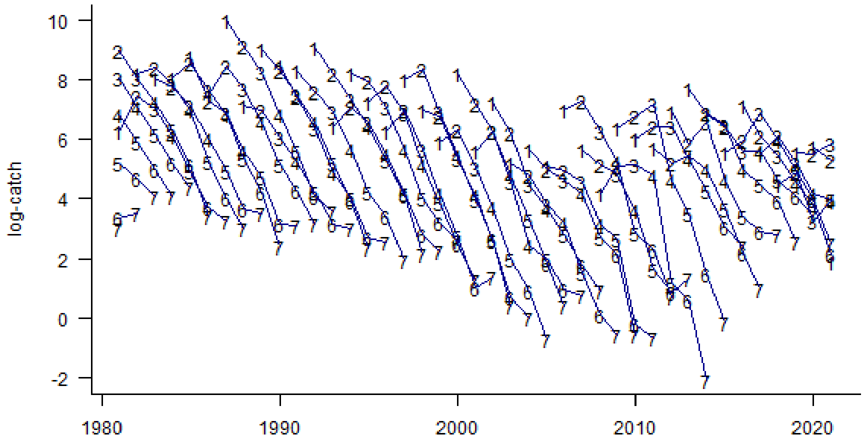


Figure 3.17. Cod.27.6a. Log catch numbers-at-age (upper) and catch curves (lower) from commercial catch-at-age data.

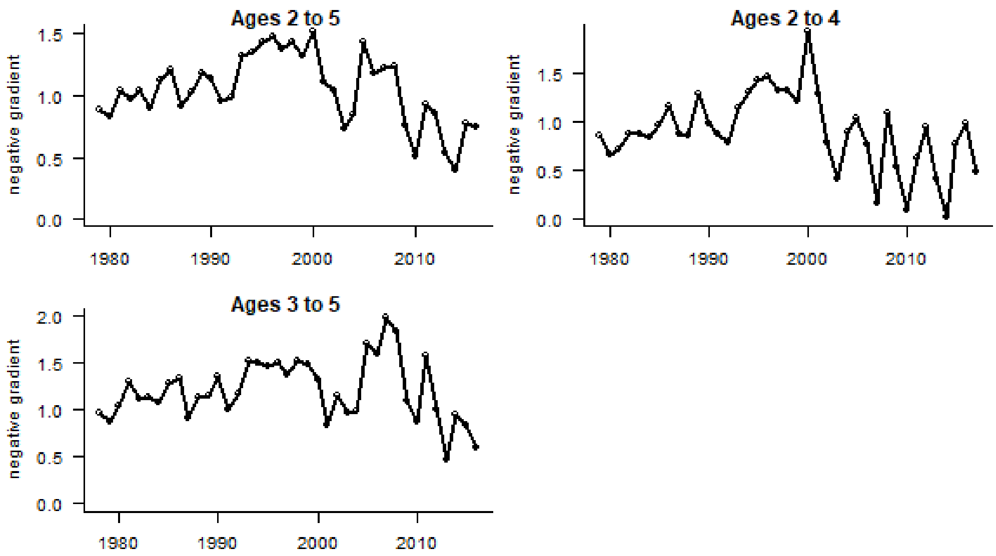


Figure 3.18. Cod.27.6a. Log catch (landings + discards) curve gradient plot using WG commercial catch-at-age data over different age ranges.

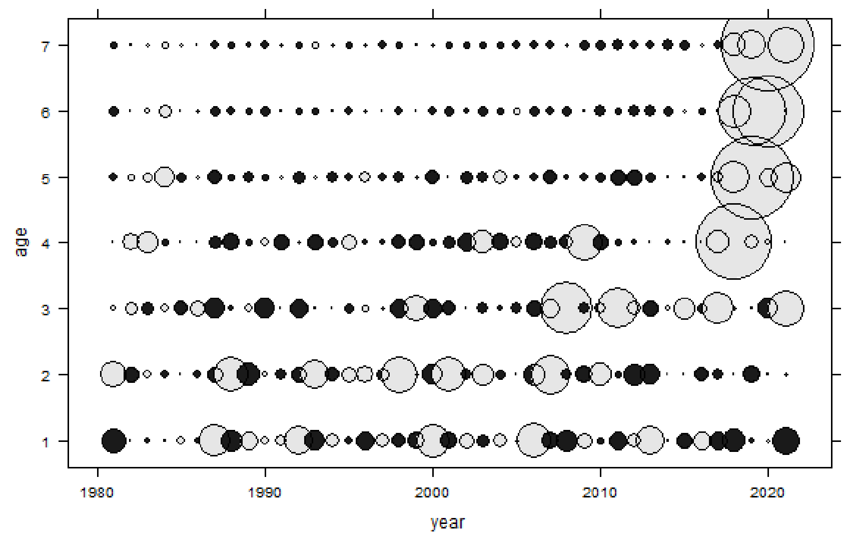


Figure 3.19. Cod.27.6a. Mean standardised catch-at-age proportions by number.

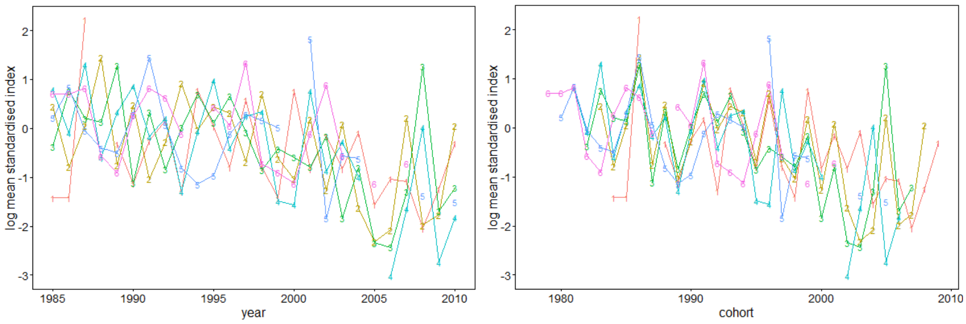


Figure 3.20. Cod.27.6a. Log mean standardised index values -by year- (left) and cohort (right) from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

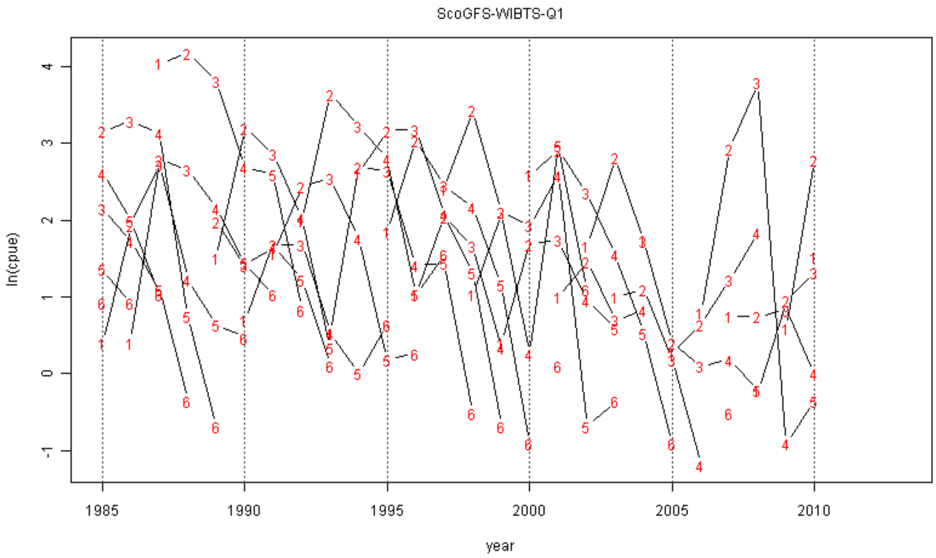


Figure 3.21. Cod.27.6a. Log catch curves from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

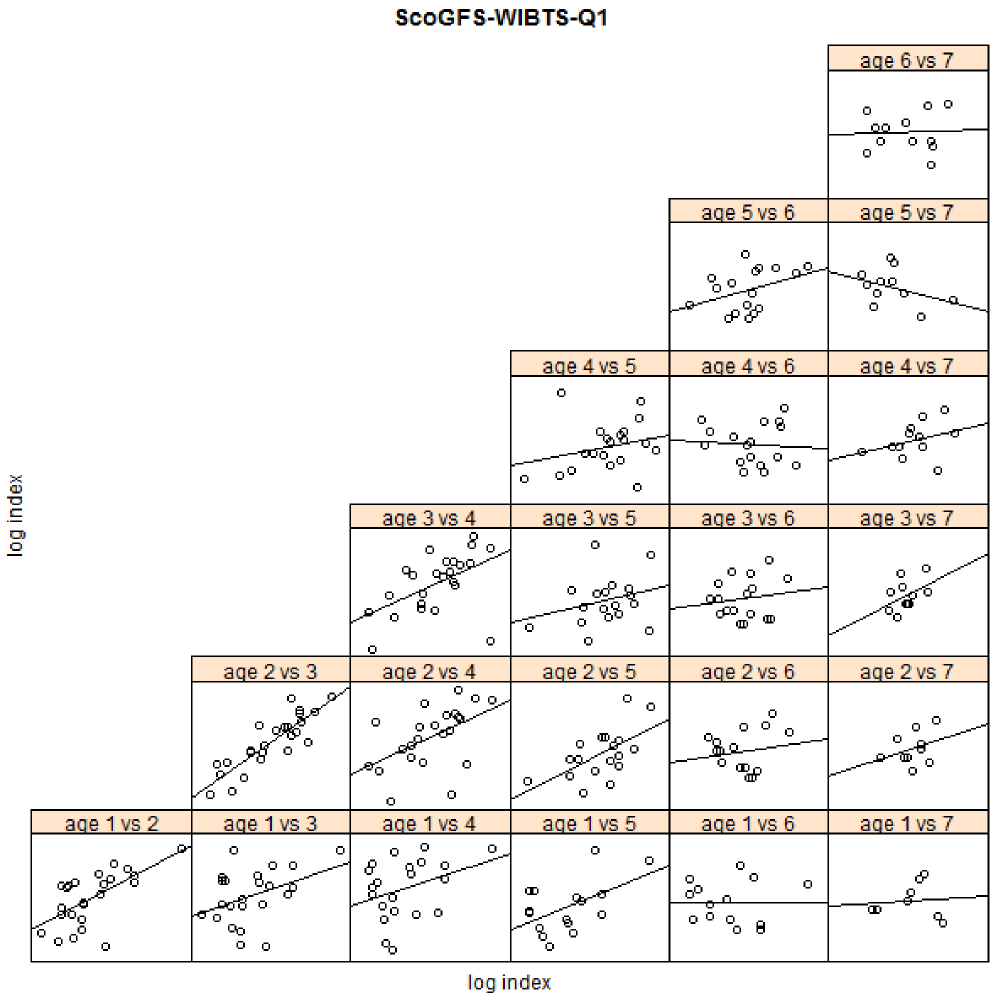


Figure 3.22. Cod.27.6a. Within-survey correlations for the Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1), comparing index values at different ages for the same cohorts. The straight line in a linear regression. Survey finished in 2010.

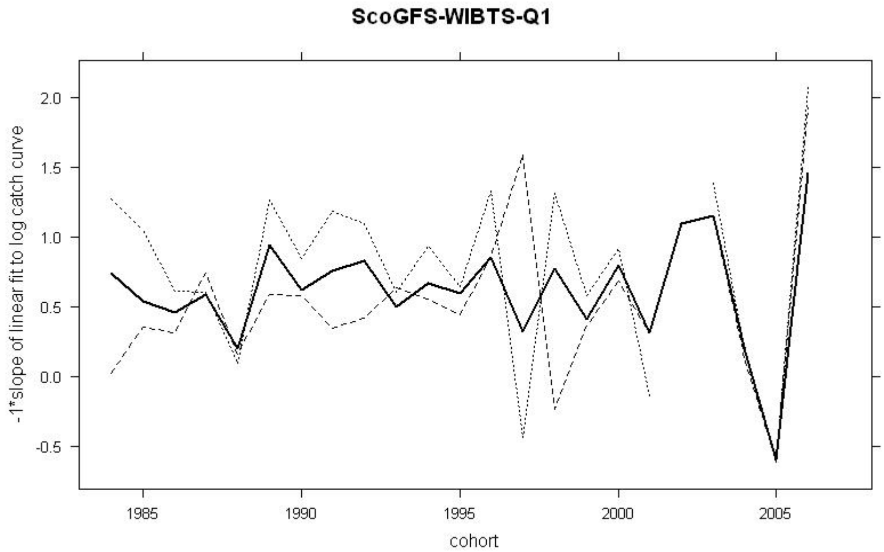


Figure 3.23. Cod.27.6a. Log catch curve gradient plot using ScoGFS-WIBTS-Q1 index data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. Last cohort shown was at-age 5 in 2010, the last year of the ScoGFS-WIBTS-Q1 survey.

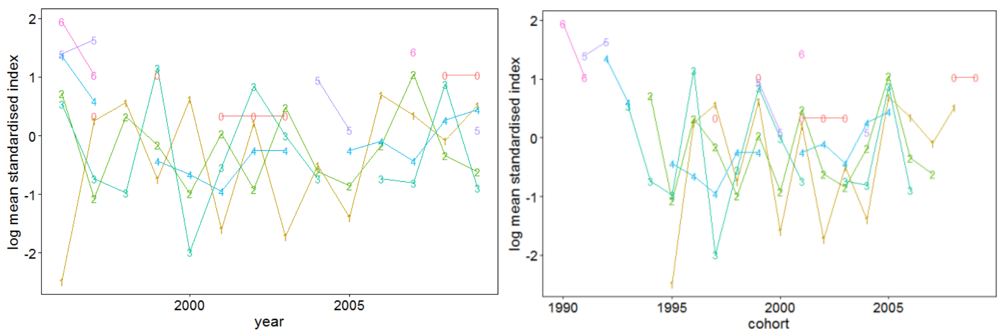


Figure 3.24. Cod in Division6a. Log mean standardised index values by year (left) and cohort (right) from ScoGFS-WIBTS-Q4.

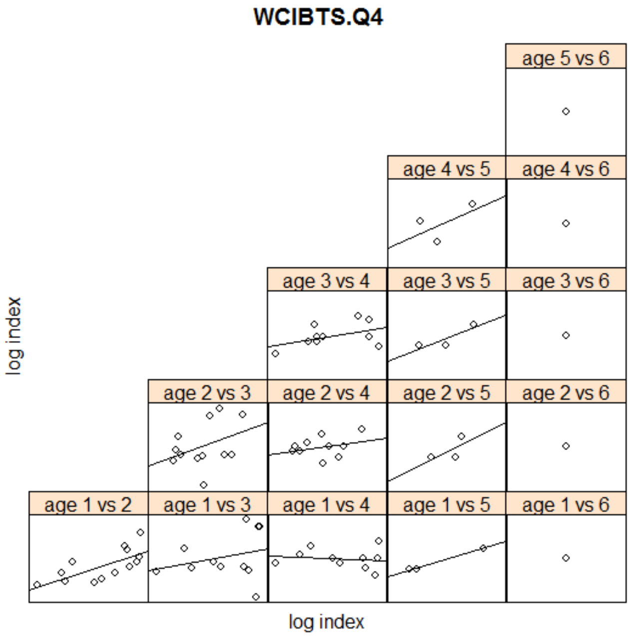


Figure 3.25. Cod.27.6a. Within survey correlations for ScoGFS-WIBTS-Q4 survey, comparing index values at different ages for the same cohorts. The solid line is a linear regression. Insufficient age 6 fish are caught to enable scatterplots to be constructed.

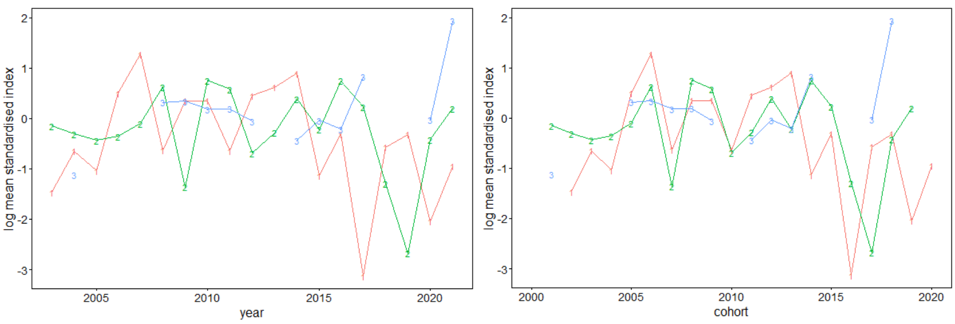


Figure 3.26. Cod.27.6a. Log mean standardised index values -by year (left) and cohort (right) from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 1–3. Survey started in 2003.

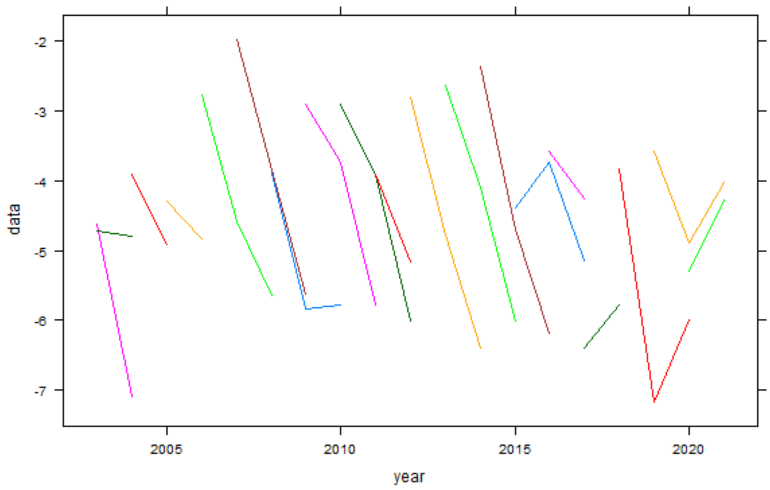


Figure 3.27. Cod.27.6a. Log catch curves from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 1–3. Survey started in 2003.

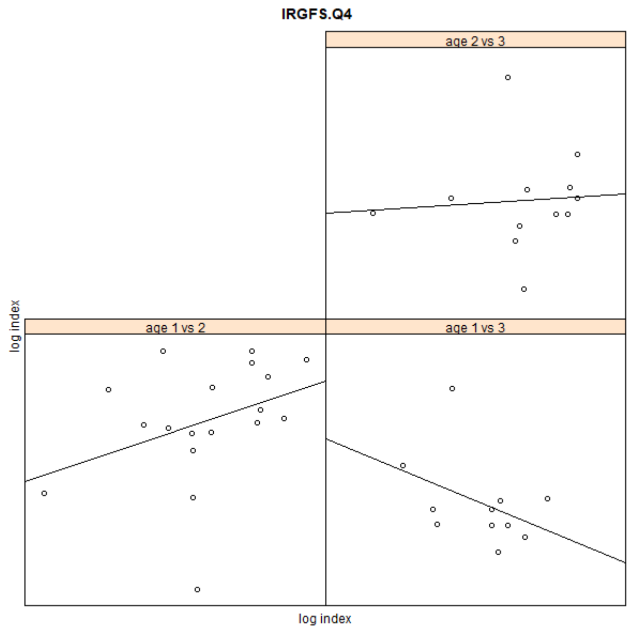


Figure 3.28. Cod.27.6a. Within-survey correlations for the Irish quarter four ground fish survey (IRGFS-WIBTS-Q4), comparing index values at different ages for the same cohorts. The straight line is a linear regression.

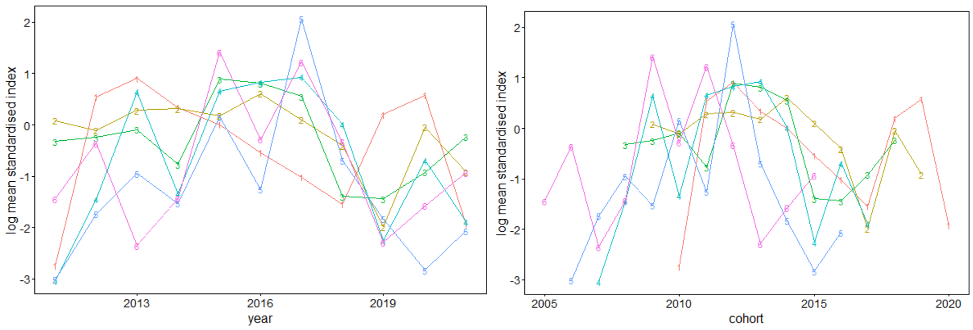


Figure 3.29. Cod.27.6a. Log mean standardised index values -by year (left) and cohort (right) - from Scottish quarter one ground fish survey UK-SCOWCGFS-Q1; ages 1–6.

Figure 3.30. Cod.27.6a. Log catch curves from new Scottish quarter one ground fish survey (UK-SCOWCGFS-Q1); ages 1–7. Survey started in 2011.

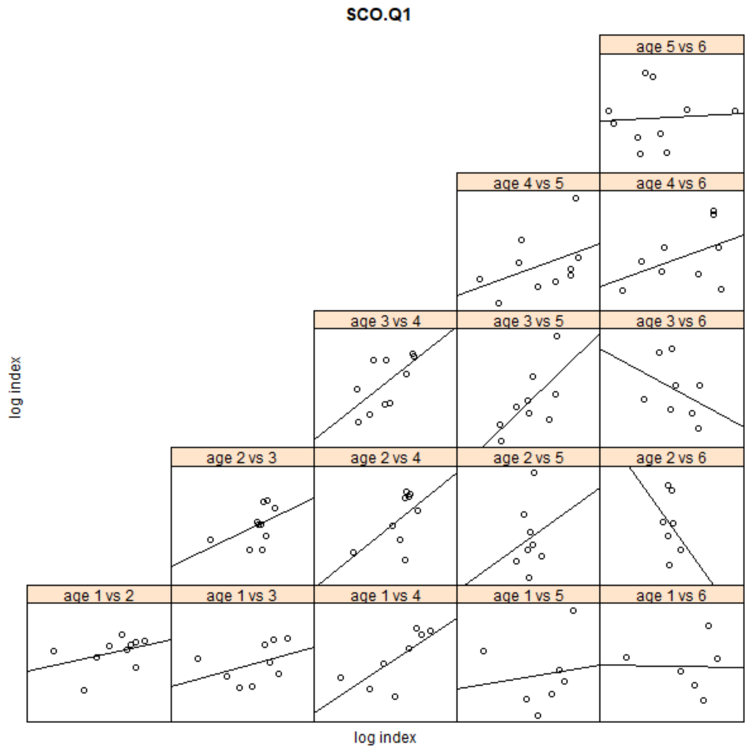


Figure 3.31. Cod.27.6a. Within survey scatterplots from new Scottish quarter one ground fish survey (UK-SCOWCGFS-Q1), comparing index values at different ages for the same cohorts. The straight line in a linear regression.

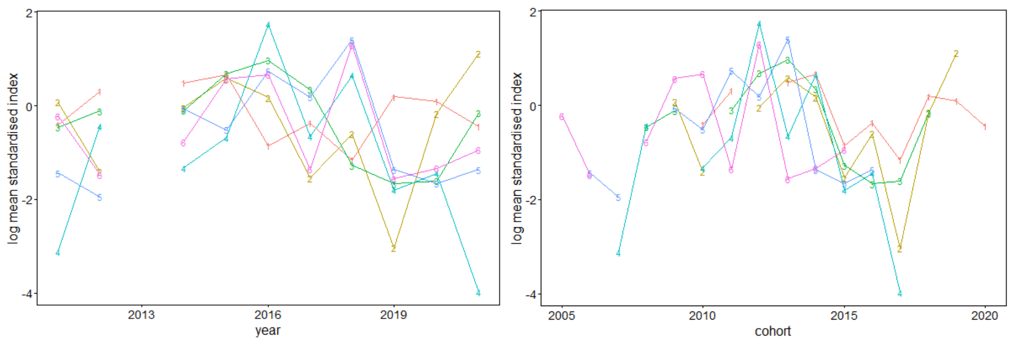


Figure 3.32. Cod.27.6a. Log mean standardised index values by year (left) and cohort (right) from Scottish quarter four ground fish survey UK-SCOWCGFS-Q4); ages 1–6.

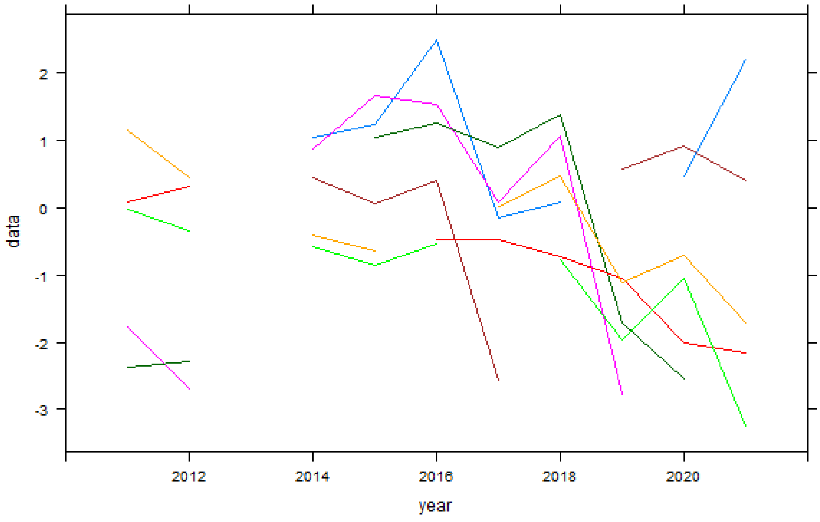


Figure 3.33. Cod.27.6a. Log catch curves from new Scottish quarter four ground fish survey (UK-SCOWCGFS-Q4).

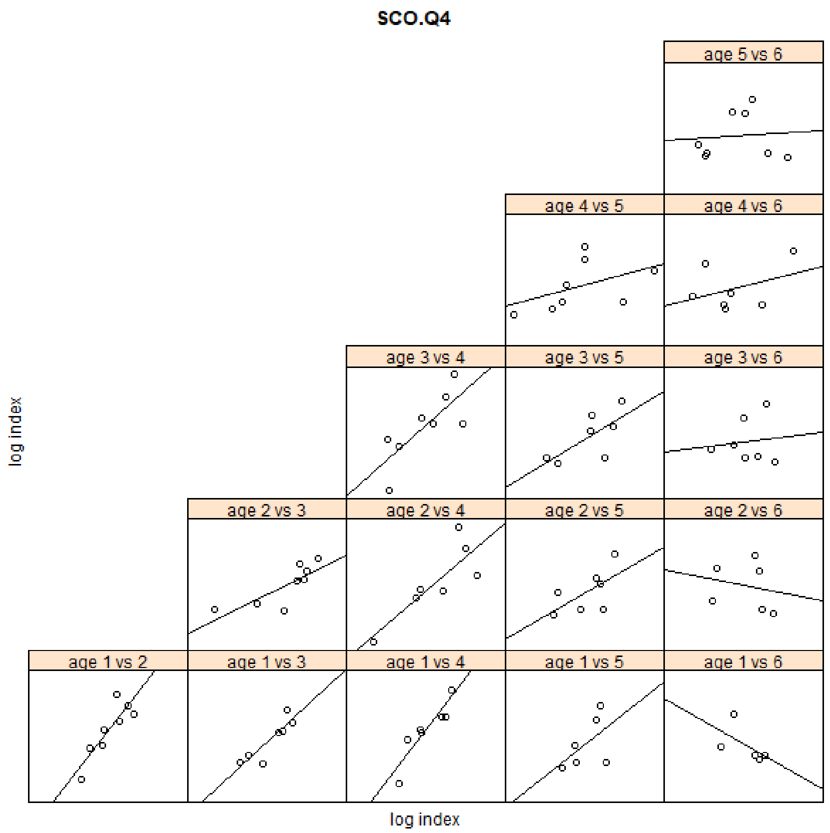


Figure 3.34. Cod.27.6a. Within survey scatterplots from new Scottish quarter four ground fish survey (UK-SCOWCGFS-Q4), comparing index values at different ages for the same cohorts. The straight line in a linear regression.

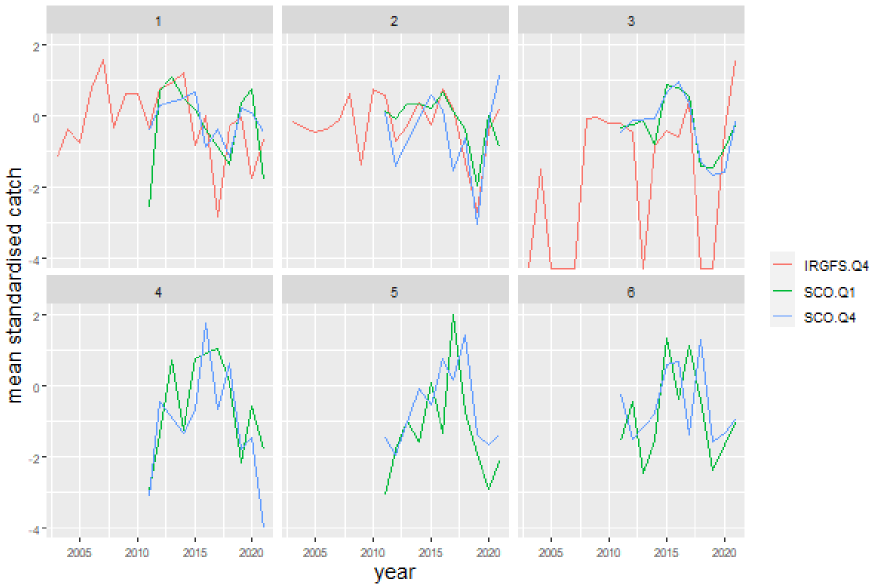


Figure 3.35. Cod.27.6a. Comparison of survey indices by age. Irish Q4 survey (IRGFS.Q4) is compared to the current Scottish surveys (SCO.Q1=UK-SCOWCGFS-Q1 & SCO.Q4=UK-SCOWCGFS-Q4). Values are mean standardised over the time period in common (2011–2021).

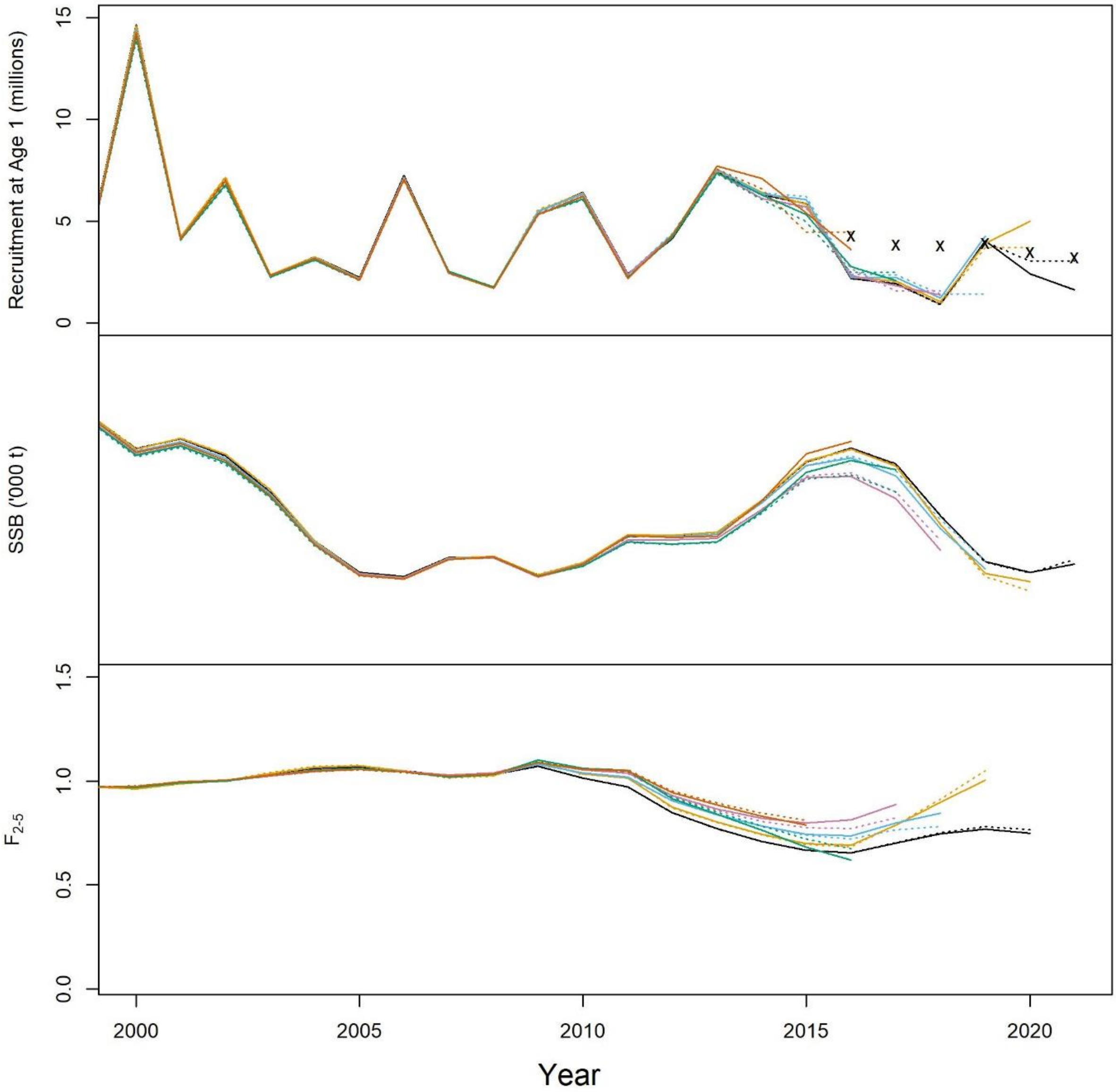


Figure 3.36. Cod.27.6a. Retrospective sensitivity analysis of SAM assessment results to lack of intermediate year survey data. Solid black line: WGCSE 2021 final assessment. Solid lines include intermediate year survey data. Dotted line exclude data.

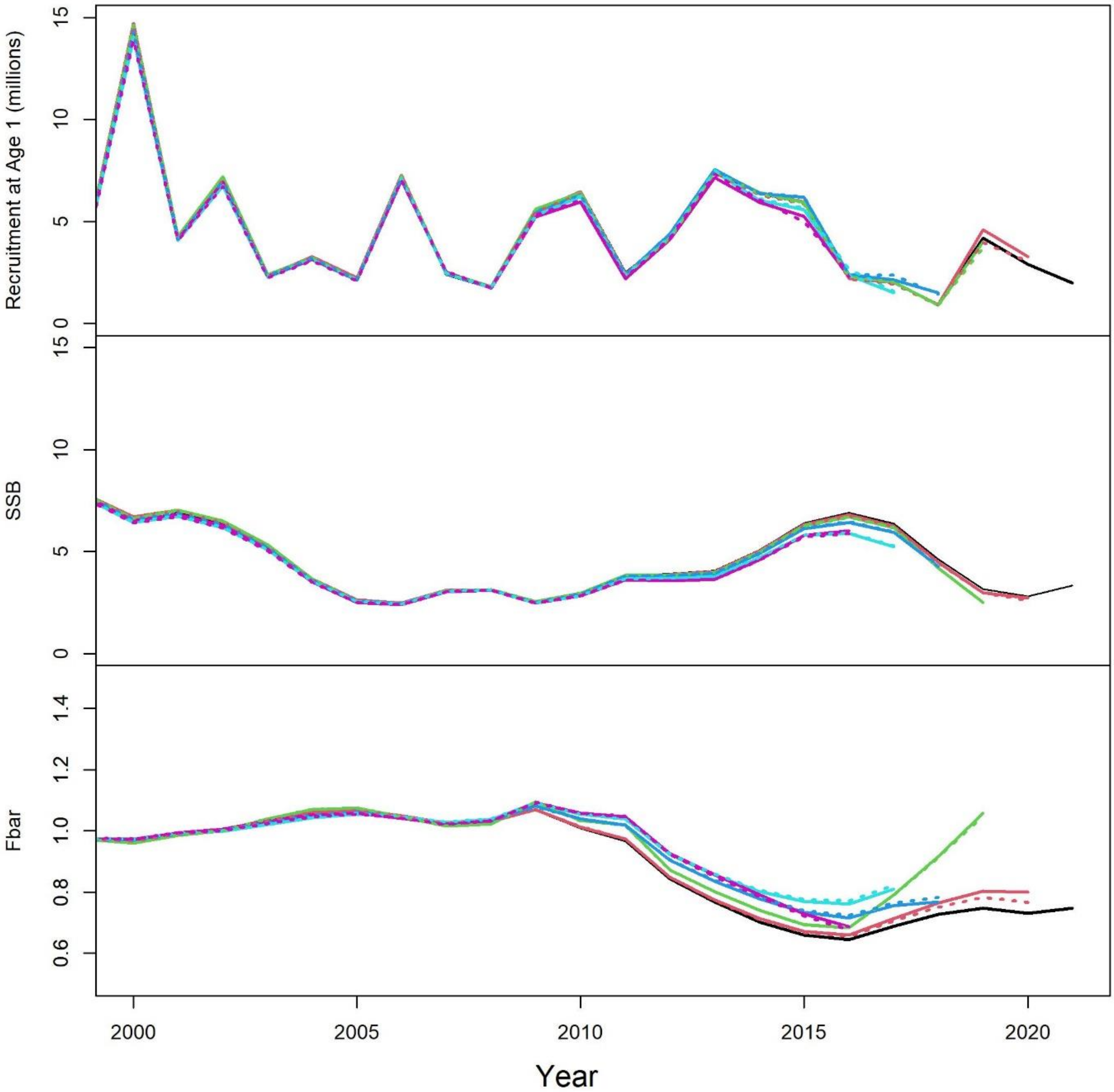


Figure 3.37. Cod.27.6a. Retrospective sensitivity analysis of SAM assessment results to exclusion of age 1 and age 2 catch data. Black line: WGCSE 2022 final assessment. Solid lines include all catch data. Dotted line exclude age 1 and 2.

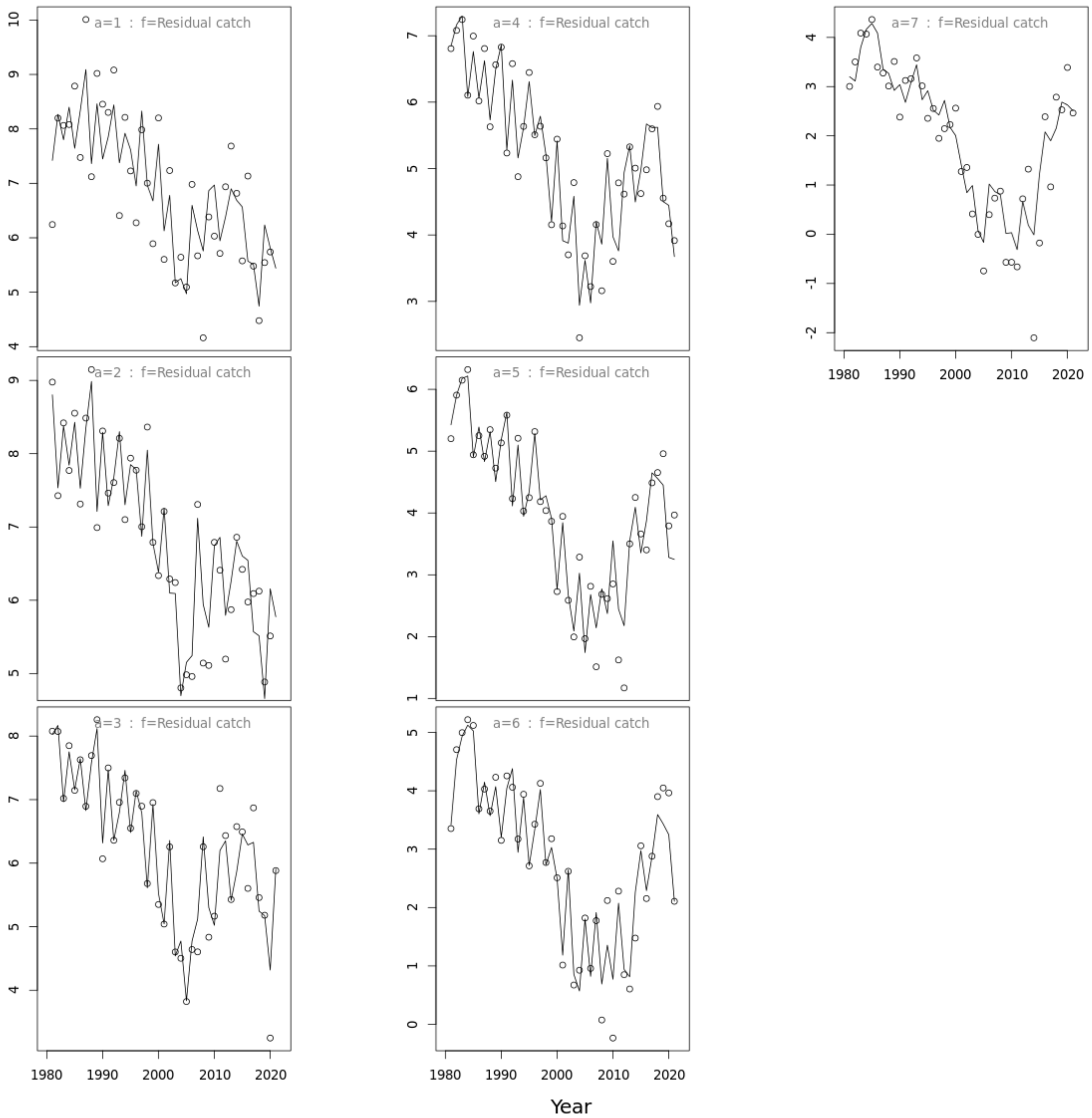


Figure 3.38. Cod.27.6a. SAM final run. Comparison of model estimated and observed log catch numbers-at-age.

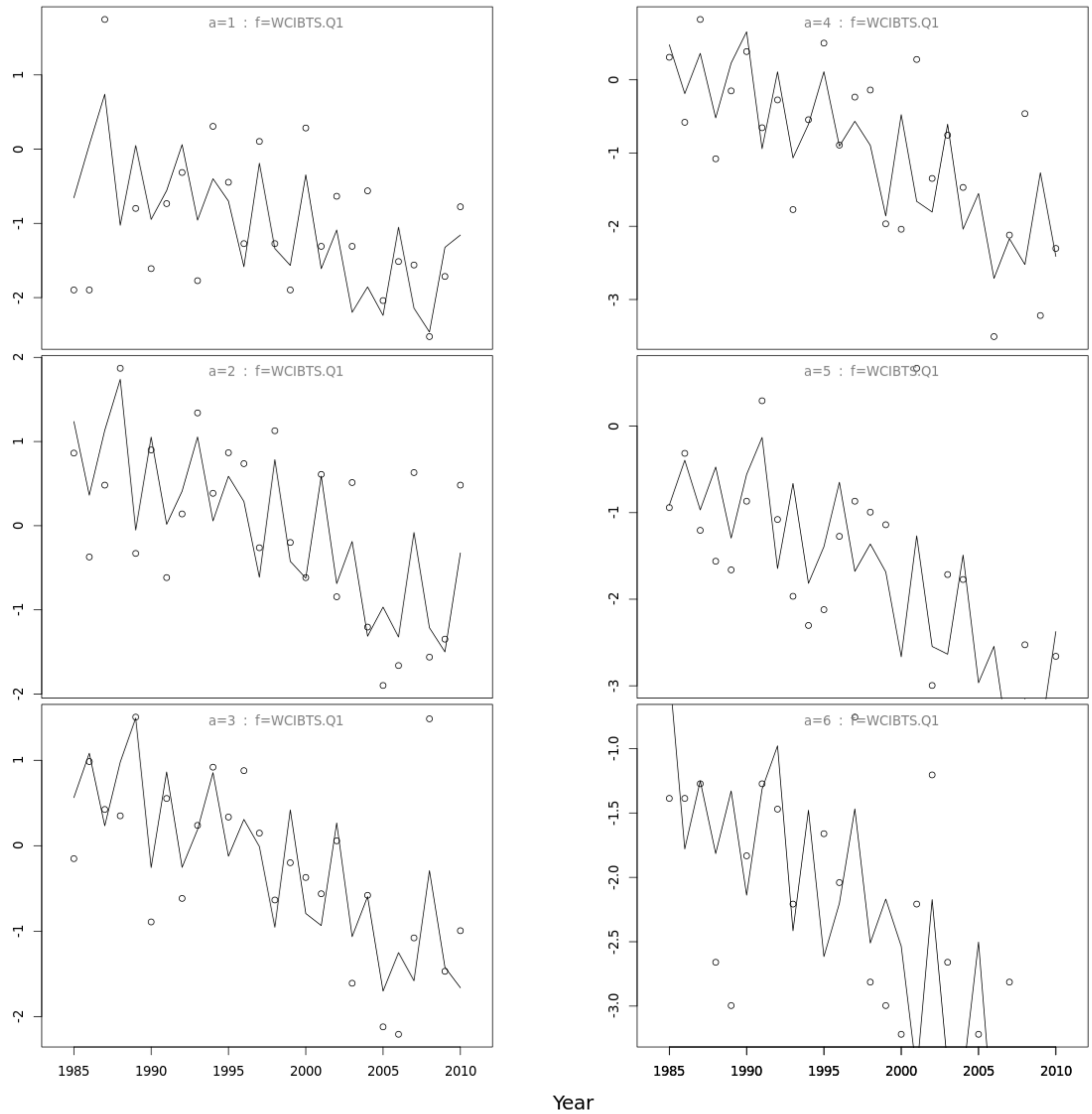


Figure 3.39. Cod.27.6a. SAM final run. Comparison of model estimated and observed log index at age (ScoGFS-WIBTS-Q1).

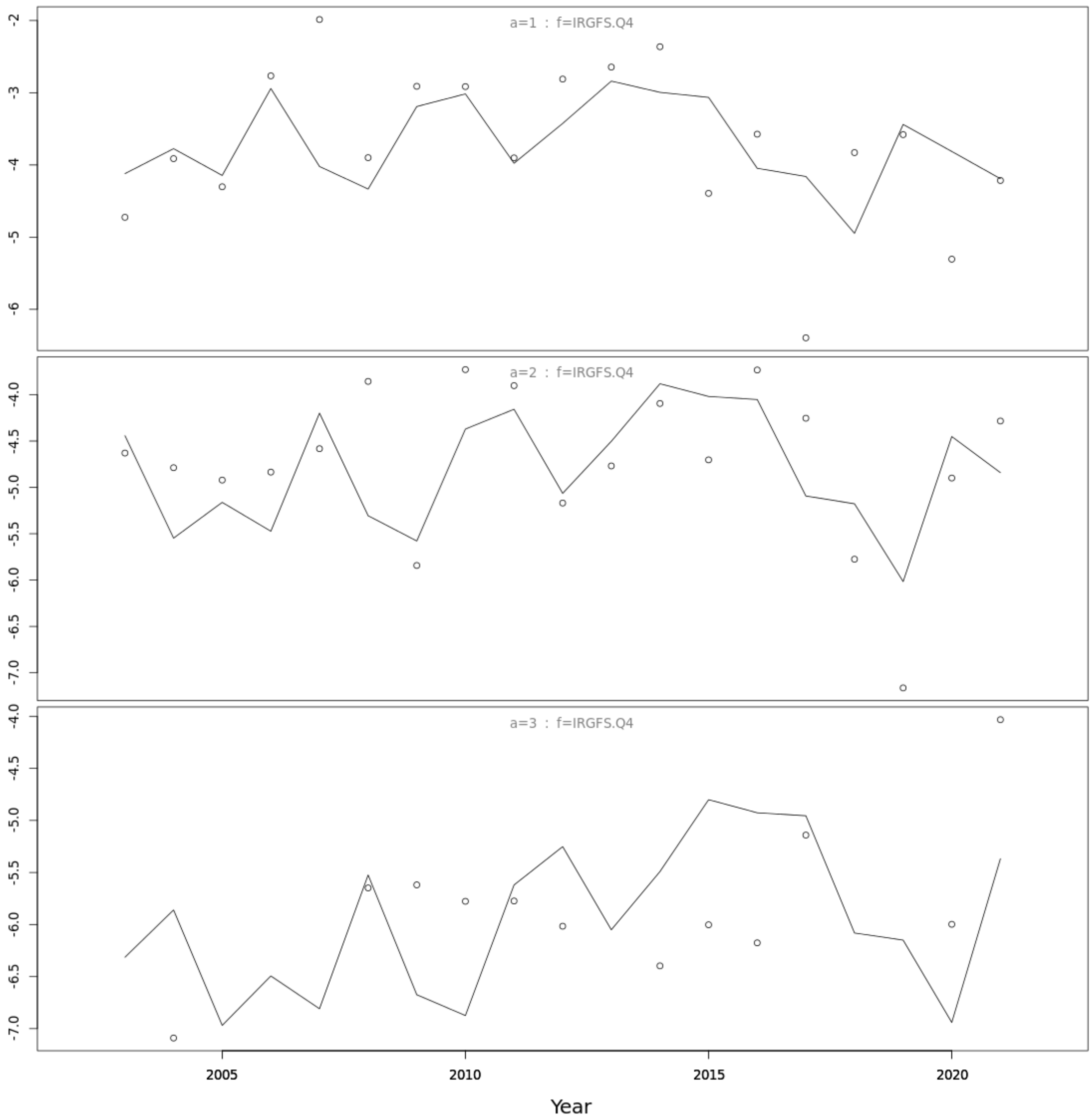


Figure 3.40. Cod.27.6a. SAM final run. Comparison of model estimated and observed log index at-age (IRGFS-WIBTS-Q4).

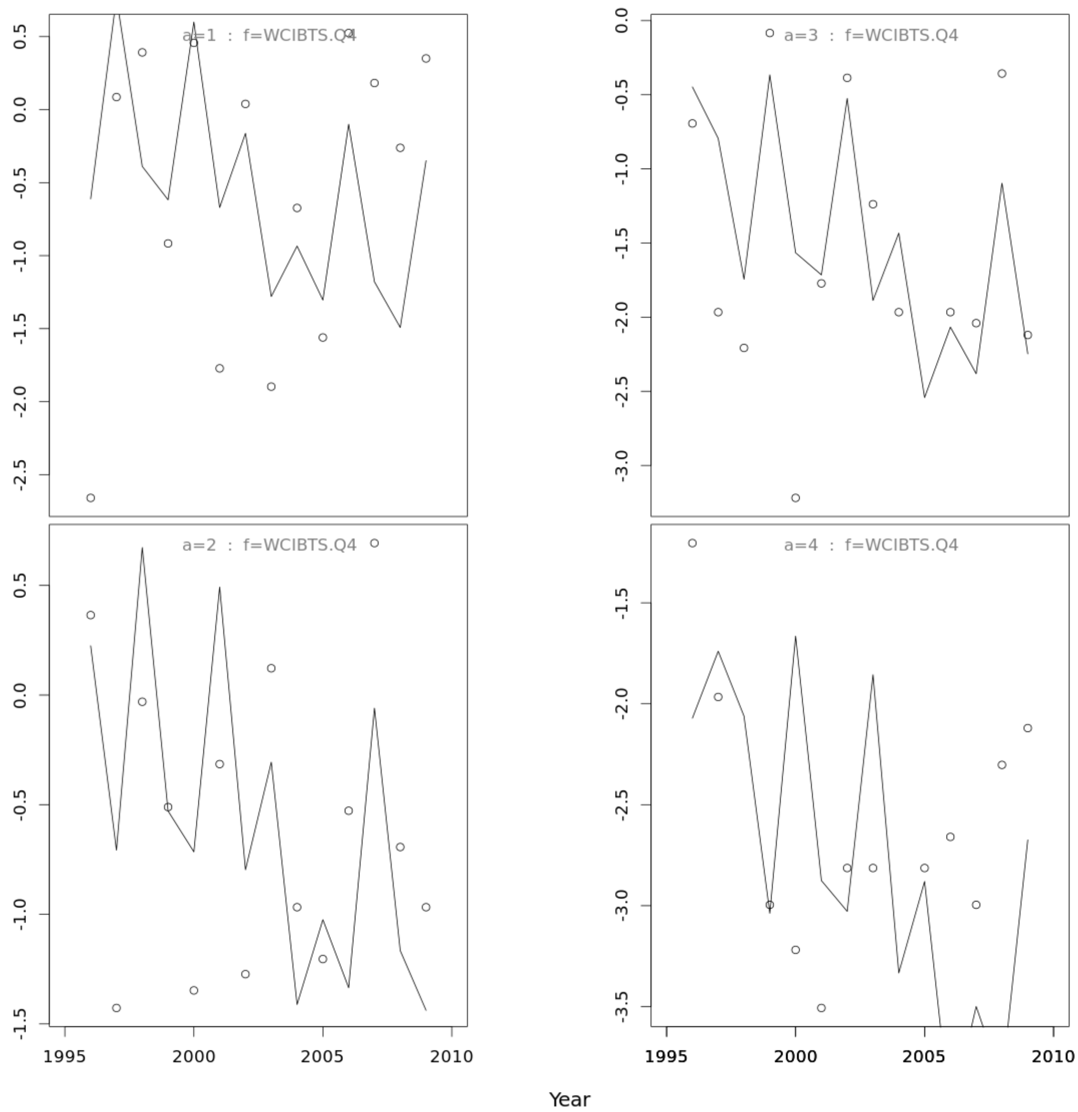


Figure 3.41. Cod.27.6a. SAM final run. Comparison of model estimated and observed log index at-age (ScoGFS-WIBTS-Q4).

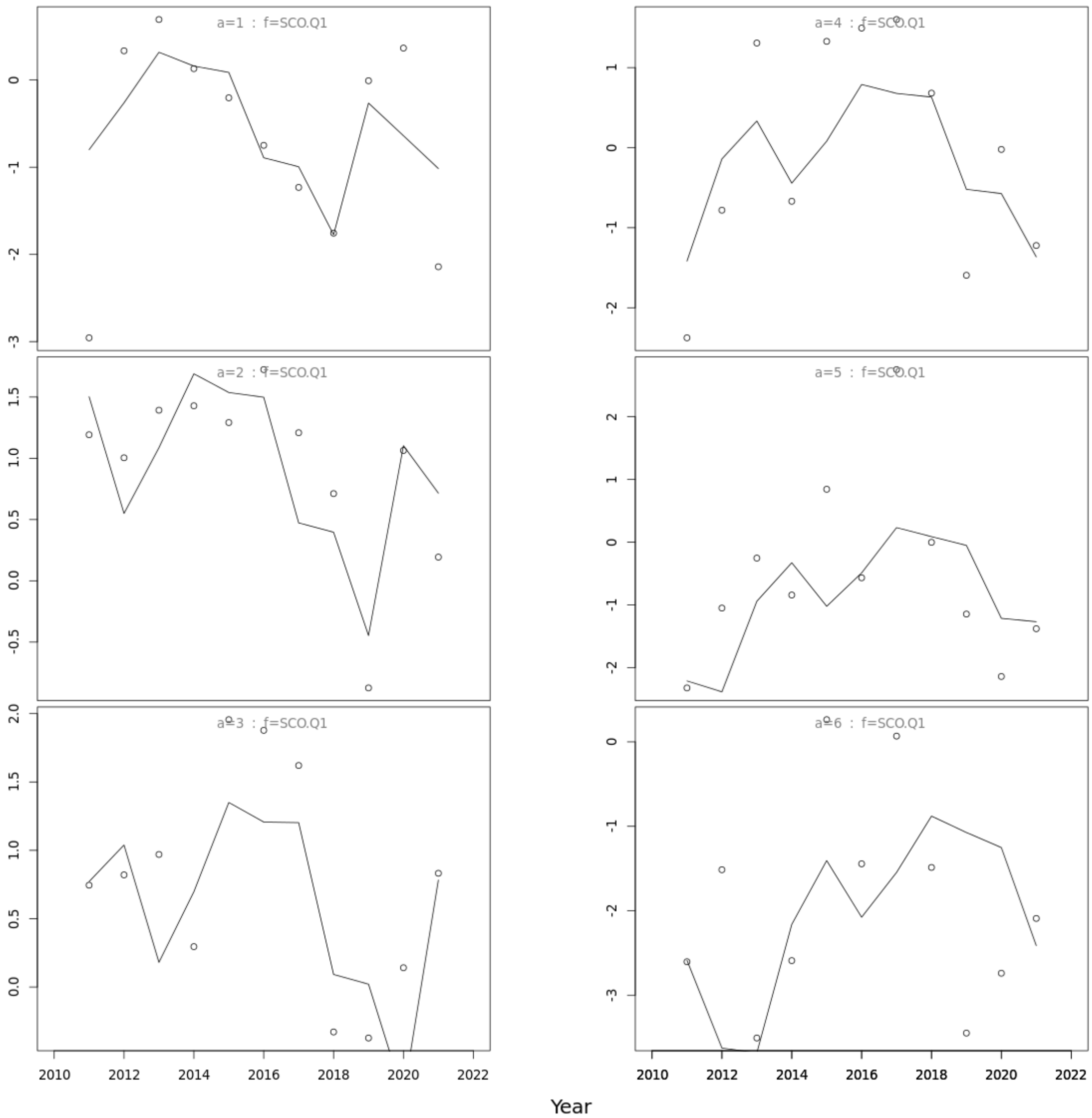


Figure 3.42. Cod.27.6a. SAM final run. Comparison of model estimated and observed log index at-age (UK-SCOWCGFS-Q1).

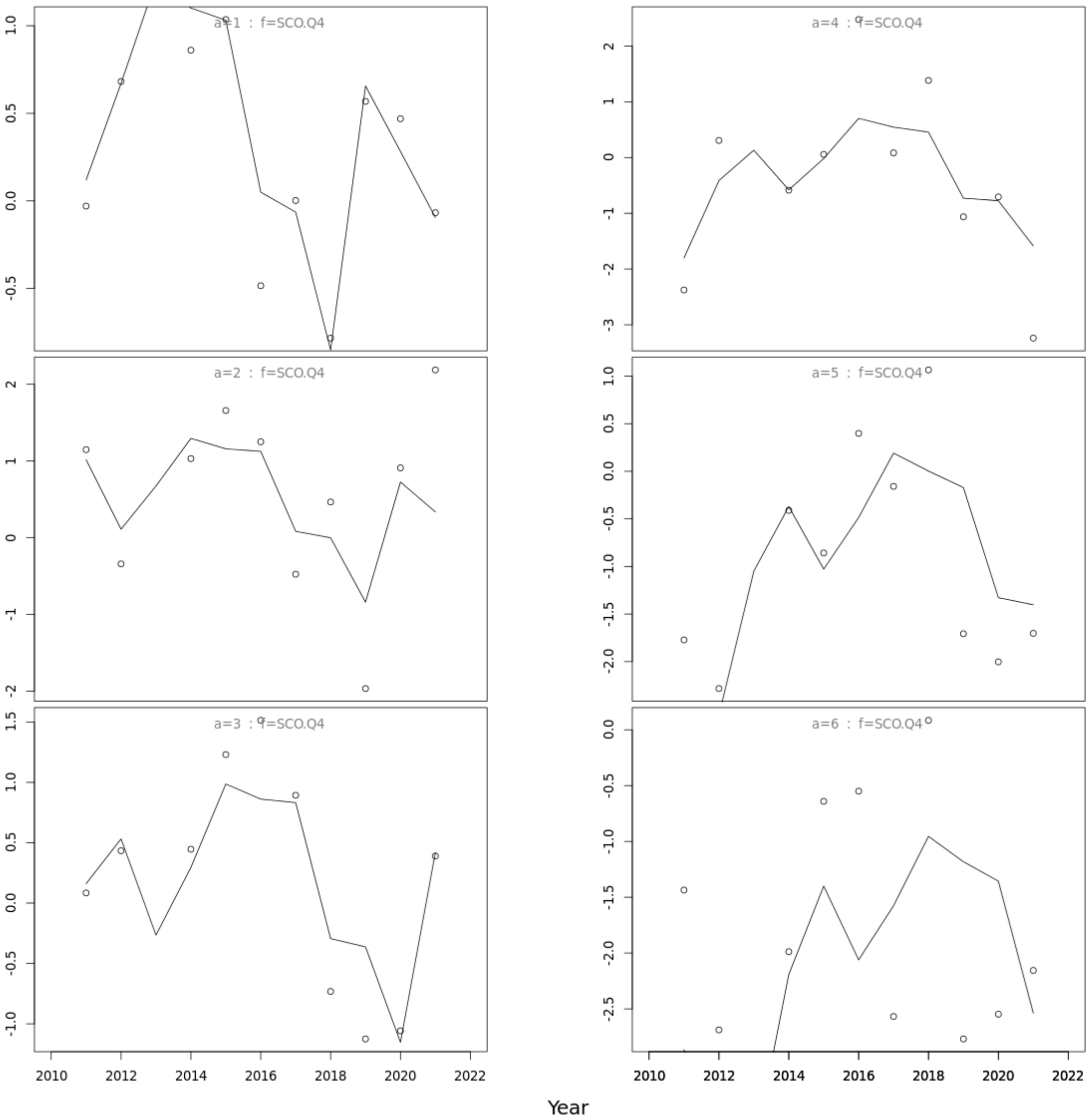


Figure 3.43. Cod.27.6a. SAM final run. Comparison of model estimated and observed log index at-age (UK-SCOWCGFS-Q4).

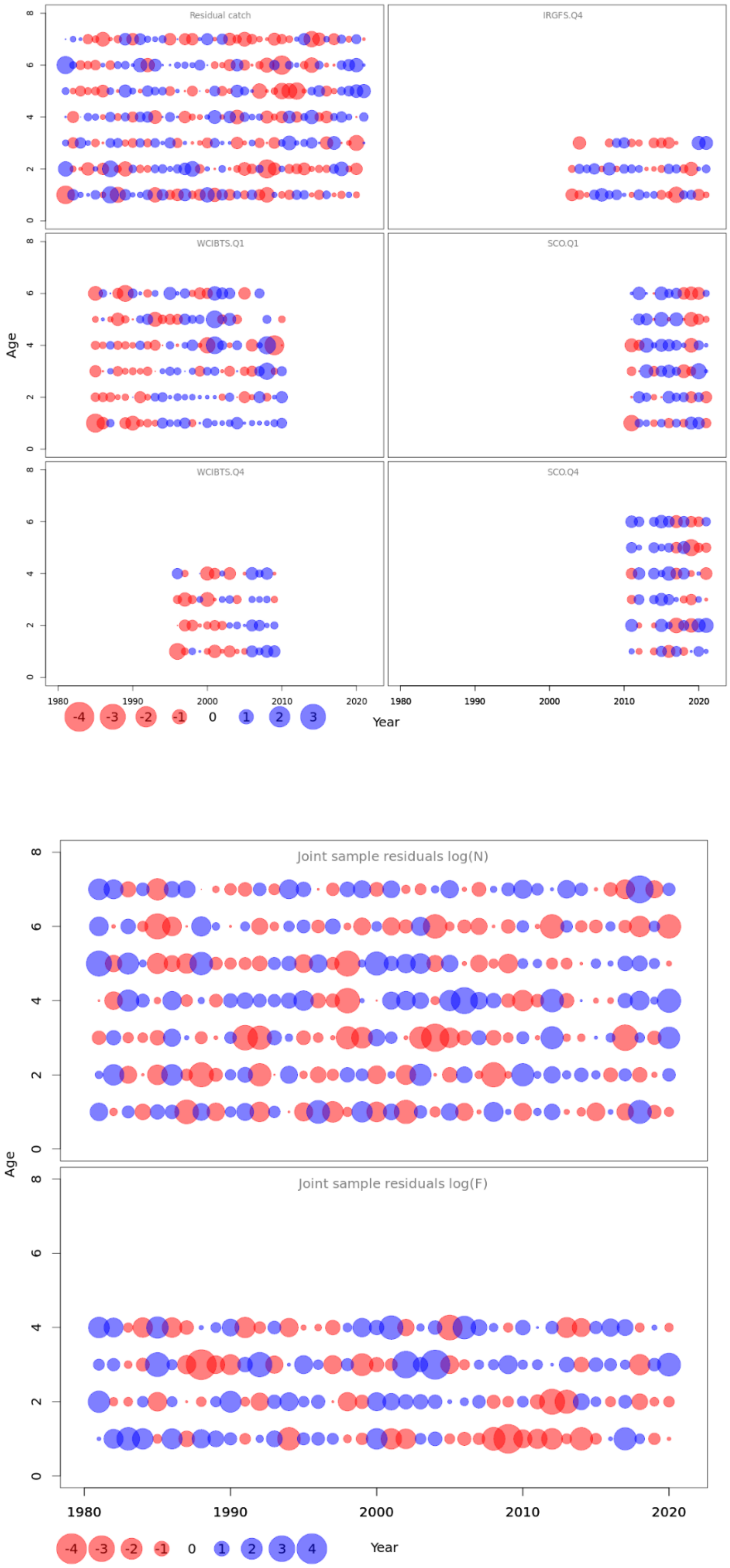


Figure 3.44. Cod.27.6a. SAM final run. One step ahead residuals for catch-at-age data and survey indices (upper panel) and process residuals (lower panel).

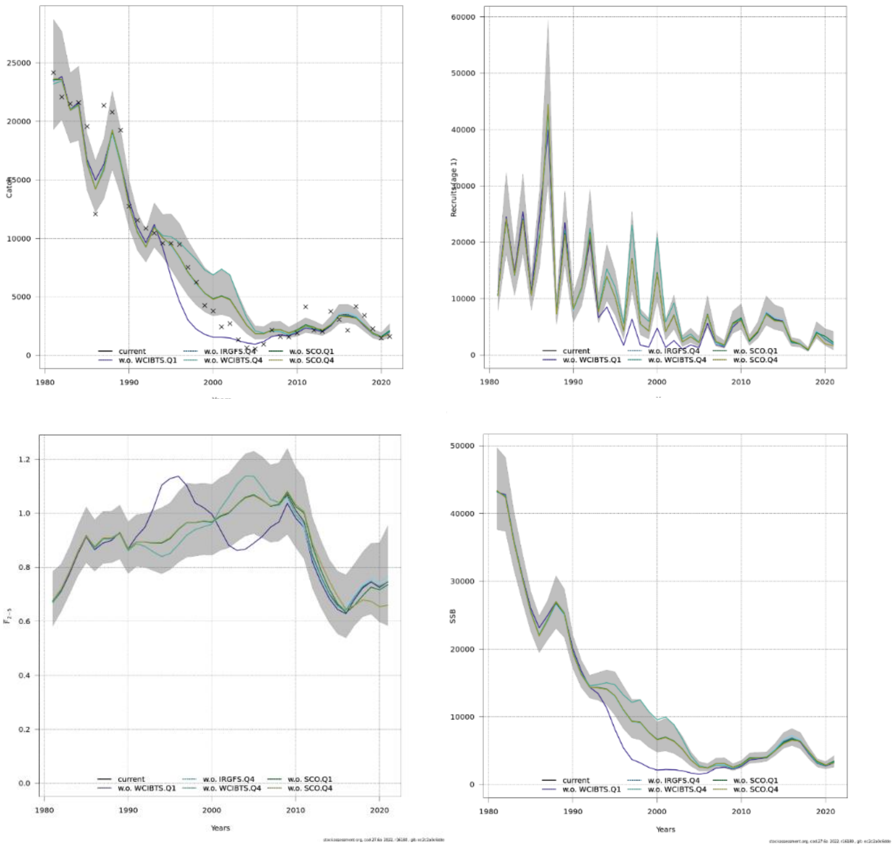


Figure 3.45. Cod.27.6a. SAM final run. Leave one out sensitivity analysis.

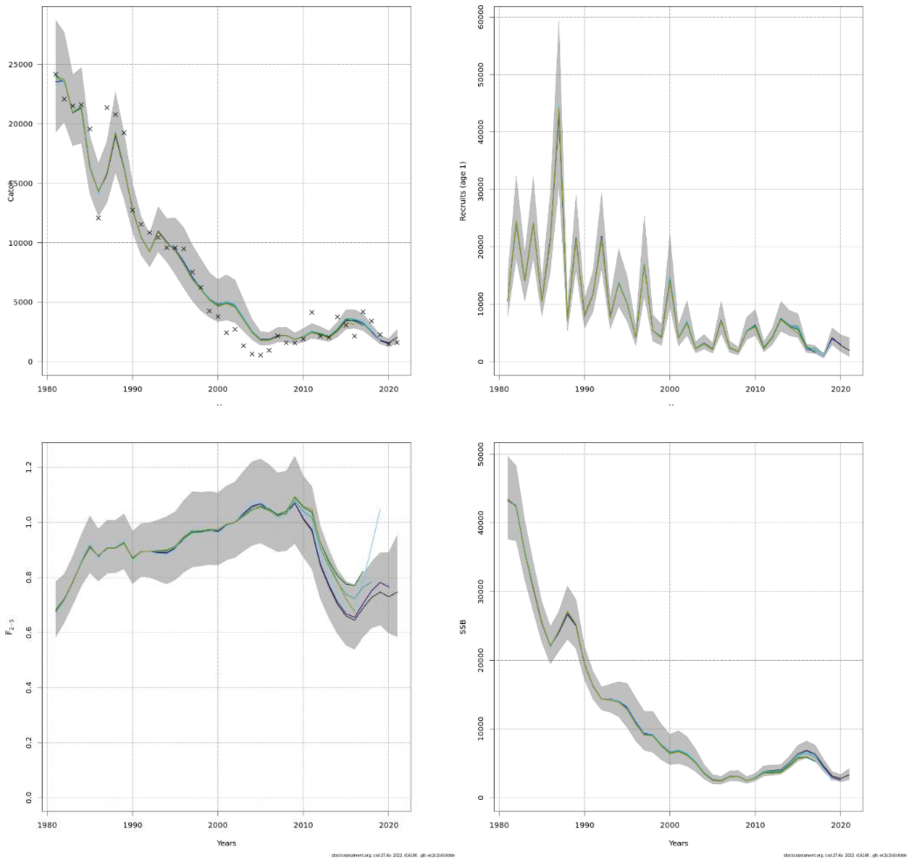


Figure 3.46. Cod.27.6a. Retrospective plots of final SAM run.

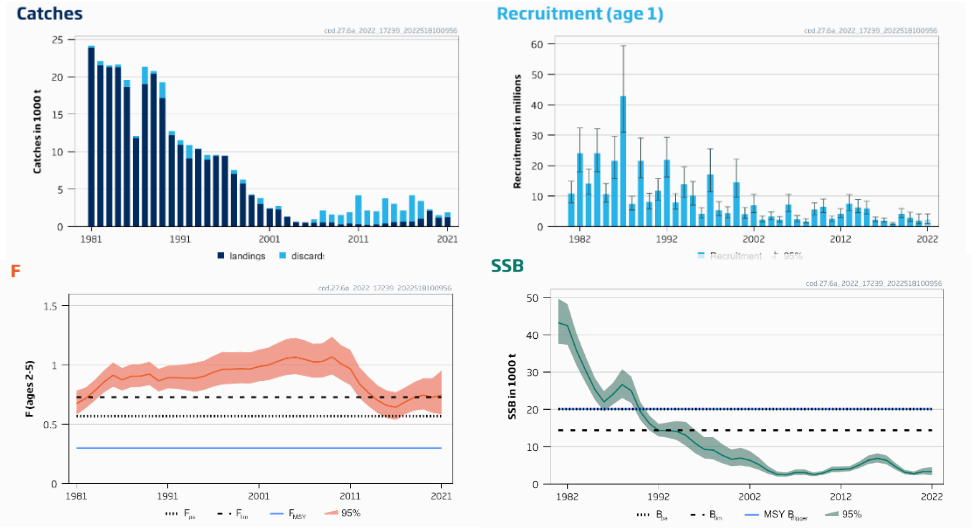


Figure 3.47. Cod.27.6a. Summary of the stock assessment. ICES estimated landings and discards shown in the upper left panel (catches from 1995–2006 (unshaded) are excluded from the assessment). Shaded areas (F and SSB) and error bars (recruitment) correspond to 95% confidence intervals.

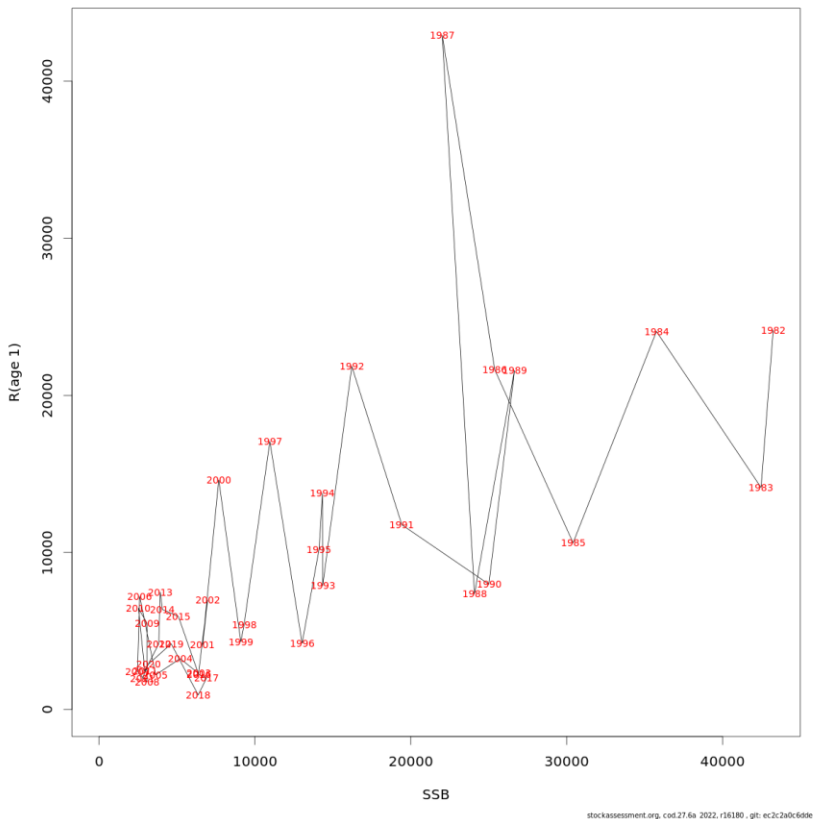


Figure 3.48. Cod.27.6a. SAM final run. Stock–recruit relationship. Numbers indicate recruitment year.

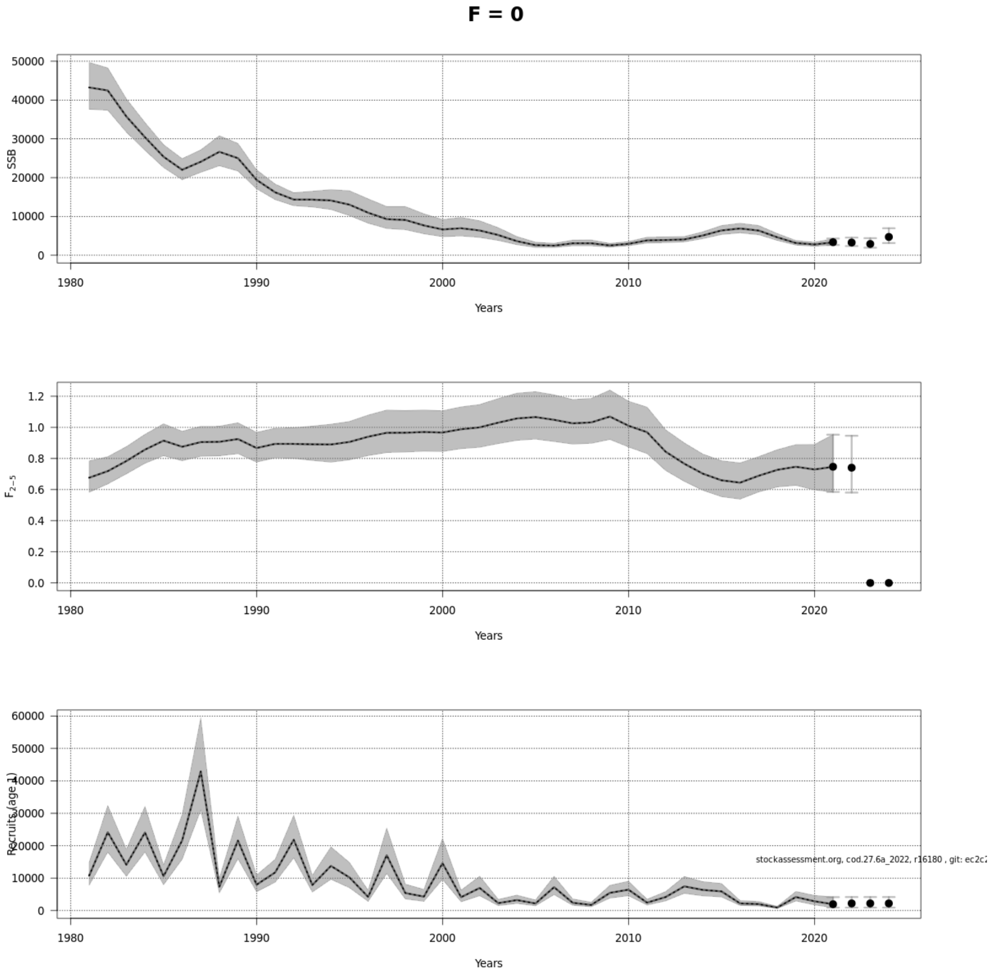


Figure 3.49. Cod.27.6a. SAM forecast assuming Fsq in the intermediate year followed by zero catch (the proposed advice) in subsequent years.

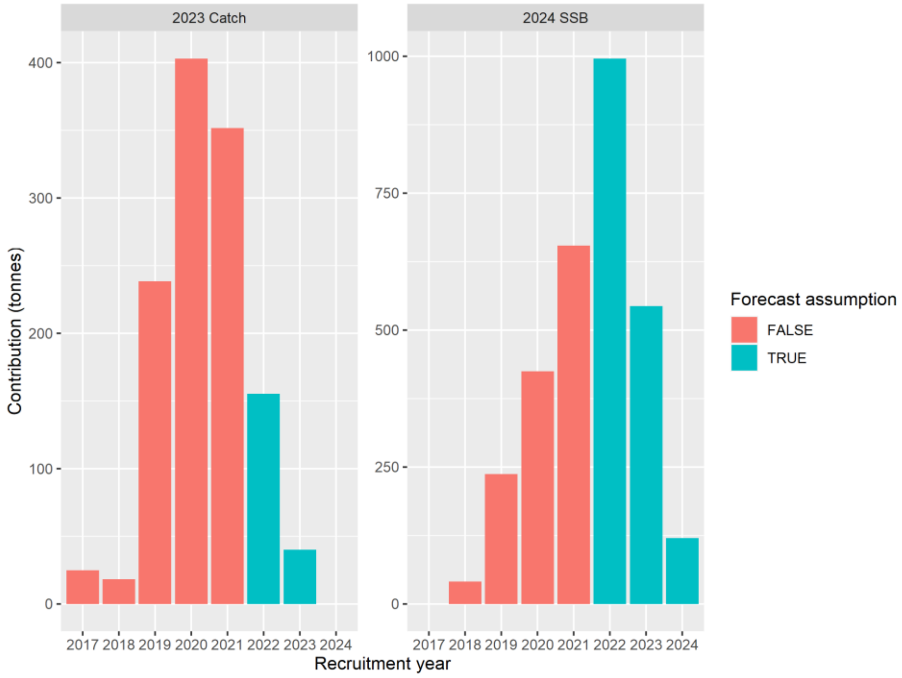


Figure 3.50. Cod.27.6a. Percentage contribution to landings yield in 2021 and SSB in 2022 by recruitment year (not year class). Blue ('TRUE') indicates forecast assumption rather than an assessment model estimate.

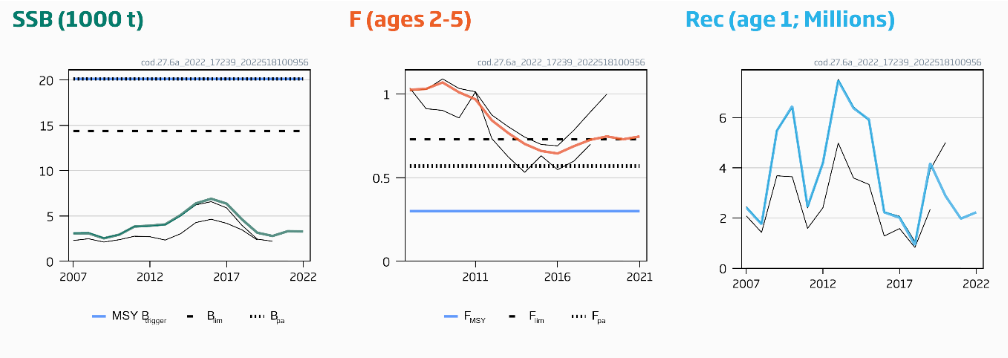


Figure 3.51. Cod.27.6a. Historical assessment comparison plots. Final year recruitment in 2022 assessment is assumed (resampled from 2016–2021) rather than an assessment model estimate due to lack of intermediate year survey.

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

Assessment in 2022

There is no assessment for this stock. Advice is provided on a triennial basis (last provided in 2020) according to the approach outlined below.

In 2020, the updated 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 unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock.

New survey information provided in 2020 indicated increased catch rates since 2018 and stable landings per unit of effort since 2016 implying that the current level of exploitation was appropriate for this stock. A precautionary buffer was therefore not applied for the advice provided in 2020.

ICES advice applicable in 2021–2023

ICES advises that when the precautionary approach is applied, catches should be no more than 14 tonnes in each of the years 2021, 2022, and 2023.

ICES advice applicable in 2018–2020

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

ICES advice applicable in 2016–2017

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

4.1 Data

Official landings data for cod in 6.b are shown by nation in Table 4.1 and Figure 4.1. Total reported landings were 25.5 tonnes in 2021. Some updates were made to historical landings and the landings for 2018 and 2019 are now considered incomplete due to missing landings associated with national GDPR issues in some countries. In the past, official landings have shown very high interannual variation and it is not known whether these are a true reflection of removals. Official landings by subdivision are given in Table 4.2. Most landings are taken from Subdivision 6.b.2.

Landings data have been uploaded to InterCatch for 2021. In addition, some landings age compositions and discard data were also uploaded to InterCatch. 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 (OTB_DEF, the main fleet operating in the area) for the years since 2014; however, there is high interannual variability in the estimated discard rate for this fleet (see below). Discard information has also been provided by Ireland for some years. Given the uncertainty surrounding these data, no estimates of total discards are provided.

	2017	2018	2019	2020	2021
Scottish OTB_DEF	1.96%	60.7%	2.4%	0.6%	23.4%
Irish OTB_DEF	0.63%	NA	18.3%	NA	17.8%

Commercial LPUE data

Irish and Scottish landings, effort and LPUE are presented in Figures 4.2 and 4.3 and Tables 4.3 and 4.4. Figure 4.2 shows a large decline in the Irish LPUE between 1995 and 2003 followed by relatively stable values at a level much lower than at the start of the time-series. In 2017, there was a large increase in effort for this fleet exceeding the previous time-series maximum. The recording of hours fished data in the log sheets is not mandatory for the Scottish fleet and consequently 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 than the Irish time-series. Whilst there were marked increases in LPUE in 2015 and 2016, given the magnitude of increase it seems unlikely to be completely attributable to an increase in stock size (an almost five-fold increase over two years) and LPUE has subsequently declined.

Survey data

Two trawl surveys cover Division 6b: the Scottish Irish Anglerfish Megrim Industry–Science Survey (SIAMISS, G3745) which generally takes place in quarter 2, and the Scottish Rockall IBTS (Rock-WIBTS-Q3, G4436) which takes place in quarter 3. Neither surveys have particularly high catch rates of cod. Table 4.5 contains catch rates by age from the Rock-WIBTS-Q3 survey. The survey typically catches on a very truncated age range of fish with a complete lack of 0-group and very few fish above age 4 and therefore may not be a particularly good index for cod in Division 6b. Biomass estimates from the SIAMISS survey (Figure 4.4) are very uncertain, but the mean value shows an increase to 2018 and decrease in 2019. These estimates have not been updated since then.

4.2 References

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

Table 4.1. 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 and NI)	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 4.1. Continued. Cod in Division 6.b (Rockall). Official catch statistics.

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Faroe Islands	-	-	-	-	-	-	-	-	3	5	-	-	-	-	-	-	-	-	-	-	
France	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Ireland	40	18	11	7	12	23	24	41	20	6	12	1	2	6	5	15	17	**	**	14	4
Norway	89	28	25	23	7	7	12	12	25	27	49	11	3	+	18	11	3	1	5	1	
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Russia	26	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	
Spain	1	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	
UK (E&W and NI)	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
UK (Scotland)	176	67	57	45	43	29	26	41	48	23	37	11	9	-	-	-	-	-	-	-	
UK	-	-	-	-	-	-	-	-	-	-	-	-	-	10	18	37	38	49	51	27	21
Total	334	115	102	75	62	58	62	94	97	61	98	23	14	15	41	62	58	50**	56**	42	25

*** Preliminary.**

**** Incomplete/missing due to national GDPR clauses.**

+ < 0.5 tonnes.

Table 4.2. Cod in 6.b. Official landings by subdivision.

Year	Subdivision 6b.1	Subdivision 6b.2
2012	0.13	23.04
2013	0.39	13.11
2014	0.02	16.25
2015	13.23	27.77
2016	3.16	59.12
2017	2.52	54.55
2018^	1.452	62.5
2019^	2.4	53.8
2020^^	0.6	14.5
2021^^		4.1

^ Incomplete due to national GDPR clauses.

^^Incomplete as UK data only reported at division level.

Table 4.3. Cod in 6.b. Landings, effort and LPUE data from the Irish otter-trawl fleet.

Year	Landings tonnes	Effort '000s Hrs	Lpue Kg/Hr
1995	414.9	9.1	45.39
1996	402	7.2	55.68
1997	130.5	7.2	18.2
1998	207.1	7.3	28.23
1999	137.8	8.79	15.88
2000	101.1	9.9	10.23
2001	33.3	7.2	4.6
2002	16.2	2.6	6.18
2003	9.9	4.5	2.18
2004	6.9	2.2	3.08
2005	8.8	3.3	2.68
2006	22.2	5.9	3.76
2007	24.2	6.6	3.68
2008	41.6	9.9	4.21
2009	21.7	4.4	4.97
2010	7.5	3.3	2.3
2011	10.2	2.5	4.01
2012	1	3.2	0.31
2013	1.8	3.8	0.46
2014	5.6	4.2	1.34
2015	5.1	4.7	1.07
2016	16.4	6.2	2.65
2017	17.3	14.9	1.16
2018	13.3	11.8	1.13
2019	9.5	17.2	0.55
2020	13.3	15.1	0.88

Table 4.4. Cod in 6.b. Landings, effort and LPUE data from the Scottish TR1 (OTB_DEF) fleet.

Year	lnds(t)	eff(kwdays)	Lpue(kg/kwday)
2003	64.09	2504466	0.0256
2004	39.76	1842103	0.0216
2005	42.98	1217357	0.0353
2006	28.25	1011354	0.0279
2007	25.98	1060551	0.0245
2008	40.29	1124197	0.0358
2009	47.76	1631239	0.0293
2010	22.65	1744452	0.0130
2011	36.54	1565753	0.0233
2012	10.78	901552	0.0120
2013	9.09	532767	0.0171
2014	9.70	668665	0.0145
2015	19.92	563098	0.0354
2016	34.01	514486	0.0661
2017	37.71	794571	0.0475
2018	49.25	794017	0.062
2019	50.65	1078714	0.046
2020	26.736	963518	0.027
2021	21.46	919033	0.023

Table 4.5. Cod in 6.b. Survey data made available to the WG: Scottish Q3 ground fish survey ((Rock-WIBTS-Q3)). Catch rates are given as number per 10 hours.

Year	Effort (10 Hours)	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
2011	10	0	0	0	0	0	0	0	0	0	0
2012	10	0	0	0	0	0	0	0	0	0	0
2013	10	0	0.493	0.493	0	0	0	0	0	0.403	0
2014	10	0	0.279	0.894	0	0	0	0	0	0	0
2015	10	0	0	0.922	0.307	0	0	0	0	0	0.307
2016	10	0	0	0.269	0.538	0.538	0	0	0.269	0	0
2017	10	0	0	0	0	0.922	1.062	0	0	0	0
2018	10	0	0	0.307	0.614	0.307	0.307	0	0	0	0
2019	10	0	1.249	0.453	0.969	0.094	0	0	0	0	0
2020	10	0	1.117	0.922	2.432	0.307	0	0	0	0	0
2021	10	0	0	1.203	0.896	0.614	0	0	0	0	0

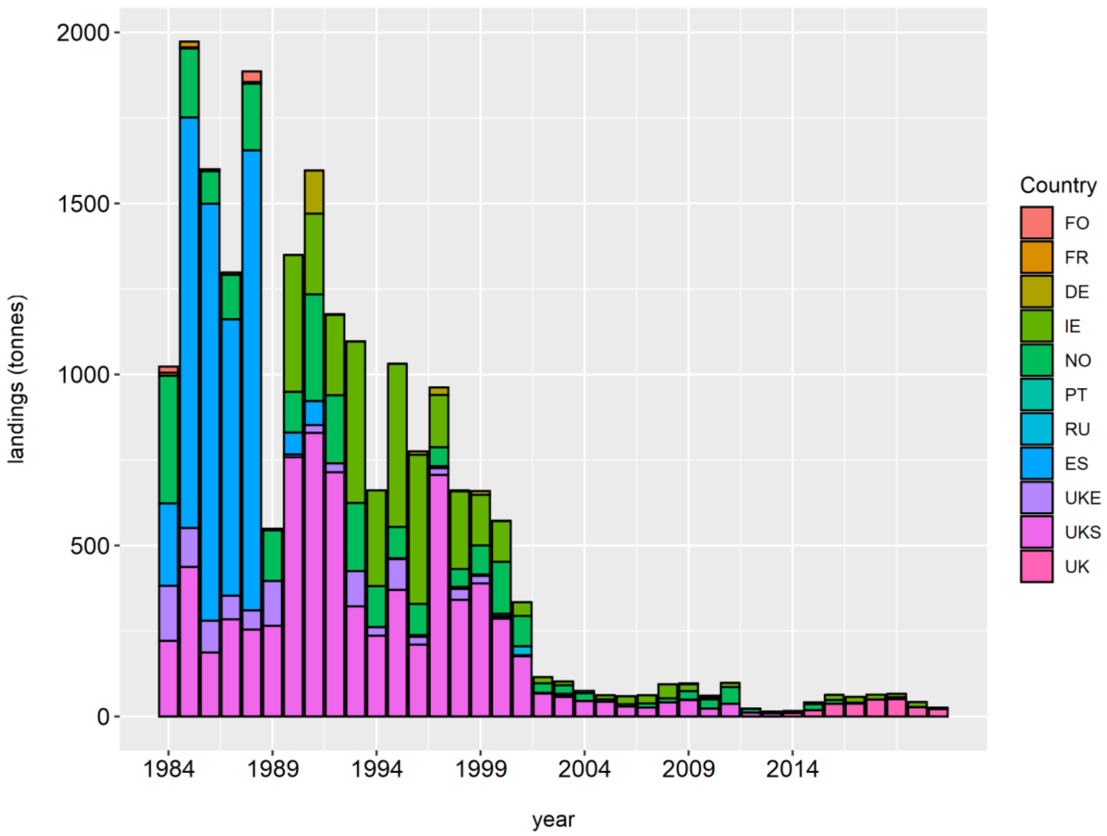


Figure 4.1. Cod in Division 6.b. Total of official landings by nation. In some cases, official landings are missing due to national GDPR clauses and in which case ICES estimates are presented here instead.

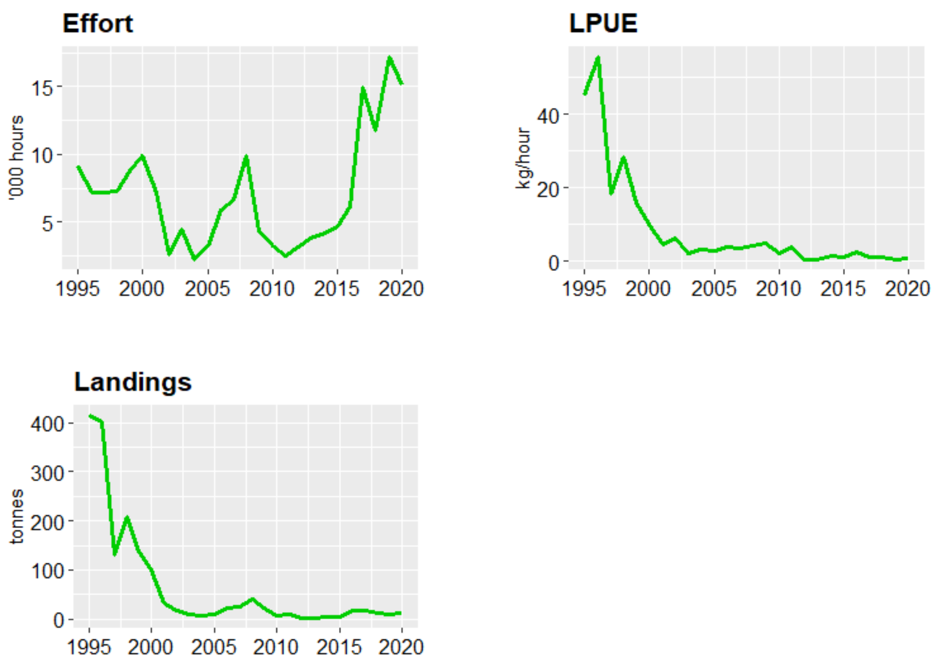


Figure 4.2. Cod in Division 6.b. Landings, effort and LPUE (kg/hr) from the Irish Otter-trawl fleet. No update for 2021.

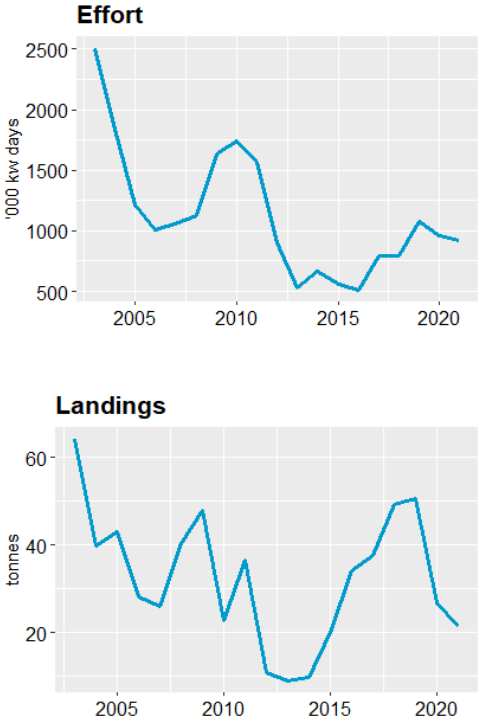


Figure 4.3. Cod in Division 6.b. Landings, effort and LPUE (Kg/kWday) from the Scottish OTB_DEF fleet.

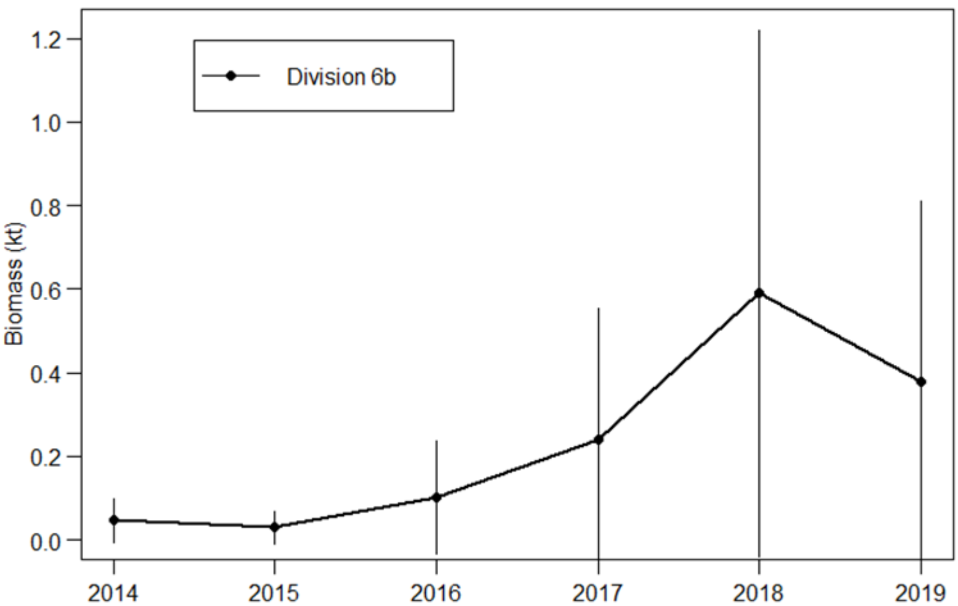


Figure 4.4. Cod in Division 6b. Estimated biomass from SIAMISS survey.

5 Cod in 7.a (Irish Sea)

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

Irish Sea fisheries are predominantly demersal trawling and seining with demersal trawling for *Nephrops* dominating effort with vessels using mesh in the range 70–99 mm. Effort using fishing gear with ≥100 mm mesh sizes is currently at a low level compared to historic activity, a considerable decline in effort was observed between 2003 and 2007 and has continued since. The species composition of catches by vessels in using ≥100 mm mesh consists primarily of 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.

There is a recreational fishery which catches cod and with declining commercial rates has become a more important aspect of the total catch. At the last benchmark in February 2022 (ICES, 2022a) the recreational fishery was included in the assessment for the first time.

Type of assessment

The stock was benchmarked in February 2022 (ICES, 2022a) and a Stock Synthesis (SS3) fully analytical model is now being used in the cod assessment.

ICES advice applicable to 2021 and 2022

ICES advised on the basis of precautionary approaches that there should be no directed fisheries, and bycatch and discards should be minimized in 2021 and 2022. Advice since 2020 was applied based on the on the 2 over 3 rule for category 3.

ICES advice applicable to 2023

ICES advised on the basis of the MSY and precautionary approach that there should be zero catches in 2023 as SSB will be below B_{lim} in 2023 and 2024.

5.1 General

Stock description and management units

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

Management applicable to 2021

TACs and quotas set for 2021

	TAC	Landed
Belgium	3	2.8
France	7	0
Ireland	104	41.8
The Netherlands	1	0
United Kingdom	91	88.7
EU (total)	115	44.6
Total	206	133.3

Management of this cod fishery is by TAC, days-at-sea limits and technical measures. Technical regulations in force in the Irish Sea, including those associated with the cod recovery plan since 2000, are described in Section 5.2.

Quota uptake in 2021 was considerably below the officially set TAC of 206 tonnes.

Table 1. Fishing opportunities (TAC) for 2022 for cod in 27.7.a.

Species:	Cod *Gadus morhua*		Zone:	7a (COD/07A.)
Belgium	3	(1)	Precautionary TAC Article 7(1) of this Regulation applies	
France	7	(1)		
Ireland	104	(1)		
Netherlands	1	(1)		
Union	115	(1)		
United Kingdom	91	(1)		
TAC	206	(1)		

(1) Exclusively for bycatches. No directed fisheries are permitted under this quota.

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R1239.

Fishery in 2021

Landings in accordance with TAC were below the TAC, however, the TAC in 2021 was considerably higher than the ICES advised value of 74 tonnes.

Since 2009, Irish landings of cod reported from ICES rectangles immediately north of the Irish Sea/Celtic Sea boundary (ICES rectangles 33E2 and 33E3) have been reallocated into the Celtic Sea as they represent a combination of inaccurate area reporting and catches of cod considered by ICES to be part of the Celtic Sea stock (ICES, 2009). The amount of Irish landings transferred from 7a to 7e–k by year is shown below. Total official landings for this stock in 2021 were 133 tonnes after this re-allocation and total catches in the area were 184 t.

Table 2. Transfers from ICES rectangles 33E2 and 33E3.

Year	Tonnes
2004	108
2005	54
2006	103
2007	527
2008	558
2009	193
2010	143
2011	147
2012	130
2013	75
2014	24
2015	39
2016	40
2017	19
2018	20
2019	37
2020	71
2021	52

The majority of landings in 2021 was taken by the *Nephrops* fleet, followed by the midwater demersal fleet. Landings and discards by métier and country can be seen in Table 8. Total uptake of cod TAC was 65%.

A Fishery–Science Partnership Survey (FSP) was repeated in the western Irish Sea in spring 2021 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.

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. Since 2006. 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.
5. 2020. The Covid-19 pandemic made the collection of observer data aboard vessels impossible for Q2–Q4, making the estimation of discard data and the establishment of age structure in catches impossible for most of the year. Age structure of the stock is available from Q1 observer data and the 3 surveys, FSP, and Q1 and Q4 groundfish surveys.
6. 2021. The continued COVID-19 situation resulted in reduced sampling; for the quarter 1 2021 the full final tow of the TR1 fleet was landed and sampled by observers ashore. There was very low sampling of cod in the *Nephrops* directed fleet, particularly in quarter 1 due to no observed trips. A raising procedure similar to the previous year was applied, in which the cod sampled in the Northern Ireland fishers self-sampling scheme were applied and raised to the full *Nephrops* catches. However, no cod were found in the provided self samples.

The annual numbers-at-age caught and the mean weights-at-age in landings (applied to the total catch) by age are given in Table 9 and Table 10; numbers of catch-at-age for 2020 are excluded due to limited discard and port sampling during the COVID-19 pandemic.

Discards data

The 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 WKNSCS (ICES, 2022a). M-at-age was calculated from tagging data following calculated following (Pollock, Hoenig *et al.*, 1989, Hoenig, Barrowman *et al.*, 1998). Natural mortality is kept constant throughout years.

Maturity

Maturity ogive has been revised in WKIrish2 (ICES, 2016). Each year the smoother is applied to the full time-series of raw data and values are accordingly updated. Updated values after application of the smoother are in Table 12. Please refer to the stock annex for further information.

Survey data used for advice

Please refer to the stock annex for a description of the surveys and survey data.

Survey	Ages	Years
FSP SURVEY (B7897)	2–6	2004–2021 (EXCLUDING 2014)
NIGFS-WIBTS-Q4 (G7655)	0	1995–2021
NIGFS-WIBTS-Q1 (G7144)	1–4	1995–2021

5.2 Historical stock development

The advice is based on the newly benchmarked assessment (WKNSCS, ICES 2022a).

Deviations from Stock Annex

During the benchmark process kept and assumed dead (i.e. 35% of released fish) removals from the recreational fishery were included in the assessment. There was considerable discussion regarding the introduction of the recreational fishery, which was in the range of 30 tonnes for each of the available data year 2017–2020. The benchmark agreed and reviewed a) a model excluding the recreational data due to issues with uncertainty of data and insufficient information of a selectivity pattern and b) combine the recreational removals with the total commercial catches, using the same selectivity pattern. With a view on a possible increase of the recreational component over the next few years with decreasing commercial fishing pressure, the benchmark decided that it would be beneficial to go for approach b to enable the incorporation of future recreational removals. The differences in SSB, F_{bar} and general perception of the stock were negligible.

In preparation for the working-group it became apparent that the values estimated for the recreational fleet ahead of the benchmark contained a data error and are now indeed estimated at approximately 120–150 tonnes for each of the year 2017–2021, similar levels to the commercial catches.

There are high uncertainties around the recreational removals and the values largely diverge from the benchmarked values.

The benchmark had agreed on a model excluding the recreational catches and passed the model as fit to benchmark and considered the inclusion of the recreational data only as a way to include them in times of increase in relation to commercial catches. In light of the data error the WGCSE working group therefore decided in this instance to exclude all recreational removals from the model.

Final assessment

The final assessment has been run in stock Synthesis (SS3). Available data and catch-at-age, discards-at-age and numbers-at-age in surveys can be seen in Figure 1–3, Figure 6 and Table 9–13, while summary of assessment results can be seen in Table 14.

The fit of the model catch-at-age data and to the indices is good, showing “all green” runs tests (Figure 11 and Figure 12) as well as the individual residuals. Further details on the use of the Runs tests and RMSE can be found in Carvalho *et al*., 2021. The retrospectives provide a good fit with Mohns Rho for SSB and F_{bar} at 0.09 and -0.14 respectively (Figure 13).

The final results of the assessment can be seen in Figure 4–6.

Final assessment: long-term trends

5.3 Short-term predictions

Short-term forecast was carried out in using the FLR forecast environment. Assumptions for the intermediate year can be seen in Table 3. Geometric mean for recruitment is from 2002–2019 (Final year-2), which encompasses the block where recruitment is supposedly reduced.

Table 3. Short-term forecast assumptions.

Variable	Value	Notes
$F_{ages\ 2–4}$ (2022)	0.038	$F_{sq} = F_{average(2018–2021)}$ *
SSB (2023)	4842	Short-term forecast fishing at f_{sq}; in tonnes.
$R_{age\ 0}$ (2022 and 2023)	17 989	Geometric Mean (2002–2019); in thousands
Total catch (2022)	165	Fishing at F_{sq}; in tonnes
Projected landings (2022) ((2022)((20(2022(2020)	159	Assuming average landing patterns (2019–2021); in tonnes
Projected discards (2022)	6	Assuming average discard patterns (2019–2021); in tonnes

*** F in 2020 was assumed to be unrepresentative due to the COVID-19 disruption and hence F_{sq} was calculated as $F_{average}$ (2018–2021) excluding 2020.**

Table 4 shows the catch scenarios, in particular the zero catch advice and the scaled MSY advices due to SSB being below $MSY_{Btrigger}$ and unable to reach B_{lim} even under a no-catch scenario. The newly introduced F_{ECO} (ICES, 2022a) is also included in a scaled version. With the Sea Surface temperature Index being being high for the recent years, F_{ECO} is currently set at 0.19.

Table 4. Catch scenarios for 2023; all weights are in tonnes.

Basis	Total catch (2023)	Projected landings (2023)	Projected discards (2023)	F_{total} (2023)	$F_{projected\ landings}$ (2023)	$F_{projected\ discards}$ (2023)	SSB (2024)	% SSB change *	% TAC change ^	% Advice change^^
ICES advice basis										
MSY approach: F = 0	0	0	0	0	0	0	5410	11.7	-100	-100
Other scenarios										
F_{MSY} × SSB (2023)/MSY $B_{trigger}$	403	382	21	0.093	0.090	0.0036	4988	3.0	96	440
$F_{MSY\ lower}$ × SSB (2023) / MSY $B_{trigger}$	308	292	16	0.071	0.068	0.0027	5087	5.1	50	320
F = $F_{MSY\ lower}$	704	667	37	0.168	0.162	0.0065	4677	-3.4	240	850
F = F_{MSY}	908	861	48	0.22	0.21	0.0086	4466	-7.8	340	1130
F = F_{pa}	1011	958	53	0.25	0.24	0.0097	4362	-9.9	390	1270
F = $F_{MSY\ upper}$	1093	1035	58	0.27	0.26	0.0106	4278	-11.7	430	1380
F = F_{2022}	170	161	9	0.038	0.037	0.00148	5232	8.0	-17.5	130
F = F_{lim}	1612	1526	86	0.43	0.41	0.0166	3754	-22	680	2100
F=F_{ECO}	788	747	41	0.19	0.183	0.0074	4589	-5.2	280	960
F_{ECO}× SSB (2023) / MSY $B_{trigger}$	347	329	18	0.080	0.077	0.0031	5047	4.2	68	370
SSB (2024) = SSB (2023)	544	516	28	0.128	0.123	0.0049	4842	0	160	640
SSB (2024) = B_{lim} **										

*** SSB 2024 relative to SSB 2023.**

**** The B_{lim} option was left blank because B_{lim} cannot be achieved in 2024, even with zero catches.**

^ Total TAC in 2023 relative to the TAC in 2022 (206 tonnes).

^^ Total Advice in 2023 relative to advice in 2022 (74 tonnes).

5.4 Biological reference points

New reference points were defined at WKNSCS (ICES, 2022a). The newly introduced F_{ECO} (ICES, 2022a) has been agreed and reviewed at the benchmark for a stock for the first time. FECO is an opportunity to use environmental data in forecast scenarios (ICES, 2022a). In case of cod in 7.a a sea surface temperature (SST) was found to be a reasonable indicator for productivity. The F_{ECO} reference point uses the inverted SST (with a 3-year lag to account for the time from larvae stage to contribution to SSB) rescaled between zero and one which informs the status of the indicator

(Is) in the advice year compared with previous years. The status of the indicator determines the placement of the FECO reference point within F_{MSY} ranges (ICES, 2019; 2020); for 2023 FECO is at 0.19, estimated as F_{MSY} lower + ((F_{MSY} upper–F_{MSY} lower)*Is).

Table 5. Biological reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	11 538	B_{pa}	ICES, 2022a
	F_{MSY}	0.222	Median point estimates of (F_{MSY}) EqSim with combined SR	ICES, 2022a
	$F_{MSY\ lower}$	0.168	Median lower estimates of (F_{MSY}) EqSim with combined SR	ICES, 2022a
	$F_{MSY\ upper}$	0.273	Median upper point estimates of (F_{MSY}) EqSim with combined SR	ICES, 2022a
	F_{ECO}	0.19	Ecosystem Indicator (I_s); $F_{ECO} = F_{MSY\ lower} + ((F_{MSY\ upper} - F_{MSY\ lower}) * I_s)$	ICES, 2022a
Precautionary approach	B_{lim}	8303	Lowest SSB with above-average recruitment	ICES, 2022a
	B_{pa}	11 538	B_{lim} combined with the assessment error	ICES, 2022a
	F_{lim}	0.43	F with 50% probability of SSB less than B_{lim}	ICES, 2022a
	F_{pa}	0.25	F_{P05}; the F that leads to SSB > B_{lim} with 95% probability	ICES, 2022a

5.5 Management plans

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

5.6 Uncertainties and bias in assessment

Surveys

The Irish Sea has relatively good survey coverage. The quarter 1 groundfish survey and the FSP survey have got good consistent cover of the age contributions. The Q 4 groundfish survey only attributes to the recruitment at age 0.

Stock structure and migrations

Stock structure and migrations have been in full discussed in the WKIrish2 report (ICES, 2016), however, there are still uncertainties and discussions.

A tagging study of Irish Sea cod and Celtic Sea cod was conducted from 2016–2019 in part to address these issues. Up to January 2019, 4238 cod were caught and tagged aboard chartered commercial fishing vessel using semi-pelagic fishing gear, FSP survey, shore angling competitions and others. Up to January 2019, 138 tagged cod were returned. The project relies on collaboration with the fishing industry to provide the data to develop a better understanding of the current behaviour, biology and stock status of Irish Sea cod. Most recent results suggest a stronger migratory behaviour of Irish Sea cod into the Celtic Sea, indicating that up to 18% of mature fish might leave the Irish Sea (ICES, 2021). This will have considerable impacts on the future management and assessment of the stock, but additional research is necessary. Currently a further project using data storage tags and trace element analysis is being conducted to understand stock structure and migratory behaviour as well as mixing.

5.7 Management considerations

A number of emergency and cod recovery plan measures have been introduced since 2000 to conserve Irish Sea cod. These include a spawning closure since 2000 and effort control since 2003. There have also been several vessel decommissioning schemes. As it has not been possible to provide analytical catch forecasts in recent years, the TAC has been reduced by 15–20% annually since 2006 and by 25% since 2009. An MSY approach was used to set TAC in 2018 and 2019, which was followed by a precautionary advice since 2020. Since 2022 the stock is being assessed using an MSY approach; however, low SSB and the incapability of reaching B_{lim} by 2024 even under with zero catches lead to a zero catch advice for 2023.

5.8 Future Issues and considerations

Cod in the Irish Sea and the Celtic Sea are in a highly exploited state and show historically a very steep age-profile. Recruitment since 2002 has been impeded.

It is essential to further the understanding of the stock structure to improve future management, which includes the further investigation of migration and natural mortality in the Irish Sea. It might be necessary for a combined approach to manage the stocks in 7.a and 7.e–g.

Under the current highly exploited status it seems that recruitment rather than fishing pressure is driving stock trends. It is also questionable in how far an MSY approach with reference points as applied in the traditional ICES format is a valid approach for this stock which is recruitment rather than fishery controlled. The working group is awaiting the outcomes of WKREF to further investigate the most appropriate way to manage the stock in the future. This might mean a shift to an MSE approach for management.

5.9 References

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Table 6. Official landings (t) of COD in Division 7.a as officially reported to ICES and figures used by ICES from 1996. All weights are in tonnes, minor differences in total value are due to rounding. Countries reported landings are official values.

Year	Belgium	France	Ireland	Nether-lands	Spain	UK (England Wales, & NI)	UK (Isle of Man)	UK (Scotland)	Total	Landings in rectan-gles 33E2 & 33E3	ICES Landings	ICES Discards
1996	142	148	2476	25	-	2359	27	126	5303		4964**	
1997	183	268	1492	29	-	2370	19	80	4441		5859**	
1998	316	269	1739	20	-	2517	34	67	4962		5318**	
1999	150	n/a	966	5	-	1665	9	80	2875		4784**	
2000	60	53	455	1	-	799	11	38	1417		1274	
2001	283	74	751	-	-	885	1	32	2026		2252	
2002	318	116	1111	-	-	1134	7	29	2715		2695	
2003	183	151	594	-	14	505	7	23	1477		1285	
2004	104	29	380	-	-	646	5	15	1179	108	1072	
2005	115	35	220	-	-	594	n/a	3	967	54	910	
2006	60	18**	275	-	-	589	n/a	6	948	103	840	
2007	67	17**	608	-	-	423	n/a	2	1117	527	702	148
2008	26	3	618**	-	-	543	22	12	1224	558	661	62
2009	19	12	323**	-	-	387	12	12	765	193	468	60
2010	21	1	289	-	-	282	1	-	594	143	464	377
2011	36	3	275	-	-	169	1	-	485	147	368	43

Year	Belgium	France	Ireland	Nether-lands	Spain	UK (England Wales, & NI)	UK (Isle of Man)	UK (Scotland)	Total	Landings in rectan-gles 33E2 & 33E3	ICES Landings	ICES Discards
2012	23	1	193	-	-	109	< 1	-	326	85	198	658
2013	13	< 1	160			107	< 1	-	281	76	206	118
2014	9	< 1	148	-	-	79	< 1	-	236	24	213	149
2015	12	< 1	137	-	-	50	< 1	-	199	39	161	224
2016	3	< 1	84	-	-	35	< 1	-	122	40	82	60
2017	5	< 1	57	-	-	41	< 1	< 1	103	19	84	59
2018	2	< 1	105	-	-	128	< 1	< 1	235	20	215	42
2019	10	< 1	- c	-	-	195	< 1	< 1	205 c	37	295	7
2020*	10	0	76	-	-	95	< 1	< 1	252	71	181	25
2021*	3	0	93	-	-	89	<1	<1	184	52	133	4

*** Preliminary official landings.**

**** Includes sample-based estimates of landings into ports.**

***** Landings in the southern part of Division 7.a (rectangles 33E2 and 33E3) are not included in the assessment and are considered to be part of the cod stock in divisions 7.e–k.**

c Incomplete/missing due to part of the data being unavailable under national GDPR clauses.

Table 7. Working Group figures for annual landings and TAC uptake since 2000. a) total, b) by country.

a)

Year	Total	TAC	% uptake
2000	1273	2100	61
2001	2251	2100	107
2002	2695	3200	84
2003	1285	1950	66
2004	1072	2150	50
2005	910	2150	42
2006	840	1828	46
2007	702	1462	48
2008	662	1199	55
2009	468	899	52
2010	465	674	69
2011	368	506	73
2012	198	380	52
2013	206	285	72
2014	213	182	117
2015	161	146	110
2016	82	146	56
2017	84	146	57
2018	215	695	31
2019	298	807	37
2020	181	257	70
2021	133	206	65

b)

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

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

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

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

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

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

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

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

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

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

2019	UK	Ireland	France	Belgium	Netherlands	Total
Landings	193.9	90	0.2	10.2	0	294.6
TAC	233	530	30	11	3	807
% uptake	83%	17%	<1%	93%	0%	36.5%
2020	**UK**	**Ireland**	**France**	**Belgium**	**Netherlands**	**Total**
Landings	95.6	75.9	0	9.5	0	181.1
TAC	74	170	9	3	1	257
% uptake	129%	45%	0%	317%	0%	70%
2021	**UK**	**Ireland**	**France**	**Belgium**	**Netherlands**	**Total**
Landings	88.7	41.8	0	2.8	0	133.3
TAC	91	104	7	3	1	206
%uptake	97%	40%	0%	93%	0	65%

Table 8. Landings and discard proportions by métier.

Catch (2021)	Landings				
137 tonnes	otter trawls		midwater trawl	beam trawls	other gear types
	Nephrops directed 33%	demersal fish directed 37%	18.7%	9.4%	1%
	133 tonnes				
	Discards				
	otter trawls		midwater trawl	beam trawls	other gear types
	77% *Nephrops* directed	<1% demersal fish directed	<1%	22%	1%
	4 tonnes				

Table 9. Total catch numbers-at-age (thousands).

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

Year	0	1	2	3	4	5	6+
1986	49	1180	2248	699	203	64	65
1987	47	4522	1793	841	252	75	43
1988	43	2971	4734	702	263	71	38
1989	41	754	2163	1886	231	86	37
1990	38	869	1075	545	372	70	30
1991	47	2169	1408	442	127	98	22
1992	37	1529	1243	664	132	42	49
1993	39	388	2907	403	119	16	13
1994	40	916	569	848	68	20	10
1995	43	678	1283	180	163	7	6
1996	88	447	1113	700	38	39	6
1997	5	651	1149.5	501	213	17	16
1998	0	231	1928	335	80	28	8
1999	141	236	843	871	66	21	7
2000	62	1107	176	107	50	4	1
2001	7	403	841	53	13	9	2
2002	0	238	564	405	7	2	3
2003*	50	121	472	109	36	1	0

Year	0	1	2	3	4	5	6+
2004*	50	161	134	174	22	6	3
2005*	50	118	256	78	34	5	1
2006	50	89	174	128	17	8	3
2007	16	216	210	56	11	1	0
2008	6	77	169	87	9	3	0
2009	329	60	57	66	17	3	0
2010	49	220	188	16	7.5	2	1
2011	10	54	106	36	2	1	1
2012	8	84	135	145	10	0	0
2013	36	37	59	30	9	2	0
2014	1	41	86	26	5	1	0
2015	0	37	80	26	4	1	0
2016	0	11	25	30	2	1	0
2017	0	12	28	16	3	0	0
2018	256	95	27	36	2	2	1
2019	0	60	68	12	9	1	2
2020*	0	108	50	20	4	2	1
2021	0	11.8	22.1	13.1	4.7	0.3	0.7

***Excluded from assessment as very low sampling.**

Table 10. Mean weights-at-age in the landings (used for whole stock and catch). *wean weight at age in landings only available for Q1, hence considerably lower than previous years and only used for forecast.

	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

	0	1	2	3	4	5	6+
1987	0.1	0.71	2.16	3.91	6.41	7.82	10.32
1988	0.1	0.61	1.56	3.76	5.67	8.02	9.88
1989	0.1	0.94	1.85	3.22	5.41	6.57	9.47
1990	0.1	0.84	1.94	3.57	5.28	7.53	9.4
1991	0.1	0.86	1.64	3.54	5.42	6.39	9.11
1992	0.1	0.81	1.96	3.99	5.98	6.92	8.67
1993	0.1	0.85	1.71	3.67	5.68	7.37	10.17
1994	0.1	0.8	1.92	3.61	6.08	7.68	8.57
1995	0.1	0.9	1.84	4.00	5.79	8.45	9.14
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

	0	1	2	3	4	5	6+
2007	0.1	0.83	1.85	3.78	5.35	7.99	10.04
2008	0.1	0.89	1.59	3.54	6.00	7.57	9.46
2009	0.1	1.1	2.01	3.46	5.31	7.1	6.82
2010	0.1	1.26	2.29	3.93	6.34	7.33	9.64
2011	0.1	0.95	1.88	3.75	5.54	6.75	9.04
2012	0.1	0.93	1.88	3.37	5.34	7.60	8.56
2013	0.1	0.97	2.32	4.06	5.54	7.43	10.79
2014	0.1	0.88	2.26	4.49	7.00	8.75	9.41
2015	0.1	0.83	1.79	3.69	6.49	8.55	9.95
2016	0.1	0.95	1.58	3.1	5.01	10.66	8.136
2017	0.1	0.70	1.82	3.82	5.85	7.62	9.74
2018	0.1	0.43	1.69	3.64	5.56	8.58	8.70
2019	NA	0.44	2.13	4.25	6.14	6.79	9.00
2020 *	0.1	0.22	1.29	3.67	5.23	7.85	9.54
2021	0.1	0.187	1.831	4.164	6.485	8.64	7.25

Table 11. Estimates of numbers discarded (a) and the discarded proportions (b) from 1968–2021. 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	

Year	0	1	2	3	4	5	6+
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
2005*	50.43	76.34	32.36	15.83	1.25	0.13	0
2006	50.43	75.08	32	15.83	1.25	0.13	0
2007	16	167	4.60	0	0	0	0

Year	0	1	2	3	4	5	6+
2008	5.50	63.40	3.40	0	0	0	0
2009	329.30	39.80	4.40	0.1	0	0	0
2010	48.70	180	60.30	1.4	0.5	0.1	0
2011	9.70	42.70	0.90	0	0	0	0
2012	7.50	79.90	100.20	112.9	5.9	0.2	0
2013	36.10	31	26.50	11	2	0.5	0
2014	1.09	34.66	41.93	10.3	1.53	0.1	0
2015	0	37.30	45.80	6.8	1.3	0.3	0
2016	0	9.84	14.15	13.45	0.91	0.74	0
2017	0.43	9.85	7.88	8.10	0.57	0.10	0.10
2018	255.50	72.19	8.89	4.88	0.12	0.22	0
2019	0	39.2	0.4	0	0	0	0
2020*	NA						
2021	0	10.6	6.1	0	0	0	0

*** very low sampling levels.**

b)

Year	0	1	2	3	4	5	6+
1968	1	0.17	0	0	0	0	0
1969	1	0.09	0	0	0	0	0
1970	1	0.05	0	0	0	0	0
1971	1	0.03	0	0	0	0	0
1972	1	0.12	0	0	0	0	0
1973	1	0.05	0	0	0	0	0
1974	1	0.12	0	0	0	0	0
1975	1	0.06	0	0	0	0	0
1976	1	0.09	0	0	0	0	0
1977	1	0.14	0	0	0	0	0
1978	1	0.20	0	0	0	0	0
1979	1	0.10	0	0	0	0	0
1980	1	0.04	0	0	0	0	0
1981	1	0.11	0	0	0	0	0
1982	1	0.36	0	0	0	0	0
1983	1	0.19	0	0	0	0	0
1984	1	0.09	0	0	0	0	0
1985	1	0.10	0	0	0	0	0
1986	1	0.17	0	0	0	0	0
1987	1	0.04	0	0	0	0	0

Year	0	1	2	3	4	5	6+
1988	1	0.06	0	0	0	0	0
1989	1	0.23	0	0	0	0	0
1990	1	0.18	0	0	0	0	0
1991	1	0.09	0	0	0	0	0
1992	1	0.10	0	0	0	0	0
1993	1	0.43	0	0	0	0	0
1994	1	0.18	0	0	0	0	0
1995	1	0.27	0	0	0	0	0
1996	1	0.29	0	0	0	0	0
1997	1	0.20	0	0	0	0	0
1998	NA	0.12	0	0	0	0	0
1999	1	0.70	0	0	0	0	0
2000	1	0.74	0	0	0	0	0
2001	1	0.16	0	0	0	0	0
2002	NA	0.18	0	0	0	0	0
2003 *	1	0.63	0.07	0.15	0.03	0.12	NA
2004*	1	0.58	0.25	0.09	0.06	0.022	0
2005*	1	0.65	0.13	0.20	0.04	0.03	0
2006	1	0.84	0.18	0.12	0.07	0.02	0
2007	1	0.77	0.02	0	0	0	NA
2008	1	0.82	0.02	0	0	0	NA

Year	0	1	2	3	4	5	6+
2009	1	0.67	0.08	0	0	0	NA
2010	1	0.82	0.32	0.06	0.07	0.05	0
2011	1	0.80	0.01	0	0	0	0
2012	1	0.95	0.74	0.78	0.60	1	NA
2013	1	0.84	0.45	0.37	0.22	0.34	NA
2014	1	0.85	0.49	0.39	0.28	0.09	NA
2015	NA	1	0.57	0.26	0.30	0.23	NA
2016	NA	0.91	0.58	0.45	0.40	0.62	0
2017	1	0.80	0.28	0.51	0.20	0.21	0.49
2018	1	0.76	0.33	0.13	0.05	0.10	0
2019	NA	0.65	<0.01	0	0	0	0
2020*							
2021	1	0.89	0.28	0	0	0	0

NA= not available.

***Data for are unavailable due to restricted discard sampling.**

Table 12. Maturity ogive updated for 2021. Prior to 1995 maturity was considered constant.

Year	1	2	3+
1996	0	0.27	1
1997	0	0.275415	1
1998	0	0.339514	1
1999	0	0.402555	1
2000	0	0.464725	1
2001	0	0.526111	1
2002	0	0.585231	1
2003	0	0.623356	1
2004	0	0.65373	1
2005	0	0.676757	1
2006	0	0.691103	1
2007	0	0.697111	1
2008	0	0.700228	1
2009	0	0.704985	1
2010	0	0.707035	1
2011	0	0.704413	1
2012	0	0.700372	1
2013	0	0.702394	1

Year	1	2	3+
2014	0	0.708485	1
2015	0	0.716712	1
2016	0	0.726138	1
2017	0	0.735987	1
2018	0	0.745951	1
2019	0	0.756372	1
2020	0	0.74887	1
2021	0	0.75601	1

Table 13. Survey catch numbers-at-age and c.v. for all three surveys.

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

year	c.v.	1	2	3	4
1995	0.68	700.73	386.15	20.03	10.78
1996	0.42	1106.13	329.28	111.67	1.39
1997	0.64	537.30	415.84	66.72	21.39
1998	0.84	169.36	769.23	56.87	11.98
1999	0.86	49.50	253.08	241.87	15.29
2000	0.65	629.60	101.053	34.58	33.01
2001	0.89	406.68	561.44	18.44	5.78
2002	0.64	662.16	253.31	333.54	0
2003	0.54	73.87	1079.20	104.05	32.70
2004	0.75	216.96	171.96	88.62	5.38
2005	0.76	63.53	225.07	29.41	27.96
2006	0.63	169.99	130.75	58.30	2.52
2007	0.95	164.35	124.39	30.60	5.15
2008	0.90	40.66	217.15	13.02	5.17
2009	0.76	144.00	59.00	33.00	9.00
2010	0.82	1022.12	208.96	14.66	2.26
2011	0.49	353.98	414.69	46.01	2.26

year	c.v.	1	2	3	4
2012	0.81	161.90	222.82	99.27	14.25
2013	0.81	276.59	213.68	60.08	1.49
2014	0.63	314.41	222.80	53.29	13.66
2015	0.84	78.96	719.35	69.19	8.56
2016	1.06	349.20	175.00	148.30	10.70
2017	0.77	69.8	445.20	57.80	12.60
2018	1.26	138.1	50.50	62.60	0
2019	0.88	214.9	171.6	27.8	14.7
2020	0.977	78.5	145.4	39.4	0
2021	1.19	86.1	158.9	38.2	0

Northern Irish Groundfish Quarter 4

year	c.v.	0
1995	0.54163	6.66
1996	0.430336	12.519
1997	0.720571	2.345
1998	0.914513	0.047
1999	0.637233	6.734
2000	0.785349	6.212
2001	0.830289	4.863
2002	0.895678	0.123
2003	0.707142	6.746
2004	0.939137	3.663
2005	0.805428	8.144
2006	0.871324	1.16
2007	1.277817	0.067
2008	1.422627	0.185
2009	0.938364	5.356
2010	1.332794	2.779
2011	0.919446	0.084
2012	1.256171	1.924
2013	0.933411	11.208
2014	0.792604	0.121
2015	0.872952	2.244
2016	1.063181	0.149
2017	0.815541	4.291
2018	1.419523	0.685
2019	1.266571	0.072
2020	1.386682	0.072
2021	1.610235	0.335

UK FSP survey

year	2	3	4	5	6+
2005	0.43	1.41	0.99	0.08	0.03
2006	0.54	2.81	0.43	0.10	0.01
2007	0.61	1.32	0.59	0.06	0.06
2008	0.22	0.82	0.15	0.08	0.02
2009	0.17	1.15	0.38	0.10	0.02
2010	0.74	0.45	0.47	0.13	0.02
2011	0.41	1.68	0.14	0.10	0.04
2012	0.36	2.30	0.80	0.07	0.02
2013	0.84	1.88	1.35	0.37	0.06
2014					
2015	0.60	2.04	1.17	0.26	0.05
2016	1.00	6.39	1.43	0.41	0.03
2017	3.06	2.85	3.84	1.01	0.23
2018	0.43	3.73	0.61	0.63	0.15
2019	1.30	0.75	0.83	0.12	0.19
2020	0.77	2.64	0.13	0.18	0.08
2021	0.24	0.71	0.19	0.01	0.027

Q1 groundfish survey CPUE and SD used in the assessment.

Year	CPUE	SD
1995	0.955344	0.214285
1996	1.728974	0.313405
1997	1.391875	0.217769
1998	1.435543	0.198929
1999	1.597456	0.255936
2000	1.023321	0.146161
2001	1.491194	0.224681
2002	2.619399	0.964573
2003	1.696543	0.235312
2004	0.764752	0.139312
2005	0.890243	0.267329
2006	0.508091	0.07914
2007	0.46498	0.104631
2008	0.501744	0.098636
2009	0.494051	0.141257
2010	0.71933	0.129658
2011	1.204889	0.364965
2012	1.017556	0.179033
2013	1.074564	0.205801
2014	1.089111	0.274391
2015	1.785167	0.26655
2016	1.374257	0.246976
2017	1.029783	0.30429
2018	0.631522	0.11959
2019	0.816597	0.221725
2020	0.492889	0.177333
2021	0.476304	0.122131

Table 14. Assessment summary.

Year	Recruitment age 0			SSB			Landings	Discards	Fishing mortality ages 2–4		
	Value	High	Low	Value	High	Low			Value	High	Low
1968	184549	250405	118693	46341	57748	34934	8541	1285	0.108	0.156	0.059
1969	248327	326531	170123	41512	52782	30242	7991	1898	0.26	0.31	0.196
1970	384744	489996	279492	36819	47717	25921	6426	708	0.28	0.33	0.24
1971	139637	192753	86521	36214	47328	25101	9246	363	0.22	0.28	0.162
1972	358296	451004	265588	41664	54267	29061	9234	1546	0.26	0.33	0.194
1973	89533	127165	51901	46927	61667	32188	11819	1222	0.26	0.35	0.166
1974	286027	363839	208215	39749	52783	26715	10251	1749	0.34	0.42	0.25
1975	95891	133523	58259	40510	53818	27201	9863	857	0.32	0.42	0.23
1976	152041	202217	101865	31895	43028	20762	10247	381	0.33	0.44	0.23
1977	156311	207075	105547	31257	42762	19752	8054	201	0.36	0.46	0.25
1978	292095	365791	218399	24799	34579	15019	5662	0	0.33	0.40	0.25
1979	325000	401048	248952	24541	33713	15368	7548	0	0.25	0.34	0.162
1980	183575	236103	131047	28154	36916	19393	10599	0	0.30	0.39	0.22
1981	87444	119000	55888	36538	46259	26816	13958	0	0.35	0.44	0.25

Year	Recruitment age 0			SSB			Landings	Discards	Fishing mortality ages 2–4		
	Value	High	Low	Value	High	Low			Value	High	Low
1982	121906	159342	84470	40865	51841	29889	13381	313	0.40	0.51	0.29
1983	176541	222405	130677	34460	45201	23719	10015	372	0.44	0.54	0.33
1984	163766	208454	119078	24049	32437	15660	8383	2	0.40	0.51	0.29
1985	125242	163658	86826	23371	30800	15943	10483	61	0.40	0.51	0.28
1986	314979	375151	254807	23174	30112	16236	9852	154	0.45	0.57	0.34
1987	148276	186496	110056	23944	31059	16830	12894	128	0.47	0.59	0.34
1988	75658	99374	51942	22126	27614	16638	14168	109	0.57	0.70	0.45
1989	87599	112687	62511	23577	28751	18403	12751	202	0.65	0.80	0.51
1990	103824	129696	77952	17093	21719	12468	7379	159	0.70	0.83	0.57
1991	159860	190436	129284	12099	15725	8473	7095	163	0.56	0.73	0.40
1992	36349	49324	23374	11486	14857	8115	7735	98	0.69	0.83	0.55
1993	79041	96308	61773	12087	14948	9225	7555	155	0.65	0.79	0.52
1994	73406	88048	58765	12400	15497	9303	5402	142	0.66	0.79	0.53
1995	79988	94120	65857	8234	10704	5765	4587	166	0.59	0.70	0.48
1996	114682	131577	97787	8845	10942	6747	4964	140	0.54	0.65	0.42

Year	Recruitment age 0			SSB			Landings	Discards	Fishing mortality ages 2–4		
	Value	High	Low	Value	High	Low			Value	High	Low
1997	29215	36741	21689	10256	12274	8237	5859	120	0.61	0.73	0.50
1998	10300	14239	6360	10136	11963	8309	5318	29	0.65	0.76	0.54
1999	85980	104796	67164	9471	11412	7531	4784	159	0.61	0.85	0.36
2000	40830	51473	30187	4321	6015	2628	1274	699	0.95	1.10	0.80
2001	45489	56269	34709	6527	8477	4576	2252	64	0.50	0.58	0.42
2002	11180	15022	7339	7807	10276	5337	2695	46	0.32	0.43	0.22
2003	23209	28893	17525	8965	11846	6084	1285	215	0.42	0.49	0.35
2004	11475	14611	8339	8052	10737	5367	1072	254	0.26	0.32	0.191
2005	15620	19403	11838	7094	9270	4919	910	204	0.25	0.32	0.187
2006	19634	24181	15086	4255	5747	2764	840	185	0.26	0.35	0.171
2007	6406	8504	4309	3072	4473	1671	702	145	0.34	0.41	0.26
2008	16137	20684	11590	3544	4851	2236	662	61	0.28	0.36	0.21
2009	39400	50454	28345	2840	3916	1764	466	88	0.28	0.34	0.21
2010	25608	33506	17709	3242	4420	2064	464	386	0.25	0.31	0.183
2011	21342	28437	14247	4322	5757	2888	365	48	0.23	0.25	0.20

Year	Recruitment age 0			SSB			Landings	Discards	Fishing mortality ages 2–4		
	Value	High	Low	Value	High	Low			Value	High	Low
2012	28200	37549	18850	5617	7499	3736	198	678	0.089	0.139	0.039
2013	47279	62332	32226	7466	10053	4879	206	152	0.188	0.21	0.171
2014	16662	22699	10625	9363	12538	6188	213	184	0.064	0.079	0.050
2015	26831	35220	18442	8841	12036	5646	161	147	0.055	0.066	0.044
2016	7164	9888	4439	8313	11116	5511	82	60	0.041	0.047	0.036
2017	18842	24703	12982	9270	12328	6213	84	59	0.023	0.028	0.0175
2018	17867	23590	12144	8196	10862	5531	215	42	0.022	0.033	0.0100
2019	13315	17999	8630	7336	9727	4945	295	7	0.049	0.063	0.035
2020	9468	14388	4549	5345	8206	2483	181	25	0.059	0.070	0.048
2021	17562	46962	0	6014	7994	4034	133	4	0.045	0.053	0.037
2022	17989*			5029							

***Geometric Mean 2002 to 2019.**

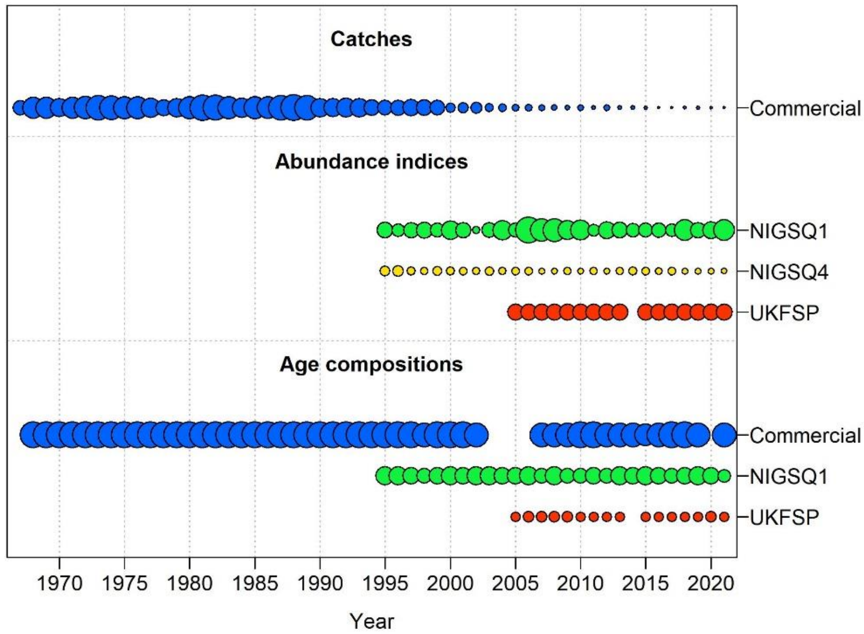


Figure 1. Available data.

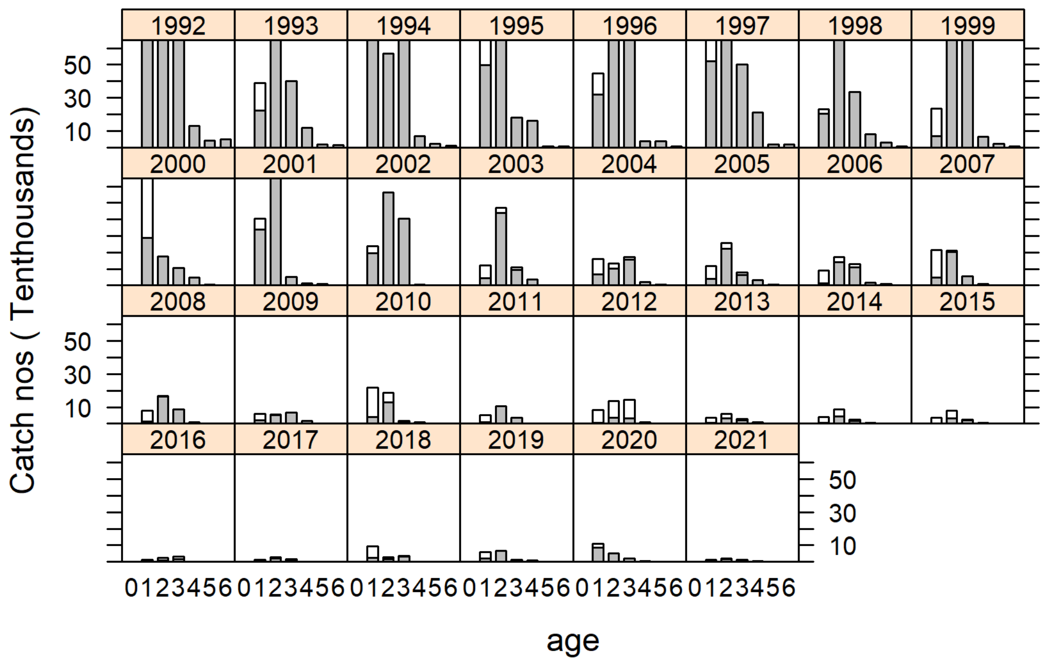


Figure 2. Landings and discards-at-age. Landings are shaded in grey, discards in white.

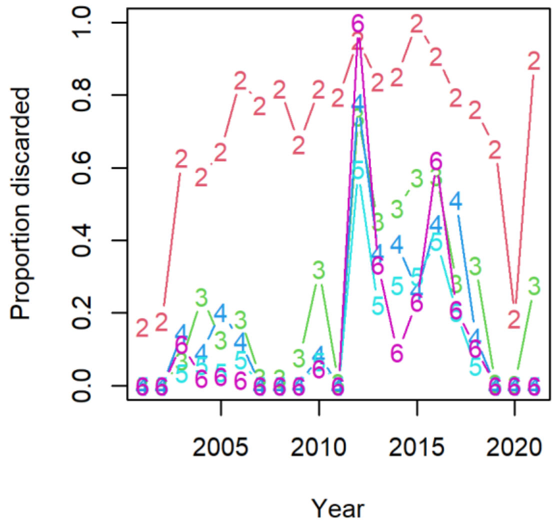


Figure 3. Proportion discarded-at-age. Ages 1 and 0 not displayed.

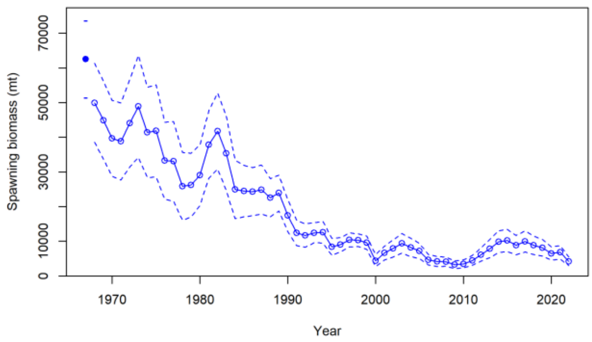


Figure 4. SSB with 95% confidence interval.

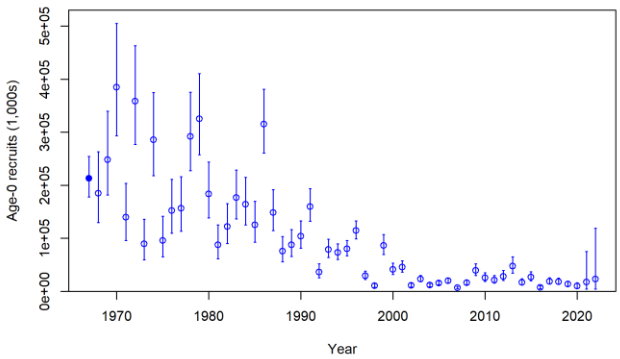


Figure 5. Recruitment with 95% confidence level. Recruitment in the figure for 2022 is model estimated and not the same as in the forecast.

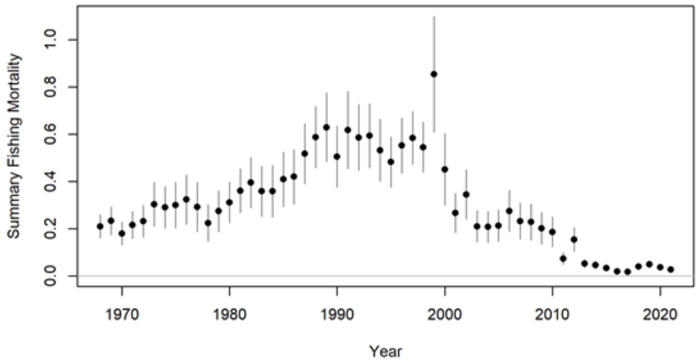


Figure 6. Age compositions for commercial data and surveys.

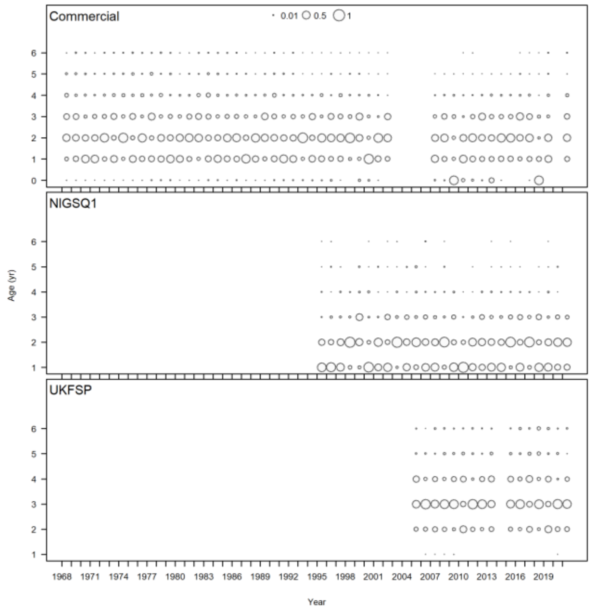


Figure 7. Residuals at-age.

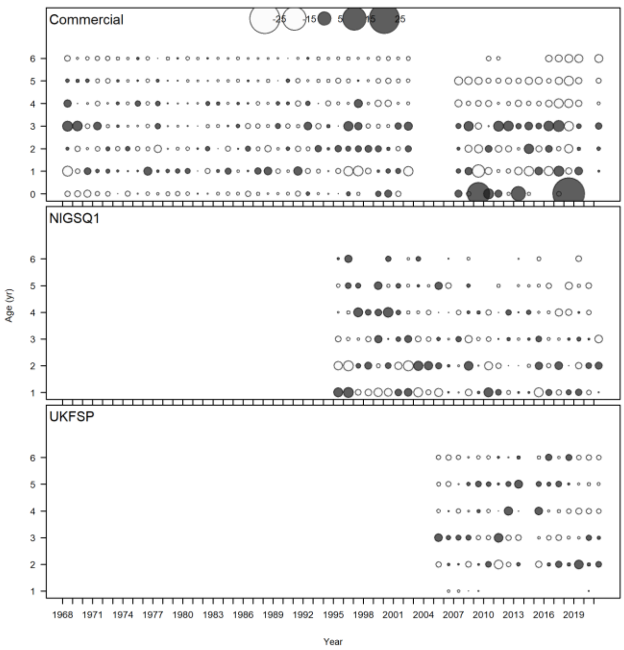


Figure 8. Log CPUE fit NIGFS Q1.

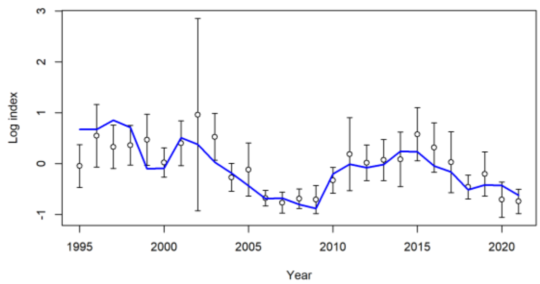


Figure 9. Log index fit NIGFS Q4.

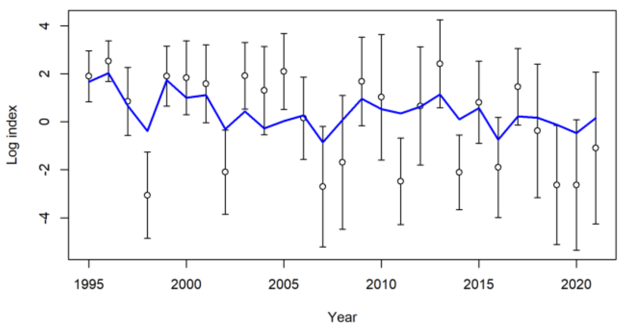


Figure 10. Log index fit UKFSP survey.

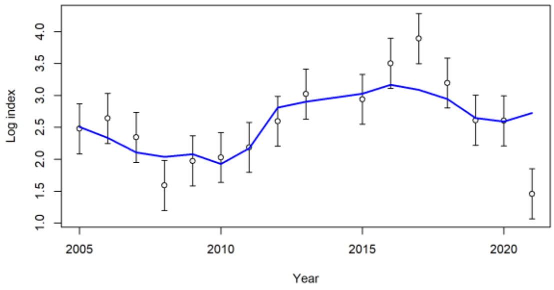
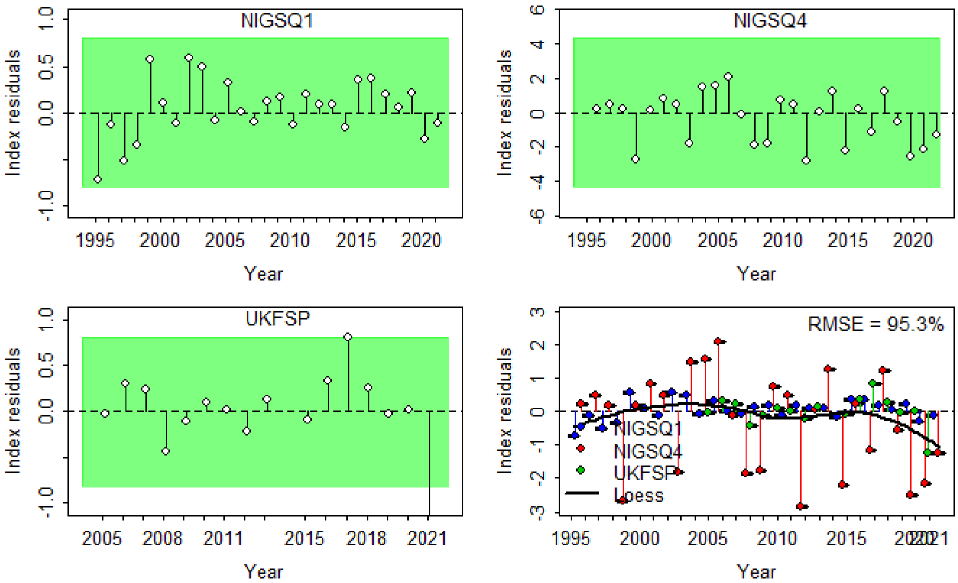


Figure 11. Results for runs tests for the three indices included and RMSE with fitted LOESS smoother.



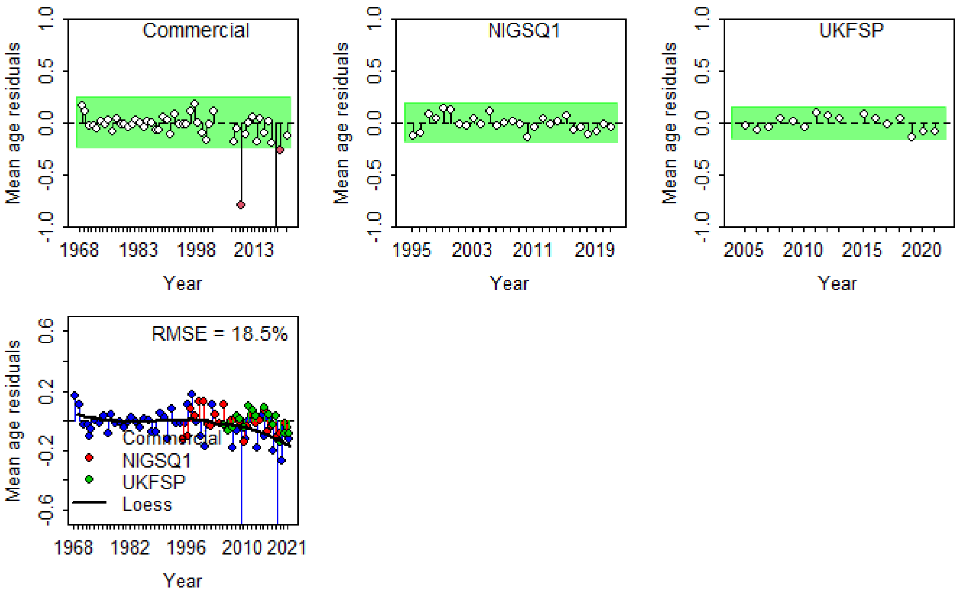


Figure 12. Mean age residual fits for total catches, NIGFSQ1 and UKFSP surveys, NIGFSQ4 survey only includes age 0 recruits and is therefore excluded.

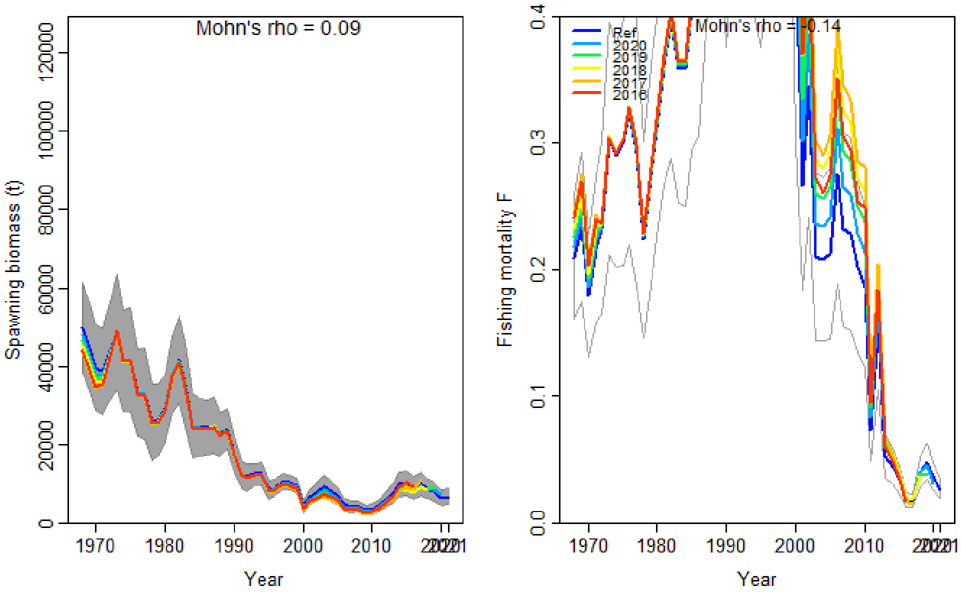


Figure 13. Mohns Rho for SSB and F_{bar}.

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

Full analytical assessment

This stock has been benchmarked at WKCELTIC 2020. XSA was replace by SAM as the assessment model. Time-series of data were updated since 2004 as well as the tuning series. The first ten years of data (1970–1979) were removed from the assessment time-series of catches, because of inconsistency in cohort tracking information. Data, assessment and forecast procedure are detailed in the stock annex.

Latest ICES advices in 2020 and 2021

2020 – "*For Cod in divisions 7.e–k, ICES advises that when the MSY approach is applied, there should be zero catch in 2021.*"

2021 – "*For Cod in divisions 7.e–k, ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in 2022.*"

6.1 General

6.2 Stock description and management units

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

Management applicable in 2021 and 2022

TAC 2021 (Council regulation 2021/1239)

Species:	Cod *Gadus morhua*		Zone:	7b, 7c, 7e-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	18	(1)	Analytical TAC	
France	290	(1)	Article 9 of this Regulation applies	
Ireland	422	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply	
The Netherlands	0	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply	
Union	730	(1)		
United Kingdom	75	(1)		
TAC	805	(1)		

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

Preliminary TAC 2022 (Council regulation 2022/109)

Species:	Cod *Gadus morhua*		Zone:	7b, 7c, 7e-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	28	(1)	Analytical TAC	
France	463	(1)		Article 9 of this Regulation applies
Ireland	92	(1)		Article 3 of Regulation (EC) No 847/96 shall not apply
Netherlands	0	(1)		Article 4 of Regulation (EC) No 847/96 shall not apply
Union	583	(1)		
United Kingdom	61	(1)		
TAC	644	(1)		

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

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

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

Fishery

Landings data used by the WG are summarised in Table 6.1 and the Figure 6.1 provides historical landings by countries. In 2021, the catches are 1360 t.

TAC was overtaken in 2021. An overtaking of the agreed TAC was observed for France, while Belgium, Ireland and UK were closed to the TAC. Cod is no longer a target species but a bycatch in haddock and whiting dedicated fisheries.

Given the rapid growth of cod in this area, discards are mostly composed of one and two year-old fish. Since 2011, quotas were not restricted and the discard rate has been stable around 10–15%. However, following the recent TAC reductions, TAC is now restrictive for most of the countries. Discards estimate for 2021 is 733 t. It corresponds to a discards rate of 54%, which is significantly greater than the average discards rate of recent years (around 20%). This discards rate increase may be the result of high grading, because of restrictive TACs and delay in total TAC attribution. This delay was mainly due to long discussions in Brexit fisheries negotiations.

Cod is mainly caught in area 27.7.g, followed by areas 27.7.h, 27.7.e and 27.7.j respectively. No landings are reported in 27.7.k and few in 27.7.j2 (Figure 6.2). France is fishing in all areas but most of its landings are taking in 27.7.h. Ireland is mainly fishing in 27.7.g and Belgium in 27.7.f and UK in 27.7.e. For each country, landings distribution in the Celtic Sea is similar to previous years.

In Celtic Sea, cod is mainly caught by OTB_DEF_100-119_0_0_all métiers (37% of the landings and 75% of the catches), followed by OTB_DEF_70–99_0_0_all, OTB_CRU_100–119_0_0_all and seine SCC_DEF_100–119_0_0_all. Beamers (i.e. TBB_DEF_70–99_0_0_all) also contribute to cod landings (Figure 6.3).

Discards rate in weight varies among métiers depending on gear, mesh size range and targeted species (Figure 6.4).

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

Information from the industry

In recent years, yields have been very low and cod is no longer targeted by French vessels and catches represent a very low number of individuals per tow.

The recent regulatory changes in the Celtic Sea since 2019 (Reg UE 2034/2018 which introduces many new selective devices since 01/07/2019 and article 13 Reg UE 123/2020) significantly modifies (1) the size structure of species catches by improving selectivity and the (2) vessel strategy in order to respect different catch composition thresholds.

6.3 Data

InterCatch procedure

Since 2013, international landings and discards data are uploaded in InterCatch. An updated data tile series, from 2004 to 2019, was provided as part of the WKCELTIC 2020. Discards are raised for unreported strata to estimate total discards in weight. During WKCELTIC efforts were made to streamline data compilation procedures for fishery-dependent data of the three main gadoids species (cod, haddock and whiting).

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 (R script). To ensure the consistency of data processing at international level, the same rules are applied each year for the allocation procedure: fill unsampled strata using as much as possible the same métier and quarter, regardless of area and country. Unsampled BMS landings and Logbook Registered Discards are filled in using discards data employing as much as possible the same métier and quarter, regardless of area and country.

The impact of the Covid-19 pandemic on the fishery cannot be quantitatively determined but may be assumed to have reduced fishing effort in quarter 2 of 2020.

The percentage of sampled versus raised data as well as the distribution of sampled data over the quarters were considered satisfactory (Figure 6.5).

Season	Source	%
1	Imported	23
2	Imported	45
3	Imported	11
4	Imported	19

Catches

Age distribution of 2021 catches (i.e. landings and discards) is illustrated in the Figure 6.10 and Table 6.2. It is noticeable that this stock has always been composed of few age classes, even though Celtic Sea cod can live up to ten years. While the catch was mainly composed of age 2 over the period 2005–2008, the strong 2009 year class has contributed strongly to the catch at older ages in recent years: 63% in number in 2012 at age 3, 36% at age 4 in 2013 (Table 8.2.a and 8.2.b). In 2014, high recruitment has been observed resulting in an increasing proportion of age 1 fish in the landings (53%), age 2 accounts for 22% of the landings. In 2015, landings are dominated by fish of age 2, in 2016 landings are dominated by fish of age 3 and in 2017 landings was mostly composed by cod of age 2. In 2018, 20% of the landings was fish of age 1, 35% of fish of age 2 and 31% of fish of age 3. In 2019, more than 50% of the catches are age 1 fish, and less than 30% of the catches are made of age superior to 2. In 2020, 36% of the catches are age 1 fish, and 58% of the catches (in number) are made of age 2. In 2021, age 1 and age2 represent each 40 % of the catches (in number).

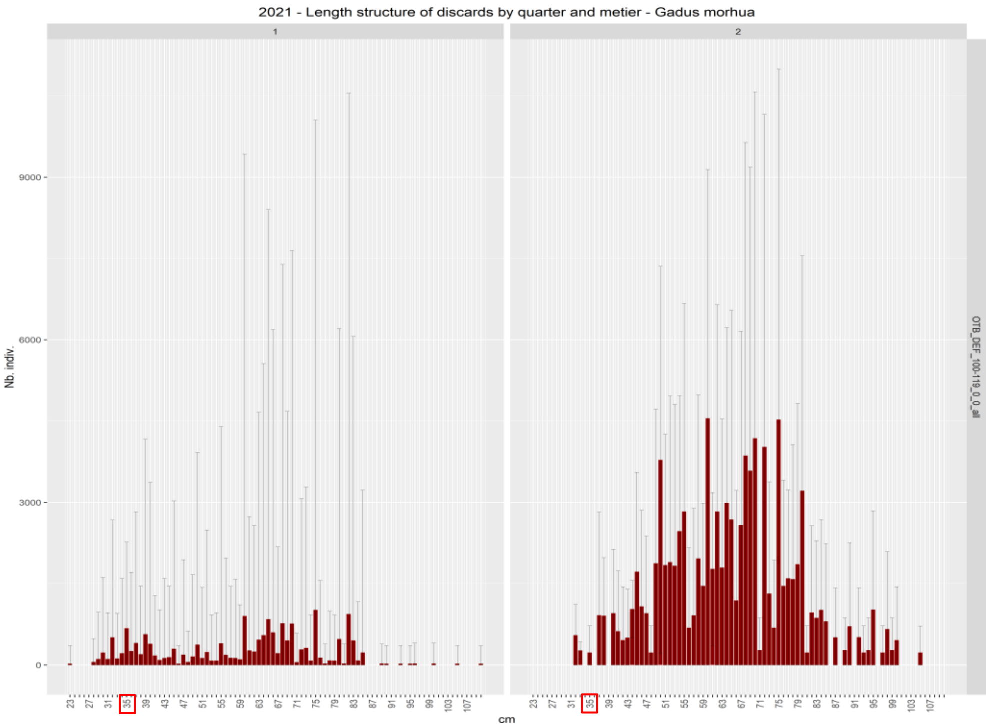
Discards

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

In 2009, age 1 individuals (30–45 cm, Mahé *et al*., 2016) were mainly discarded. In 2010, most of them were landed. In 2011, ages 1 and 2 represents respectively 51% and 46% of the total discards in numbers for all fleets. Due to the low TAC relative to the high magnitude of recruitment in 2009 and 2010, all countries had unusually high discard rates in 2011, generally 70% by weight was made up of fish above the minimum landing size (MLS, i.e. 35 cm for Celtic Sea cod). The high-graded fish from the French fishery have been added to the landings in 2003–2011. In 2014, total amount of discards was 740 t (639 t imported + 101 t raised), giving a discard rate of 19%. This discards rate was higher than the average 10% and mostly consisted of undersized fish from the strong 2013 year class (fish of age 1 in 2014). In 2015, the total amount of discard was 565 t (250 t sampled and uploaded in InterCatch and 309 t resulting from the raising procedures), giving a discard rate by weight of 12%, which is considered the usual discard rate for this species in the mixed fisheries. High grading in 2015 (discards of fish above Minimum conservation size) was low. In 2016, the total amount of discards was 220 t (154 t sampled and uploaded in InterCatch and 52 t resulting from the raising procedures), giving a discard rate by weight of 6.3%. In 2017, the total amount of discards was 117 t (47 t sampled and uploaded in InterCatch and 62 t resulting from the raising procedures), giving a discard rate by weight of 5%, which is considered lower than average. They are mainly composed of age 1 fish (Figure 6.10).

In recent years, due to quota constraints at vessels levels, length distribution of discards for the UK fleet have shown high-grading pattern (cod being a non-target species). However, this fleet has little contribution to both, landings and discards quantities and this was no more reported in 2017. In 2019, discards are mostly composed of fish of 1 year, as in 2018 (Figure 6.10).

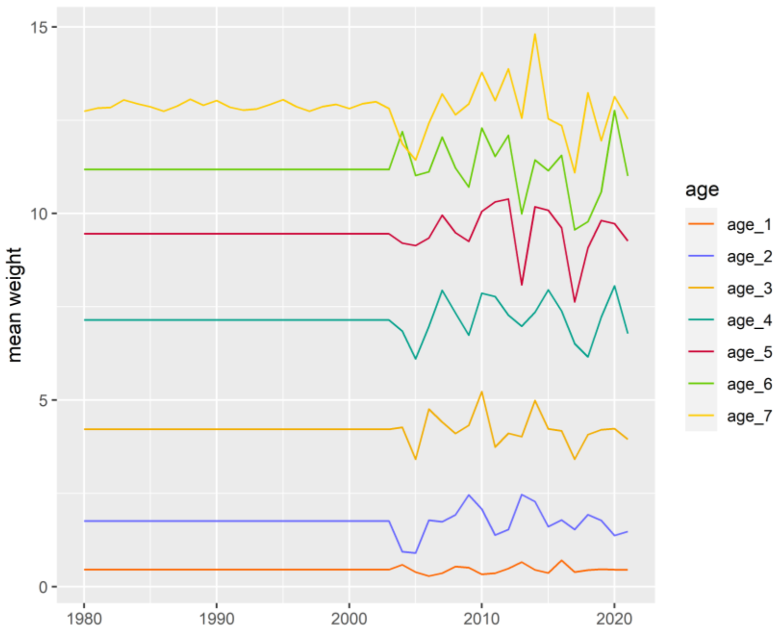
In 2021, French fleet have recorded high-grading pattern for its discards, maybe due to restrictive TACs and delay in total TAC attribution. Individual TAC allocations were attributed in three times and the entire individual TAC was allocated in June. The two preliminary individual TAC, allocated for the period between January and March and between March and July, were reached before the end of their corresponding periods which have led to discard high grading in Q1 and 2.



Biological

Catch numbers-at-age, catch weights-at-age and stock weights-at-age are given respectively in Tables 6.2, 6.3 and 6.4.

Temporal trends in stock and catch were scrutinized at WGCSE 2021, to ensure that reduce sampling due to Covid-19 pandemic did not impact catch weight. No important issues were reported.



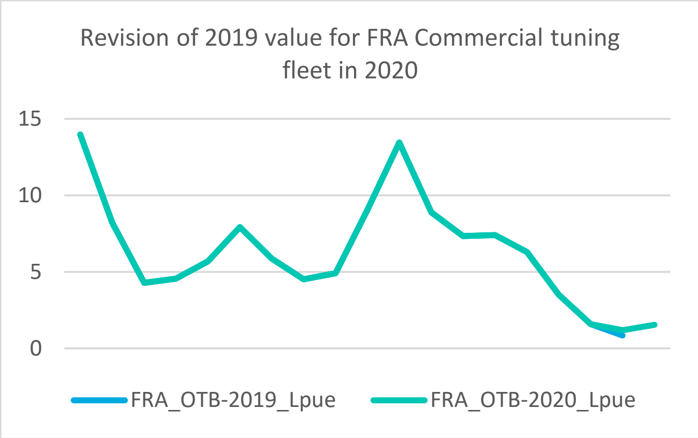
Biological parameters are described in the stock annex which has been updated at WKCELTIC 2020. Celtic Sea cod are very fast growing and early maturing compared with more northern cod stocks.

Commercial LPUE

Tables 6.5 a–c gather the values of landings, fishing effort and LPUE dataseries for the French (a), Irish (b) and UK fleets (c). Figures 6.6 a–c illustrate the trends of LPUE and effort by country.

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

Since 2013, French fishing effort and LPUE have decreased (Figure 6.6a). Effort of Irish fleet targeting gadoids (i.e. Otter trawl 27.7.g) remains at a high level as a consequence of mixed-fisheries interaction with increased whiting and haddock fisheries opportunities (Figure 6.6b). In the meantime, the Spawning–Stock Biomass (SSB) is low, as such LPUE is decreasing since 2013. In 2018, Otter trawl Irish 27.7.g LPUE has increased. Effort of the UK trawl fleet in 27.7.e–k shows a decreasing trend (down to zero in 2016) and increases since then, while beam trawl effort in 27.7.e–k relatively stable in recent years (Figure 6.6c). Minor revision of FRA commercial fleet from 0.84 to 1.18 in 2019 was made, which is believed to have very little impact on assessment results.



The impact of the Covid-19 pandemic on the fishery cannot be quantitatively determined, but a slight reduction of fishing effort of the main fleets in 2020 was observed for all country. As, a result in 2020, LPUE of Irish otter trawls in 7g and UK trawls in 7ek are decreasing, while French otter trawl LPUE remain stable.

Remark: The UK English and Welsh effort data are only reliable for vessels over 12 metres registered length, and therefore has always been provided to working groups for vessels greater than 12 metres. The fleet of vessels over 12 meter has been declining gradually over the years, until in 2016 no effort recorded from this fleet. The zero figures provided for 2016 have been checked and are correct (Figure 6.6c).

Surveys and commercial tuning fleet

Two ongoing surveys, both part of the DCF, IBTS Q4 (EVHOE-WIBTS-Q4; IGFS-WIBTS-Q4) are combined and modelled to produce a single index using VAST modelling (see details in the stock annex and WKCELTIC 2020 report).

In 2017 and 2018, the French EVHOE survey was not conducted due to technical difficulties at the beginning of the survey. The Irish survey covered additional stations normally undertaken by the EVHOE survey.

Commercial tuning index based on French OTB and OTT fleet is provided. The calculation of the commercial tuning series was updated at WKCELIC 2020 to better account for changes in fleet behaviour along the years (see details in the stock annex and WKCELTIC 2020 report). LPUE is decreasing since 2012.

The historical time-series of commercial tuning index (OTDEF French fleet for quarters 2, 3 and 4), and the survey index are shown in Table 6.6.

Data issues

No important issues were reported this year. Owing to notable divergence of recent discards patterns, it was not possible to forecast separate landings and discards estimates for 2023.

Catch sampling of the fisheries has been reduced in 2020 due to Covid-19, which may have result in a higher uncertainty associated with discard estimates and age structure of the catch. However, this was considered to have had minimal impact on the perception of the stock status.

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

6.4 Stock assessment

Model used: SAM (stockassessment.org).

Final update assessment (SAM)

The final assessment was run with the same settings as established by WKCELTIC 2020 and described in the stock annex. Discards are included in the assessment. (sotcokassessment.org, Cod_7ek_WGCSE2020).

Residuals and diagnostics do not highlight any problem regarding the input data and model fit (Figure 6.7 and 6.8). Outputs from the assessment are reported in Tables 6.7–6.10 and in Figures 6.7–6.11.

The comparison of runs with and without tuning indices indicates is shown in Figure 6.12b. The information contains in both indices are consistent.

In 2022, the assessment shows a downward revision in F (Figure 6.12a). The estimate of fishing mortality is highly sensitive to the additional annual data, this is due to the low stock size.

Mohn's rho analysis (i.e. a measure of the relative difference between an estimate from an assessment with a truncated time-series and an estimate of the same quantity from an assessment using the full time-series) resulted in values of -12% for $F_{bar\,(2–5)}$, 23% for SSB and 40% for recruitment.

The retrospective bias in assessment when an additional year of data are incorporated may be due to the variability of cod recruitment over years, the strong dependency of the fishery to recruitment (not well estimated by the survey) and the unexpected disappearance of fish of older age.

Despite the high values of the Mohn's rho coefficient and the uncertainties in the estimates of the most recent year, the assessment has been validated (the stock is maintained in category 1), and the output are used to provide the short-term forecast. This decision follows the guidelines provide by WGBIAS (decision tree). Despite the uncertainties in the estimates of the most recent years, SSB and F are estimated well below biological references points.

The conclusions of the very recent benchmark was that given the recruitment driven dynamics of the stock and the low stock size reducing.

State of the stock

Tables 6.7 and 6.8 summarise the estimated fishing mortality-at-age and the stock numbers-at-age, respectively. The stock summary is reported in Table 6.9 and Figure 6.11.

Catches were around 5000 t between 2000 and 2016, with some higher catches following strong recruitments, and decreased around 1300 t since 2019 (Figure 6.11). Reliable discard estimates are available since 2004 and range between 134 and 3749 t depending on the interplay between recruitment dynamics and TAC constraints.

Recruitment has been highly variable over time with occasional very high recruitment followed by period of low recruitments. Since 2012, recruitment has been very weak with the exception of the 2014 year class, which is above average (Table 6.9 and Figure 6.11).

Spawning–stock biomass (SSB) has been fluctuating around B_{pa} since 2004, except from 2011 to 2013 (as the consequence of a very good recruitment year) and is below B_{lim} since 2017 (Table 6.9 and Figure 6.11, ICES, 2012).

Fishing mortality has been above F_{MSY} for the entire time-series, fluctuating between F_{lim} and F_{pa}. Fishing mortality increased up to above F_{lim} between 2017 and 2019 (Table 6.9 and Figure 6.11).

6.5 Short-term projections

Assumptions made for the short-term projections are described in Table 6.12 and followed the stock annex.

F status quo was used as an assumption of F in 2021 to reflect recent fishing pressure and was kept for 2022.

Recruitment values of 2022 and 2023 are similar in the stochastic forecast, because random resampling of a distribution may lead to identical median estimates. The recruitment age 1 fish values are 1305 thousands in 2022 and 2023.

SSB is predicted to be 992 t in 2023 which would still be below B_{lim} (4200 t) (Table 6.11).

ICES provides zero-catch advice for this stock in 2023, because the median SSB remains below B_{lim} by 2023 under all catch scenarios (Tables 6.12 and 6.13).

In the ICES advice framework, this would result in advised catches between 46 tonnes (at $F_{MSY\ lower} \times SSB_{2023}/MSY\ B_{trigger}$) and 77 tonnes (at $F_{MSY} \times SSB_{2023}/MSY\ B_{trigger}$), but the median SSB would remain below B_{lim} by 2024.

The assumed recruitment in 2022 and 2023 used in the forecast constitutes a significant part (70%) of the projected SSB in 2024 (45% and 25%, respectively; Figure 6.14 and Table 6.14).

6.6 Medium-term projection

No medium-term projections were carried out.

6.7 Biological reference points

The reference points have been estimated using the agreed ICES guidelines, see Table 6.11 (ICES, 2016). F_{pa} was set to $F_{p0.5}$; the F that leads to SSB ≥ B_{lim} with 95% probability at the last benchmark in 2020.

6.8 Management plans

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

6.9 Uncertainties and bias in assessment and forecast

The stock was benchmarked in 2020 (ICES, 2020a). The model was changed to a stochastic state –space assessment model (SAM). Maturity and natural mortality information was updated, discards were included in the assessment, catch (landings and discards) time-series were reviewed and updated from 2004 to 2018, commercial tuning series were reviewed and included as biomass index, and survey indices were updated to a single modelled time-series using a vector-autoregressive spatio-temporal model (VAST). The F-pattern shows less variability across the time-series and higher estimates in most recent years than the previous assessment. Fishing mortality is observed to be sensitive to the addition of an extra year of data.

However, despite this uncertainty, it is quite clear that the cod stock is well below SBB limits and well above F target. Given that situation and the recommendations of WKBIAS, the last benchmark and WGCSE 2022 validated the proposed assessment model and its use for prediction.

6.10 Recommendations for future developments

There is room for development of a modelled commercial tuning fleet instead of the current method based on catch thresholds. Indeed, despite the work performed to improve the commercial tuning fleet, it is never easy to account for changes in fisheries targeting behaviours. Indeed, in recent years, cod is not targeted anymore by most of the fisheries.

Even if the survey index combined two surveys, it is based on few fish. Further work and sensitivity analysis on the VAST assumptions might also be performed and documented in the future to ensure that the model will converge for all ages and show low retrospective patterns.

6.11 Management considerations

The strong retrospective pattern implies that the current F estimates might be uncertain. Forecasts are sensitive to the assumption on recruitment as the landings are usually composed of a high proportion of age 2 fish (and age 1 for discards).

The recent technical measures introduced in the Celtic Sea, increase in the mesh size of the square mesh panels and raised lines are expected to reduce catches of Celtic Sea cod and improved the selection pattern. Impact of this measure should be monitored.

Additionally, mixed-fisheries issues could be responsible for maintaining F at high level, as other gadoids fishing opportunities are higher. In this context, cod is no longer a target species but can be considered as bycatch in the fleet targeting haddock, whiting and *Nephrops*.

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

6.12 References

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

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

Table 6.1. Cod in Division 7.e–k. History of official commercial landings presented by country and used by the Working Group. All weights are in tonnes.

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in rectangles 33E2 and 33E3 *
1971	NA	NA	NA	NA	NA	5782	NA	NA
1972	NA	NA	NA	NA	NA	4737	NA	NA
1973	NA	NA	NA	NA	NA	4015	NA	NA
1974	NA	NA	NA	NA	NA	2898	NA	NA
1975	NA	NA	NA	NA	NA	3993	NA	NA
1976	NA	NA	NA	NA	NA	4818	NA	NA
1977	NA	NA	NA	NA	NA	3059	NA	NA
1978	NA	NA	NA	NA	NA	3647	NA	NA
1979	NA	NA	NA	NA	NA	4650	NA	NA
1980	NA	NA	NA	NA	NA	7243	NA	NA
1981	NA	NA	NA	NA	NA	10597	NA	NA
1982	NA	NA	NA	NA	NA	8766	NA	NA
1983	NA	NA	NA	NA	NA	9641	NA	NA
1984	NA	NA	NA	NA	NA	6631	NA	NA
1985	NA	NA	NA	NA	NA	8317	NA	NA
1986	NA	NA	NA	NA	NA	10475	NA	NA

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in rectangles 33E2 and 33E3 *
1987	NA	NA	NA	NA	NA	10228	NA	NA
1988	554	13863	1480	1292	2	17191	NA	NA
1989	910	15801	1860	1223	15	19809	NA	NA
1990	621	9383	1241	1346	158	12749	NA	NA
1991	303	6260	1659	1094	20	9336	NA	NA
1992	195	7120	1212	1207	13	9747	NA	NA
1993	391	8317	766	945	6	10425	NA	NA
1994	398	7692	1616	906	8	10620	NA	NA
1995	400	8321	1946	1034	8	11709	NA	NA
1996	552	8981	1982	1166	0	12681	NA	NA
1997	694	8662	1513	1166	0	12035	NA	NA
1998	528	8096	1718	1089	0	11431	NA	NA
1999	326	5488	1883	897	0	8594	NA	NA
2000	208	4281	1302	744	0	6535	NA	NA
2001	347	6033	1091	838	0	8309	NA	NA
2002	555	7368	694	618	0	9235	NA	NA
2003	136	5222	517	346	0	6221	NA	NA

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in rectangles 33E2 and 33E3 *
2004	153	2934	657	281	1	4027	543	108
2005	186	2127	855	309	1	3478	1426	54
2006	101	2431	995	371	3	3902	2118	103
2007	107	3113	1208	411	3	4842	1248	527
2008	65	2994	1222	295	1	4577	306	558
2009	48	3020	847	267	5	4187	1229	193
2010	52	2449	1030	296	3	3831	3040	143
2011	123	4808	1010	427	7	6376	3749	147
2012	290	6900	1539	706	8	9443	2341	85
2013	202	5051	1470	548	3	7273	562	76
2014	141	2715	1189	466	0	4512	1569	24
2015	121	3373	1109	422	3	5028	483	39
2016	97	2579	881	365	1	3924	525	40
2017	82	1578	623	188	0	2471	134	19
2018	49	611	706 c	130	0	1496 c	316	20
2019	43	369	554 c	84	NA	1051 c	300	37
2020**	18	371	487	44	2	922	231	71

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in rectangles 33E2 and 33E3 *
2021**	11	261	309	46	0	627	733	52

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

**** Preliminary official landings.**

[c] Incomplete due to part of the data being unavailable under national GDPR clauses.

Table 6.2. Cod in Division 7e–k. Catch number-at-age (in thousands). Number-at-age 1 and 2 before 2004 are estimated by the assessment model.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1980	NA	NA	285	175	52	55	14
1981	NA	NA	811	153	41	20	12
1982	NA	NA	888	169	36	19	5
1983	NA	NA	540	424	77	21	11
1984	NA	NA	134	97	94	22	5
1985	NA	NA	465	61	40	47	15
1986	NA	NA	673	254	30	31	17
1987	NA	NA	448	250	62	20	15
1988	NA	NA	320	133	46	21	8
1989	NA	NA	2483	149	77	18	11
1990	NA	NA	1006	663	79	21	16
1991	NA	NA	229	330	203	48	14
1992	NA	NA	329	64	70	53	17
1993	NA	NA	928	79	24	19	16
1994	NA	NA	1199	258	27	10	17
1995	NA	NA	310	284	73	13	5
1996	NA	NA	1199	134	95	43	4
1997	NA	NA	951	297	48	22	6
1998	NA	NA	641	254	99	36	8
1999	NA	NA	756	158	59	36	14
2000	NA	NA	419	169	44	17	14
2001	NA	NA	136	98	70	19	19
2002	NA	NA	883	64	33	12	11
2003	NA	NA	827	217	15	9	7
2004	873	1077	229	189	65	5	6
2005	2875	2080	182	93	47	19	8
2006	7477	1052	295	17	25	13	9
2007	3556	1302	355	79	10	8	11

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2008	467	885	403	122	27	4	6
2009	2212	421	424	120	47	11	4
2010	9794	618	151	107	46	14	5
2011	2325	4905	423	49	34	13	4
2012	746	1860	1757	117	18	14	11
2013	388	383	581	516	55	16	7
2014	4708	415	83	132	149	8	2
2015	242	2272	137	26	47	37	7
2016	624	195	707	33	7	17	16
2017	159	561	57	166	24	5	15
2018	902	172	137	14	38	5	2
2019	944	247	29	26	4	11	2
2020	342	548	36	3	2	2	2
2021	329	321	140	16	4	2	1

Table 6.3. Cod in Division 7e–k. Catch weight-(in kg) at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1980	0.457	1.756	4.217	7.147	9.454	11.179	12.73800
1981	0.457	1.756	4.217	7.147	9.454	11.179	12.82433
1982	0.457	1.756	4.217	7.147	9.454	11.179	12.84160
1983	0.457	1.756	4.217	7.147	9.454	11.179	13.04373
1984	0.457	1.756	4.217	7.147	9.454	11.179	12.94520
1985	0.457	1.756	4.217	7.147	9.454	11.179	12.85860
1986	0.457	1.756	4.217	7.147	9.454	11.179	12.73800
1987	0.457	1.756	4.217	7.147	9.454	11.179	12.87613
1988	0.457	1.756	4.217	7.147	9.454	11.179	13.06075
1989	0.457	1.756	4.217	7.147	9.454	11.179	12.90245
1990	0.457	1.756	4.217	7.147	9.454	11.179	13.02887
1991	0.457	1.756	4.217	7.147	9.454	11.179	12.84900
1992	0.457	1.756	4.217	7.147	9.454	11.179	12.76847
1993	0.457	1.756	4.217	7.147	9.454	11.179	12.80275
1994	0.457	1.756	4.217	7.147	9.454	11.179	12.92082
1995	0.457	1.756	4.217	7.147	9.454	11.179	13.04880
1996	0.457	1.756	4.217	7.147	9.454	11.179	12.86750
1997	0.457	1.756	4.217	7.147	9.454	11.179	12.73800
1998	0.457	1.756	4.217	7.147	9.454	11.179	12.86750
1999	0.457	1.756	4.217	7.147	9.454	11.179	12.92300
2000	0.457	1.756	4.217	7.147	9.454	11.179	12.81200
2001	0.457	1.756	4.217	7.147	9.454	11.179	12.94226
2002	0.457	1.756	4.217	7.147	9.454	11.179	12.99664
2003	0.457	1.756	4.217	7.147	9.454	11.179	12.81200
2004	0.585	0.939	4.268	6.849	9.207	12.192	11.86933
2005	0.388	0.899	3.412	6.107	9.138	11.017	11.43300
2006	0.285	1.780	4.758	6.971	9.341	11.119	12.42300
2007	0.362	1.738	4.412	7.943	9.953	12.043	13.20200
2008	0.541	1.925	4.105	7.337	9.483	11.220	12.64783

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2009	0.510	2.457	4.324	6.740	9.252	10.707	12.93800
2010	0.330	2.078	5.223	7.863	10.056	12.290	13.78180
2011	0.358	1.381	3.740	7.774	10.314	11.531	13.02500
2012	0.488	1.532	4.108	7.276	10.386	12.096	13.87391
2013	0.655	2.471	4.019	6.976	8.088	9.991	12.55800
2014	0.448	2.281	4.988	7.353	10.180	11.432	14.80600
2015	0.367	1.608	4.230	7.952	10.087	11.147	12.53600
2016	0.706	1.787	4.175	7.386	9.619	11.556	12.35400
2017	0.393	1.532	3.414	6.517	7.630	9.563	11.09620
2018	0.444	1.927	4.076	6.160	9.081	9.780	13.23200
2019	0.465	1.774	4.203	7.223	9.815	10.576	11.95100
2020	0.455	1.369	4.233	8.058	9.731	12.757	13.13100
2021	0.450	1.477	3.946	6.784	9.264	11.004	12.535

Table 6.4. Cod in Division 7e–k. Stock weight at age =1st quarter values.

year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1980	0.370	1.421	3.936	6.901	9.324	11.107	13.574000
1981	0.370	1.421	3.936	6.901	9.324	11.107	13.578000
1982	0.370	1.421	3.936	6.901	9.324	11.107	13.578800
1983	0.370	1.421	3.936	6.901	9.324	11.107	13.626820
1984	0.370	1.421	3.936	6.901	9.324	11.107	13.583600
1985	0.370	1.421	3.936	6.901	9.324	11.107	13.607930
1986	0.370	1.421	3.936	6.901	9.324	11.107	13.574000
1987	0.370	1.421	3.936	6.901	9.324	11.107	13.580400
1988	0.370	1.421	3.936	6.901	9.324	11.107	13.695250
1989	0.370	1.421	3.936	6.901	9.324	11.107	13.620270
1990	0.370	1.421	3.936	6.901	9.324	11.107	13.640620
1991	0.370	1.421	3.936	6.901	9.324	11.107	13.579140
1992	0.370	1.421	3.936	6.901	9.324	11.107	13.575410
1993	0.370	1.421	3.936	6.901	9.324	11.107	13.577000
1994	0.370	1.421	3.936	6.901	9.324	11.107	13.582470
1995	0.370	1.421	3.936	6.901	9.324	11.107	13.588400
1996	0.370	1.421	3.936	6.901	9.324	11.107	13.580000
1997	0.370	1.421	3.936	6.901	9.324	11.107	13.574000
1998	0.370	1.421	3.936	6.901	9.324	11.107	13.580000
1999	0.370	1.421	3.936	6.901	9.324	11.107	13.582570
2000	0.370	1.421	3.936	6.901	9.324	11.107	13.577430
2001	0.370	1.421	3.936	6.901	9.324	11.107	13.605840
2002	0.370	1.421	3.936	6.901	9.324	11.107	13.624640
2003	0.370	1.421	3.936	6.901	9.324	11.107	13.577430
2004	0.356	0.830	4.035	6.101	9.324	13.784	9.952167
2005	0.320	0.830	4.035	6.101	9.324	11.135	15.169000
2006	0.267	1.516	4.370	6.325	9.350	11.081	12.688000
2007	0.290	1.453	3.916	8.101	10.658	11.413	15.827000
2008	0.344	1.623	4.027	7.200	8.941	10.916	12.550670

year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2009	0.399	1.914	3.880	6.404	8.898	10.507	13.964000
2010	0.286	1.597	4.874	7.466	9.852	11.254	13.545200
2011	0.324	1.030	3.478	8.051	10.251	11.355	15.493000
2012	0.410	1.289	3.641	6.979	9.704	12.111	15.844000
2013	0.440	1.774	3.746	6.854	7.334	9.330	12.844000
2014	0.363	1.762	4.109	6.762	10.082	11.634	15.360000
2015	0.428	1.202	4.326	8.210	10.337	11.508	14.311000
2016	0.618	1.542	3.622	7.110	10.048	11.707	13.416000
2017	0.335	1.337	3.313	6.189	7.249	9.651	10.962330
2018	0.376	1.617	3.675	5.655	8.508	9.223	12.240000
2019	0.366	1.509	3.821	7.254	9.725	10.795	11.486000
2020	0.420	1.200	3.705	8.174	10.286	13.407	13.634000
2021	0.401	1.154	3.272	6.038	8.786	11.148	15.225

Table 6.5a. Cod in Division 7e–k. LPUE for French OT-DEF fleets. Units: landings in tonnes, effort in 000s hours fished and LPUE in kg/hour fished. This series is used to tuned the assessment model.

Year	Effort	Landings
2002	264146	3692073
2003	240535	1978251
2004	214247	918840
2005	156961	714850
2006	125245	712566
2007	150288	1193033
2008	138626	814340
2009	143812	647808
2010	143730	705691
2011	258383	2332986
2012	252110	3393990
2013	190886	1696287
2014	151518	1113363
2015	185791	1374691
2016	178399	1122665
2017	137849	483571
2018	102586	163178
2019	114838	136473
2020	96907	149412
2021	97502	102964

Table 6.5b. Cod in Division 7e–k. Time-series of landings, effort and LPUE for the Irish fleets. Units: landings in tonnes live weight, effort in 000s hours fished and LPUE in kg/hour fished.

	Otter_trawl_27.7j			Beam_trawl_27.7j			Scottish_seiner_27.7j			Gillnet_27.7j		
	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	339,3	93,2	3,6	0,0	0,2	0,2	75,5	5,3	14,4	178,8	21,3	8,4
1996	326,4	70,2	4,6	8,7	1,4	6,3	124,5	8,2	15,3	65,0	5,2	12,4
1997	352,7	82,7	4,3	3,4	1,7	2,0	115,8	10,7	10,8	45,5	8,3	5,5
1998	262,7	89,1	2,9	19,1	5,2	3,7	103,4	6,6	15,6	59,1	16,0	3,7
1999	76,7	40,5	1,9	27,5	7,4	3,7	9,6	1,4	6,8	24,6	8,7	2,8
2000	95,5	63,9	1,5	21,2	6,9	3,1	24,4	3,5	7,0	13,8	7,0	2,0
2001	148,5	67,4	2,2	10,7	3,0	3,6	31,3	4,4	7,1	14,8	6,6	2,3
2002	150,0	90,4	1,7	5,4	3,1	1,7	24,6	8,9	2,8	12,3	8,1	1,5
2003	73,6	107,4	0,7	8,8	9,0	1,0	12,0	7,9	1,5	6,3	11,2	0,6
2004	36,1	88,3	0,4	2,5	2,2	1,2	10,3	8,1	1,3	4,2	6,1	0,7
2005	37,8	71,3	0,5	4,7	2,4	2,0	17,5	5,8	3,0	3,4	6,1	0,6
2006	39,6	64,5	0,6	2,0	1,5	1,3	15,6	5,3	2,9	7,2	7,3	1,0
2007	35,9	78,3	0,5	7,8	2,4	3,3	9,8	3,5	2,8	6,5	10,5	0,6
2008	33,1	66,7	0,5	2,6	1,1	2,3	9,5	2,8	3,3	6,5	7,9	0,8
2009	26,6	73,0	0,4	4,7	2,8	1,7	8,9	3,3	2,7	8,0	10,9	0,7
2010	52,5	85,7	0,6	1,7	1,0	1,7	17,0	4,4	3,9	8,4	9,4	0,9
2011	57,7	62,8	0,9	1,7	0,6	2,7	21,6	4,6	4,7	16,8	8,0	2,1
2012	62,8	65,6	1,0	0,4	0,3	1,5	29,8	5,4	5,6	25,2	8,3	3,0
2013	66,1	61,3	1,1	1,8	0,6	3,3	32,5	6,6	4,9	15,4	9,8	1,6
2014	51,6	53,9	1,0	1,2	0,6	1,9	52,6	7,4	7,1	9,7	12,2	0,8
2015	63,6	46,9	1,4	0,6	0,1	6,3	38,2	5,3	7,2	18,1	14,2	1,3
2016	48,5	50,7	1,0	0,3	0,2	1,5	25,2	5,3	4,7	15,8	17,1	0,9
2017	41,3	56,4	0,7	0,0	0,0	10,0	24,0	5,3	4,5	10,4	18,0	0,6
2018	42,3	52,1	0,8	0,2	0,1	2,4	28,5	6,4	4,5	5,9	16,8	0,4
2019	30,4	53,4	0,6	0,2	0,1	1,7	18,1	7,3	2,5	5,5	14,5	0,4
2020	26,72	44,11	0,61	0,07	0,02	2,92	17,16	5,53	3,10	13,80	13,52	1,02
2021	12,95	40,28	0,32	0,11	0,31	0,35	11,05	5,29	2,09	15,24	19,73	0,77

	Otter_trawl_27.7g			Beam_trawl_27.7g			Scottish_seiner_27.7g			Gillnet_27.7g		
NA	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	418,1	148,2	2,8	106,8	39,6	2,7	51,1	10,4	4,9	47,1	13,6	3,5
2017	361,4	136,1	2,7	46,4	35,2	1,3	42,1	9,7	4,3	22,4	14,8	1,5
2018	387,6	108,2	3,6	72,6	37,4	1,9	61,1	9,7	6,3	16,7	14,0	1,2
2019	244,8	103,9	2,4	71,9	34,1	2,1	50,9	14,3	3,6	21,9	16,0	1,4
2020	184,36	89,91	2,05	55,00	29,14	1,89	51,51	13,59	3,79	20,08	15,02	1,34
2021	108,54	83,90	1,29	45,08	31,57	1,43	28,73	14,8	1,94	15,59	17,59	0,89

Table 6.5c. Cod in Division 7e–k. Time-series of landings, effort and LPUE for the UK fleets. Units: landings in tonnes, effort in days fished and LPUE in kg/day.

	Beam_trawl_27.7ek		Trawl_27.7ek		Trawl_27.7e	
YEAR	**Lands..t.**	**Effort..Days.**	**Lands..t..1**	**Effort..Days..1**	**Lands..t..2**	**Effort..Days..2**
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
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

	Beam_trawl_27.7ek		Trawl_27.7ek		Trawl_27.7e	
YEAR	Lands..t.	Effort..Days.	Lands..t..1	Effort..Days..1	Lands..t..2	Effort..Days..2
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
2017	35.49	14283	19.37	3718	9.33	2398
2018	24.41	13065	17.51	3233	5.34	1987
2019	18.03	12649	11.76	2660	3.64	1548
2020	10.21	12332	2.55	1481	1.74	1093
2021	14.87	12593	2.53	1895	1.25	1353

Table 6.6. Cod in Division 7e–k. Time-series of survey indices scrutinized at WGCSE and used in the assessment.

Cod in Divisions 7e-k, tuning fleets, WGCSE2021			
102			
FR-OTDEF Q2+3+4 trawlers in 7e–k			
2002	2020		
1	1	0.25	1
-1	-1		

Year	Effort	Landings
2002	264146	3692073
2003	240535	1978251
2004	214247	918840
2005	156961	714850
2006	125245	712566
2007	150288	1193033
2008	138626	814340
2009	143812	647808
2010	143730	705691
2011	258383	2332986
2012	252110	3393990
2013	190886	1696287
2014	151518	1113363
2015	185791	1374691
2016	178399	1122665
2017	137849	483571
2018	102586	163178
2019	114838	136473
2020	96907	149412
2021	97502	102964

next table

IR-GFS FR-EVHOE Q4 combined indices - VAST Modelling			
2003	2020	NA	NA

1	1	0.79	0.92
1	4	NA	NA

Year	Effort	Age 1	Age 2	Age 3	Age 4
2003	1	24.431	39.006	49.727	17.447
2004	1	34.942	33.287	15.157	18.076
2005	1	112.156	33.891	12.266	0.000
2006	1	74.788	44.300	8.044	0.000
2007	1	95.111	69.869	33.235	12.524
2008	1	29.186	72.709	30.874	11.022
2009	1	58.069	20.743	27.982	11.823
2010	1	491.426	62.255	5.542	7.331
2011	1	241.122	364.573	24.152	4.165
2012	1	21.254	115.420	141.296	26.223
2013	1	25.047	8.148	23.572	33.161
2014	1	292.211	30.564	13.048	20.528
2015	1	13.884	154.490	9.121	0.000
2016	1	128.255	21.528	113.529	17.994
2017	1	21.796	65.972	26.003	38.008
2018	1	36.502	9.271	12.465	11.512
2019	1	145.144	36.138	2.239	6.908
2020	1	55.313	105.361	3.107	0.958
2021	1	23.014	28.033	37.635	1.668

Table6.7. Cod in Division 7e–k. Final SAM fishing mortality-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+	F_{bar}(mean 2–5)
1980	0.494	0.976	0.912	0.891	0.880	1.107	1.107	0.915
1981	0.485	0.958	0.894	0.869	0.855	1.073	1.073	0.894
1982	0.461	0.909	0.845	0.818	0.802	1.002	1.002	0.843
1983	0.464	0.915	0.851	0.821	0.803	1.000	1.000	0.848
1984	0.426	0.836	0.775	0.743	0.727	0.902	0.902	0.770
1985	0.428	0.841	0.779	0.745	0.726	0.898	0.898	0.773
1986	0.450	0.887	0.824	0.786	0.763	0.936	0.936	0.815
1987	0.459	0.905	0.842	0.802	0.778	0.947	0.947	0.832
1988	0.442	0.869	0.808	0.764	0.741	0.897	0.897	0.796
1989	0.464	0.914	0.851	0.800	0.773	0.928	0.928	0.835
1990	0.500	0.990	0.924	0.867	0.835	0.995	0.995	0.904
1991	0.531	1.054	0.989	0.927	0.894	1.060	1.060	0.966
1992	0.531	1.055	0.990	0.925	0.893	1.056	1.056	0.966
1993	0.525	1.042	0.977	0.908	0.876	1.032	1.032	0.951
1994	0.538	1.068	1.002	0.929	0.896	1.053	1.053	0.974
1995	0.526	1.044	0.979	0.904	0.872	1.022	1.022	0.950
1996	0.533	1.057	0.992	0.909	0.874	1.017	1.017	0.958
1997	0.525	1.041	0.976	0.887	0.845	0.974	0.974	0.937
1998	0.538	1.068	1.003	0.906	0.859	0.980	0.980	0.959
1999	0.546	1.085	1.019	0.916	0.865	0.978	0.978	0.972
2000	0.541	1.075	1.010	0.903	0.851	0.955	0.955	0.960
2001	0.550	1.093	1.028	0.919	0.868	0.968	0.968	0.977
2002	0.562	1.117	1.052	0.934	0.879	0.975	0.975	0.995
2003	0.551	1.093	1.030	0.910	0.856	0.947	0.947	0.972
2004	0.539	1.069	1.008	0.889	0.838	0.928	0.928	0.951
2005	0.554	1.097	1.038	0.915	0.867	0.962	0.962	0.979
2006	0.519	1.023	0.969	0.855	0.818	0.914	0.914	0.916
2007	0.507	1.000	0.952	0.844	0.814	0.917	0.917	0.903
2008	0.486	0.959	0.920	0.822	0.801	0.909	0.909	0.875

2009	0.481	0.951	0.917	0.824	0.811	0.928	0.928	0.875
2010	0.465	0.921	0.891	0.804	0.798	0.921	0.921	0.853
2011	0.462	0.918	0.888	0.801	0.798	0.927	0.927	0.851
2012	0.489	0.977	0.947	0.855	0.856	1.001	1.001	0.908
2013	0.508	1.023	0.994	0.900	0.906	1.065	1.065	0.956
2014	0.483	0.973	0.942	0.852	0.858	1.011	1.011	0.906
2015	0.495	1.000	0.967	0.873	0.880	1.044	1.044	0.930
2016	0.518	1.052	1.017	0.916	0.924	1.101	1.101	0.977
2017	0.587	1.201	1.162	1.048	1.058	1.264	1.264	1.117
2018	0.612	1.254	1.212	1.087	1.094	1.307	1.307	1.162
2019	0.600	1.231	1.188	1.066	1.072	1.289	1.289	1.139
2020	0.541	1.105	1.062	0.950	0.961	1.162	1.162	1.020
2021	0.554	1.133	1.089	0.977	0.990	1.196	1.196	1.047

Table 6.8. Cod in Division 7e–k. Final SAM stock number-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1980	17720	4867	698	299	89	70	21
1981	8019	6664	1318	228	95	29	23
1982	3889	2988	1869	401	76	34	13
1983	8433	1440	864	636	141	28	15
1984	9296	3258	402	271	216	51	12
1985	8141	3697	1030	149	104	84	22
1986	9219	3198	1152	373	61	43	34
1987	27983	3487	942	378	130	25	25
1988	14070	11124	993	314	123	47	15
1989	4807	5524	3482	365	120	46	21
1990	6490	1779	1604	1106	145	44	23
1991	17005	2352	462	478	347	57	21
1992	19077	6167	581	132	139	106	23
1993	10876	6892	1571	163	42	44	35
1994	21331	3797	1773	457	53	14	23
1995	16618	7699	915	488	143	18	10
1996	12144	5958	1987	286	151	49	8
1997	12659	4287	1490	569	102	47	15
1998	7921	4586	1080	420	188	41	18
1999	4374	2809	1145	299	128	65	19
2000	16676	1474	684	311	94	43	26
2001	14810	6063	347	189	98	33	23
2002	5412	5275	1506	99	60	31	18
2003	3354	1850	1196	386	31	20	15
2004	4741	1211	443	309	119	11	11
2005	7966	1865	277	136	98	41	8
2006	8275	2736	469	64	44	32	16
2007	6203	2819	729	145	21	16	17
2008	2242	2181	719	214	50	8	11

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2009	5403	847	612	221	74	19	6
2010	24640	1998	250	188	79	25	8
2011	9323	9490	615	88	66	29	10
2012	1771	3552	2762	203	34	24	13
2013	2337	638	958	816	70	13	11
2014	11992	852	169	276	266	22	6
2015	1111	4661	244	50	93	87	9
2016	2320	407	1207	76	16	31	27
2017	666	821	110	302	26	6	16
2018	1472	222	173	27	74	7	5
2019	3502	459	44	36	8	19	3
2020	1305	1216	86	10	8	2	4
2021	923	455	270	23	4	3	2

Table 8.9. Cod in Divisions 7e–k. Final SAM summary table.

Year	R(age 1)	Low	High	SSB	Low	High	$F_{bar(2–5)}$	Low	High	TSB	Low	High
1980	17720	8502	36932	10247	7843	13387	0.915	0.749	1.119	20177	13640	29845
1981	8019	3988	16127	13034	9933	17105	0.894	0.750	1.066	20721	14781	29049
1982	3889	1949	7760	13167	10494	16521	0.843	0.712	0.999	17074	13373	21799
1983	8433	4312	16495	10489	8677	12681	0.848	0.716	1.003	14789	11776	18573
1984	9296	4767	18131	8588	6982	10565	0.770	0.630	0.942	14269	10651	19114
1985	8141	4205	15762	9830	7912	12213	0.773	0.640	0.932	15542	11741	20574
1986	9219	4695	18101	10758	8700	13301	0.815	0.693	0.958	16576	12729	21587
1987	27983	14496	54019	10551	8582	12972	0.832	0.707	0.978	23444	16386	33542
1988	14070	7264	27253	16219	12026	21873	0.796	0.659	0.960	28970	20206	41534
1989	4807	2454	9419	21417	16488	27820	0.835	0.705	0.988	27766	21184	36393
1990	6490	3257	12932	17023	13673	21193	0.904	0.773	1.058	21029	16842	26257
1991	17005	8528	33908	10934	9097	13143	0.966	0.811	1.150	18890	13951	25578
1992	19077	9725	37422	10555	8075	13797	0.966	0.824	1.132	21805	14990	31719
1993	10876	5449	21710	13519	10277	17783	0.951	0.818	1.106	22481	16162	31269
1994	21331	10979	41447	13521	10730	17038	0.974	0.834	1.137	24384	17768	33463
1995	16618	8616	32050	14295	11018	18546	0.950	0.818	1.102	25728	18429	35916
1996	12144	6327	23307	15874	12485	20184	0.958	0.825	1.114	24810	18594	33104
1997	12659	6588	24326	14352	11592	17770	0.937	0.805	1.091	22249	16992	29133
1998	7921	4120	15232	12818	10363	15855	0.959	0.826	1.114	19044	14555	24918
1999	4374	2287	8365	10582	8628	12978	0.972	0.835	1.130	14352	11320	18197
2000	16676	9099	30560	7486	6228	8999	0.960	0.826	1.115	14808	10932	20059
2001	14810	8194	26768	8824	6725	11577	0.977	0.844	1.132	18362	13296	25358
2002	5412	3108	9426	11384	9147	14167	0.995	0.857	1.156	17249	13446	22129
2003	3354	2123	5296	9163	7727	10867	0.972	0.847	1.116	11943	10025	14227
2004	4741	2937	7653	5463	4694	6358	0.951	0.838	1.080	7738	6566	9119
2005	7966	5530	11477	4190	3640	4823	0.979	0.849	1.129	7530	6393	8868
2006	8275	5536	12371	5522	4708	6477	0.916	0.809	1.037	9783	8177	11705
2007	6203	4238	9079	6708	5695	7900	0.903	0.796	1.023	10591	8897	12607
2008	2242	1541	3262	6814	5818	7981	0.875	0.769	0.996	9416	8013	11065

Year	R(age 1)	Low	High	SSB	Low	High	$F_{bar(2–5)}$	Low	High	TSB	Low	High
2009	5403	3739	7808	5438	4656	6350	0.875	0.771	0.994	8505	7273	9947
2010	24640	17401	34892	5431	4675	6310	0.853	0.742	0.981	14031	11440	17211
2011	9323	6505	13361	9140	7692	10861	0.851	0.739	0.980	16807	13986	20196
2012	1771	1229	2551	14076	11764	16842	0.908	0.806	1.024	17612	14870	20859
2013	2337	1599	3414	10315	8747	12165	0.956	0.831	1.100	12115	10433	14068
2014	11992	8271	17387	6343	5420	7423	0.906	0.791	1.038	11435	9560	13678
2015	1111	759	1627	6499	5510	7666	0.930	0.813	1.064	9626	7946	11660
2016	2320	1586	3394	5834	4832	7043	0.977	0.856	1.117	7862	6625	9331
2017	666	447	992	3224	2705	3843	1.117	0.972	1.285	3978	3364	4703
2018	1472	1000	2168	1689	1450	1966	1.162	1.004	1.345	2452	2113	2845
2019	3502	2423	5062	1097	940	1279	1.139	0.984	1.320	2709	2202	3333
2020	1305	856	1990	1346	1105	1640	1.020	0.811	1.282	2588	2106	3180
2021	923	464	1837	1334	1036	1716	1.047	0.812	1.350	2007	1531	2632

Table 6.10a. Cod in Division 7e–k. Table of model parameters.

Parameter name	par	sd(par)	exp(par)	Low	High
logFpar_0	-6.920	0.050	0.001	0.001	0.001
logFpar_1	-3.149	0.159	0.043	0.031	0.059
logFpar_2	-2.190	0.156	0.112	0.082	0.153
logFpar_3	-1.929	0.156	0.145	0.106	0.198
logSdLogFsta_0	-2.480	0.465	0.084	0.033	0.212
logSdLogN_0	-0.079	0.132	0.924	0.710	1.202
logSdLogN_1	-2.012	0.396	0.134	0.061	0.295
logSdLogObs_0	-0.707	0.214	0.493	0.322	0.756
logSdLogObs_1	-1.129	0.251	0.323	0.196	0.534
logSdLogObs_2	-1.235	0.110	0.291	0.233	0.362
logSdLogObs_3	-1.850	0.218	0.157	0.102	0.243
logSdLogObs_4	-0.449	0.139	0.638	0.483	0.843
transfIRARdist_0	-0.754	0.447	0.470	0.193	1.149
itrans_rho_0	1.849	0.706	6.356	1.548	26.092

Table 6.10b. Cod in Division 7e–k. Model fitting.

Model	log(L)	#par	AIC
Current	-221.51	14	471.01
base	-209.68	14	447.37

Table 6.11. Cod Division 7e–k. Short-term forecast assumption.

Variable	Value	Notes
F ages 2–5 (2022)	1.139	$F_{sq} = F_{average}$ (2019–2021)
SSB (2023)	992	Fishing at F_{sq}; in tonnes.
Recruitment age 1 (2022–2023)	1305,1305	Median from resampled (2015–2021); in thousands
Total catch (2022)	1220	Fishing at Fsq, in tonnes.

Table 6.12. Cod in Division 7e–k. Reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	5800	B_{pa}; in tonnes	ICES (2020a)
	F_{MSY}	0.29	Segmented regression with B_{lim} (EqSim)	ICES (2020a)
Precautionary approach	B_{lim}	4200	B_{loss}, lowest observed SSB from which there has been some recovery (2005) rounded value; in tonnes	ICES (2020a)
	B_{pa}	5800	$B_{lim} \times 1.4$; in tonnes	ICES (2020a)
	F_{lim}	1.13	Segmented regression with B_{lim} (EqSim)	ICES (2020a)
	F_{pa}	0.77	$F_{p0.5}$; the F that leads to SSB ≥ B_{lim} with 95% probability	ICES (2020a)
Management plan	MAP MSY $B_{trigger}$	5800	MSY $B_{trigger}$; in tonnes	EU (2019), ICES (2020a)
	MAP B_{lim}	4200	B_{lim}; in tonnes	EU (2019), ICES (2020a)
	MAP F_{MSY}	0.29	F_{MSY}	EU (2019), ICES (2020a)
	MAP range F_{lower}	0.17	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY	EU (2019), ICES (2020a)
	MAP range F_{upper}	0.41	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY	EU (2019), ICES (2020a)

Table 6.13. Stochastic Short-term forecast.

F_{MSY}

Year	$F_{barmedian}$	F_{barlow}	$F_{bar\ high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.290	0.207	0.406	1305	666	3502	992	490	1909	406	247	759
2024	0.290	0.199	0.420	1305	666	3502	2042	1040	4137	740	429	1424

Basis for the advice F=0

Year	$F_{barmedian}$	F_{barlow}	Fbar high	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.000	0.000	0.000	1305	666	3502	992	490	1909	0	0	0
2024	0.000	0.000	0.000	1305	666	3502	2649	1419	5309	0	0	0

Other scenarios

F status quo then F_{MSY} HCR

Year	$F_{barmedian}$	F_{barlow}	$F_{bar\ high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.050	0.035	0.069	1305	666	3502	992	490	1909	77	47	146
2024	0.290	0.199	0.420	1305	666	3502	2531	1345	5088	890	513	1736

F status quo then F_{MSY} lower HCR

Year	$F_{barmedian}$	F_{barlow}	$F_{bar\ high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.029	0.021	0.041	1305	666	3502	992	490	1909	46	28	86
2024	0.290	0.199	0.420	1305	666	3502	2579	1375	5183	904	521	1766

F status quo then F_{MSY} upper HCR

Year	$F_{barmedian}$	F_{barlow}	$F_{bar\ high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.070	0.050	0.098	1305	666	3502	992	490	1909	108	66	204
2024	0.290	0.199	0.420	1305	666	3502	2485	1316	4998	876	505	1706

Stable SSB

Year	$F_{barmedian}$	F_{barlow}	$F_{bar\ high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	1.116	0.796	1.563	1305	666	3502	992	490	1909	1136	681	2078
2024	1.145	0.787	1.660	1305	666	3502	992	426	2173	1195	666	2228

F_{2022}

Year	$F_{barmedian}$	F_{barlow}	$F_{bar\ high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	1.139	0.813	1.596	1305	666	3502	992	490	1909	1151	689	2104
2024	1.139	0.783	1.652	1305	666	3502	972	416	2135	1175	654	2192

F_{pa}

Year	$F_{barmedian}$	F_{barlow}	$F_{bar\ high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.770	0.549	1.078	1305	666	3502	992	490	1909	890	538	1637
2024	0.770	0.530	1.116	1305	666	3502	1336	618	2813	1148	660	2138

F_{lim}

Year	$F_{barmedian}$	F_{barlow}	$F_{bar\ high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	1.130	0.806	1.583	1305	666	3502	992	490	1909	1145	686	2094
2024	1.130	0.777	1.638	1305	666	3502	980	420	2151	1175	655	2193

B_{lim} - Not archivable.

B_{pa}, MSYBtrigger, not archivable.

Table 6.14. Catch option table.

Basis	Total catch (2023)	F_{total} (2023)	SSB (2024)	% SSB change *
ICES advice basis				
MSY and precautionary considerations: F = 0	0	0	2649	167
Other scenarios				
$F_{MSY} \times SSB_{2023}$/MSY $B_{trigger}$	77	0.050	2531	155
$F_{MSY\ lower} \times SSB_{2023}$/MSY $B_{trigger}$	46	0.029	2579	160
$F_{MSY\ upper} \times SSB_{2023}$/MSY $B_{trigger}$	108	0.070	2485	150
$F=F_{MSY}$	406	0.290	2042	106
F = 0	0	0	2649	167
$F=F_{lim}$	1145	1.130	980	-1.2
$F = F_{pa}$	890	0.770	1336	35
$SSB_{2024} = B_{lim}$				
SSB_{2024} = Bpa = MSY $B_{trigger}$				
$F = F_{2022}$	1151	1.139	972	-2
$SSB_{2024}=SSB_{2023}$	1136	1.116	992	0

Table 6.15.Cod in Division 7e–k. Forecast (a) yield in 2023 and (b) SSB in 2024.

recruitment	val	type	Prop	Age
2023	0,00024668	2023 Catch	17,194287	1
2022	0,0006068	2023 Catch	42,2951259	2
2021	0,00024928	2023 Catch	17,3752029	3
2020	0,00014912	2023 Catch	10,3938527	4
2019	0,00015426	2023 Catch	10,7518776	5
2018	2,24E-05	2023 Catch	1,55794101	6
2017	6,19E-06	2023 Catch	0,43171295	7
2024	0	2024 SSB	0	1
2023	651,38811	2024 SSB	25,0285744	2
2022	1188,47341	2024 SSB	45,6652411	3
2021	375,213077	2024 SSB	14,4169785	4
2020	186,541001	2024 SSB	7,16754763	5
2019	176,350869	2024 SSB	6,77600769	6
2018	24,6112966	2024 SSB	0,94565077	7

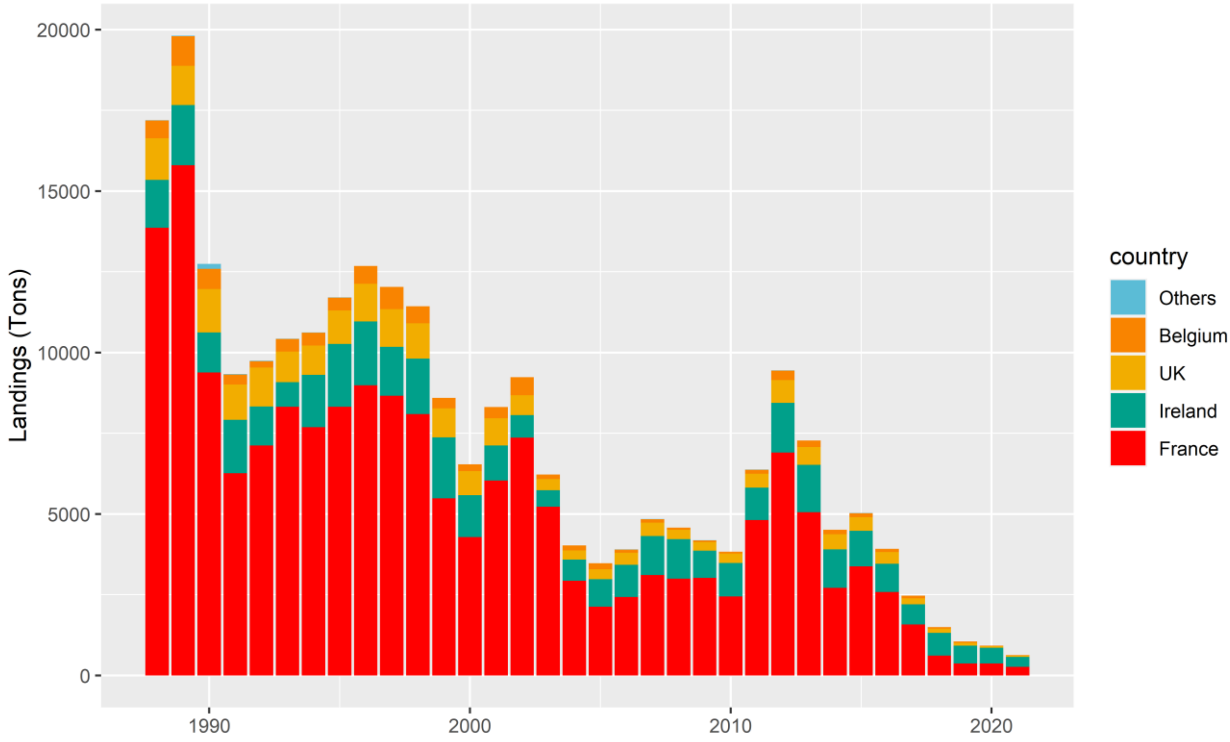


Figure 6.1. Cod in Division 7e–k. Historical landings (in tonnes) by country. Revised at WKCELTIC 2020.

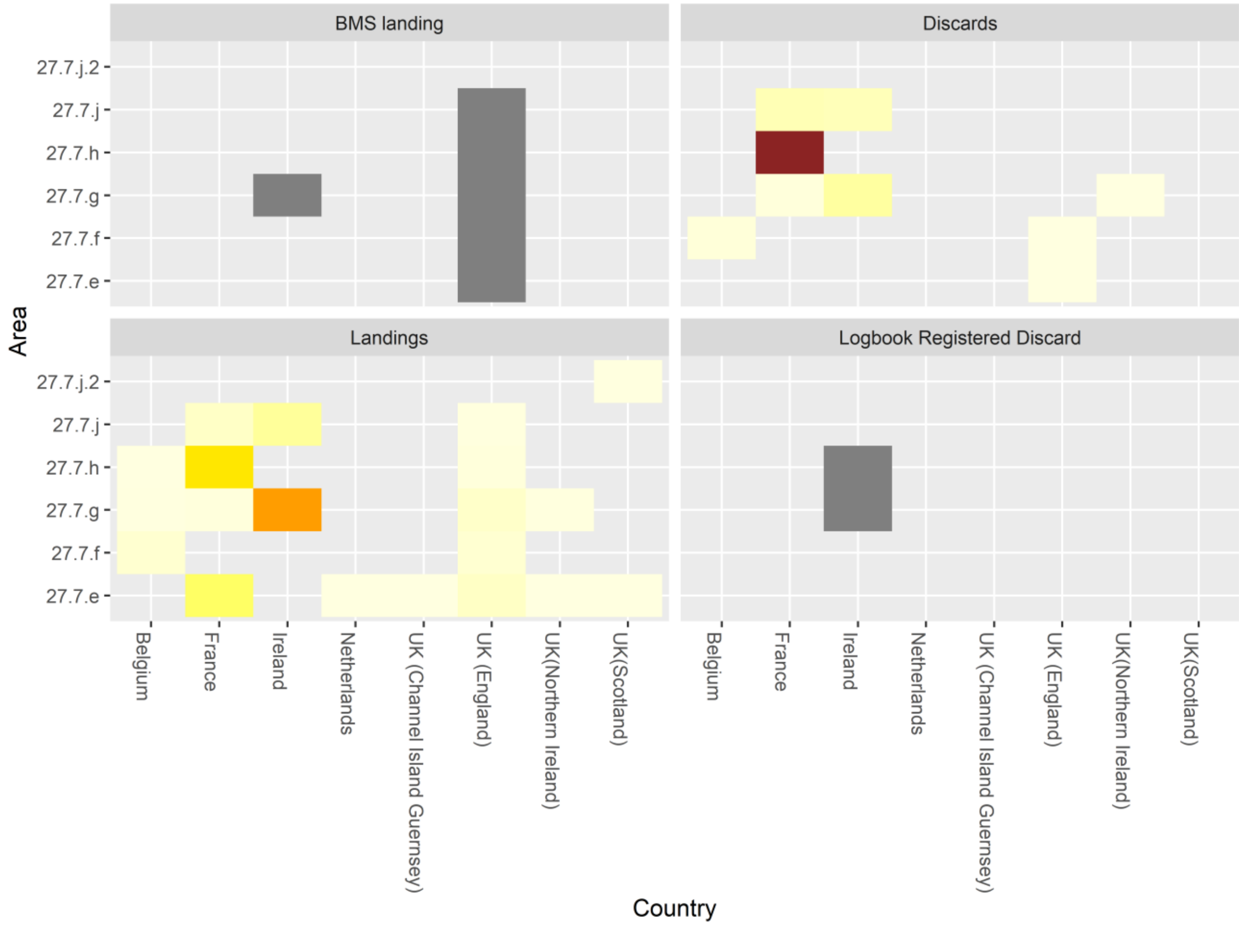


Figure 6.2. Cod in Division 7e–k. Catches volume in Tonnes (i.e.landings and discards) by area and country.

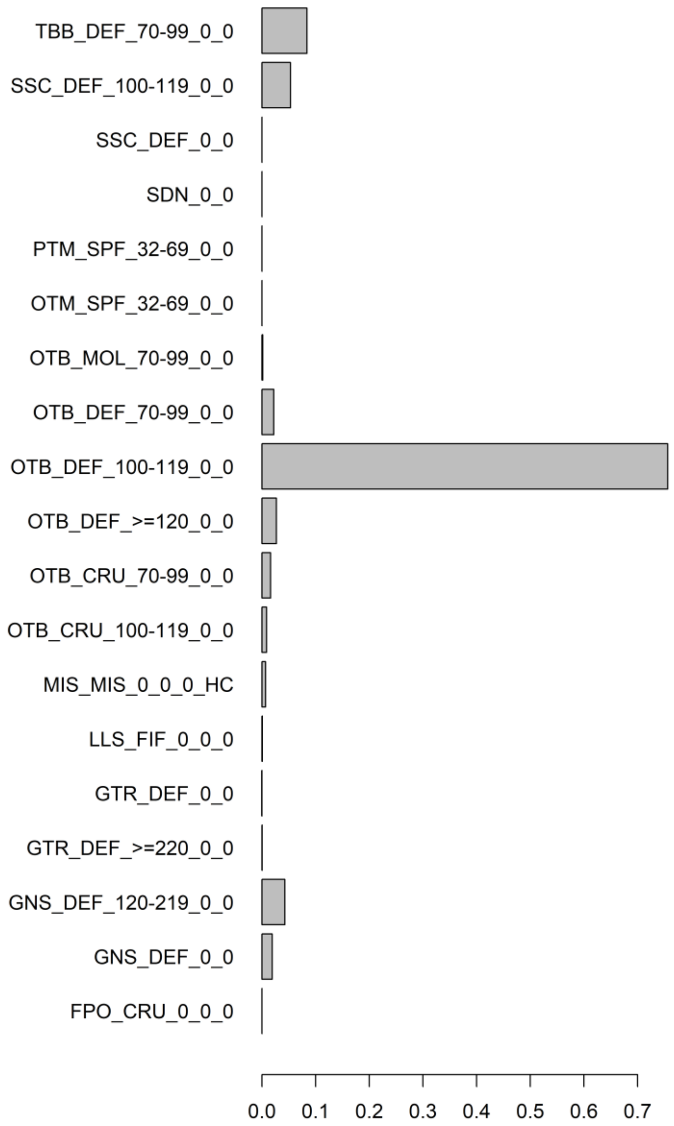


Figure 6.3. Cod in Division 7e–k. Proportion of the catches per métier (Level 6).

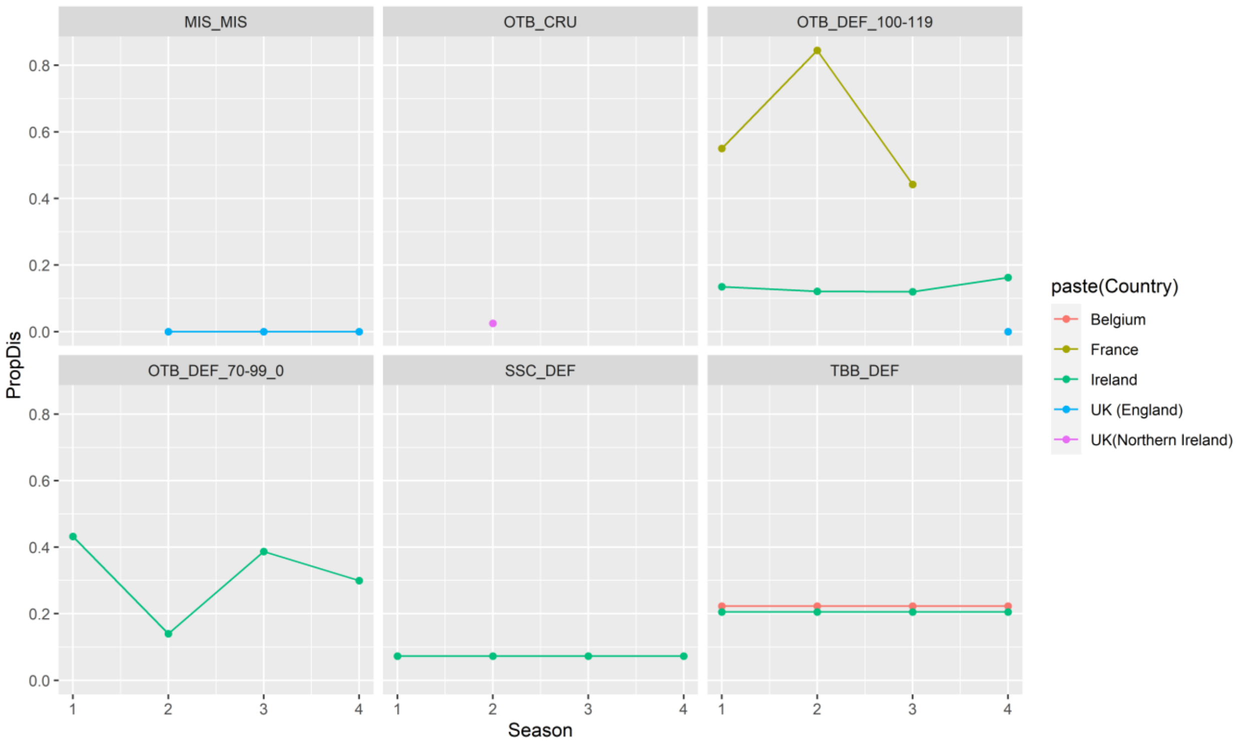


Figure 6.4. Cod in Division 7e–k. Discard proportion per métier and season.

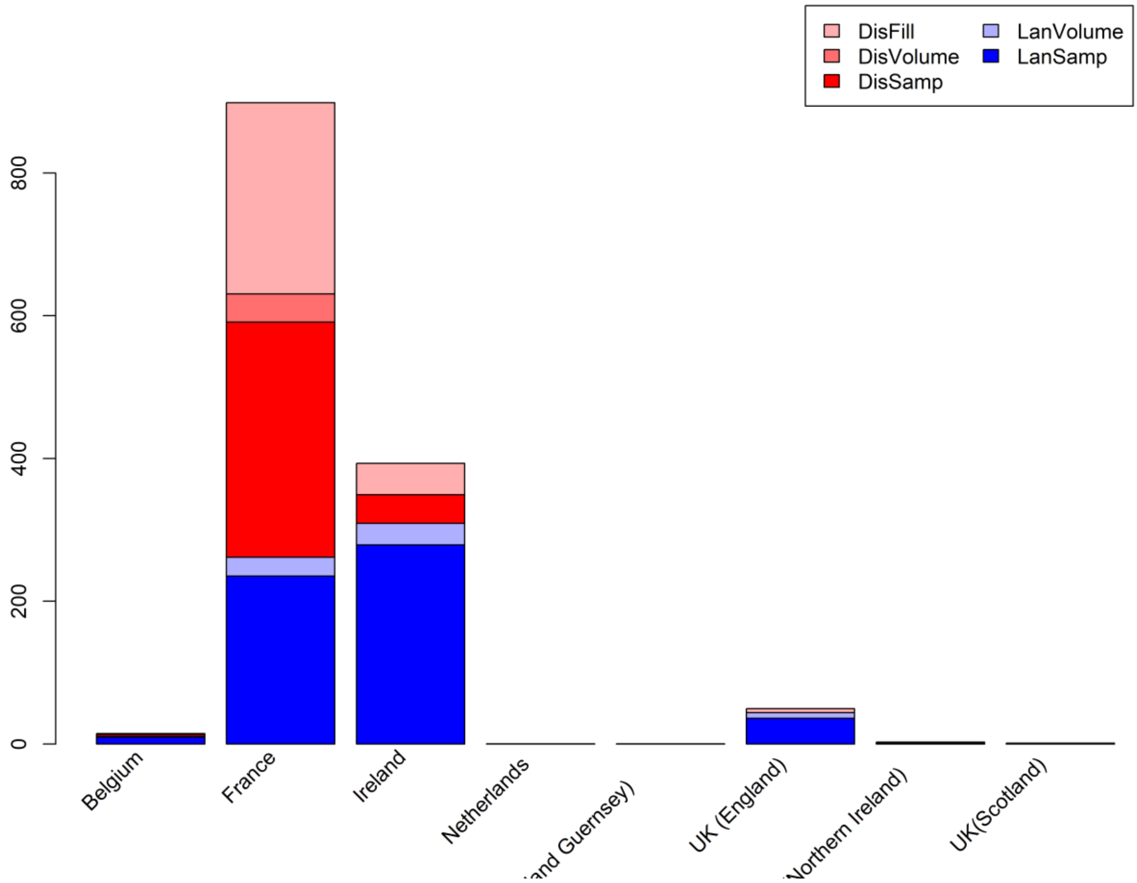


Figure 6.5. Cod in Division 7e–k. Allocation procedure.

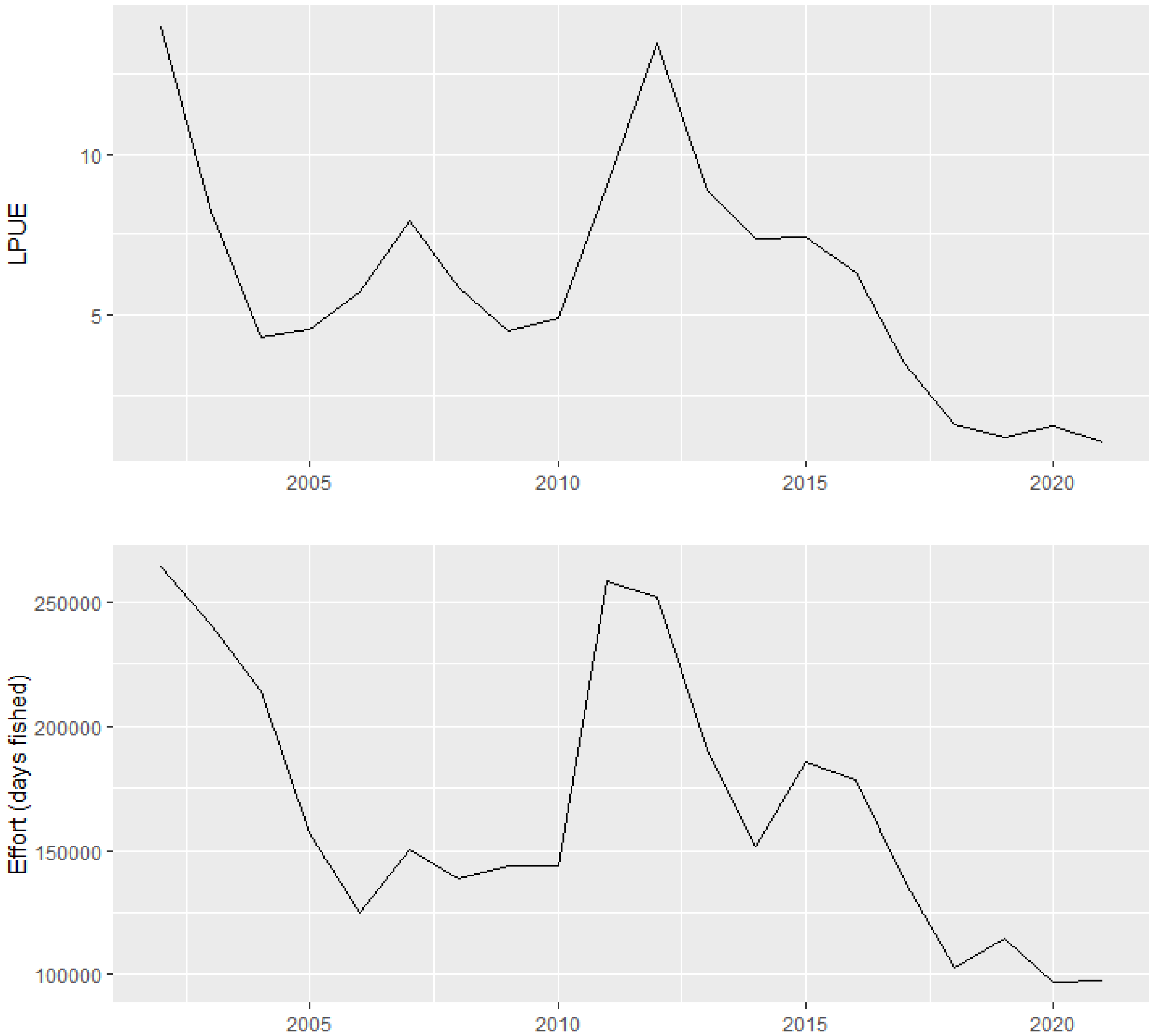


Figure 6.6a. Cod in Division 7e–k. Time-series of (a) LPUE and (b) fishing effort for the French fleets. Units: LPUE in kg/day and fishing effort in days fished.

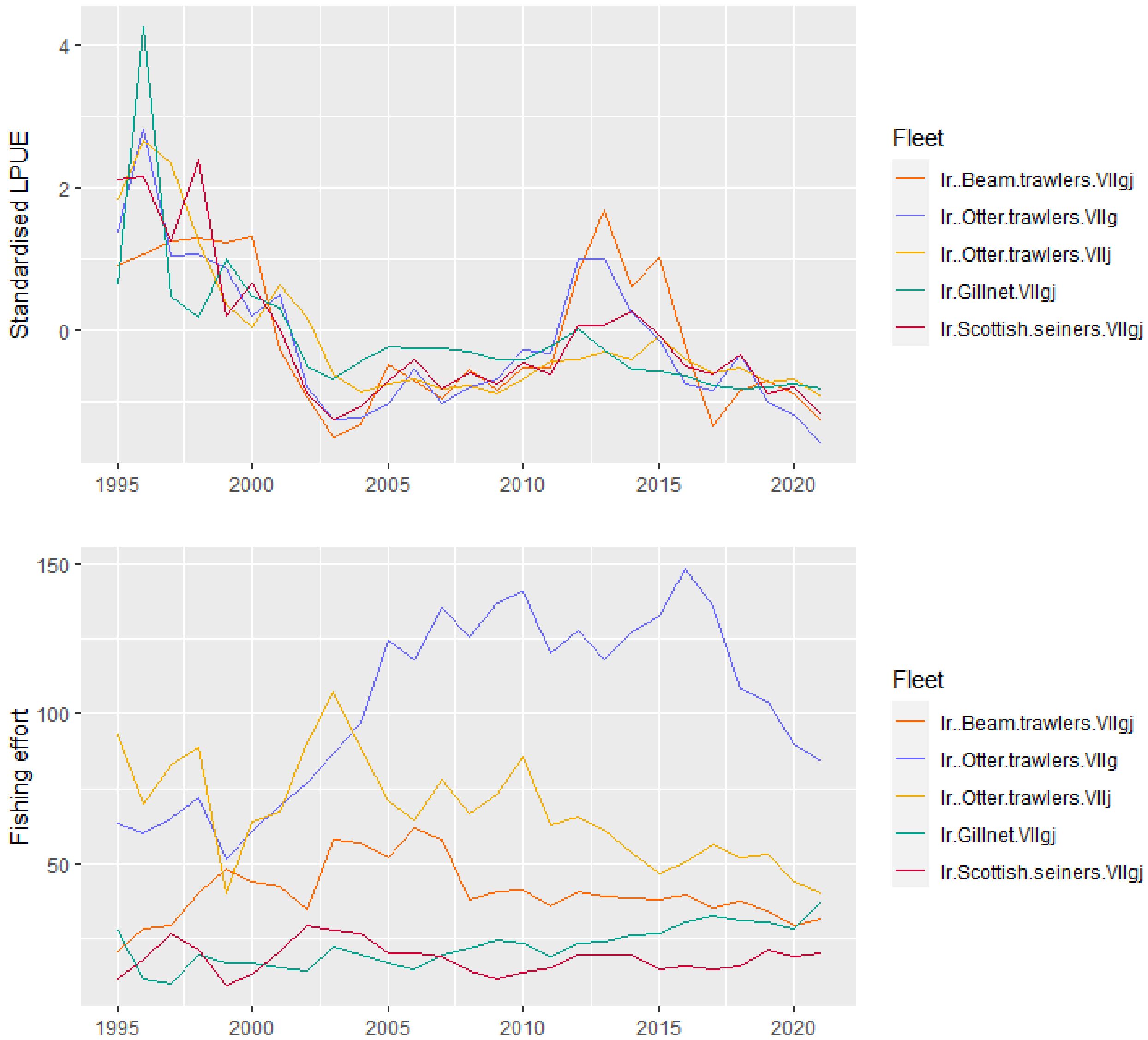


Figure 6.6b. Cod in Division 7e–k. Time-series of (a) LPUE and (b) fishing effort for the Irish fleets. Units: LPUE in kg/day fished and Effort in 000s hours fished.

Figure 6.6c. Cod in Division 7e–k. Time-series of LPUE and fishing effort for the UK fleets. Units: LPUE in kg/day and fishing effort in days fished.

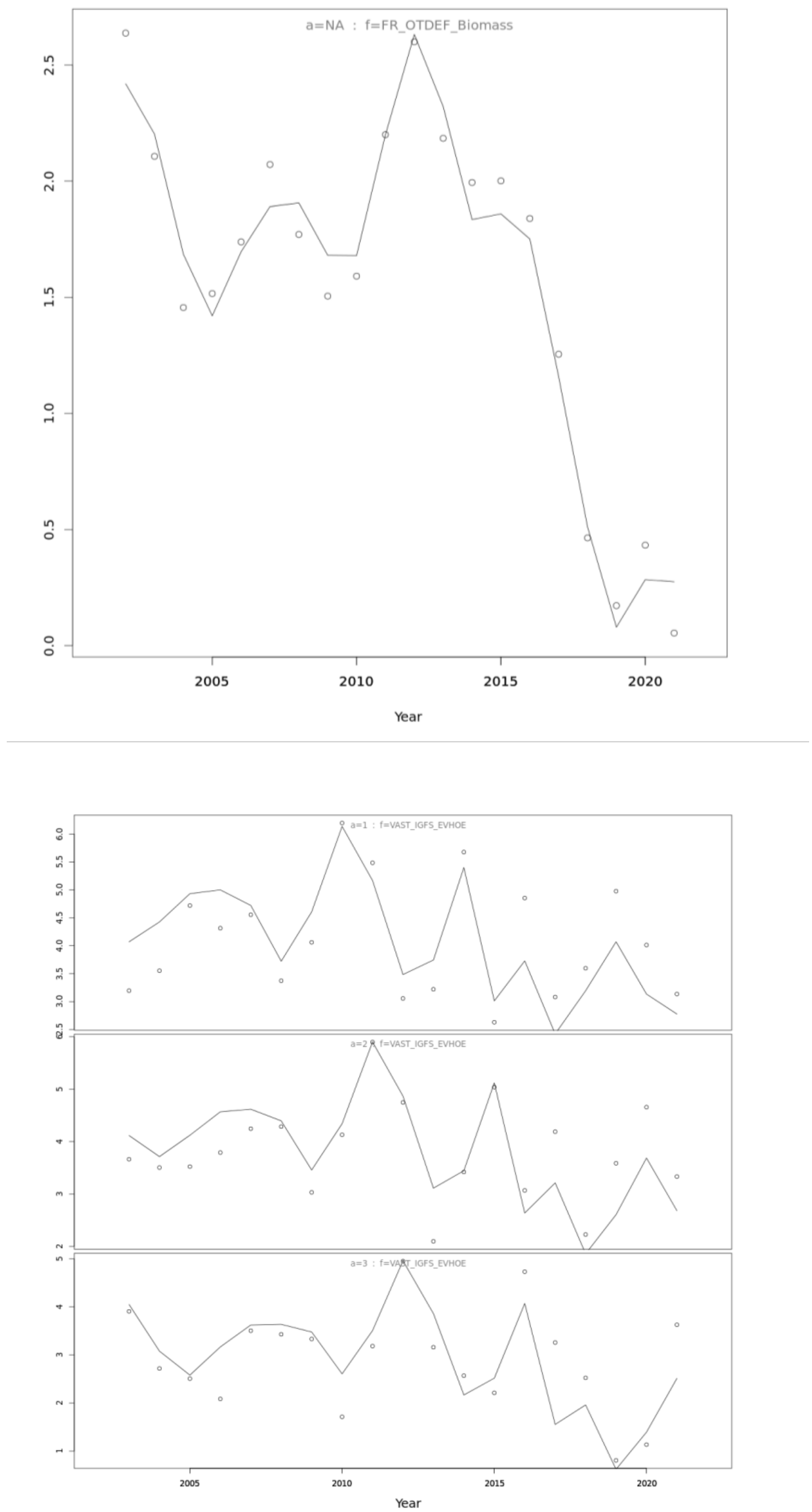


Figure 6.7. Cod in Division 7e–k. Fits of the tuning indices used in the assessment. Commercial tuning fleet corresponds to French OTDEF Q2+3+4 as biomass index. The survey index is a combined index based on both French IR-GFS and FR-Evhoe Q4 data where mean number-at-age are modelled using VAST.

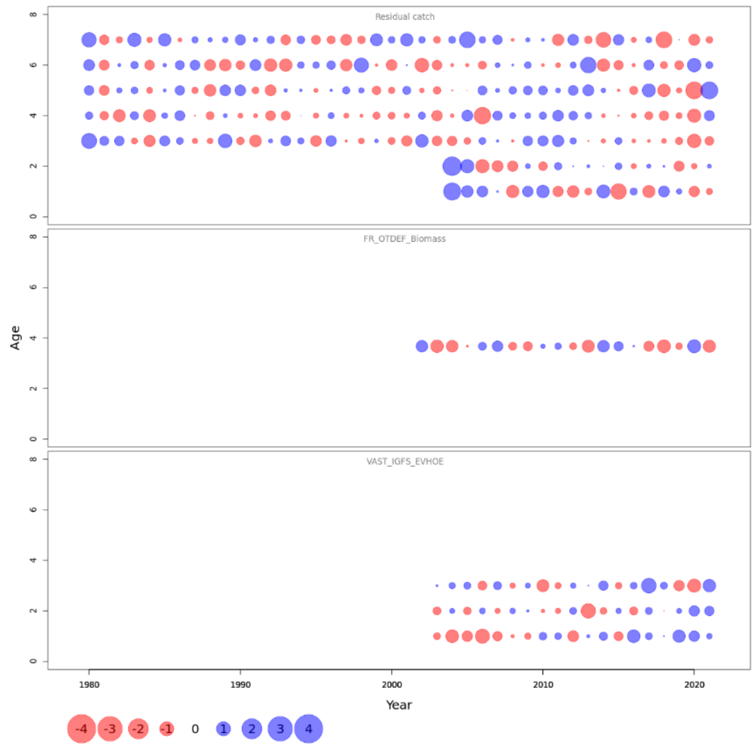


Figure 6.8. Cod in Division 7e–k. Final assessment. Residuals.

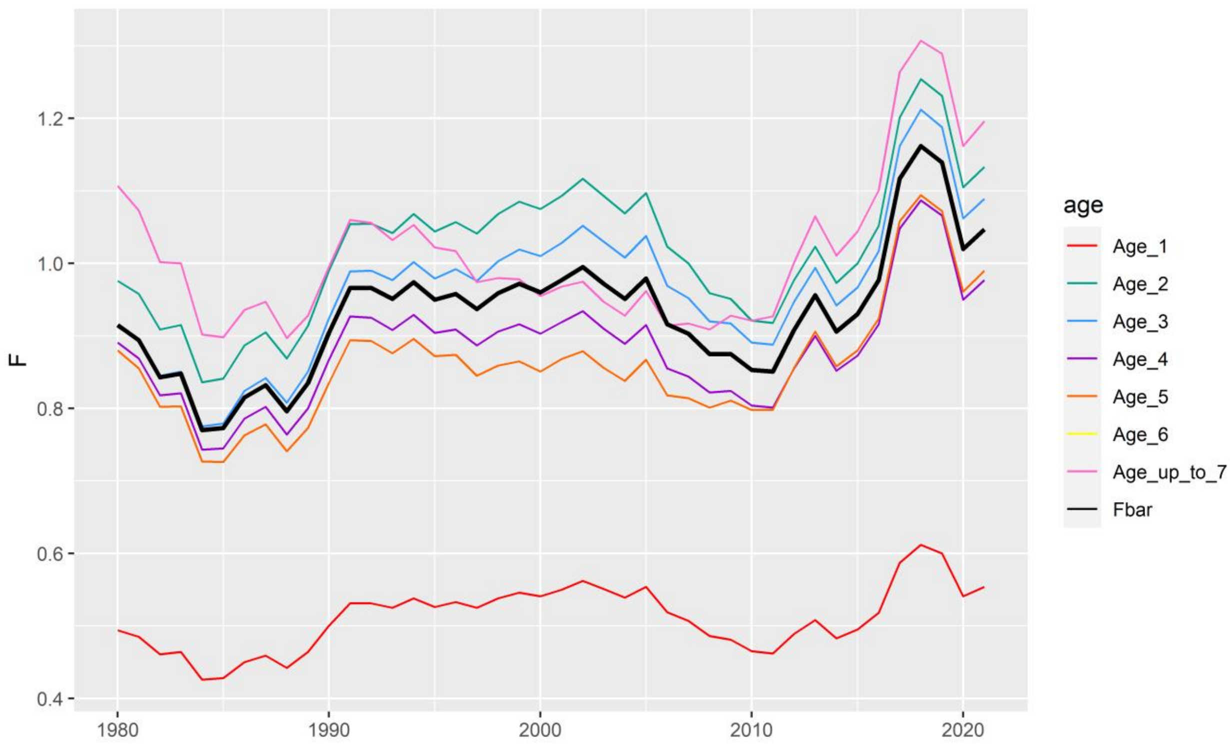


Figure 6.9. Cod in Division 7e–k. Fishing mortality.

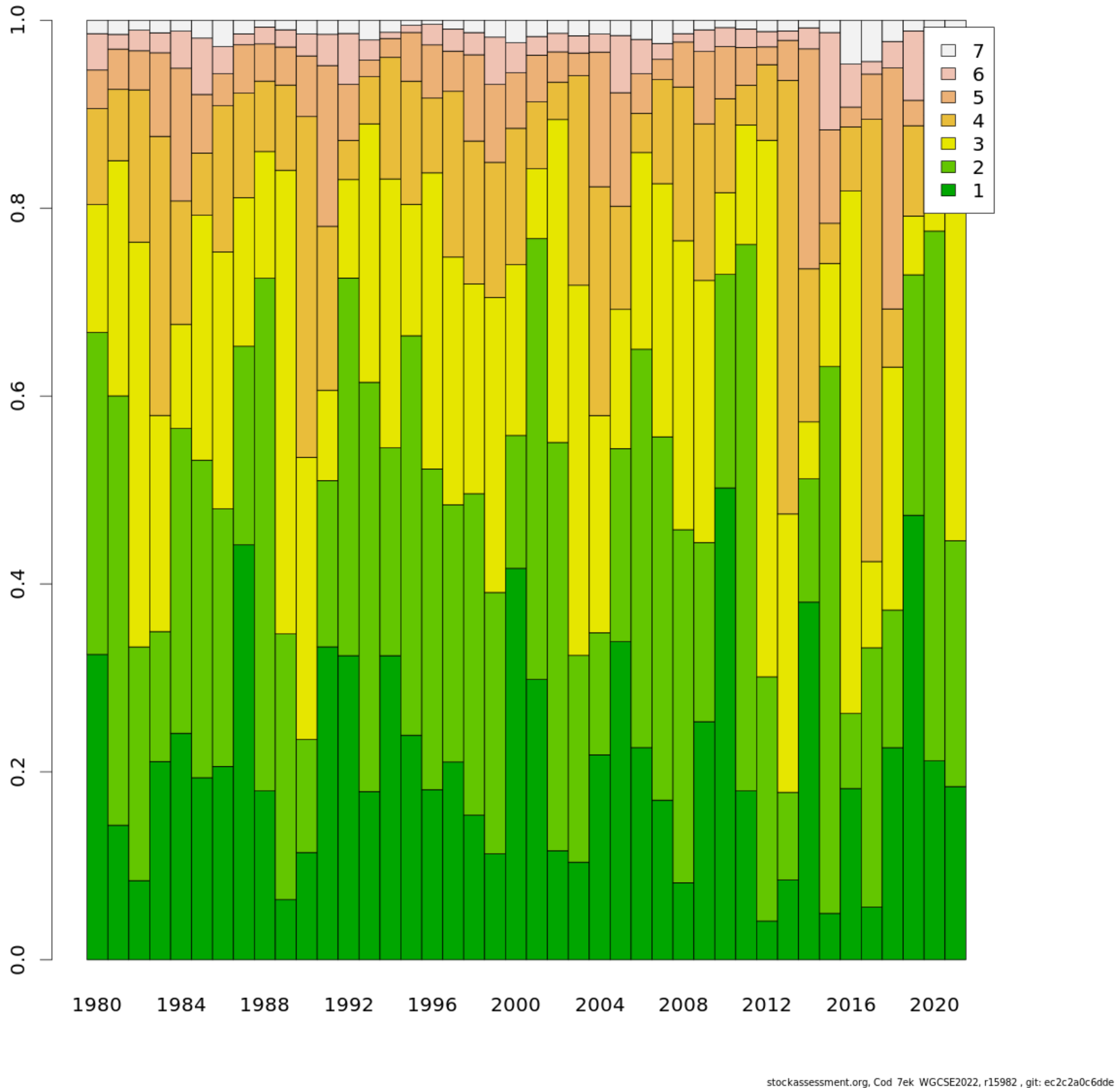
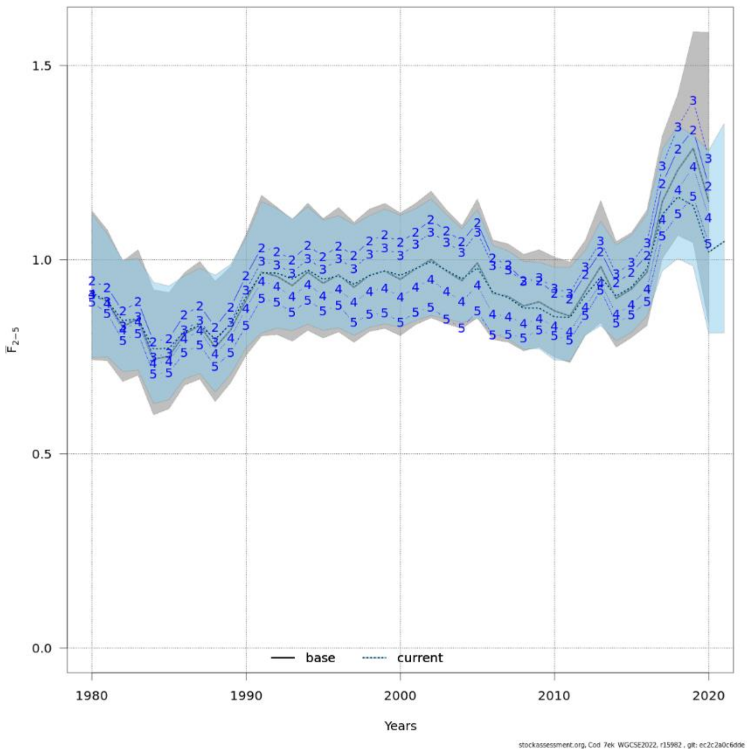


Figure 6.10. Cod in Division 7e–k. Final SAM outputs. Catch proportion-at-age. Age 0 are not included in the assessment.


1.5
1.0
0.5
0.0
$\bar{F}_{2-5}$
base
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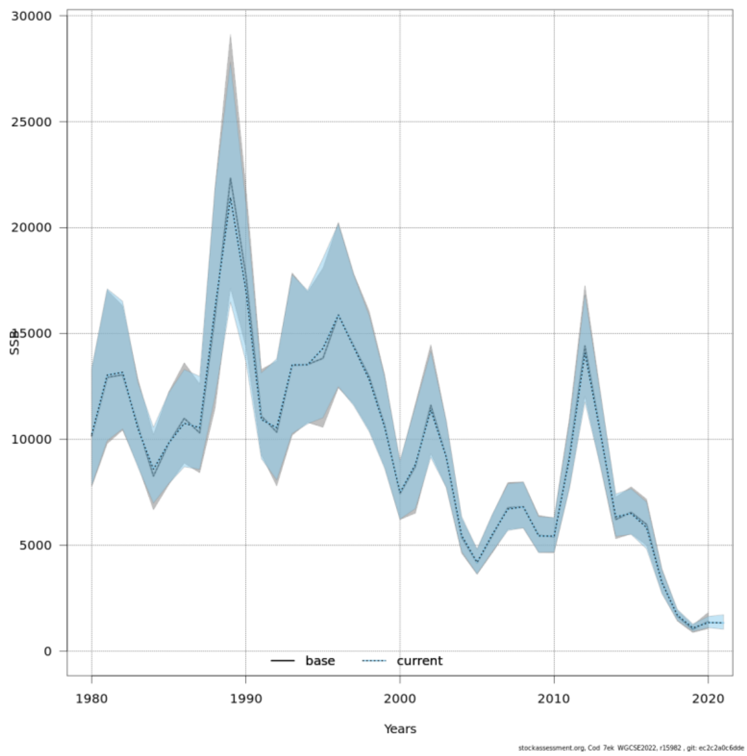
1980
1990
2000
2010
2020
Years
stockassessment.org, Cod 7ek WGCSE2022, r15982 , git: ec2c2a0c6dde


30000
25000
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SSB
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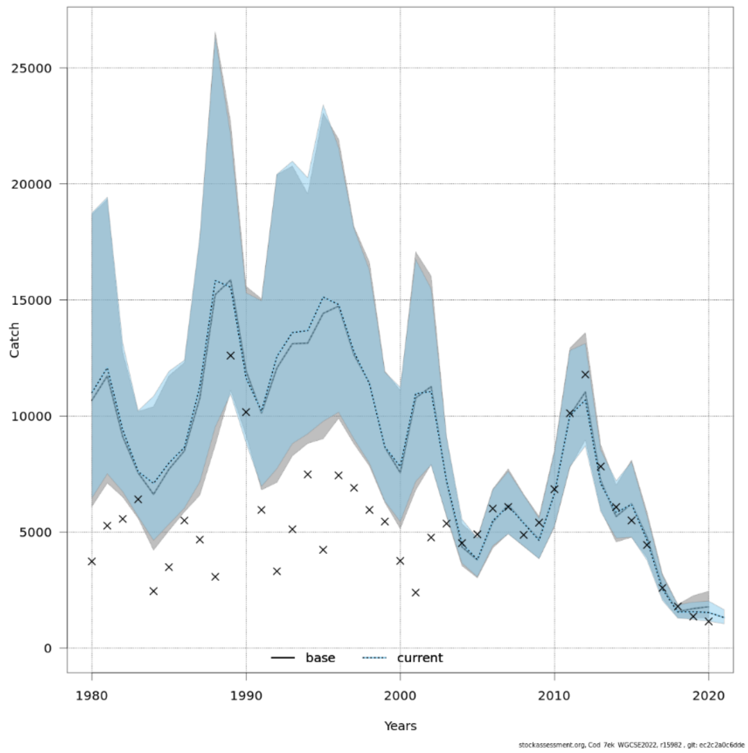
Years
stockassessment.org, Cod 7ek WGCSE2022, r15982 , git: ec2c2a0c6dde



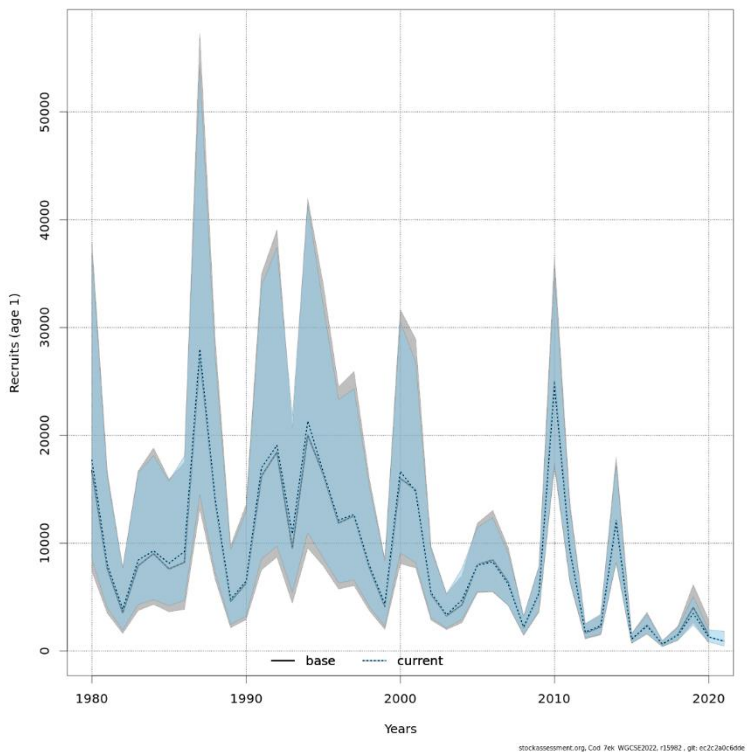
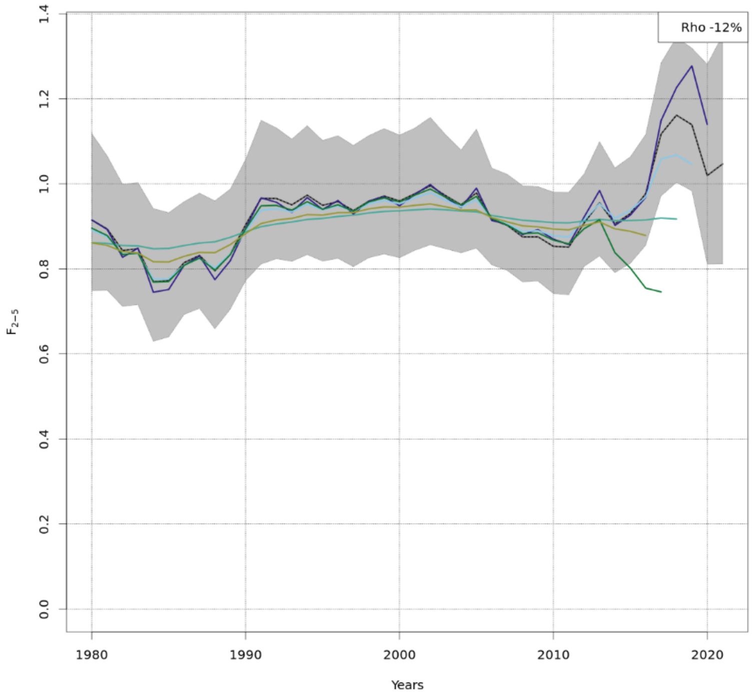


Figure 6.11. Cod in Division 7e–k. Final SAM outputs. SSB, F, R and catches estimates.



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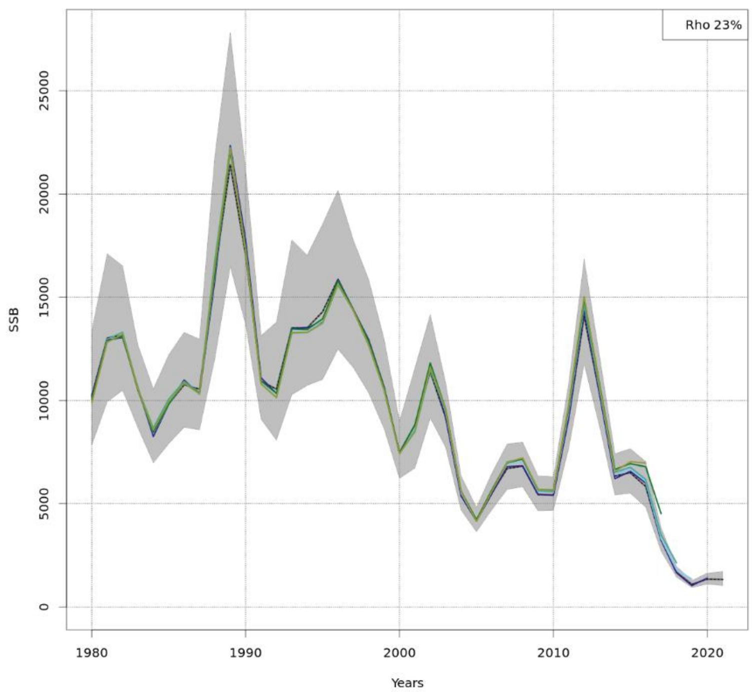


stockassessment.org, Cod 7ek WGCSE2022, r15982 , git: ec2c2a0c6dde

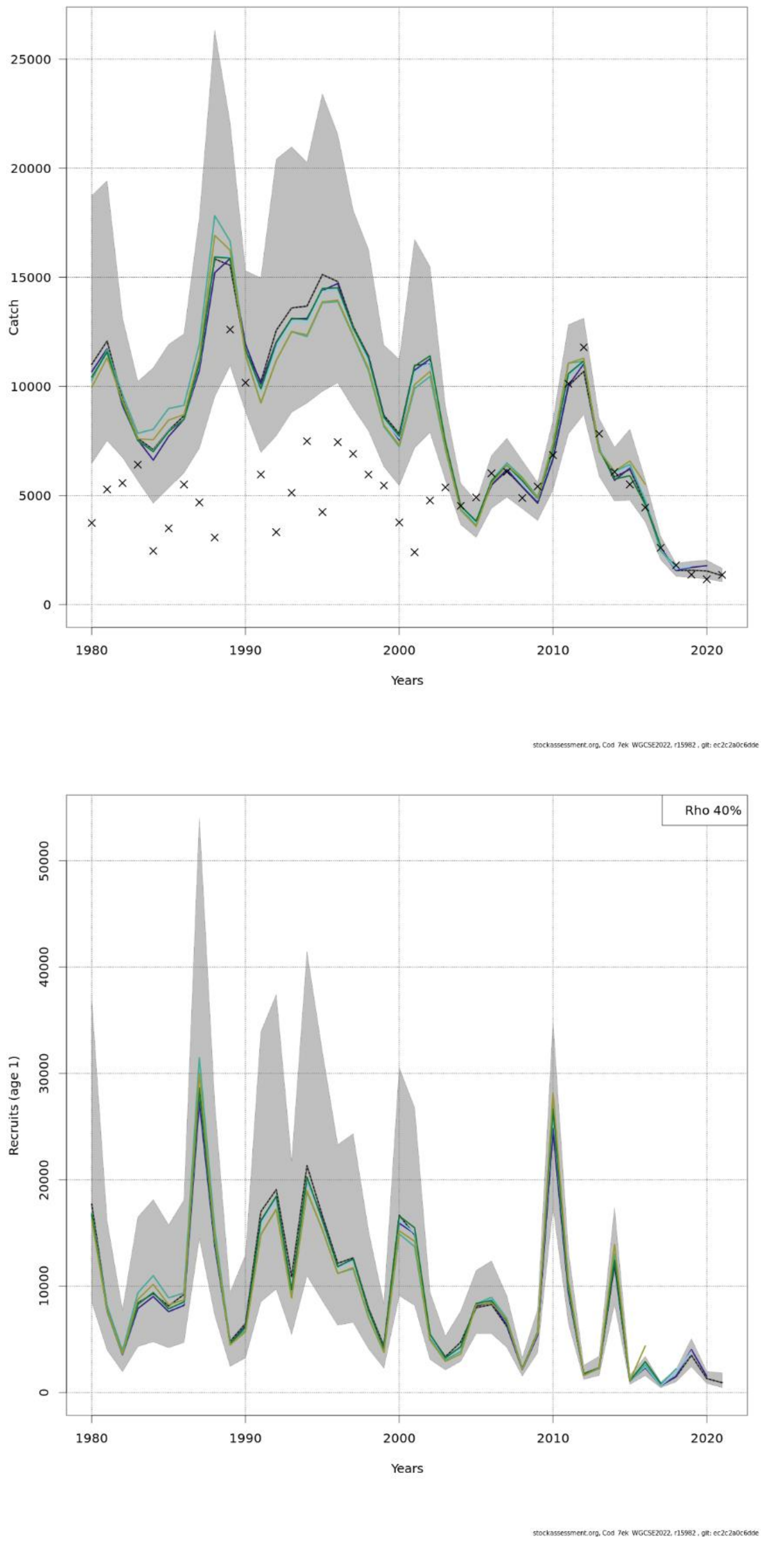
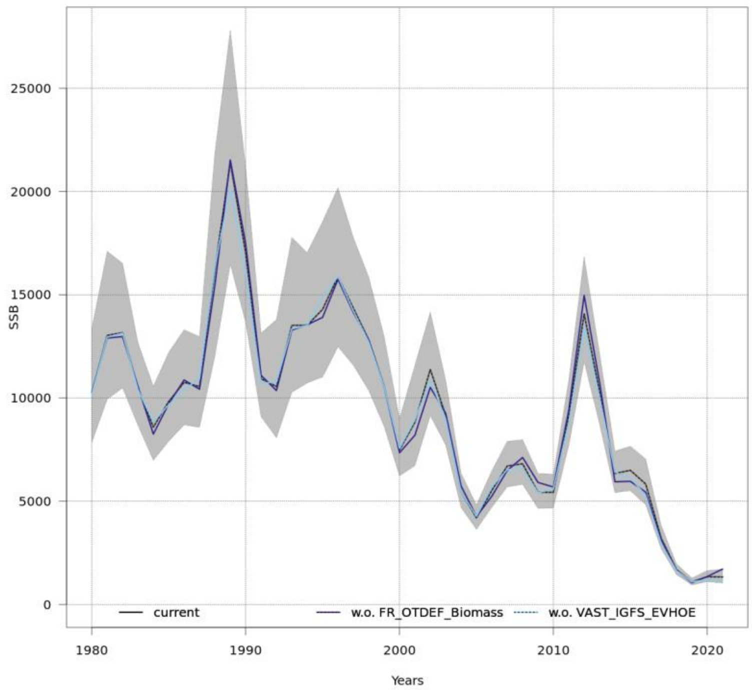
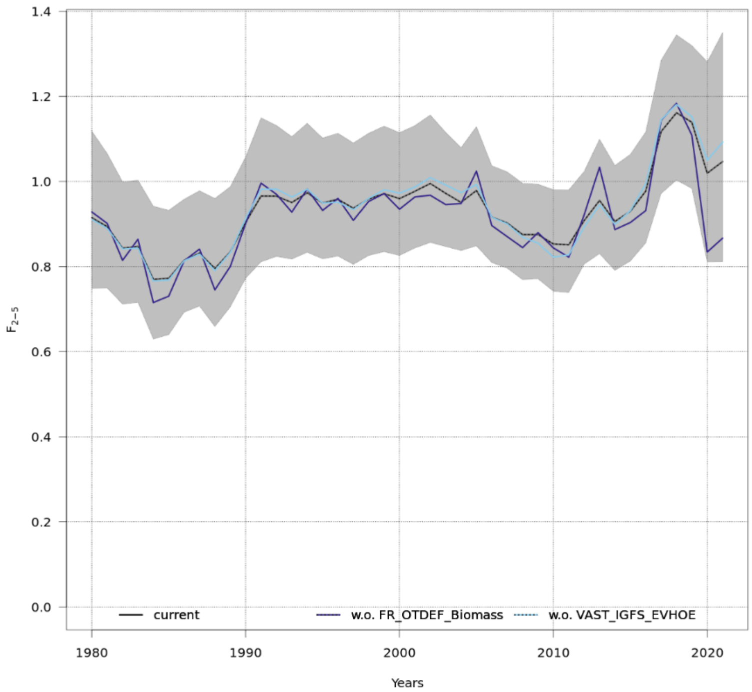


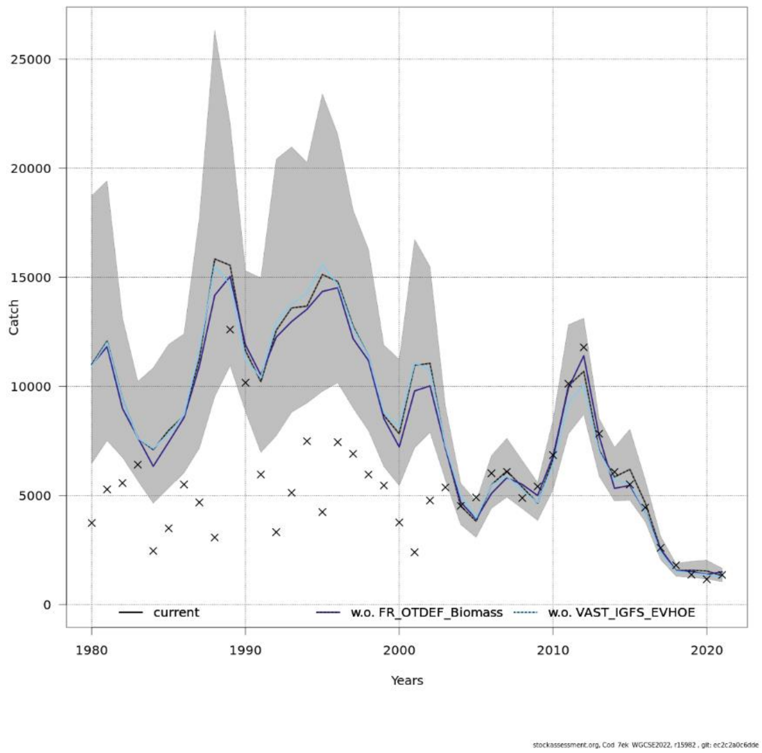
Figure 6.12a. Cod in Division 7e–k. Final SAM. Retrospective plots.



stockassessment.org, Cod 7ek WGCSE2022, r15982 , git: ec2c2a0c6dde



stockassessment.org, Cod 7ek WGCSE2022, r15982 , git: ec2c2a0c6dde



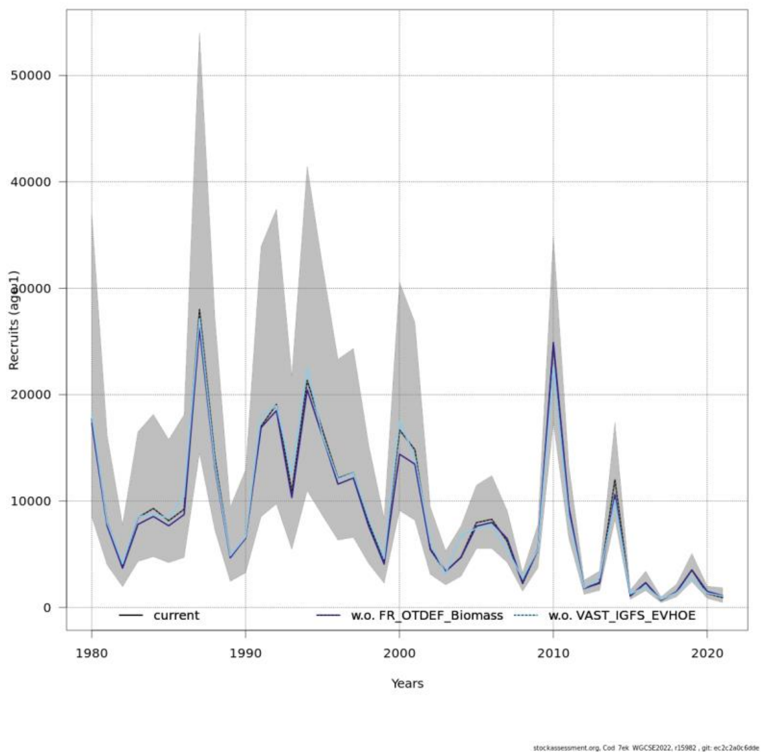


Figure 6.12b. Cod in Division 7e–k. Final SAM. Comparison between runs (runs with the two tuning indices, with only the survey index and with only the commercial tuning index).

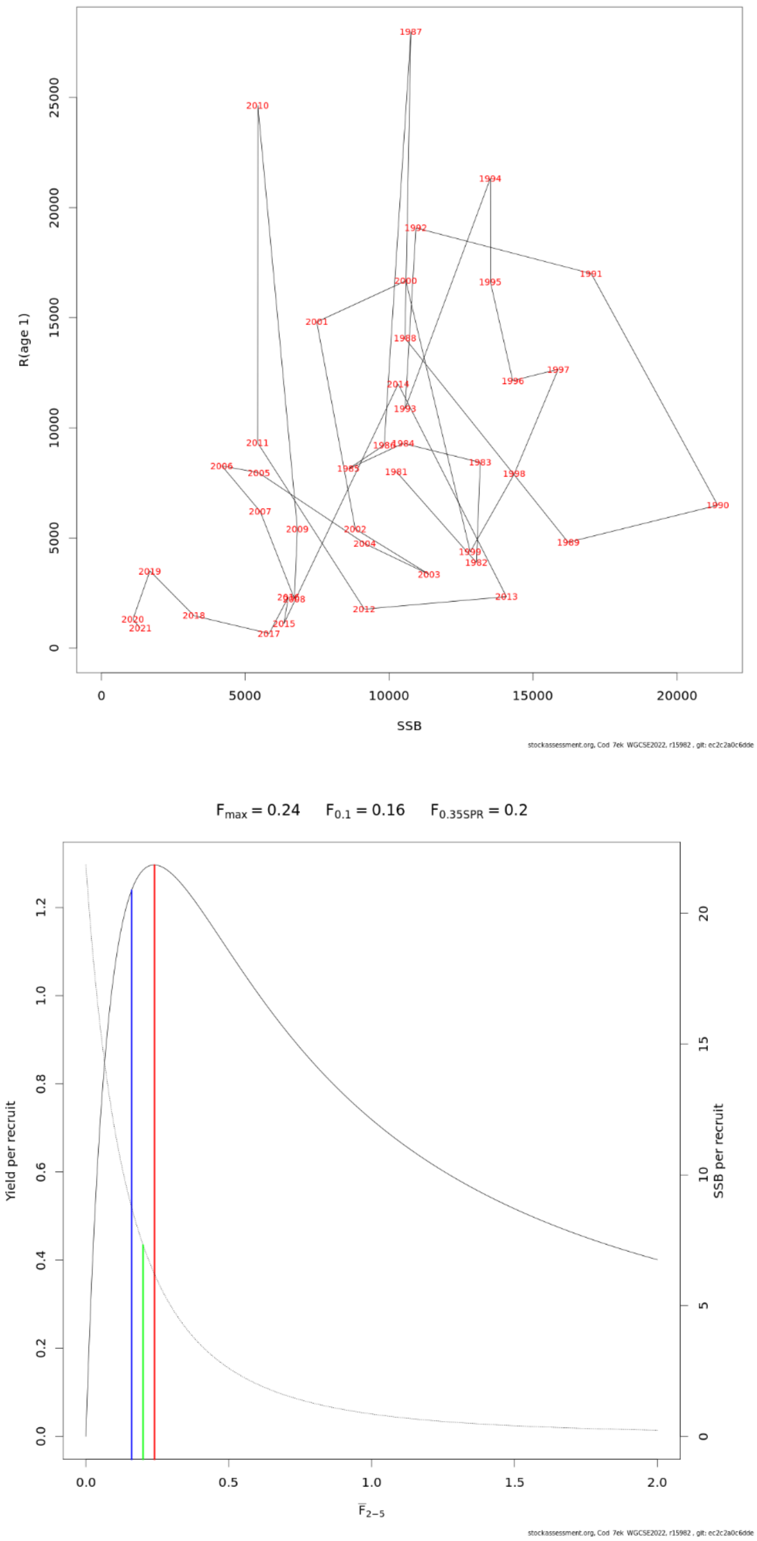


Figure 6.13. Cod in Division 7e–k. Stock–recruitment plots and yield per recruit information.

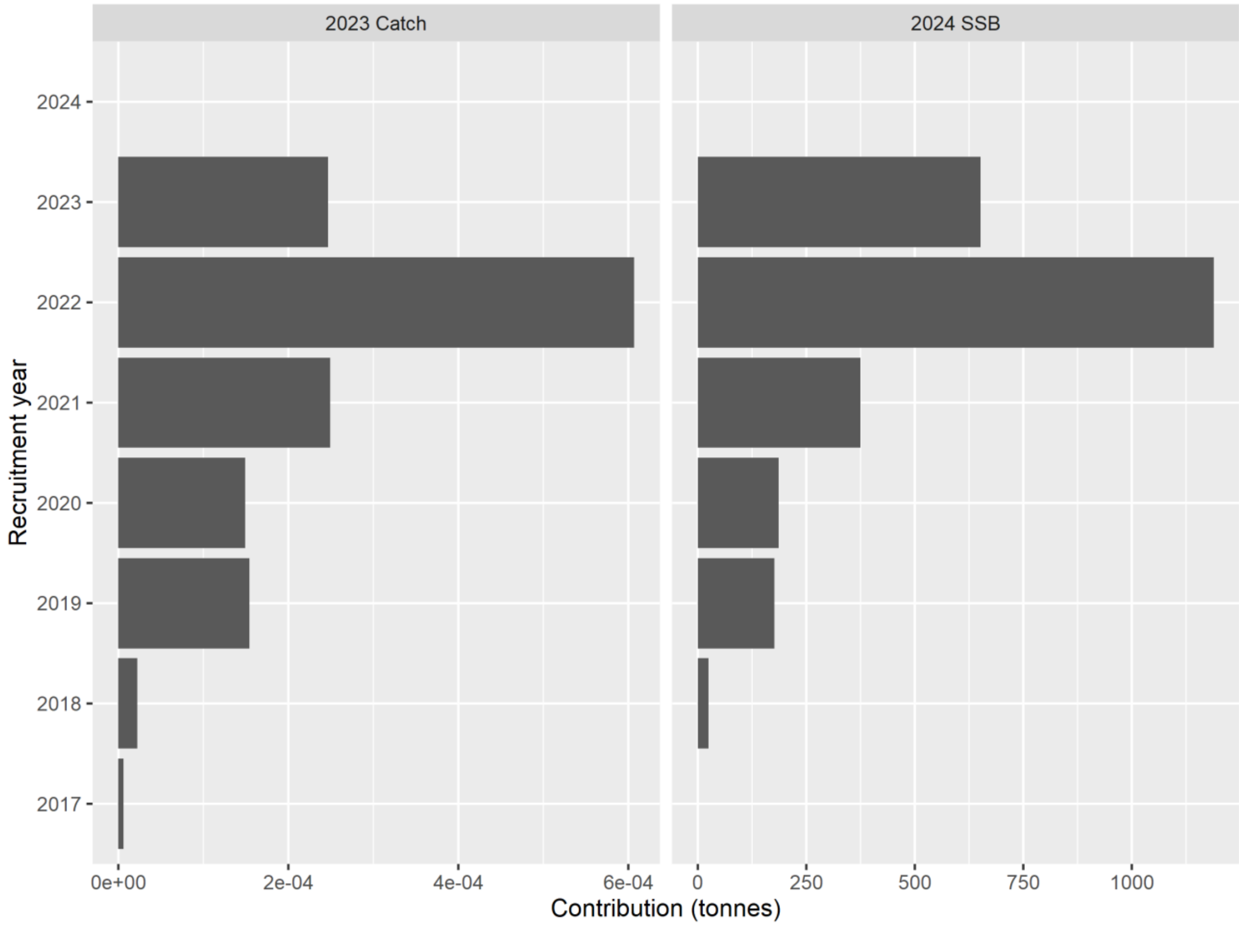


Figure 6.14. Cod in Division 7e–k. Forecast (a) yield in 2023 and (b) SSB in 2024.

7 Haddock in Division 6.b (Rockall)

7.1 Introduction

In previous years an age-structured assessment model has been used to provide advice as a category 1 stock. This year, methods to update the previously utilised survey index were unavailable and the agreed assessment (and forecast) could not be carried out. Consequently, the assessment this year is based on a new biomass index derived from the Rock-WIBTS-Q3 as an indicator of stock size and a mean catch length indicator as a proxy for fishing pressure (under a category 3 approach). The WG considers this to be a temporary measure until such a time as a benchmark for this stock can be scheduled.

The derivation of the biomass index and the estimation of data/parameters required for the length indicators are described in further detail below.

7.2 General

Advice

ICES advice has been provided on the basis of the MSY approach since 2014. Last year's advice was for catches of no more than 5825 tonnes (for 2022).

Stock description and management units

The haddock stock at Rockall is considered to be 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 2021 and 2022

The TAC is set for the UK, EU and international waters of 6b, and international waters of 12 and 14. For 2021 and 2022, the breakdown by country is given below:

TAC 2021

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	United Kingdom, Union and international waters of 6b; international waters 12 and 14 (HAD/6B1214)
Belgium	16	Analytical TAC	
Germany	19	Article 8(2) of this Regulation applies	
France	799		
Ireland	570		
Union	1 404		
United Kingdom	6 971		
TAC	8 375		

TAC 2022

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	United Kingdom, Union and international waters of 6b; international waters of 12 and 14 (HAD/6B1214)
Belgium	12	Analytical TAC	
Germany	12	Article 8(2) of this Regulation applies	
France	542		
Ireland	385		
Union	951		
United Kingdom	4 874		
TAC	5 825		

The ICES advice, agreed TAC for EU waters, and WG estimates of landings during 2002–2021 are summarised below. All values are in tonnes.

YEAR	Predicted catch corresp. to advice	Predicted landings corresp. to advice#	BASIS	AGREED TAC [a]
2002	< 1300		Reduce F below 0.2	
2003	-		Lowest possible F	
2004	-		Lowest possible F [b]	702
2005	-		Lowest possible F [b]	702
2006	-		Lowest possible F [b]	597
2007	< 7100		Reduce F below F_{PA} [b]	4615
2008	< 10640		Keep F below F_{PA} [b]	6916
2009		< 4300	No long-term gains in increasing F [b]	5879
2010		< 3300	Little gain on the long-term yield by increasing F [b]	4997
2011		<2700	Reduction in F is needed to keep SSB to above B_{PA} in 2012	3748
2012		< 3300	MSY approach	3300
2013	0	0	No directed fisheries, minimize bycatch and discards	990
2014	<1620	<0980	MSY approch	1210
2015	<4310	<2930	MSY approch	2580
2016	< 3932	< 3225	MSY approach	3225
2017	≤ 4690	≤ 4130	MSY approach	4690
2018	≤ 5163		MSY approach	5163
2019	≤10469		MSY approach	10469
2020	≤10472		MSY approach	10472
2021	≤6239		MSY approach	8375
2022	≤5825		MSY approach	5825

[a] Prior to 2014, the TAC was set for Divisions 6.a and 6.b (plus 5.b, 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.

The minimum conservation reference size of haddock taken by EU and UK vessels at Rockall is 30 cm. There is no minimum landing size for haddock taken by non-EU/UK vessels within 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, Section A.3). The protected area (the whole rectangle) is referred to as the Rockall Haddock Box. In 2022, in response to a request for advice from NEAFC on the efficiacy of the closure to protect juvenile haddock, ICES concluded the following:

The Rockall Haddock Box does coincide with areas of high juvenile and adult haddock densities, with high densities also observed outside the box to the northeast. For most years since the closure, haddock densities of age classes 1+ have been higher inside than outside the box. The overall impact of the current closure area on the Rockall haddock stock continues to be difficult to assess

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, Section A.3). A new area to protect cold-water corals (Empress of Britain Banks) was established by the NEAFC in 2007 and 2012.

Since 2009 in NEAFC regulatory area, including international waters of Rockall, a discard ban was established. The fishery for haddock within EU/UK waters is under the landing obligation.

There is no agreed management plan for haddock in this area. Two management strategies (NEAFC and EU MAP) have been assessed to be precautionary. NEAFC requested ICES to evaluate the harvest control rules (HCRs) that use F_{MSY} as a target. ICES concluded that the NEAFC HCRs in the long-term management strategy for Rockall haddock were consistent with the precautionary approach (ICES, 2019a).

The multiannual management plan (MAP) which has been adopted by the EU for this stock (EU, 2019) has not been agreed with UK.

Fishery in 2021

Russian fishery in 2021

No information was provided on the Russian fishery at Rockall in 2021. Total official landings of haddock at Rockall by the Russian Federation amounted to 20 t (Table 7.3.1).

UK fishery in 2021

A small number of larger Scottish demersal trawlers continue to target haddock at Rockall with the fishery largely conducted during the summer months and periods of good weather. Other important target species included anglerfish (*Lophius* spp.), ling, saithe and megrim. Total Scottish haddock landings in 6b have declined by over 40% since 2019. Quota uptake was also relatively low (<50%) in 2021 which may be related to availability of haddock (and quota) on less distant fishing grounds such as in Divisions 6a and 4a. In 2021 there was a significant increase in the proportion of UK landings taken in international waters (almost 30% in 2021 compared to an average of 15% over 2018-2020). (Table 7.3.2).

Irish fishery in 2021

Reported landings by Irish vessels decreased in 2021 compared to 2020 (Table 7.3.1), although as for UK vessels there was an increase in the proportion of landings being taken in the NEAFC area. Irish vessels used single otter trawls with a mesh size ranging from 100 to 120 mm together with a square mesh panel.

7.3 Data

Landings

Nominal landings as reported to ICES are given in Table 7.3.1 and shown in Figure 7.3.1, along with Working Group estimates of total estimated landings. Revisions to official catch statistics for previous years are also shown in Table 7.3.1. Some data previously submitted are now no longer or only partially available due to national data confidentiality clauses (Ireland in 2018 and 2019). As has been the case for over 10 years, the majority of the reported landings come from the UK (almost 90% in 2021) with smaller amounts reported by Ireland and the Russian Federation.

Data for the NEAFC area only (Sub-division 6b.1) are also shown in Table 7.3.1 and in Table 7.3.2 by nation. Up to 2019, these area taken from the official landings statistics. For 2020 and 2021, the estimates are a mixture of official landings and landings from Intercatch as landings for the UK are not available split by sub-division in the preliminary official landings data. In some years, Russian landings are reported as being from 27.6b_NK (i.e. unknown sub-division), however it is assumed that all these landings have been taken in the NEAFC area (i.e. sub-division 27.6.b.1). The proportion of the total landings coming from international waters is almost 30% in 2021, a substantial increase compared to 2019 and 2020.

Anecdotal evidence suggests that misreporting of haddock from Rockall has occurred historically (particularly on fishing trips where vessels fish in both Division 6a and 6b), but a quantitative estimation of the degree of misreporting is not possible.

Landings data submitted to Intercatch are shown in Figure 7.3.2. Russian Federation landings were not submitted by the national data submitter for 2021, however a comparison of historical official landings and ICES estimates suggested the two to be consistent and therefore ICES estimated landings for the Russian Federation were assumed equal to the official reported landings for 2021 (and subsequently imported to Intercatch).

International age composition and mean weight-at-age in the landings were compiled according to the methods described in the Stock Annex. Landings age compositions were allocated to unsampled fleets using a weighted average of all sampled fleets (excluding the Russian fleet which retain all landings on board). The weighting algorithm used is 'Mean weight weighted by numbers-at-age or length'.

The need to use a data limited approach for the assessment and advice this year meant that length frequency data also had to be processed. Landings length compositions were allocated to unsampled fleets in the same manner as age compositions. Data were processed in InterCatch for 2012 onwards.

BMS landings

In 2016, Below Minimum Size (BMS) landings (subject EU landings obligation) were negligable at 0.4 t. In 2017 and 2018 BMS landings were not reflected in the catch statistic. 4 t of BMS landings were reported in 2019, 2 t in 2020 and < 1 t in 2021. The assessment includes BMS landings within total landings (although these unsampled data are allocated age/length compositions from sampled discards).

Discards

Haddock at Rockall have lower size-at-age than haddock from other areas (Blacker, 1971; Khlivnoy, 2006; Filina, Khlivnoy and Vinnichenko, 2009). Historically, the discard rate was as high between 12 and 75% by weight according to the results of discards trips (see the Stock Annex). The methods used to reconstruct the historical time-series of discards when sampling data were insufficient or unavailable is described in the Stock Annex.

At the 2019 benchmark, the catch-at-age data from 2012 onwards were re-estimated in InterCatch. The two main fleets (UK(Scotland OTB_DEF_>=120 and Irish OTB_DEF_100–119) are t sampled for both landings and discards. Discard rate allocation to other unsampled fleets consisted of:

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

Discards age and length compositions are allocated to unsampled fleets in a similar manner to landings age/length compositions. This process has been conducted annually since the 2019 benchmark.

Figure 7.3.3 shows estimated landings and discards for 2021 after raising. Scottish landings data are submitted to InterCatch by sub-division with sampling available only for sub-division 6.b.2 and hence there are raised discards associated with this component of the landings. The final mix of numbers-at-length from sampled and un-sampled landings and sampled and raised (unsampled) discards is given in Figure 7.3.4. The unsampled landings and unsampled raised discards are both associated with the Scottish landings from sub-division 6.b.1.

During the 2019 benchmark meeting, the discards data for 2010 were also revised. The discards were calculated on average discards proportion of total catch but prior to the 2019 benchmark, the discards only for 2010 were calculated on that proportion applied to the landings (not total catch). The benchmark concluded that the previous method applied for 2010 was incorrect, as discards proportion is relative the total catch. Since 2019 in correct assessment, the discards for 2010 were calculated based on the discards numbers in 2009 at-age recalculated using the ratio between total landings in 2009 and 2010 (by numbers).

The WG estimates of total landings and discards by weight are given in Table 7.3.3 and shown in Figure 7.3.5. In recent years, the total discard proportion by weight (Figure 7.3.6) has shown substantial variability but is typically below 20% (21% in 2021). This is substantially lower than the estimated discard proportion at the start of the time series when the Scottish fleet was generally utilising a smaller mesh size.

Due to the distant nature of the fishery and the fact that there are relatively few vessels/trips making landings, sampling levels for both landings and discards for this stock are relatively poor. Sampling levels did not significantly worsen during the COVID-19 pandemic and the WG considers that sampling levels are adequate for the estimation of catch length-based indicators.

Age- and length-compositions and mean weights-at-age

Raised landings numbers-at-age and discard numbers-at-age are given in Tables 7.3.4 and 7.3.5 respectively and total catch numbers-at-age in Table 7.3.6. Although these are not required for the data limited approach utilised this year, they are included here for completeness.

The catch-at-length compositions which are used to derive length based indicators for the data limited approach utilised this year are shown in Figure 7.3.7.

Annual mean weights-at-age in landings, discards and catch are given in Tables 7.3.7, 7.3.8 and 7.3.9 and shown in Figure 7.3.8. Mean weights-at-age in the landings (and catch) were relatively stable historically, but show a significant increase since the mid-2000s, particularly at ages 4 and above, as well as showing increased variability. While the variability may be due to low sampling levels, the reason for the trend is not known, but could potentially be due to cohort dependent growth rates although this has not been fully explored.

Biological

There was no change in natural mortality and maturity compared last year's assessment (see the Stock Annex) although neither are used in the data limited approach employed this year.

Historically, stock weights-at-age were assumed to be equal to the raw catch weights. However, the number of sampled trips for both landings and discards has been low for a number of years and this appears to have led to substantial variability in the mean weight-at-age estimates. For this reason, at the 2019 benchmark, it was agreed that five year rolling average catch mean weights-at-age should be used as stock mean weights-at-age. These are given in Table 7.3.10.

As a check on the trends in the stock mean weights-at-age derived from catch mean weights-at-age, mean weights-at-age were also derived from survey data and a comparison made (Figure 7.3.9). Survey mean weights-at-age are calculated by i) estimating an annual length-weight relationship (from the samples in the DATRAS 'CA' data), ii) calculating individual weight-at-length using the length-weight parameters, iii) deriving an annual length frequency –at-age by raising the ALK (from the 'CA' data) to the total length distribution (from 'HL' data), iv) calculating mean weight-at-age using the results of ii) and iii). (Pre 2011 an average weight-length relationship over all available years was used as no individual weight data were recorded in this period).

Although there are missing values in the survey data, values appear reasonably consistent with those from the catch and there is some evidence of an increase since the early 2000s (although more recently, survey estimates appear somewhat lower). For the derivation of the total biomass index used as the stock indicator, the stock mean weights-at-age 1-7 are derived from the catch mean weights as per previous assessment WGs (5 year rolling mean) while age 0 stock mean weights-at-age are derived from the survey as these are largely not available from the catch (and in the years they are available, estimates are likely to be impacted by gear selectivity).

Surveys

The Scottish Rock-IBTS-Q3 survey is the only survey available for this stock. The survey is coordinated by IBTS and described further in the IBTS reports, the Stock Annex and the 2019 benchmark report (ICES, 2019).

The survey originally began in the 1990s, but in 2011, a number of changes were made: the survey groundgear was changed from GOV-C to GOV-D and the survey changed from a fixed station design to random stratified covering a greater depth range than previously. Studies conducted in 2006 and 2009, comparing the catchability of the two groundgears (WD 5 in ICES, 2012a) suggested no significant differences in the catch rate of haddock. The assessment WG in 2012 (ICES, 2012b) proposed an approach which was agreed at the 2019 benchmark, whereby only the subset of survey stations occurring within the depth range of the original (pre 2011) survey were included in the post 2011 index calculation. This allowed the survey to be treated as a continuous time series in the assessment (known as the 'standard index'). This year, the WG was unable to recreate the calculation of the 'standard index' and therefore the 2021 index value could not be calculated according to this approach. Therefore, a new index was calculated according to the survey design.

In the new index calculation (2011 onwards), numbers at length per haul are standardised to numbers per hour towing (LFD). An ALK is calculated for each of the four strata and then this ALK is applied to the LFDs from each of the hauls separately to produce age frequencies for each haul. Finally, for each stratum, the age frequencies are summed and the values divided by the number of valid hauls to provide numbers at age per hour. This procedure can be summarised as

$$CPUE_{i,a} = \frac{\sum_{h=1}^{H_i} \sum_{l=l_{\min}}^{l=l_{\max}} N_{i,a,l,h}}{H_i}$$

where $N_{i,a,l,h}$ is the number of fish at age a and length l caught during haul h, H_i is the number of valid hauls in stratum i and $CPUE_{i,a}$ is the catch per unit effort of fish at age a in stratum i.

For each age, the age frequency for each stratum is raised by the stratum area. These raised frequencies are then summed and the result divided by the total area in the assessment region. The final index value for each age is given by

$$I_a = \frac{\sum_{i=1}^{S} CPUE_{i,a} A_i}{\sum_{i=1}^{S} A_i}$$

where A_i = area (m^2) of stratum i and S = number of strata. Survey variance estimates are calculated in a similar manner.

The old index (pre-survey change in 2011) is given in Table 7.3.11. The new index (estimate and variance) is given in Table 7.3.12. The previously used continuous 'standard index' is not presented but can be found in last year's WG report (ICES, 2021).

Plots of survey log cpue at age by cohort are shown in Figure 7.3.10 and comparative scatterplots of log index at-age are shown in Figure 7.3.11. The survey shows good internal consistency in tracking of year-class strength through time.

In Figure 7.3.12 compares the new (2011 onwards) index with that used in previous assessment WGs mean standardised over the common time period. The two indices show small differences, mostly confined to age 0 and the older ages, where the new index appears to be higher for the strong year classes.

Commercial Effort, Lpue and Cpue

Commercial effort data have previously been provided for Scottish, Irish and Russian fleets, along with lpue and cpue data respectively. These data have not been updated in recently years and have not been used for assessment purposes and are therefore not included here (See 2020 WG report for data).

7.4 Derivation of stock indicators

Survey index

The biomass index for use in the data limited approach to advice was derived as the sum of products of the survey numbers-at-age (Table 7.3.12) and stock mean weights-at-age (Table 7.3.10). The index is shown in Figure 7.3.13 (and Table 7.3.13) in comparison and broken down by age class in Figure 7.3.14. The survey biomass index increases from its lowest value at the start of the time series and shows a general decline since 2018. The SSB from the 2021 assessment also shows an increase although this does not begin until after 2014 when the individuals are mature (knife edge maturity at age 3 assumed in the assessment).

Growth parameter estimation

Rockall haddock is a poorly studied stock and there is limited published information on individual growth. Fishbase quote a value of L_∞=43.8 cm and k=0.269 for von Bertalanffy growth parameters for 'Rockall Island' based on Blacker (1971), although the latter publication does not appear to contain these values or the data source from which they are derived, but indicates that this stock is slower growing than others. Fishbase also contains a range of estimates from other haddock stocks around the UK (Figure 7.3.16). There are multiple L_∞ values for North Sea haddock which range from 48 cm to 74 cm and the diversity of values may be associated with cohort dependent growth which is believed to occur in haddock stocks (due to varying cohort size and associated resources).

Given that the Scottish Q3 Rockall haddock survey data contains a substantial amount of length and age sampling, von Bertalanffy growth parameters were estimated using these data. Although it is acknowledged that deriving growth parameters based on length-stratified age samples (the 'CA' data in Datras) results in biased estimates (Perreault et al., 2020) there appears to be no agreed approach as to how best to account for the overall length frequency data in the calculation. The approach taken here was to calculate the length given age (using 'CA' and 'HL' data from Datras) and use a weighted nls regression with each length weighted according to the proportion at length given age. (such that proportions sum to 1 for each age). All survey data from 1999 onwards were included and vB parameters were estimated for each cohort separately for cohorts with more than 6 age classes. Figure 7.3.15 shows the fitted vB curves and length-age data points (although the weighting of each point is not shown). It is clear from this figure that when there are no age zero data points, the k value cannot be estimated correctly (much too small) resulting in an almost linear vB curve with very high L_∞. However, it is also clear that there is significant variability in estimates between cohorts. The WG therefore agreed to take the median L_∞ (55 cm) and k (0.24) values forward for use in the data limited approach. These values are compared to those in Fishbase in Figure 7.3.16. The value is around the middle of the other estimated values while L_∞ appears to be towards the lower end of the range of values (but higher than the previously quoted value for Rockall haddock).

Length-based indicator

Initially annual estimates were made for Lc and $L_{F=M}$ (assuming Linf=55) and are shown in Table 7.3.14. The annual estimate of Lc is calculated as the lower boundary of the length class which has length frequency at half the maximum (i.e the half the frequency at the modal length). The last 5 years (2017-2021) was taken as the period over which to calculate Lc for use in the length-based indicator (and associated reference point) calculation. During this period, catch length frequency data do not appear to be too noisy (Figure 7.3.7) and the stock consists of the full range of lengths (i.e. recruitment has been reasonable over a number of years). Averaged over 2017-2021, Lc=31.6 and the resulting length-based indicator reference point, $L_{F=M}$ = 37.4 cm. The mean length of individuals > Lc (31.6cm) in the catch was then calculated on an annual basis. The resulting mean length estimates (and LBI i.e. values relative to the $L_{F=M}$ reference point) are given in Table 7.3.15. LBI values are greater than one for the whole time series for which they are available which suggests that the stock is being fished below FMSY.

The development of the indicators in relation to their reference points is shown in Figure 7.3.17.

7.5 Derivation of data limited reference points

The only reference points used in the assessment this year are those associated with the data limited approach. MSY Btrigger is defined from the lowest observed survey index (66.764 kg hr^{-1} in 2011). The fishing pressure proxy indicator (length-based indicator) is always given in relative terms and therefore the indicator reference point value is 1. The MSY proxy reference length

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	93.5	Biomass index trigger value ($I_{trigger}$), defined as $I_{trigger} = I_{loss} \times 1.4$, where I_{loss} is the lowest observed historical biomass index value from 2011. In kg per hour.
	$F_{MSY\ proxy}$	1	$L_{mean}/L_{F=M}$; Mean catch length divided by MSY proxy reference length ($L_{F=M}$ = 37.4 cm).

7.6 Application of the advice rule

The ICES data limited approach for category 3 stocks was applied. According to the new WKLIFE approach, given that this stock has a von Bertalanffy k value between 0.2 and 0.32, the ‘rfbm’ rule with m=0.9 is applied. The WG considered that recent catches have not been too different compared to the advice and therefore the starting point for the application of the rule was last year’s advice. This rule uses the application of a multiplier based on the recent trend in a stock biomass index (r), the fishing pressure proxy (f), a biomass safeguard (b) and a precautionary multiplier (m). The stock has declined by 38% in recent years, however, it is still well above the Itrigger value and therefore the biomass safeguard is 1. In this case the stability clause is applied to limit the decline in advice to 30%.

Previous catch advice Ay		5825 tonnes
Stock biomass trend		
Index A (2020, 2021)		401 kg hr^{-1}
Index B (2017, 2018, 2019)		646 kg hr^{-1}
r: Index ratio (A/B)		0.62
Fishing pressure proxy		
Mean catch length (Lmean = L2021)		39.0 cm
MSY proxy length (LF = M)		37.4 cm
f: multiplier for relative mean length in catches ($L_{mean}/L_{F = M\ 2020}$)		1.04
Biomass safeguard		
Last index value (I_{2021})		446 kg hr^{-1}
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		93.5 kg hr^{-1}
b: multiplier for index relative to trigger min{$I_{2021}/I_{trigger}$, 1}		1
Precautionary multiplier to maintain biomass above Blim with 95% probability		
m: multiplier (generic multiplier based on life history)		0.90
RFB calculation**		3378 tonnes
Stability clause (+20%/−30% compared to Ay, only applied if b≥1)	Applied	0.70
Discard rate		9%
Catch advice for 2023 and 2024 (Ay × stability clause)		4078 tonnes
Projected landings corresponding to advice***		3704 tonnes
% advice change^		-30 %

7.7 Management plans

In 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 a management plan. In light of ICES suggestions, the necessary adjustments required to draft a plan were considered. The revised proposal for a harvest control component of a long-term management plan for haddock at Rockall was forwarded to NEAFC for approval at the 2012 Annual Meeting. ICES was requested to evaluate the EU-Russia proposal for the harvest control component of the management plan for Rockall haddock and to evaluate the proposal of protection of juvenile Rockall haddock. The management plan states total catch should not exceed the established TAC and includes measures to record and minimise discards.

ICES evaluated a new HCR proposal for Rockall haddock between RF and EU nations 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 NEAFC regulatory area (RA) established a ban on discards. Measures to reduce discards for the stock distribution area were required. The remainder of the management plan for this species is considered to be suitable and has been agreed by the Contracting Parties (NEAFC, 2015).

In 2017, NEAFC requested ICES to evaluate the harvest control component and to consider whether the plan is consistent with the precautionary approach required to provide sustainable harvesting of the stock.

In 2019, ICES evaluated the harvest control rules (HCRs) proposed for Rockall haddock and advised that they are considered precautionary in the short, medium, and long term under the assumption of intermediate levels of productivity.

The HCRs with TAC constraint rule (a) in the request are precautionary in the long term under all scenarios, except those with very low recruitment. If recruitment is low (as observed between 2007 and 2012) over a long time frame, without sporadic recruitment peaks, none of the HCRs are precautionary in the long term. TAC constraint rule (a) generally leads to lower probability of SSB < B_{lim} than the constraint rule (b), both in the short and long term.

7.8 Recommendation for next benchmark

The WG was unable to recreate the survey index used in previous assessments due to the lack of availability of code/spreadsheet. Therefore the agreed (at 2019 benchmark) category 1 assessment could not be conducted and advice had to be provided on the basis of a category 3 stock. Given that the previous category 1 assessment was not rejected and that survey and catch data are considered adequate for an analytical assessment, the WG agreed that this stock should be benchmarked as soon as possible with the following issues.

Type	Problem/Aim	Work Required	Data Required
Tuning series	Calculation of previously used index (derived from Scottish Q3 survey) cannot be reproduced due to non availability of code/spreadsheet. Need to agree a new index for use in the assessment. Due to survey design change in 2011 may require a break in the index or potentially modelled index to account for this.	Develop a modelled index including relevant explanatory variables. Explore internal consistency. Comparison with previously used index & stratified mean estimates (from MSS work up). Consider sensitivity of assessment results/quality of assessment for alternative indices.	Scottish Q3 survey data (available in Datras)
Biological parameters	Stock mean weights are currently assumed rolling average of catch mean weights which have shown significant increases (particularly older ages) and variability in recent years. which contributes to the increase in stock size. Not clear if this is a low sampling issue or a real change (cohort effect?).	Explore catch sampling data for mean sizes (consistency across samples/fleets etc). Use survey data to derive mean weights at age for comparison. Other options?	Catch mean weights at age data. Survey data (in Datras).
Biological parameters	Maturity - currently assumption of knife edge at age 3. Limited data suggests some maturity at age 2. Consider whether current assumption remains appropriate.	Review available data/literature. Comparison to other stocks.	Maturity data - very limited due to timing of current survey (no Q1 survey).
Biological parameters	Natural mortality. Currently fixed over all ages. Last benchmark suggested exploring potential for age-dependent M based on life-history/mean weights.	Explore alternative approaches for deriving natural mortality values.	Life history parameters.
Assessment method	Previous cat1 assessment used FLXSA. Poor catch sampling leads to substantial uncertainty in the catch at age data used in the assessment - a more appropriate	Development of a SAM assessment.	Assessment input data.

Type	Problem/Aim	Work Required	Data Required
	assessment method which can account for this uncertainty is required (e.g. SAM).		
Biological reference points	If a new analytical assessment is agreed, biological ref pts will need to be re-estimated.	Re-estimation of biological ref pts.	Assessment model outputs.
Discards	Very poor sampling of the fishery. Some historical discard data (UK & EU fleets) have been estimated using a combination of survey data & selectivity/discard ogives derived from years with samples. Unlikely to be able to revisit or make revisions due to unavailability of raw data. Not clear if all recent data have been uploaded to Intercatch. (Currently 2012 onwards processed in Intercatch).	Check WKROCK data call (2019), contents of Intercatch & with national data submitters. If additional data likely to be available, then data call, otherwise, no data call.	

1. .

7.9 Management considerations

The fishery for haddock at Rockall is partly in international waters and can therefore be exploited by non UK and EU vessels. The agreed TAC applies only to UK and EU vessels.

Previously, advice for this stock was given following ICES MSY approach based on a Category 1 stock assessment; the applied method gives advice following ICES MSY approach for data limited stocks using the empirical rfb rule (Fischer et al., 2021).

The basis for the advice (rfb rule) has a biennial advice interval and so advice is provided for 2 years (ICES 2022).

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Table 7.3.1. Nominal landings (tonnes) of haddock in Division 6.b, as officially reported to ICES.

Year	Faroe Islands	France	Iceland	Ireland	Norway	Portugal	Russian Federation	Spain	UK (E,W, & NI)	UK (Scot.)	UK (total)	Total	Unallocated	Landings from NEAFC area**	ICES landings[#]
1996	-	-	-	747	24	-	-	1	293	5753		6818	254	n/a	7072
1997	-	-	+	895	24	-	-	22	165	4114		5220	-53	n/a	5167
1998	-	-	-	704	40	4	-	21	561	3768		5098	-112	n/a	4956
1999	-	-	167	1021	61	-	458	25	288	3970		5990	-634	n/a	5356
2000	-	5	-	824	152	-	2154	47	36	2470		5688	-243	n/a	5445^
2001	-	2	-	357	70	-	630	51	-	1205		2315	-295	n/a	2020^
2002	-	-	-	206	49	-	1630	7	+	1145		3037	81	n/a	3118^
2003	-	-	-	169	60	-	4237	19	56	1607		6148	-180	n/a	5968^
2004	-	-	-	19	32	-	5844	-	-	411		6306	128	n/a	6434
2005	-	-	-	105	33	-	4708	-	-	332		5178	61	n/a	5239
2006	2	+	-	41	123	-	2154	5	1	439		2765	-9	n/a	2756
2007	2	-	-	338	84	-	1282	+	8	1635		3349	-2	n/a	3347
2008	16	-	-	721	36	-	1669	1	-	1779		4222	0	n/a	4222
2009	10	1	-	352	71	-	55	+	-	2951		3440	-199	n/a	3241
2010	42	-	-	169	65	-	198	+	-	2931		3405	-1	n/a	3404
2011	2	+	-	123	40	-	-	-	-	1732		1897	-37	n/a	1860
2012	53	-	-	31	48	-	1	-	-	577		710	-24	33	686
2013	-	-	-	105	121	-	4	-	-	596		826	63	147	889
2014	24	2	-	94	55	-	388	-	-	1152		1713	132	423	1845
2015	1	-	-	190	66	-	136	-			2052	2445	65	241	2510
2016	+	-	-	362	63	-	-	-			2160	2585^^	-81	565	2504^^
2017	+	-	-	500	26	-	153	-			3907	4586	-156	715	4430
2018	-	-	-	431[##]	16	-	-	-			3418	3865[##]	-15	782[##]	3850
2019	-	8	-	4[##]	13	-	245	1			6536	6807[##]^^	975	809	7782^^
2020*	-	-	-	679	14	-	133	+			4575	5401^^	109	745	5510^^
2021*	+	+	-	510		-	20	-			3558	4088^^	7	1183	4095^^

*** Preliminary official landings.**

****Official landings except 2020 & 2021 which include ICES estimates.**

^ Includes the total Russian catch.

^^ Including below minimum size (BMS) landings.

+ <0.5 tonnes.

 # Updated in 2022.

##Incomplete: part of the data being unavailable under data confidentiality clauses.

n/a = Not available.

Table 7.3.2. Haddock 27.6b. Landings from the NEAFC area (Subdivision 27.6b.1). (Mixture of official landings and ICES estimates – see Section 7.3 for explanation).

Year	Faroe Islands	France	Ireland	Norway	Russian Federation	Spain	UK (total)	Total
2012		0	2.2	4.96	1	0	24.6	32.8
2013		0	4.5	31.4	4	0	107.2	147.1
2014		0	5.85	28.9	388	0	0	422.7
2015		0	6.4	38.6	136	0	59.9	240.9
2016		0	5.2	47.9	-	0	511.8	564.9
2017		0	19.9	7.3	153	0	535.1	715.3
2018		0	**	9.9	-	0	772.6	782.5**
2019		1.4	3.8	7.3	245	0.51	550.4	808.5
2020*			15.3	11.6	133		584.6	744.6
2021*	0.2	0.012	140.9		20	0	1021.6	1182.7

*Preliminary

**Incomplete: part of the data being unavailable under data confidentiality clauses.

Table 7.3.3. Haddock in 6.b. ICES estimates of landings and discards. (* Indicates including BMS)

Year	Landings	Discards
1991	5656	13231
1992	5321	11874
1993	4781	9854
1994	5732	11028
1995	5588	9170
1996	7072	9356
1997	5167	5893
1998	4986	10863
1999	5356	11065
2000	5445	6611
2001	2020	1536
2002	3118	4154
2003	5968	5520
2004	6434	883
2005	5239	505
2006	2756	386
2007	3347	2242
2008	4222	2104
2009	3241	1556
2010	3404	907
2011	1860	152
2012	686	26
2013	889	1065
2014	1845	332
2015	2510	554
2016	2504	401
2017	4430	379
2018	3850	788
2019	7782*	303
2020	5510*	130
2021	4095*	1117

Table 7.3.4. Haddock in 6.b. International landings numbers (*10^3) at-age.

			Age				
Year	1	2	3	4	5	6	7
1991	87	6807	3011	1344	558	32	464
1992	86	3642	5623	964	580	364	160
1993	28	1919	4740	1157	489	144	290
1994	30	1160	5299	3665	1039	66	141
1995	1	146	5205	4791	1319	279	43
1996	2	5149	1861	4149	2347	473	85
1997	0	319	2102	2155	3658	1540	192
1998	4	392	1815	1340	1898	2284	1301
1999	245	2600	2994	1972	1228	1600	2291
2000	33	3446	5081	3006	1296	1176	1963
2001	402	994	1116	555	991	462	549
2002	657	2983	3998	2111	809	217	392
2003	920	8103	11010	1848	1189	879	593
2004	197	1765	9502	9119	1364	286	472
2005	887	2835	6866	7913	725	98	182
2006	2344	768	1290	2356	2269	428	150
2007	31	1220	2709	1074	1550	1634	719
2008	17	749	6191	1164	479	761	848
2009	5	11	244	5243	460	261	486
2010	0	71	196	352	4078	274	294
2011	2	23	71	177	181	2405	222
2012	0	0	134	51	0	35	410
2013	162	14	2	46	6	46	553
2014	226	1553	418	52	138	47	679
2015	9	820	3214	104	7	61	112
2016	127	612	2137	842	3	2	11
2017	7	1336	1783	2179	1207	58	59
2018	0	3418	502	2233	598	222	13
2019	10	1514	10556	59	484	90	60
2020	21	1936	1190	3392	364	518	180
2021	132	544	2863	556	1788	53	337

Table 7.3.5. Haddock in 6.b. International discards numbers (*10³) at-age.

YEAR			AGE				
	1	2	3	4	5	6	7
1991	21099	27040	12178	3998	1146	313	58
1992	15998	21069	12961	4397	1181	312	46
1993	11151	17456	10755	3781	1128	317	69
1994	8140	19464	12570	4545	1409	410	91
1995*	2748	9685	16379	4965	1145	508	36
1996	12094	13662	9051	5463	952	278	7
1997*	9957	10216	3286	1944	1344	218	15
1998*	14220	19415	8357	3423	1842	483	91
1999*	17037	19348	9209	3526	2191	1084	485
2000*	8189	9136	5616	1912	755	322	103
2001*	7268	1019	583	266	50	15	21
2002	12706	8136	539	334	89	43	51
2003	5655	15503	3558	217	97	48	8
2004	735	2346	781	93	22	10	2
2005	174	888	554	210	28	11	11
2006	536	707	336	58	22	8	1
2007	1458	8609	921	440	678	193	0
2008	458	1458	5246	128	28	203	82
2009	218	696	993	2803	35	2	18
2010*	152	463	868	1736	19	2	2
2011*	2	36	4	6	0	174	27
2012*	5	6	10	7	3	0	18
2013*	4733	84	99	40	33	38	12
2014*	179	1454	0	0	0	0	0
2015*	71	2153	173	0	0	0	0
2016*	245	439	503	146	0	0	0
2017*	1187	334	20	12	0	0	0
2018*	88	2955	3	40	0	0	0
2019*	275	471	308	8	76	0	0
2020*	237	263	0.00	0.2	0	0	0
2021*	2797	1556	339	72	74	0	0

*** Data calculated using estimates from discard observer trips.**

Table 7.3.6. Haddock in 6.b. International catch (landings and discards) numbers (*10^3) at-age.

			Age				
Year	1	2	3	4	5	6	7
1991	21 186	33 847	15 189	5 341	1 704	346	522
1992	16 084	24 711	18 584	5 361	1 761	676	206
1993	11 178	19 375	15 494	4 938	1 617	461	359
1994	8 170	20 623	17 868	8 209	2 449	476	232
1995	2 749	9 831	21 584	9 756	2 464	787	79
1996	12 096	18 811	10 911	9 612	3 299	751	92
1997	9 957	10 535	5 388	4 098	5 002	1 758	206
1998	14 224	19 807	10 173	4 763	3 740	2 767	1 391
1999	17 282	21 949	12 203	5 499	3 419	2 684	2 776
2000	8 222	12 581	10 698	4 917	2 050	1 498	2 066
2001	7 669	2 013	1 699	821	1 041	477	570
2002	13 363	11 119	4 537	2 445	898	260	444
2003	6 576	23 606	14 568	2 065	1 286	927	602
2004	932	4 112	10 282	9 212	1 386	296	474
2005	1 061	3 723	7 420	8 124	753	109	193
2006	2 880	1 475	1 626	2 414	2 291	436	151
2007	1 489	9 829	3 630	1 514	2 227	1 827	720
2008	476	2 207	11 437	1 291	507	964	930
2009	223	707	1 237	8 046	495	263	504
2010	152	534	1 064	2 087	4 096	276	296
2011	4	59	75	183	181	2 579	249
2012	5	6	144	58	3	35	428
2013	4 896	98	101	86	39	84	565
2014	406	3 008	418	52	138	47	679
2015	80	2 973	3 387	104	7	61	112
2016	374	1 051	2 639	988	3	2	11
2017	1 194	1 670	1 802	2 191	1 207	58	59
2018	88	6373	504	2273	598	222	13
2019	288	1995	10866	67	560	90	60
2020	264	2202	1190	3392	364	518	180
2021	2931	2101	3202	628	1862	53	337

Table 7.3.7. Haddock in 6.b. International landings mean weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.302	0.402	0.444	0.592	0.724	0.963	0.704
1992	0.136	0.366	0.455	0.658	0.612	0.759	0.954
1993	0.305	0.402	0.503	0.701	0.830	0.820	0.972
1994	0.314	0.356	0.452	0.558	0.638	1.224	0.890
1995	0.377	0.311	0.414	0.479	0.640	0.699	1.236
1996	0.327	0.436	0.501	0.487	0.627	0.709	0.783
1997	0.300	0.315	0.401	0.444	0.564	0.661	0.973
1998	0.256	0.344	0.494	0.517	0.542	0.591	0.678
1999	0.085	0.177	0.326	0.417	0.495	0.595	0.662
2000	0.111	0.206	0.242	0.328	0.413	0.483	0.720
2001	0.094	0.281	0.344	0.497	0.427	0.522	0.690
2002	0.107	0.196	0.227	0.323	0.521	0.627	0.804
2003	0.100	0.164	0.246	0.350	0.387	0.423	0.606
2004	0.142	0.172	0.241	0.293	0.446	0.617	0.754
2005	0.103	0.184	0.230	0.310	0.461	0.614	1.095
2006	0.084	0.167	0.223	0.327	0.440	0.598	0.789
2007	0.096	0.238	0.275	0.322	0.449	0.521	0.578
2008	0.125	0.197	0.302	0.444	0.583	0.752	0.984
2009	0.300	0.346	0.420	0.416	0.692	0.512	1.031
2010	0.052	0.420	0.517	0.457	0.591	0.980	1.473
2011	0.214	0.329	0.613	0.454	0.694	0.594	0.780
2012	0.189	0.368	0.632	0.850	0.898	1.412	1.238
2013	0.510	0.554	0.713	0.972	1.361	0.948	1.267
2014	0.186	0.351	0.268	0.545	1.000	1.036	1.370
2015	0.107	0.327	0.615	0.354	1.178	0.948	1.439
2016	0.409	0.574	0.664	0.767	1.576	1.808	2.650
2017	0.173	0.460	0.587	0.692	0.944	0.780	1.270
2018	-1	0.332	0.564	0.705	0.935	1.235	1.928
2019	0.190	0.489	0.589	0.825	1.116	1.440	1.683
2020	0.298	0.531	0.576	0.807	0.749	1.029	1.363
2021	0.284	0.394	0.512	0.837	0.818	1.138	1.150

Table 7.3.8. Haddock in 6.b. International discards mean weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.142	0.199	0.253	0.306	0.345	0.358	0.499
1992	0.133	0.217	0.258	0.298	0.330	0.342	0.499
1993	0.137	0.220	0.260	0.307	0.346	0.359	0.504
1994	0.153	0.226	0.263	0.308	0.345	0.356	0.508
1995	0.118	0.220	0.276	0.325	0.341	0.329	0.438
1996	0.136	0.218	0.276	0.326	0.370	0.348	0.515
1997	0.136	0.238	0.272	0.312	0.372	0.442	0.512
1998	0.141	0.248	0.267	0.291	0.327	0.336	0.451
1999	0.139	0.212	0.255	0.288	0.313	0.318	0.417
2000	0.189	0.267	0.289	0.311	0.330	0.334	0.484
2001	0.135	0.247	0.294	0.344	0.412	0.440	0.513
2002	0.137	0.254	0.308	0.335	0.398	0.338	0.382
2003	0.161	0.223	0.287	0.342	0.337	0.440	0.487
2004	0.148	0.218	0.282	0.343	0.324	0.371	0.449
2005	0.171	0.240	0.298	0.357	0.387	0.473	0.511
2006	0.132	0.233	0.334	0.420	0.495	0.435	0.423
2007	0.115	0.179	0.233	0.227	0.243	0.280	0.420
2008	0.202	0.264	0.279	0.370	0.351	0.358	0.446
2009	0.247	0.287	0.319	0.343	0.360	0.662	0.507
2010	0.141	0.220	0.292	0.301	0.322	0.534	0.250
2011	0.178	0.248	0.300	0.302	0.795	0.727	0.481
2012	0.263	0.295	0.488	0.319	0.339	0.733	0.797
2013	0.201	0.337	0.228	0.397	0.247	0.679	0.980
2014	0.082	0.218	-	-	-	-	-
2015	0.104	0.227	0.334	-	-	-	-
2016	0.240	0.276	0.325	0.393	-	-	-
2017	-	0.308	0.482	0.520	0.726	-	-
2018	0.088	0.258	0.361	0.422	0.479	0.536	-
2019	0.180	0.259	0.297	0.374	0.486	-	-
2020	0.2422	0.274	-	0.512	-	-	-
2021	0.182	0.284	0.336	0.344	0.394	-	-

Table 7.3.9. Haddock in 6.b. International catch (landings and discards) mean weights-at-age (kg).

YEAR	AGE					
	1	2	3	4	5	6	7
1991	0.142	0.240	0.291	0.378	0.469	0.414	0.681
1992	0.133	0.239	0.318	0.362	0.423	0.567	0.852
1993	0.137	0.238	0.335	0.400	0.493	0.503	0.882
1994	0.153	0.233	0.319	0.420	0.469	0.477	0.740
1995	0.118	0.222	0.309	0.401	0.501	0.460	0.870
1996	0.136	0.278	0.314	0.396	0.553	0.575	0.762
1997	0.136	0.240	0.322	0.381	0.512	0.634	0.940
1998	0.141	0.250	0.308	0.354	0.436	0.546	0.663
1999	0.138	0.208	0.272	0.334	0.379	0.483	0.619
2000	0.189	0.250	0.267	0.321	0.382	0.451	0.709
2001	0.133	0.264	0.326	0.447	0.427	0.520	0.683
2002	0.135	0.239	0.237	0.325	0.509	0.579	0.755
2003	0.153	0.203	0.256	0.349	0.384	0.424	0.604
2004	0.147	0.198	0.244	0.294	0.444	0.609	0.753
2005	0.114	0.197	0.235	0.311	0.459	0.600	1.062
2006	0.093	0.198	0.245	0.329	0.441	0.595	0.787
2007	0.114	0.186	0.265	0.294	0.386	0.496	0.578
2008	0.199	0.241	0.291	0.437	0.571	0.669	0.937
2009	0.248	0.288	0.339	0.391	0.668	0.513	1.012
2010	0.141	0.247	0.333	0.327	0.590	0.977	1.464
2011	0.198	0.280	0.596	0.449	0.695	0.603	0.748
2012	0.263	0.295	0.622	0.784	0.372	1.411	1.219
2013	0.211	0.368	0.236	0.704	0.423	0.827	1.261
2014	0.140	0.286	0.268	0.545	1.000	1.036	1.370
2015	0.104	0.254	0.601	0.354	1.178	0.948	1.439
2016	0.298	0.449	0.600	0.711	1.556	1.808	2.650
2017	0.219	0.430	0.586	0.691	0.944	0.780	1.270
2018	0.088	0.298	0.563	0.700	0.935	1.233	1.928
2019	0.180	0.434	0.581	0.771	1.030	1.440	1.683
2020	0.245	0.500	0.576	0.807	0.749	1.029	1.363
2021	0.186	0.312	0.493	0.781	0.801	1.138	1.150

Table 7.3.10. Haddock 6.b. Stock mean weights-at-age (kg). (* Indicates values from survey data)

YEAR	AGE							
	0*	1	2	3	4	5	6	7
1991	NA	0.142	0.240	0.291	0.378	0.469	0.414	0.681
1992	NA	0.133	0.239	0.318	0.362	0.423	0.567	0.852
1993	NA	0.137	0.238	0.335	0.400	0.493	0.503	0.882
1994	NA	0.153	0.233	0.319	0.420	0.469	0.477	0.740
1995	NA	0.137	0.234	0.314	0.392	0.471	0.484	0.805
1996	NA	0.136	0.242	0.319	0.396	0.488	0.516	0.821
1997	NA	0.136	0.242	0.320	0.399	0.506	0.530	0.839
1998	NA	0.137	0.245	0.314	0.390	0.494	0.538	0.795
1999	0.017	0.134	0.240	0.305	0.373	0.476	0.540	0.771
2000	NA	0.148	0.245	0.297	0.357	0.452	0.538	0.739
2001	0.022	0.148	0.242	0.299	0.368	0.427	0.527	0.723
2002	0.028	0.147	0.242	0.282	0.356	0.426	0.516	0.686
2003	0.029	0.150	0.233	0.272	0.355	0.416	0.491	0.674
2004	NA	0.151	0.231	0.266	0.347	0.429	0.517	0.701
2005	0.028	0.136	0.220	0.260	0.345	0.444	0.546	0.771
2006	0.027	0.128	0.207	0.243	0.322	0.447	0.561	0.792
2007	0.030	0.124	0.197	0.249	0.315	0.423	0.545	0.757
2008	0.013	0.134	0.204	0.256	0.333	0.460	0.594	0.823
2009	0.008	0.154	0.222	0.275	0.352	0.505	0.574	0.875
2010	NA	0.159	0.232	0.295	0.355	0.531	0.650	0.956
2011	0.008	0.180	0.248	0.365	0.380	0.582	0.651	0.948
2012	0.018	0.210	0.270	0.436	0.477	0.579	0.834	1.076
2013	0.024	0.212	0.295	0.425	0.531	0.550	0.866	1.141
2014	0.020	0.191	0.295	0.411	0.562	0.616	0.971	1.212
2015	0.023	0.183	0.297	0.465	0.567	0.734	0.965	1.207
2016	0.018	0.203	0.330	0.465	0.619	0.906	1.206	1.588
2017	0.012	0.195	0.357	0.458	0.601	1.020	1.080	1.598
2018	0.021	0.170	0.343	0.524	0.600	1.123	1.161	1.731
2019	0.012	0.178	0.373	0.586	0.645	1.129	1.242	1.794
2020	0.015	0.206	0.422	0.581	0.736	1.043	1.258	1.779
2021	0.025	0.184	0.395	0.560	0.750	0.892	1.124	1.479

Table 7.3.11. Haddock in 6.b. Scottish Q3 Rockall haddock survey 1991-2009 (old index).

	0	1	2	3	4	5	6	7	8
1991	14458	16398	4431	683	315	228	37	64	3
1992	20336	44912	14631	3150	647	127	200	4	32
1993	15220	37959	15689	3716	1104	183	38	73	21
1994	23474	13287	11399	4314	969	203	30	12	4
1995	16923	16971	6648	5993	1935	483	200	16	-1
1996	33578	19420	5903	1940	1317	325	69	6	1
1997	28897	10693	2384	538	292	281	71	9	1
1998	-1	-1	-1	-1	-1	-1	-1	-1	-1
1999	10178	9969	2410	708	279	172	90	64	32
2000	-1	-1	-1	-1	-1	-1	-1	-1	-1
2001	31813	7455	521	284	154	39	14	12	14
2002	11704	20925	2464	173	105	65	20	10	15
2003	2526	10114	10927	1656	138	97	100	26	6
2004	-1	-1	-1	-1	-1	-1	-1	-1	-1
2005	24452	4082	920	1506	2107	231	33	13	7
2006	3570	18715	2562	256	1402	1694	349	16	6
2007	558	2671	6019	570	254	516	367	28	2
2008	85	560	966	3813	182	41	282	249	49
2009	132	139	323	488	1651	40	9	54	17

Table 7.3.12. Haddock in 6.b. Scottish Q3 Rockall haddock survey 2011 onwards (number per 10 hours).

Mean

	0	1	2	3	4	5	6	7+
2011	5.34	15.86	137.60	17.92	67.95	101.45	816.59	8.03
2012	14778.60	2.15	8.47	55.82	9.59	59.30	32.03	424.06
2013	3247.62	12258.74	7.94	22.05	36.56	22.59	27.98	347.17
2014	1925.84	6146.09	5274.52	3.84	0.00	8.82	0.00	109.53
2015	1211.67	2237.97	5390.05	4194.88	0.00	0.00	8.60	51.27
2016	33441.08	1154.50	1403.12	2444.32	1702.92	13.55	0.76	25.63
2017	18583.48	23852.74	615.22	966.59	1595.60	691.67	0.71	10.78
2018	6118.72	2878.79	10395.64	249.22	532.29	856.83	325.10	3.94
2019	2933.15	4003.82	2934.86	5806.47	107.41	131.20	317.02	178.34
2020	25149.28	1456.96	2114.08	774.48	1700.02	39.63	52.60	94.52
2021	29363.38	9445.42	679.64	864.30	414.42	892.77	45.34	55.80

Variance

	0	1	2	3	4	5	6	7+
2011	2.90	27.76	1697.44	19.08	340.97	526.65	25921.61	2.69
2012	108959685.11	0.68	5.41	273.30	6.75	277.59	44.99	6162.86
2013	625196.73	3346529.04	25.18	152.47	844.77	86.09	360.46	16760.42
2014	195960.84	403331.21	620653.05	5.04	0.00	7.89	0.00	462.41
2015	65123.93	61454.67	171518.52	314384.40	0.00	0.00	12.67	99.08
2016	549457752.18	21367.73	29421.70	130113.84	88936.29	6.86	0.25	34.44
2017	184354785.46	4911190.53	6874.48	14332.22	41415.90	6184.16	0.02	3.33
2018	1204812.27	116784.67	1341249.83	5489.44	14867.12	62230.53	14816.24	1.29
2019	803305.84	260170.82	192851.61	2520643.85	804.91	820.30	6292.20	1548.22
2020	136236520.83	33883.47	50157.51	16396.79	131875.36	172.91	304.24	554.79
2021	77305629.48	1045147.35	5115.86	10912.53	2708.44	12225.15	63.14	24.66

Table 7.3.13. Haddock in Division 27.6.b. Survey biomass index (estimate and variance) including ages 0+ in kg per 10 hours.

Year	idx	var
2011	667.64	11323.48
2012	822.24	44562.36
2013	3139.49	173139.86
2014	2908.21	69487.92
2015	4059.65	85357.36
2016	3545.33	245237.44
2017	7219.27	238626.71
2018	5982.50	267038.84
2019	6176.63	916841.05
2020	3558.91	122493.71
2021	4464.18	99515.50

Table 7.3.14. Haddock in Division 27.6.b. Annual estimates of modal length, Lc, LF=M and Lmax.

Year	Lmode	Lc	LFeqM	Lmax
2012	48	34	39.25	74
2013	26	24	31.75	74
2014	27	26	33.25	82
2015	29	26	33.25	73
2016	38	31	37	72
2017	37	34	39.25	76
2018	31	28	34.75	91
2019	37	33	38.5	77
2020	38	33	38.5	82
2021	33	30	36.25	82

Table 7.3.15. Haddock in Division 27.6.b. Summary of the stock indicators used in the assessment and advice.

Year	low	value	high	Lbar	LBI	landings	discards	bms	catch
1991	NA	NA	NA	NA	NA	5656	13231	0	18868
1992	NA	NA	NA	NA	NA	5321	11874	0	17199
1993	NA	NA	NA	NA	NA	4781	9854	0	14655
1994	NA	NA	NA	NA	NA	5732	11028	0	16751
1995	NA	NA	NA	NA	NA	5588	9170	0	14754
1996	NA	NA	NA	NA	NA	7072	9356	0	16433
1997	NA	NA	NA	NA	NA	5167	5893	0	11049
1998	NA	NA	NA	NA	NA	4986	10863	0	15841
1999	NA	NA	NA	NA	NA	5356	11065	0	16417
2000	NA	NA	NA	NA	NA	5445	6611	0	12058
2001	NA	NA	NA	NA	NA	2020	1536	0	3554
2002	NA	NA	NA	NA	NA	3118	4154	0	7274
2003	NA	NA	NA	NA	NA	5968	5520	0	11498
2004	NA	NA	NA	NA	NA	6434	883	0	7321
2005	NA	NA	NA	NA	NA	5239	505	0	5740
2006	NA	NA	NA	NA	NA	2756	386	0	3141
2007	NA	NA	NA	NA	NA	3347	2242	0	5587
2008	NA	NA	NA	NA	NA	4222	2104	0	6325
2009	NA	NA	NA	NA	NA	3241	1556	0	4799
2010	NA	NA	NA	NA	NA	3404	907	0	4311
2011	46	67	88	NA	NA	1860	152	0	2012
2012	41	82	124	45.7	1.22	686	26	0	712
2013	232	314	396	42.9	1.15	889	1065	0	1952
2014	239	291	342	44.8	1.2	1845	332	0	2175
2015	349	406	463	39.5	1.05	2510	554	0	3063
2016	257	355	452	39.1	1.04	2504	401	0	2906
2017	626	722	818	40.6	1.09	4430	379	0	4810
2018	497	598	700	38.7	1.03	3850	788	0	4640
2019	430	618	805	41.4	1.1	7778	303	4	8090
2020	287	356	424	41.2	1.1	5508	130	2	5640
2021	385	446	508	39.0	1.04	4094	1117	1	5212

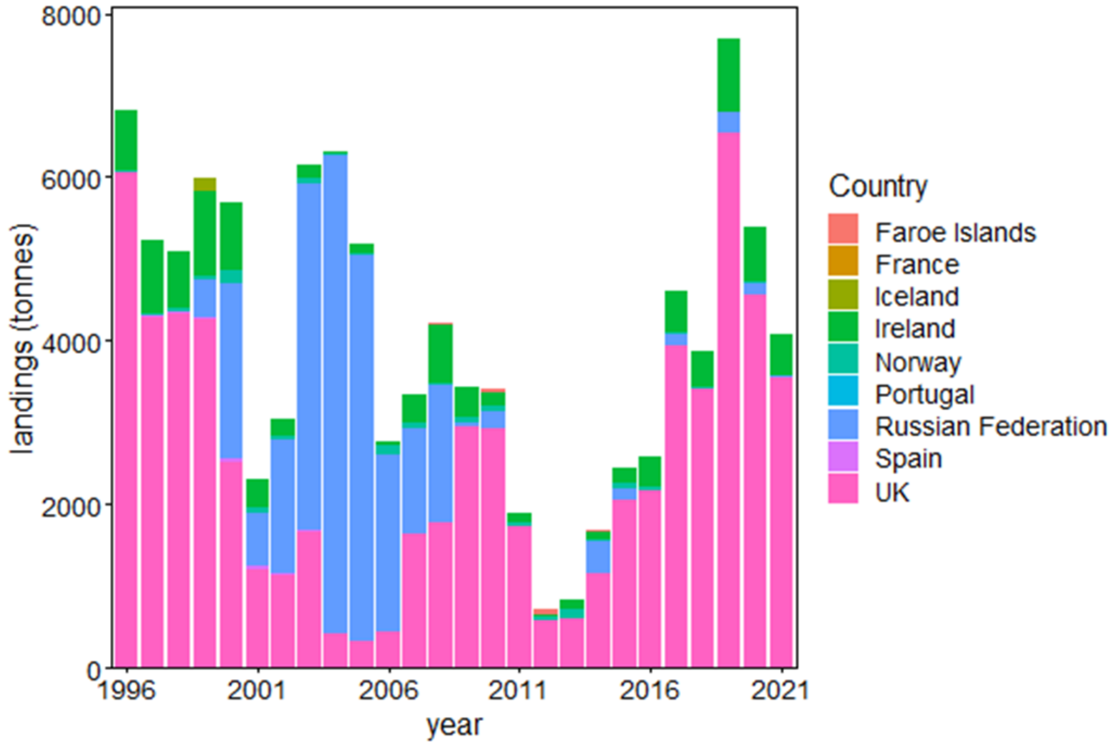


Figure 7.3.1. Haddock in Division 6.b. Official landings by country.

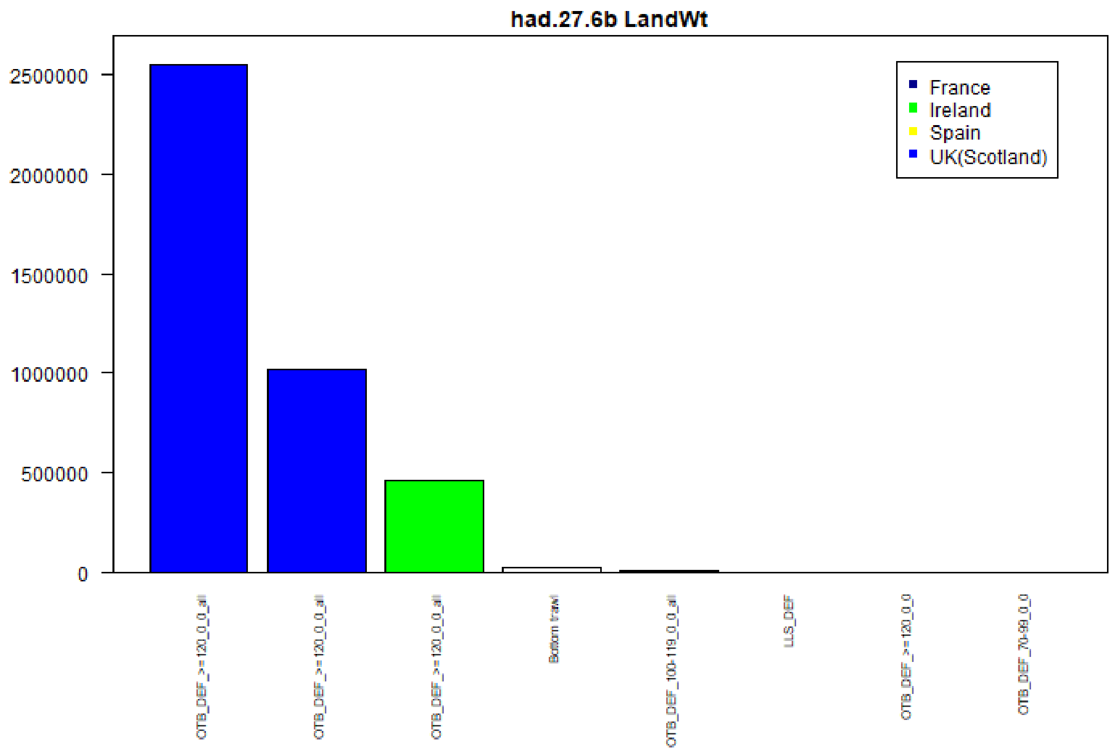


Figure 7.3.2. Haddock in Division 6.b. ICES estimated landings as submitted to Intercatch for 2021.

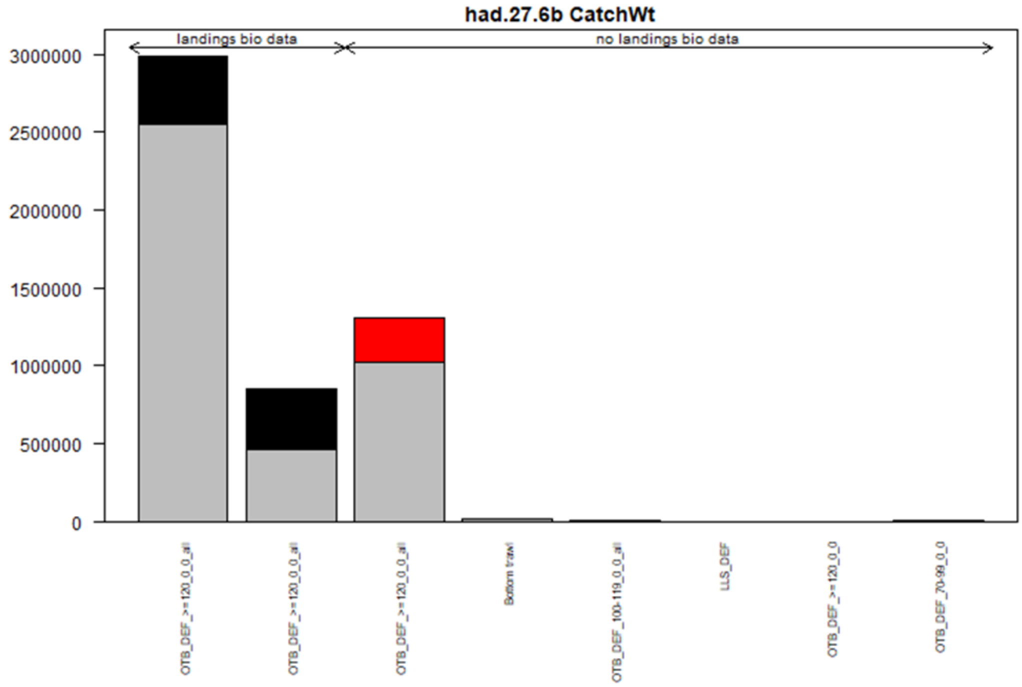


Figure 7.3.3. Haddock in Division 6.b. ICES estimated landings and discards after raising in Intercatch (grey=imported landings; black=imported discards; red=raised discards).

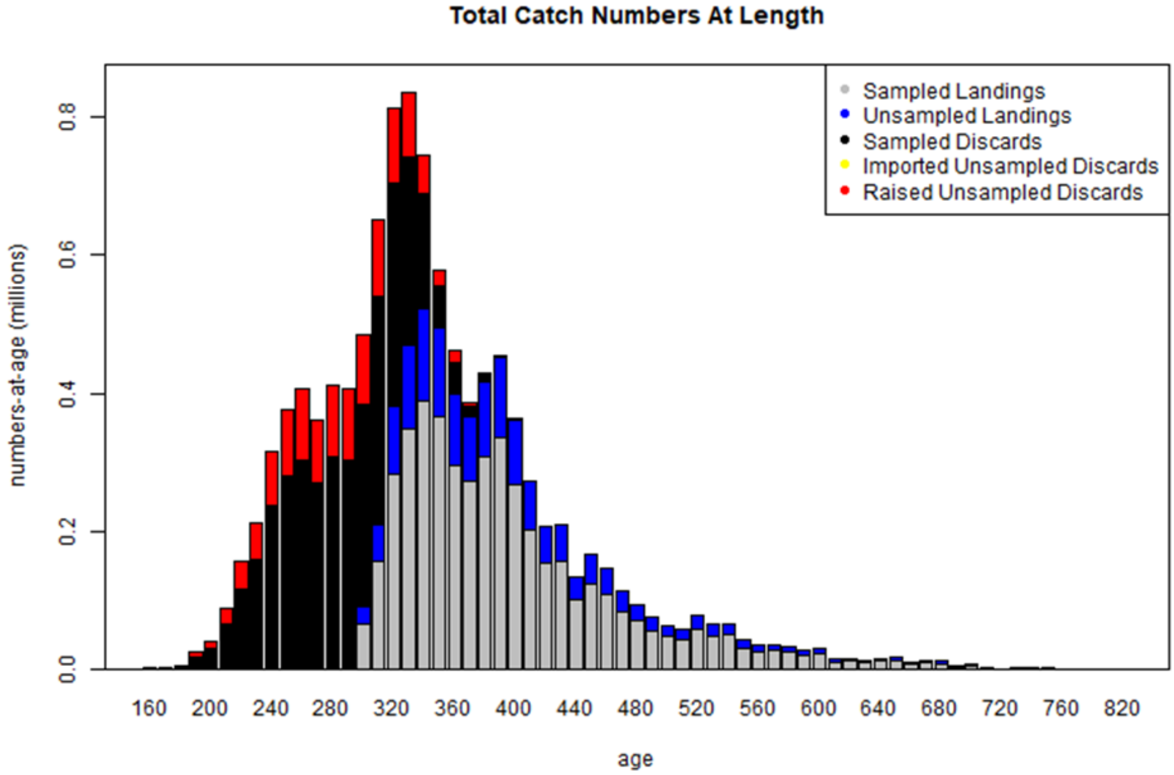


Figure 7.3.4. Haddock in Division 6.b. Catch numbers-at-length by sampled and un-sampled landings and sampled and raised (unsampled) discards for 2021, after allocations within InterCatch.

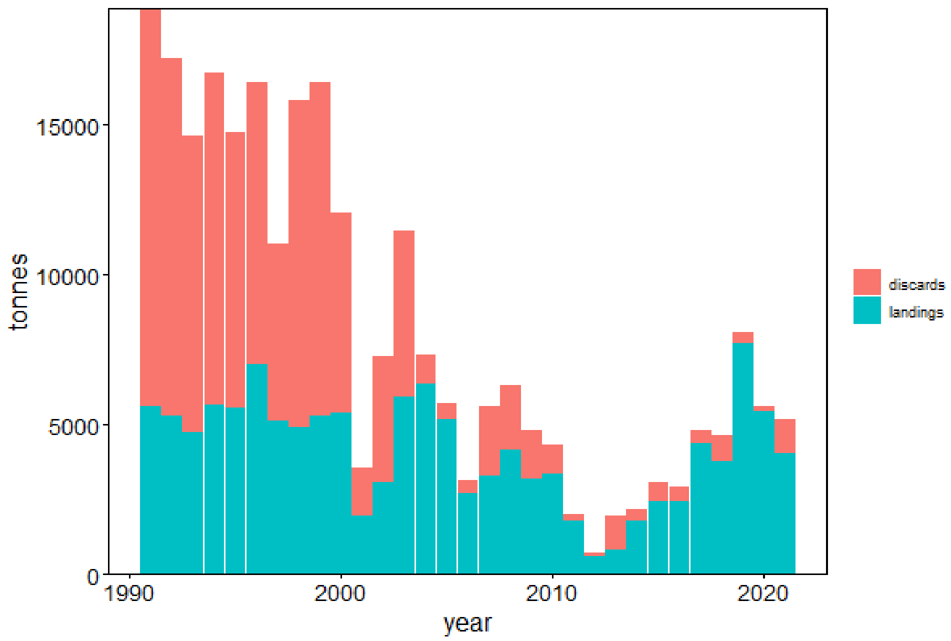


Figure 7.3.5. Haddock in Division 6.b. ICES estimates of total landings and discards.

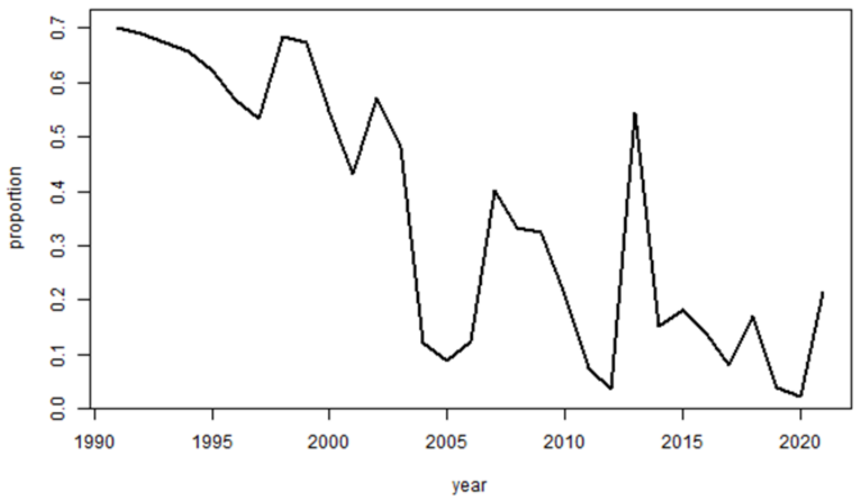


Figure 7.3.6. Haddock in Division 6.b. Discard proportion by weight.

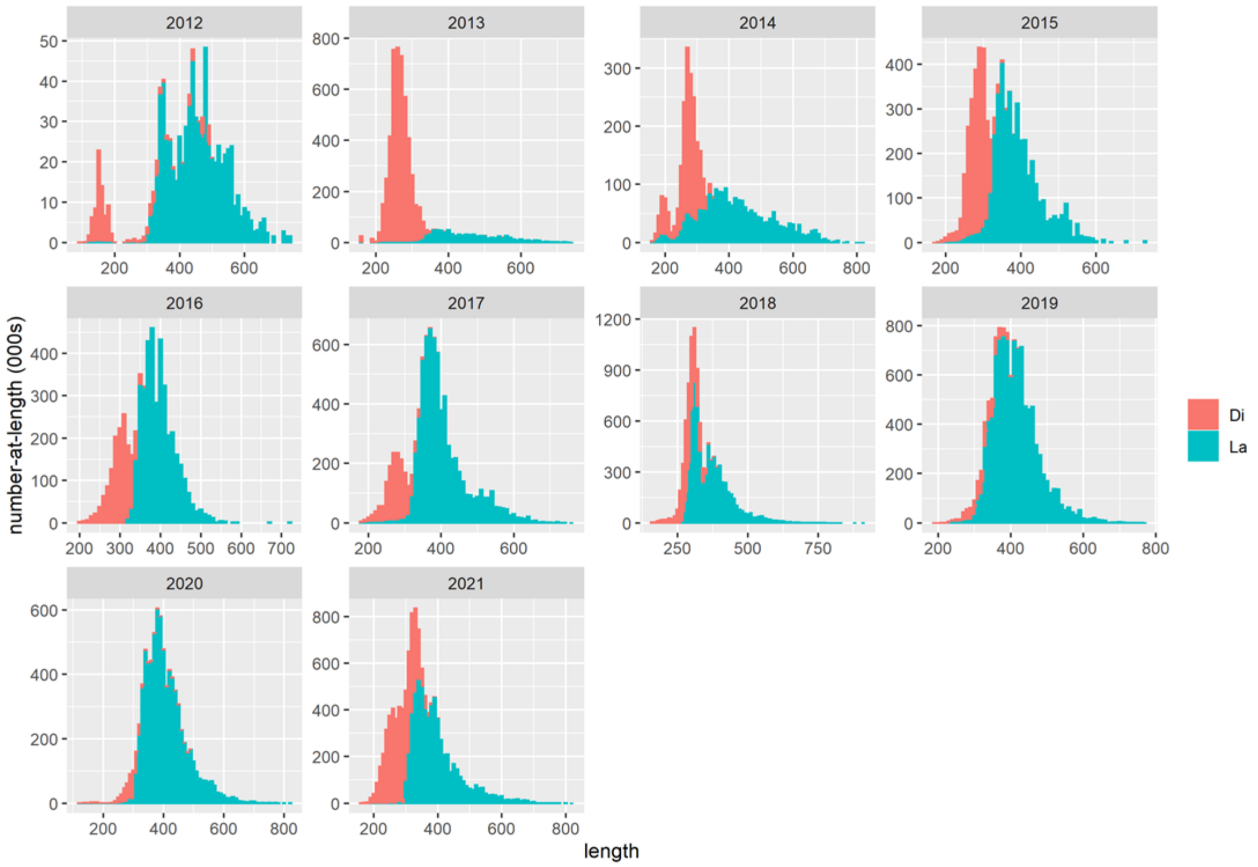


Figure 7.3.7. Haddock in Division 6.b. Catch-at-length in numbers by year. Red: discards, blue: landings.

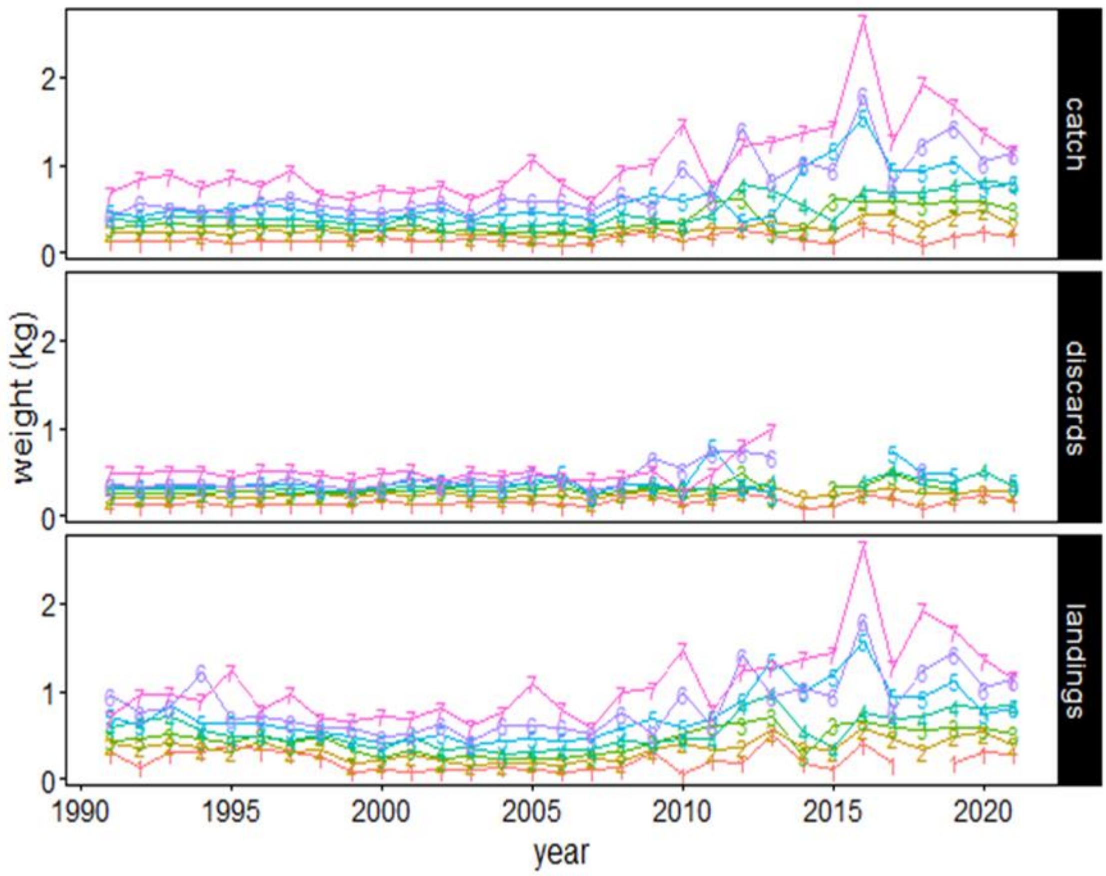


Figure 7.3.8. Haddock in Division 6.b. Mean weight-at-age in catch, discards and landings.

Figure 7.3.9. Haddock in Division 6.b. Mean weight-at-age in catch, stock and survey.

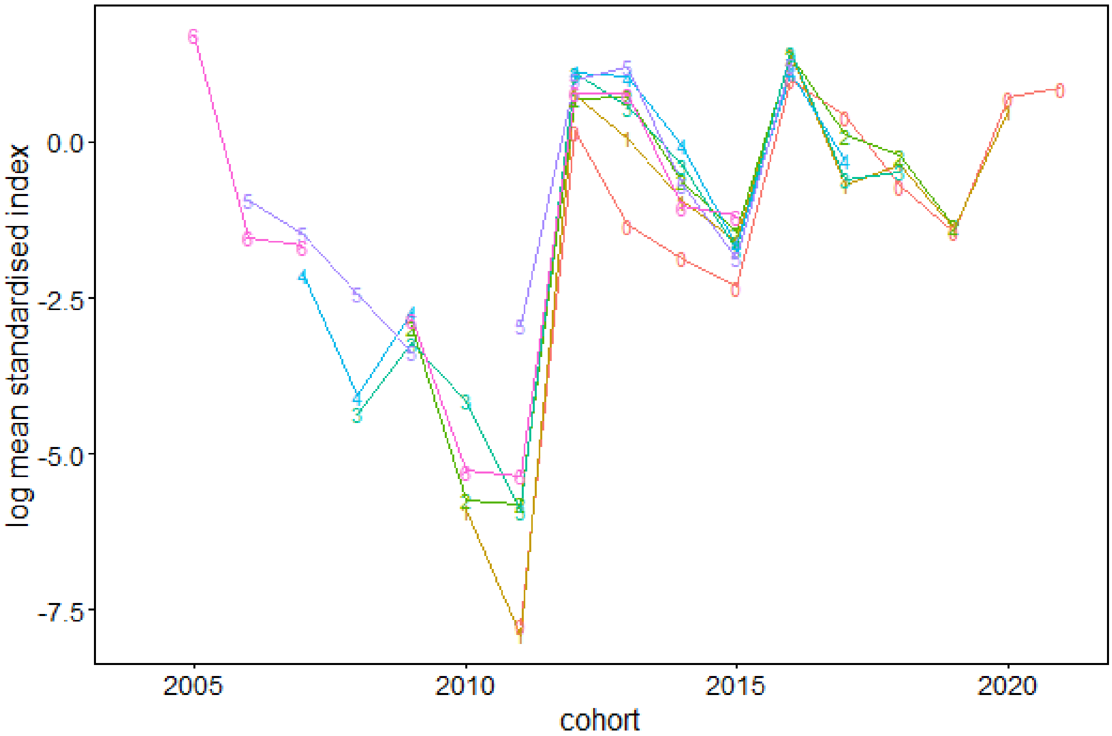


Figure 7.3.10. Haddock in Division 27.6.b. Log mean standardised index values by cohort from ScoRoc-Q3 survey (2011 onwards).

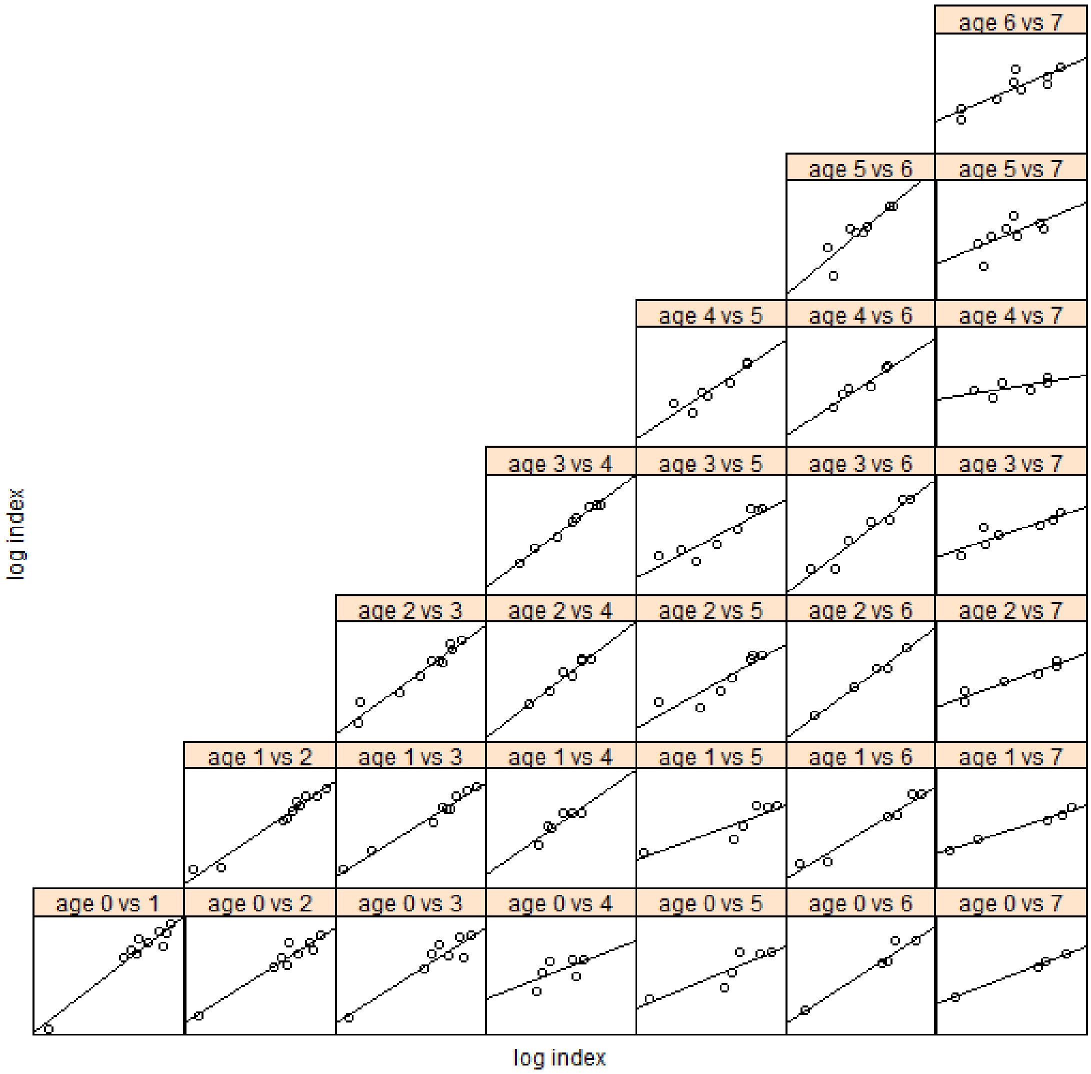


Figure 7.3.11. Haddock in Division 27.6.b.. Within-survey correlations for the ScoRoc-Q3 survey, comparing index values at different ages for the same cohorts (2011 onwards).

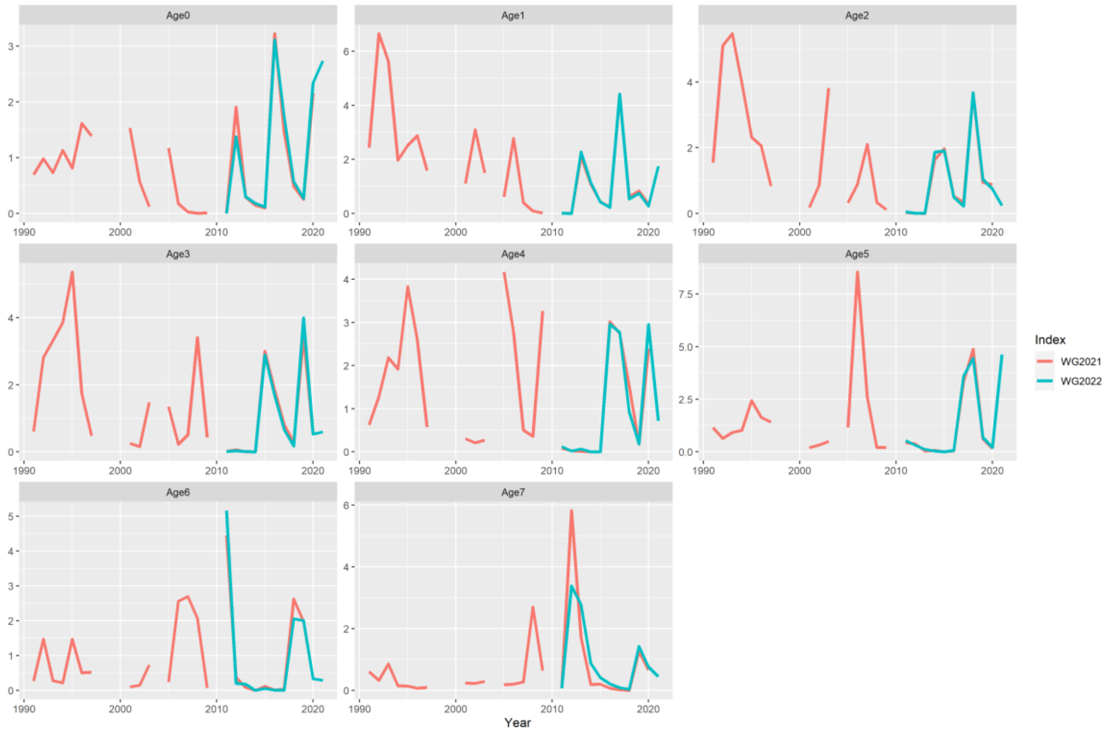


Figure 7.3.12. Haddock in Divisino 27.6.b. Comparison of survey index at age between the new index (2011 onwards) and the 'standard index' from the 2021 WG.

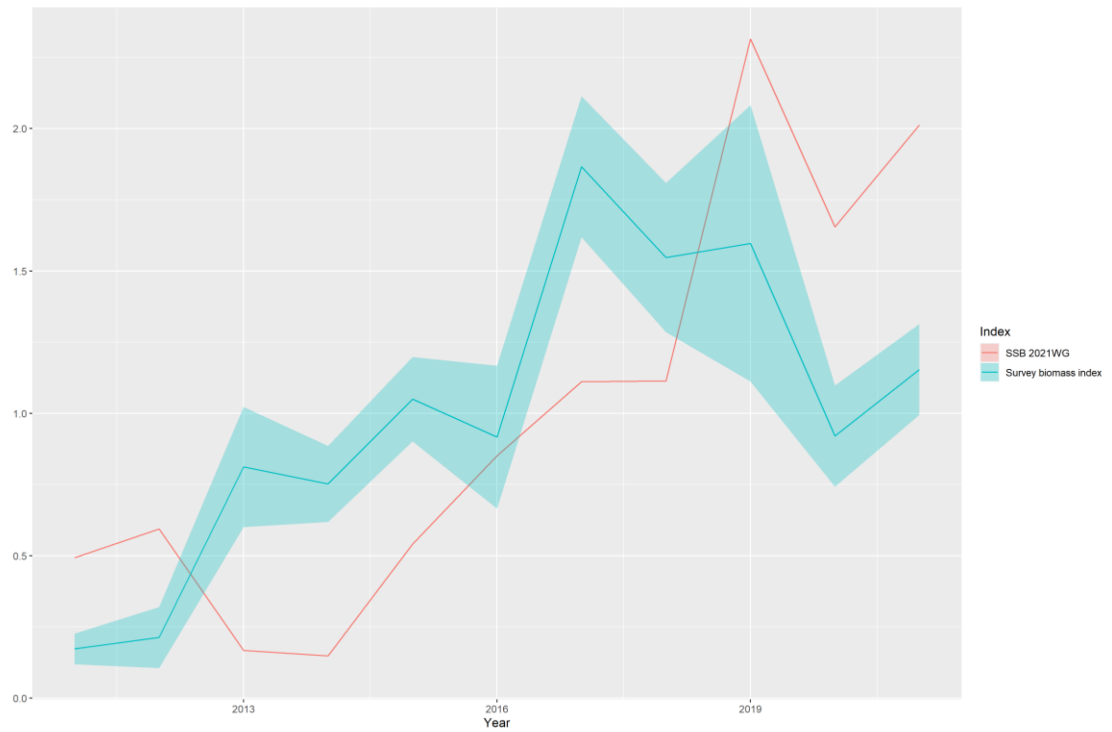


Figure 7.3.13. Haddock in Division 27.6.b. Comparison of biomass index with SSB from 2021 WG assessment (including the intermediate year value). Series are mean standardised.

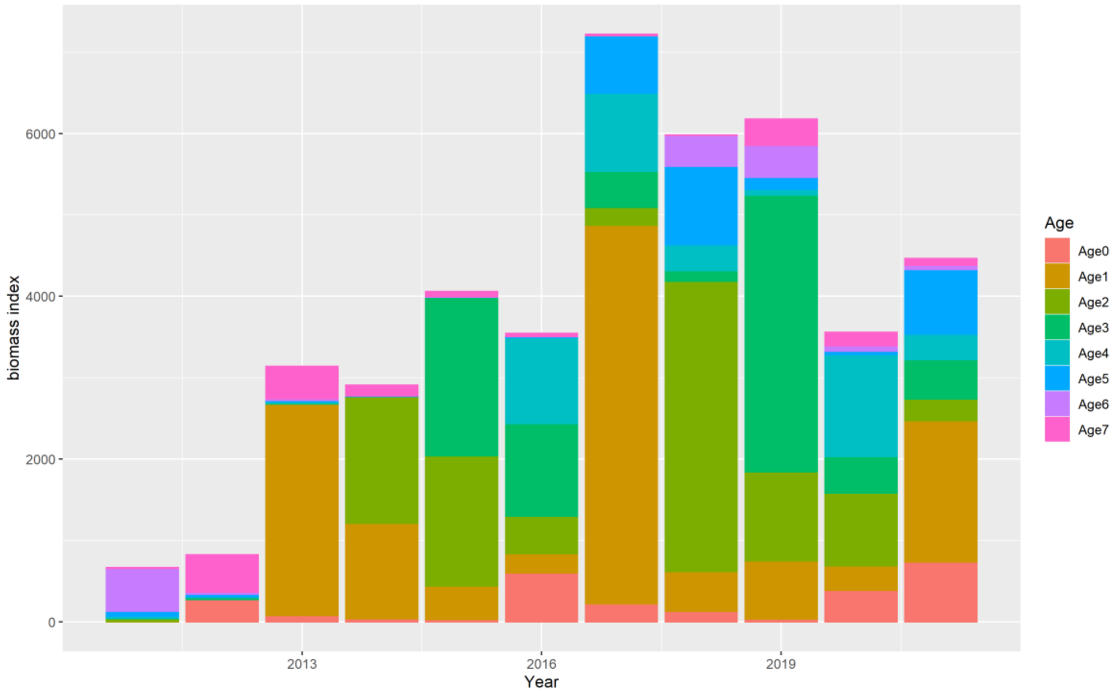


Figure 7.3.14. Haddock in Divison 27.6.b. Survey biomass (kg 10 hr^{-1}) over time by age.

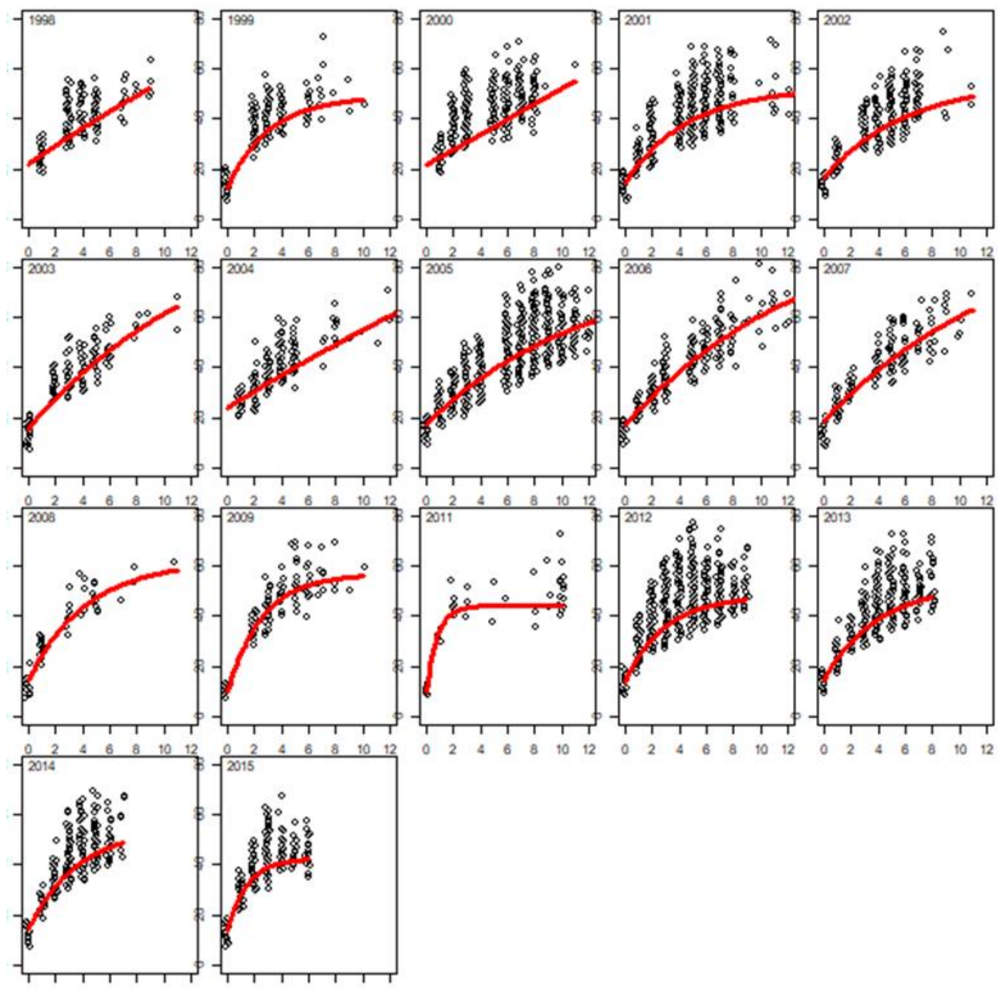


Figure 7.3.15. Haddock in Division 27.6.b. von Bertalanffy curves fitted to survey data by cohort. Note that circles represent individual length-age combinations and the weighting of each value is not shown.

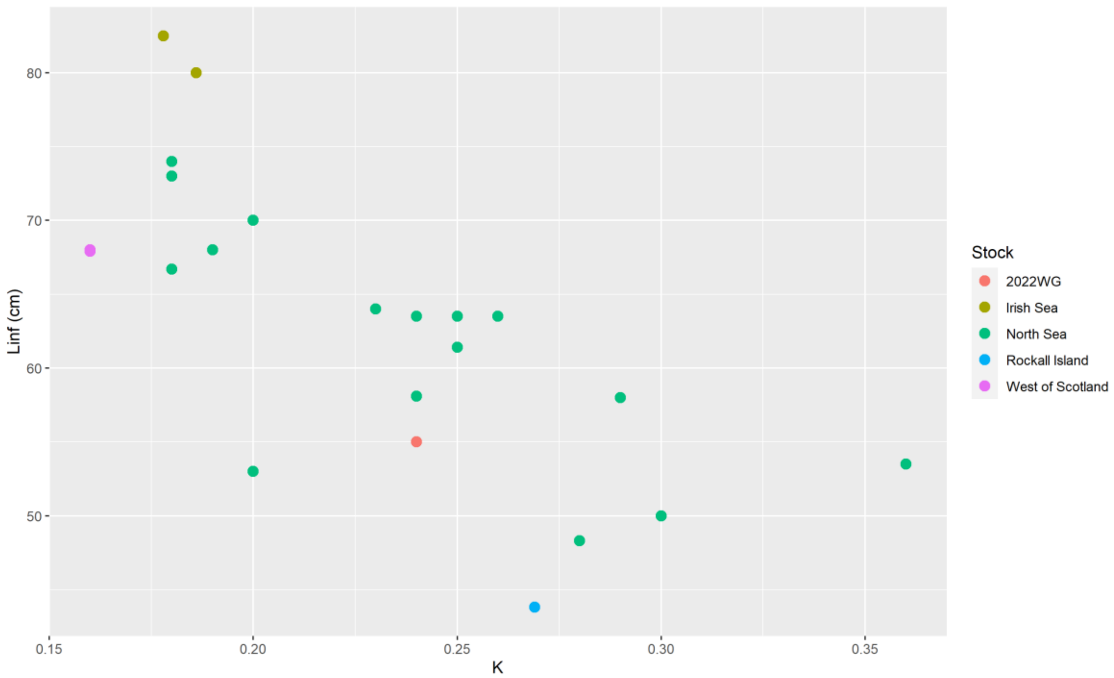


Figure 7.3.16. Comparison of growth parameters estimated at WG 2022 with those in Fishbase (other stocks around UK).

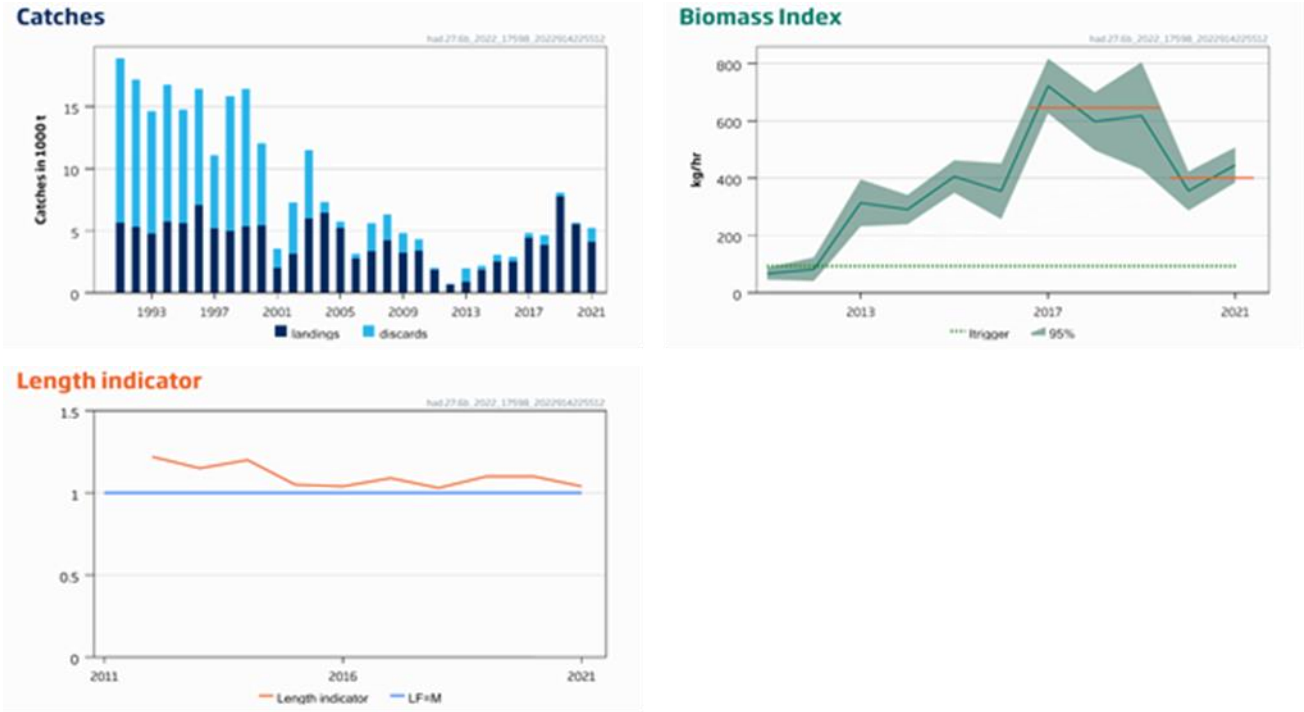


Figure 7.3.17. Haddock in Division 27.6.b. Summary of the stock assessment.

8 Haddock in Divisions 7.b,c,e–k

Type of assessment in 2021

The Celtic Sea haddock (27.7b,c,e–k) assessment was benchmarked in 2020, with discard and landings data reviewed and updated from 2005 onwards.

The 2022 SAM assessment was undertaken in the web tool: www.stockassessment.org. The procedure detailed in the Stock Annex, performed in the preceding year was followed.

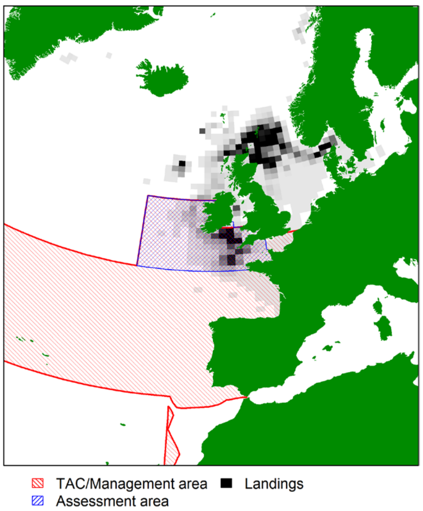
ICES advice applicable to 2022

Last year's full advice is available in the Report of the ICES Advisory Committee, 2021. ICES Advice 2021, had.27.7b–k. https://doi.org/10.17895/ices.advice.7764. The headline advice was as follows:

"ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 15 946 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by some of the relevant management authorities for this stock."

8.1 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 8.1 shows the spatial distribution of international haddock landings in the NE Atlantic for 2016. It is clear from the figure that the stock extends into Area 8 and it could be argued that landings from 8 should be included in the stock area. In recent years these landings varied between 20 and 300 t which is up to 4% of the total landings in the stock area.

The TAC for haddock is set for the combined Areas 7.b–k, 8, 10 and 10 and EU waters of CECAF 34.1.1. This does not correspond to the stock assessment area (7.b–k).

2022 management (Council Regulation (EU) 2022/109)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	7b-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	146	Analytical TAC	
France	8 762	Article 8(2) of this Regulation applies	
Ireland	2 920		
Union	11 828		
United Kingdom	2 550		
TAC	15 000		

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.

The 2020 EU Council Regulation included Article 13, "Remedial measures for cod and whiting in the Celtic Sea" which will impact the Celtic Sea haddock fishery as these three species occupy similar areas. Article 13 implements spatial and fishing gear restrictions in an effort to reduce fishing pressure on cod and whiting.

8.2 The fishery

The official landings reported to ICES are given in Table 8.1. Before 2002, the TAC was well in excess of the landings in the TAC area. The TAC appeared to become restrictive for France in 2003–2004 and Ireland in 2001–2003. 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. In the last two years uptake by France has reduced to less than 50% and UK quota share increased substantially due to Brexit.

Figure 8.1 shows the distribution of international landings between 2015 and 2019. Most haddock landings were taken from the northern North Sea, Irish Sea, Rockall and from the Celtic Sea.

Figure 8.2 shows a longer time-series of official landings and TAC. The time-series is characterised 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.

Working Group estimates of the landings and discards are given in Table 8.2 and shown in Figure 8.3. The discard estimate for 2010 was the highest on record at 16 547 tonnes, this was mainly a consequence of the 2009 cohort entering the fishery.

Table 8.3 and Figure 8.4 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.

8.2.1 Information from the industry

No updated information from industry was received.

8.3 Data

8.3.1 Landings and discard numbers-at-age

Catch sampling in 2021 increased compared to 2020 when it was impacted owing to the COVID 19 pandemic and is considered sufficient to describe the stock.

Discard and retained catch-at-age distributions are shown in Figure 8.5. Many of the discarded fish will be above the MLS, which is likely to be the result of restrictive quota.

Landings numbers-at-age are given in Table 8.4 and discard numbers-at-age are given in Table 8.5. 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. Figure 8.6 shows proportional representation of landings relative to catch (discards + landings) by age, 1993–2021. Discards account for a large proportion of the catch numbers up to age 3. Figure 8.7 shows the proportions-at-age that are discarded.

Sampled and unsampled catch (landings and discards) by country are shown in Figure 8.8.

Figure 8.9 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).

8.3.2 Biological

The assumptions of natural mortality and maturity are described in the stock annex. The maturity ogive used in the assessment is quite sharp, with 0.39% of 2 year olds and 91% of 3 year olds mature (stock annex).

8.3.3 Surveys and commercial tuning fleets

The available surveys and commercial tuning fleets are described in detail in the stock annex. One survey index is used in the assessment: the FR-IRL-IBTS index, which is a combined index from the French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS surveys. This is standardised following the VAST procedure (stock annex).

The index data are given Table 8.6. The standardised indices are given by year in Figure 8.10 and by cohort in Figure 8.11. Figure 8.12 shows the scatterplot matrices of the log indices. These plots indicate that the internal consistency of the indices is robust.

8.4 Historical stock development

Model used: SAM

Software used: Stock Assessment.Org (https://www.stockassessment.org)

8.4.1 Data screening

The general approach to data screening and analysis was followed in addition to the data exploration tools available in the FLR package FLEDA. The results of the data screening are fully documented using R markdown and are available in the folder 'Data\Stock\had-7bce–k' in the ICES SharePoint.

8.4.2 Final update assessment

The final assessment was run with the same settings as established by WKCELTIC 2020 and described in the stock annex. While discards were combined with the landings and not supplied separately to the model, annual discard fractions were incorporated.

Figure 8.13 shows the residuals of that catch proportions-at-age. For age classes where discards dominate, the residuals are relatively large. There are no obvious pattern in the younger ages but the residuals in the middle of the time-series show a mostly positive evolution from the 2006 cohort. The strongest negativities residuals occur for the older age classes in 2006. Observed and assessment predicted catches are shown in Figure 8.14. The predicted catches were generally accurate while there was a tendency for under estimation from 2011–2018. The observed and predicted index CPUE values are shown in Figure 8.15. The assessment generally follows the survey index trends in age classes across the time-series.

In the proportions-at-age residual plots of the survey (FRA-IRL-WIBTS_VAST) there are no consistent patterns (Figure 8.16). The assessment generally follows the survey index trends in age classes across the time-series.

The SAM assessment is shown in Figure 8.17, detailing catch, landings, SSB F and recruits with 95% confidence intervals.

8.4.3 State of the stock

Table 8.7 shows the estimated fishing mortality-at-age and Table 8.8 shows the stock numbers-at-age. The stock summary is given in Table 8.9.

The spawning–stock biomass (SSB) peaked in 2011 as the very strong 2009 year class matured; this cohort was followed by three years of below-average recruitment which led to a rapid decline in SSB after 2011. Recent recruitment has varied around the average, with a notable peak in 2009 and in 2018. SSB appears to have stabilised, while fishing mortality (F) has been above F_{MSY} for the entire time-series but shows a declining trend.

8.5 Short-term projections

Because recruitment of haddock is characterised by sporadic events, the assumed median recruitment for the intermediate years introduces significant uncertainty for the SSB estimate.

Short-term projections were performed in SAM as a stochastic process. Recruitment was estimated at 275 943 in 2022 and 2023 respectively, (medians 1993–2021; thousands). The short-term predictions are expected to give a reasonably reliable estimate of landings and discards in 2022 (assuming average F 2019–2021 and average discard patterns seen in 2019–2021).

Intermediate year assumptions are given in Table 8.10. The management options are given in Table 8.11.

8.6 MSY evaluations and biological reference points

ICES carried out and evaluation of MSY and PA reference points for this stock at WKCELTIC (ICES, 2020). The results are summarized below:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	12 822	B_{pa}; in tonnes.	ICES (2020a)
	F_{MSY}	0.353	Based on simulation using a segmented regression stock–recruitment relationship (EqSim)	ICES (2020a)
Precautionary approach	B_{lim}	9227	Lowest observed SSB; in tonnes	ICES (2020a)
	B_{pa}	12 822	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.20$ (default setting); in tonnes	ICES (2020a)
	F_{lim}	1.40	F with 50% probability of SSB < B_{lim}	ICES (2020a)
	F_{pa}	0.71	$F_{p0.5}$; the F that leads to SSB ≥ B_{lim} with 95% probability	ICES (2020a)
EU MAP	MAP MSY $B_{trigger}$	12 822	MSY B_{pa}; in tonnes	EU (2019), ICES (2020a)
	MAP B_{lim}	9227	Lowest observed SSB; in tonnes	EU (2019), ICES (2020a)
	MAP F_{MSY}	0.353	F_{MSY}	EU (2019), ICES (2020a)
	MAP range F_{lower}	0.221	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY	EU (2019), ICES (2020a)
	MAP range F_{upper}	0.521	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY	EU (2019), ICES (2020a)

8.7 Management plans

The EU multiannual plan (MAP) for the Western Waters (EU, 2019), incorporating the stock haddock 7.b,c,e–k has been agreed. This MAP "establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks", under article 17 states that "It is appropriate to establish the target fishing mortality (F) that corresponds to the objective of reaching and maintaining MSY as ranges of values which are consistent with achieving MSY(F_{MSY}). Those ranges, based on best available scientific advice, are necessary in order to provide flexibility to take account of developments in the scientific advice, to contribute to the implementation of the landing obligation and to take into account the characteristics of mixed fisheries."

8.8 Uncertainties and bias in assessment and forecast

8.8.1 Landings

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches, although the assessment is contingent on the accuracy of the landings statistics. Catch sampling in 2021 increased compared to 2020 when it was impacted owing to the COVID-19 pandemic and is considered sufficient to describe the stock.

Sampling indicated that stock weights-at-age decreased compared to those used for the 2021 assessment. This may have contributed to reduced SBB estimates in the assessment.

8.8.2 Discards

Irish discards have been monitored since 1995. The number of trips sampled has varied considerably over time (between three and 62 trips per year). Sample numbers were particularly low in 1995, 1999–2002 and in 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. Discards were estimated for the early part of the time-series at WKROUND (2012) and retained by WKCELTIC up to 2004.

Although recent discard estimates are considered to be more reliable, the problem remains that the number of observer trips is very small compared to the total number of trips (typically <1% of all trips are sampled). The level of uncertainty owing to the small sample sizes is likely to be high, but the cost of increasing discard coverage would be considerable. As mentioned sampling levels were considerably low in 2020.

8.8.3 Assessment bias

Figure 8.18 shows the retrospective of the ASAP analysis. The predicted catch shows little retrospective pattern neither does the SSB estimate with the Mohn's rho for SSB estimated to be low at 4%. The Recruitment however, has a relatively high Mohn's rho at 21% owing primarily to the last of five data reductions. F shows variable tendencies with removal of data years, however no overall pattern is discernible and the Mohn's rho is low at -4%.

The historical assessment results (Figure 8.19) shows a revision in estimated stock size for the 2022 assessment due to the addition of new data for 2021, recent low recruitment and older year classes being removed from the stock.

8.9 Forecast

The 2018 cohort is projected to account for 32% the projected catch in 2023, This strong cohort was picked up by both the Irish and French quarter 4 surveys in 2018 but its contribution only accounts for 15% of SSB in 2024.

Figure 8.20 shows the assessment and forecast of the final SAM run for the F_{MSY} catch option leading to an SSB of 48 157 tonnes in 2024 and advised catch of 11 901 tonnes.

The assumed recruitment in 2022 and 2023 used in the forecast would constitute a minor part of the projected catches in 2023 (8%) and approximately 31% of the SSB in 2024 (Figure 8.21).

8.10 Recommendation for next benchmark

8.10.1 Stock audit

The audit of the 2021 report did not raise any concerns.

8.10.2 Recommendations for future work

Future benchmarks should consider mixed fisheries and multispecies interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species.

Catch data should continue to be monitored for indirect evidence of improved selection patterns due to the augmented TCMs in the Celtic Sea. Direct monitoring of escapement through SMPs would also be useful.

It would be desirable to include discards separately in the assessment model in order to specify greater precision for the discard numbers-at-age than for the landings numbers-at-age. However, WKROUND (2012) concluded that this resulted in undesirable residual patterns. The benchmark workshop did not have sufficient time to fully evaluate this problem.

8.11 Management considerations

The stock size fluctuates strongly over the time. The size of the stock is determined to a large extent by recruitment, which has been erratic and in 2018 is shown to have been large. There is no discernible relationship between stock size and recruitment, as is the case with most haddock stocks.

Fishing mortality has been consistently above F_{MSY}, but this has not led to a decreasing trend in stock size, which suggests that the stock is robust to overfishing, however F has been increasing since 2015 and at current levels the SSB could quickly fall below $MSYB_{trigger}$ if recruitment were to be low for three or four years. The high recruitment seen in 2018 is moving through the fishery and the older year classes are being removed from the stock.

Discarding of undersize as well as marketable fish is a serious problem for this stock, with approximately $^2/_3$ in catch numbers and almost half the catch weight has been discarded on average over the past decade. Alternative or complimentary approaches to managing such strong, recruit-driven fluctuations are required, especially with regard to the EU landings obligation.

The minimum landing size of haddock is 30 cm, which is approximately the same as the mean length of two-year old haddock in the Celtic sea. Because gadoids are caught in a mixed fishery, restrictive quota in recent years have led to increased discarding of marketable fish as well as already considerable discarding of undersized fish. Technical measures have been introduced to reduce discards of undersize gadoids (110 mm square-mesh panel in the *Nephrops* fisheries and 100 mm in the gadoid fisheries). It is not clear whether this is sufficient to reduce discard mortality of future cohorts. It is important that technical measures are fully implemented and their effectiveness in reducing discards and impact on commercial catches are monitored and evaluated.

8.12 References

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing

Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008.

COUNCIL REGULATION (EU) 2020/123 of 27 January 2020, fixing for 2020 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.

COUNCIL REGULATION (EU) 2021/703 of 26 April 2021, amending Regulations (EU) 2021/91 and (EU) 2021/92 as regards certain fishing opportunities for 2021 in Union and non-Union waters.

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 8.1. Haddock in 7.b,c, e–k. Official landings (quota uptake in brackets).

Year	BEL	ESP	FRA	IRL	UK*	Others	Total	TAC**
1994	123	0	2788	908	240	17	4076	
1995	189 (28%)	19	2964 (74%)	966 (72%)	266 (44%)	64	4468	6000
1996	133 (9%)	48	4527 (49%)	1468 (47%)	439 (31%)	38	6653	14000
1997	246 (16%)	54	6581 (71%)	2789 (90%)	569 (41%)	31	10270	14000
1998	142 (6%)	260	3674 (28%)	2788 (63%)	445 (22%)	52	7361	20000
1999	51 (2%)	88	2725 (19%)	2034 (42%)	278 (13%)	71	5247	22000
2000	90 (5%)	110	3088 (28%)	3066 (83%)	289 (17%)	13	6656	16600
2001	165 (12%)	646	4842 (61%)	3608 (135%)	422 (35%)	19	9702	12000
2002	132 (128%)		4348 (70%)	2188 (106%)	315 (34%)	106	7089	9300
2003	118 (130%)		5781 (106%)	1867 (103%)	393 (48%)	82	8241	8185
2004	136 (127%)		6130 (96%)	1715 (80%)	313 (33%)	159	8453	9600
2005	167 (130%)		4174 (54%)	2037 (80%)	292 (25%)	197	6867	11520
2006	99 (77%)		3191 (42%)	1874 (73%)	274 (24%)	183	5621	11520
2007	119 (93%)		4143 (54%)	1931 (75%)	385 (33%)	50	6628	11520
2008	109 (84%)		3638 (47%)	1800 (70%)	566 (49%)	121	6234	11579
2009	131 (102%)		5430 (70%)	2983 (116%)	716 (62%)	48	9308	11579
2010	170 (132%)		6240 (81%)	2609 (101%)	852 (74%)	128	9999	11579
2011	211 (143%)		8389 (95%)	3323 (112%)	1657 (124%)	129	13709	13316
2012	232 (125%)		11793 (106%)	4129 (112%)	1901 (114%)	166	18221	16645
2013	174 (111%)		8747 (93%)	2699 (86%)	1455 (103%)	23	13098	14148
2014	99 (94%)		6375 (101%)	2092 (99%)	785 (83%)	21	9372	9479
2015	118 (127%)		5679 (102%)	1657 (89%)	769 (92%)	6	8229	8342
2016	88 (109%)		4487 (93%)	1730 (107%)	692 (95%)	27	7024	7258
2017	110 (128%)		4885 (95%)	1677 (97%)	690 (89%)	12	7374	7751
2018	89 (116%)		4470 (97%)	1444 (94%)	583 (84%)	9	6595	6910
2019	90 (97%)		4259 (77%)	1323 (71%)	516 (62%)	74	6262	8329
2020	106 (88%)		3522 (49%)	2203 (91%)	543 (50%)	102	6476	10859
2021	156 (94%)		4249 (48%)	3379 (114%)	515 (21%)	149	8447	15000

*** 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 8.2. Haddock in 7.b,c, e–k. 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****	Total CatCH
1993							3348	505	594	109	1208	4556
1994							4131	1116	594	176	1886	6017
1995							4470	730	1221	267	2218	6688
1996							6756	3170	713	426	4309	11065
1997							10827	2129	502	253	2883	13710
1998							7928	680	140	114	934	8862
1999							4970	477	54	55	586	5556
2000							7499	1587	727	189	2503	10002
2001							9278	2234	743	441	3418	12696
2002	134	85	3878	2070	301	20	6488	871	5651	552	7073	13561
2003	116	82	5960	1731	362	41	8292	1835	6941	680	9456	17748
2004	137	143	6336	1785	303	73	8777	1108	5156	486	6750	15527
2005	166	209	4101	2078	285	0	6839	1564	5818	2571	9953	16792
2006	98	194	3131	1899	269	1	5592	1313	2745	1841	5899	11491
2007	117	186	4134	2139	385	1	6961	372	2483	696	3552	10513
2008	108	166	4577	1984	558	0	7392	990	3741	2930	7660	15052
2009	129	49	5503	3270	711	2	9664	905	3320	3098	7322	16986
2010	170	115	6421	2899	821	3	10429	3260	4570	10870	18701	29130
2011	211	78	8381	3702	1551	35	13957	3963	4329	7515	15807	29764
2012	232	79	12293	4596	1929	67	19196	2754	2653	2878	8285	27481
2013	174	51	8738	3097	1458	20	13538	671	1116	2175	3962	17501
2014	99	3	6350	2543	849	2	9846	1732	1171	2715	5619	15464
2015	118	0	5683	2035	766	6	8608	2024	2519	2398	6941	15549
2016	88	0	4573	2271	689	27	7648	5482	2810	3773	12065	19713
2017	111	0	4895	2381	699	11	8099	2633	1928	2130	6691	14789
2018	89	0	4377	1989	578	12	7046	1920	1189	2688	5798	12844
2019	89	89	4548	2412	518	27	7683	1616	1445	542	3603	11259
2020	102	176	3815	3193	546	27	7859	1450	1873	937	4260	12119
2021	149	108	4257	4211	516	19	9260	706	1075	604	2385	11645

*** 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.**

****** Discard estimates are available from 2005; prior to 2005, discard estimates are based on limited sampling.**

Table 8.3. Haddock in 7.b,c, e–k. 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

	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
2010	131	30.83	54	4.36	144	7.33	101	5.15	103.7
2011	216	22.90	40	6.39	129	10.51	84	5.58	87.1
2012	188	45.03	44	4.93	135	13.17	84	6.58	86.2
2013	215	27.40	42	5.38	126	8.69	80	4.92	40.3
2014	203	19.81	46	5.22	142	5.11	77	3.91	32.1
2015	NA	NA	31	4.42	150	4.95	78	2.91	21.2
2016	NA	NA	39	2.41	164	4.94	83	3.09	NA
2017	NA	NA	36	2.25	151	5.10	92	2.43	NA
2018	NA	NA	46	2.19	125	5.33	93	1.70	NA
2019	NA	NA	32	2.42	127	5.86	93	1.73	NA
2020	NA	NA	34	2.80	98	11.2	84	1.86	NA
2021	NA	NA	39	4.23	92	14.68	86	2.70	NA

Table 8.4. Haddock in 7.b,c, e–k. 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	1075	1732	4230	1821	280	75	1	3
2006	0	839	3250	1034	2189	484	42	28	0
2007	0	404	4617	2916	737	1310	161	33	4
2008	0	1692	3268	3736	1046	286	414	91	50
2009	0	338	7111	2760	1890	577	228	234	38
2010	0	1757	5192	6031	1036	580	257	110	123
2011	0	100	12726	3607	3410	661	261	129	132
2012	0	82	1135	19931	2559	1795	323	109	108
2013	0	86	465	1899	10533	861	468	96	44
2014	0	277	854	467	1511	5585	368	219	40
2015	0	41	4881	632	309	928	2030	257	80
2016	0	62	310	5200	216	143	546	682	92
2017	0	58	2019	1071	3930	135	117	246	312
2018	0	70	714	2833	926	1653	42	64	150
2019	0	513	1566	1257	2678	529	762	41	110
2020	0	120	4318	1449	755	1381	260	175	30
2021	0	285	1295	6691	740	569	640	248	169

Table 8.5. Haddock in 7.b,c, e–k. 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	30472	25291	6821	97	1	0	0	0
2006	0	20089	4529	11	10	4	1	0	0
2007	0	10748	8498	572	6	6	0	0	0
2008	0	34221	12620	1676	78	0	0	0	0
2009	0	21175	13989	592	64	0	0	0	0
2010	0	95699	19014	2742	34	1	0	0	0
2011	0	5881	58967	1675	262	16	1	0	1
2012	0	2732	5169	18518	153	55	2	0	0
2013	0	4076	2767	1372	4028	58	2	1	1
2014	0	20197	3315	507	631	732	4	1	0
2015	0	3590	18090	704	26	155	162	13	6
2016	0	27587	5222	8406	51	12	56	501	2
2017	0	3208	11913	1602	2121	31	2	4	3
2018	0	5287	5127	5306	491	215	0	2	2
2019	0	12878	2847	773	409	37	17	1	4
2020	0	2722	10938	597	28	25	1	1	0
2021	0	4890	3773	2799	23	12	1	0	0

Table 8.6. Haddock in 7.b,c, e–k. VAST survey data.

Year \Age	0	1	2	3	4	5	6	7
2003	34982.4	194259.7	15511.0	1334.3	1035.4	27.7	16.2	8.8
2004	103867.4	19061.2	23731.4	2359.3	957.7	523.2	886.2	10.5
2005	55665.8	31406.5	4458.3	6394.8	821.6	233.3	46.9	0.0
2006	31208.7	10366.1	6855.0	1490.4	1348.0	280.7	58.1	36.0
2007	247100.9	14940.9	3707.3	2046.6	679.5	886.7	100.0	15.6
2008	86672.2	55580.3	2482.9	657.1	744.0	288.1	749.1	203.1
2009	877972.9	20715.2	16571.4	592.8	357.3	310.6	403.0	185.2
2010	32993.8	304206.9	10352.3	5037.2	272.1	259.2	349.2	122.1
2011	20579.7	12717.4	79367.2	2428.1	1343.6	256.1	147.0	58.1
2012	7210.7	6947.1	4289.0	14181.3	768.1	722.3	111.8	58.9
2013	224645.3	2602.7	2864.8	1441.9	5204.1	408.2	395.8	52.3
2014	29933.8	57670.6	1177.0	963.1	1019.8	2106.0	338.0	139.1
2015	124666.7	27660.7	17862.8	641.1	402.0	756.3	1232.6	88.4
2016	17973.7	50953.4	13233.5	5759.2	457.2	235.0	931.0	287.3
2017	49415.3	6918.5	16135.7	3316.2	944.4	100.0	16.6	212.8
2018	268416.0	9928.8	1646.1	2772.4	1484.4	756.6	27.5	30.3
2019	86436.1	144323.1	4827.1	999.3	1753.2	561.8	342.3	26.5
2020	32867.8	34934.2	54667.9	990.0	552.9	1167.1	1263.0	375.1
2021	74261.7	15950.7	14723.3	12309.2	279.2	88.3	336.4	175.2

Table 8.7. Haddock in 7.b,c, e–k. Fishing mortality- (F) at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	-	0.336	0.733	0.58	0.577	0.568	0.549	0.611	0.611
1994	-	0.326	0.704	0.552	0.542	0.529	0.511	0.569	0.569
1995	-	0.322	0.698	0.552	0.539	0.525	0.508	0.563	0.563
1996	-	0.312	0.687	0.554	0.545	0.529	0.512	0.566	0.566
1997	-	0.324	0.725	0.611	0.622	0.614	0.602	0.662	0.662
1998	-	0.317	0.718	0.616	0.648	0.652	0.647	0.705	0.705
1999	-	0.298	0.681	0.583	0.618	0.626	0.625	0.674	0.674
2000	-	0.326	0.761	0.656	0.703	0.721	0.722	0.762	0.762
2001	-	0.332	0.791	0.692	0.753	0.775	0.783	0.818	0.818
2002	-	0.32	0.78	0.684	0.758	0.789	0.805	0.841	0.841
2003	-	0.308	0.754	0.673	0.758	0.84	0.873	0.911	0.911
2004	-	0.31	0.758	0.673	0.748	0.838	0.869	0.886	0.886
2005	-	0.301	0.717	0.605	0.632	0.673	0.667	0.671	0.671
2006	-	0.257	0.599	0.495	0.501	0.529	0.523	0.553	0.553
2007	-	0.242	0.572	0.478	0.464	0.476	0.466	0.5	0.5
2008	-	0.243	0.591	0.513	0.494	0.499	0.494	0.549	0.549
2009	-	0.224	0.556	0.508	0.505	0.517	0.514	0.581	0.581
2010	-	0.204	0.517	0.494	0.506	0.536	0.544	0.632	0.632
2011	-	0.184	0.476	0.481	0.514	0.566	0.591	0.71	0.71
2012	-	0.174	0.451	0.474	0.521	0.59	0.628	0.776	0.776
2013	-	0.164	0.424	0.442	0.485	0.553	0.594	0.754	0.754
2014	-	0.151	0.399	0.422	0.454	0.523	0.565	0.736	0.736
2015	-	0.138	0.369	0.406	0.436	0.501	0.548	0.731	0.731
2016	-	0.137	0.365	0.414	0.448	0.512	0.553	0.744	0.744
2017	-	0.133	0.364	0.424	0.471	0.539	0.568	0.759	0.759
2018	-	0.127	0.353	0.418	0.463	0.531	0.55	0.739	0.739
2019	-	0.11	0.312	0.387	0.44	0.512	0.534	0.724	0.724
2020	-	0.096	0.272	0.349	0.409	0.483	0.495	0.67	0.67
2021		0.098	0.277	0.361	0.437	0.531	0.544	0.735	0.735

Table 8.8. Haddock in 7.b,c, e–k. Stock numbers-at-age (start of year) (`1000).

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	137524	49768	13058	4520	1235	370	302	189	88
1994	392005	45842	17372	3505	1575	443	138	116	101
1995	475242	132728	15835	4817	1253	599	173	55	85
1996	165752	161429	46200	4372	1722	475	238	70	55
1997	59509	55715	59026	12579	1551	652	189	98	50
1998	87806	19777	19339	16615	4021	533	236	70	53
1999	359811	29275	6949	5319	5684	1297	182	83	41
2000	348755	122416	10656	1974	1874	2006	454	66	44
2001	475463	116929	42918	2772	632	612	643	146	36
2002	976184	159321	40207	10986	845	190	190	195	54
2003	241122	333972	57296	9927	3503	240	60	58	74
2004	341271	82024	116486	15061	3092	1045	66	17	35
2005	236237	113484	30131	30417	4683	902	274	16	14
2006	195043	79149	39074	8111	9976	1558	291	89	11
2007	681770	66138	29855	11916	3145	3913	600	117	37
2008	414184	226343	25472	9523	4513	1312	1610	253	66
2009	2316405	137399	85206	7960	3596	1777	556	665	124
2010	214532	782004	54019	27400	3056	1421	713	230	306
2011	86560	72897	305166	17851	10229	1263	559	280	203
2012	60869	28896	31230	104263	6815	3922	494	208	165
2013	604932	20796	11901	12313	39220	2628	1419	178	117
2014	225966	203091	8773	4354	5532	15239	1027	522	95
2015	496568	77258	84473	3331	1754	2505	5935	401	201
2016	102096	169264	34136	32327	1339	732	1074	2286	198
2017	143397	34294	69828	13695	12646	529	292	424	797
2018	869056	46502	14779	26598	5712	4964	199	113	397
2019	275943	294093	19140	5927	10804	2355	1913	78	172
2020	186296	90507	128613	7439	2491	4492	964	741	83
2021	304566	63104	40065	54649	3094	1043	1824	404	291

Table 8.9. Haddock in 7.b,c,e–k. Stock Summary: Estimated recruitment, spawning–stock biomass (SSB), and average fishing mortality.

Year	R(age 0)	Low	High	SSB	Low	High	F_{bar} (3–5)	Low	High	TSB	Low	High
1993	137524	67900	278540	9267	6188	13880	0.575	0.394	0.84	19783	13990	27975
1994	392005	247144	621773	10974	7617	15810	0.541	0.389	0.753	32099	23884	43139
1995	475242	300708	751076	11602	8259	16297	0.539	0.398	0.729	46548	35747	60612
1996	165752	106170	258771	20604	15368	27625	0.543	0.407	0.724	45167	36043	56599
1997	59509	38128	92881	25319	19321	33177	0.616	0.48	0.79	34879	27737	43860
1998	87806	56018	137632	19822	15556	25258	0.639	0.507	0.804	25763	20960	31666
1999	359811	231157	560067	13115	10534	16328	0.609	0.485	0.764	26487	21450	32706
2000	348755	225057	540440	11742	9688	14231	0.693	0.569	0.844	34376	27579	42848
2001	475463	312325	723813	18392	14106	23980	0.74	0.609	0.899	41599	33481	51686
2002	976184	650852	1464136	23438	18383	29883	0.743	0.612	0.903	62197	50211	77045
2003	241122	166214	349789	27763	22230	34672	0.757	0.617	0.928	73203	58226	92031
2004	341271	235849	493815	39966	31562	50608	0.753	0.599	0.947	63761	52722	77111
2005	236237	162874	342644	28620	23356	35071	0.637	0.515	0.787	55332	46724	65526
2006	195043	133225	285545	24306	20233	29198	0.508	0.397	0.65	45631	38857	53587
2007	681770	472854	982989	22460	19091	26424	0.473	0.372	0.601	66103	53945	81000
2008	414184	288369	594892	21044	17755	24942	0.502	0.408	0.619	75801	62525	91895
2009	2316405	1600195	3353174	32887	26829	40312	0.51	0.416	0.626	190901	145238	250919
2010	214532	138162	333116	39668	33456	47033	0.512	0.418	0.626	180396	141033	230746
2011	86560	60654	123532	98217	77185	124979	0.52	0.425	0.637	123094	99343	152522
2012	60869	41822	88590	71729	57593	89335	0.528	0.429	0.652	82248	67253	100586
2013	604932	421428	868340	46457	37571	57445	0.493	0.402	0.606	87387	72061	105973
2014	225966	154582	330313	29415	24229	35711	0.466	0.38	0.573	76165	63717	91046
2015	496568	346622	711378	40176	32827	49170	0.448	0.363	0.552	94519	78256	114162
2016	102096	70213	148455	37846	31556	45390	0.458	0.371	0.566	76953	64649	91599
2017	143397	97262	211414	44690	37221	53657	0.478	0.383	0.597	64019	54522	75172
2018	869056	576472	1310138	35005	29269	41866	0.471	0.374	0.593	95050	75318	119951
2019	275943	176134	432310	31040	26143	36854	0.446	0.346	0.575	107357	83826	137492
2020	186296	108999	318408	56954	43126	75217	0.414	0.302	0.568	86278	67596	110123
2021	304566	132001	702725	54513	40077	74148	0.443	0.305	0.643	82443	61512	110497

Table 8.10. Haddock in divisions 7.b,c,e–k . Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
F_{ages} 3–5 (2022)	0.443	Average F = (2019–2021) scaled to $F_{ages\ 3–5}$ in 2021
SSB (2023)	47 157	Short-term forecast; in tonnes
R_{age} 0 (2022, 2023)	275 943	Median resampled (1993–2021); in thousands*
Total catch (2022)	15 320	Short-term forecast; in tonnes
Projected landings (2022)	12 308	Short-term forecast, assuming average 2019–2021 landing pattern; in tonnes
Projected discards (2022)	3012	Short-term forecast, assuming average 2019–2021 discard pattern; in tonnes

*** Random resampling of a distribution may lead to different median estimates.**

Table 8.11. Haddock in divisions 7.b,c,e–k. Assumptions made for the interim year and in the forecast.

Haddock in divisions 7.b–k. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2023)	Projected landings (2023)	Projected discards (2023)	F_{total} (2023)	$F_{projected\ landings}$ (2023)	$F_{projected\ discards}$ (2023)	SSB (2024)	% SSB change *	% advice change ^
ICES advice basis									
EU MAP ^^: F_{MSY}	11901	9064	2837	0.353	0.309	0.044	48157	2.12	-25
F = MAP $F_{MSY\ lower}$	7862	6030	1832	0.221	0.194	0.027	52430	11.2	-26
F = MAP $F_{MSY\ upper}$	16424	12419	4005	0.521	0.457	0.064	43270	-8.2	-25.3
Other scenarios									
F = 0	0	0	0	0	0	0	61031	29.4	-100
F_{pa}	20787	15604	5183	0.71	0.62	0.088	38652	-18.0	30
F_{lim}	32583	23767	8816	1.400	1.23	0.17	26386	-44.0	104
$SSB_{2024} = B_{lim}$	50807	34676	16131	4.05	3.55	0.50	9227	-80.4	219
$SSB_{2024} = B_{pa} =$ MSY $B_{trigger}$	46662	32469	14193	3.08	2.70	0.38	12822	-72.8	193
$F = F_{2022}$	14401	10923	3478	0.44	0.39	0.06	45431	-3.66	-9.69
$SSB_{2024} = SSB_{2023}$	12788	9731	3057	0.384	0.337	0.047	47157	0.00	-19.8

*** SSB_{2024} forecast relative to SSB_{2023}.**

**** Numbers presented are estimations of the reference values.**

^ Advice values for 2022 relative to the corresponding 2021 values (MAP advice of 15 946, 10 570, and 21 988 tonnes, respectively; other values are relative to F_{MSY}).

^^ EU multiannual plan (MAP) for the Western Waters (EU, 2019).

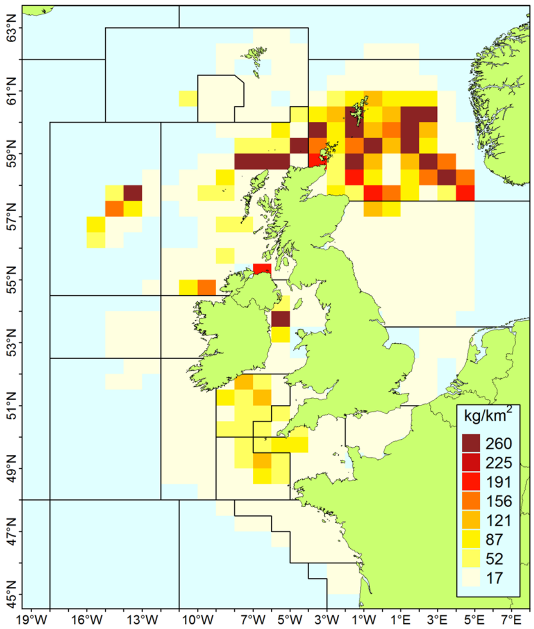


Figure 8.1. International haddock landings by ICES rectangle (all gears; 2016; data from https://stecf.jrc.ec.europa.eu/data-dissemination).

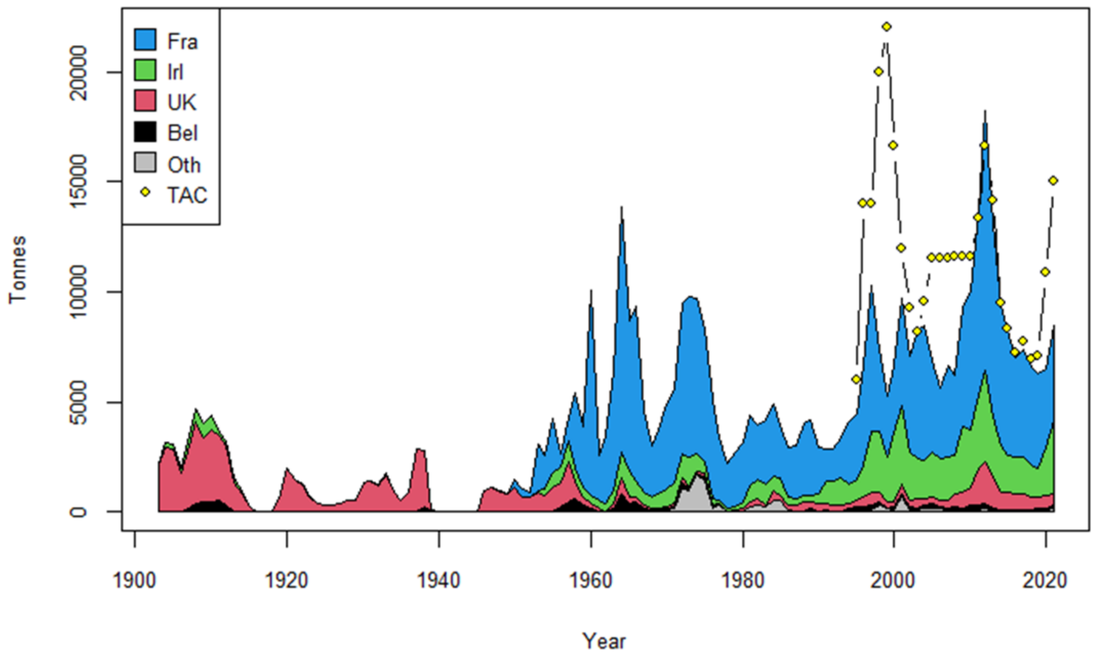


Figure 8.2. Haddock in 7.b,c,e–k. Official ICES landings and TAC of haddock in 7.b–k.

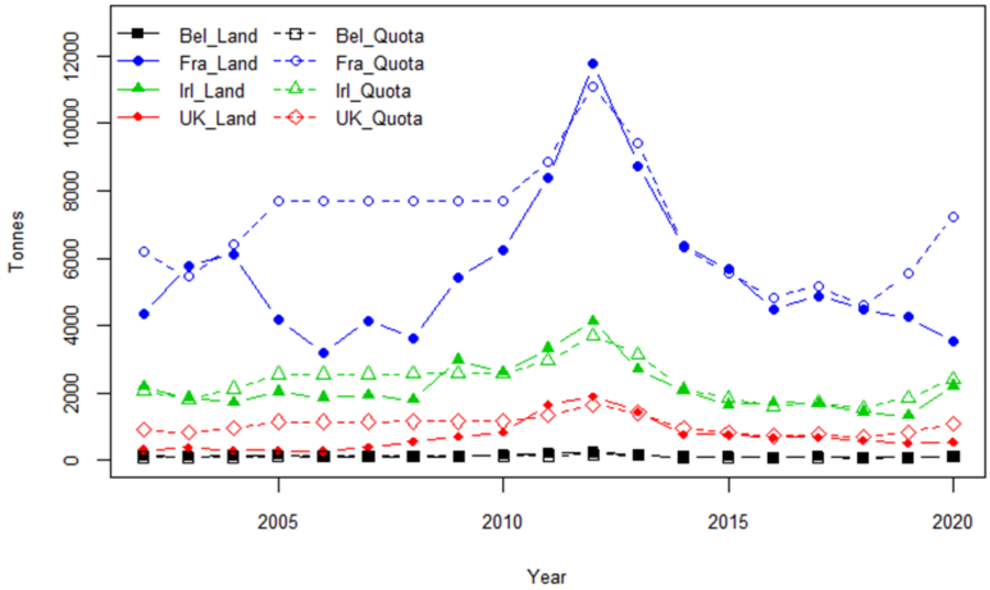


Figure 8.3. Haddock in 7.b,c,e–k. ICES estimates of landings and quota by country.

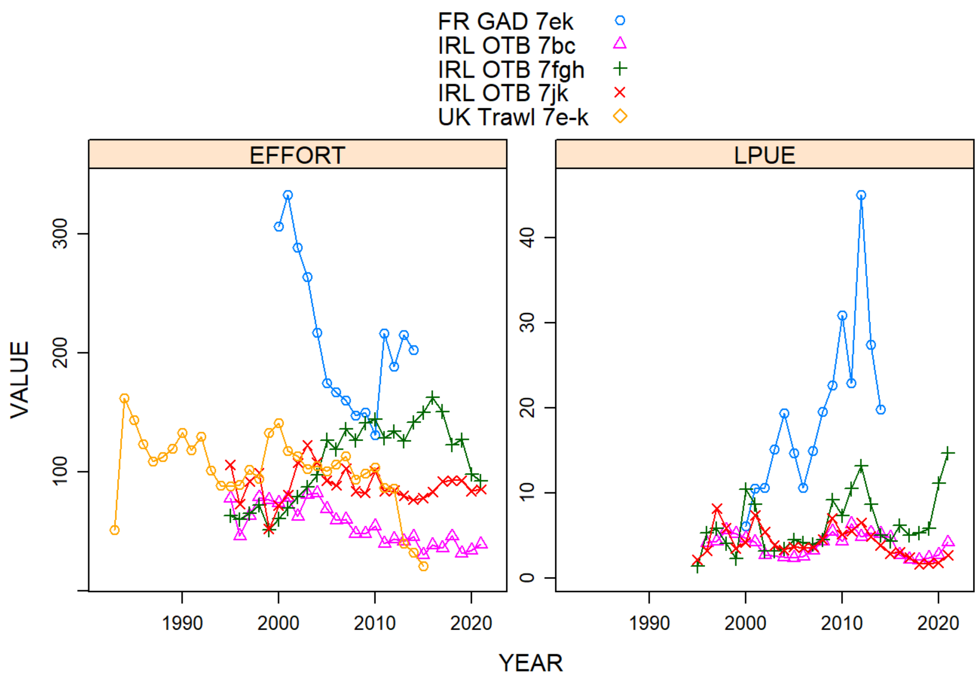


Figure 8.4. Haddock in 7.b,c,e–k. Effort ('1000h) of the Irish Otter trawl fleets, the French demersal otter trawl fleet and for UK trawl fleet (effort in fishing days, rescaled to other fleets) and LPUE (kg/h) for the Irish and French fleets.

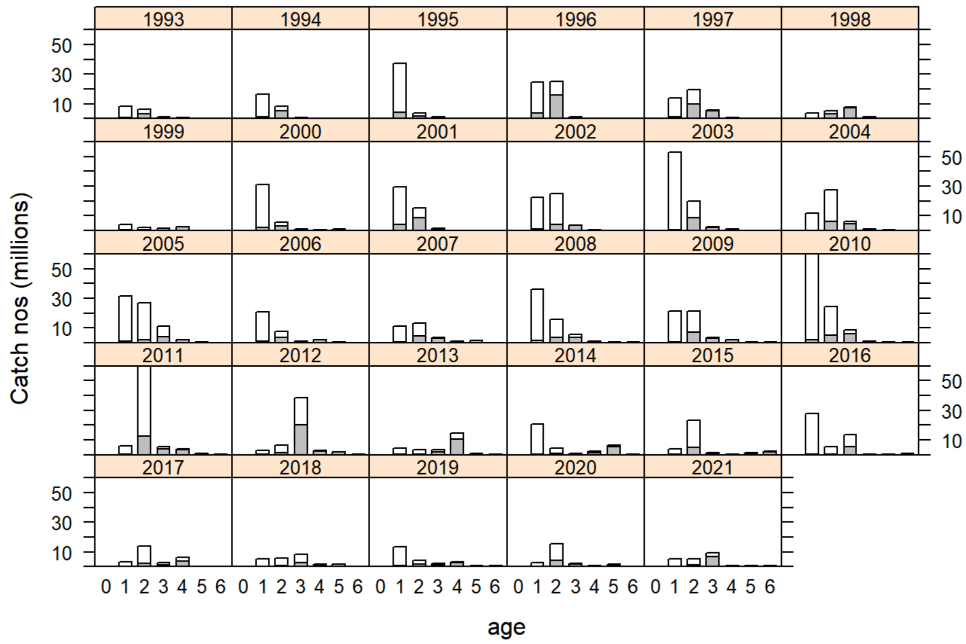


Figure 8.5. Haddock in 7.b,c,e–k. Discarding by number by age class (grey = landings, white = discards).

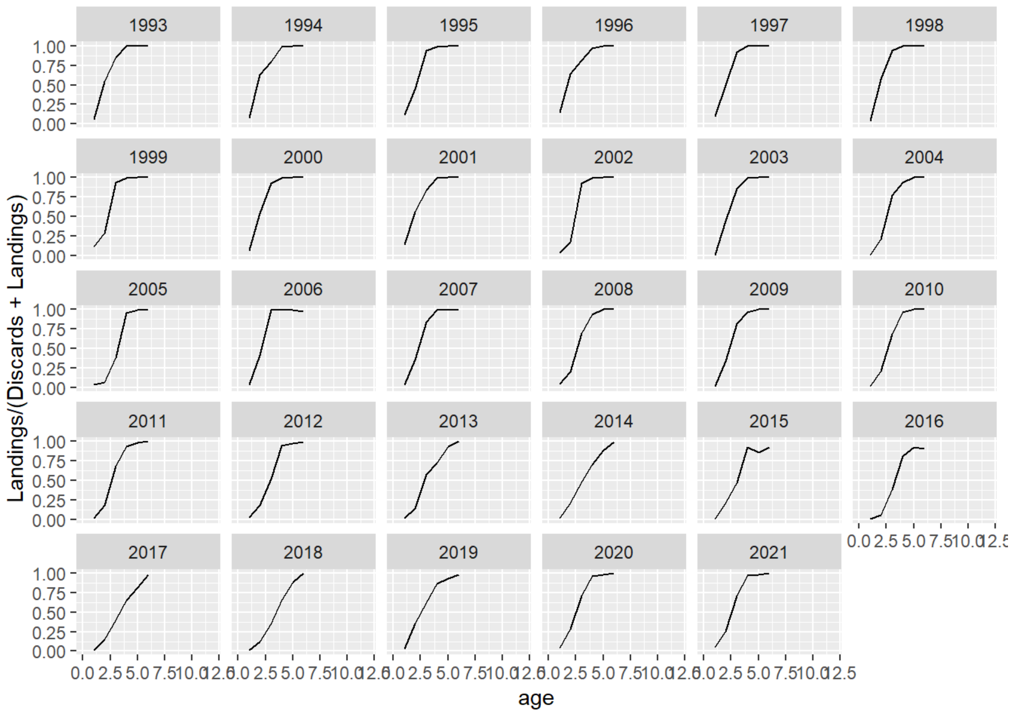


Figure 8.6. Haddock in 7.b,c,e–k. Proportional representation of landings relative to catch (discards + landings) by age, 1993–2021.

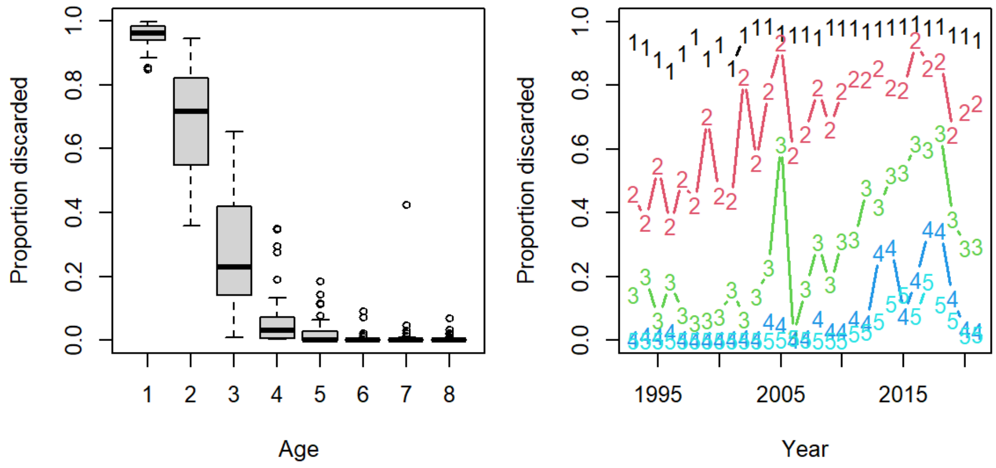


Figure 8.7. Haddock in 7.b,c,e–k. Proportion of discards by age (left) and year (right).

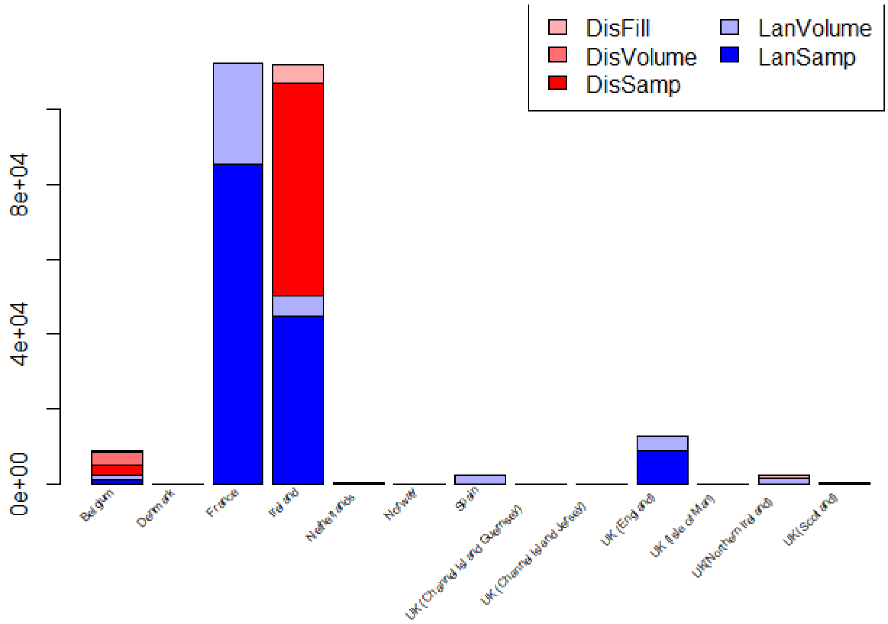


Figure 8.8. Haddock in 7.b,c,e–k . Distribution sampled and unsampled the catches by country and gear.

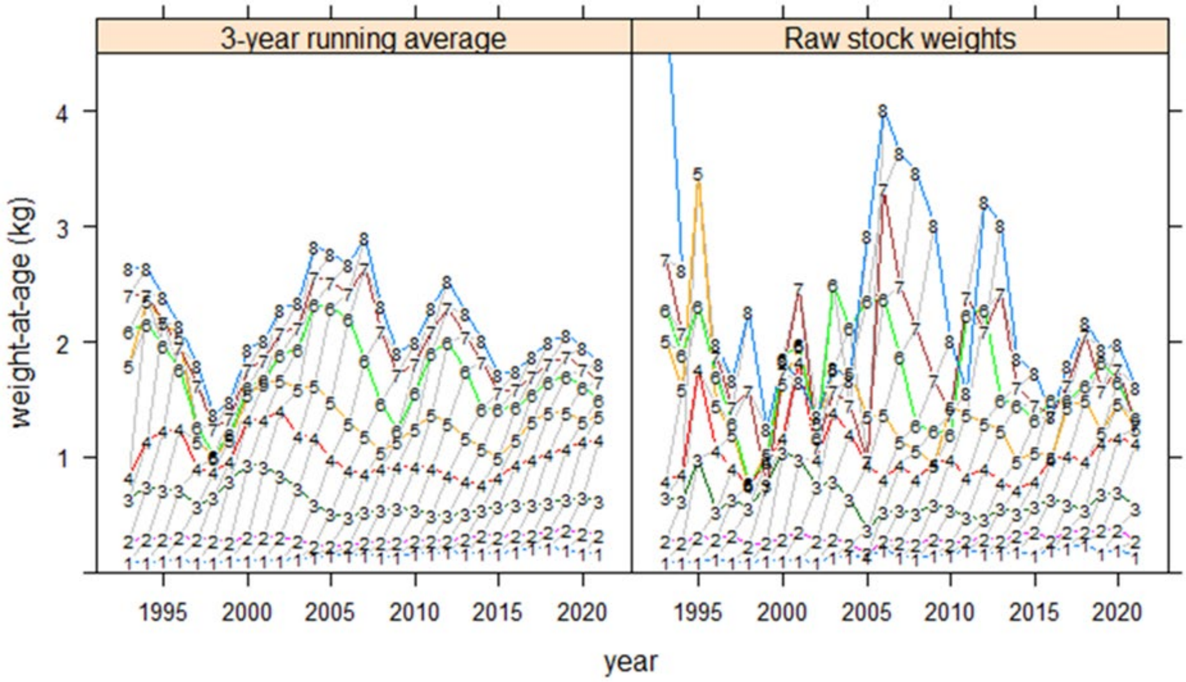


Figure 8.9. Haddock in 7.b,c,e–k. Raw stock weights-at-age (left) and the three-year running average stock weights (right).

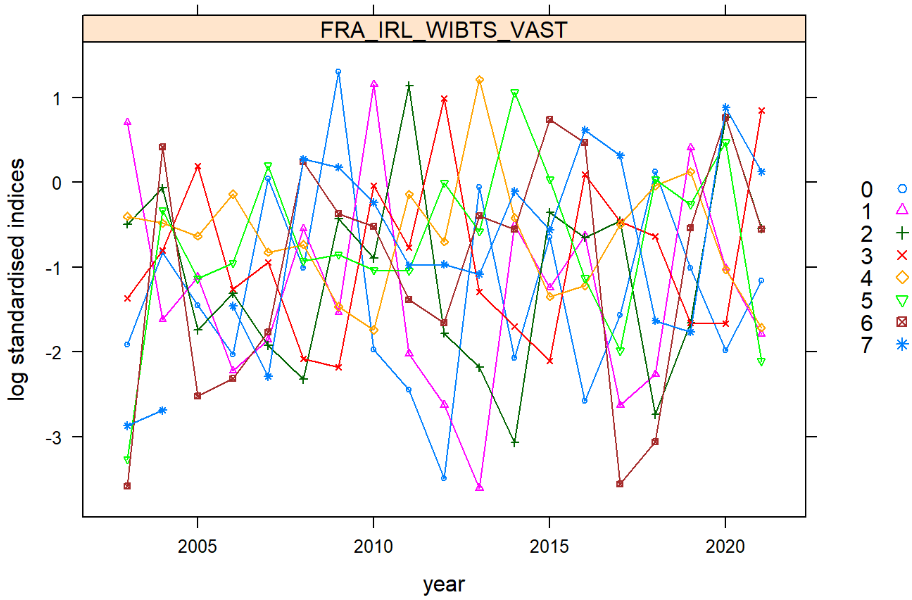


Figure 8.10. Haddock in 7.b,c,e–k. Log VAST standardised tuning fleets by year. The FRA-IRL-IBTS survey is the combined French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS survey.

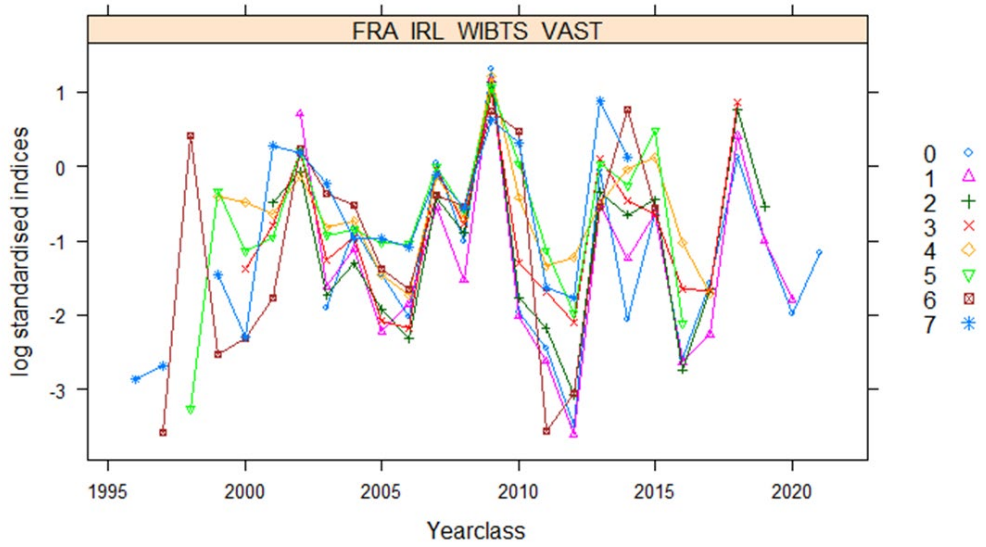


Figure 8.11. Haddock in 7.b,c,e–k. Log VAST standardised tuning fleets by cohort.

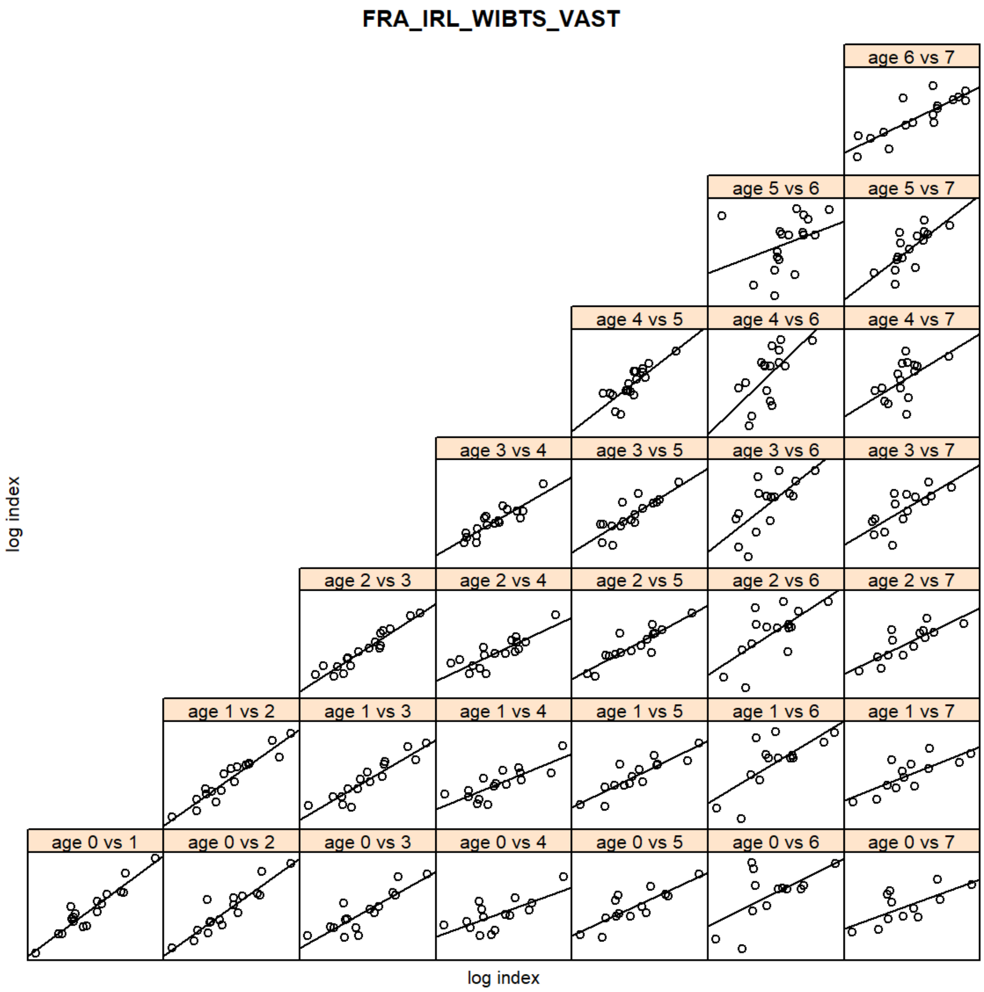


Figure 8.12. Haddock in 7.b,c,e–k. Scatterplot matrix of log indices of cohorts at different ages.

Figure 8.13. Haddock in 7.b,c,e–k. Residuals of the proportions-at-age in catch (upper) and survey (lower).

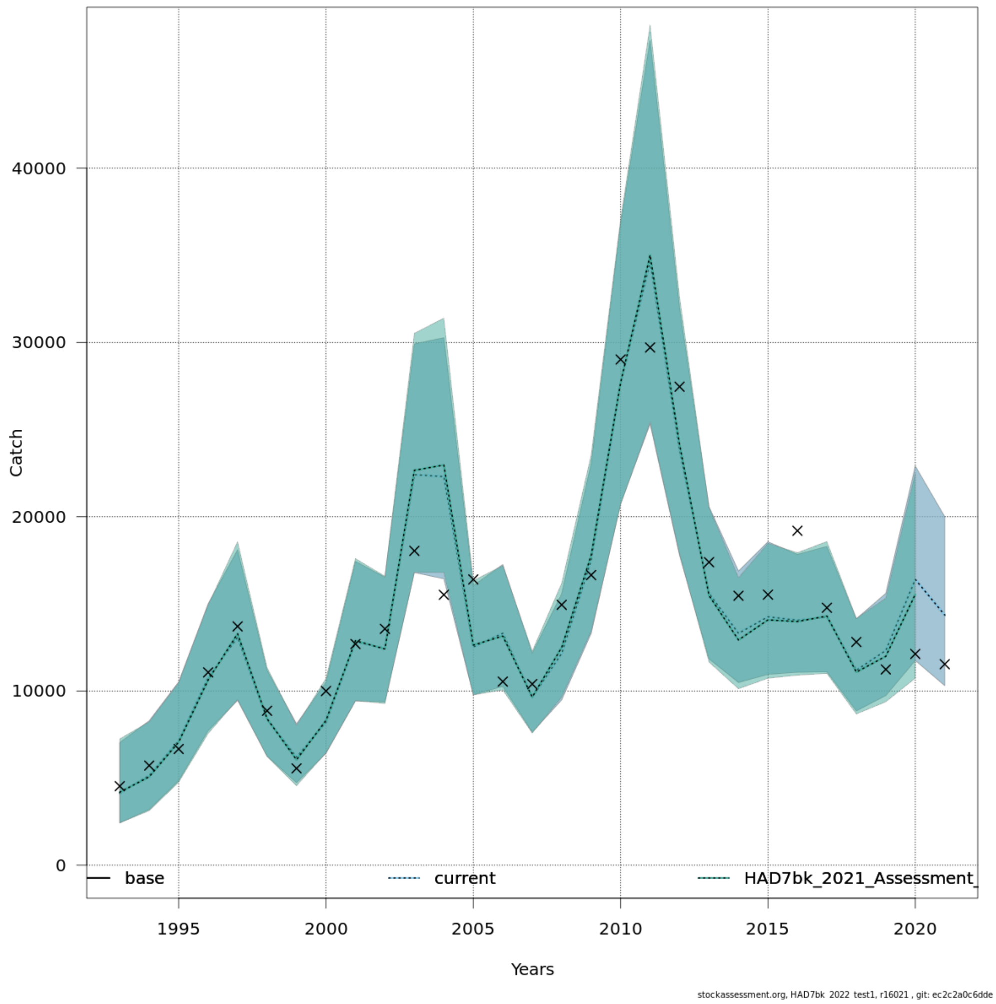


Figure 8.14. Haddock in 7.b,c,e–k. Observed (line) and predicted (x) catches.

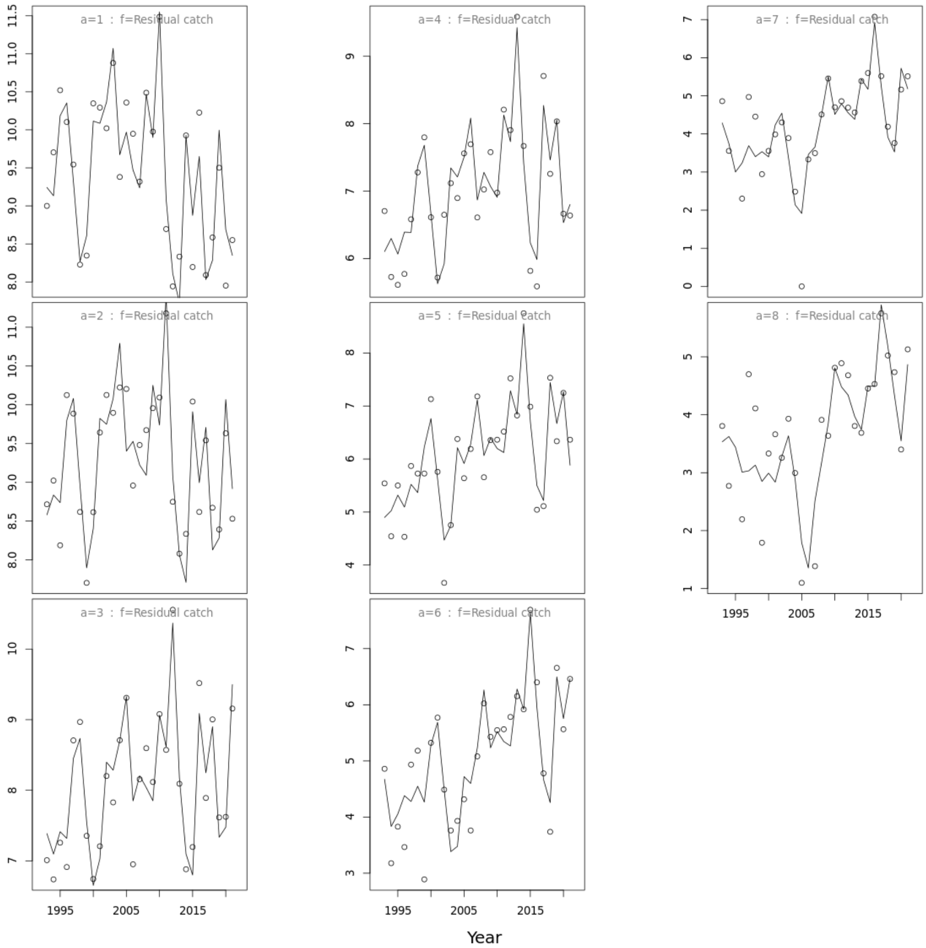


Figure 8.15. Haddock in 7.b,c,e–k. Observed and predicted (circles and line respectively) catch-at-age.

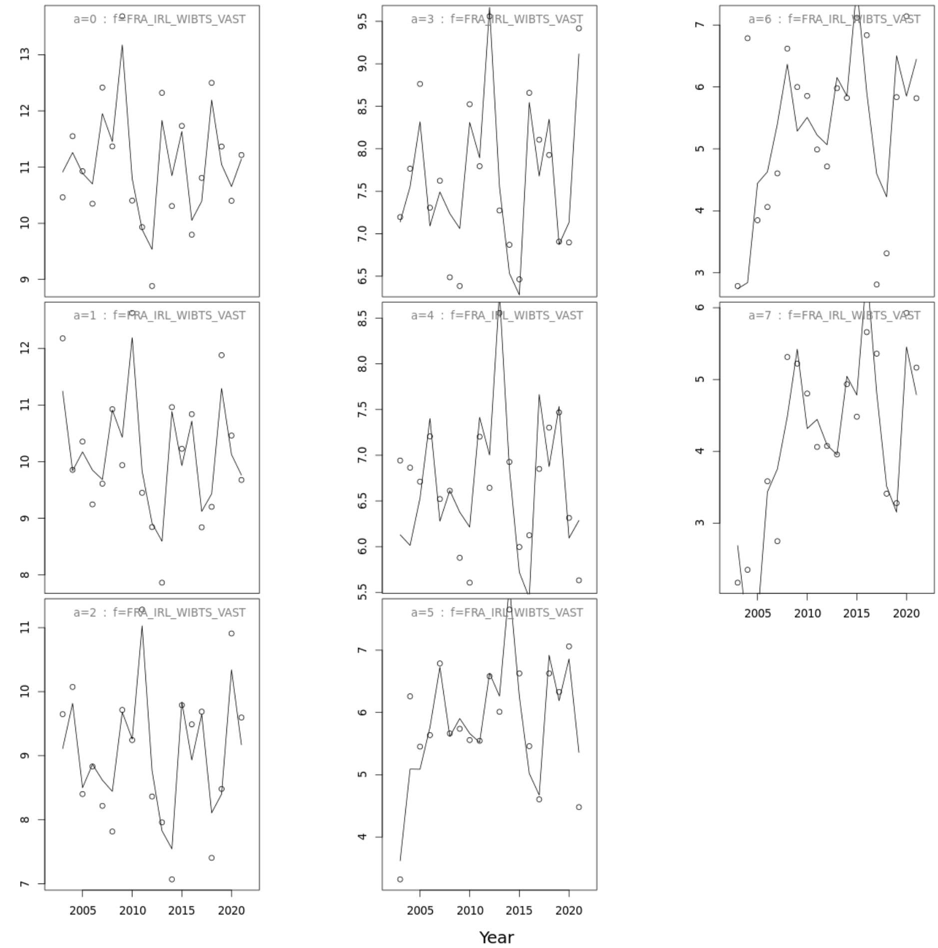


Figure 8.16. Haddock in 7.b,c,e–k. Observed and predicted (circles and line respectively) VAST survey indices.

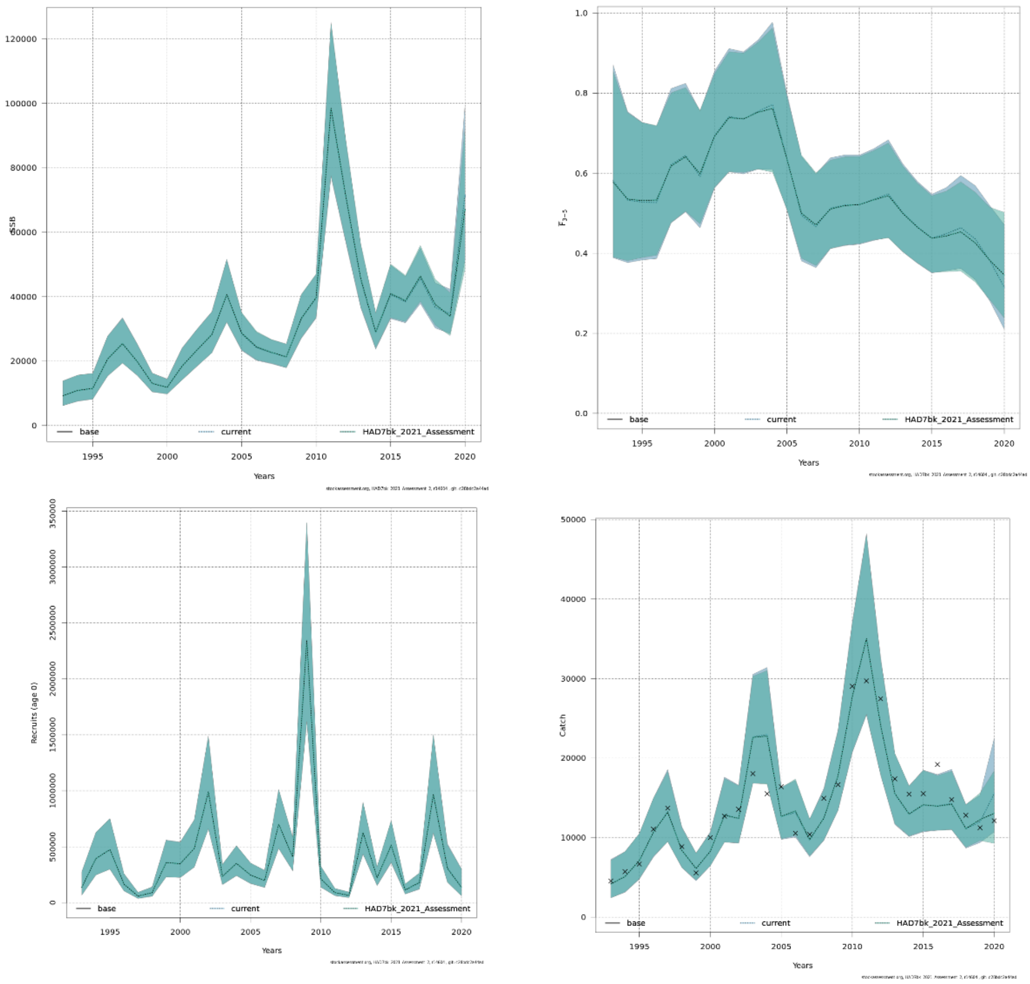


Figure 8.17. Haddock in 7.b,c,e–k. SAM assessment stock summary plots.

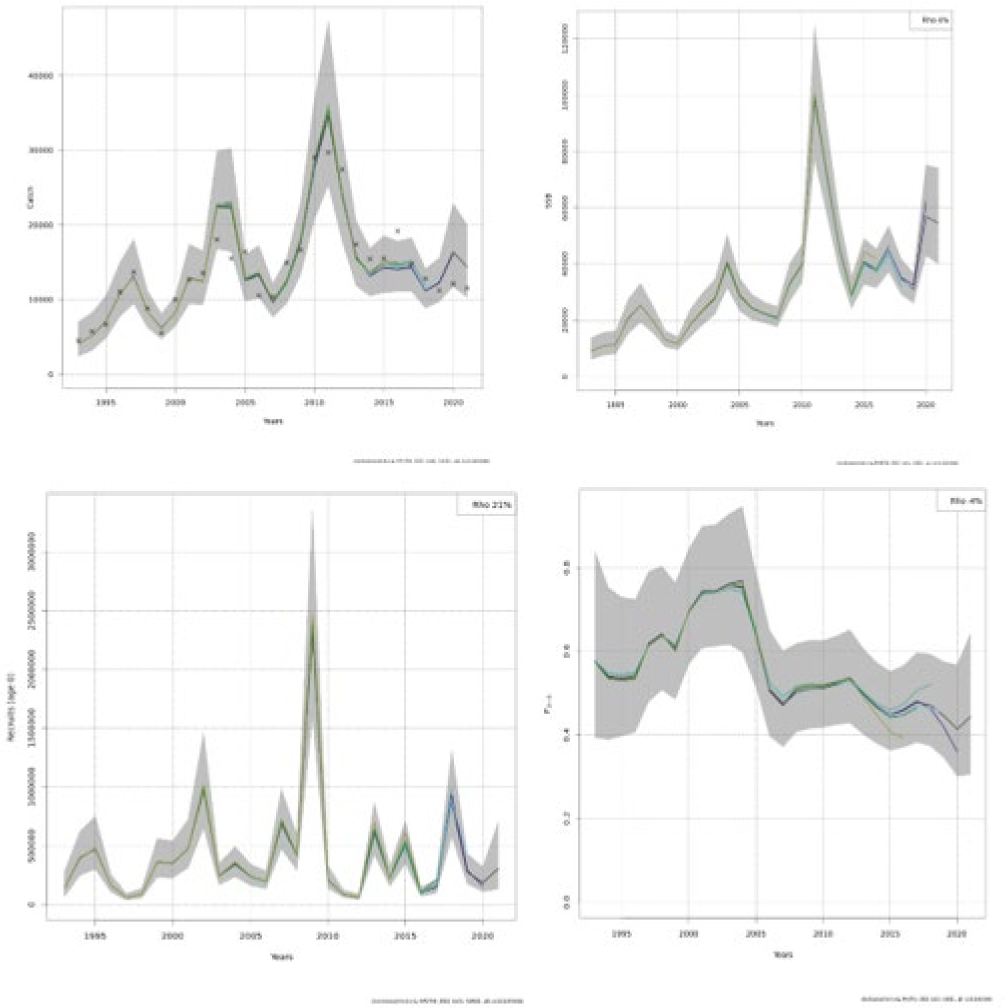


Figure 8.18. Haddock in 7.b,c,e–k. Retrospective analysis of the final SAM assessment run. Catch (top left), SSB (top right), recruitment (bottom left) and F (bottom right).

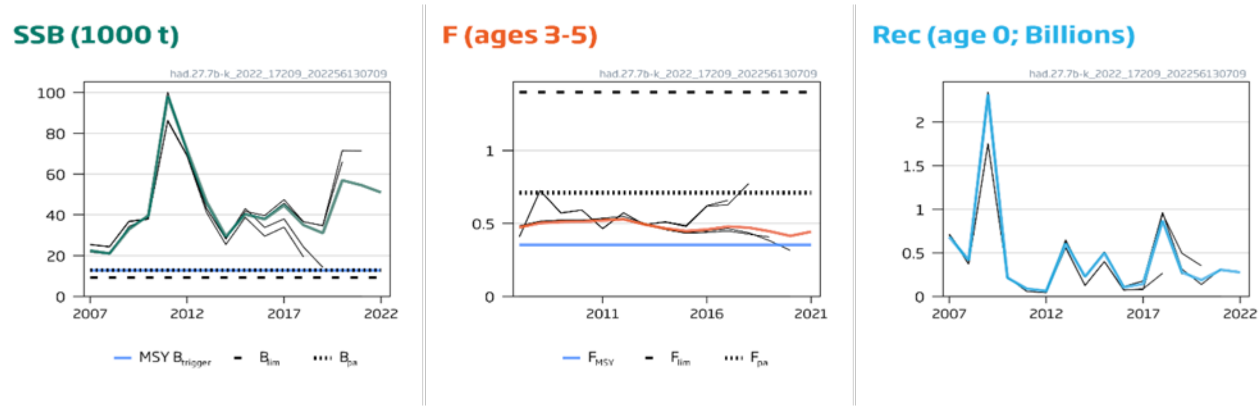


Figure 8.19. Haddock 7.b,c,e–k. Historical assessment results (final-year recruitment and SSB assumptions included). The assessment was benchmarked in 2020, prior to which a different method (ASAP based) was applied.

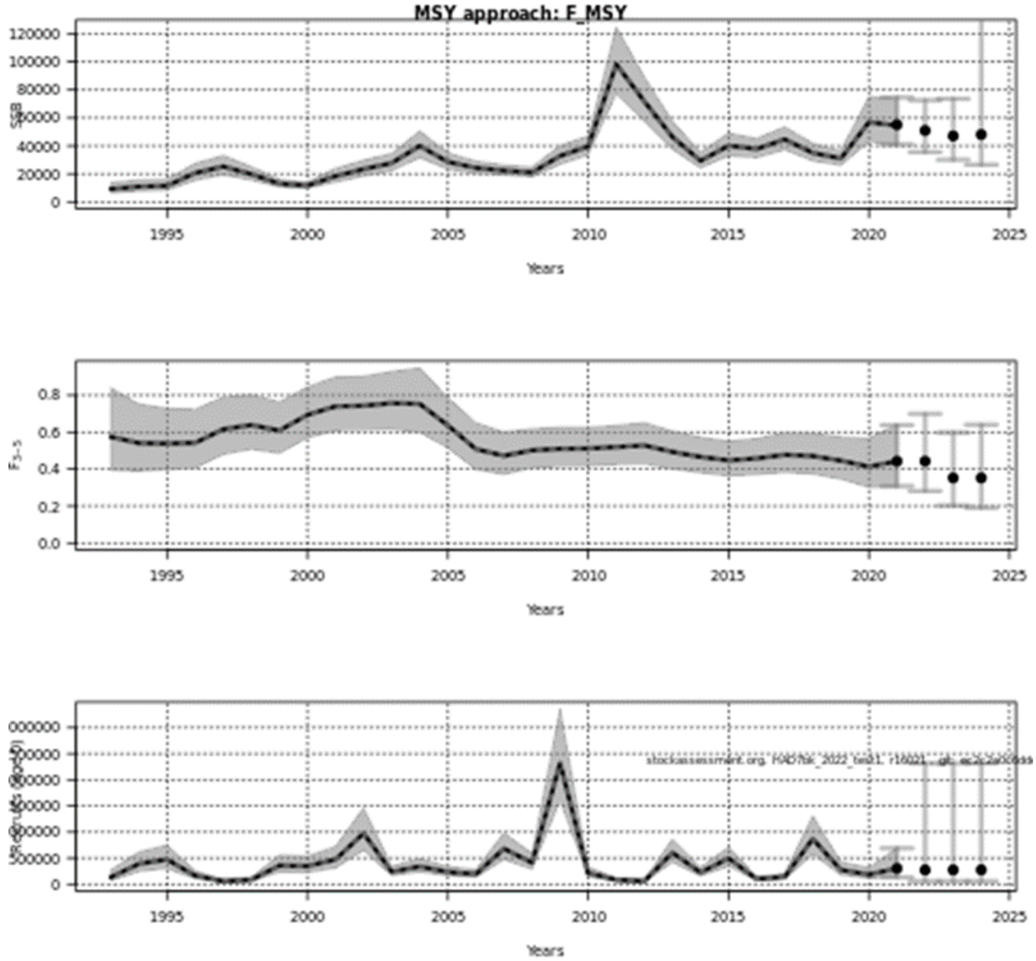


Figure 8.20. Haddock in 7.b,c,e–k. Assessment and forecast of the final SAM run. SSB (top), and F (middle) and recruitment (bottom).

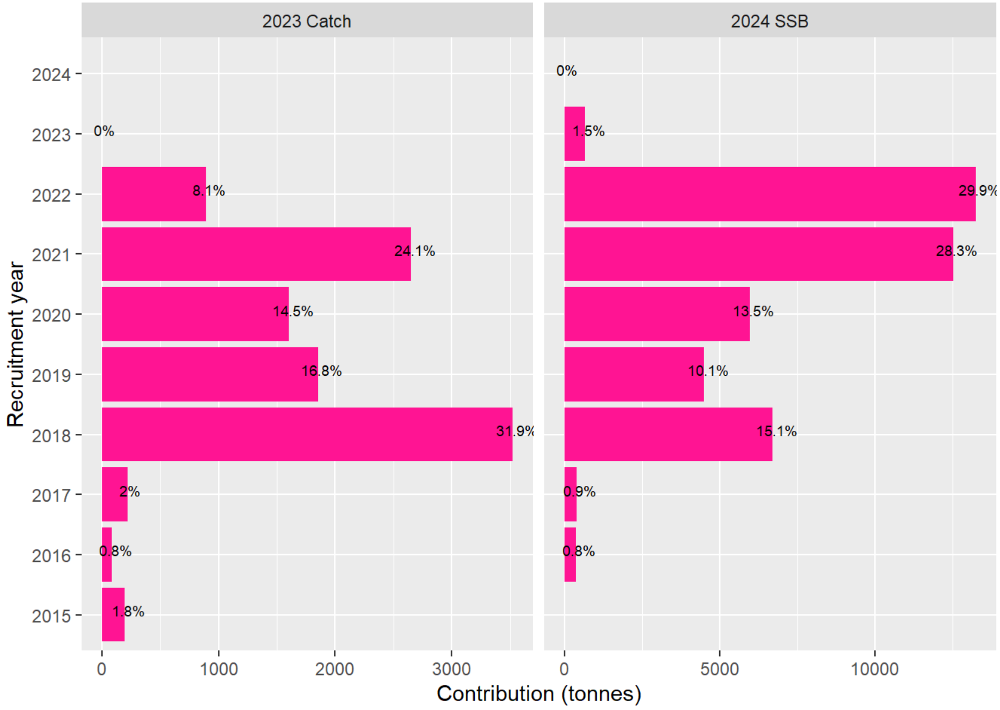


Figure 8.21. Haddock 7.b,c,e–k. Recruitment Contribution of recent year classes used in predictions, and the relative (%) contributions to catch and SSB (by weight) of these year classes.

9 Haddock (*Melanogrammus aeglefinus*) in Division7.a (Irish Sea)

Type of assessment

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

ICES advice applicable to 2022

ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 3038 tonnes.

ICES advice applicable to 2023

ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 2648 tonnes.

9.1 General

Stock descriptions and management units

The stock and management units are both ICES Division 7.a (Irish Sea). Landing taken or reported by Irish vessels in the southern most rectangles of 7.a have been reassigned to the 7.b–k stock since 2003 because they are believed to be part of the Celtic Sea stock.

Management applicable to 2023

Management measures include TAC and effort restrictions as well as technical measures. Due to the bycatch of cod in the haddock fishery, the regulations affecting Irish Sea haddock remain linked to those implemented under the cod recovery plan. From 1st January 2019 all fleets catching haddock are subject to the landing obligation.

TAC regulations for 2022 are given below.

2022 management (Council Regulation (EU) 2020/123)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	7a (HAD/07A.)
Belgium	43	Analytical TAC Article 8(2) of this Regulation applies	
France	196		
Ireland	1171		
Union	1410		
United Kingdom	1628		
TAC	3038		

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

Landings obligation

Since 2017 the landings obligation has been applied to the stock. According to the delegate regulation (EC, 2015) vessels where more than 25% of their landings using trawls and seines in the reference years (2013 and 2014) and area were specified gadoids (cod, haddock, whiting and saithe) were covered by the Landings Obligation. This implies that all catches of haddock in the Irish Sea by those vessels must be landed. From the 1st January 2019 all fleets catching haddock are subject to the landings obligation.

Fishery in 2021

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

The fishery in 2021 was prosecuted by a similar fleet and gears as in recent years, with directed fishing restricted during the cod closure under special conditions. The targeted whitefish fishery that developed during the 1990 using semi-pelagic trawls has declined considerablybut since 2014 there has been a slight increase in activity due to abundance of the haddock stock and increased fishing opportunity. However, this continues to be pursued by a small number of vessel (<15). A proportion of the TAC is taken as bycatch in the *Nephrops* fishery in a mixed fishery.

In 2020, the whitefish fishery was considerably impacted by the COVID-19 pandemic, resulting in lower fishing effort, which is represented in the landings and total catches.

In 2021, the uptake of TAC was 62%. The primary two nations exploiting the stock are the UK and Ireland. The UK used 54% of quota allocation whilst Ireland used 99%. ICES catch estimates are adjusted for reallocation of Irish landings from southern rectangles of 7.a to 7.g, as it is believed that these fish do not belong to the 7.a stock. Table 9.1 gives nominal landings of haddock from the Irish Sea (Division 7.a) as reported by each country to ICES since 1984. Newly introduced gear restriction in the Republic of Ireland waters meant that Northern Irish vessels were unable to fish in ROI waters without modifying their gear accordingly.

9.2 Data

Sampling was reduced in 2021 due to the COVID-19 pandemic. In the first quarter the TR1 fleet was asked to bring the full final haul ashore and the full haul was sampled following on-sea protocols once the vessel had returned to shore. Sampling on the *Nephrops* fleet was low during quarter 1, however resumed in quarters 2–4. The criteria for submitting samples to InterCatch was a minimum of one sample for every 4% of the landings. If that criterium was not met, sampled data were not submitted. As a result, landings only files were submitted to InterCatch for cod and haddock from Ireland.

In Northern Ireland landings and discards sampling in the first quarter was conducted by requesting the TR1 fleet to bring the full final haul ashore. This was sampled following on-sea protocols once the vessel had returned to shore. Sampling on the *Nephrops* fleet was low during quarter 1, however resumed in quarters 2–4.

Landings

Table 9.2 gives the long-term trend of nominal landings of haddock from the Irish Sea (Division 7.a) as reported to ICES since 1972, together with Working Group estimates. The 1993–2005 WG estimates includes sampled-based re-estimates of landings into the main Irish Sea ports. 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 (see Annex 2). The series of numbers-at-age in the international commercial catch is given in Table 9.3. Sampling levels were not considered adequate to derive catch age compositions in 2003.

Discards

Annual discard data were updated for Ireland and Northern Ireland. Historic discard numbers-at-age for the different sampled fleets are given in the stock annex (see Annex 2). Issues relating to the reliability and confidence in the data were addressed at the benchmark assessment for this stock (WKROUND 2013; WKIrish3 2017).

Methods for estimating quantities and composition of discards from UK (NI) and Irish *Nephrops* trawlers are described in the stock annex. Sampling levels have increased in recent years. The large estimates of discarding for *Nephrops* fleets observed by previous WG are still evident. A historic time-series of discard numbers-at-age was constructed at the benchmark. Discard rates are very variable between fleets.

Biological data

The derivation of biological parameters and variables is described in the stock annex (see Annex 2). Natural mortality-at-age was calculated using the methods proposed by Lorenzen (1996) at WKIrish2 (2016). The proportions mature-at-age was also recalculated at the benchmark, and based on the mean proportion observed during the NIGFS-WIBTS-Q1 survey with a smoother fitted that is updated annually.

There is evidence of trends in mean length-at-age over time (Figure 9.1), which needs to be reflected in the stock weights-at-age. Since 2001 the WG calculated stock weights by fitting a von

Bertalanffy growth curve to survey estimates of mean length-at-age in March, described in the Stock Annex. The procedure was updated this year using NIGFS-WIBTS-Q1 (2021) and quarter one commercial landings data for 2021. The time-series of length–weight parameters indicate a reduction in expected weight-at-length since 1996, although this strength of this decline has reduced in recent years (see stock annex for historical data):

	Length–weight parameters		Expected weight-at-length	
Year	A	B	30 cm	40 cm
2006	0.00506	3.165	239	595
2007	0.00469	3.194	244	612
2008	0.00523	3.159	242	601
2009	0.00431	3.224	249	629
2010	0.00413	3.238	250	635
2011	0.00457	3.207	250	629
2012	0.00499	3.174	243	606
2013	0.00451	3.208	247	622
2014	0.00591	3.121	241	591
2015	0.00423	3.232	251	637
2016	0.00420	3.233	250	634
2017	0.004144	3.235	249	631
2018	0.006453	3.108	251	614
2019	0.004911	3.196	258	647
2020	0.005161	3.165	245	608
2021	0.00591	3.1184	239	586

The following parameter estimates were obtained:

Mean LI_{yc} = 45.4 cm; K = 0.428; t_0 = -0.092

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

Year class	Effect	Year class	Effect
1990	0.949	2004	0.983
1991	0.979	2005	0.989
1992	0.954	2006	0.953
1993	1.045	2007	0.986
1994	1.092	2008	0.961
1995	1.018	2009	1.002
1996	1.049	2010	1.058
1997	0.968	2011	1.074
1998	1.024	2012	1.106
1999	1.004	2013	1.014
2000	0.995	2014	1.019
2001	0.971	2015	0.943
2002	0.971	2016	0.920
2003	0.998	2017	1.001
		2018	0.999
		2019	0.999
		2020	
		2021	

The year-class effects show a smooth decline from the mid-1990s coinciding with the rapid growth of the stock and may represent density-dependent growth effects, although other environmental factors may contribute. There is evidence in a reversal of this trend in recent years. The resultant stock weights-at-age are given in Table 9.3. The weight-at-age in the stock shows a decreasing trend over time which appears to have reversed in recent years.

Surveys

The survey data considered in the assessment for this stock are given in Table 9.5. All survey series data for haddock available to the Working Group are described in the stock annex (see Annex 2). The following age-structured abundance indices were used in the assessment:

- UK (NI) groundfish survey (NIGFS) in March (age classes 1 to 4, years 1992–2021). Acronym NIGFS-WIBTS-Q1.
- UK (NI) groundfish survey (NIGFS) in October (age classes 0 to 3; years 1991 to 2021). Acronym NIGFS-WIBTS-Q4.

- UK (NI) Methot-Isaacs-Kidd (NI-MIK) net survey in June (age 0; years 1994–2021, excluding 2020).
- UK Fishery Science Partnership (UKFspW) western Irish Sea roundfish survey (age classes 2 to 5, years 2004–2021, the survey was not conducted in 2014).

The relative log standardised indices for cohorts are plotted against time in Figure 9.2. While 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 could be tracked in all indices, indicating that the different surveys are capturing the prominent year-class signals in this stock (Figure 9.2). Correlation between survey indices by age is positive for all surveys and show high consistency within each survey (Figure 9.3). 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 9.2).

9.3 Assessment

The assessment presented is the single fleet ASAP model.

The following model settings were applied in 2022.

ASAP was used for the assessment and model settings:

Option	Setting
Use likelihood constant	Yes
Mean F (F_{bar}) age range	2–4
Fleet selectivity block 1	Asymptotic
Fleet selectivity block 2	Age coefficients (age 0–5) (0.2;0.5;0.8;1;0.7;0.5)
Fleet selectivity block 3	Age coefficients (age 0–5) (0.3;0.6;0.7;0.7;0.4;0.2)
Fleet selectivity block 4	Age coefficients (age 0–5) (0.1;0.6;0.8;0.9;1.0;1.0)
Discards	Included in catch (not specified separately from landings)
Index units	4 (numbers)
Index month	NIGFS-Q1 (3); NIGFS-Q4 (10); NIMIK (7); UKFSPW(3)
Index selectivity linked to fleet	-1 (not linked)
Index age range	NIGFS-Q1 (1–4); NIGFS-Q4 (0–3); NIMIK (0); UKFSPW(2–5)
Index Selectivity (NIGFS-Q1)	Double logistic
Index Selectivity (NIGFS-Q4)	Asymptotic
Index Selectivity (NIMIK)	
Index Selectivity (UK-FSPW)	Asymptotic
Index CV & ESS (NIGFS-Q1)	Observed strata CV (lower limit 0.1); ESS = 50
Index CV & ESS (NIGFS-Q4)	Observed strata CV (lower limit 0.1); ESS = 50
Index CV & ESS (NIMIK)	Observed station CV (lower limit 0.1); ESS = 50; not used for 2020
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– 2019 (0.15); 2020 (0.175); 2021 (0.15)

Option	Setting
Catch effective sample size	1993–2000 (50); 2003–2006 (1); 2007–2019 (50); 2020 (1); 2021 (50)
Lambda for recruit deviations	0 (freely estimated)
Lambda for total catch	1
Lambda for total discards	NA (discards included in catch)
Lambda for F-Mult in 1st year	0 (freely estimated)
Lambda for F-Mult deviations	0 (freely estimated)
Lambda for index	1 for both indices in the model
Lambda for index catchability	0 for all indices (freely estimated)
Lambda for catchability devs	NA (phase is negative)
Lambda N in 1st year deviations	0 (freely estimated)
Lambda devs initial steepness	0 (freely estimated)
Lambda devs unexpl stock size	0 (freely estimated)

Final update assessment

The final assessment was run with the same settings as established by WKIrish 2017 and described in the stock annex, with the addition of a new selectivity pattern 2013–2021, as applied in 2018 and with the lower starting value for selection of age 0 haddock in the final selectivity block. Hence the changes as described in the stock annex were followed. Discards were combined with the landings as catch in the model.

Figure 9.5 shows the predicted and observed catch. The catch information from 2007 to present is regarded as the most confident, during 2003–2006 it is regarded that catch and sampling information is of relatively lower quality due to lack of sampling opportunity. Before 2003, the catch series is regarded as of intermediate confidence. The model has close fit to the current observed catch 2011–present. Before this time, there is consistent over estimation of the catch 2000–2011 following a period of consistent underestimation of catch 1993–2001. Figure 9.6 shows the residuals of the catch proportions-at-age. For all ages there appears to good fit with no consistent pattern, however, there are some large deviations from observed and predicted for age 5 fish since 2015. Figure 9.7 shows that the catch is dominated by fish <4 years, therefore the large residuals for fish of age 5 are likely to result from low sampling and small contribution of 5+ fish to the stock. The fishing pressure (F)-at-age is shown in Table 9.6.

The residuals of the indices are shown in Figure 9.7. A good fit to the NI-MIK index is seen across the series, although some single year events are observed with a strong deviation in the last two years of the index. For the UKFSPW survey a poor fit in years 2017 and 2018 is evident. This suggests an inability of the model to track the large survey index values, this should be investigated further to explore the method of index calculation. There is strong tracking of both NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 index patterns in general, however, a general trend to under estimate the NIGFS-WIBTS-Q1 index by the model early 2000s to 2013, followed by a period of over-estimation (during years of high abundance, and with the decline in SSB the model is once again underestimating Q1 survey index.

Figure 9.9 shows the residuals of the survey proportions-at-age. For all indices there is close fit between the observed and model predicted fit for fish up to four years old. The largest deviations occur in five year old fish in the UKFSPW survey, which over-reported five year old fish prior to 2014.

Figure 9.10 shows the retrospective analysis. The predicted catch shows no obvious retrospective pattern, neither does the recruitment estimate or fishing pressure. The results of the assessment are given in Table 9.8.

Comparison with previous assessments

Figure 9.11 shows the comparison of the current assessment with previous ASAP and model. There is close agreement with the stock trends of the current assessment and the previous assessment. Mohn's Rho values were calculated for five retrospective runs 2021: 2016 for F_{bar} (0.08), SSB (-0.04) and recruitment (-.51).

State of the stock

Following a period of sustained decline, since 2008, SSB increased 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. Since 2018 SSB has declined from the highest observed level and continued the decline in 2021.

With the very low recruitment in 2020, the SSB is further projected to decline in 2022 and 2023.

9.4 Short-term projections

Short-term projections were performed using FLR libraries. Recruitment for 2022–2024 was estimated at (GM 1993–2019; 364 084 thousands). The F used in the forecast for 2022 was derived as F_{sq}= $F_{average}$ (2018–2021), excluding the 2020 F as this is deemed to be non-representative for the fishery and due to low effort of the TR1 fleet during the COVID-19 pandemic.

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 9.7. The management options output is given in Table 9.9.

Estimates of the relative contribution of recent year classes to the 2023 landings and 2024 SSB are shown in Figure 9.12. The contribution to landings in 2023 consists mainly of the 2018 cohort (72%), with the SSB in 2024 largely be dependent on the 2019 cohort, comprising 67% of the SSB and the 2021 cohort contributing 17%. This is an issue as the SSB will largely consist of the plus group.

9.5 Biological reference points

MSY evaluations

In response to an EU special request to provide plausible and updated F_{MSY} ranges for Irish Sea haddock the management reference points for the stock were re-estimated (Table 9.10 ICES, 2018). The B_{lim} was set as the lowest SBB at which above recruitment in the upper quartile has been observed (2994 t). The S–R plot for Irish Sea haddock shows no obvious S–R relationship mainly because the recruitment is highly variable. B_{lim} was estimated as 4160 t. MSY $B_{trigger}$ is set to 4281 t as the stock has been fished at or below F_{MSY} for more than five years. F_{MSY} median point estimates is 0.28. The upper bound of the F_{MSY} range giving at least 95% of the maximum yield was estimated to 0.35 and the lower bound at 0.20. F_{lim} is estimated to be 0.50 as F with 50% probability of SSB <B_{lim}; F_{pa} as 0.41= $F_{p.05}$ the F that leads to SSB>B_{lim} with 95% probability; F_{lim} x exp(-1.645 x σ); σ = 0.20.

Yield and biomass-per-recruit

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

9.6 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).

9.7 Uncertainties and bias in assessment and forecast

Landings

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment. However, within the assessment there is relocation of reported landings in rectangles 33E2 and 33E3 which are not considered part of the stock. Historic misreporting estimates are considered in the assessment and accounted for, current misreporting is not considered to be a factor within the fishery.

Discards

Sampling levels of discarding at sea remains high. For Northern Irish vessels targeting haddock 27.0% of trips are observed and 2.7% of the main *Nephrops* targeted fishery trips observed, however due to the COVID-19 pandemic the sampling level of the *Nephrops* targeting fishery has been impacted in 2021.

Selectivity

A breakpoint in selectivity is applied in 2000, associated with management measures to reduce fishing mortality on cod. The model included three selectivity blocks in fishery-dependent data, reflecting bycatch and targeted fishery until the year 2000 (asymptotic). After 2007, a fleet selectivity pattern without targeted fishing of older fish (dome-shaped) is applied. During 2000–2007 a transition between a fully selected stock to a regime without targeted fishing of older fish is fitted. The use of current specified selectivity blocks may require review at annual at regular intervals. In the current assessment a new selectivity pattern for the fishery was added from 2013 onwards with full selection of fish older than three years. With advice and management for haddock or other species, it is possible that the character of the fishery may change. A retrospective analysis demonstrated a consistent historic downward revision of the perceived SSB trend, however, there is consistent estimation of F. The initial two years of the retrospective plot show significant deviations. This was considered due to the model having a selectivity block, beginning in 2007, with reduced selection for older fish and the introduction of the UKFspW, with an asymptotic selectivity pattern, starting in 2007. The short period to estimate the selectivity parameters for both the fishery and survey index are considered to contribute to the instability of the model during this time.

Surveys

The survey indices used in the model have spatial coverage of the assessment area. The combination of a recruitment index (NI-MIK), juvenile fish survey indices (NIGFS-WIBTS-Q1 & NIGFS-WIBTS-Q4) and the UKFspW survey aimed at older fish using commercial fishing gear means that the full age range of the stock is covered by survey information.

9.8 Recommendations for next benchmark assessment

This stock was benchmarked through the WKIrish process in 2016–2017. New estimation of the MikNet survey and re-estimation of ages might need an inter-benchmark.

9.9 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 9.1. Landings (t) of HADDOCK in Division 7.a, 1984–present, as officially reported to ICES. (Working Group figures are given in Table 9.2).

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	3	4	5	10	12	4	4	1	8	18
France	38	31	39	50	47	n/a	n/a	n/a	73	41
Ireland	199	341	275	797	363	215	80	254	251	252
Netherlands	-	-	-	-	-	-	-	-	-	-
UK(E&W)[1]	29	28	22	41	74	252	177	204	244	260
UK (Isle of Man)	2	5	4	3	3	3	5	14	13	19
UK (N. Ireland)	38	215	358	230	196	…	…	…	…	…
UK (Scotland)	78	104	23	156	52	86	316	143	114	140
Total	387	728	726	1,287	747	560	582	616	703	730

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	22	32	34	55	104	53	22	68	44	20
France	22	58	105	74	86	n/a	49	184	72	146
Ireland	246	320	798	1,005	1,699	759	1,238	652	401	229
Netherlands	-	-	1	14	10	5	2	-	-	-
UK(E&W)[1]	301	294	463	717	1,023	1,479	1,061	1,238	551	248
UK (Isle of Man)	24	27	38	9	13	7	19	1	-	-
UK (N. Ireland)	…	…	…	…	…	…	…	…	…	…
UK (Scotland)	66	110	14	51	80	67	56	86	47	31
Total	681	841	1,453	1,925	3,015	2,370	2,447	2,229	1,115	674

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Belgium	15	22	23	30	15	7	9	16	13	6.2
France	20	36	20	11	6	3	2	8	3	.7
Ireland	296	139	184	477	319	388	333	434	561	492
Netherlands	-	-		-	-	-	-	-	-	-
UK (England & Wales)[1]	421	344	419	559	521	446	593	355	236	154
UK (Isle of Man)	-	-	-	-	1	1	-	-	<1	<.1
UK (N. Ireland)	…	…	…	…	…	…	…	…	…	…
UK (Scotland)	9	6	9	1	17	1	2			-
United Kingdom									236	154
Total	761	547	655	1078	879	846	939	813	813	654

Country	2014	2015	2016	2017	2018	2019	2020*	2021*
Belgium	7	7	5	5	4	9	4	3
France	0	7	1	5	0	0	0	0
Ireland	541	507	632	114	949	1347	754	1162
Netherlands	-	-		-	-	-	-	-
UK (England & Wales)[1]	-	-		-	-	-	-	-
UK (Isle of Man)	<1	<1		-	-	-	-	-
UK (N. Ireland)	…	-		-	-	-	-	-
UK (Scotland)	-	-		-	-	-	-	-
United Kingdom	426	634	825	1240	1580	1197	539	884
Total	974	1154	1463	2363	2532	2553	1296	2048

*** Preliminary.**

[1] 1989–2015 Northern Ireland included with England and Wales.

n/a = not available.

Table 9.2. Haddock in 7.a. Total international landings of haddock from the Irish Sea, 1972–present as officially reported to ICES. Working Group figures, assuming 1972–1992 official landings to be correct, are also given. The 1993–2005 WG estimates include sampled-based estimates of landings at a number of Irish Sea ports. Sample-based evidence confirms more accurate catch reporting since 2006. Landings in tonnes live weight. Since 1993 the landings have been corrected to exclude catches from the southernmost rectangles, which are not considered part of this stock.

Year	Official landings	WG landings	ICES discards**	ICES catch	% Discard	Landings taken or reported in rectangles 33E2 and 33E3
1972	2204	2204				
1973	2169	2169				
1974	683	683				
1975	276	276				
1976	345	345				
1977	188	188				
1978	131	131				
1979	146	146				
1980	418	418				
1981	445	445				
1982	303	303				
1983	299	299				
1984	387	387				
1985	728	728				
1986	726	726				
1987	1287	1287				
1988	747	747				
1989	560	560				
1990	582	582				
1991	616	616				
1992	703	656				
1993	730	813				
1994	681	1042				
1995	841	1736	780	2516	31%	16
1996	1453	2981	709	3690	19%	33
1997	1925	3547	895	4442	20%	36

Year	Official landings	WG landings	ICES discards**	ICES catch	% Discard	Landings taken or reported in rectangles 33E2 and 33E3
1998	3015	4874	1015	5889	17%	28
1999	2370	4095	634	4729	13%	34
2000	2447	1357	802	2159	37%	11
2001	2229	2246	269	2515	11%	74
2002	1115	1817	387	2204	18%	82
2003	674	659	-	-	-	64
2004	761	1217	392	1609	24%	53
2005	547	666	551	1217	45%	35
2006	655	633	306	939	33%	26
2007	1078	886	722	1608	45%	222
2008	879	786	643	1429	45%	194
2009	846	581	579	1160	50%	285
2010	939	679	508	1187	43%	267
2011	813	446	307	753	41%	374
2012	n/a	343	599	942	64%	473
2013	654	254	283	537	53%	410
2014	953	518	488	1006	49%	444
2015	1154	833	652	1451	44%	322
2016	1463	1008	298	1306	23%	455
2017	2363	1662	333	1995	17%	715
2018	2532	1993	568	2561	22%	532
2019	2537	1778	672	2450	27%	759
2020	1296	7423	234	976	24%	554
2021	2048	1219	674	1891	36%	827

Table 9.3. Haddock in 7.a: stock weights-at-age.

	Age					
	0	1	2	3	4	5
1993	0.02	0.095	0.42	1.043	1.759	2.563
1994	0.02	0.083	0.338	0.968	1.999	3.028
1995	0.02	0.085	0.347	0.785	1.708	3.219
1996	0.02	0.083	0.359	0.788	1.319	2.718
1997	0.022	0.07	0.357	0.863	1.435	2.391
1998	0.018	0.06	0.253	0.743	1.384	2.165
1999	0.016	0.057	0.226	0.561	1.294	2.262
2000	0.017	0.048	0.23	0.51	0.966	2.123
2001	0.018	0.051	0.201	0.548	0.93	1.822
2002	0.017	0.056	0.215	0.472	0.983	1.637
2003	0.017	0.05	0.229	0.485	0.798	1.52
2004	0.017	0.041	0.199	0.509	0.816	1.306
2005	0.018	0.031	0.165	0.459	0.902	1.347
2006	0.014	0.033	0.128	0.378	0.803	1.435
2007	0.019	0.034	0.136	0.299	0.68	1.402
2008	0.014	0.037	0.139	0.31	0.515	1.167
2009	0.025	0.042	0.153	0.326	0.563	0.98
2010	0.017	0.04	0.176	0.357	0.58	0.945
2011	0.018	0.052	0.167	0.407	0.624	0.937
2012	0.012	0.057	0.209	0.375	0.688	0.96
2013	0.023	0.059	0.233	0.491	0.673	1.115
2014	0.022	0.038	0.238	0.512	0.812	1.04
2015	0.017	0.046	0.153	0.577	0.97	1.371
2016	0.021	0.047	0.192	0.354	1.015	1.533
2017	0.022	0.054	0.137	0.347	0.809	1.476
2018	0.023	0.068	0.196	0.472	0.601	0.987
2019	0.024	0.066	0.121	0.480	0.636	1.04
2020*	0.023	0.063	0.151	0.433	0.682	1.168
2021	0.034	0.064	0.117	0.372	0.552	0.967

***Average weights 2017–2019.**

Table 9.4. Haddock in 7.a: Catch numbers-at-age.

	Age					
	0	1	2	3	4	5
1993	790	1568	2066	19	1	1
1994	16857	821	258	922	3	2
1995	950	8079	1587	107	220	5
1996	15171	1380	5510	728	16	30
1997	347	8828	1528	2388	201	16
1998	4209	4642	10532	252	488	42
1999	4944	3200	3436	4773	25	57
2000	287	11118	1771	466	457	418
2001	7883	425	3246	1074	30	89
2002	2105	8229	789	2063	142	18
2003	2000	2000	400	800	50	25
2004	10797	2056	421	827	46	78
2005	6048	4342	1416	285	193	34
2006	5334	2971	656	524	63	51
2007	2282	3537	3371	671	60	47
2008	2158	4569	2052	837	242	36
2009	4327	2490	2021	629	121	36
2010	3933	4058	834	464	309	59
2011	5669	2324	942	239	97	52
2012	6235	2799	774	201	27	28
2013	4525	1162	558	156	41	17
2014	1392	3854	1265	189	17	10
2015	518	1915	3087	324	63	5
2016	512	1845	907	1079	109	108
2017	231	783	2234	829	1096	78
2018	56	1039	5325	2845	426	526
2019	415	5276	4528	604	1132	467
2020	0	3269	559	282	598	367
2021	716	782	3064	2256	364	133

Table 9.5. Haddock in 7.a: Available tuning data and maturity ogive

```
IRISH SEA haddock, 2013 WG,ANON,COMBSEX,TUNING DATA(effort, nos-at-age)
101
NIGFS-WIBTS-Q1
1993 2021
1 1 0.21 0.25
0 5
```

1	0	139	569	31	0	0
1	0	644	58	183	0	0
1	0	24823	437	0.1	43	0
1	0	1065	3743	67	3	1.1
1	0	25118	474	1457	44	2.1
1	0	3913	8694	70	105	1.1
1	0	6058	680	2072	16	11.1
1	0	14028	1853	64	147	5
1	0	3277	6990	770	40	20.1
1	0	28755	842	1059	78	1.1
1	0	6966	14162	341	356	26.1
1	0	19945	2379	2206	45	35.1
1	0	24488	6454	406	234	15
1	0	13444	12721	2194	91	33.1
1	0	20918	11325	3661	240	27
1	0	7480	12009	2559	495	48.1
1	0	9345	3888	2877	163	42
1	0	17058	1765	524	239	27
1	0	17278	5543	299	67	50
1	0	13509	5266	1095	38	13
1	0	8245	5202	751	119	20
1	0	33807	2260	773	108	22
1	0	15495	22420	1297	407	44
1	0	14418	9109	5594	205	38
1	0	4321	18887	5524	323	33
1	0	7897	4683	7086	1709	1369
1	0	38570	6789	814	832	183
1	0	16709	28889	2571	260	257
1	0	2478.3	17390.6	6690.7	550.6	41

```
NIGFS-WIBTS-Q4
1991 2021
1 1 0.83  0.88
0 4
```

1	**36.127**	**0.716**	**3.965**	**0**	**0**
1	2.042	151.766	1.171	0.959	0
1	15.289	101.536	0.753	0	0.045
1	1067.99	13.327	13.2	0.092	0.001
1	160.434	398.722	1.81	0.886	0.04
1	365.679	10.521	39.889	0.08	0.034
1	685.913	28.002	0.527	1.633	0.001
1	59.867	93.66	5.533	0.125	0.104
1	584.902	19.354	28.408	0.947	0
1	146.491	105.115	1.18	3.372	0
1	552.309	59.354	30.746	0.295	0.27
1	666.652	167.224	7.422	4.911	0.001
1	476.2	122.094	12.378	0.264	0.052
1	387.556	111.692	35.717	2.228	0.441
1	94.667	102.086	37.1	11.654	0.375
1	88.61	46.338	23.832	1.991	0.33
1	451.303	45.695	6.139	4.891	0.23
1	219.533	82.392	5.858	1.752	0.973
1	207.925	42.145	7.808	1.044	0.093
1	165.294	79.593	12.05	1.275	0
1	1004.22	8.279	1.531	0.179	0
1	339.218	311.607	68.768	3.016	0.423
1	455.385	81.189	108.663	2.309	0.362
1	99.046	154.865	52.207	4.273	0.281
1	191.946	42.885	90.324	15.934	6.202
1	690.663	167.338	12.891	16.507	2.003
1	21.174	179.518	169.383	8.19	0.58
1	133.3	1209	50	13.2	0.66

```
NIMIK
1994 2021
1 1 0.38 0.47
0 0
```

1	47000
1	1700
1	47800
1	14500
1	2500
1	15400
1	1700
1	17100
1	1200
1	4250
1	25970
1	8250
1	40240
1	3820
1	6638
1	18540
1	4532
1	6606
1	9818
1	28325
1	12892
1	48463
1	1800
1	26900
1	30954
1	23942
1	NA
1	16800

```
FSP Haddock: Tuning data
101
UKFspW
2005 2021
1 1 0.15 0.25
0 5
```

1	0	0	1.774	1.506	4.981	0.291
1	0	0.308	7.749	7.336	0.546	1.115
1	0	0.208	42.727	37.286	6.289	0.697
1	0	0	4.657	12.836	7.213	0.794
1	0	0	0.662	3.99	1.443	0.541
1	0	0.627	1.422	3.78	2.753	0.866
1	0	0.048	0.598	1.976	1.121	0.81
1	0	0.27	4.135	4.772	0.79	0.226
1	0	0.035	3.684	7.674	1.742	0.176
1	NA	NA	NA	NA	NA	NA
1	0	0.437	31.2	19.349	5.051	0.554
1	0	0	0	59.769	12.592	6.205
1	0	0	19.748	85.536	246.488	10.838
1	0	0	0	36.397	62.861	55.448
1	0	0.339	4.357	25.291	40.261	22.519
1	0	0	0	26.759	16.887	16.539
1	0	0	0	43.95	18.27	14.03

Maturity ogive at-age.

Year	0	1	2	3	4	5+
1993	0	0	0.762	0.99	1	1
1994	0	0	0.762	0.99	1	1
1995	0	0	0.784	0.99	1	1
1996	0	0	0.78	0.99	1	1
1997	0	0	0.777	0.99	1	1
1998	0	0	0.775	0.99	1	1
1999	0	0	0.773	0.99	1	1
2000	0	0	0.771	0.99	1	1
2001	0	0	0.769	0.99	1	1
2002	0	0	0.767	0.99	1	1
2003	0	0	0.763	0.99	1	1
2004	0	0	0.762	0.99	1	1
2005	0	0	0.771	0.99	1	1
2006	0	0	0.784	0.99	1	1
2007	0	0	0.797	0.99	1	1
2008	0	0.01	0.809	0.99	1	1
2009	0	0.01	0.817	0.99	1	1
2010	0	0.01	0.825	0.99	1	1
2011	0	0.01	0.833	0.99	1	1
2012	0	0.01	0.841	0.99	1	1
2013	0	0.02	0.847	0.99	1	1
2014	0	0.02	0.846	0.99	1	1
2015	0	0.02	0.848	1	1	1
2016	0	0.03	0.85	1	1	1
2017	0	0.03	0.851	1	1	1
2018	0	0.03	0.853	1	1	1
2019	0	0.03	0.853	1	1	1
2020	0	0.03	0.854	1	1	1
2021	0	0.06	0.855	1	1	1

Table 9.6. Haddock in 7.a: F-at-age.

	Age					
	0	1	2	3	4	5
1993	0.032533	0.3892	0.861503	0.91716	0.920132	0.920281
1994	0.04169	0.498745	1.103981	1.175304	1.179113	1.179304
1995	0.038902	0.465392	1.030154	1.096706	1.100261	1.100439
1996	0.02542	0.304103	0.673138	0.716625	0.718948	0.719065
1997	0.028486	0.340777	0.754316	0.803049	0.805651	0.805782
1998	0.032306	0.386486	0.855495	0.910764	0.913716	0.913864
1999	0.045476	0.544036	1.204235	1.282034	1.28619	1.286398
2000	0.03025	0.361882	0.801032	0.852782	0.855546	0.855685
2001	0.123163	0.404643	0.73249	0.786004	0.551934	0.393002
2002	0.154348	0.507099	0.917957	0.985021	0.691685	0.492511
2003	0.126182	0.414562	0.750445	0.805271	0.565464	0.402636
2004	0.122492	0.402438	0.728499	0.781721	0.548927	0.390861
2005	0.100897	0.331491	0.600069	0.643908	0.452154	0.321954
2006	0.057887	0.190183	0.344271	0.369423	0.25941	0.184711
2007	0.096329	0.316482	0.572899	0.614753	0.431682	0.307377
2008	0.144765	0.505022	0.575852	0.547062	0.299876	0.145633
2009	0.112144	0.391222	0.446092	0.423789	0.232303	0.112817
2010	0.163635	0.570852	0.650915	0.618372	0.338965	0.164617
2011	0.088326	0.308132	0.351348	0.333782	0.182965	0.088856
2012	0.093186	0.325087	0.370681	0.352148	0.193032	0.093745
2013	0.007748	0.06819	0.120837	0.120837	0.120837	0.120837
2014	0.01022	0.089946	0.159389	0.159388	0.159389	0.159389
2015	0.009024	0.079421	0.140738	0.140738	0.140738	0.140738
2016	0.006105	0.053732	0.095216	0.095216	0.095216	0.095216
2017	0.007814	0.068769	0.121862	0.121862	0.121862	0.121862
2018	0.009921	0.087311	0.15472	0.15472	0.15472	0.15472
2019	0.010692	0.094097	0.166745	0.166745	0.166745	0.166745
2020	0.004897	0.043096	0.076369	0.076369	0.076369	0.076369
2021	0.010063	0.088559	0.156931	0.156931	0.156931	0.156931

Table 9.7. Forecast input data.

Variable	Value	Source	Notes
F ages 2–4 (2021)	0.159	ICES (2022a)	Fsq = $F_{average(2018-2021)}$ excluding 2020
SSB (2023)	11817	ICES (2022a)	Short-term forecast
R age 0 (2022 and 2023) (thousand)	364084	ICES (2022a)	Geometric mean (1993–2019)
Catch (2022)	1846	ICES (2022a)	Short-term forecast, fishing at F_{sq}
Wanted catch * (2022)	1545	ICES (2022a)	Average discard rate (2019–2021)
Unwanted catch *(2022)	301	ICES (2022a)	Average discard rate (2019–2021)

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

Table 9.8. Haddock in Division 7.a. Assessment summary. All weights are in tonnes, recruitment (age 0) in thousands. Low and high refer to 95% confidence intervals.

Year	Recruitment age 0			SSB			Land-ings	Dis-cards*	F ages 2–4		
	Low	Value	High	Low	Value	High			Low	Value	High
1993	116600	152730	188861	1640	2288	2937	813	365	0.40	0.68	0.96
1994	421898	520923	619948	1408	2161	2913	1042	468	0.40	0.72	1.03
1995	39534	63565	87597	1492	2312	3131	1736	780	0.52	0.94	1.37
1996	1087922	1340978	1594034	3603	4773	5944	2981	709	0.48	0.75	1.02
1997	149800	210066	270332	2638	3952	5265	3547	895	0.57	0.94	1.31
1998	260460	342308	424155	6375	8051	9727	4874	1015	0.68	0.98	1.27
1999	539265	669483	799702	4062	5504	6946	4095	634	0.97	1.46	1.95
2000	64449	98739	133030	1769	2646	3522	1357	802	0.60	1.04	1.48
2001	553816	698136	842457	2689	3746	4803	2246	269	0.48	0.73	0.98
2002	91899	132937	173975	1840	2790	3741	1817	387	0.59	0.95	1.31
2003	309707	419741	529776	2224	3233	4243	1517	390	0.46	0.77	1.09
2004	500341	642619	784897	1418	2371	3324	1217	392	0.43	0.76	1.09
2005	384571	490288	596004	1389	2229	3070	666	551	0.35	0.63	0.90
2006	450802	558138	665473	1968	2885	3803	633	306	0.198	0.35	0.51
2007	169235	219870	270505	2828	3859	4889	886	722	0.39	0.59	0.80
2008	115259	154177	193095	2834	3931	5027	786	643	0.34	0.52	0.71
2009	256751	328391	400031	2211	3343	4475	581	579	0.25	0.40	0.55
2010	186107	242003	297898	1804	2862	3920	679	508	0.37	0.61	0.84
2011	229755	297411	365066	1538	2539	3540	446	307	0.189	0.32	0.45
2012	210728	286718	362707	1776	2823	3869	343	599	0.197	0.34	0.47
2013	1092158	1375162	1658166	2315	3638	4960	254	282	0.076	0.133	0.191
2014	475004	626559	778114	3470	5107	6744	518	488	0.103	0.172	0.24
2015	706489	927283	1148077	8046	10842	13637	833	652	0.092	0.150	0.21
2016	207449	293473	379497	10782	14457	18131	1008	298	0.062	0.101	0.139
2017	273576	383175	492774	13817	18505	23192	1662	333	0.079	0.129	0.178
2018	632164	872205	1112247	13986	18988	23990	1993	568	0.097	0.163	0.23
2019	389547	570827	752108	11121	15753	20385	1778	672	0.101	0.175	0.25
2020	25337	61526	97716	10081	14579	19078	742	177	0.042	0.079	0.116
2021	176790	321561	466333	10297	14944	19590	1219	672	0.088	0.161	0.23
2022		370456**			14274						

*** Discards estimates available since 2007, prior to 2007 discards estimates are based on limited sampling.**

****Geometric mean recruitment 1993–2019.**

Table 9.9. Haddock in Division 7.a. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2023)	Wanted catch* (2023)	Un-wanted catch* (2023)	F_{total} (2023)	F_{wanted} (2023)	$F_{un-wanted}$ (2023)	SSB (2024)	%SSB change **	%Advice change ^
ICES advice Basis									
EU MAP ***: F_{MSY}	2648	2107	541	0.28	0.171	0.109	9321	-21	-12.8
F = MAP $F_{MSY\ lower}$	1956	1560	396	0.2	0.122	0.078	10044	-15	-35.6
F = MAP $F_{MSY\ upper}$	3216	2554	661	0.35	0.21	0.137	8732	-26	5.9
Other scenarios									
F = 0	0	0	0	0	0	0	12115	2.5	-100
F = F_{pa}	3676	2915	761	0.41	0.25	0.16	8258	-30	21
F = F_{lim}	4323	3421	903	0.5	0.3	0.195	7597	-36	42.3
F = F2022	1587	1267	320	0.15947	0.097	0.062	10432	-11.7	-47.8
SSB2023 = B_{lim}	9125	7029	2095	1.52547	0.93	0.6	2994	-75	200
SSB2023 = B_{pa}	7834	6092	1742	1.15805	0.71	0.45	4160	-65	158
SSB2023=MSY $B_{trigger}$	7704	5997	1708	1.12632	0.69	0.44	4281	-64	154
SSB2023=SSB2022	280	224	56	0.02653	0.0162	0.0104	11817	0	-90.8

*** "Wanted" and "unwanted" catch are used to describe fish that would be landed and discarded in the absence of the EU landing obligation, based on discard rate estimates for 2019–2021.**

**** SSB 2024 relative to SSB 2023.**

***** EU multiannual plan (MAP) for the Western Waters (EU, 2019).**

^ Advice value for 2023 relative to the F_{MSY} advice value for 2022 (3038 tonnes).

Table 9.10. Haddock in 7.a Management reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	4281 tonnes	5th percentile of BMSY; Irish Sea haddock has been fished at, or below F_{MSY} for >five years.	ICES (2018a)
	F_{MSY}	0.28	Median point estimates of EqSim with segmented regression stock–recruitment relationship	ICES (2018a)
	$F_{MSYLower}$	0.20	F at 95% of MSY below F_{MSY}	ICES (2018a)
	$F_{MSYUpper}$	0.35	F at 95% of MSY above F_{MSY}	ICES (2018a)
Precautionary approach	B_{lim}	2994 tonnes	Lowest observed SSB with >75th percentile recruitment	ICES (2018a)
	B_{pa}	4160 tonnes	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.20$	ICES (2018a)
	F_{lim}	0.50	F with 50% probability of SSB <B_{lim}	ICES (2018a)
	F_{pa}	0.41	$F_{p0.05}$; the F that leads to SSB>B_{lim} with 95% probability	ICES (2018a)
Management plan	SSB_{MGT}	Not applicable		
	F_{MGT}	Not applicable		

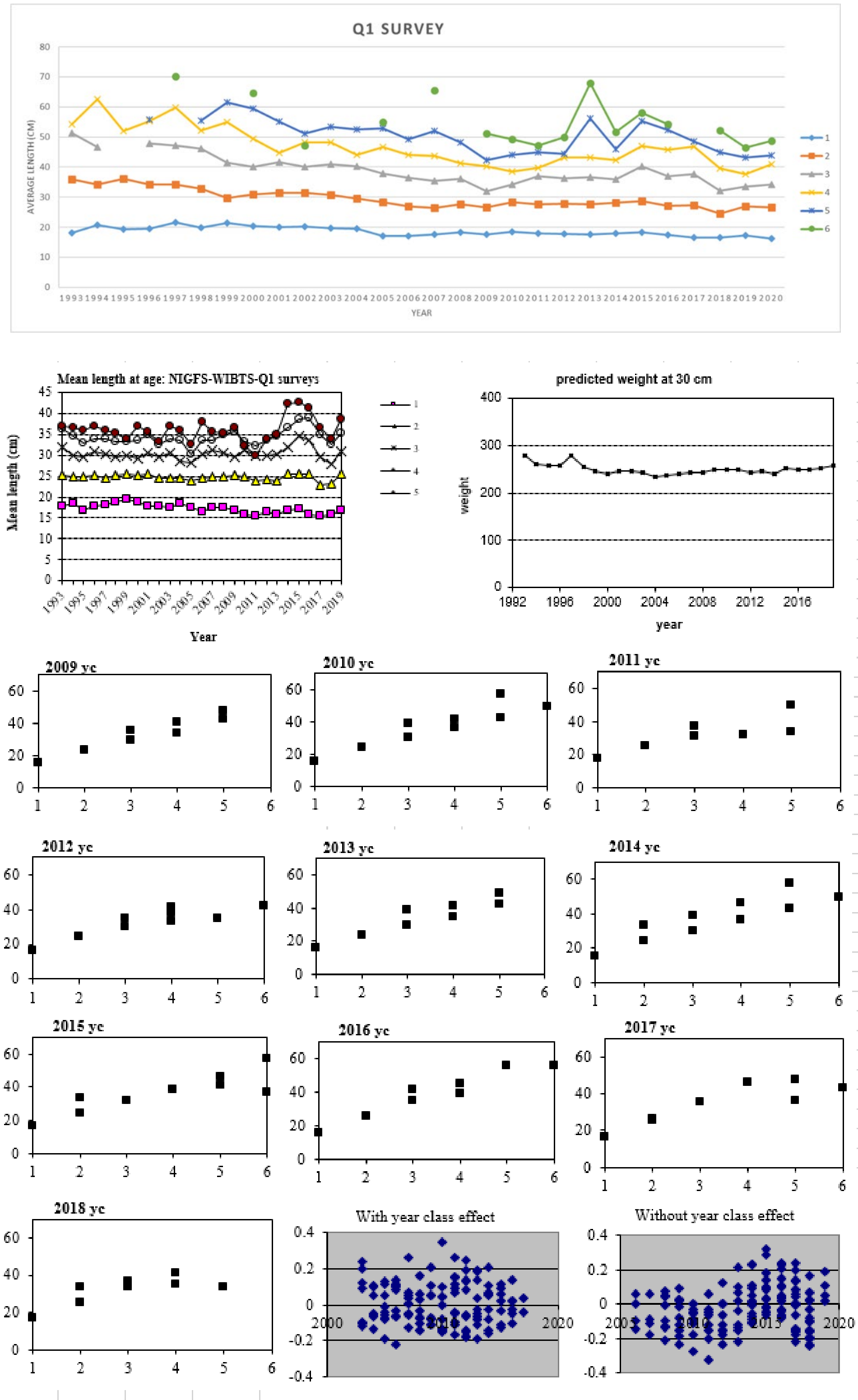


Figure 9.1. Haddock in 7.a: Growth of haddock in the Irish Sea. Top two panels: mean length-at-age in UK(NI) groundfish surveys in March (NIGFS-WIBTS-Q1), by year and age, and expected mean weight-at-length based on length–weight parameters from each survey. Lower panels: mean length-at-age from March 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.

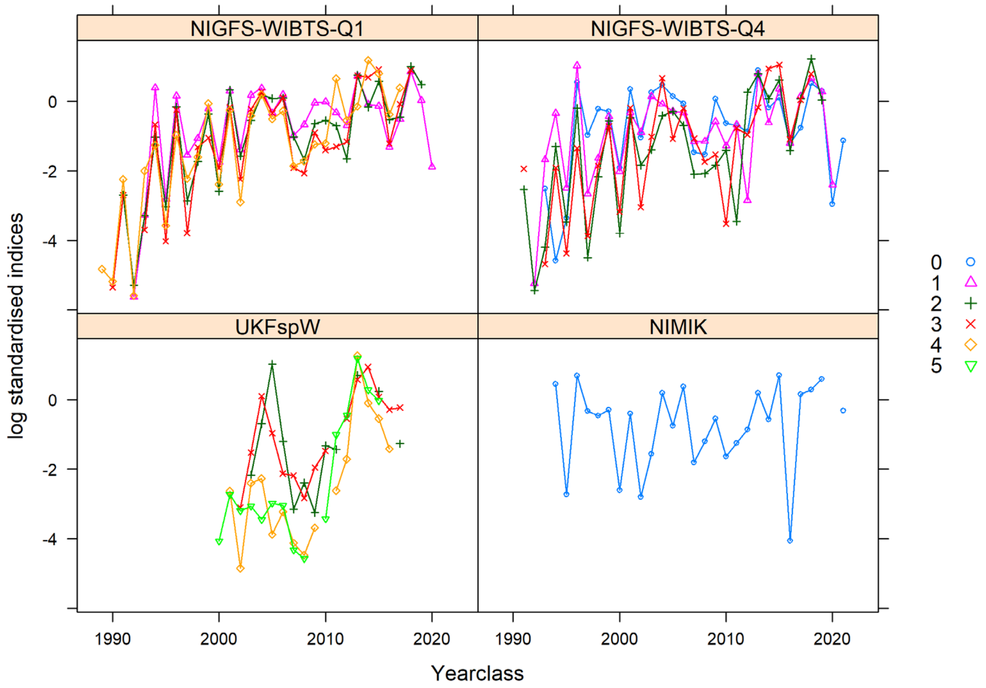
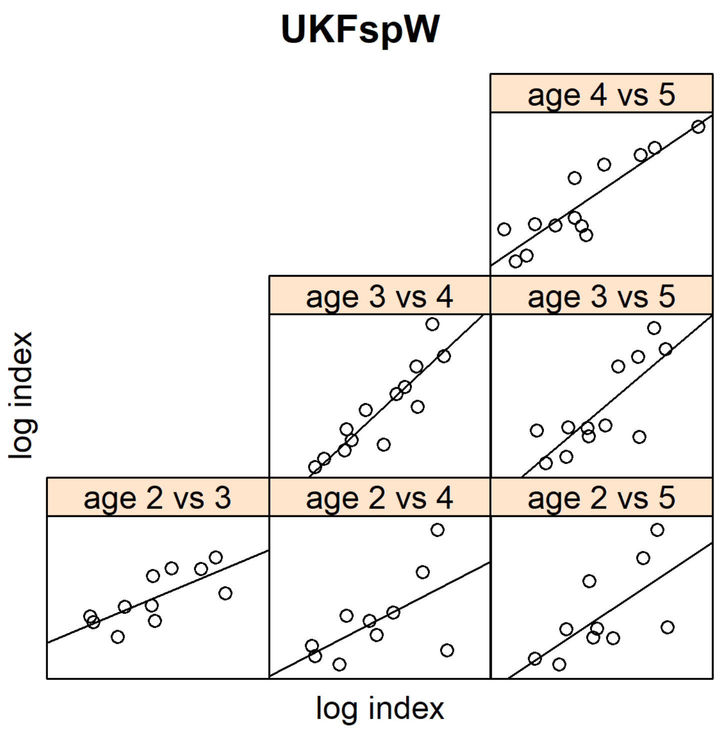


Figure 9.2. Haddock in 7.a: Trends in log-standardised survey indices.



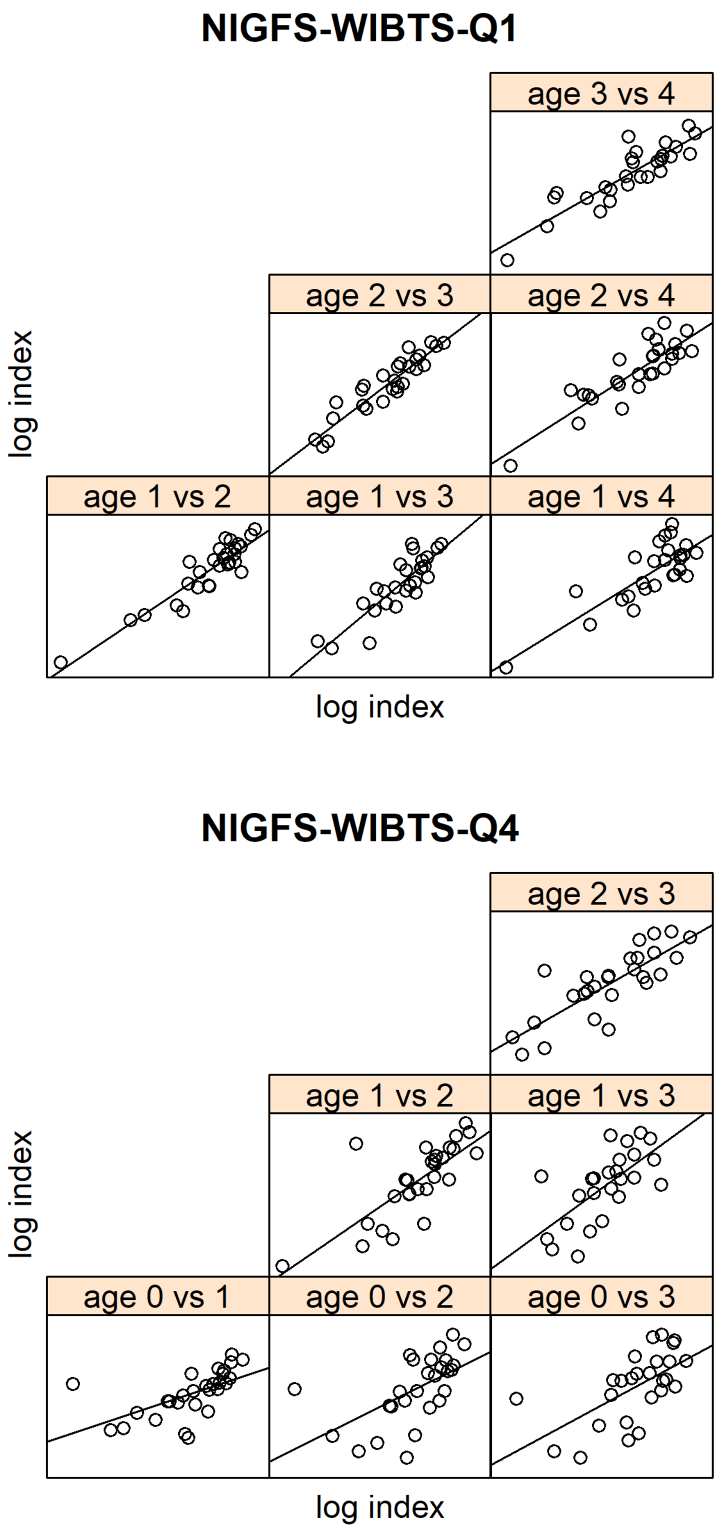


Figure 9.3. Haddock in 7.a: Scatterplot matrix of log indices of cohorts at different ages.

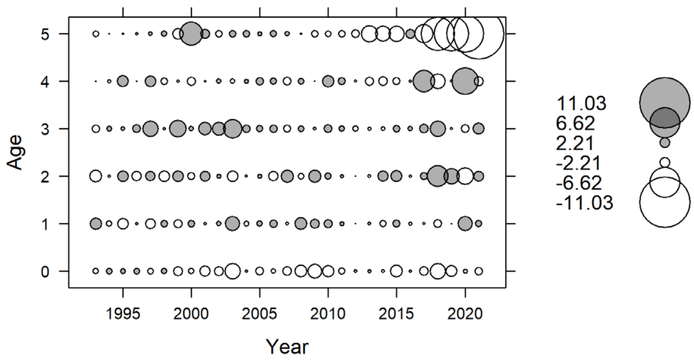


Figure 9.4. Standardised residuals from fitted and observed catch age proportions.

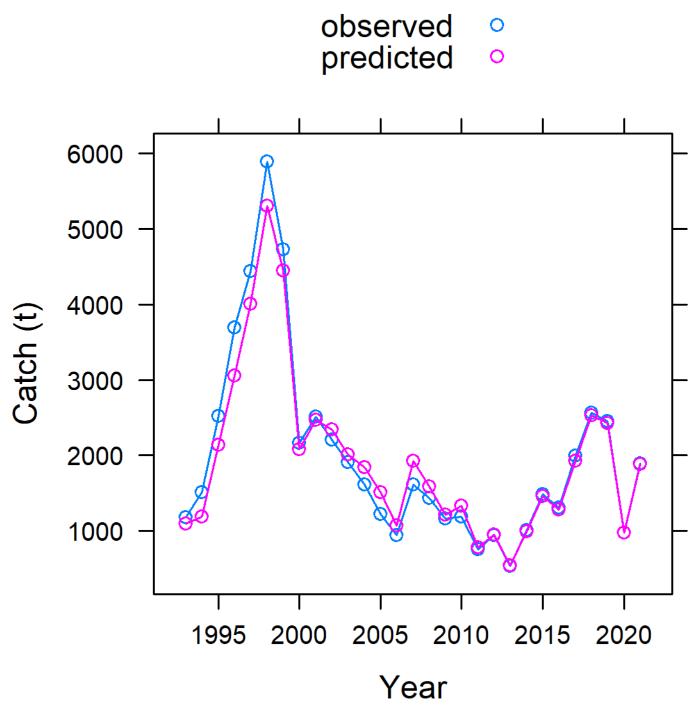


Figure 9.5. Fitted and observed catch from update assessment.

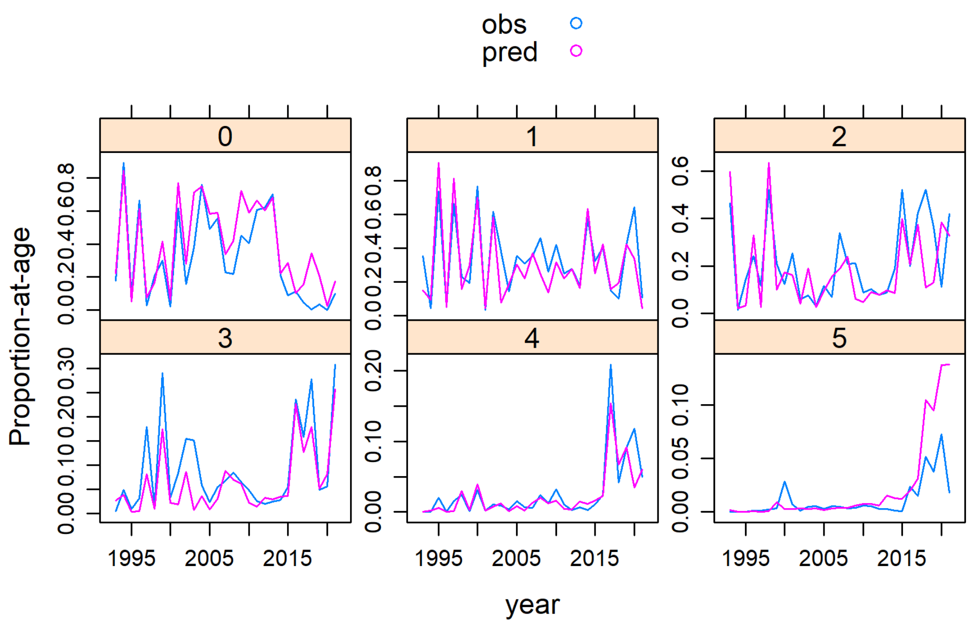


Figure 9.6. Fitted and observed catch age proportions from update assessment.

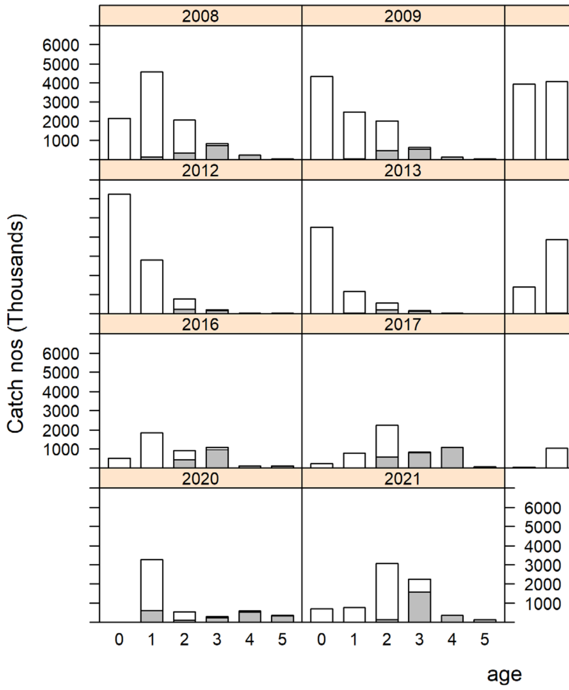


Figure 9.7. Observed catch numbers 2008–present.

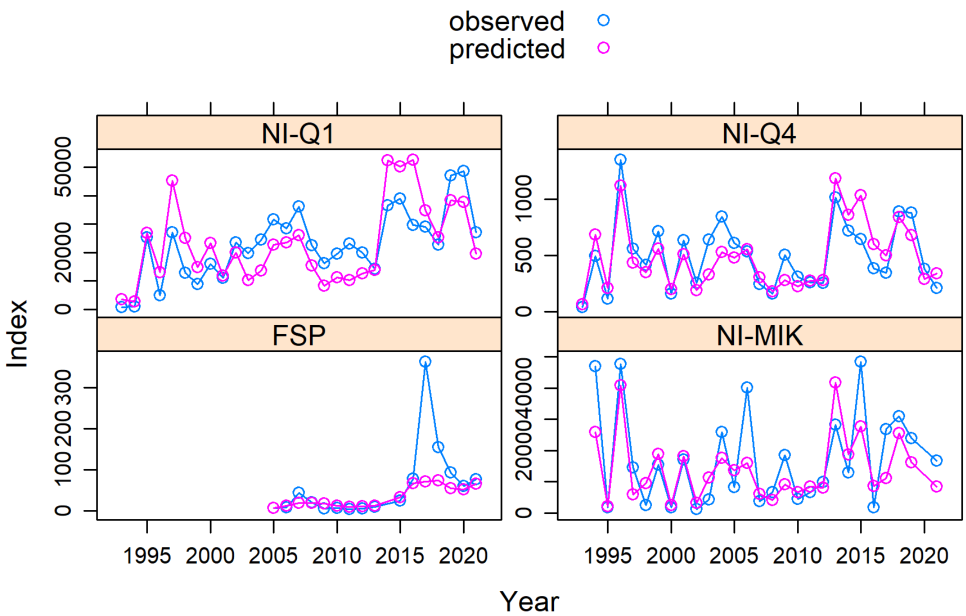


Figure 9.8. Fitted and observed index series from update assessment.

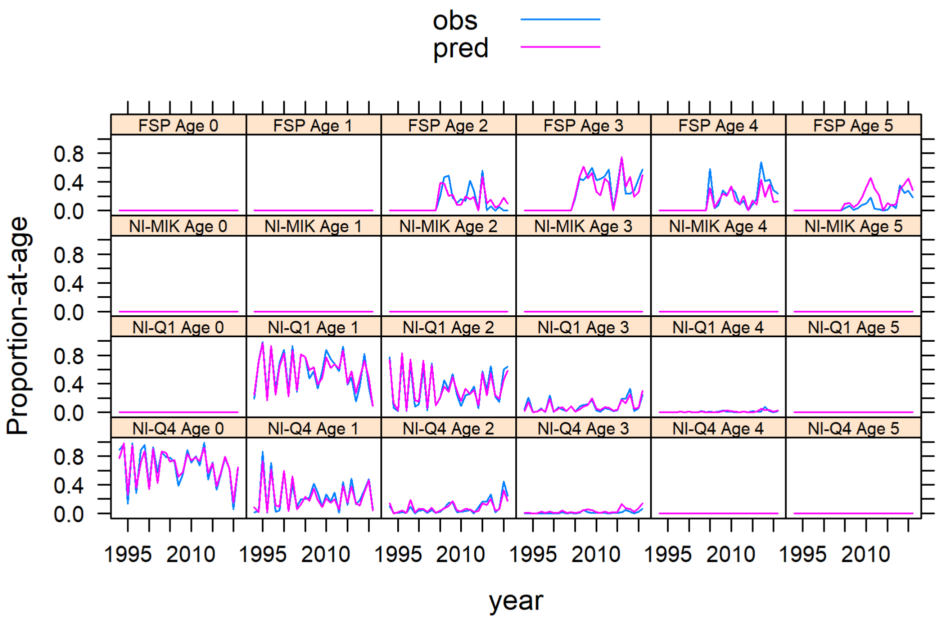
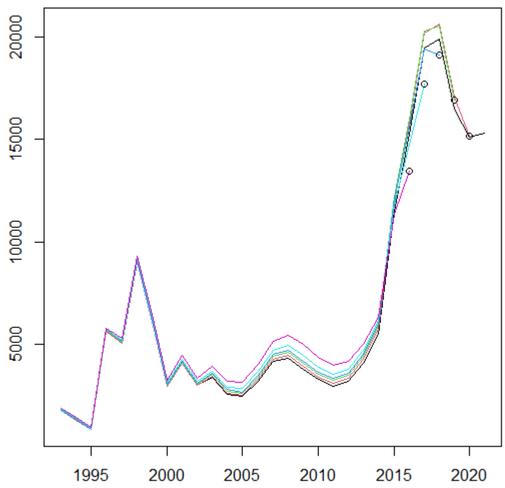
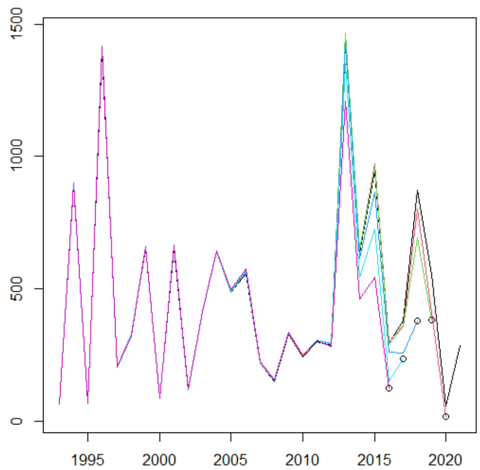


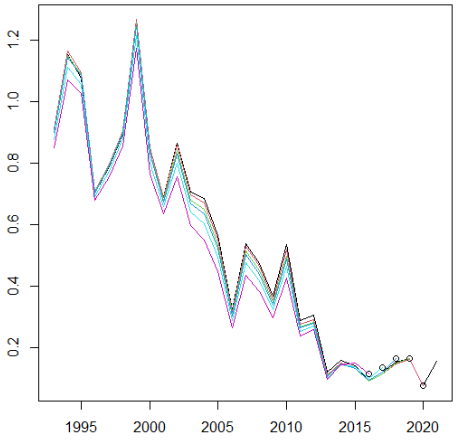
Figure 9.9. Fitted and observed index age proportions from update assessment.





SSB -0.044

Recruitment -0506



F_{bar} 0.082

Figure 9.10. Retrospective plot the final update model.

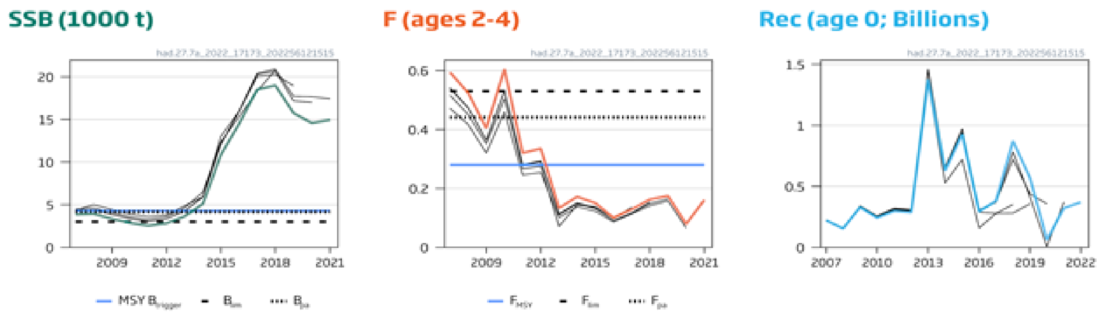


Figure 9.11. Haddock in Division7.a. Historical assessment results.

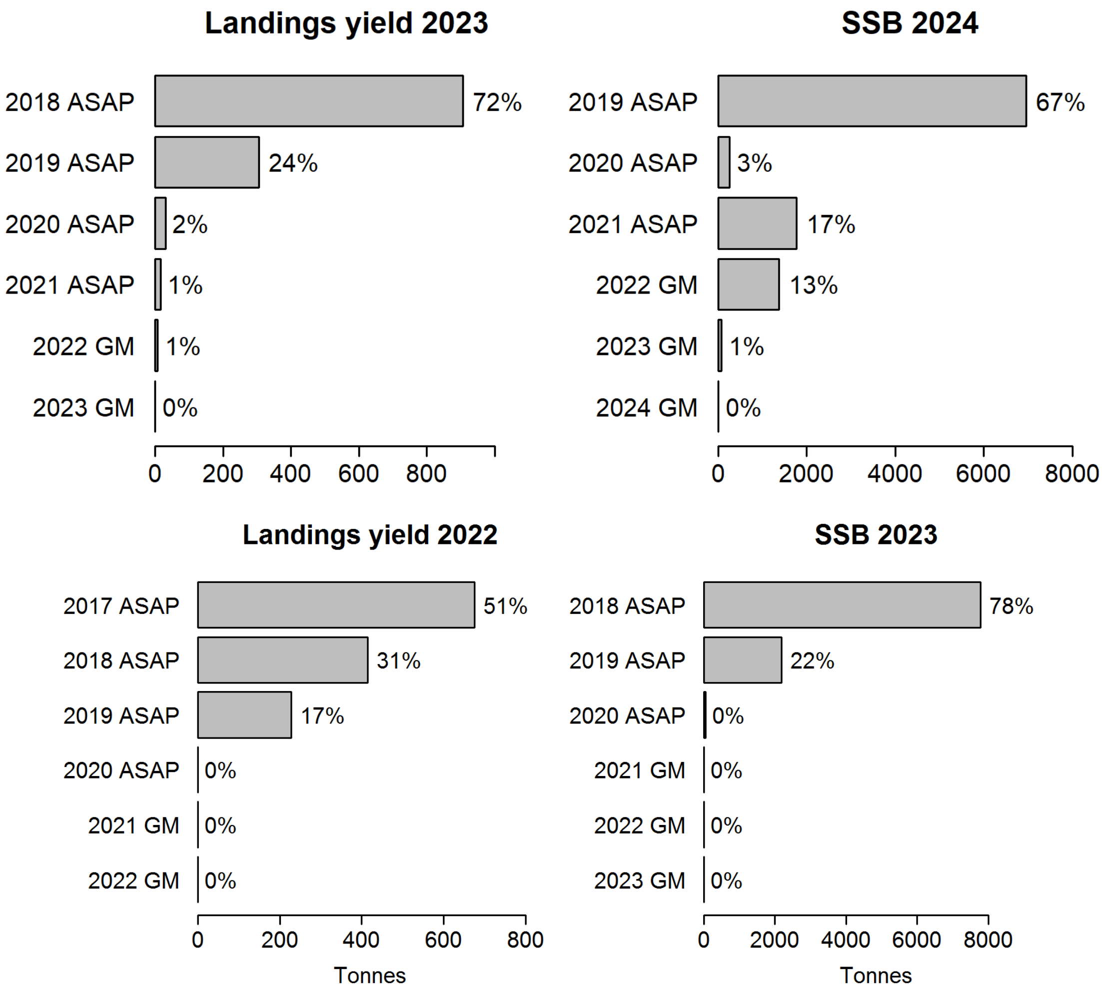


Figure 9.12. Haddock in 7a. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

10 Megrim (*Lepidorhombus* ssp.) in divisions 4.a and 6.a (northern North Sea, West of Scotland)

Type of assessment in 2022

Update of 2021 assessment with new landings and survey data. The model used to carry out the assessment is the Schaefer Surplus production process model in R and Winbugs.

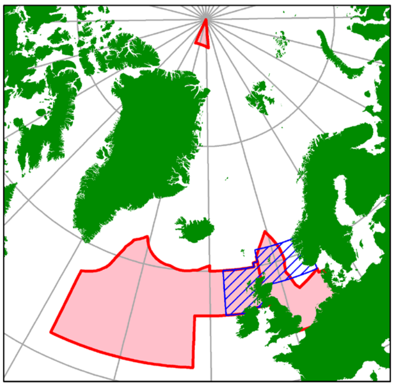
ICES advice applicable to 2023

ICES advise that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2023 that correspond to the F ranges in the plan are between 5550 tonnes and 7200 tonnes.

10.1 General

Stock description and management units

Megrim stock structure is uncertain and historically the Working Group has considered megrim populations in 6.a and 6.b as separate stocks. The review group questioned the basis for this in 2004. Data collected during an EC study contract (98/096) on the 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' showed significantly different growth parameters and significant population structure difference between megrim sampled in 6.a and 6.b (Anon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear. As noted by WGNSDS (2008), megrim in 4.a has historically not been considered by ICES. 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. 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:	United Kingdom and Union waters of 4; United Kingdom waters of 2a (LEZ/2AC4-C)
Belgium	8	(1)	Analytical TAC	
Denmark	7	(1)	Article 8(2) of this Regulation applies	
Germany	7	(1)		
France	45	(1)		
Netherlands	36	(1)		
Union	103	(1)		
United Kingdom	2 660	(1)		
TAC	2 763			

(1) Special condition: of which up to 20 % may be fished in United Kingdom, Union and international waters of 6a north of 58° 30' N (LEZ/*6AN58).

Species:	Megrims *Lepidorhombus* spp.		Zone:	6; United Kingdom and international waters of 5b; international waters of 12 and 14 (LEZ/56-14)
Spain	550	(1)	Analytical TAC Article 8(2) of this Regulation applies	
France	2 146	(1)		
Ireland	627	(1)		
Union	3 323	(1)		
United Kingdom	2 258	(1)		
TAC	5 581			

(1) Special condition: of which up to 25 % may be fished in United Kingdom and Union waters of 2a and 4 (LEZ/*2AC4C).

2022 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 2020 TAC for ICES Division 6 and EU waters of 5.b was 36.7%. The small uptake was mainly due to poor utilisation of quota by France and the UK, managing only 5.8 and 37.4% respectively. In Area 4 and 2.a, uptake of the TAC was 78.4%. The majority of available TAC (96.2%) is allocated to the UK, who take 86.1% of it.

Fishery in 2021

Landings

Catches of megrim comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al*., 1995; Anon, 2001).

Commercial catches are dominated by female megrim, typically 90% of the total catch. The InterCatch catch estimate is 3803 tonnes, and the ICES landings estimate for 6.a and 4.a. is 3603 tonnes. The total ICES landings are well below the total TAC covering the fished areas of 4.a–6.a.

Official landings data for each country together with Working Group best estimates of landings from 6.a are shown in Table 10.2 and for 4.a in Table 10.3. To estimate ICES landings, we take InterCatch estimates and, if unavailable, we use official estimates. There are often minor differences between official data and InterCatch for most countries.

Discards

Discard data were made available by Ireland, Scotland and France and total discards were estimated to be 200 tonnes or 5.6% by weight for the stock area in 2021. Total discard estimates have been reasonably consistent around 5–10% over the last nine years, although there have been some changes in rates within countries.

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 breakdown of 2021 catch by main gear type in InterCatch is given below:

Catch	Landings			Discards		
	Finfish trawls	*Nephrops* trawls	Other Gears	Finfish trawls	*Nephrops* trawls	Other Gears
3803 tonnes	98%	<1%	1.6%	34%	66%	<1%
	3603 tonnes			200 tonnes		

Surveys

Indices from six fishery-independent surveys are used in the assessment. The surveys are outlined in Table 10.1 below and details can be viewed in the stock annex.

Table 10.1. Summary indices used for surplus production model.

NUMBER	SURVEY	NATIONALITY	AREA	TIME-SERIES	DEPTH RANGE (M)
1	SCO-IBTS-Q3 (G2829)	SCOTLAND	4.A	1987-PRESENT	<400 M
2	SCO-IBTS-Q1 (G1022)	SCOTLAND	4.A	1987-PRESENT	<400 M
3	SCOGFS-WIBTS-Q1 (G1179)	SCOTLAND	6.A	1986-2010	40-400
4	SCOGFS-WIBTS-Q4 (G4299)	SCOTLAND	6.A	1986-2010	50-300
5	SIAMISS-Q2 (G3745)	SCOTLAND	6.A*/4.A	2005-PRESENT	50-1050
6	SIAMISS-Q2 (G1794)	IRELAND	6.A*	2005-PRESENT	50-850

Figures 10.1 to 10.5 present the megrim biomass maps for the SIAMISS and IBTS surveys. The SIAMISS bubble plots show and increasing abundance over time throughout the area over the time-series. Figures 10.2. (Sco-IBTS-Q3 (G2829) 4.a) and 13.3 (Sco-IBTS-Q1(G1022) 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 10.4 (ScoGFS-WIBTS-Q1(G1179) 6.a) and 10.5 (ScoGFS-WIBTS-Q4(G4299) 6.a) also show an increase in biomass over the time-series and are shown until the survey design and ground gear changed in 2010. Data were truncated from the time-series going into the assessment.

10.2 Estimation of survey cpue indices

Cpue trends of survey data

The data from the IBTS surveys exhibit a relatively large proportion of zeros, therefore the delta method of Stefánsson (1996) was used to generate indices. This method (delta-gamma model) comprises fitting two generalized linear models. The first model (binomial GLM) is used to obtain the proportion of non-zero tows, and is fit to the data coded as 1 or 0, if the tow contained a positive or zero CPUE, respectively. The second model is fit to the positive only CPUE data using a gamma or lognormal GLM.

The biomass trend for the SIAMISS survey is shown in Figure 10.6. There is a weakly increasing trend over time with year effects evident in 6.a in 2013 and 2017. The biomass trends for the four IBTS surveys are shown in Figure 10.7.

10.3 Stock assessment

The input data for the stock assessment are given in Table 10.4 this comprises of a time-series from all survey indices, and ICES catch estimates for this stock.

2022 Final run

The Pearson residual diagnostic plots for the final assessment are shown in Figure 10.8. The residuals for the two 6.a surveys and the SIAMISS survey are fairly randomly dispersed around zero. A trend in the residuals is evident for the two 4.a surveys, 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 10.9. The priors are given in Table 10.5. The posterior distributions are similar to previous year's assessments. The posterior parameter estimates for the final assessment model are given in Table 10.6. These are similar to recent assessments.

Figure 10.10 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 SIAMISS 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 issue needs to be examined further in the next benchmark.

The time-series of B/B_{MSY} and F/F_{MSY} landings and discards used in the final assessment are given in Table 10.7.

Comparison with previous assessments

Figure 10.11 compares the final assessment with those conducted by WGCSE at previous meetings. The 2022 assessment assesses the biomass estimate to be stable at the 2021 levels; prior to being revised down in recent years. Estimates of fishing mortality continue on an upward trend. There are also some deviations in the historic estimates of F and Biomass around 2000. These are linked to the use of the 6.a surveys to derive the delta-gamma CPUEs truncated in 2010.

To evaluate evidence of possible bias in the assessment population metrics, a Mohn's Rho analysis resulted in values of -0.045 for F_{bar} and 0.044 for biomass. ICES considers a value greater than 0.20 to be unacceptably high.

State of the stock

The state of the stock has not changed since last year. Fishing mortality has been below F_{MSY} for almost the full time-series and has an overall declining trend since the late 1990s. Biomass has consistently been above MSY $B_{trigger}$ and shows an increasing trend since 2005. The stock in 2022 is estimated to be 1.44 times B_{MSY} and the fishing mortality in 2021 is estimated to be have been 52% of F_{MSY}.

10.4 Short-term projections

Short-term projections have been updated according to the method set out in the stock annex. The basis for the catch options is given in Table 10.8.

The management option table is given in Table 10.9. Fishing at F_{MSY} in 2023 is projected to result in total catches of 7200 t (landings of 6798 t and discards of 402 t) and a Biomass of 1.32 times B_{MSY} in 2024.

10.5 Biological reference points

Precautionary approach reference points

F_{MSY}, B_{MSY} and the yield at MSY are all directly estimated in the model. It should be noted that these will vary when new survey and catch information is added. B_{pa} and B_{lim} are defined as 50%B_{MSY} and 30%B_{MSY} respectively. F_{lim} is defined as 1.7 F_{MSY} and is the F that drives the stock to B_{lim} assuming B_{lim}=30%B_{MSY}. The derivation is given below:

P=rB(1-B/K)

The surplus productivity associated with B_{lim} is:
$P_{lim}=rB_{lim}(1-B_{lim}/K)$
The corresponding F is:
$F_{lim}=rB_{lim}(1-B_{lim}/K)/B_{lim} = r(1-B_{lim}/K)$
$B_{lim}=0.3B_{MSY} = 0.3K/2$
$F_{lim} = r(1-0.3K/(2K)) = r(1-0.3/2) =0.85r$
F_{MSY}=r/2, let x denote the proportionality between F_{MSY} and F_{lim}
$xF_{MSY}=F_{lim}$
$x(r/2)=0.85r$
$x=2*0.85$
$x=1.7$

MSY reference points

In 2015 ICES provided precautionary F_{MSY} ranges that are derived to deliver no more than a 5% reduction in long-term yield compared with MSY. Details of this analysis are given in WKMSYREF3 (ICES, 2015) and the derivations are given below.

	MSY 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)]	K [d)]

The stock has been fished below F_{MSY} for more than ten years, therefore, the WG considered it appropriate to set the MSY $B_{trigger}$ = B_{MSY} according to the ICES guidelines (ICES, 2017).

Uncertainties and bias in assessment and forecast

The model estimates of B and F do have large uncertainty. Despite this, there is a low probability that SSB is below MSY $B_{Trigger}$ and a high probability that F is below F_{MSY}.

The reference points are re-estimated within the assessment. The change between 2022 and 2021 reference points are consistent with previous years and results in a rescaling of relative stock status. However, in absolute terms, stock trends are consistent with those of previous years.

The biomass time-series from surveys has increasing uncertainty boundaries as the index increases. This results in uncertainty bounds in the model estimates; shows a contraction from the 2021 assessment.

Owing to incomplete discard data, historical discard rates (1985–2012) are assumed to have declined, from 30% at the beginning of the time-series, to an estimate of 15% in 2012. The evaluation of current stock status is robust to this assumption. Estimates since 2013 are based on observed discards.

Recommendation for next benchmark

This stock was subject to an inter-benchmark in 2012 (IBP-MEG, 2012). Due to incomplete age data, particularly for 4.a, a Bayesian state–space surplus production model was chosen as the final assessment model. Subsequent update assessments have highlighted a problem fitting to the 4.a surveys which needs to be examined in a future benchmark.

WGCSE recommends the following explorations:

- The SIAMISS survey should be merged into one continuous index. The length data for the index should also be examined.
- The ScoGFS-WIBTS-Q1/Q4 2011+: the ScoGFS-WIBTS-Q1/Q4 survey time-series should also be examined for re-introduction into the assessment as a new time-series. There may also be scope to integrate the IGFS.
- Available length and age-structured data should be compiled for this stock.
- Length or age-structured assessment models could be explored.

Once sufficient progress has been made on the points above, WGCSE will suggest a benchmark schedule.

Management considerations

Megrim is a bycatch species in the mixed demersal trawl in divisions 6.a and 4.a. Management measures for other species have constrained the fishery and reduced effort and fishing mortality on megrim. The general increase in mesh size in 6 and 4 since 2010 has also benefited the stock.

The TAC in 6 has not been fully utilised. However, the uptake rate is country-specific, with some Member States reporting landings above their quota in the North Sea. Partial quota uptake by individual Member States may be linked to reduction in effort rather than reflective of a reduction in biomass. The TAC and assessment area are incompatible. There are two separate TAC areas covering ICES areas 6 and 4, whereas the assessment covers ICES divisions 6.a and 4.a combined. Due consideration of the inconsistency between management and assessment area is required when setting fishing opportunities for this stock and the separate 6.b Rockall stock. ICES (2013) have advised the EC that the TAC areas should be consistent with the assessment area and that ICES has no basis on how to split the catch advice so that it is consistent with the TAC areas.

10.6 References

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Table 10.2. 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

Year	Belgium	France	Ireland	Netherlands	Spain	UK – Eng, Wales & N.Irl.	UK – Scotland	UK	Official Total	ICES landings
2016	0	189	408	0	146			694	1437	1437
2017	0	132	336	0	313			579	1359	1359
2018	0	117	301	0	273			680	1370	1392
2019	0	122	271	0	368			844	1606	1611
2020*	0	119	250	0	302			710	1381	1380
2021*	0	123	378	0	335			633	1468	1464

*** Preliminary official landings.**

Table 10.3. 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

Country	Belgium	Denmark	France	Germany	Germany, Fed. Rep. of	Ireland	Netherlands	Norway	Spain	Sweden	UK – Eng, Wales & N.Irl.	UK – England & Wales	UK- N. Ire-land	UK – Scotland	UK	Official total	ICES landings
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

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
2015	0	26	1437	0		0	0	8	0	0					1175	1217	1230
2016	0	46	13	2		0	2	21	0	0					1278	1362	1361
2017	0	60	36	3		0	< 0.5	29	0	0					1199	1327	1235
2018	0	61	67	1		0	1	34	0	0					1543	1706	1611
2019	0	63	103	4		0	1	46	0	0					1340	1557	1585
2020*	< 0.5	40	80	3		0	4	48	0	< 0.5					1768	1943	1935
2021*	0	73	74	9		0	1	49	0	< 0.5					1944	2150	2139

*** Preliminary official landings.**

Table 10.4. 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	2.587	NA	NA	NA	NA	NA
1986	1.688	NA	1.288	NA	NA	NA
1987	1.371	NA	1.525	NA	NA	NA
1988	2.009	NA	1.721	NA	NA	NA
1989	1.162	NA	1.345	NA	NA	NA
1990	1.073	1.589	0.771	NA	NA	NA
1991	0.793	1.274	0.509	0.331	NA	NA
1992	0.958	1.885	0.654	0.319	NA	NA
1993	1.013	2.058	1.106	0.306	NA	NA
1994	1.589	3.246	0.270	0.381	NA	NA
1995	1.556	1.863	0.000	0.391	NA	NA
1996	1.940	1.946	0.516	0.605	NA	NA
1997	1.100	1.081	0.433	0.430	NA	NA
1998	1.094	1.893	0.836	0.224	NA	NA
1999	1.322	1.360	1.005	0.237	NA	NA
2000	1.140	1.186	0.869	0.249	NA	NA
2001	0.998	0.968	0.297	0.092	NA	NA
2002	0.760	1.857	1.269	0.352	NA	NA
2003	1.272	1.205	0.519	0.316	NA	NA
2004	1.244	1.064	0.283	0.460	NA	NA
2005	0.690	1.013	0.590	0.809	1660.379	4753.223
2006	0.917	1.121	0.790	0.927	2688.942	3344.997
2007	0.907	1.199	0.868	1.389	3380.351	6347.544
2008	1.253	0.957	1.607	1.195	2467.080	7754.168
2009	1.573	1.397	1.949	1.100	3830.668	5946.946
2010	1.171	NA	1.769	1.726	3312.129	5394.946
2011	NA	NA	1.983	1.638	2501.990	4683.594

year	sco.6.a.q1	sco.6.a.q4	sco.4.a.q1	sco.4.a.q3	monk.6.a	monk.4.a
2012	NA	NA	2.609	1.523	3450.807	4839.468
2013	NA	NA	2.669	1.477	6174.864	6460.015
2014	NA	NA	2.202	1.277	3033.072	11970.300
2015	NA	NA	3.014	1.297	2563.105	4986.899
2016	NA	NA	1.440	1.274	3027.648	8207.787
2017	NA	NA	1.830	1.013	6508.563	10238.937
2018	NA	NA	1.414	1.073	3364.165	7154.307
2019	NA	NA	0.657	0.963	2143.573	7982.271
2020	NA	NA	1.362	0.866	NA	NA
2021	NA	NA	1.154	0.736	3268.490	6897.872

Table 10.5. *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	$\mathrm{Uniform}(0.001, 2.0)$	
Carrying capacity	K	$\mathrm{Uniform}\left(\ln\left(\max(C)\right), \ln\left(10 \times \sum_{t=1985}^{2010} C_t\right)\right)$	From the maximum catch to ten times the cumulative catch across all years assuming uniform distribution on the logarithmic scale
Catchabilities	$\log(q_j)$	$\mathrm{Uniform}(-11.0, 0.0)$	Uniformly distributed on log-scale. See catchability sensitivity in Section 2.2.3.1
Process error variance	$\frac{1}{\sigma_u^2}$	$\mathrm{Gamma}(\mathrm{shape} = 0.001, \mathrm{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Measurement error variances	$\frac{1}{\sigma_{\varepsilon,j}^2}$	$\mathrm{Gamma}(\mathrm{shape} = 0.001, \mathrm{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Proportion of *K* in 1985	a	$\mathrm{Uniform}(0.01, 2.0)$	

Table 10.6. Parameter estimates for final assessment outputs.

Parameter	Estimates 2014	Estimates 2015	Estimates 2016	Estimates 2017	Estimates 2018	Estimates 2019	Estimates 2020	Estimates 2021	Estimates 2022
r.hat	0.55	0.51	0.51	0.51	0.47	0.50	0.51	0.52	0.52
K.hat	43134	47216	46840	42681	55129	44116	42625	41634	40573
MSY	5660	5612	5362	5072	5362	5123	5101	5020	4978
F_{MSY}	0.28	0.26	0.26	0.25	0.23	0.25	0.26	0.26	0.26
B_{MSY}	21567	23608	23420	21340	27565	22058	21313	20817	20287
B	4109	42416	42356	37610	38057	37062	32660	32408	31632
F	0.08	0.07	0.07	0.07	0.08	0.08	0.1	0.1	0.12
B_{lim}	6470	7082	7026	6402	8269	6617	6394	6245	6086
B_{trig}	10783	11804	11710	10670	13782	11029	10656	10408	10143

Table 10.7. Time-series of B/B_{MSY} and F/F_{MSY} estimates and landings and discards in tonnes for the final assessment.

Year	B/B_{MSY}			Landings	Discards*	F/F_{MSY}		
	Low	Value	High			Low	Value	High
1985	1.20	2.33	3.54	4499	1928	0.38	0.68	1.16
1986	1.08	1.64	2.25	2858	1193	0.33	0.53	0.77
1987	1.07	1.54	2.05	4614	1874	0.58	0.93	1.31
1988	1.02	1.43	2.04	5212	2061	0.65	1.15	1.66
1989	0.80	1.15	1.56	3451	1327	0.50	0.88	1.27
1990	0.74	1.05	1.43	3047	1140	0.47	0.82	1.22
1991	0.70	0.99	1.30	3310	1204	0.59	0.95	1.40
1992	0.72	1.04	1.38	3574	1263	0.58	0.98	1.46
1993	0.79	1.12	1.51	3802	1305	0.57	0.97	1.42
1994	0.81	1.21	1.70	3900	1300	0.53	0.93	1.32
1995	0.86	1.24	1.75	4670	1511	0.59	1.10	1.57
1996	0.82	1.19	1.71	5253	1649	0.68	1.31	1.91
1997	0.72	1.00	1.37	4856	1478	0.78	1.40	2.01
1998	0.66	0.95	1.37	4253	1254	0.67	1.26	1.86
1999	0.62	0.92	1.36	3759	1074	0.59	1.13	1.70
2000	0.57	0.86	1.24	3494	966	0.56	1.10	1.64
2001	0.55	0.80	1.11	3571	956	0.65	1.20	1.80
2002	0.55	0.82	1.18	2803	725	0.47	0.88	1.32
2003	0.58	0.86	1.21	2369	592	0.37	0.70	1.06
2004	0.59	0.87	1.22	2067	499	0.32	0.58	0.88
2005	0.63	0.89	1.16	1527	356	0.24	0.41	0.61
2006	0.72	1.01	1.31	2054	461	0.30	0.49	0.73
2007	0.82	1.15	1.47	2348	508	0.31	0.50	0.73
2008	0.91	1.28	1.66	2894	602	0.34	0.56	0.83
2009	1.01	1.40	1.84	2871	574	0.30	0.51	0.72
2010	1.03	1.41	1.85	3197	614	0.36	0.56	0.84
2011	1.03	1.45	1.91	3257	600	0.29	0.47	0.68

Year	B/B_{MSY}			Landings	Discards*	F/F_{MSY}		
	Low	Value	High			Low	Value	High
2012	1.16	1.58	2.08	2545	449	0.26	0.42	0.60
2013	1.27	1.77	2.43	2737	327	0.22	0.37	0.53
2014	1.33	1.79	2.36	2500	309	0.20	0.33	0.48
2015	1.21	1.67	2.17	2471	152	0.21	0.31	0.44
2016	1.28	1.75	2.26	2792	167	0.23	0.36	0.51
2017	1.37	1.88	2.62	2594	193	0.19	0.32	0.45
2018	1.25	1.69	2.16	3003	255	0.26	0.41	0.56
2019	1.12	1.55	1.96	3197	184	0.29	0.45	0.65
2020	1.13	1.56	2.07	3316	214	0.30	0.47	0.68
2021	1.14	1.53	1.99	3603	200	0.34	0.52	0.74
2022	0.95	1.44	2.01					

*** Discard estimates prior to 2013 are approximated, based on limited sampling information.**

Table 10.8. Basis for the catch options.

Variable	Value	Notes
F_{2022}/F_{MSY}	0.52	*Status quo*: F_{sq} = relative F (2021)
B_{2023}/B_{MSY}	1.53	Fishing at F_{sq}
Catch (2022)	3580	Fishing at F_{sq}; in tonnes
Projected landings (2022)	3380	Assuming average landings ratio (2019–2021); in tonnes
Projected discards (2022)	200	Assuming average discard ratio (2019–2021); in tonnes

Table 10.9. The management option table.

Basis	Total catch (2023)	Projected landings (2023)	Projected discards (2023)	Fishing mortality F_{2023}/F_{MSY}	Stock size B_{2024}/B_{MSY}	% B change*	% TAC change^	% advice change^^
ICES advice basis								
MSY approach = F_{MSY}	7200	6798	402	1	1.32	−13.1	-13.7	-2.0
EU MAP^^^: F_{MSY}	7200	6798	402	1	1.32	−13.1	-13.7	-2.0
F = MAP^^^ $F_{MSY\ lower}$	5550	5240	310	0.76	1.41	−7.1	-33	−24
F = MAP^^^ $F_{MSY\ upper}$	7200	6798	402	1	1.32	−13.1	-13.7	-2.0
F = 0	0	0	0	0	1.71	11.7	−100	−100
$B_{2024} = B_{lim}$	26800	25302	1498	3.70	0.33	−79	221	264
$B_{2024} = B_{pa}$ = MSY $B_{trigger}$	13000	12273	727	1.80	1.01	−33	56	77
$B_{2024} = B_{2023}$	3500	3304	196	0.48	1.52	0	-58	−52

*** Biomass 2024 relative to biomass 2023.**

^ Total catch in 2023 relative to TAC 2022 (8344 tonnes).

^^ Advice value for 2023 relative to the advice value for 2022 (7350 tonnes).

^^^ EU multiannual plan (MAP) for the Western Waters (EU, 2019).

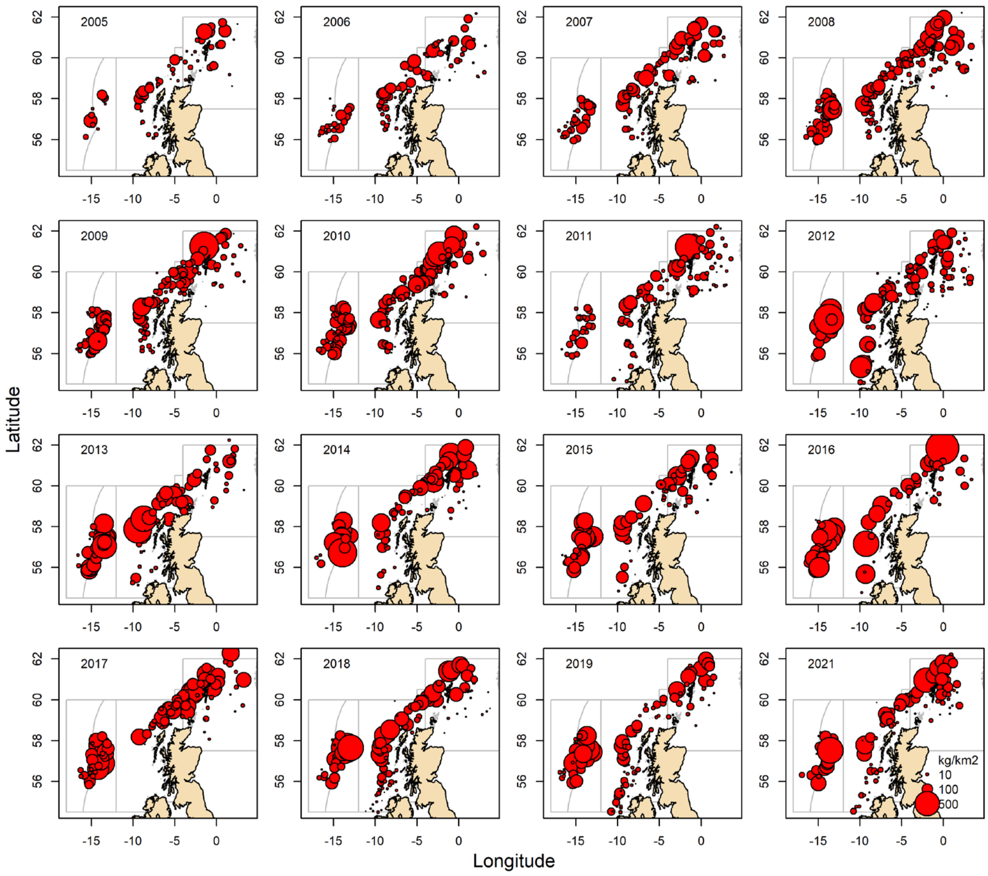


Figure 10.1. Maps of the northern continental shelf around the British Isles showing the biomass of megrim during the Scottish Irish Anglerfish and Megrim Industry Science Survey (SIAMISS) survey 2005–2021. There was no survey in 2020 due to COVID.

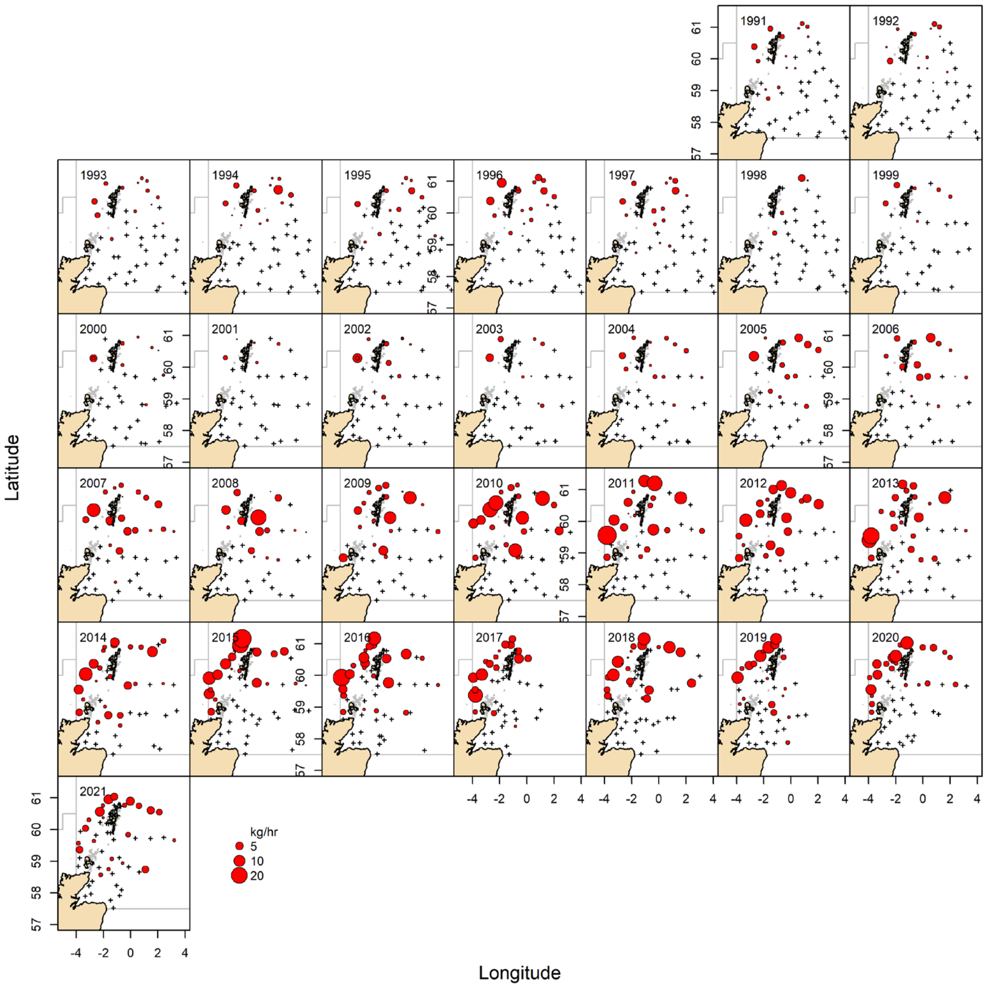


Figure 10.2. Sco-IBTS Q3 4.a 1991–present megrim biomass maps.

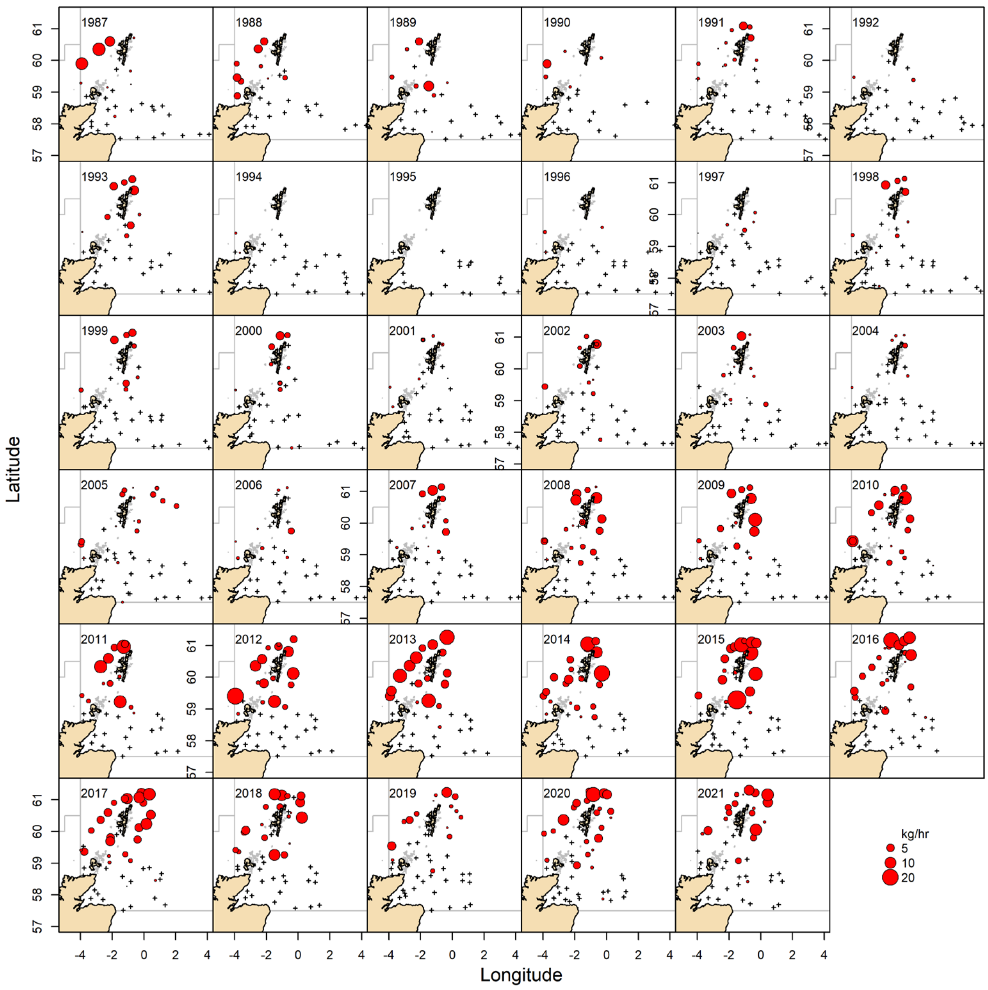


Figure 10.3. ScoIBTS Q1 4.a 1986–present megrim biomass maps.

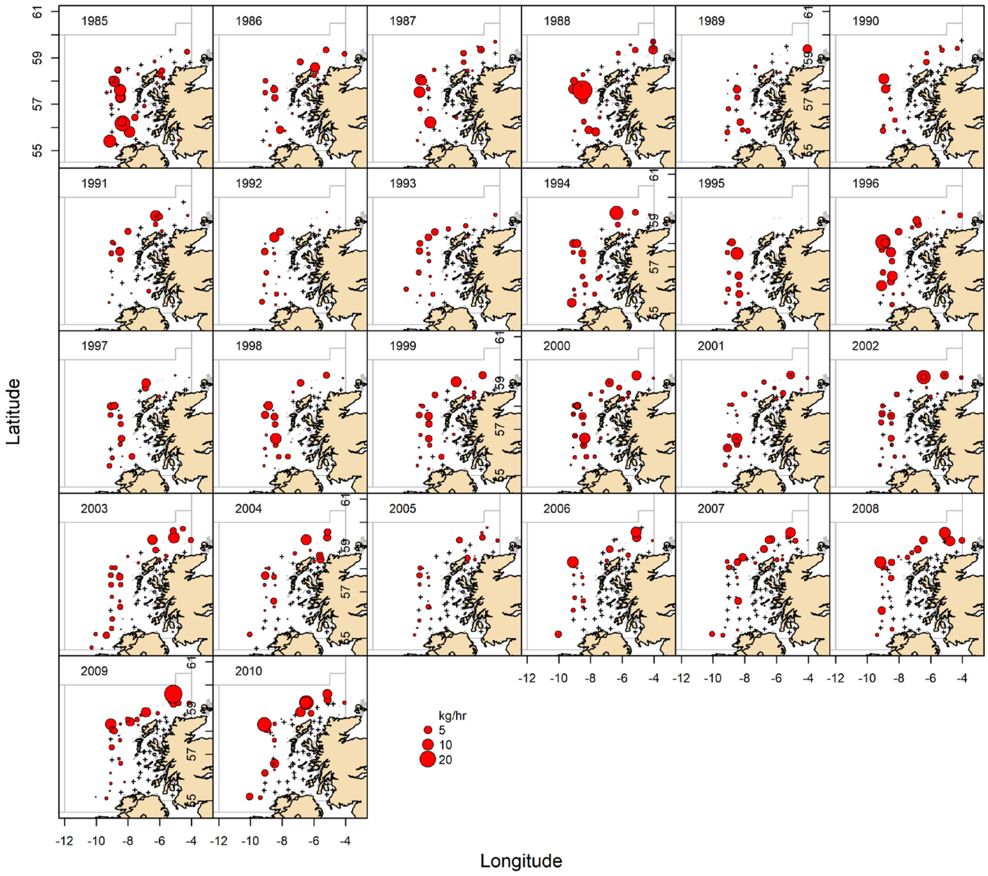


Figure 10.4. ScoGFS-WIBTS Q1 6.a megrim biomass maps.

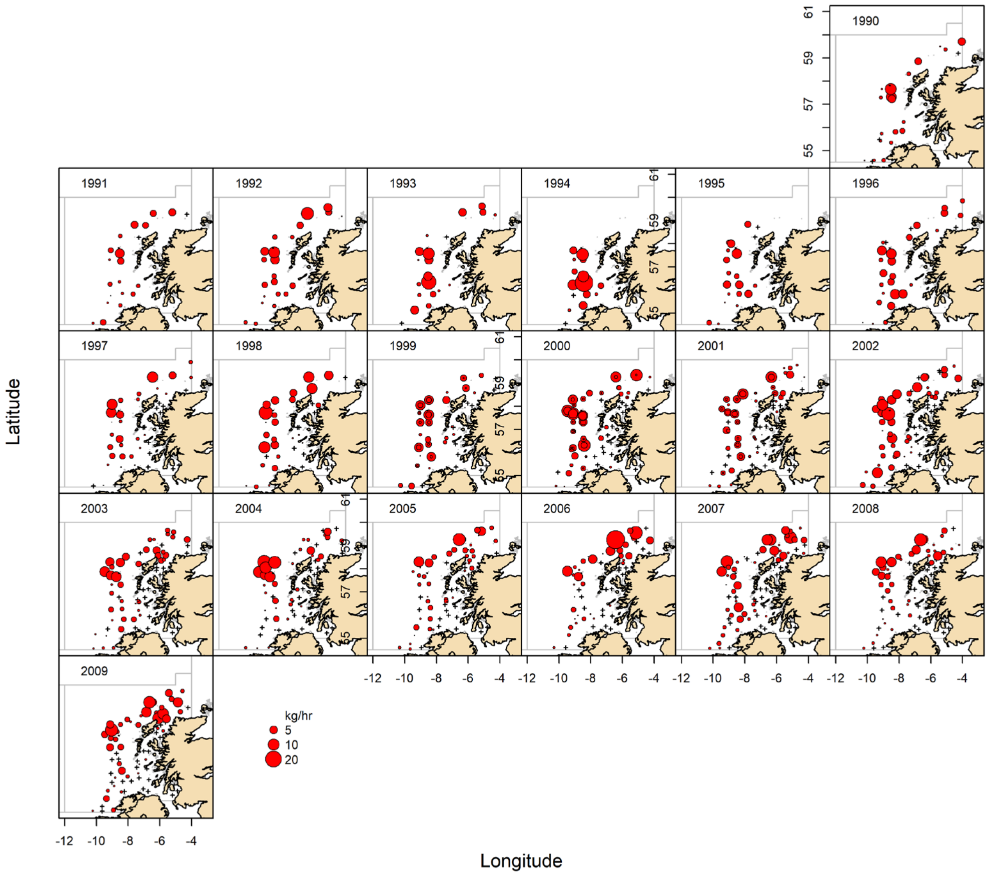


Figure 10.5. ScoGFS-WIBTS Q4 6.a megrim biomass maps.

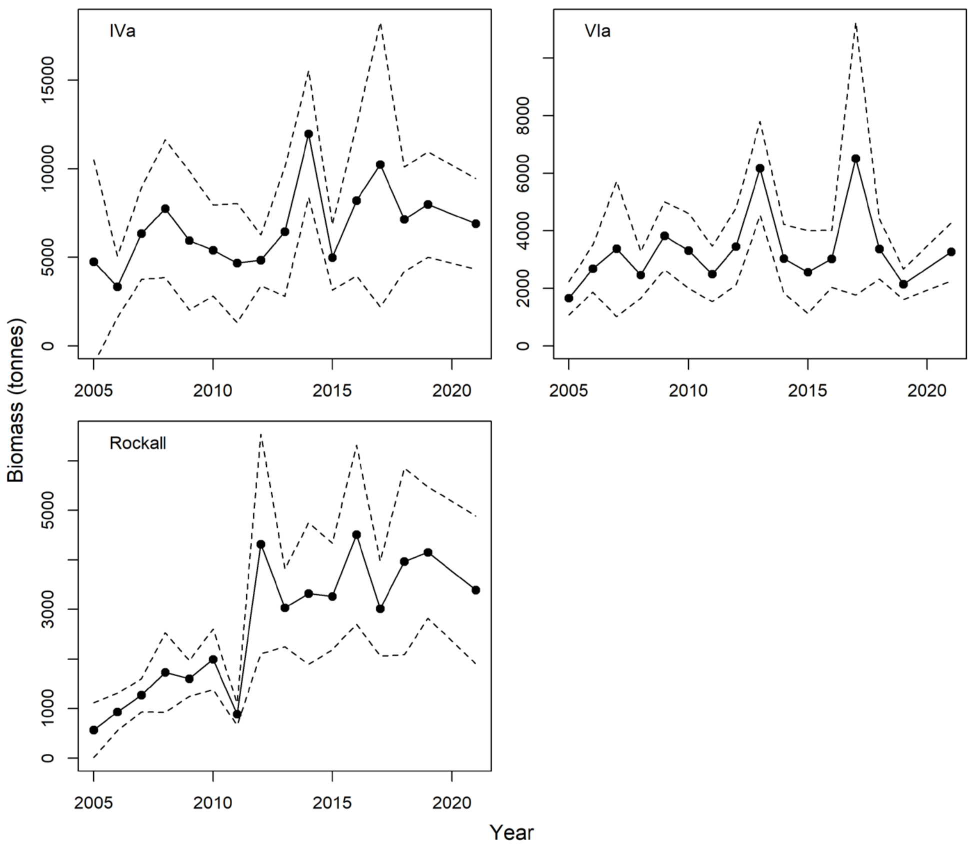


Figure 10.6. Megrim biomass estimates in ICES divisions 4, 6.a and 6.b from Scottish Irish Anglerfish and Megrim Industry Science Survey (SIAMISS) survey with 95%cls.

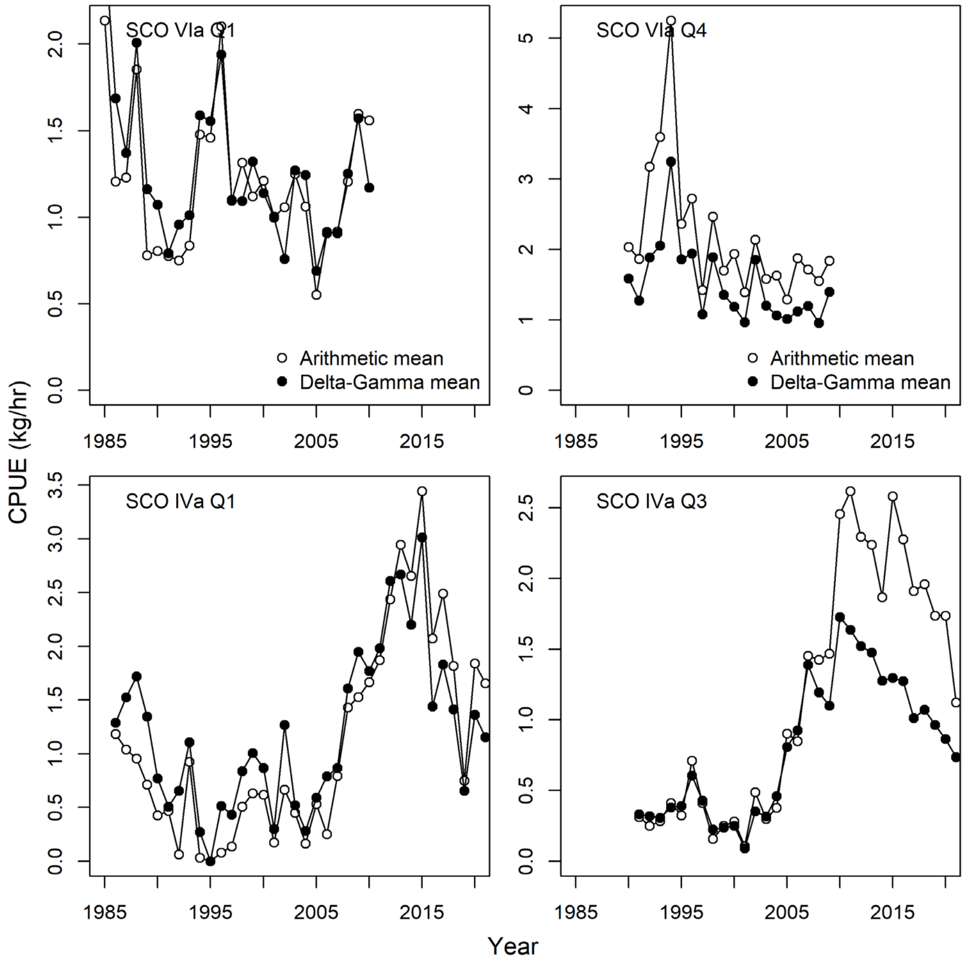


Figure 10.7. Megrim CPUE estimates in ICES Division 6.a Q1 top left panel and 6.a Q4.

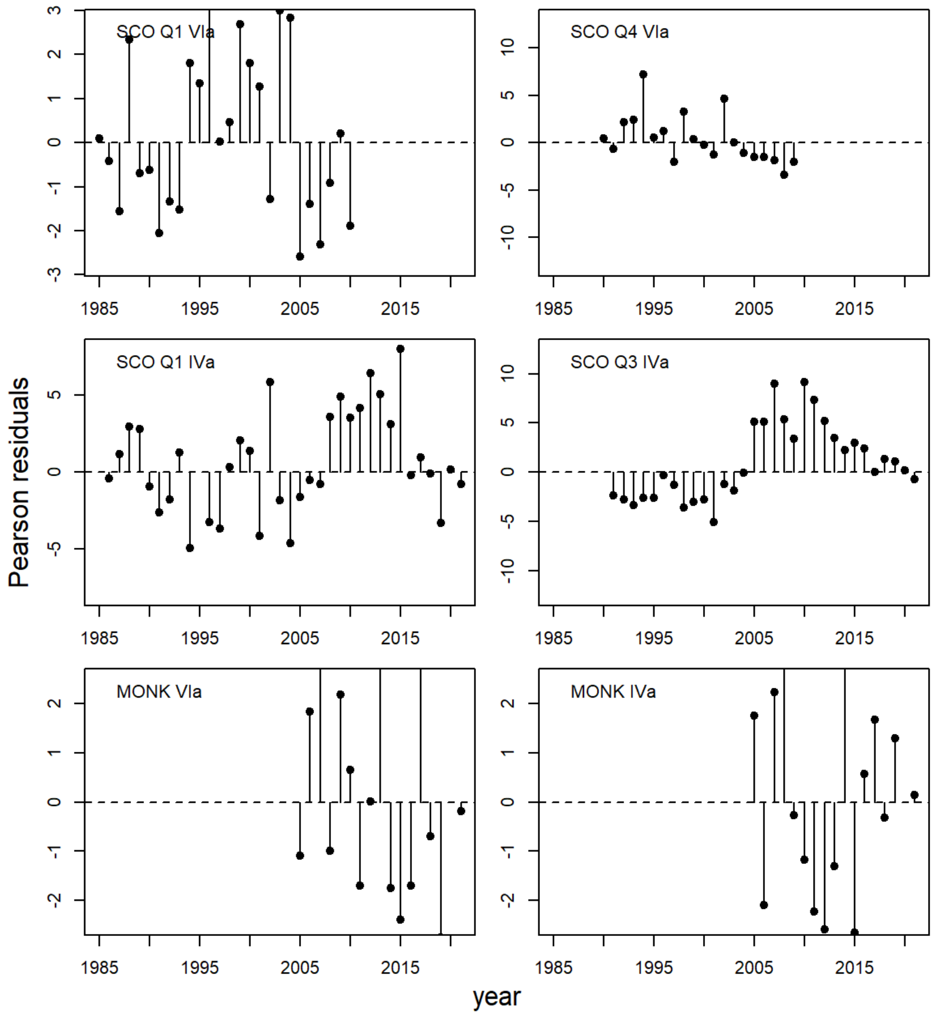


Figure 10.8. Pearson residuals for the six survey indices.

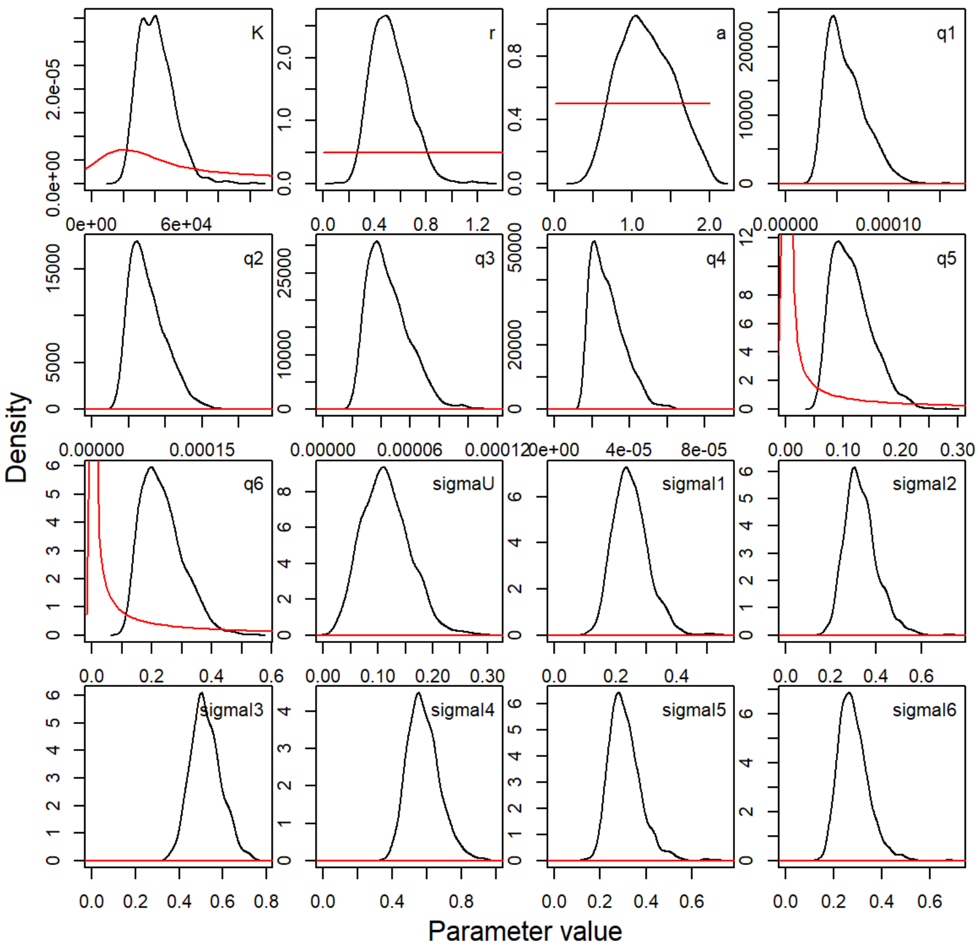


Figure 10.9. Prior (red line) and posterior distributions (black line) for the parameters in the model.

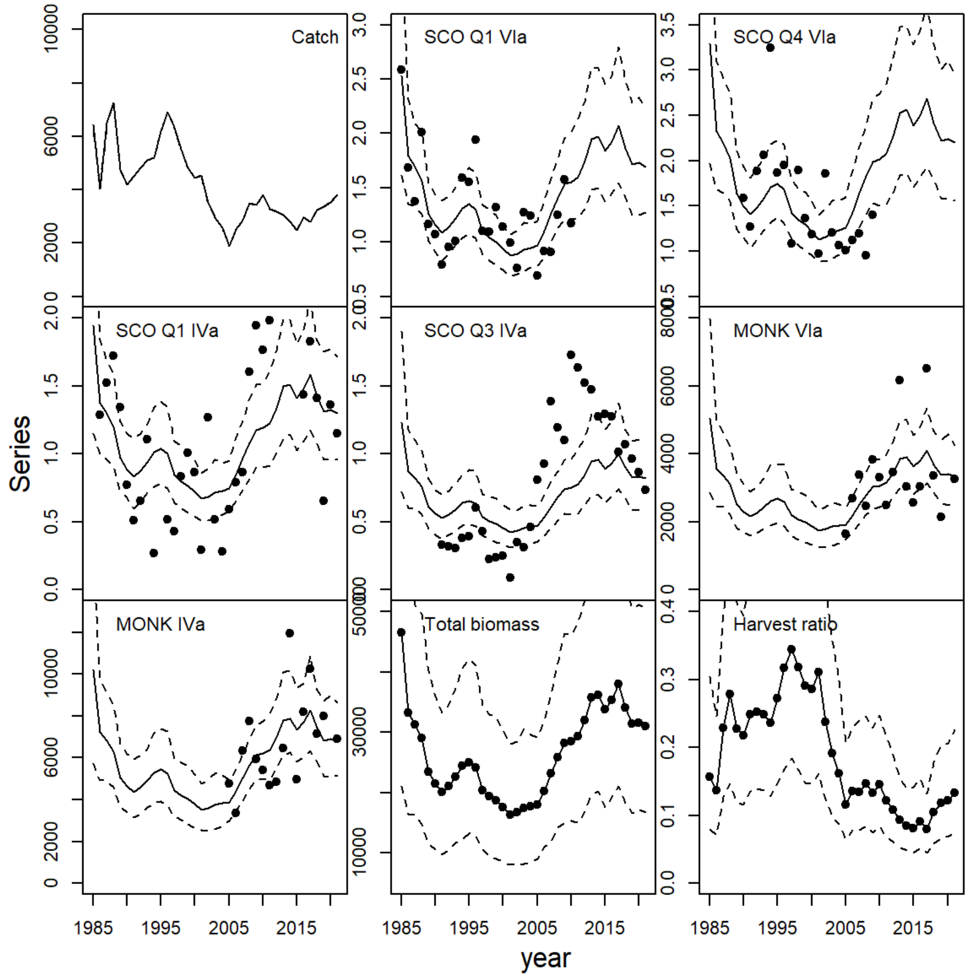


Figure 10.10. Time-series of catch and model estimates of total biomass and exploitation rate (median values are shown as solid lines and 95% confidence intervals shown as broken lines). The model fits to the various CPUE series is also shown (observations dots, median fit solid line and 95% confidence intervals shown as broken lines).

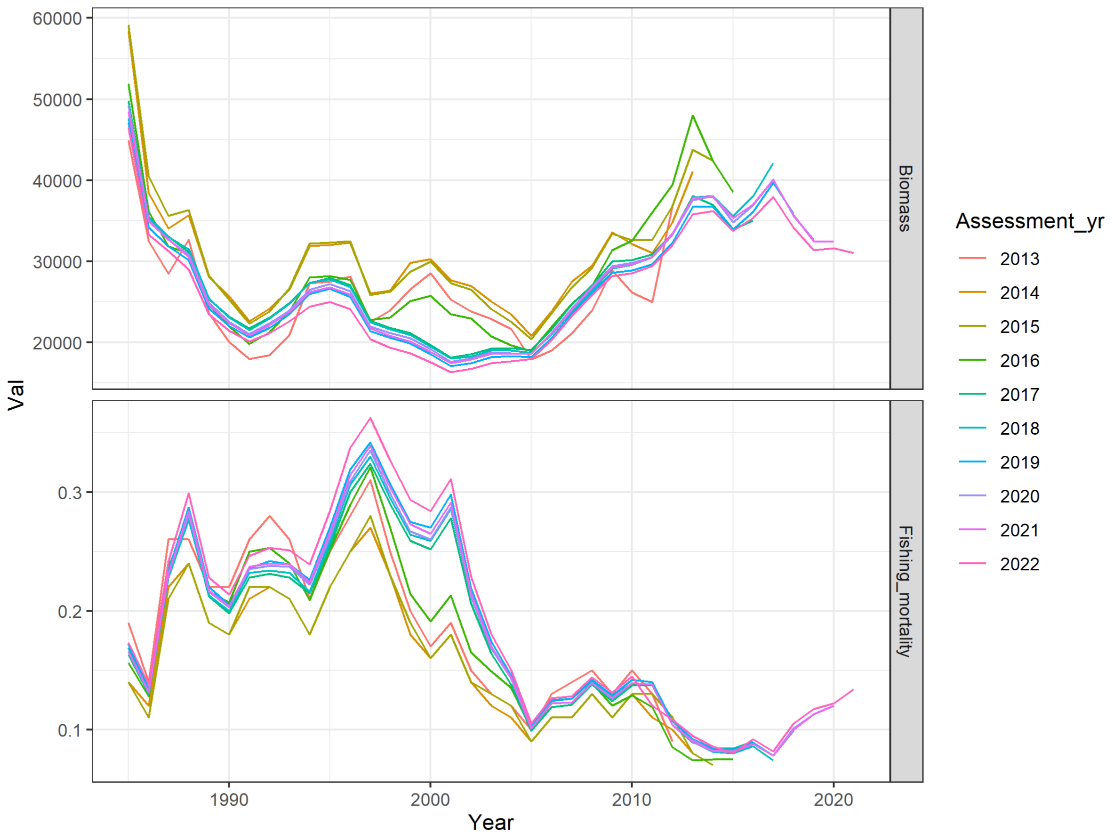


Figure 10.11. Comparison with previous assessments.

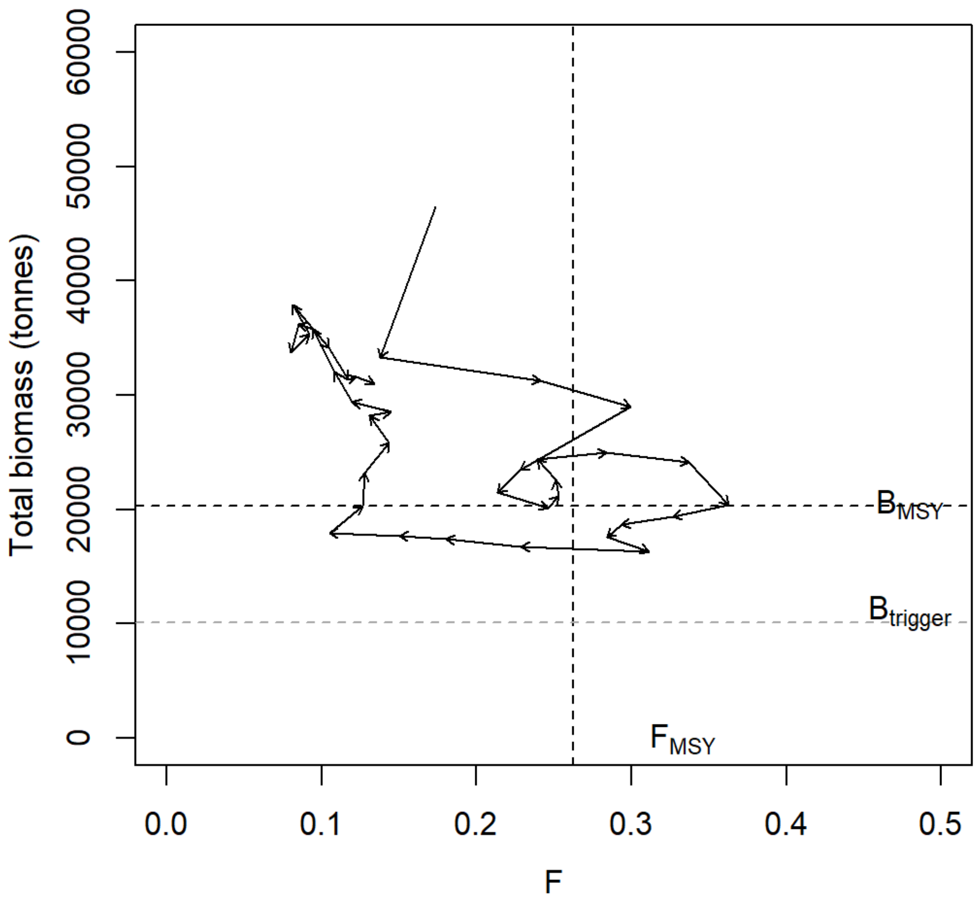


Figure 10.12. Kobe plot of stock status.

11 Megrim (*Lepidorhombus* spp.) in Division 6.b (Rockall)

Type of assessment in 2022

This stock was benchmarked in 2021 (ICES, 2021) and, as a result, the stock was changed from category 3 to category 2. The assessment, which is now based on Surplus Production in Continuous Time (SPiCT, Pedersen and Berg, 2017), includes revised assumptions and model priors. Reference points were also revised. These changes have resulted in a more reliable assessment and the methodology is appropriate to determine stock status and a short-term catch forecast.

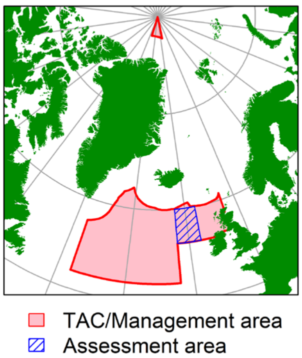
ICES advice applicable to 2023

ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2023 should be no more than 1022 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 (Gordon, 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).

TAC regulations for 2021 and 2022 are given below:

2021:

Species:	Megrims *Lepidorhombus* spp.		Zone:	6; United Kingdom and international waters of 5b; international waters of 12 and 14 (LEZ/56-14)
Spain	526	(1)	Analytical TAC	
France	2 053	(1)	Article 8(2) of this Regulation applies	
Ireland	600	(1)		
Union	3 179	(1)		
United Kingdom	2 046	(1)		
TAC	5 225			

(1) Special condition: of which up to 25 % may be fished in: United Kingdom and Union waters of 2a and 4 (LEZ/*2AC4C).

2022:

Species:	Megrims *Lepidorhombus* spp.		Zone:	6; United Kingdom and international waters of 5b; international waters of 12 and 14 (LEZ/56-14)
Spain	550	(1)	Analytical TAC Article 8(2) of this Regulation applies	
France	2 146	(1)		
Ireland	627	(1)		
Union	3 323	(1)		
United Kingdom	2 258	(1)		
TAC	5 581			

(1) Special condition: of which up to 25 % may be fished in United Kingdom and Union waters of 2a and 4 (LEZ/*2AC4C).

Fishery in 2021

Ireland had the highest catches in 2021 followed by the UK and Spain (Table 14.1). The majority of the landings and catches are from otter trawlers.

Catch	Landings		Discards
631 tonnes	Otter trawls 85%	Other gears 15%	Otter trawls 100%
	566 tonnes		65 tonnes

Landings

Official landings data for each country together with Working Group best estimates of landings from 6.b are shown in Table 14.1 and Figure 14.1.

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 for 2021 were available for Ireland, UK and Spain in InterCatch. Total discard estimates were available from 2005–2021. 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 2017–2020). In 2021, discards represented approximately 10% of catch; increasing to 65 from 59 tonnes (Table 14.1 and Figure 14.1).

Surveys

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish. Sixteen years of survey data are available and these cover the main distribution of the anglerfish fishery. The survey is also considered to have greater spatial coverage for megrim, and as such was recommended by WKAGME (2008) as the main source of data of megrim relative biomass, for all megrim stocks in the Northern Shelf.

The survey index for 6.b is shown in Figure 14.2. Due to technical reasons the survey was unable to sample in Division 6.b, so the stock size is unknown for 2022. This value is also absent in 2020 due to the absence of the SCO-IV-VIAMISS-Q2 [G1794] survey cancellation due to Covid. Sensitivity trials showed the assessment to be robust to the missing data and it was decided by the group to use the updated assessment despite the missing input data. Details and outputs of the sensitivity trials are included below in the uncertainties section of the report.

The available data shows the stock abundance to have been stable since 2012 prior to which it displayed a largely increasing abundance and biomass trend since 2005. The area-stratified survey provides a minimum estimate of absolute biomass; survey catches are raised based on swept area and weighted by area. The survey assumes that all megrim in the trawl path are retained e.g. q=1. Assuming full retention is overly optimistic, therefore the minimum estimate of stock biomass was provided.

Historical stock development

Prior to the benchmark in 2021, the stock was a category 3 stock that utilised a SPiCT assessment and the ratio of the mean of the last two SCO-IV-VIAMISS-Q2 index values.

Final Assessment

Following on from the benchmark (ICES, 2021), the final assessment utilised a SPiCT model utilising the recommendations and developed settings. The catch data is shown in Figure 14.1 and combined the landings and discard estimates. The abundance index from the SCO-IV-VIAMISS-Q2 survey is shown in Figure 14.2. Following on from the sensitivity and robustness testing at the benchmark the following prior settings were applied:

- Surplus production curve fixed (n=2)
- Intrinsic growth rate (r) 0.39 – modelled from FishLife
- An initial biomass depletion prior of 0.5
- Intermediate year catch – average of last 3 years' catch

The output of the model can be seen in Figure 14.3. The residuals are good (Figure 14.4) and the retrospective plots for the assessment show good agreement with all the peels (Figure 14.5). Final parameter estimates from the SPiCT run are given in Table 14.2.

State of the stock

The summary plots can be seen in Figure 14.3 and they show fishing pressure on the stock is below F_{MSY} and biomass is above MSY $B_{trigger}$ and B_{lim}.

Short-term projections

Short term projections were conducted using a 2022 catch that was the average of the preceding 3 years, and the assumptions are shown below:

Variable	Value	Notes
F (2022)/F_{MSY}	0.62	F corresponding to *status quo* catch
B (2023)/B_{MSY}	1.31	Short term forecast (STF) with *status quo* catch
Catch (2022)	759	Status quo catch (average 2019-2021) ; in tonnes

Four management scenarios were explored and the catch and relative reference points estimated for 2023. Adopting the MSY approach (using the 35th percentile of predicted catch under F=F_{MSY}) gave an estimated catch of 1022 tonnes, a F/F_{MSY} of 0.91 and a B/B_{MSY} of 1.26.

Basis	Total catch (2023)	F_{2023}/F_{MSY}	B_{2024}/B_{MSY}	% B change
MSY approach (35th percentile of predicted catch distribution under F = F_{MSY})	1022	0.91	1.26	-3.67
F_{MSY}	1116	1.00	1.24	-5.17
F_{2021}	793	0.69	1.31	-0.06
F=0	0	0	1.47	12.4

MSY reference points

The MSY reference points are calculated based on the relative reference points estimated by the SPiCT model, so will change when the assessment is updated. The reference points are calculated as:

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	0.5 *	Relative value (B/B_{MSY}) from the SPiCT assessment model. B_{MSY} is estimated directly from the SPiCT model and changes when the assessment is updated.
	F_{MSY}	1 *	Relative value (F/F_{MSY}) from the SPiCT assessment model. F_{MSY} is estimated directly from the SPiCT model and changes when the assessment is updated.
Precautionary approach	B_{lim}	0.3 × B_{MSY}	Relative value (equilibrium yield at this biomass is 50% of MSY).
	F_{lim}	1.7 × F_{MSY}	Relative value (the F that drives the stock to B_{lim}).

Uncertainties and bias in assessment and forecast

Due to the missing 2022 and 2020 survey data sensitivity analyses were conducted to determine the impact on the assessment. Comparisons between the 2021 assessment and the updated 2022 were conducted, and showed that the r, K and q parameters (shown in the table below) estimated were very similar, with less than 3% change for each. There were some differences in the estimates states in the assessments, with lower fishing mortality and higher biomass states in 2022. This would be expected due to the catches being reduced by 31% in 2021.

Parameter	2021 Assessment	2022 Assessment	Percent.Change
<chr>	<dbl>	<dbl>	<dbl>
r	0.379	0.384	1.379
K	9421.813	9177.065	-2.598
q	0.615	0.618	0.440
B_2021.38	5903.066	5938.855	0.606
F_2021.38	0.156	0.105	-32.834
B_2021.38/Bmsy	1.259	1.301	3.321
F_2021.38/Fmsy	0.829	0.549	-33.732

Figure 14.6 compares the time series of the relative statuses as estimated by last year's assessment and the updated assessment. There is very good agreement up until 2022, at which point the assessment would be expected to diverge due to the large decrease in catches (31%) in 2021. The updated assessment produces a slight increase in advice from 2021 (<3%), based on these lower catches, and lower intermediate year catch assumptions.

To evaluate the assessments robustness to missing data, scenarios was recreating using the complete time series as used in 2019. Three assessments were compared:

- Full time series up to 2019
- Missing index in 2019
- Missing index in 2017 and 2019

The parameters and the state of the stock are very similar in all three scenarios. Comparing the full scenario and missing two index values found the r and k parameter estimates to be less than 1% different. The survey catchability parameter differed more (11%) but that might be expected to be more poorly estimated as the index time series becomes significantly shortened. The fishing mortality and biomass estimates differed approximately 5% between the assessments. Overall the time series of relative states show good agreement (Figure 14.7).

Paramater	Full	Missing Last	Missing Last and -2
<chr>	<dbl>	<dbl>	<dbl>
r	0.374	0.375	0.377
K	9725.512	9525.894	9641.080
q	0.609	0.602	0.679
B_2019.38	6180.054	6109.830	5904.964
F_2019.38	0.156	0.159	0.165
B_2019.38/Bmsy	1.278	1.291	1.234
F_2019.38/Fmsy	0.836	0.853	0.880

The catch advice from these different assessment was also in good agreement, ranging from 1036 tonnes in the full assessment down to 992 with both missing data points.

Both these analyses provide reasonable reassurance that the current assessment is robust to missing survey data to the current extent. It also shows that the catch advice is unlikely to have been greatly impacted. There is some concern due to the large decrease in catch in 2021 when there is no available estimate of abundance to verify the health of the stock. It appears that this is partially due to decreased fishing effort in the area, although some decrease in lpue is also noted.

Currently the assessment uses the SCO-IV-VIAMISS-Q2 survey to estimate biomass. It should be noted that the survey was specifically designed to catch angler fish. While this is not an issue when the biomass index is presented in the relative context, in the case of megrim; the raised biomass calculation is based on full retention of megrim in the haul. The estimates are therefore considered as the minimum.

Recommendation for next Benchmark

This stock was subject to benchmark in 2021.

Management considerations

The TAC in 6 has not been fully utilised; the uptake rate is country-specific; 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.

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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 Division 6.b. History of catch and landings; official landings presented by country and ICES estimated catch. All weights are in tonnes.

Year	France	Ireland	Spain	UK (England, Wales, & Northern Ireland)	UK (England & Wales)	UK (Scotland)	UK	Official landings	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	-	-	-	190	344	344	75
2007	-	87	19	-	-	-	188	106	106	22
2008	-	68	84	-	-	-	142	294	294	59
2009	-	48	46	-	-	-	165	226	226	44
2010	-	47	41	-	-	-	93	139	139	26
2011	-	72	28	-	-	-	69	155	155	7
2012	-	120	61	-	-	-	89	224	224	21
2013	-	181	-	-	-	-	58	278	278	15
2014	-	230	73	-	-	-	95	343	343	15
2015	-	256	190	-	-	-	130	453	453	85
2016	-	272	69	-	-	-	116	405	405	145
2017	-	358	215	-	-	-	180	586	586	233
2018	-	438	61	-	-	-	263	762	764	203
2019	25	76 †	94	-	-	-	229	791	757	34
2020*	41	467	112	-	-	-	246	866	861	59
2021*	1	293	71				212	577	566	65

*** Landing values are preliminary.**

† Incomplete/missing as a result of part of the data being unavailable under data confidentiality clauses.

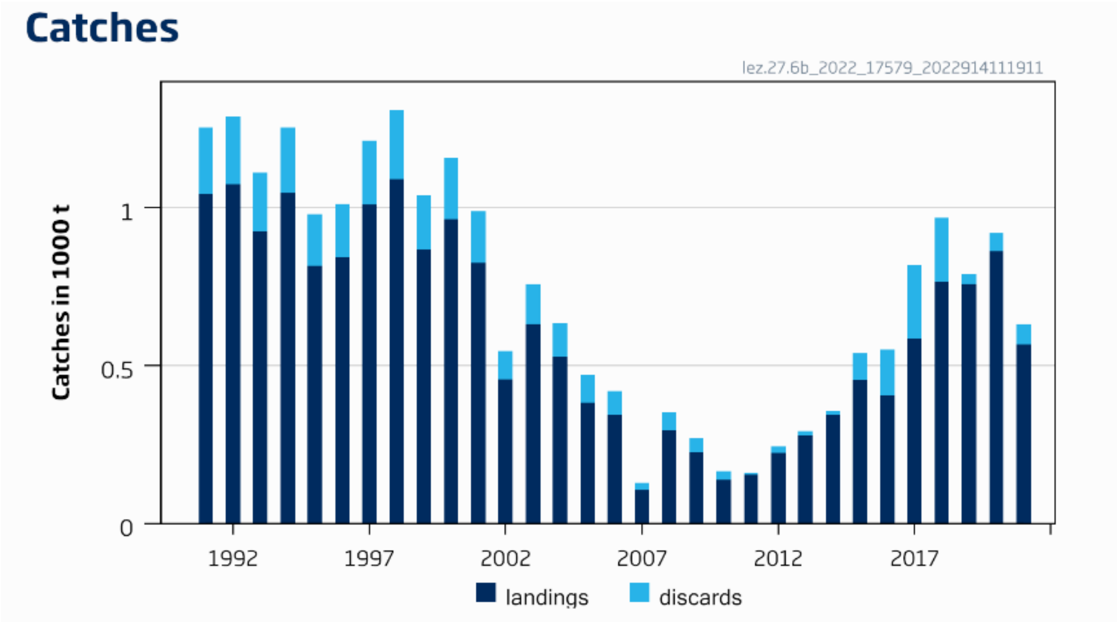

Figure 14.1. Lez.27.6b ICES estimated landings and discards. Discard data are only available since 2005; values prior to that are assumed to be 20% of landings based on the observed ratio from 2017 to 2020.

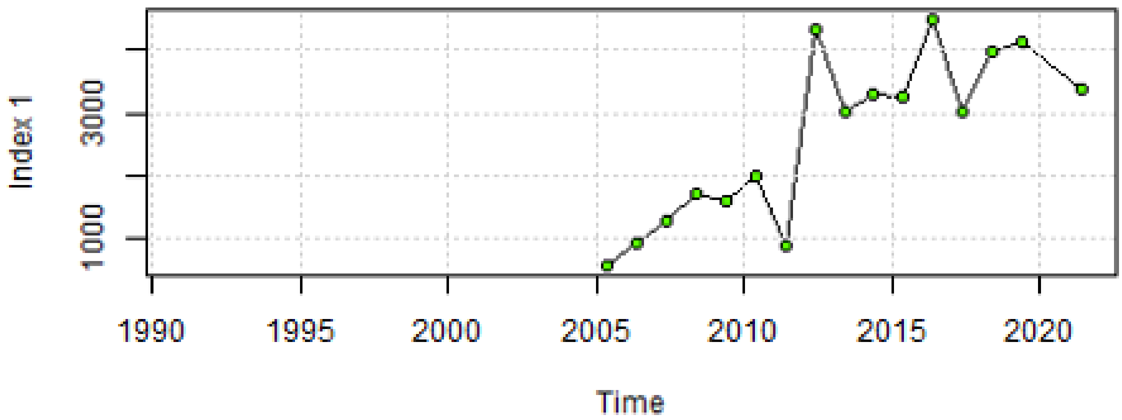

Figure 14.2. Survey data for lez.6b from SIAMISS (SCO-IV-VI-AMISS-Q2 [G1794])

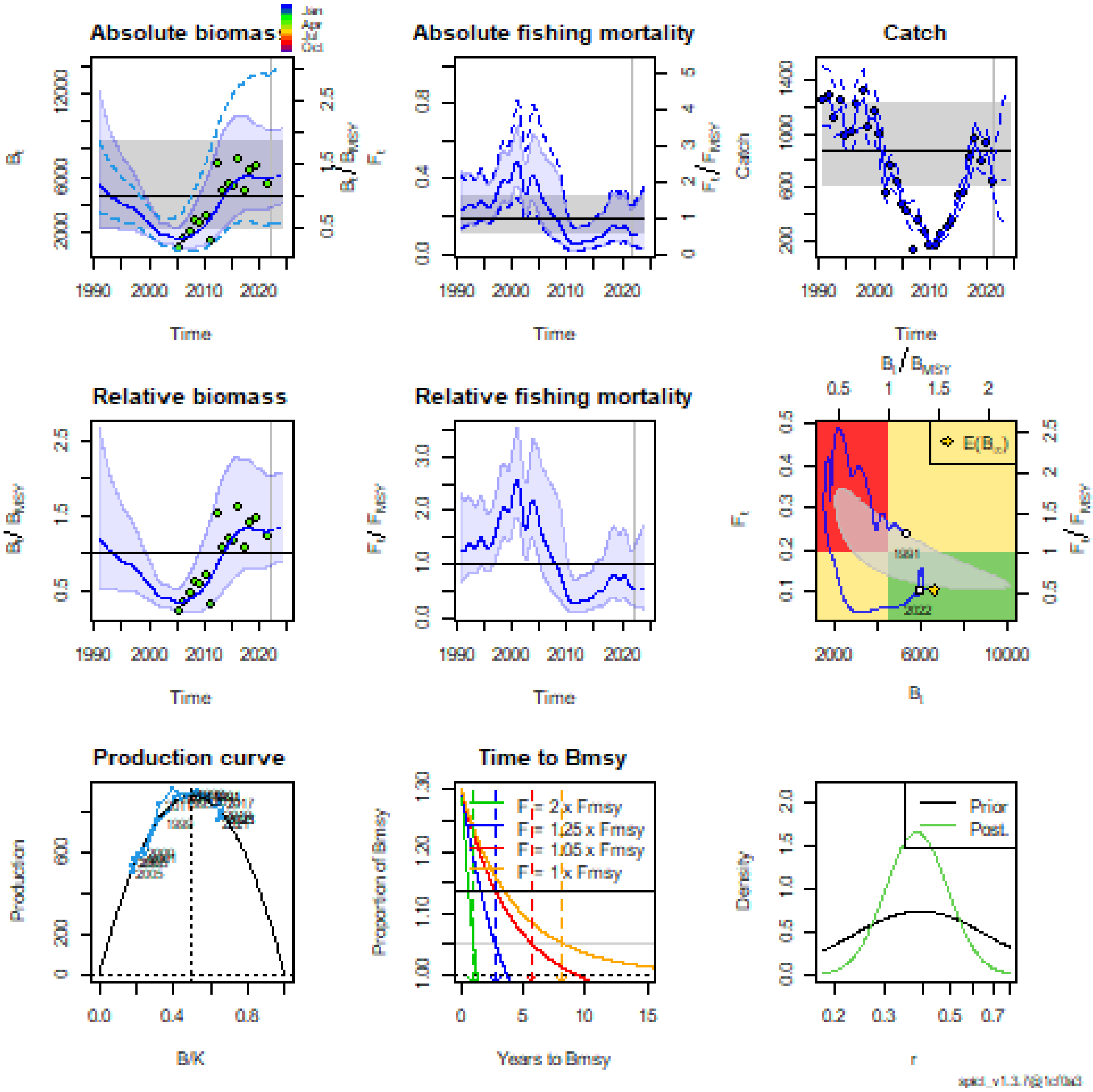

Figure 14.3. SPiCT model output for lez.27.6b. Top right: observed and fitted catch with 95 ci. Centre left: Biomass relative to B_{MSY}. Centre: F relative to F_{MSY}. Corresponding MSY quantities are shown in each plot as horizontal lines (0.5 B_{MSY} in the case of the relative biomass plot). Centre right Kobe plot of stock trajectory.

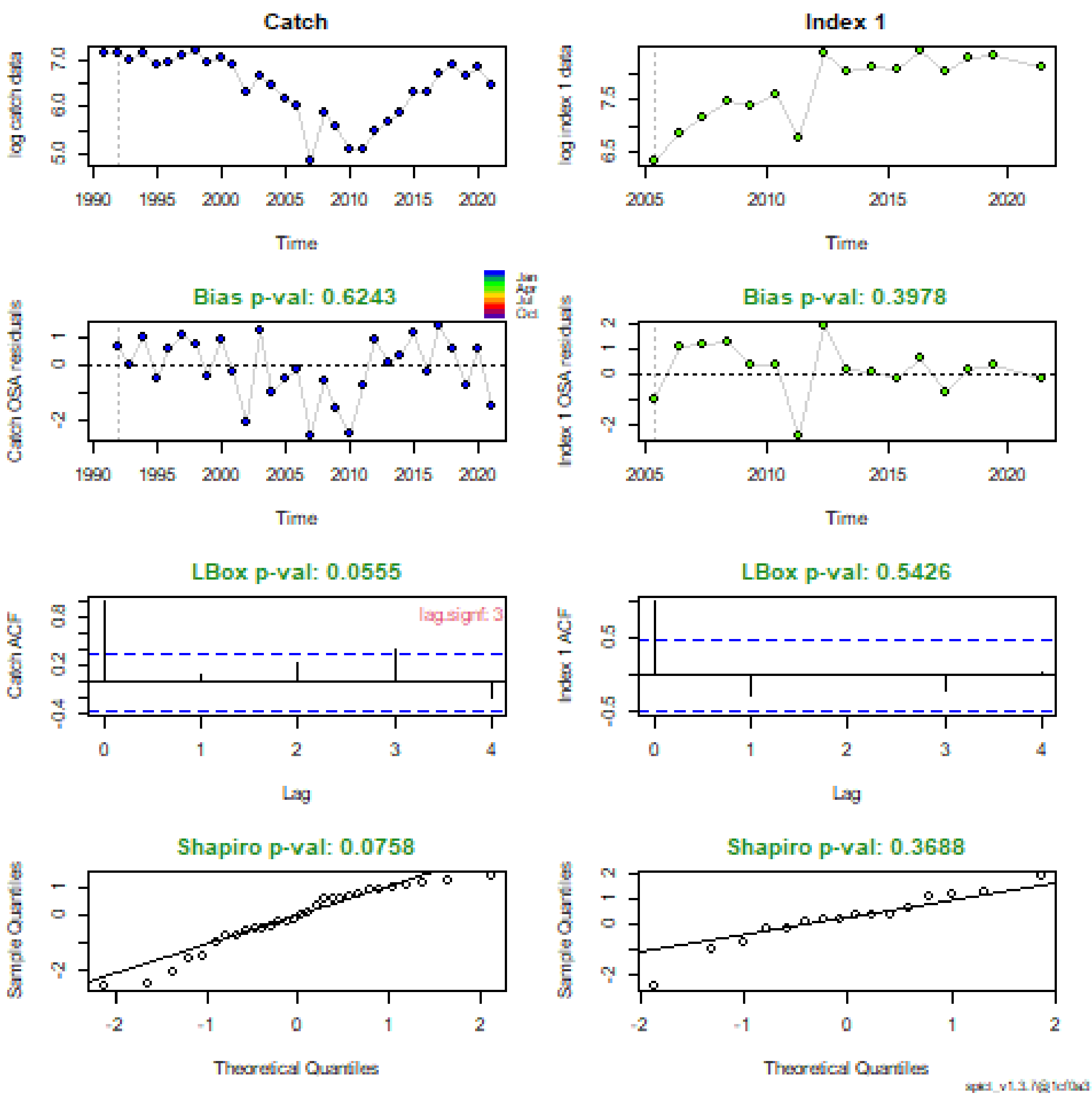

Figure 14.4. SPiCT model residual output for lez.27.6b

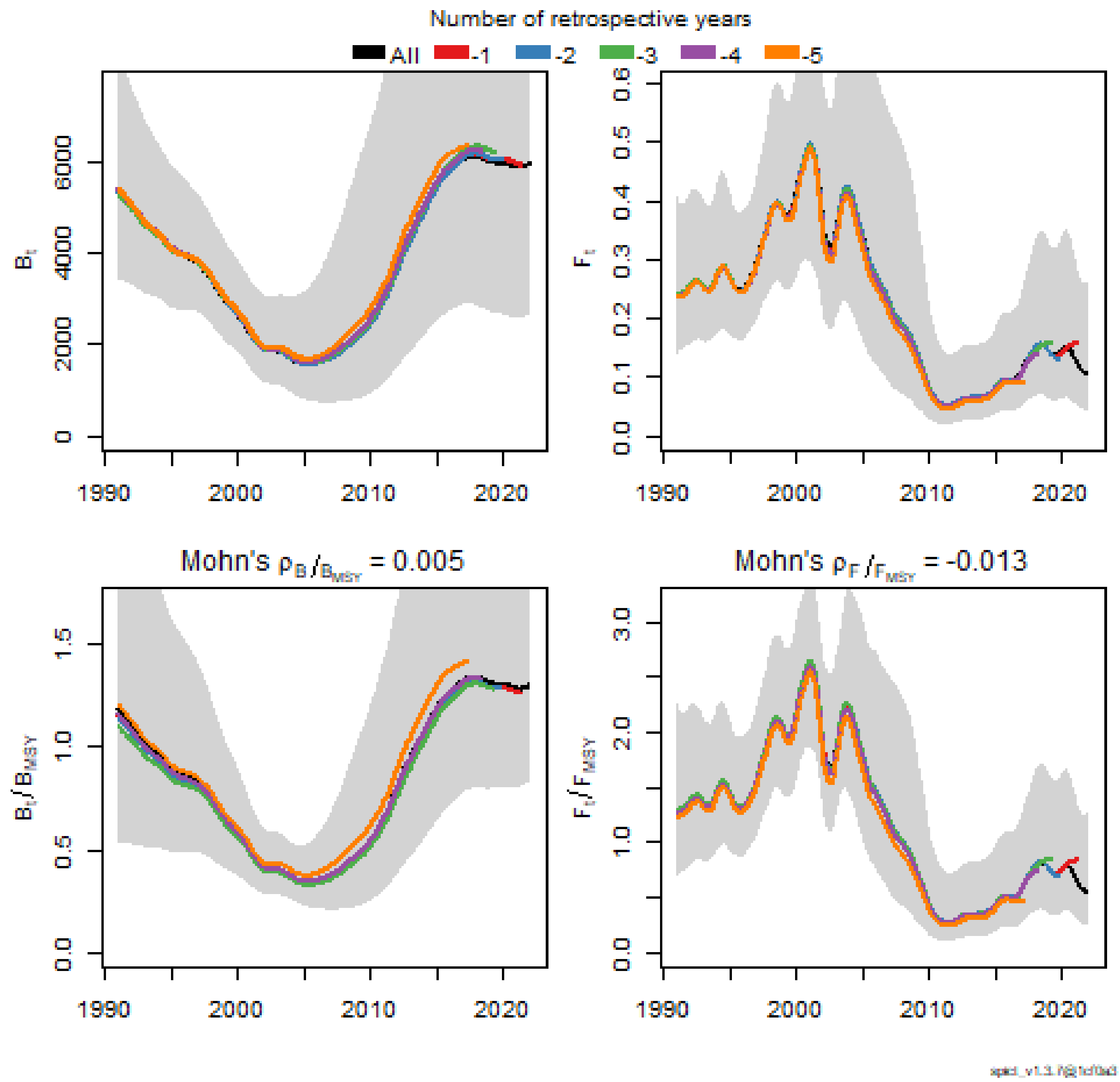

Figure 14.5. SPiCT model retrospectives for lez.27.6b

Table14.2. SPICT results for Lez.27.6b.

```
Model parameter estimates w 95% CI
           estimate       cilow        ciupp    log.est
 alpha    5.9604221   0.7450337 4.768460e+01  1.7851413
 beta     0.3342888   0.0982301 1.137625e+00 -1.0957499
 r        0.3838002   0.2388906 6.166110e-01 -0.9576333
 rc       0.3838002   0.2388906 6.166110e-01 -0.9576333
 rold     0.3838002   0.2388906 6.166110e-01 -0.9576333
 m      880.5398435 619.4560299 1.251663e+03  6.7805352
 K     9177.0656892 4863.6232775 1.731601e+04  9.1244628
 q        0.6176870   0.2677990 1.424715e+00 -0.4817734
 sdb      0.0551011   0.0071406 4.251910e-01 -2.8985853
 sdf      0.2790944   0.1823418 4.271848e-01 -1.2762053
 sdi      0.3284259   0.2253436 4.786626e-01 -1.1134440
 sdc      0.0932981   0.0363117 2.397173e-01 -2.3719552
 pp       0.9615441   0.7651621 9.948154e-01  3.2190290
 robfac  10.4473688   2.3561872 6.681155e+01  2.2457363

Deterministic reference points (Drp)
          estimate       cilow        ciupp   log.est
 Bmsyd 4588.5328446 2431.8116387 8658.0034944  8.431316
 Fmsyd    0.1919001    0.1194453    0.3083055 -1.650780
 MSYd   880.5398435  619.4560299 1251.6633606  6.780535
Stochastic reference points (Srp)
          estimate       cilow        ciupp   log.est rel.diff.Drp
 Bmsys 4566.3266273 2423.0463927 8605.4228799  8.426464 -0.004863037
 Fmsys    0.1911496    0.1189586    0.3071504 -1.654699 -0.003926166
 MSYs   872.8348518  617.1145708 1234.5206457  6.771746 -0.008827548

States w 95% CI (inp$msytype: s)
                   estimate        cilow        ciupp    log.est
 B_2021.94      5938.8541864 2620.3230175 1.346017e+04  8.6892715
 F_2021.94         0.1050109    0.0420162 2.624536e-01 -2.2536909
 B_2021.94/Bmsy    1.3005759    0.8310666 2.035333e+00  0.2628071
 F_2021.94/Fmsy    0.5493651    0.2379788 1.268188e+00 -0.5989920

Predictions w 95% CI (inp$msytype: s)
                 prediction        cilow        ciupp    log.est
 B_2024.00      6223.0147558 2763.9332488 1.401116e+04  8.7360098
 F_2024.00         0.1050113    0.0314164 3.510072e-01 -2.2536875
 B_2024.00/Bmsy    1.3628054    0.8951825 2.074704e+00  0.3095454
 F_2024.00/Fmsy    0.5493670    0.1743656 1.730870e+00 -0.5989886
 Catch_2023.00   647.0016731  324.4560955 1.290194e+03  6.4723489
 E(B_inf)       6583.3951800           NA           NA  8.7923059
```

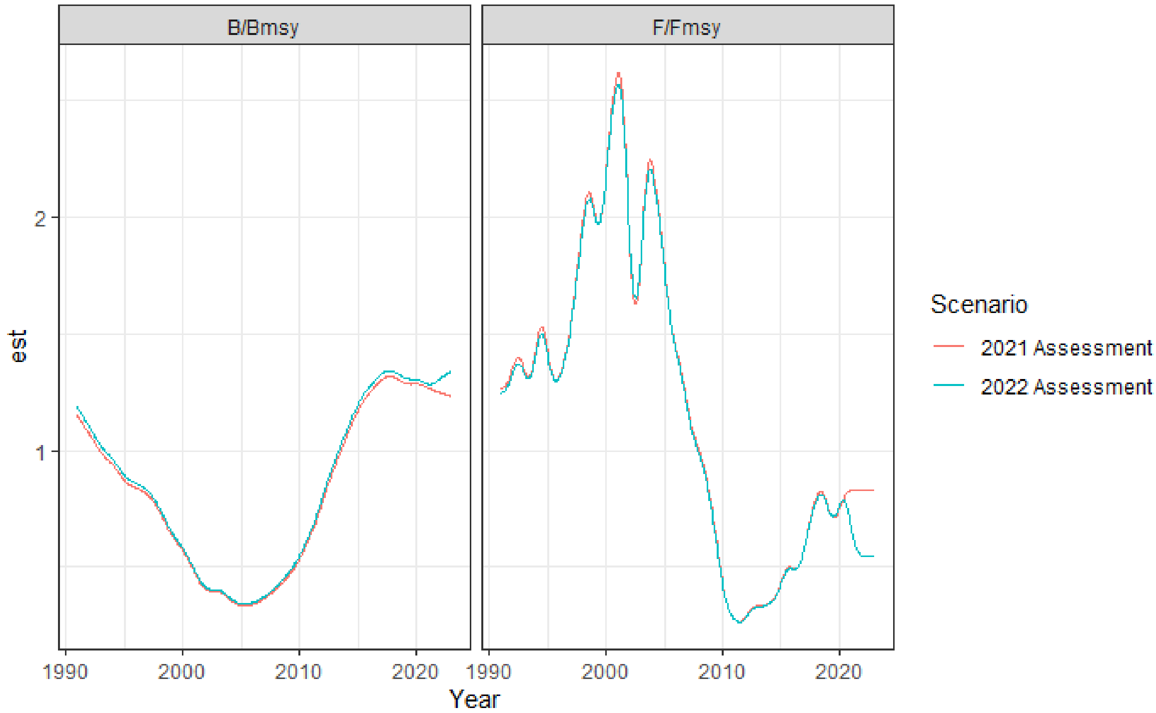

Figure 14.6. Comparison of relative time series from the SPiCT assessments for lez.27.6b in 2021 and 2022

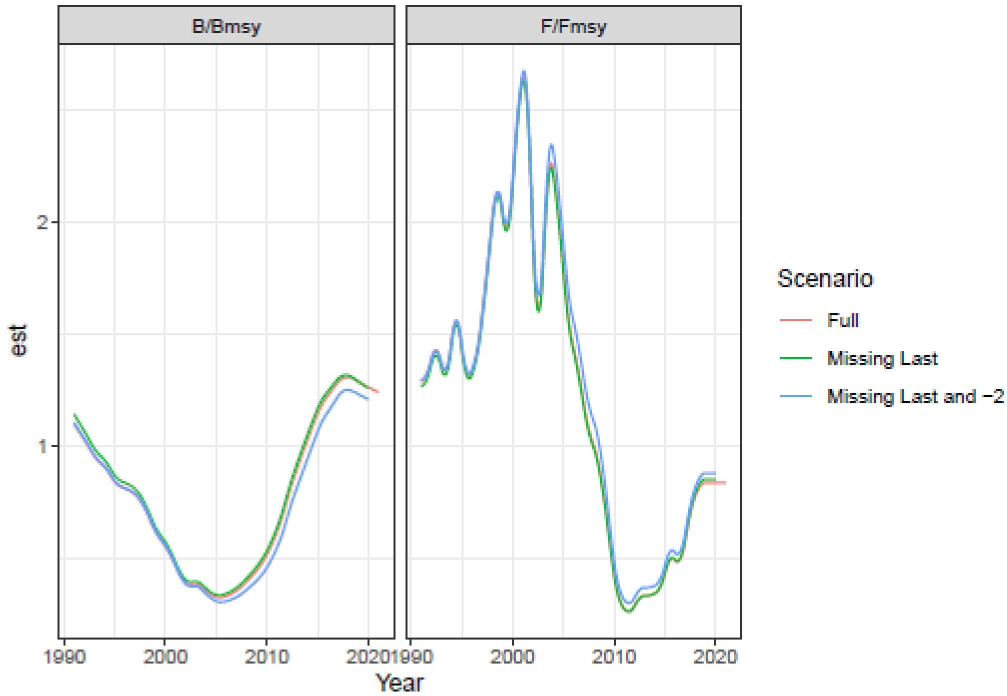

Figure 14.7. Sensitivity analyses comparing time series from the SPiCT assessments for lez.27.6b in with missing survey data points

12 Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 11 (West of Scotland, North Minch)

Nephrops stocks have previously been identified by WGNEPH on the basis of population distribution, and defined as separate Functional Units. The Functional Units (FU) in ICES Division 6.a (of which there are three) are defined by the groupings of ICES statistical rectangles given in Table 12.1 and illustrated in Figure 12.1. 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 2022

The assessment of North Minch *Nephrops* in 2022 is based on a combination of examining trends in fishery indicators and abundance estimated by underwater TV survey, both of which comprise an extensive data series for this FU. The assessment follows the process defined by the benchmark WG (WKNEPH 2009 and WKNEPH 2013) and is conducted annually according to standards set out by the Manual for the Nephrops Underwater TV Surveys (Dobby H., et al, 2021). Further details on the assessment and catch options are provided in the stock annex.

ICES advice applicable to 2021

'ICES advises that when the EU multiannual plan (MAP) for Western waters and adjacent waters is applied, catches in 2021 that correspond to the F ranges in the MAP are between 3075 tonnes and 3953 tonnes. The entire range is considered precautionary when applying the ICES advice rule.

To ensure that the stock in Functional Unit 11 is exploited sustainably, management should be implemented at the functional unit level.'

ICES advice applicable to 2022

'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 the years 2018 – 2020, catches in 2022 should be no more than 3853 tonnes.

To ensure that the stock in Functional Unit 11 is exploited sustainably, management should be implemented at the functional unit level.

ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 6. ICES considers this plan to be precautionary when implemented at the FU level.'

12.1 General

Nominal landings as reported to ICES for divisions 6.a and 6.b are presented in Table 12.1.1. Total official landings from Division 6.a were 9764.4 tonnes in 2021, mostly reported by the UK with only 42 tonnes reported from Ireland. Table 12.1.2 and Figure 12.1.1 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 2021, 237 tonnes of landings were reported from outside the FUs which is lower than the long-term average (Table 12.1.2). The main areas of activity outside FUs are the Stanton Bank (to the west of the South Minch) and areas of suitable sediment along the shelf edge and slope to the west of the Hebrides. There are no functional units in Division 6.b and only very small quantities of *Nephrops* are landed (Table 12.1.1(b)).

Stock description and management units

The North Minch (FU 11) is located at the northern end of the west coast of Scotland (Figure 12.1). 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 2021 and 2022

The management unit is Subarea 6 and EU and international waters of 5.b. The TAC for this area is 12 065 tonnes in 2022, down from 15 294 tonnes in 2021.

Since 2016, fisheries catching *Nephrops* in Division 6.a have been covered by the EU landing obligation (EU, 2015a). Creel fisheries are exempt from the landing obligation due to high survivability of discards. Dermersal trawlers using a codend between 80mm–110mm and within 12 miles of shore are also exempt from the landings obligation.

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex if available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland compliance officers.

In 2021, the fishery was generally described as fairly good. It was reported that COVID-19 did not have much impact on the local fishery, with market remaining stable for most of the year.

In recent years the fishery starts steadily, with a good yield in the summer fishery from May to August. The fishery then tails off in the Autumn. This is said to be a seasonal occurrence rather than being caused by bad weather. The majority of the Western Isles trawl fleet has tended to relocate to the east coast and to the fishing grounds in the Firth of Forth/Eyemouth/Shields for the winter months in recent years. Trawl activity in the winter months is generally at a relatively low level.

Activity in the *Nephrops* trawl sector was up in 2021 owing to the relaxation of COVID-19 pandemic rules. However, the creel sector remained fairly stable.

The largest part of the North Minch fleet is still based at Stornoway, numbering approximately 75 vessels in 2021. The majority of the Stornoway vessels (52) are below 10 m in length.

The fleet were targeting the same areas in the North Minch as previous years. The notable changes were that the trawl fleet stayed in the West coast when in previous years they would go to the East coast from September onward. The trawl fleet also lost most of their summer fishing due to the COVID-19 pandemic.

Very few vessels came from outside to fish in the area and activity in the area overall has been reduced in 2021.

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.

Further general information on the fishery can be found in the stock annex.

12.2 Data available

InterCatch

Data for 2021 were successfully uploaded into InterCatch prior to the 2022 WG meeting. Uploaded data were worked up in InterCatch to generate 2021 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.

The COVID-19 pandemic resulted in a reduced sampling effort of commercial catches for FU11 in 2021, as was also the case in 2020. Discard sample data for FU11 were only available for Quarter three and four, and so, InterCatch estimates of discard rates for Quarters one and two in InterCatch were based on samples collected in Quarter three and four. Following download of data from InterCatch, alternate methods of 2021 discard estimation were thus considered. It was agreed at WGCSE that estimates of discard rates and associated size distributions for 2021 would be based on an averaging of discard samples across all quarters for which data are available between 2017 and 2021. Minimum and maximum discard rates over the same period were also examined to gain an appreciation of the plausible range of discarding that might have occur in 2021. Assessment estimates affected by changes in discard rates are annotated hereafter to reflect this; i.e. "x (y/z)", where x is the estimate based on the average discard rate between 2017 and 2021, y is based on minimum discard rate, and z on maximum discard rate over the same period.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Tables 12.1.1(a) and 12.1.1(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 12.2.1. Landings from this fishery are usually only reported from Scotland; between 2012 and 2014 two tonnes of *Nephrops* landings were reported by Ireland and values between one and three tonnes have been reported since 2017. Total reported Scottish landings in 2021 were 2073.1 tonnes, consisting of 1547 tonnes landed by trawlers targeting *Nephrops* (~75%), 472 tonnes landed by creel vessels (~23%) and 53 tonnes by other trawlers. In 2021, a small amount of *Nephrops* below minimum size (BMS) was also reported (1.1 tonnes).

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 Targeting Crustaceans and OTT_CRU – Multirig Otter Trawls Targeting Crustaceans) has shown a decreasing trend since 2000 (Figure 12.2.1) but in 2012 the effort increased by 20% due to the influx of vessels from the North Sea during the first quarter of the year. Since then, effort has declined although there was a small increase in 2016. The decline in effort observed in recent years continued until 2020. The observed increase in effort for 2021 may be attributed to the relaxation of the COVID-19 pandemic rules. Note that the year range in effort time-series (2000–2021) does not match the more extensive year range available for landings, due to a lack of confidence in the reliability of older effort data in the Marine Scotland Science database. The effort is also slightly inconsistent with the landings data because effort is provided for TR2 vessels only, while the '*Nephrops* trawl' landings also 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 12.2.2. Owing to the relaxation of COVID-19 pandemic rules, which disrupted both the fishing industry and government sampling programmes, sampling effort in 2021 was slightly higher compared to 2020, although still lower than recent years. 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.

Length compositions

Figure 12.2.2 shows a series of annual length–frequency distributions for the period 2000 to 2021. 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 2021, the mean size of males increased while that of the female slight decreased when compared to 2020. s.

Sex ratio

Males consistently make the largest contribution to the landings, although the proportion of males does vary between years (Figure 12.2.3(a)). This is likely due to the varying seasonal pattern in the fishery and associated relative catchability (due to different burrow emergence behaviour) of male and female *Nephrops.* Males are available throughout the year and the fishery is prosecuted in all quarters (although effort is usually reduced during the winter months when the weather is poor). Females are mainly taken in the summer when they emerge after egg hatching. The seasonal change in proportion of males to females is evident in Figure 12.2.3(b). In 2021 the normal temporal trend in sex ratios was observed 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 12.2.4 and Table 12.2.3) decreasing between 2010 and 2012, followed by an increase in 2013–2015 and a decrease again in 2016 and stable in 2017 followed by an increasing trend onward. 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 2020 (and also size, Figure 12.2.2) in particular were due to a higher proportion of creel landings. Figure 12.2.5 shows the mean weight by sample and gear type over the period 2011–2021. There is no obvious trend in North Minch trawl-caught mean weights for males and females, however, a decrease in the mean weight of creel caught males is still obvious. 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 2021 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 ~5.8% by number in the last three years (Table 12.2.4). In 2021, the discard rate increased to 6.2% by number (from 5.7% in 2020).

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 2023 is 5.8% based on a three-year average of 2019 – 2021.

Abundance indices from UWTV surveys

The 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 2022, due to the COVID-19 pandemic, the UWTV survey was carried out with a reduced scientific staffing, necessitating a reduced sampling schedule in some areas. UWTV survey in 2022 sampled 72% of the planned stations in relative to 2021(100% of planned stations). While unquantified, the 28% reduction in the number of sampled stations is considered to have minimal impact on the quality of the abundance estimate.

A total of 36 valid TV stations were used in the final survey analysis (Table 12.2.5). Table 12.2.6 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 13.2%, lower than the precision level agreed (Table 12.2.6).

Figure 12.2.6 shows the distribution of stations in recent TV surveys (2016–2022), with the size of the symbols reflecting the *Nephrops* burrow density. Table 12.2.5 and Figure 12.2.7 show the time-series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates.

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009; ICES, 2013). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative relative to absolute conversion factor estimated for FU11 was 1.33 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 33%.

12.3 Assessment

Comparison with previous assessments

The assessment follows the same procedure 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).

State of the stock

The assessment summary is provided in Table 12.2.4. 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 2022 was 1346 million individuals, a 3.2% decrease from the 2021 estimate. The stock is still well above the MSY $B_{trigger}$ value of 541 million, or the rounded value of 540 million individuals used in the provision of advice (Figure 12.2.7).

The calculated harvest rate in 2021 (dead removals/TV abundance = 4.6%) is below the F_{MSY} proxy for this stock (the value associated with high long-term yield and low risk depletion) of 10.8%.

12.4 Catch option table

Landings predictions and catch options at various harvest rates (based on principles established at WKNEPH (ICES, 2009)), including a selection of those equivalent to the per-recruit reference points, are made on the basis of the 2022 UWTV survey conducted in August (although normally in June). These were presented in September 2022 for the provision of advice.

The table below shows the agreed inputs to the catch options table.

Input	Data	2022 assessment
Survey abundance (millions)	UWTV 2022	1346
Mean weight in projected landings (g)	1999–2021	26.54
Mean weight in projected discards (g)	1999–2021	11.3
Dead projected discards	average 2019–2021	5.8%*
Discards survival rate	Proportion by number (assumed)	25%**
Dead discard rate	average 2019 - 2021	4.4%

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 2021 for producing the catch options.

*Based on mean discard rate (2017–2021) allocated to Quarters 1 – 2 of 2021; estimates of 8.4% and 4.0% were derived based on the maximum and minimum observed discard rates, respectively, for the same period

** Discard survival in the creel fishery is assumed to be 100%, as outlined in the stock annex.

12.5 Reference points

New reference point F_{MSY} were derived for this stock at WKMSYRef4 (ICES, 2016). This was updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values a five-year average was chosen. Similarly, the five-year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five-year average of the F above F_{MAX} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy, which occasionally appear. For this stock, the F_{MSY} proxy has been revised from 10.9% to 10.8%.

WKFMSYRef4 did not update the MSY $B_{trigger}$ except for rounding to tens of millions. MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased (ICES, 2013) and is calculated as 541 million individuals and rounded to 540 million for use as MSY $B_{trigger}$ in the advice. Full details are contained in the stock annex.

These reference points should remain under review by WGCSE and may be revised, should improve data become available.

Table 12.2.4 and Figure 12.5.1 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%. A sudden increase was observed in 2012, following this, the harvest rate declined and has remained below the F_{MSY} proxy. Harvest rate historical low of 3.1% was recorded in 2020, with a slight increase to 4.6% in 2021 (still well below F_{MSY} proxy). It is likely that prior to 2006, the estimated harvest rates may not be representative due to underreporting of landings.

12.6 Management strategies

Scotland has recently established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

On the 8th of February 2016, phase 1 of the fisheries management measures for inshore MPAs in Scottish waters came into force (SG, 2016). These measures relate to both NCMPA (Marine (Scotland) Act and the UK Marine and Coastal Access Act) and SACs (EC Habitats Directives – Council Directive 92/43/EEC) both of which have the aim of conserving biological diversity in Scottish waters and contribute to Scotland's MPA network (SG, 2017a). Although not specific to the management of the *Nephrops* fishery, they will influence spatial patterns of fishing for *Nephrops* where controls on the two main gear types, demersal trawls and creels are implemented on *Nephrops* habitat. Within the North Minch functional unit, two MPAs are covered by fisheries management measures. Specifically, the Wester Ross NCMPA where fishing activity is banned for demersal 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 12.6.1.

12.7 Quality of assessment and forecast

The length and sex composition of the landings data is considered to be well-sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the fishery adequately. The reduced sampling effort in 2021 just like in 2020 meant that discard sample data were only available for Quarter 3 and 4, and it was agreed at WGCSE that estimates of discard rates and size distributions for Quarters 1 and 2 of 2021 would be adequately approximated for the purpose of forecasting by averaging of discard samples across all available Quarters between 2017 and 2021. The landings length compositions from 1999 onwards, are derived from both creel and trawl samples. The creel fishery which accounted for an increasing proportion of landings by 31% in 2020 has decrease in 2021 to 22.8%. This part of the fishery exhibits a length distribution 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 (i.e. 2019–2021 for the 2022 assessment) 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 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 stock area was revised in 2013 (ICES, 2013) using integrated VMS-logbook data to more accurately estimate the spatial extent of *Nephrops* catches. Two other factors however, have the potential to increase the fished area further. Firstly, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations and secondly, it is known that most of the sea lochs have areas of mud substrate and are typically fished by creel boats. In recent years, a number of TV surveys have taken place in the major North Minch sea lochs in an attempt to improve estimates of the ground area and *Nephrops* abundance. Work presented at the WKNEPH 2013 (ICES, 2013) showed that the total area of the sea lochs is 105 km^2, which is considerably smaller than the offshore VMS area estimated to be 2908 km^2. Therefore, it is unlikely that the exclusion of these inshore areas from the survey have an impact in the mean densities and overall abundance of *Nephrops* in the North Minch.

12.8 Recommendation for next benchmark

This stock was last benchmarked in 2013 (ICES, 2013). WGCSE will keep the stock under close review and recommend a future benchmark as required.

12.9 Management considerations

The WG, ACOM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level and management at the functional unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

Creel fishing takes place in this area but overall effort by this fleet in terms of creel numbers is not known, and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the North Minch and STECF estimates that discards of whiting and haddock are high in 6.a generally. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Efforts to reduce discards and unwanted bycatches of cod include the implementation of large square meshed panels (SMPs) of 120 mm under the west coast emergency measures, and SMPs of 200 mm which were introduced under the Scottish Conservation Credits scheme.

12.10 References

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Table 12.1. ***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 12.1.1(a). Nominal landings (tonnes) of *Nephrops* in Division 6.a, 1980–2021, as officially reported to ICES.

	France	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	UK	TOTAL
1980	5	1	-	-	7422	-	7428
1981	5	26	-	-	9519	-	9550
1982	1	1	-	1	9000	-	9003
1983	1	1	-	11	10 706	-	10 719
1984	3	6	-	12	11 778	-	11 799
1985	1	1	28	9	12 449	-	12 488
1986	8	20	5	13	11 283	-	11 329
1987	6	128	11	15	11 203	-	11 363
1988	1	11	7	62	12 649	-	12 730
1989	-	9	2	25	10 949	-	10 985
1990	-	10	4	35	10 042	-	10 091
1991	-	1	-	37	10 458	-	10 496
1992	-	10	-	56	10 783	-	10 849
1993	-	7	-	191	11 178	-	11 376
1994	3	6	-	290	11 047	-	11 346
1995	4	9	3	346	12 527	-	12 889
1996	-	8	1	176	10 929	-	11 114
1997	-	5	15	133	11 104	-	11 257
1998	-	25	18	202	10 949	-	11 194
1999	-	136	40	256	11 078	-	11 510
2000	1	130	69	137	10 667	-	11 004
2001	9	115	30	139	10 568	-	10 861
2002	-	117	18	152	10 225	-	10 512
2003	-	145	12	81	10 450	-	10 688
2004	-	150	6	267	9941	-	10 364
2005	-	153	17	153	7616	-	7939
2006	-	133	1	255	13 419	-	13 808

	France	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	UK	TOTAL
2007	-	155	-	2088	14 120	-	16 363
2008	-	56	1	419	14 795	-	15 271
2009	-	53	-	1226	11 462	-	12 741
2010	-	45	1	1962	10 250	-	12 258
2011	-	38	-	2517	10 419	-	12 974
2012	-	28	-	2502	11 807	-	14 337
2013*	-	5	-	-	-	12866	12871
2014	-	51	-	-	-	12760	12811
2015	-	75	-	-	-	11653	11728
2016	-	107	0	-	-	14600	14707
2017	-	114	-	-	-	11442	11557
2018	-	65	0	-	-	8849	8914
2019	-	92	-	-	-	9 018*	9110
2020	-	71	-	538	6334	6872	6943
2021	-	42	-	984	8738.4	9722.4	9764.4

*** Includes 8.6 t landings reported by Isle of Man.**

Table 12.1.1(b). Nominal landings (tonnes) of *Nephrops* in Division 6.b, 1980–2021 as officially reported to ICES. There are no Functional Units in ICES Division 6.b but occasional small landings are made.

	France	Germany	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	TOTAL
1980	-	-	-	-	-	-	0
1981	-	-	-	-	-	-	0
1982	-	-	-	-	-	-	0
1983	-	-	-	-	-	-	0
1984	-	-	-	-	-	-	0
1985	-	-	-	-	-	-	0
1986	-	-	-	8	-	-	8
1987	-	-	-	18	11	-	29
1988	-	-	-	27	4	-	31
1989	-	-	-	14	-	-	14
1990	-	-	-	10	1	-	11
1991	-	-	-	30	-	-	30
1992	-	-	-	2	4	1	7
1993	-	-	-	2	6	9	17
1994	-	-	-	5	16	5	26
1995	1	-	-	2	26	1	30
1996	-	6	-	5	65	5	81
1997	-	-	1	3	88	23	115
1998	-	-	1	6	46	7	60
1999	-	-	-	5	2	5	12
2000	2	-	8	3	4	4	21
2001	1	-	1	14	2	7	25
2002	1	-	-	7	3	7	18
2003	-	-	1	5	6	18	30
2004	-	-	-	2	7	13	22
2005	3	-	1	1	5	7	17
2006	-	-	-	-	1	3	4

	France	Germany	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	TOTAL
2007	-	-	-	2	3	-	5
2008	-	-	-	-	-	-	0
2009	-	-	-	-	-	-	0
2010	-	-	-	-	-	-	0
2011	-	-	-	-	-	-	0
2012	-	-	-	-	-	-	0
2013	-	-	-	-	-	-	0
2014	-	-	-	-	-	-	0
2015	-	-	-	-	-	-	0
2016	-	-	-	-	-	0	0
2017	-	-	-	-	-	2	2
2018	-	-	-	-	-	0	0
2019	-	-	0	-	-	-	0
2020	-	-	0.5	-	-	-	-
2021	-	-	0.02	-	-	-	0

Table 12.1.2. ***Nephrops*****, Total *****Nephrops***** landings (tonnes) by Functional Unit plus Other rectangles, 1981–2021.**

Year	FU11	FU12	FU13	Other	Total
1981	2861	3652	2968	39	9520
1982	2799	3552	2620	27	8998
1983	3197	3413	4076	34	10720
1984	4143	4300	3310	36	11789
1985	4060	4008	4286	104	12458
1986	3381	3484	4341	89	11295
1987	4084	3892	3009	257	11242
1988	4035	4473	3664	529	12701
1989	3205	4745	2812	212	10974
1990	2546	4430	2909	182	10067
1991	2793	4442	3038	255	10528
1992	3559	4237	2803	248	10847
1993	3193	4458	3343	344	11338
1994	3614	4414	2630	441	11099
1995	3655	4682	3987	460	12784
1996	2872	3995	4057	239	11163
1997	3046	4344	3621	243	11254
1998	2441	3730	4841	157	11169
1999	3257	4052	3752	438	11499
2000	3247	3953	3417	421	11038
2001	3259	3991	3182	420	10852
2002	3440	3305	3384	397	10526
2003	3269	3879	3173	433	10754
2004	3082	3869	2973	403	10327
2005	2949	3848	3395	254	10446
2006	4166	4633	4780	241	13820
2007	3978	5471	6660	420	16529
2008	3799	5356	5923	128	15206
2009	3496	4285	4779	185	12745

Year	FU11	FU12	FU13	Other	Total
2010	2413	3846	5843	569	12671
2011	2697	3702	6432	219	13050
2012	3542	3989	6687	435	14653
2013	3413	3776	5435	234	12858
2014	3257	3179	6207	53	12696
2015	3002	3400	5147	309	11858
2016	3529.4*	4402	6447	236	14614.4
2017	2491	3757	5403	250	11901
2018	1956	2540	4143	160	8799
2019	1979	2220	4683	173	9055
2020	1331	1976	3636	151	7094
2021	2073.1	2696.3	4995	237	10001.31

***Includes below minimum size landed discards of 0.4 t.**

Table 12.2.1. ***Nephrops*****, North Minch (FU11), Nominal Landings of** ***Nephrops*****, 1981–2021.**

UK Scotland						**Other United Kingdom and Ireland**	**Total**
year	*Nephrops* trawl	other	creel	Below Minimum Size	Subtotal		
1981	2320	171	370	0	2861	0	2861
1982	2323	105	371	0	2799	0	2799
1983	2784	96	317	0	3197	0	3197
1984	3449	160	534	0	4143	0	4143
1985	3235	117	708	0	4060	0	4060
1986	2641	203	537	0	3381	0	3381
1987	3459	143	482	0	4084	0	4084
1988	3450	148	437	0	4035	0	4035
1989	2603	112	490	0	3205	0	3205
1990	1941	134	471	0	2546	0	2546
1991	2229	126	438	0	2793	0	2793
1992	2978	149	432	0	3559	0	3559
1993	2699	86	408	0	3193	0	3193
1994	2916	245	453	0	3614	0	3614
1995	2940	183	532	0	3655	0	3655
1996	2354	148	370	0	2872	0	2872
1997	2553	102	391	0	3046	0	3046
1998	2023	68	350	0	2441	0	2441
1999	2792	56	409	0	3257	0	3257
2000	2695	28	524	0	3247	0	3247
2001	2649	42	568	0	3259	0	3259
2002	2775	79	586	0	3440	0	3440
2003	2606	45	618	0	3269	0	3269
2004	2391	30	661	0	3082	0	3082
2005	2270	23	656	0	2949	0	2949
2006	3446	23	697	0	4166	0	4166

UK Scotland						Other United Kingdom and Ireland	Total
year	*Nephrops* trawl	other	creel	Below Minimum Size	Subtotal		
2007	3361	26	591	0	3978	0	3978
2008	3229	13	557	0	3799	0	3799
2009	2849	34	613	0	3496	0	3496
2010	1783	9	621	0	2413	0	2413
2011	2109	17	571	0	2697	0	2697
2012	2963	12	565	0	3540	2	3542
2013	2356	480	575	0	3411	2	3413
2014	2752	13	490	0	3255	2	3257
2015	2561	23	418	0	3002	0	3002
2016	3039	15	475	0.4	3529.4*	0	3529.4*
2017	2086	30	374	0	2489	1	2490
2018	1592	30	331	0	1950	3	1953
2019	1521	31	425	0	1975	2	1977
2020	900	17	414	0	1331	0	1331
2021	1547	53	472	1.1*	2073.1	0	2073.1

***Below minimum size landings not rounded to show it was reported.**

Table 12.2.2. ***Nephrops*** **Scottish sampling levels all FUs in 6.a (including N. Irish for Clyde).**

		2019		2020		2021	
FU		N trips*	N measured	N trips*	N measured	N trips*	N measured
North Minch	Landings	41	23 952	25	8 551	34	13368
	Discards	35	3 658	4	443	9	1439
South Minch	Landings	40	21 378	18	8 203	33	13770
	Discards	25	1 578	7	673	3	306
Clyde	Landings	22	19 227	24	10 037	31	14510
	N.Irish Landings						
	Discards	33	4 073	-	-		

*** Number of trips expressed as number of hauls for discards.**

Table 12.2.3. *Nephrops* mean weight in the landings (FU11–13).

Year	FU11	FU12	FU13
1990	21.39	19.99	24.27
1991	25.35	21.74	20.65
1992	21.66	24.10	25.16
1993	20.79	21.26	29.44
1994	23.45	24.96	25.28
1995	22.24	21.96	19.24
1996	26.68	23.10	21.68
1997	21.71	23.37	24.21
1998	23.65	22.18	17.98
1999*	22.70	25.14	17.39
2000	24.19	27.30	19.96
2001	25.33	23.79	19.46
2002	25.93	26.83	16.35
2003	26.03	27.86	19.13
2004	25.16	27.37	18.80
2005	27.65	28.11	17.96
2006	24.52	26.24	19.27
2007	23.61	23.95	19.05
2008	23.90	23.91	16.59
2009	25.42	23.87	18.31
2010	29.39	25.86	21.21
2011	27.56	31.10	19.34
2012	23.43	29.17	21.83
2013	27.52	27.48	20.72
2014	27.96	29.91	20.79
2015	28.74	28.15	22.21
2016	25.76	24.76	17.70
2017	25.89	27.76	17.02
2018	27.39	27.27	16.14
2019	26.59	28.54	17.2
2020	31.06	36.58	18.96
2021	34.78	29.96	15.27
Average**	26.54	27.43	16.91

*** From 1999 onwards, mean weights are shown for trawl and creels combined.**

**** Average for FU11 and FU12 (1999–2021); FU13 (2018–2021).**

Table 12.2.4. ***Nephrops*****, North Minch (FU11): Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest rate.**

YEAR	LANDINGS IN NUMBERS (MILLIONS)	DISCARDS IN NUMBERS (MILLIONS)	REMOVALS IN NUMBERS (MILLIONS)**	ADJUSTED SURVEY VMS (MILLIONS)*	HARVEST RATE VMS	LANDINGS (TONNES)	DISCARDS (TONNES)	DISCARD RATE	DEAD DISCARD RATE	MEAN WEIGHT IN LANDINGS (g)	MEAN WEIGHT IN DISCARDS (g)
1999	144	28	165	794	20.7	3257	273	16.4	12.8	22.7	9.69
2000	134	10	142	1166	12.1	3247	100	6.9	5.2	24.19	10.08
2001	129	17	141	1092	13	3259	160	11.7	9.1	25.33	9.32
2002	133	28	154	1337	11.5	3440	277	17.6	13.8	25.93	9.78
2003	126	30	148	1751	8.5	3269	299	19.2	15.2	26.03	10
2004	122	18	136	1751	7.8	3082	202	13	10.1	25.16	11.02
2005	107	50	144	1540	9.4	2949	507	32	26.1	27.65	10.09
2006	170	74	225	1762	12.8	4166	757	30.3	24.6	24.52	10.27
2007	168	12	177	1206	14.7	3978	214	6.5	5	23.61	18.1
2008	159	19	173	1047	16.5	3799	194	10.5	8.1	23.9	10.36
2009	138	35	164	1195	13.7	3496	327	20.3	16	25.42	9.34
2010	82	12	91	1293	7	2413	128	12.4	9.6	29.39	10.98
2011	96	16	108	1726	6.3	2697	154	14.2	11	27.56	9.66
2012	151	21	167	891	18.7	3542	213	12.6	9.3	23.43	10.33
2013	122	24	140	1403	10	3413	364	16.4	12.8	27.52	15.18
2014	115	8	121	1251	9.6	3257	77	6.3	4.8	27.96	9.99
2015	103	15	114	1445	7.9	3002	143	12.6	9.8	28.74	9.66
2016	136	22	152	1422	10.7	3529***	266	14	10.9	25.76	12.05
2017	95	5	99	1050	9.4	2491	65	5.3	4	25.89	12.51
2018	72	5	75	1188	6.4	1956	59	6.6	5.1	27.39	11.46
2019	74	4	78	1232	6.3	1979	51	5.5	4.2	26.59	11.92
2020	43	3	45	1439	3.1	1331	31	5.7	4.3	31.06	11.84
2021	61	4	64	1391	4.6	2073.1	65	6.2	4.7	34.78	16.02
2022				1346							
Average****									4.6	26.54	11.28

*** 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: 2018–2021; Mean weight in landings and discards average: 1999–2021.**

Table 12.2.5. ***Nephrops*****, North Minch (FU11): Results of the 1994–2022 TV surveys (values adjusted for bias).**

YEARS	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS/M²)	ABUNDANCE (SEDIMENT; MILLIONS)	95% CONFIDENCE INTERVAL (SEDIMENT; MILLIONS)	ABUNDANCE (VMS; MILLIONS)	95% CONFIDENCE INTERVAL (VMS; MILLIONS)
1994	41	0.29	500	74	820	122
1995				No Survey		
1996	38	0.19	330	47	541	76
1997				No Survey		
1998	38	0.31	547	77	898	127
1999	36	0.27	484	89	794	147
2000	39	0.40	711	82	1166	134
2001	56	0.38	666	81	1092	133
2002	37	0.46	815	91	1337	149
2003	41	0.60	1068	129	1751	211
2004	38	0.60	1068	107	1751	175
2005	41	0.53	939	100	1540	164
2006	30	0.61	1074	101	1762	165
2007	36	0.41	735	92	1206	150
2008	41	0.36	638	95	1047	157
2009	26	0.41	729	138	1195	227
2010	37	0.44	-	-	1293	231
2011	41	0.59	-	-	1726	226
2012	41	0.31	-	-	891	181
2013	41	0.48	-	-	1403	206
2014	44	0.43	-	-	1251	171
2015	41	0.50	-	-	1445	370
2016	39	0.49	-	-	1422	290
2017	42	0.36	-	-	1050	149
2018	44	0.40	-	-	1188	244
2019	47	0.42	-	-	1232	256
2020	33	0.49	-	-	1439	319
2021	50	0.48	-	-	1391	215
2022	36	0.46			1346	355

Table 14.2.6. ***Nephrops*****, North Minch (FU11): Results of the 2022 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 (CV)
2022 TV survey								
VMS	2908	36	0.463	0.134	1345.9	31531	1	
Total	2908	36			1345.9	31531	1	0.132

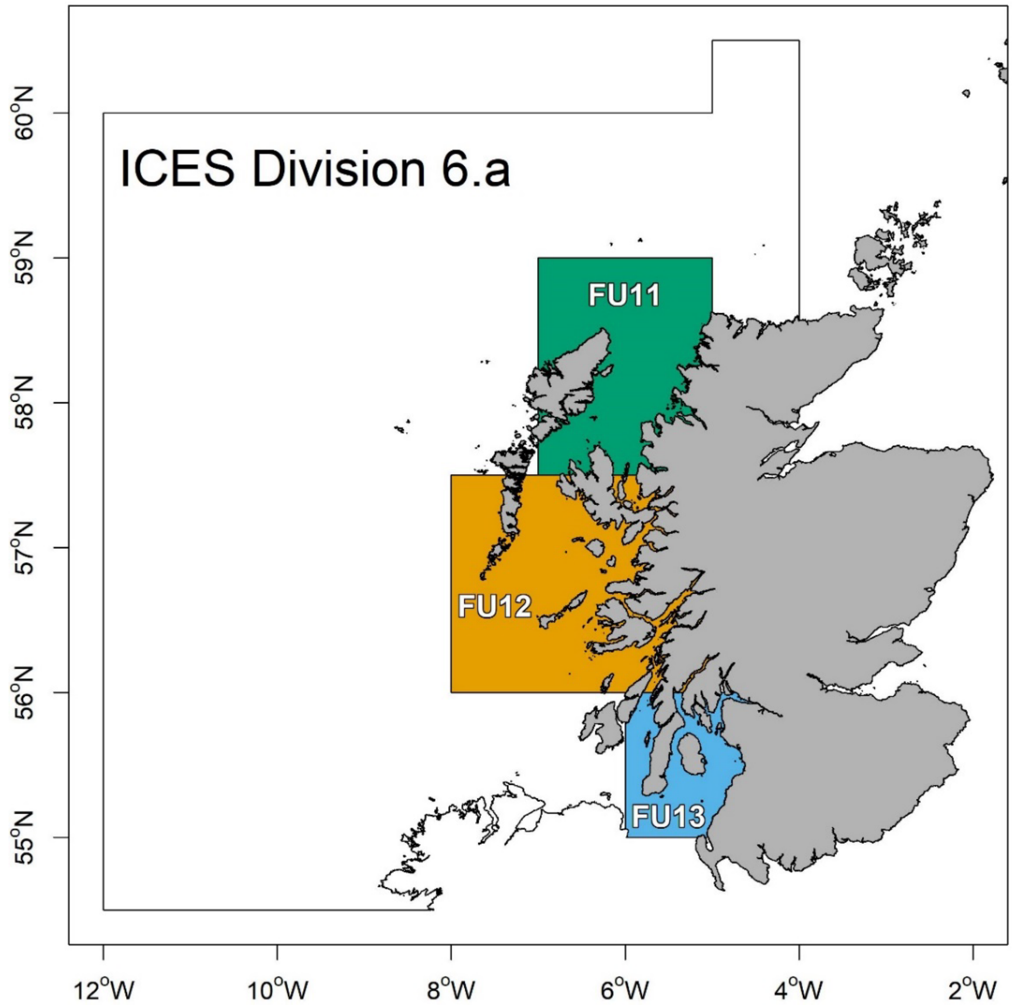


Figure 12.1. ***Nephrops*** **Functional Units in 6.a. North Minch (FU11), South Minch (FU12), Clyde (FU13).**

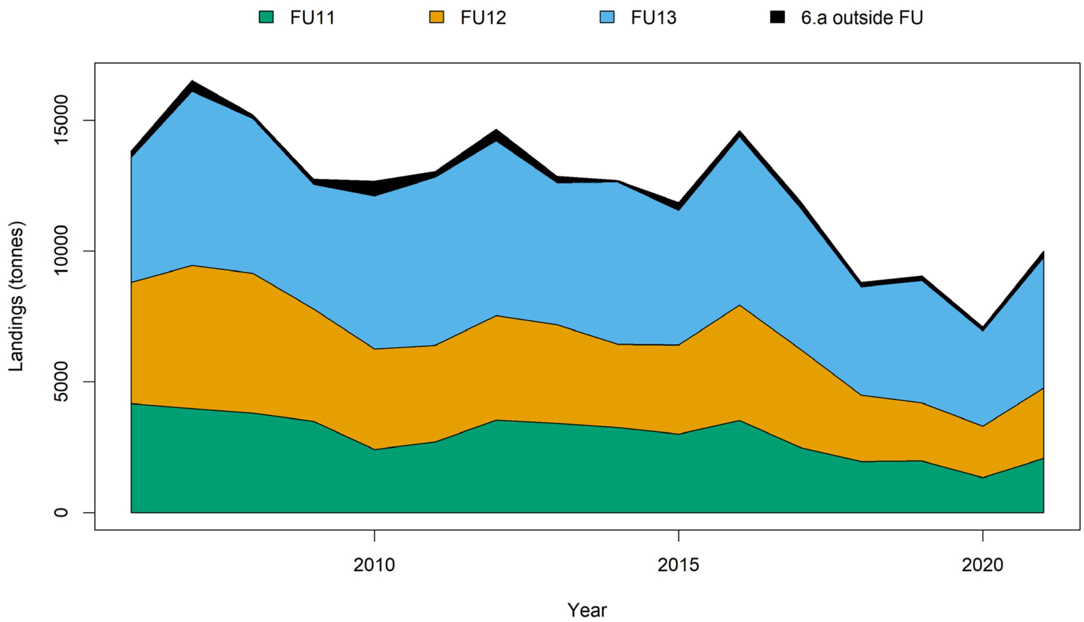
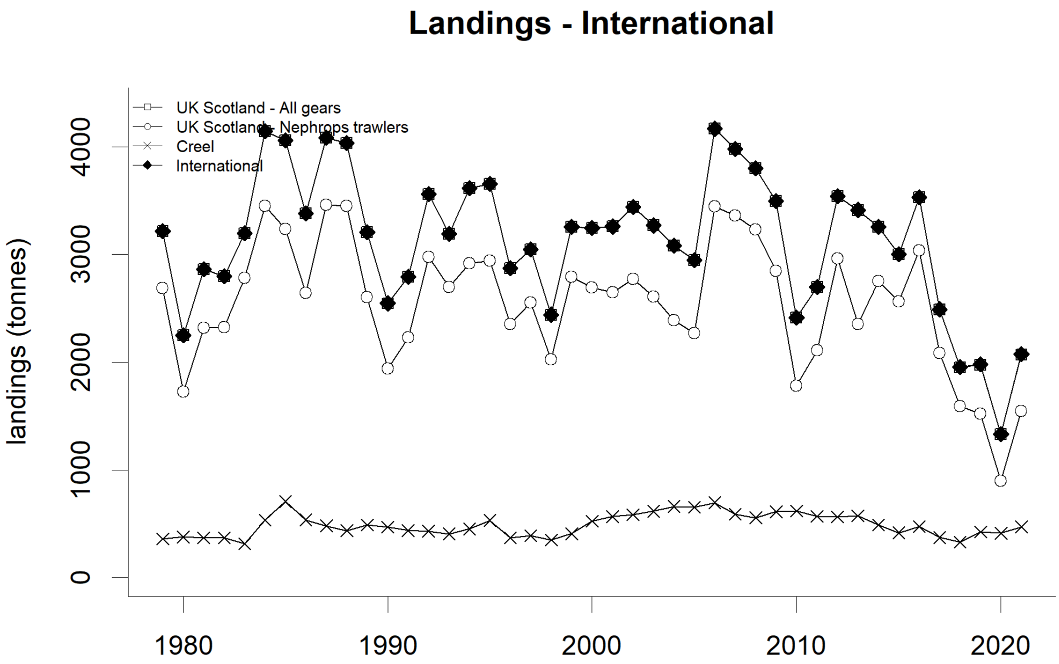


Figure 12.1.1. ***Nephrops*** **in Division 6.a. Landings (tonnes) by functional unit (FU11, 12 &13) and from rectangles outside the functional units (6.a outside FU).**



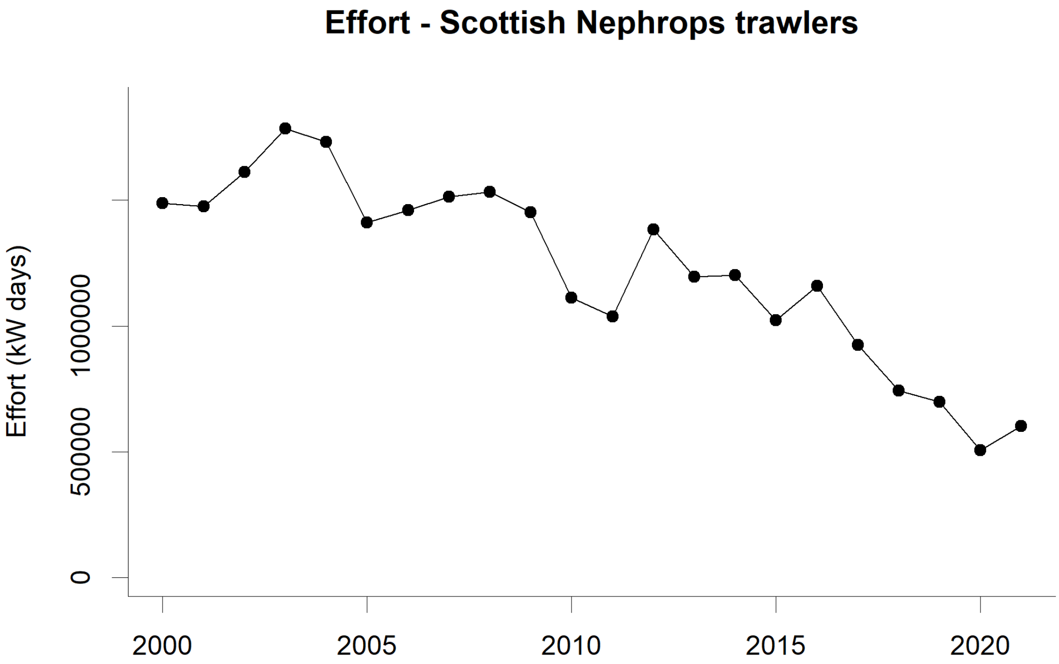


Figure 12.2.1. ***Nephrops*, North Minch (FU11). Long-term landings and effort.**

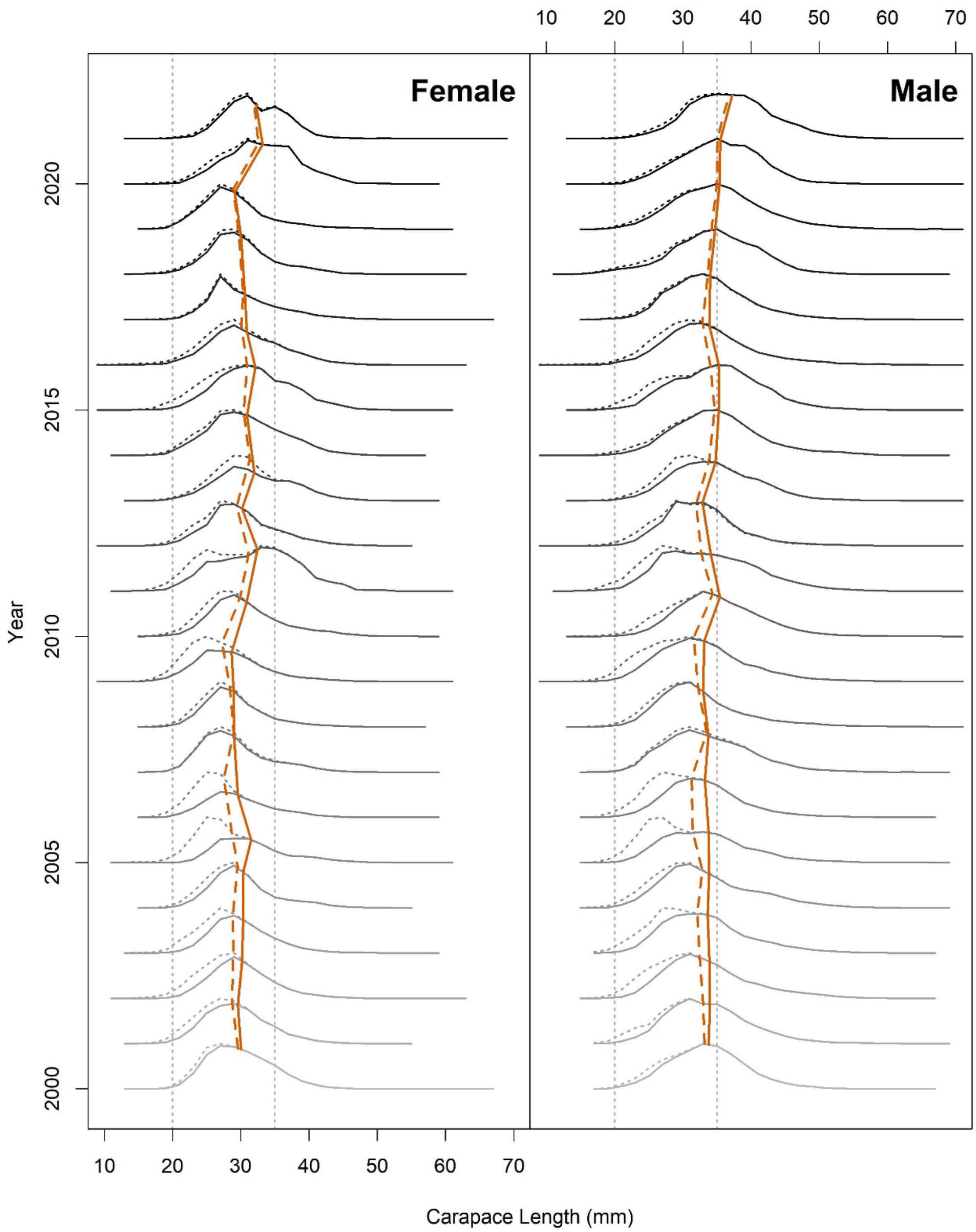


Figure 14.2.2. ***Nephrops*****, North Minch (FU11), Catch length–frequency distribution (dotted) and landings (solid) for Nephrops, 2000 – 2021. Mean size in catches and landings are represented by solid and dashed lines, respectively. Vertical dotted lines are minimum conservation reference size (20 mm) and 35 mm.**

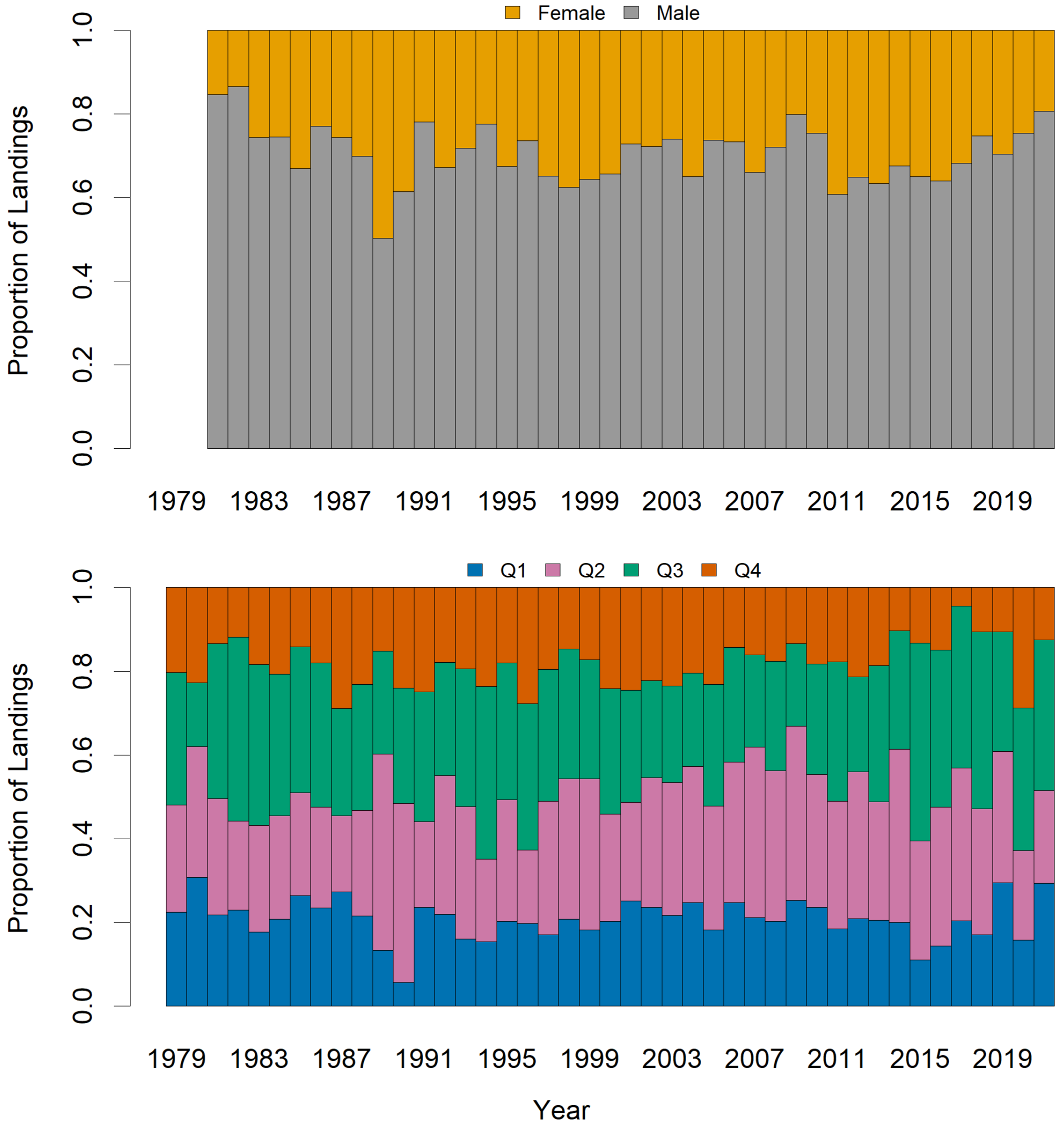


Figure12.2.3 (a). *Nephrops,* North Minch (FU11), Proportion of landed weight by sex (top), by quarter (bottom) from Scottish trawlers.

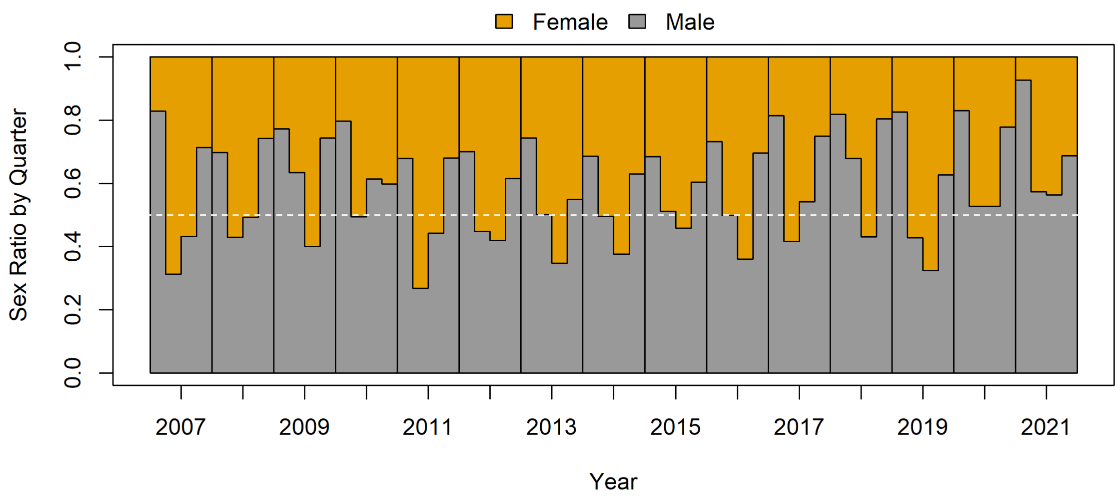


Figure 12.2.3 (b). ***Nephrops,*** **North Minch (FU11), quarterly numeric proportions by sex (2007–2021).**

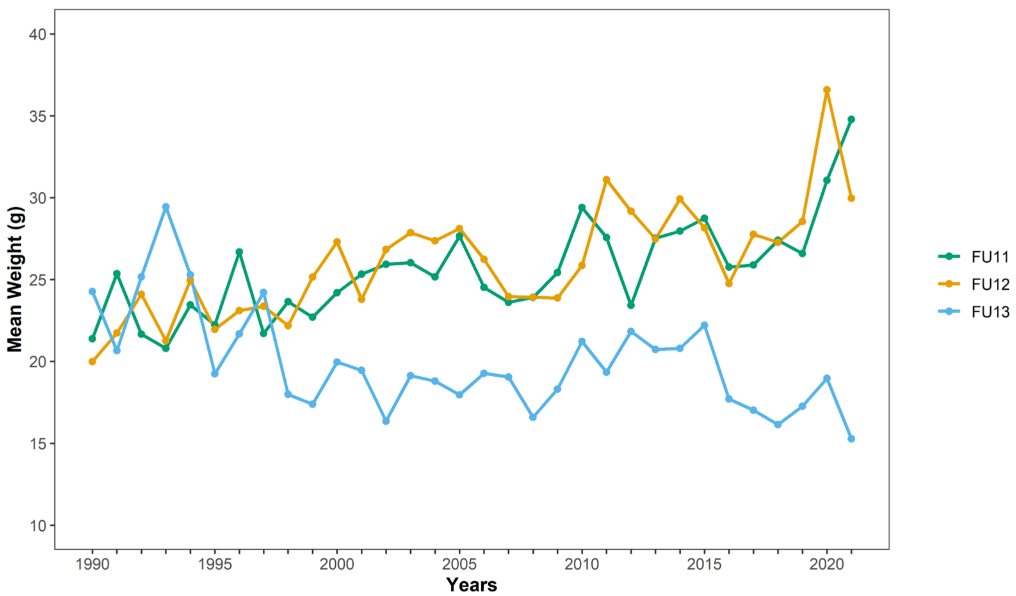


Figure 12.2.4. ***Nephrops*****, (FU11 North Minch, FU12 South Minch and FU13 Clyde), mean weight in the landings from 1990–2021 (from Scottish market sampling data).**

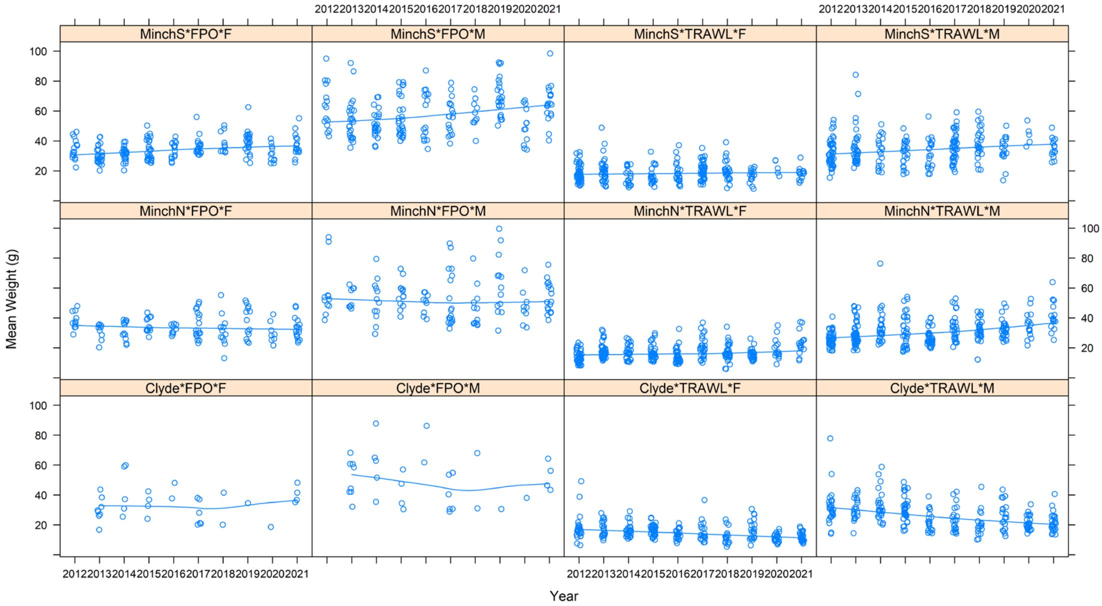


Figure 12.2.5. ***Nephrops*, (FU11 North Minch, FU12 South Minch, FU13 Clyde), mean weight in 2011–2021 by sample date, sex, métier and functional unit.**

Figure 12.2.6. ***Nephrops*, North Minch (FU11), TV survey station distribution and density (mean burrows/m²), 2016–2021. Bubbles in these figures are all scaled the same. Red crosses represent zero observations.**

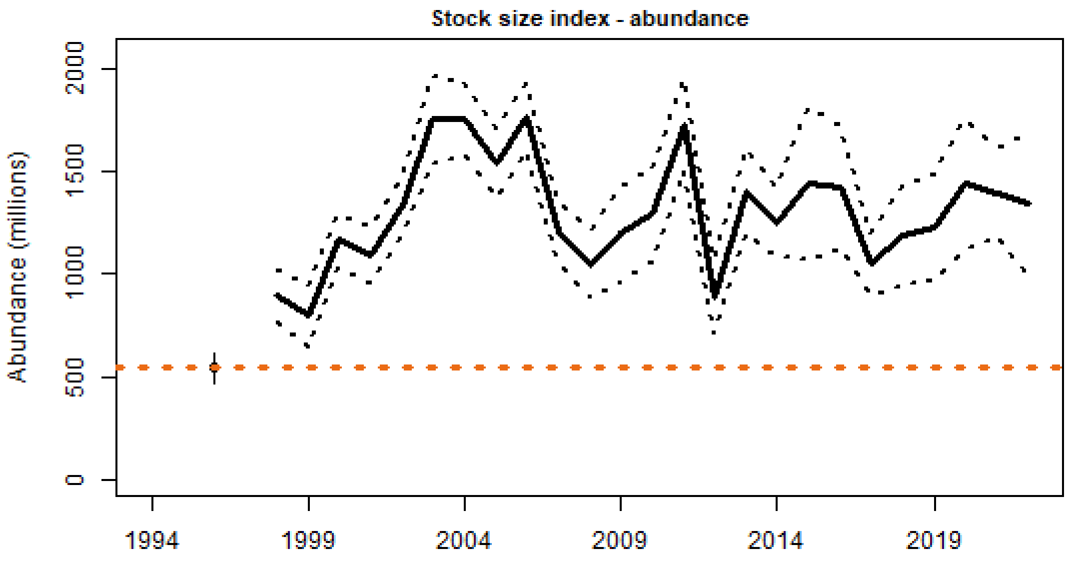


Figure 12.2.7. ***Nephrops*, North Minch (FU11), time-series of revised TV survey abundance estimates (adjusted for bias; solid black line), with 95% confidence intervals (dashed black lines), 1994–2022 (no survey in 1995 and 1997). The dashed red line is the rounded $B_{trigger}$ value of 540 million individuals.**

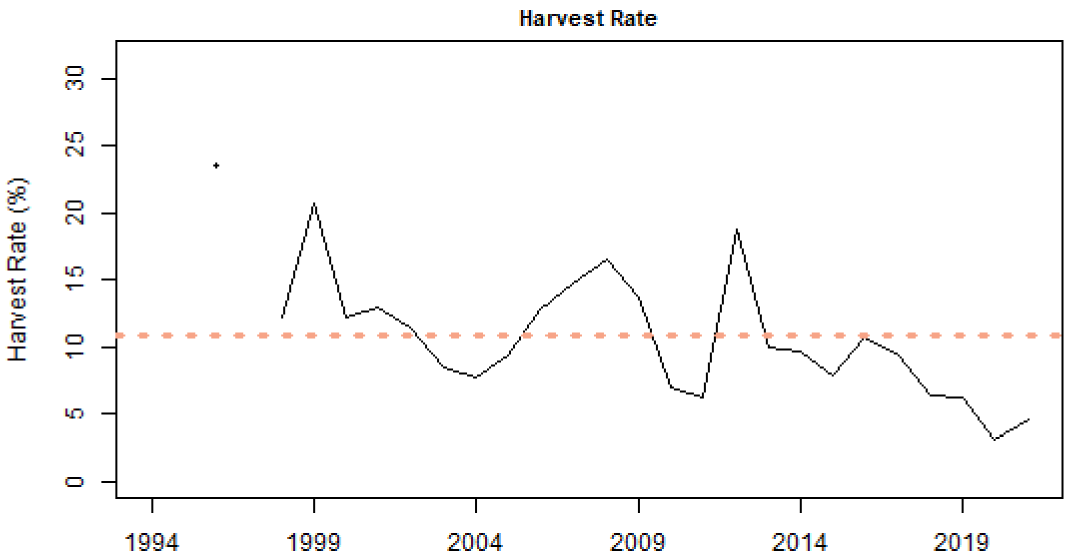


Figure 12.5.1. ***Nephrops*, North Minch (FU11), harvest rate, 1994–2021 (no survey data in 1995 and 1997). The harvest rate is calculated by dead removals/TV abundance. The dashed and solid lines are the F_{MSY} proxy harvest rate (10.8%) and the time-series of estimated harvest rates, respectively. Harvest rates prior to 2006 are considered unreliable.**

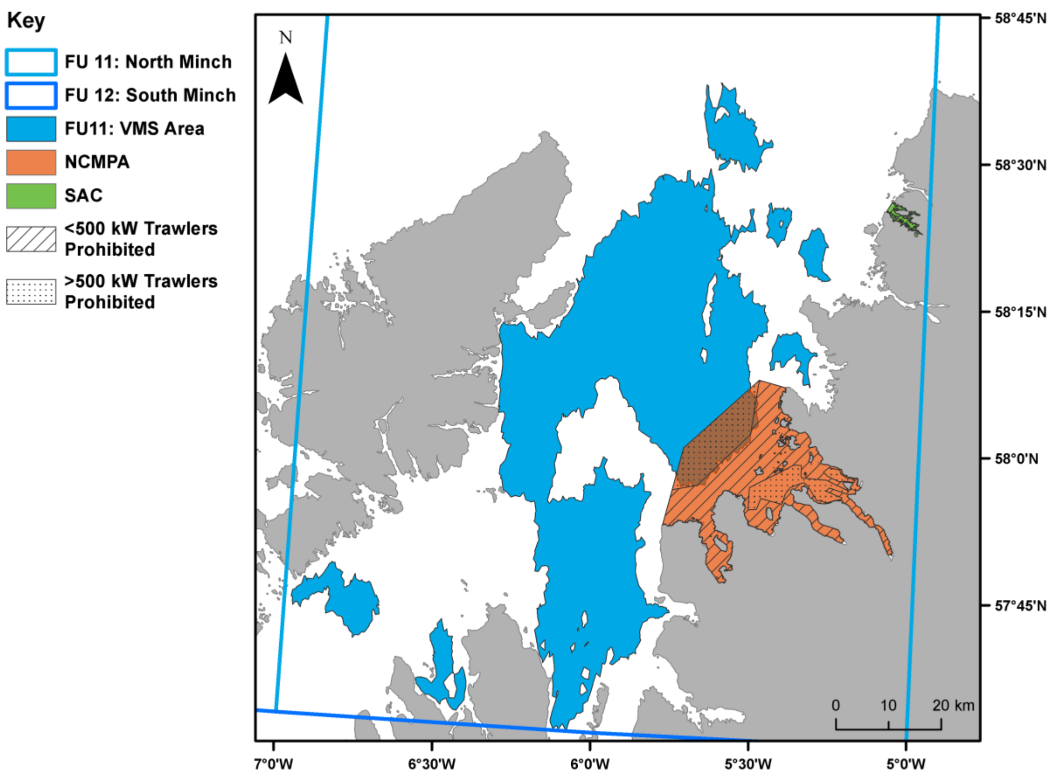


Figure 12.6.1. The area of *Nephrops* habitat (estimated from VMS data) within the North Minch (FU11) relative to the areas of the Nature Conservation MPA (NCMPA) and Special Area of Conservation (SAC) showing areas within these where demersal trawling is banned (hatched) and where it is permitted for vessels below 500 kW (clear; depending on gear type, see SG, 2016). Geographic Coordinate System: OSGB 1936, Datum: OSGB 1936, Projected Coordinate System: British National Grid. Coastline by Wessel and Smith (2016), MPA sites subsetted from NCMPA (SNH, 2015) and SAC (SNH, 2016) layers, management areas by SG (2017b) and functional units generated from merged ICES rectangles (ICES, 2017). Map and modified layers created using ArcGIS (ESRI, 2014).

13 Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 12 (West of Scotland, South Minch)

Type of assessment in 2022

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follow the process defined by the benchmark WG (WKNEPH, 2009; WKNEPH, 2013). Full details are provided in the stock annex.

ICES advice applicable to 2021

'ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2021 that correspond to the F ranges in the MAP are between 4703 tonnes and 5916 tonnes, assuming recent discard rates. The entire range is considered precautionary when applying the ICES advice rule.

To ensure that the stock in Functional Unit 12 is exploited sustainably, management should be implemented at the functional unit level.'

ICES advice applicable to 2022

'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 the years 2018–2020, catches in 2022 should be no more than 3977 tonnes.

To ensure that the stock in Functional Unit (FU) 12 is exploited sustainably, management should be implemented at the FU level.

ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 6. ICES considers this plan to be precautionary when implemented at the FU level.'

13.1 General

Stock description

The South Minch (FU12) is located midway down the west coast of Scotland (see. Section 12 FU11 North Minch, Figure 12.1). The area is characterised by numerous islands of varying size, with sea lochs occurring along the mainland coast. These topographical features create a diverse habitat with complex hydrography and a patchy distribution of various soft sediments. Further details are provided in the stock annex.

Management applicable to 2021 and 2022

Management is at the ICES subarea level as described at the beginning of Section 12 FU11 North Minch.

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex where available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland compliance officers. In 2021 the fishery was described as remaining generally very poor. The COVID-19 affected the markets for product, with even small local markets ceasing operations due to closure of restaurants and other establishments for extended periods of time.

Two distinct fleets operate in the South Minch and the main ports are Oban and Mallaig. In Oban there are 56 local vessels (40 <10m vessels), while there was no information available from Mallaig for 2021. The local fleet in Oban changes quite frequently, e.g. some operators attempt to move to larger vessels but cannot find sufficient numbers to crew them.

Since 2009, vessels have been required to fit 120 mm square meshed panels, in accordance with the west coast emergency measures (Council Reg. (EU) 43/2009). Large SMPs (200 mm) are also widely used and were made mandatory for all TR2 vessels with power >112 kW fishing as part of the previous Scottish Conservation Credits scheme. Twin rig vessels tend to use a 200 mm square mesh panel with a 100 mm or larger mesh codend. These vessels do not catch bulk quantities and this leads to *Nephrops* of better average size and quality. A comment was noted in 2017 about the use of bungee cords to keep the meshes closed. This was investigated by Compliance officers but was deemed to be legal and was not reported as a problem in subsequent years.

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.

Further general information on the fishery can be found in the stock annex.

13.2 Data available

InterCatch

Data for 2021 were uploaded to InterCatch prior to the 2022 WG meeting. Uploaded data were worked up in InterCatch to generate 2021 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.

The COVID-19 pandemic resulted in reduced sampling of commercial catches for FU12 in 2021, as was also the case in 2020. Discard sample data for FU12 was only available for quarter three of 2021, and so, InterCatch estimates of discard rates for quarters one, two, and four were based on samples collected in quarter three. Following download of data from InterCatch, alternate methods of 2021 discard estimation were also considered. It was agreed at WGCSE that estimates of discard rates and associated size distributions for 2021 would be based on an averaging of discard samples across all available quarters between 2017 and 2021. Minimum and maximum discard rates over the same period were also examined to gain an appreciation of the plausible range of discarding that might have occurred in 2021. Assessment estimates affected by changes in discard rates are annotated hereafter to reflect this; i.e. "*x* (*y*/*z*)", where *x* is the estimate based on the average discard rate from samples available between 2017 and 2021, *y* is based on minimum discard rate, and *z* on maximum discard rate over the same period.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Table 12.1.1 (see. Section 12 FU11 North Minch). 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 13.2.1, 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 2021 were 2577.3 tonnes (plus 77 tonnes from other UK vessels, and 42 tonnes from Ireland), consisting of 1939 tonnes (75%) landed by Scottish *Nephrops* trawlers and 619 tonnes (24%) landed by Scottish creel vessels. A small amount of below minimum size (BMS) landings was also reported (0.3 tonnes). The proportion of creel caught landings has generally increased somewhat over the past decade, from 19% in 2012 to 24% in 2021.

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). The decline in effort observed in recent years halted in 2021, with a slight observed increase in effort following the extensive interruptions the fishery experienced in 2020 due to the COVID-19 pandemic. Note that the effort time-series range (2000–2021) does not match the more extensive range available for landings due to a lack of confidence in the reliability of older effort data in the Marine Scotland Science database. The effort is also slightly inconsistent with the landings data because effort is provided for TR2 vessels only, while the '*Nephrops* trawl' landings also includes landings by large mesh trawlers targeting *Nephrops*.

Sampling levels

Length compositions of landings and discards are obtained during market sampling and onboard observer sampling respectively. These sampling levels are shown in Table 12.2.2 (see. Section 12 FU11 North Minch). Sampling effort in 2021 was lower than years preceding 2020, due to disruptions to both the fishing industry and government sampling programmes attributable to the COVID-19 pandemic. Length compositions for the creel fishery are available for landings only as the small numbers of discards from the fishery survive well. Therefore, these animals are not considered to be removed from the population, and 100% survival is assumed (ICES, 2013).

Length compositions

Figure 13.2.2 shows a series of annual length–frequency distributions from 2002 onwards which appear fairly stable across the time-series. Catch and landings length compositions, and mean size are shown for each sex. The mean size of males and females decreased slightly in 2021.

Sex ratio

The sex ratios observed in the South Minch in 2020 & 2021 showed some divergence from those observed in years with better sample coverage, although males still made the largest contribution to the annual landings in most quarters. In the years prior to 2020, males were available to the fishery throughout the year while females were mainly caught in the summer when they emerge from their burrows after egg hatching has occured. This seasonal change could be observed in the quarterly sex ratios, with males dominating the catch in quarters one and four, and a more even sex ratio observed in quarters two and three. However, in 2020, all quarterly sex ratios were majority male (Figure 13.2.3) due to the decreased number of samples which were available for the year. In 2021, the quarterly sex ratios were more similar to typical years, although quarter four had the highest male ratio of the series. This metric is used as an indicator, whereby increasing proportions of females in the catch might signal an effect of acute overfishing. In the case of recent years, however, the unusual sex ratios are known to be due to poor sampling, and not a cause for concern to management.

Mean weights

The mean weight in the landings (Figures 15.2.4 and 15.2.5; see. Section 12 FU11 North Minch, Table 15.2.3) have fluctuated around a relatively high level since 2011. Seasonal variability (and occasional outliers) in mean weights are seen in the individual sample estimates. There appears to be a small increase in the mean weight of the males for the trawl caught *Nephrops* and also for both males and females caught by creels (Figure 15.2.5). The annual estimate of mean weight in the landings has an effect on the catch forecast. Over the time-series, there is a general increasing trend in mean weights in the landings, however, there was a substantial decrease in mean weight in 2021 following the highest recorded mean weight in 2020.

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 3% to over 25%. In 2021, the discarding rate was 5.6% (2.1%/28.6%) based on mean discard rates observed between 2017 and 2021. This represents a decrease on 2020 (7.8%). The low levels of discarding in recent years may be explained by poor fishing and a gradually decreasing fleet (Table 13.2.2).

Studies (Charuau *et al*., 1982; Sangster *et al*., 1997; Wileman *et al*., 1999) suggest that some *Nephrops* survive the discarding process, thus, 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 assumed. The discard rate (adjusted to account for survival) which will be used in the forecast was estimated by taking a three-year average (2019–2021), amounting to 6.8% (3.7%/10.7%).

Abundance indices from UWTV surveys

An underwater TV survey of the stock is conducted annually according to standards set out by the Manual for the Nephrops Underwater TV Surveys (Dobby *et al*., 2021). Surveys use a stratified random approach, and have been carried out 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, 36 stations have been considered valid each year, and raised to a stock area of 5072 km^2 (derived from BGS sediment data). The 2022 UWTV survey of FU 12 was carried out in two stages, during June/July and August/September of 2022. The first part was the regularly scheduled annual survey, while the second was an ad hoc survey to collect data in areas which were missed during the annual survey for logistic reasons. The first part of the survey collected random stations mostly located in the inshore areas to the east and south of the FU, and some in the central area. The second part of the survey collected stations in the northwest, some of which were randomly assigned and some which were moved from the southwest to maximise sample collection during the time which was at the survey team's disposal. A total of 41 valid TV stations were completed in 2022 and used in the survey analysis (Table 13.2.3; 24 stations in the first part of the survey and 17 in the second part), with one station excluded from the second part of the survey due to an excessively rocky seabed.

TV survey abundance estimates from 1995–2022 are shown in Table 13.2.3 and Figure 13.2.4. Since 2007, the stock has undergone cycles wherein abundance oscillates between high and low values over five to six year periods (Figure 13.2.4), with changes of up to 1199 million individuals between the lowest and highest points of a cycle (between 2012 and 2016). The 2022 abundance represents a 32% increase in relation to 2021.

Table 13.2.4 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 decreased in 2022, in comparison to the 2021 survey, in all strata apart from Sandy Mud. 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 13.2.5). The CV for the 2022 TV survey (Table 13.2.4) is lower than the 20% precision level agreed by WGNEPS (2019; 12.6%).

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009; ICES, 2013), WGNEPS (ICES, 2018a), WKNEPS (ICES, 2018b) and (Leocádio *et al*., 2018). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative relative to absolute conversion factor estimated for FU12 was 1.32 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 32%.

13.3 Assessment

Comparison with previous assessments

The assessment follows the same procedure as last year and is based on a combination of examining trends in fishery indicators and underwater TV abundance estimates. The process was defined by the benchmark WG and is described in the stock annex.

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 2022 survey are shown in Table 16.2.4, and compared with the 2020 and 2021 outcomes. 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 2022 was 1677 million individuals, above the MSY $B_{trigger}$ value of 1016 million, or the rounded value of 1020 million used for the provision of advice.

The calculated harvest rate in 2021 (dead removals/TV abundance = 7.5%; <u>7.2%/9.2%</u>) was below the F_{MSY} proxy for this stock (the value associated with high long-term yield and low risk depletion) of 11.7%.

13.4 Catch scenarios table

Landings predictions and catch options at various harvest rates (based on principles established at WKNEPH (ICES, 2009), are made on the basis of the 2022 UWTV survey conducted in June. These were presented at WGCSE NEPH in September 2022 for the provision of advice.

Catch scenarios table inputs and historical estimates of mean weight in landings and harvest rates are presented in Table 16.2.2 and summarised below. The calculation of catch scenarios for the South Minch follows the procedure outlined in the stock annex.

Given the variability in mean weights it was considered more appropriate to use a full time-series average, from 1999 (first year with creel and trawl length distributions combined) until 2021.

The table below shows the agreed inputs to the catch scenario table.

Input	Data	2022 assessment
Survey abundance (millions)	UWTV 2022	1677
Mean weight in projected landings (g)	1999–2021	27.43
Mean weight in projected discards (g)	1999–2021	10.18
Projected discard rate	2019–2021	6.8%*
Discard survival rate	Proportion by number (assumed)	25%**

*** Based on mean discard rate (2017-2021) allocated to 2021; estimates of 10.7% and 3.7% were derived based on the maximum and minimum observed discard rates, respectively, for the same period**

**** Discard survival in the creel fishery is assumed to be 100%, as outlined in the stock annex.**

13.5 Reference points

New reference points were derived for this stock at WKMSYRef4 (ICES, 2016e). These are updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years which corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values, a five-year average was chosen. Similarly, the five-year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five-year average of the F above F_{MAX} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy, which occasionally appear. For this stock, the F_{MSY} proxy has been revised from 12.3% to 11.7%.

For *Nephrops* stocks, MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased and is calculated as 1016 million individuals (in 2010). This value was rounded to 1020 million, in the advice from WKMSYRef4 on MSY $B_{trigger}$. Full details are contained in the stock annex.

These should remain under review by WGCSE and may be revised should improved data become available.

Table 13.2.2 and Figure 13.5.1 show the harvest rates for FU12. The harvest rate has fluctuated over the time-series and has been below the F_{MSY} proxy since 2013. The increase in 2016, compared to the 2013–2015 harvest rates, was due to relatively increased landings compared to abundance. The harvest rate more than halved in 2018 compared to 2017, and has continued to decrease through 2020 to a new historical low, increasing again in 2021 (7.5%; 7.2%/9.2%).

It is likely that prior to 2006, the harvest rates are underestimates due to under-reported landings.

13.6 Management strategies

Scotland has established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

On the 8th of February 2016, phase 1 of the fisheries management measures for inshore MPAs in Scottish waters came into force (SG, 2016). These measures relate to both Nature Conservation MPAs (NCMPAs; Marine (Scotland) Act and the UK Marine and Coastal Access Act) and Special Areas of Conservation (SACs; EC Habitats Directives – Council Directive 92/43/EEC) both of which have the aim of conserving biological diversity in Scottish waters and contribute to Scotland's MPA network (SG, 2017a). Although not specific to the management of the *Nephrops* fishery, they will influence spatial patterns of fishing for *Nephrops* where controls on the two main gear types, demersal trawls and creels, are implemented on *Nephrops* habitat. There are seven protected areas within the South Minch functional unit with fisheries management measures. MPAs on the main areas of *Nephrops* habitat include the Loch Sunart to the Sound of Jura NCMPA where demersal trawling is banned in some areas, i.e. zoned, and seasonal closures implemented in others, Loch Sunart NCMPA/SAC, where demersal trawling is banned and creeling is zoned, the East of Mingulay SAC, demersal trawling banned and creeling zoned, and the Trenish Isles SAC, demersal trawling banned. Another area is the Loch Duich, Long and Alsh NCMPA/SAC, covering some patches of muddy sediment, where demersal trawling is banned or temporally closed in other areas that extend beyond the MPA onto muddy sediment. Other areas include the Loch Creran SAC/NCMPA, demersal trawling banned and creeling zoned, and the Firth of Lorn SAC, which has the same management as the Loch Sunart to the Sound of Jura NCMPA. For the Firth of Lorn and Loch Creran, management was in place prior to 2016 (SG, 2016). An additional NCMPA, at Loch Carron, was designated using emergence powers in 2017 (SG, 2017b). The areas of the SACs and NCMPAs relative to the estimated *Nephrops* habitat within the South Minch functional unit are displayed in Figure 13.6.1.

13.7 Quality of assessment and forecast

The length and sex composition of the landings data is considered to be generally adequately sampled, sampling levels have remained relatively consistent over the past two years (see Section 16.2), with the exception of quarter 2 of 2020 where sampling efforts were disrupted by the COVID-19 pandemic. Discard sampling has been conducted for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the trawl fishery adequately. The reduced sampling effort in 2021 meant that discard sample data were only available for Quarter three, and it was agreed at WGCSE that estimates of discard rates and size distributions for 2021 would be adequately approximated for the purpose of forecasting by averaging of discard samples across all available Quarters between 2017 and 2021. The landings length compositions from 1999 onwards are derived from both creel and trawl samples. The creel fishery, which accounts for an increasing proportion of the landings in recent years (~24-29% in the past three years) and increasingly operates over similar areas to trawling, exhibits a length composition composed of larger animals.

There are concerns over the accuracy of historical landings and effort data prior to 2006 when Buyers and Sellers legislation was introduced and the reliability began to improve. Because of this, the final assessment adopted is independent of official statistics. Harvest rates since 2006 are also considered more reliable due to more accurate landings data reported under new legislation. Incorporation of creel length compositions has also improved estimates of harvest rates.

Underwater TV surveys have been conducted for this stock every year since 1995. The number of valid stations in the survey has remained relatively stable throughout the time period. The survey is targeted at known areas of mud, sandy mud and muddy sand within the South Minch. The variance of density estimates in the South Minch is relatively high, particularly in the sandy mud strata, resulting in large confidence intervals and a greater uncertainty on the abundance estimates than in other FUs. This makes it difficult to determine which population changes are significant. Although the CV's have been smaller in recent years.

There is a need to explore options to implement further stratification for the South Minch survey area. In the provision of catch options based on the absolute survey estimates, additional uncertainties related to mean weight in the landings and the discard rates also arise. A three-year average (i.e. 2019–2021 for the 2022 assessment) of discard rates (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options.

The cumulative relative to absolute conversion factor estimates for FU12 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised. The landings derived in the forecast (catch options table) are sensitive to the input dead discard rate and mean weights in landings, and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. Work is underway to improve the area estimation. VMS data linked to landings (from queries of the Scottish FIN database) suggest no major differences between areas fished and the mud sediment maps. Two other factors however, are likely to increase the estimate of ground area available for *Nephrops* and *Nephrops* directed fishing. Firstly, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations and secondly, it is known that most of the sea lochs have areas of mud substrate and are typically fished by creel boats. In recent years, limited TV surveys have taken place in some of the sea lochs and attempts are being made to utilise these data to improve estimates of mud area and *Nephrops* abundance in the South Minch.

13.8 Recommendation for next benchmark

This stock was last benchmarked in 2009. WGCSE will keep the stock under close review and recommend future benchmark as required.

At WGCSE 2022 it was agreed that a benchmark/interbenchmark should be carried out on FU12 Nephrops, addressing the potential for provision of abundance estimates with reduced uncertainty using alternate estimation methods (REF WGCSE 2022 report).

13.9 Management considerations

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the functional unit level could provide controls to ensure effort and catch were in line with resources available.

Creel fishing takes place in this area but overall effort in terms of creel numbers is not known and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the South Minch and estimated discards of whiting and haddock by the TR2 fleet are high in area 6.a generally. It is important that efforts continue to ensure that unwanted bycatch is kept to a minimum in this fishery.

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Table 13.2.1. *Nephrops*, South Minch (FU12), ICES estimates of landings of *Nephrops*, 1981–2021.

UK SCOTLAND						OTHER UK	IRELAND	TOTAL
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIMUM SIZE	SUB TOTAL			
1981	2966	254	432	0	3652	0	0	3652
1982	2925	206	421	0	3552	0	0	3552
1983	2595	362	456	0	3413	0	0	3413
1984	3229	477	594	0	4300	0	0	4300
1985	3096	424	488	0	4008	0	0	4008
1986	2694	288	502	0	3484	0	0	3484
1987	2928	418	546	0	3892	0	0	3892
1988	3544	364	555	0	4463	10	0	4473
1989	3846	338	561	0	4745	0	0	4745
1990	3732	263	435	0	4430	0	0	4430
1991	3596	342	503	0	4441	1	0	4442
1992	3478	209	549	0	4236	1	0	4237
1993	3609	194	650	0	4453	5	0	4458
1994	3742	264	405	0	4411	3	0	4414
1995	3443	717	508	0	4668	14	0	4682
1996	3108	417	469	0	3994	1	0	3995
1997	3518	329	493	0	4340	3	1	4344
1998	2851	340	538	0	3729	0	1	3730
1999	3165	359	514	0	4038	0	14	4052
2000	2940	311	700	0	3951	0	2	3953
2001	2823	391	768	0	3982	0	9	3991
2002	2234	314	743	0	3291	0	14	3305
2003	2812	203	858	0	3873	0	6	3879
2004	2864	105	879	0	3848	0	21	3869
2005	2812	46	955	0	3813	1	34	3848
2006	3570	97	922	0	4589	9	35	4633
2007	4437	21	959	0	5417	19	35	5471

UK SCOTLAND						OTHER UK	IRELAND	TOTAL
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIMUM SIZE	SUB TOTAL			
2008	4433	12	896	0	5341	2	13	5356
2009	3346	24	900	0	4270	4	11	4285
2010	2836	19	969	0	3824	16	6	3846
2011	2876	11	783	0	3670	23	9	3702
2012	3159	32	773	0	3964	19	6	3989
2013	2490	543	729	0	3762	13	1	3776
2014	2490	3	637	0	3130	32	17	3179
2015	2662	18	665	0	3345	22	33	3400
2016	3450	22	838	0	4310	33	59	4402
2017	2833	60	775	0	3668	23	66	3757
2018	1693	86	682	0	2461	45	34	2540
2019	1493	39	621	0	2153	29	38	2220
2020	1320	25	554	0	1899	8	69	1976
2021	1939	19	619	0.3	2577.3	77	42	2696.3

Table 13.2.2. ***Nephrops*, South Minch (FU12): Adjusted TV survey abundance, landings, discard rate proportion by number) and estimated harvest rate.**

YEAR	LANDINGS NUMBER (MILLIONS)	DISCARDS NUMBER (MILLIONS)	REMOVALS NUMBER (MILLIONS)**	ADJUSTED SURVEY (MILLIONS)	HARVEST RATE*	LANDINGS (TONNES)	DISCARDS (TONNES)	DISCARD RATE (%)	DEAD DISCARD RATE (%)	MEAN WEIGHT IN LANDINGS (g)	MEAN WEIGHT IN DISCARDS (g)
1999	161	29	183	1086	16.9	4052	206	15.4	12	25.14	7
2000	145	33	170	1854	9.2	3953	284	18.7	14.7	27.3	8.5
2001	168	65	216	2037	10.6	3991	591	27.9	22.5	23.79	9.11
2002	123	26	143	1899	7.5	3305	247	17.6	13.8	26.83	9.37
2003	139	38	168	2157	7.8	3879	381	21.3	16.9	27.86	10.1
2004	141	44	175	2558	6.8	3869	454	23.8	19	27.37	10.26
2005	137	49	174	2208	7.9	3848	452	26.5	21.2	28.11	9.17
2006	177	30	199	1845	10.8	4633	324	14.3	11.1	26.24	10.97
2007	228	66	278	1016	27.3	5471	903	22.4	17.8	23.95	13.73
2008	224	74	279	1608	17.4	5356	605	24.7	19.8	23.91	8.23
2009	179	26	199	1542	12.9	4285	216	12.5	9.6	23.87	8.44
2010	149	12	158	2076	7.6	3846	133	7.7	5.9	25.86	10.76
2011	118	11	126	1945	6.5	3702	92	8.2	6.3	31.1	8.78
2012	133	16	145	919	15.8	3989	145	10.8	8.3	29.17	9.05
2013	136	4	140	1718	8.1	3776	50	3.1	2.4	27.48	11.31
2014	105	19	120	2073	5.8	3179	233	15.6	12.1	29.91	12.04
2015	120	10	128	1998	6.4	3400	121	7.7	5.9	28.15	12.04
2016	177	31	201	2118	9.5	4402	365	14.9	11.6	24.76	11.74
2017	131	13	140	1384	10.1	3757	108	9.4	7	27.76	8.29
2018	91	4	94	1946	4.8	2540	54	4.5	3.4	27.27	12.74
2019	79	4	83	2362	3.5	2220	46	4.9	3.7	28.54	11.22
2020	54	5	57	1927	3	1976	46	7.8	6	36.58	9.91
2021	90	7	95	1272	7.5	2696.3	84	7.6	5.8	29.96	11.35
2022	-	-	-	1677	-	-	-	-	-	-	-
Average***									5.2	27.43	10.18

*** Harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

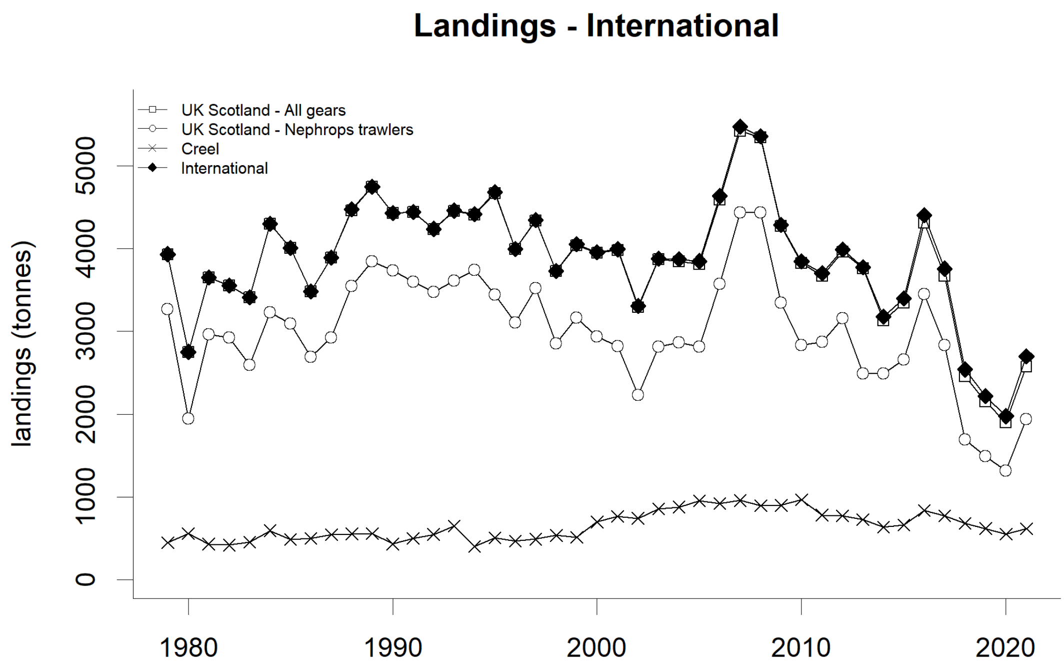
***** Dead discard average: 2019–2021; Mean weight in landings and discards average: 1999–2021.**

Table 13.2.3. ***Nephrops*****, South Minch (FU12): Results of the 1995–2022 TV surveys (adjusted for bias).**

YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS/m²)	ABUNDANCE (MILLIONS)	95% CONFIDENCE INTERVAL (MILLIONS)
1995	33	0.227	1152	251
1996	21	0.288	1473	530
1997	36	0.212	1086	185
1998	38	0.288	1452	232
1999	37	0.212	1086	260
2000	41	0.364	1854	348
2001	47	0.402	2037	459
2002	31	0.371	1899	567
2003	25	0.424	2157	756
2004	38	0.508	2558	473
2005	33	0.432	2208	740
2006	36	0.364	1845	598
2007	39	0.197	1016	155
2008	33	0.318	1608	415
2009	25	0.303	1542	634
2010	34	0.409	2076	665
2011	36	0.383	1945	778
2012	38	0.182	919	185
2013	38	0.339	1718	365
2014	36	0.409	2073	530
2015	35	0.394	1998	514
2016	37	0.417	2118	440
2017	41	0.273	1384	282
2018	39	0.383	1946	371
2019	40	0.466	2362	578
2020	40	0.38	1927	517
2021	41	0.251	1272	339
2022	41	0.33	1677	471

Table 13.2.4. *Nephrops* South Minch (FU12). Results by stratum of the 2020–2022 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).

STRATUM	AREA (km^2)	NUMBER OF STATIONS	MEAN BURROW DENSITY (no./m^2)	OBSERVED VARIANCE	ABUNDANCE (MILLIONS)	STRATUM VARIANCE	PROPORTION OF TOTAL VARIANCE	SURVEY PRECISION LEVEL (CV)
2020 TV Suvey								
M	303	2	0.193	0.008	58.6	381	0.006	
SM	2741	20	0.474	0.148	1299.7	55679	0.834	
MS	2028	18	0.281	0.047	569.2	10685	0.16	
Total	5071	40			1927.4	66745		0.131
2021 TV Suvey								
M	303	3	0.402	0.084	121.7	2564	0.089	
SM	2741	17	0.261	0.046	716.9	20574	0.716	
MS	2028	21	0.214	0.029	433	5580	0.194	
Total	5071	41			1271.6	28719	0.999	0.126
2022 TV Suvey								
M	303	4	0.317	0.057	95.8	1324	0.024	
SM	2741	16	0.448	0.105	1228.9	49419	0.89	
MS	2028	21	0.173	0.024	351.8	4766	0.086	
Total	5071	41			1676.5	55508	1	0.129



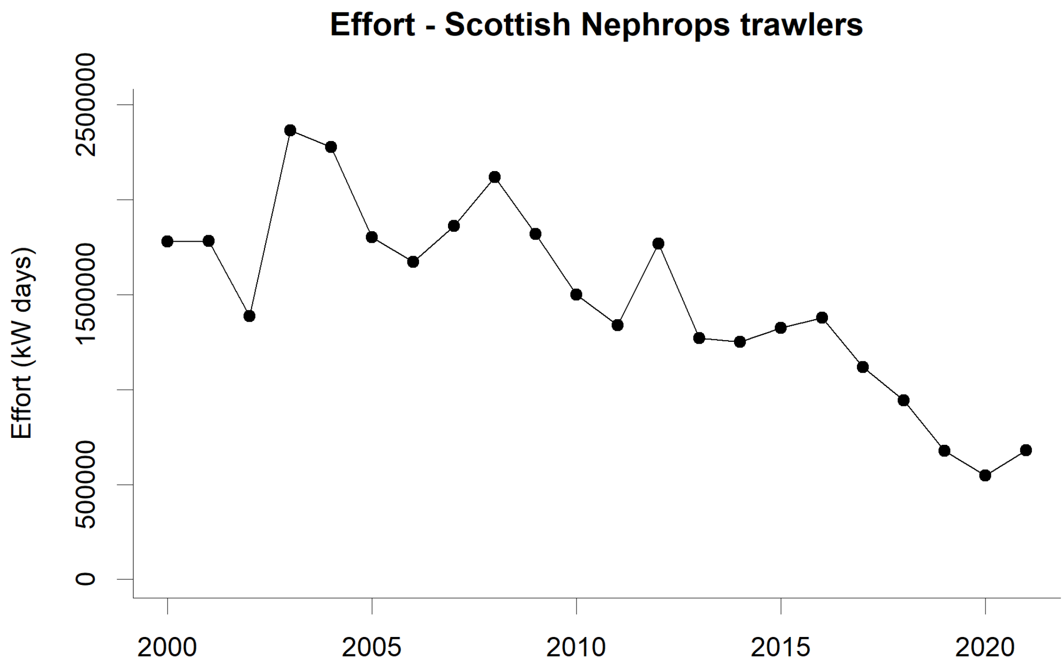


Figure 13.2.1. ***Nephrops,*** **South Minch (FU12). Long-term landings and effort.**

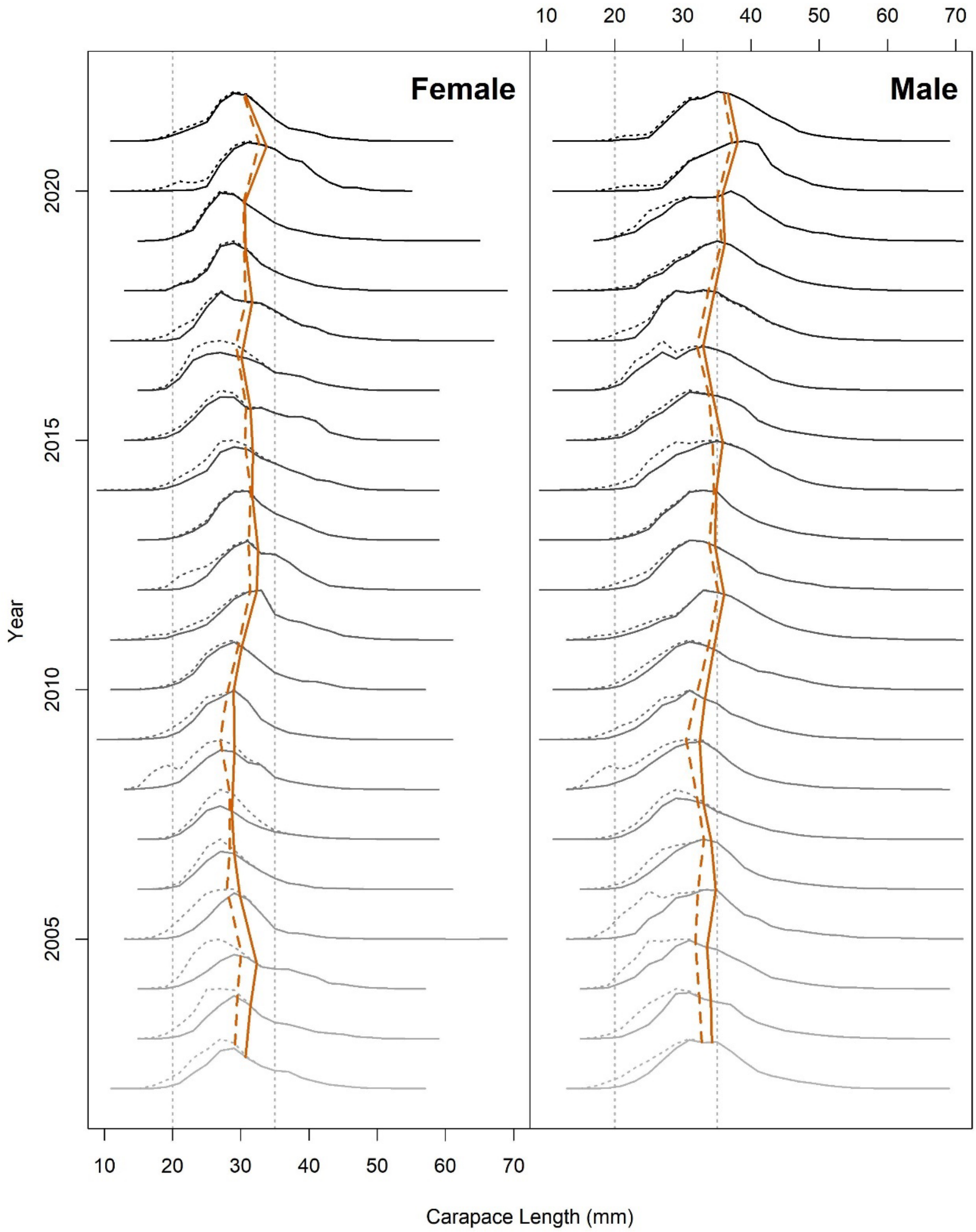


Figure 13.2.2. ***Nephrops*. South Minch (FU12). Catch length–frequency distribution and mean size in catches (dotted) and landings (solid) for *Nephrops* in the North Minch, 2002–2021. Vertical dotted lines are minimum conservation reference size (20 mm) and 35 mm.**

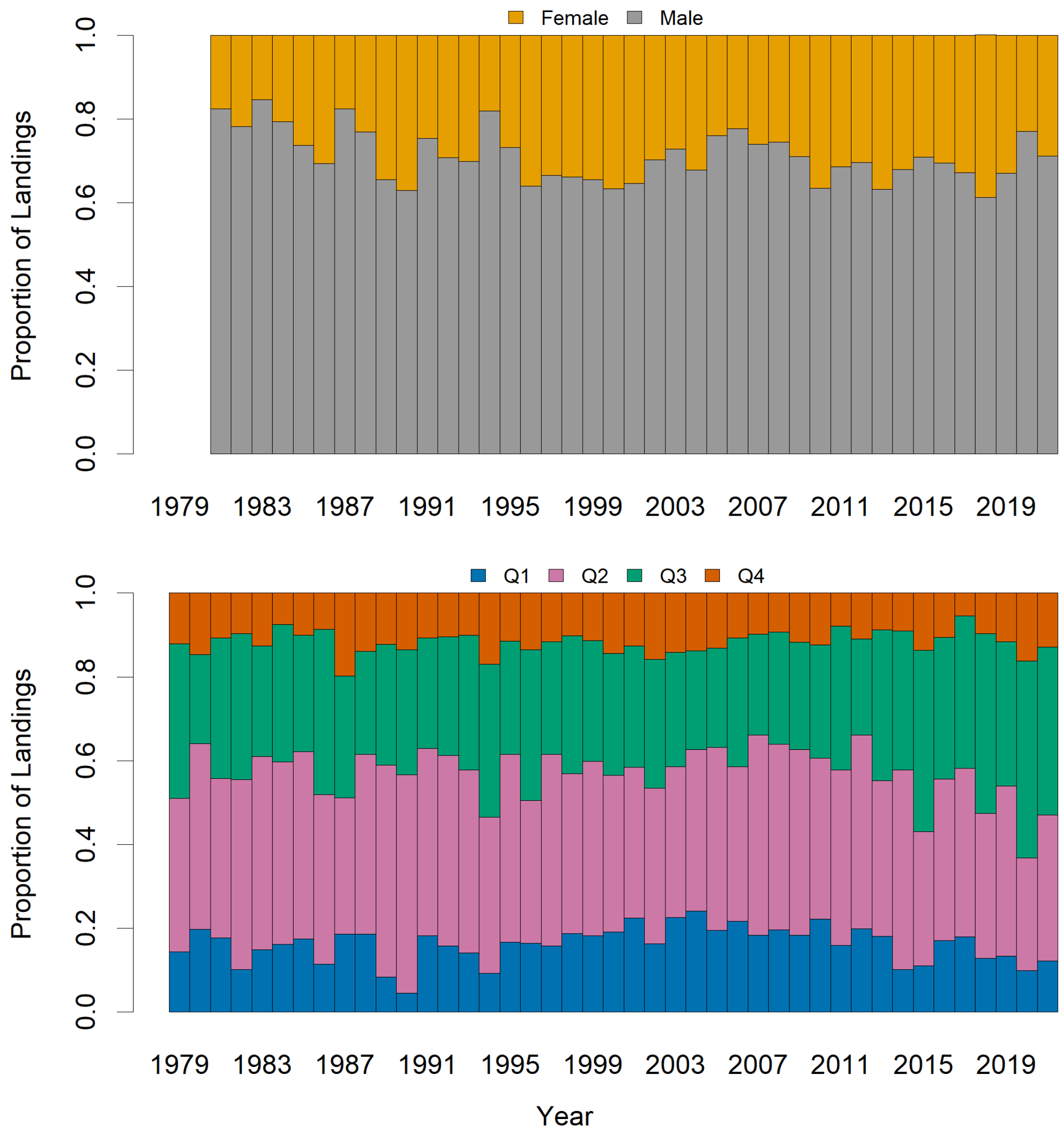


Figure 13.2.3. (a) *Nephrops,* South Minch (FU12). Proportion of landings by sex and quarter from Scottish trawlers.

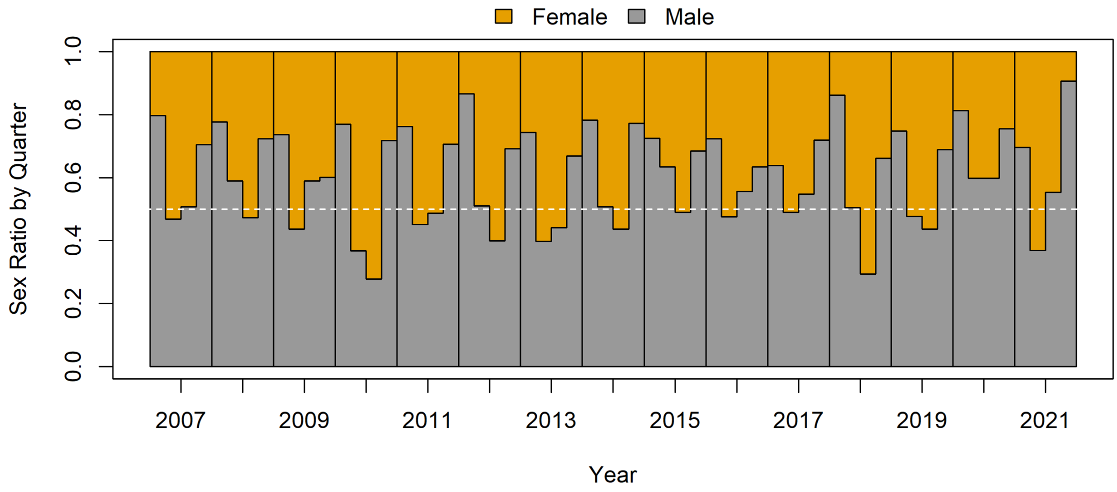


Figure 13.2.3 (b) ***Nephrops,*** **South Minch (FU12), Proportion of males by quarter (2007–2021).**

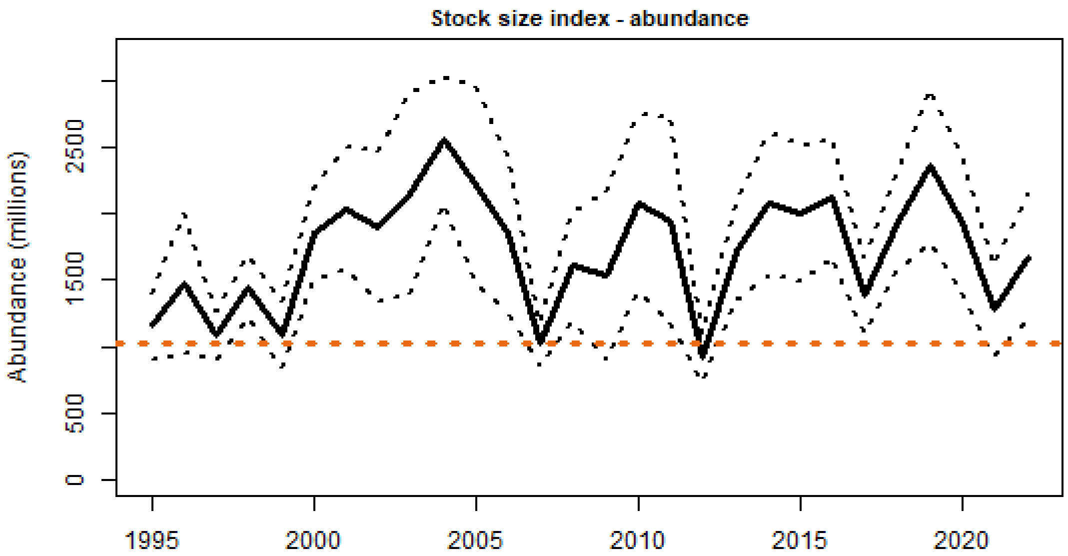


Figure 16.2.4. ***Nephrops*****, South Minch (FU12), Time-series of TV survey abundance estimate (adjusted for bias, solid black line), with 95% confidence intervals (dashed black lines), 1995–2022. The dashed red line is the rounded $B_{trigger}$ value of 1020 million individuals.**

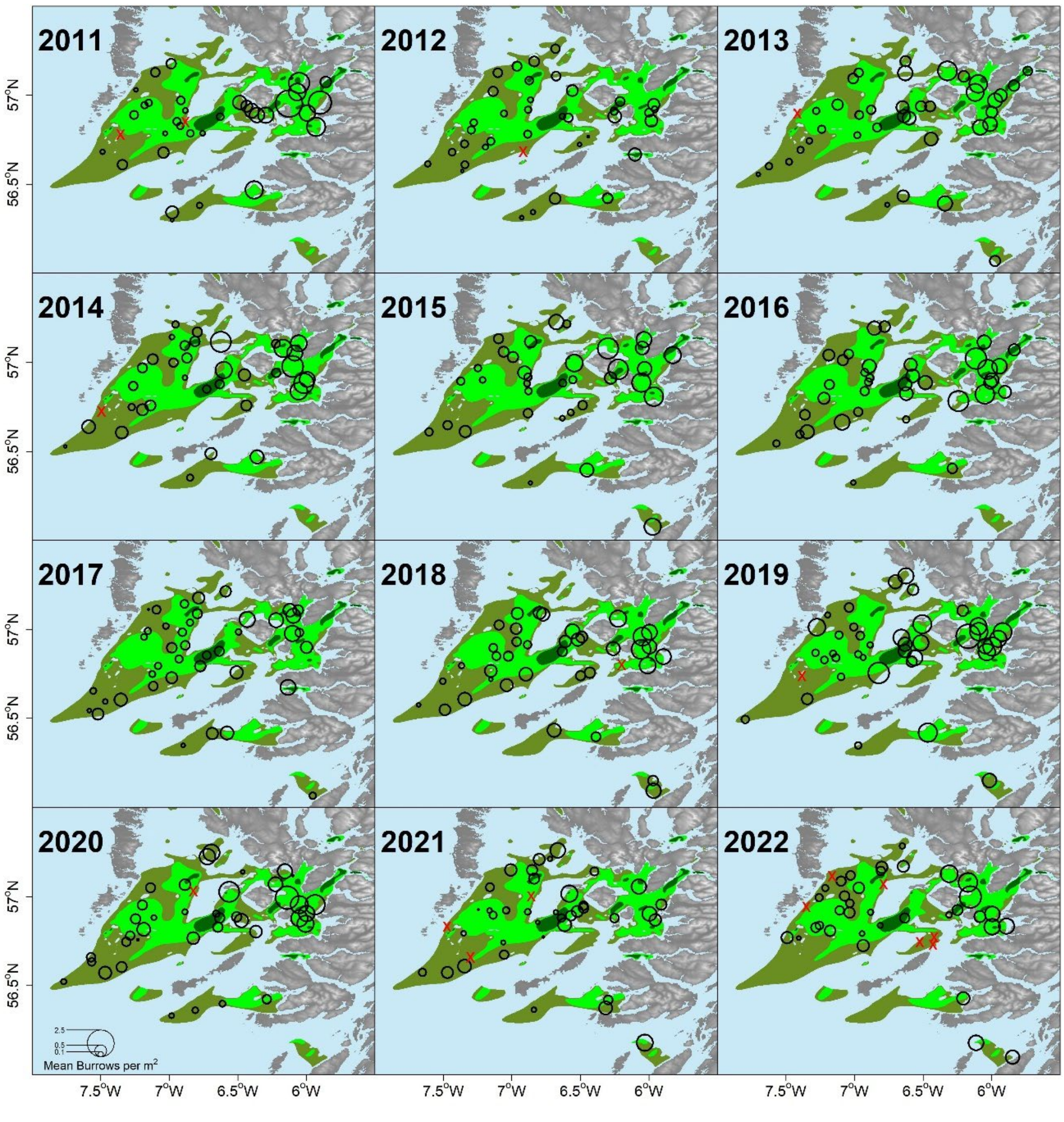


Figure 16.2.5. ***Nephrops*, South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2011–2022. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles in this figure are all scaled the same. Red crosses represent zero observations.**

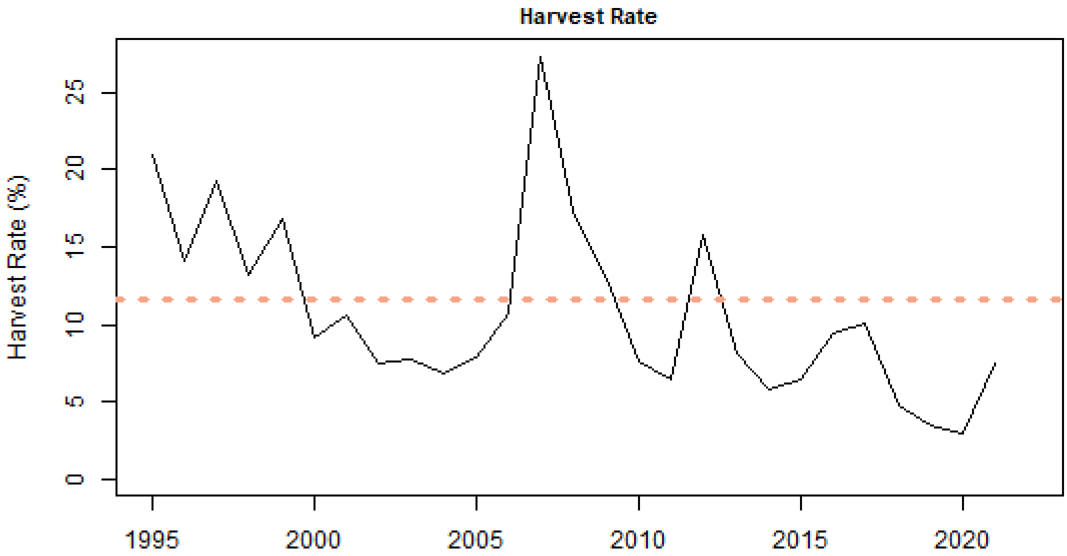


Figure 16.5.1. ***Nephrops*, South Minch (FU12), harvest rate, 1995–2021. The dashed and solid lines are the F_{MSY} proxy harvest rate (11.7%) and the time-series of estimated harvest rates, respectively. Harvest rates prior to 2006 are considered unreliable.**

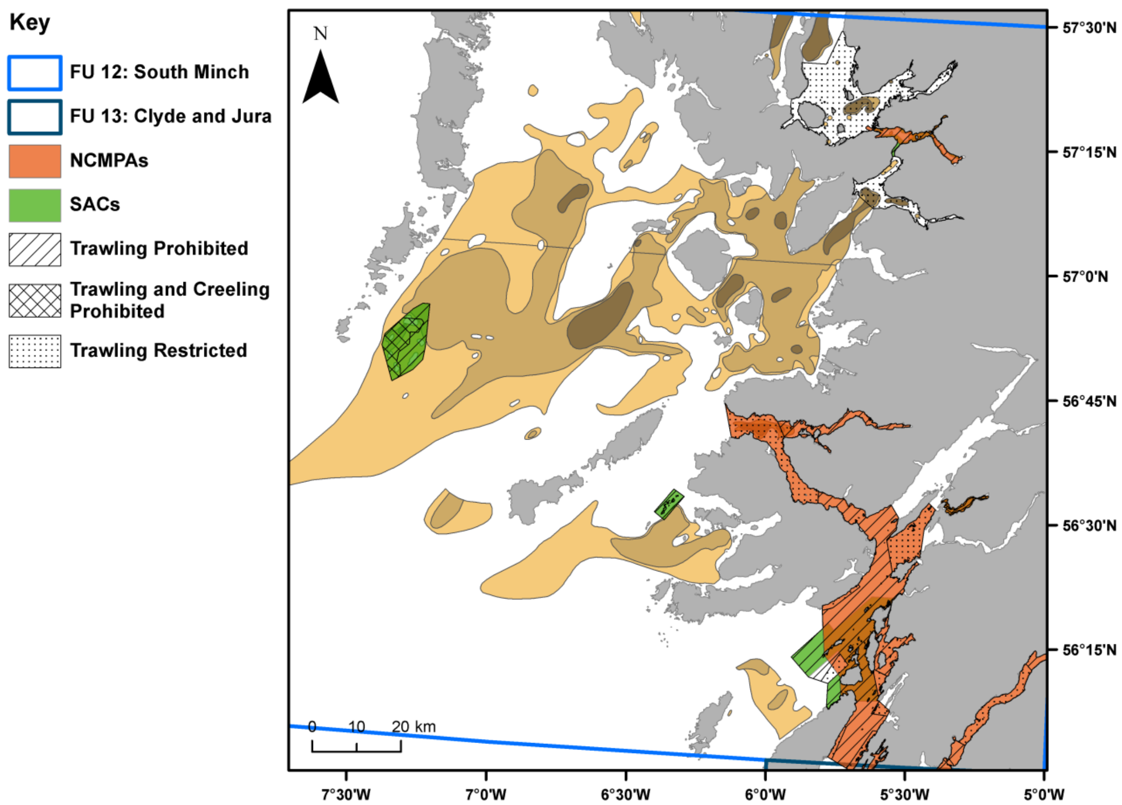


Figure 16.6.1. The area of *Nephrops* habitat (Mud, Muddy Sand and Sandy Mud) within the South Minch (FU12) relative to the areas of the Nature Conservation MPAs (NCMPAs) and Special Area of Conservations (SACs) with fisheries management measures. Areas where demersal trawling is prohibited, restricted (i.e. vessel size restrictions or seasonal closures) and where creeling is prohibited are displayed. For more detailed information see SG (2016). Geographic Coordinate System: OSGB 1936, Datum: OSGB 1936, Projected Coordinate System: British National Grid. Coastline by Wessel and Smith (2016), MPA sites subsetted from NCMPA (SNH, 2015) and SAC (SNH, 2016) layers, management areas from SG (2017c) and functional units generated from merged ICES rectangles (ICES, 2017b). Map and modified layers created using ArcGIS (ESRI, 2014).

14 Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 13 (West of Scotland, the Firth of Clyde and Sound of Jura)

Type of assessment in 2022

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 2021

'ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2021 that correspond to the F ranges in the MAP are between 3638 tonnes and 5425 tonnes (3142–4791 tonnes for the Firth of Clyde and 496–634 tonnes for the Sound of Jura), assuming recent discard rates. The entire range is considered precautionary when applying the ICES advice rule.

To ensure that Nephrops stocks are exploited sustainably, management of Nephrops should be implemented at the functional unit level. In this particular functional unit (FU), additional measures should be implemented to ensure that landings taken in each subarea (the Firth of Clyde and the Sound of Jura) are in line with the advice.'

ICES advice applicable to 2022

'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 the years 2018–2020, catches in 2022 should be no more than 4235 tonnes (3607 tonnes for the Firth of Clyde and 628 tonnes for the Sound of Jura).

To ensure that the stock in Functional Unit (FU) 13 is exploited sustainably, management should be implemented at the FU level. In this particular FU, additional measures should be implemented to ensure that landings taken in each subarea (the Firth of Clyde and the Sound of Jura) are in line with the advice.

ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 6. ICES considers this plan to be precautionary when implemented at the FU level.'

14.1 General

Stock description

The Clyde functional unit (FU13) is located in the southern waters off the west coast of Scotland (see. Section 12 FU11 North Minch, Figure 12.1). 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 2021 and 2022

Management is at the ICES subarea level as described at the beginning of Section 12 FU11 North Minch.

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex where available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland fishery compliance officers.

There are 26 *Nephrops* vessels including 20 trawlers and six creelers fishing out of Ayr. Six boats left the fleet in 2021 due to crewing difficulties. All trawlers use 80 mm single or twin rigs with square mesh panels (SMP) of at least 160 mm, in accordance with The Sea Fishing (Licences and Notices) (Scotland) Regulations 2011. *Nephrops* trawling vessels with power >200 kW, or >12m, are required to use a 300 mm SMP.

The activity of Northern Irish vessels was not perceived to be high since 2017, when compared to previous years. Many vessels have moved to other areas where there was better fishing, some travelling as far away as Eyemouth, and vessels fishing in FU13 did not land locally instead going back to their home port because of better fuel and market prices.

Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night as are vessels greater than 21 m in length. Most creel boats operating in the Clyde have two crew members and operate around 1000 creels. Creeling activity now takes place quite widely in the northern parts of the Firth operating on some of the same grounds but often taking place during the weekend trawling ban.

In terms of the influence of Marine Protected Area (MPA) management measures on the fishery, the South Arran Nature Conservation MPA (NCMPA) removed a large sea area for *Nephrops* trawlers to operate over. Trawlers which would have operated in this area were displaced to areas where they would not have targeted previously, or where they would have only operated in poor weather conditions. This allowed creelers to move into the areas were trawling was banned. There have been recent reports of increases in creel numbers in this area and this has resulted in gear conflict within the creel sector. The small area of the Upper Loch Fyne NCMPA closed to trawlers was reported to have had little impact.

Further general information on the fishery can be found in the stock annex.

14.2 Data available

InterCatch

Commercial data for 2021 were uploaded to InterCatch prior to the 2022 WG meeting. Uploaded data were worked up in InterCatch to generate 2021 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.

The COVID-19 pandemic resulted in a reduced sampling effort of commercial catches for FU13 in 2021, as was also the case in 2020. There were no representative discards samples collected for FU13 in 2021, thus alternate methods of estimating discards were explored. It was agreed at WGCSE that estimates of discard rates and size distributions for 2021 would be based on an averaging of discard samples across all quarters from 2017-2019, the same procedure that was carried out for 2020 discards. Minimum and maximum discard rates over the same period were also examined to gain an appreciation of the plausible range of discarding that might have occurred in 2021. Assessment estimates affected by changes in discard rates are annotated hereafter to reflect this; i.e. "*x* (*y*/*z*)", where *x* is the estimate based on the average discard rate 2017–2019, *y* is based on minimum discard rate, and *z* on maximum discard rate over the same period.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Table 12.1.1 (see. Section 12 FU11 North Minch). These relate to the whole of area 6.a of which the FU13 is a part. Landings statistics for FU13 provided through national laboratories are presented in Table 14.1.1, broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, although Northern Ireland contributed 904 tonnes in 2021. Total reported Scottish landings in 2021 were 4088 tonnes (plus 907 tonnes from other UK vessels i.e. Northern Ireland & England), consisting of 3805 tonnes landed by trawlers (93%) and 233 tonnes (5.7%) landed by Scottish creel vessels. Scottish creel landings have generally increased in the most recent years, from approximately 3% in 2012 to just below 6% of total landings in 2021.

Statistical rectangle 40E4 covers parts of both the Firth of Clyde and the Sound of Jura. Table 14.2.1 shows the split in landings between the two subareas comprising FU13. Historically the allocation of landings to the two components of FU13 was carried out by the fishery office and required them to have detailed knowledge of where vessels have been fishing within 40E4. The apparent sudden decline in landings from the Sound of Jura in 2001 is not considered to be associated with a sudden change in fishing practices and is thought more likely to be due to changes in fishery office recording practices. For this reason, the landings split is considered unreliable in recent years and the commercial landings data are now presented for the combined Firth of Clyde and Sound of Jura. Given the relative magnitudes of the fisheries (Clyde likely to be much bigger), the commercial data are likely to be more representative of the Clyde.

Effort data

In 2015, WGCSE agreed that effort should be reported in kW days, as this is likely to be more informative about changes in the actual fleet effort. Effort shows an overall decreasing trend but was stable through 2010 to 2012 (Figure 17.2.1). Effort increased in 2016 in comparison to 2015, but had been on a generally decreasing trend until 2021, when a slight increase in effort was observed following the extensive interruptions the fishery experienced in 2020 due to the COVID-19 pandemic. Note that the effort time-series range (2000–2021) does not match the more extensive year range available for landings due to a lack of confidence in the reliability of older effort data in the Marine Scotland Science database. The effort is also slightly inconsistent with the landings data because effort is provided for TR2 vessels only, while the '*Nephrops* trawl' landings also 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 12.2.2 (see. Section 12 FU11 North Minch). Sampling of landings length compositions in the Sound of Jura is more infrequent but samples have been included in the FU13 raising procedure when available. Length compositions for the creel fishery are available for landings only. This is because survival in the animals that are discarded (although little quantitative information exists) is assumed to be high (ICES, 2013). Therefore, these animals are not considered to be removed from the population, and 100% survival is assumed (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 14.2.2 shows a series of annual Clyde length–frequency distributions for the period 2002 to 2021. Catch and landings length compositions, and mean size are shown for each sex. The mean sizes of both sexes have fluctuated around relatively small ranges since 2015. The mean size of females in the catch has remained relatively stable over the past three to four years, whereas the mean size of males showed an increase until 2020, and then a slight decrease in 2021.

Sex ratio

Sex ratio in FU 13 shows some variation but males generally make the largest contribution to the annual landings (Figure 14.2.3(a)). This occurs because males are available throughout the year and the fishery takes place in all quarters, although effort is generally reduced during the winter months because of poor weather. Females on the other hand are mainly taken in the summer when they emerge after egg hatching. The seasonal change in proportion of males to females is evident in Figure 14.2.3(b) where males typically dominate in quarters one and four but the ratio is generally more even in quarters two and three. In 2016, males dominated in all quarters, but this was within the observed range of variation typically seen for this stock. The pattern was again fairly typical between 2017 and 2019, but in 2020 all quarterly sex ratios were majority male due to the decreased number of samples which were available for the year. Sampling was also reduced in 2021, but an increased proportion of females was observed in quarter 2. This metric is used as an indicator, whereby increasing proportions of females in the catch might signal an effect of acute overfishing. In this case, however, the atypical sex ratios observed in 2020 (and to some degree 2021) are known to be due to poor sampling, and not a cause for concern to management.

Mean weights

The mean weights in the landings have fluctuated in this FU over the time-series. Since 2015 there has been a variable but somewhat decreasing trend in this metric. Mean weight for FU13 is generally lower than other areas over the time-series (Table 12.2.3). There is a trend of increasing mean weights in the samples of landings for creel catches, noticeable for both sexes, but particularly for males in the early years of the time-series. However, this has declined in recent years, although sampling levels are low, particularly in the early and most recent years of the time-series. Given the seasonal variation present in other FUs it is not possible to state with any certainty that this trend is real (Figures 12.2.4 and 12.2.5; see. Section 12 FU11 North Minch).

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 25% by number in this FU since 1999. Since 2010, discard rates have been estimated to be substantially lower than the long term average, and in 2018 were at the lowest rate in the time-series at only 2.5% (Table 14.2.2). The discard rate in FU13 increased substantially in 2019 to 19.1%. Due to an absence of discard sampling in 2020 and 2021, a discard rate of 10.5% (1.8%/26.8%) was calculated based on a mean rate across all quarters 2017-2019, and allocated to all quarters in 2020 and 2021. The discard rate (adjusted to account for survival) which will be used in the forecast was estimated by taking a three-year average 2019–2021, amounting to 10.4% (8%/14.8%).

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.

Abundance indices from UWTV surveys

An underwater TV survey of the stock is conducted annually according to standards set out by the Manual for the Nephrops Underwater TV Surveys (Dobby *et al*., 2021). Surveys have been carried out in 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 raised to the estimated ground area available for *Nephrops*; 2080 km^2 based on contoured superficial sediment information (British Geological Surveys).

In 2022, 30 valid stations were used in the final survey analysis for the Firth of Clyde (Table 17.2.3) and 12 stations for the Sound of Jura (Table 14.2.4). Table 14.2.5 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 14.2.6. A CV (coefficient of variation, or relative standard deviation) of <20% is considered an acceptable precision level for UWTV survey estimates of abundance (SGNEPS, ICES, 2012). CVs for the three most recent TV surveys in Firth of Clyde and Sound of Jura are lower than the precision level agreed.

Figure 14.2.4 shows the distribution of stations in recent TV surveys (2011–2022) across FU13 (the two distinct subareas can be clearly seen) with the size of the symbols proportional to the *Nephrops* burrow density. Table 14.2.3 and Figure 14.2.5 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 14.2.4 and Figure 17.2.6. Most surveys have detected generally higher densities in the southern part of the Clyde.

The TV survey estimates of abundance for *Nephrops* in the Firth of Clyde suggest that the population increased until the mid-2000s implying a sustained period of increased recruitment. Following this, abundance has fluctuated around the values previously observed in the early 2000s.

In 2022, the overall abundance increased slightly but remained within recently observed ranges (Figure 14.2.5).

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 appeared relatively stable from 2017 until 2021, but in 2022 it dropped below the 15% quantile of estimated values (Figure 14.2.6).

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009; ICES, 2013). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative relative to absolute conversion factor estimated for FU13 was 1.19 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 19%.

14.3 Assessment

Comparison with previous assessments

The assessment in 2022 is based on a combination of examining trends in fishery indicators and underwater TV survey data, using an extensive data series 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 2022 follows that of previous years (since 2015) in that the commercial data for Clyde and Sound of Jura have been combined, because of concerns regarding the accuracy of the landings data. There are also no discard samples and limited market samples available for the Sound of Jura. Therefore, the harvest rate and catches for the two areas are presented as a combined total. *Nephrops* abundance will continue to be monitored separately, with a TV survey being conducted in both subareas where logistically possible.

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 2022 was 1665 million individuals, a 17.7% increase from the 2021 estimate, well above the $B_{trigger}$ value of 580 million. The abundance estimate for the Sound of Jura in 2022 was 241 million individuals, a 22.3% decrease from the 2021 estimate, but again above the $B_{trigger}$ value of 160 million.

The harvest rate for the FU13 in 2021 (dead removals for both subareas/ Firth of Clyde and Sound of Jura TV abundance = 21%) was above the F_{MSY} proxy value (the value associated with high long-term yield and low risk depletion) for the Clyde (15.1%), and the Sound of Jura (12.0%). Note the F_{MSY} proxy values for this stock were revised in October 2015 at WKMSYRef4 (ICES, 2016b).

14.4 Catch option table

Landings predictions and catch options at various harvest rates (based on principles established at WKNEPH (ICES, 2009)), will be made for Firth of Clyde and Sound of Jura on the basis of the

2022 UWTV survey conducted in June. These will be presented in October 2022 for the provision of advice.

Catch scenario table inputs and historical estimates of mean weight in landings and harvest rates are presented in Table 17.2.2 and summarised below. The calculation of catch options for the Firth of Clyde follows the procedure outlined in the stock annex.

The table below shows the agreed inputs to the catch scenarios table for FU13.

Input	Data	2022 assessment
Survey abundance (millions)	UWTV 2022	1 665 Clyde; 241 SoJ
Mean weight in projected landings (g)	2019–2021	17.16
Mean weight in projected discards (g)	2019–2021	7.33
Projected discards	Average 2019–2021 (proportion by number; combined for Firth of Clyde and Sound of Jura)	13.4%
Discards survival	Proportion by number (assumed)	25%
Dead projected discards	2019–2021	10.4%*

*** Based on mean discard rate (2017-2019) allocated to all Quarters of 2020 & 2021. Estimates of 14.8% and 8% were derived based on the maximum and minimum observed discard rates, respectively, for the same period**

14.5 Reference points

F_{MSY} proxy for this stock was revised in October 2015 at WKMSYRef4 (ICES, 2016a; ICES, 2016b). These were updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, which corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values a five-year average was chosen. Similarly, the five-year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five year average of the F above F_{MAX} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy, which occasionally appear. For this functional unit the F_{MSY} proxy has been revised to 15.1% for the Clyde and 12.0% for the Sound of Jura respectively.

For *Nephrops* stocks, MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased and is calculated as 579 million individuals for the Firth of Clyde. The advice from WKMSYRef4 (ICES, 2016b) rounded this value to give an MSY $B_{trigger}$ of 580 million.

MSY $B_{trigger}$ was not previously proposed for FU13 (SJ) as there were few points in the survey series (due to missing years). WKMSYRef4 stated that the survey series is now considered to be of sufficient length to allow the B_{loss} (abundance in 1995) to be proposed as the MSY $B_{trigger}$. This results in a value of 160 million (ICES, 2016b). Full details are contained in the stock annex.

These should remain under review by WGCSE and may be revised should improved data become available.

Table 17.2.2 and Figure 17.4.1 show the estimated harvest rates over this period. The harvest rate was calculated from the total dead removals for both subareas divided by the combined abundance for the Firth of Clyde TV survey and the Sound of Jura. This does result in some years were the harvest rate is not calculable as we do not have a full time-series of TV surveys for the Sound of Jura. The combined harvest rate peaked in 2007 at 43.0% before declining to around the F_{MSY} level for the Clyde in 2010–2011. The harvest rate has fluctuated since then, and increased in 2021 to 19.3% from 9.4% in 2020. It is unlikely that prior to 2006, the estimated harvest rates are representative of actual harvest rates due to under-reporting of landings.

14.6 Management strategies

Scotland has recently established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

A weekend ban on mobile gear was introduced in the Clyde in 1986 under a Scottish Statutory Instrument. Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night, as are vessels greater than 21 m in length.

On the 8th of February 2016, phase 1 of the fisheries management measures for inshore MPAs in Scottish waters came into force (SG, 2016). These measures relate to both NCMPA (Marine (Scotland) Act and the UK Marine and Coastal Access Act) and Special Areas of Conservation (EC Habitats Directives – Council Directive 92/43/EEC) both of which have the aim of conserving biological diversity in Scottish waters and along with other protected sites make up Scotland's MPA network (SG, 2017a). Although not specific to the management of the *Nephrops* fishery they will influence spatial patterns of fishing for *Nephrops* where controls on the two main gear types, demersal trawls and creels, are implemented on *Nephrops* habitat. There are three NCMPAs within the Clyde functional unit. The MPA, which extends onto the main patch of *Nephrops* habitat, is the South Arran NCMPA, within the Firth of Clyde subarea, where a complete ban on demersal vessels greater than 120 gross tonnage has been implemented. Partial closures (i.e. zoned management) for demersal trawlers smaller than this size and creelers are also in place. For Loch Sween, north of the main habitat area in the Sound of Jura subarea, demersal trawling by vessels is banned. However, for trawlers smaller than 75 gross tonnage, temporal closures are in place over some of the area. For the Upper Loch Fyne and Loch Goil NCMPA, just north of the main habitat area in Firth of Clyde subarea, demersal trawling by vessels greater than 75 gross tones is banned and the activity of vessels below this is zoned. Creeling activity is also zoned (SG, 2016). The areas of the NCMPAs relative to the estimated *Nephrops* habitat within the Clyde functional unit are presented in Figure 17.6.1.

14.7 Quality of assessment and forecast

There are concerns over the accuracy of historical landings and effort data and because of this the final assessment adopted is independent of official statistics. Harvest rates since 2006 are also considered more reliable due to more accurate landings data reported under new legislation.

One of the main issues for this FU is the problem of not being able to split the landings between the Sound of Jura and Firth of Clyde. This means that we are unable to provide harvest rates for the two subareas separately. What is currently provided is not actually a harvest rate for either sub area; but is likely more representative of the Firth of Clyde. This has an impact on the quality of the assessment but not on the forecast.

In recent years, the length and sex composition of the landings data is considered to be well sampled. However, in 2018 sampling levels fell below this normal standard. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in the Firth of Clyde subarea fishery since 1990, and is considered to represent the fishery adequately. There are few samples available from the Sound of Jura and these have been included in the FU13 raising procedure.

Discard sampling in 2021 was impacted by the COVID-19 pandemic, with no valid samples collected in Functional Unit 13. Estimates of discard rates for all quarters in the assessment were based on mean discard rates across all quarters from 2017-2019 (see "InterCatch", above). This change is considered to have had minimal impact on the quality of the assessment because discard rates have been consistently low in recent years.

Underwater TV surveys have been conducted for this stock every year since 1995. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals around the abundance estimates are stable throughout the series and relatively low compared with other FUs in area 6.a. In the provision of catch scenarios based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. A three-year average (2019–2021) of discard rate (adjusted to account for some survival of discarded animals) has been used in the calculation of catch advice.

The cumulative relative to absolute conversion factor estimates for FU13 component is largely based on expert opinion (see stock annex). The precision of these bias corrections cannot yet be characterised. The method to derive landings for the catch options is sensitive to the input dead discard rate and mean weight in landings and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. VMS data, recently made available and linked to landings (from queries of the Scottish FIN database) suggest no major differences between areas fished and the mud sediment maps. The inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations, while in the Clyde the non-estimated sea loch areas are relatively small.

14.8 Recommendation for next benchmark

This stock was last benchmarked in 2009 (ICES, 2009). WGCSE recommends that the issue concerning the split of landings between Sound of Jura and the Firth of Clyde be examined when this stock is next proposed for benchmark process.

14.9 Management considerations

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the Functional Unit level could provide controls to ensure effort and catch were in line with resources available. In this FU, the two subareas imply that additional controls may be required to ensure that the landings taken in each subarea are in line with the landings advice.

Creel fishing takes place in part of this area although the relative scale of the fishery is smaller than in the Minches. Overall effort in terms of creel numbers is not known, and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the Firth of Clyde and estimated discards of whiting and haddock by the TR2 fleet are generally high in area 6.a. It is important that efforts continue to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod include the implementation of large square meshed panels (SMPs) of 120 mm under the west coast emergency measures, and SMPs of 200 mm implemented as part of the previous Scottish Conservation Credits scheme. A seasonal closure (early spring) in the southwest part of the Firth of Clyde is in place to protect spawning cod although *Nephrops* vessels are derogated to fish in those parts where mud sediments are distributed.

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Table 14.1.1. *Nephrops*, Clyde and Sound of Jura (FU13), ICES estimates of landings of *Nephrops*, 1981–2021.

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

UK SCOTLAND						OTHER UK	IRELAND	TOTAL**
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIMUM SIZE	SUB TOTAL			
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

UK SCOTLAND						OTHER UK	IRELAND	TOTAL**
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIMUM SIZE	SUB TOTAL			
2016	4922	6	267	0	5195	1252	4	6447
2017	4195	3	263	0	4461	942	1	5403
2018	3574	13	253	0	3840	303	0	4143
2019	3834	3	265	0	4102	581	0	4683
2020	2869	10	225	0	3104	532		3636
2021	3805	50	233	0	4088	907		4995

Table 14.2.1. *Nephrops,* Clyde (FU13), ICES estimated landings of *Nephrops*, in each of the subareas (Firth of Clyde and Sound of Jura 1981–2021).

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

YEAR	UK LANDINGS		
	FIRTH OF CLYDE	SOUND OF JURA	ALL SUBAREAS
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	6447
2017	NA	NA	5403
2018	NA	NA	4143
2019	NA	NA	4683
2020	NA	NA	3636
2021	NA	NA	4995

Table 14.2.2. ***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

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)
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
2017	316	32	340	1568	306	18.1	5403	275	199	9.5	7.1	17.02	8.55
2018	268	7	273	2193	275	11.1	4143	68	51	2.5	1.9	16.14	9.79
2019	271	64	319	2083	318	13.3	4683	435	326	19.1	15	17.26	6.81
2020	195	23	212	1941	NA	9.4	3636	174	130	10.5	8.1	18.96	7.59
2021	328	38	356	1414	310	20.6	4995	292	219	10.5	8.1	15.27	7.59
2022	-	-	-	1665	241	-	-	-	-	-	-	-	-
Average***											10.4	17.16	7.33

*** Harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Dead discard average: 2019–2021; Mean weight in landings and discard average: 2019–2021.**

Table 14.2.3. *Nephrops*, Clyde (FU13): Firth of Clyde subarea. Results of the 1995–2022 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
2017	38	0.754	1568	239
2018	40	1.055	2193	297
2019	38	1.002	2083	381
2020	28	0.933	1941	297
2021	41	0.68	1414	211
2022	30	0.8	1665	316

Table 14.2.4. *Nephrops*, Clyde (FU13): Sound of Jura subarea. Results of the 1995–2022 TV surveys (values adjusted for bias).

YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS / m²)	ABUNDANCE (millions)	95% CONFIDENCE INTERVAL (millions)
1995	7	0.42	160	58
1996	10	0.45	171	26
1997	no surveys			
1998				
1999				
2000				
2001	13	0.71	272	76
2002	9	1.04	398	167
2003	12	0.68	260	68
2004	no survey			
2005	11	0.79	303	84
2006	10	1.13	430	134
2007	10	0.67	255	58
2008	no survey			
2009	12	0.66	251	68
2010	12	0.98	376	39
2011	12	0.82	312	73
2012	12	0.98	371	61
2013	9	0.52	198	35
2014	9	0.61	231	90
2015	12	0.98	376	127
2016	12	1.11	422	42
2017	12	0.80	306	71
2018	12	0.72	275	53
2019	12	0.832	318	61
2020	no survey			
2021	12	0.812	310	98
2022	12	0.632	241	71

Table 14.2.5. ***Nephrops,*** **Clyde (FU13): Firth of Clyde subarea. Results by stratum of the 2020–2022 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

STRATUM	AREA (km^2)	NUMBER OF STATIONS	MEAN BURROW DENSITY (no./m^2)	OBSERVED VARIANCE	ABUNDANCE (MILLIONS)	STRATUM VARIANCE	PROPORTION OF TOTAL VARIANCE	SURVEY PRECISION LEVEL (CV)
2020 TV survey								
M	716.8	10	1.084	0.058	777	2983	0.095	
SM	698.6	9	1.294	0.246	904.3	13364	0.428	
MS	664.6	9	0.946	0.304	628.4	14895	0.477	
Total	2080	28			2309.7	31242	1	0.076
2021 TV survey								
M	716.8	16	0.718	0.078	514.3	2486	0.223	
SM	698.6	13	0.843	0.089	588.8	3354	0.301	
MS	664.6	12	0.469	0.144	311.3	5309	0.476	
Total	2080	41			1414.4	11149	1	0.072
2022 TV survey								
M	716.8	13	0.84	0.094	602.4	3711	0.149	
SM	698.6	9	1.072	0.243	748.8	13169	0.527	
MS	664.6	8	0.471	0.147	313.4	8098	0.324	
Total	2080	30			1664.6	24978	1	0.088

Table 14.2.6. *Nephrops,* Clyde (FU13): Sound of Jura subarea. Results by stratum of the 2019, 2021, and 2022 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 (CV)
2019 TV survey								
M	90	2	0.689	0.088	62	357	0.389	
SM	150	4	0.878	0.023	131.8	128	0.139	
MS	142	6	0.874	0.129	124.1	434	0.472	
Total	382	12			317.9	919	1	0.101
2021 TV survey								
M	90	1	0.387	0.044	34.8	355	0.148	
SM	150	5	0.845	0.254	126.8	1140	0.474	
MS	142	6	1.046	0.27	148.6	909	0.378	
Total	382	12			310.2	2404	1	0.157
2022 TV survey								
M	90	2	0.626	0.01	56.3	42	0.033	
SM	150	5	0.676	0.011	101.3	47	0.037	
MS	142	5	0.59	0.287	83.8	1159	0.93	
Total	382	12			241.4	1247	1	0.162

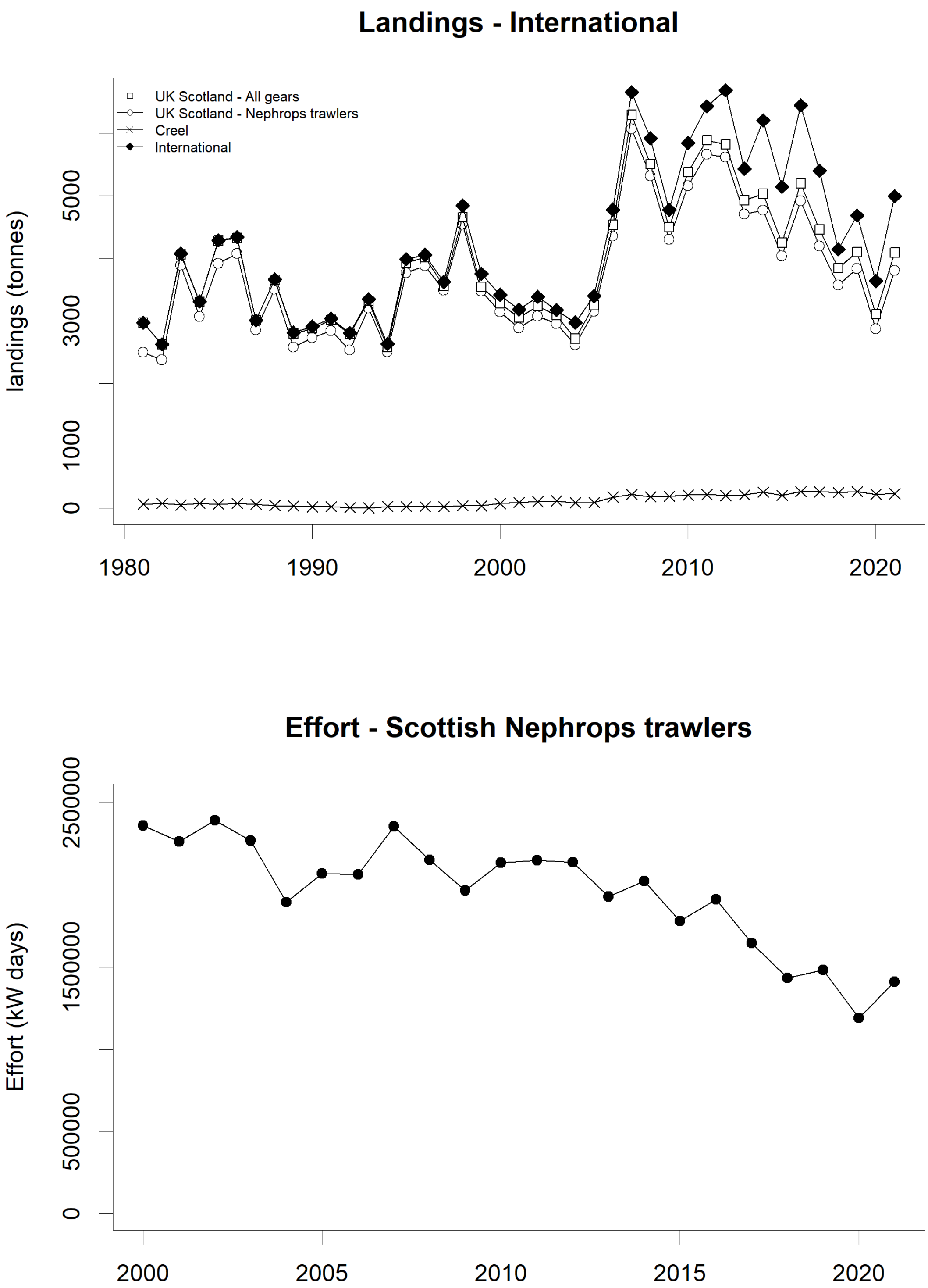


Figure 14.2.1. ***Nephrops*****, Clyde (FU13). Long-term landings and effort.**

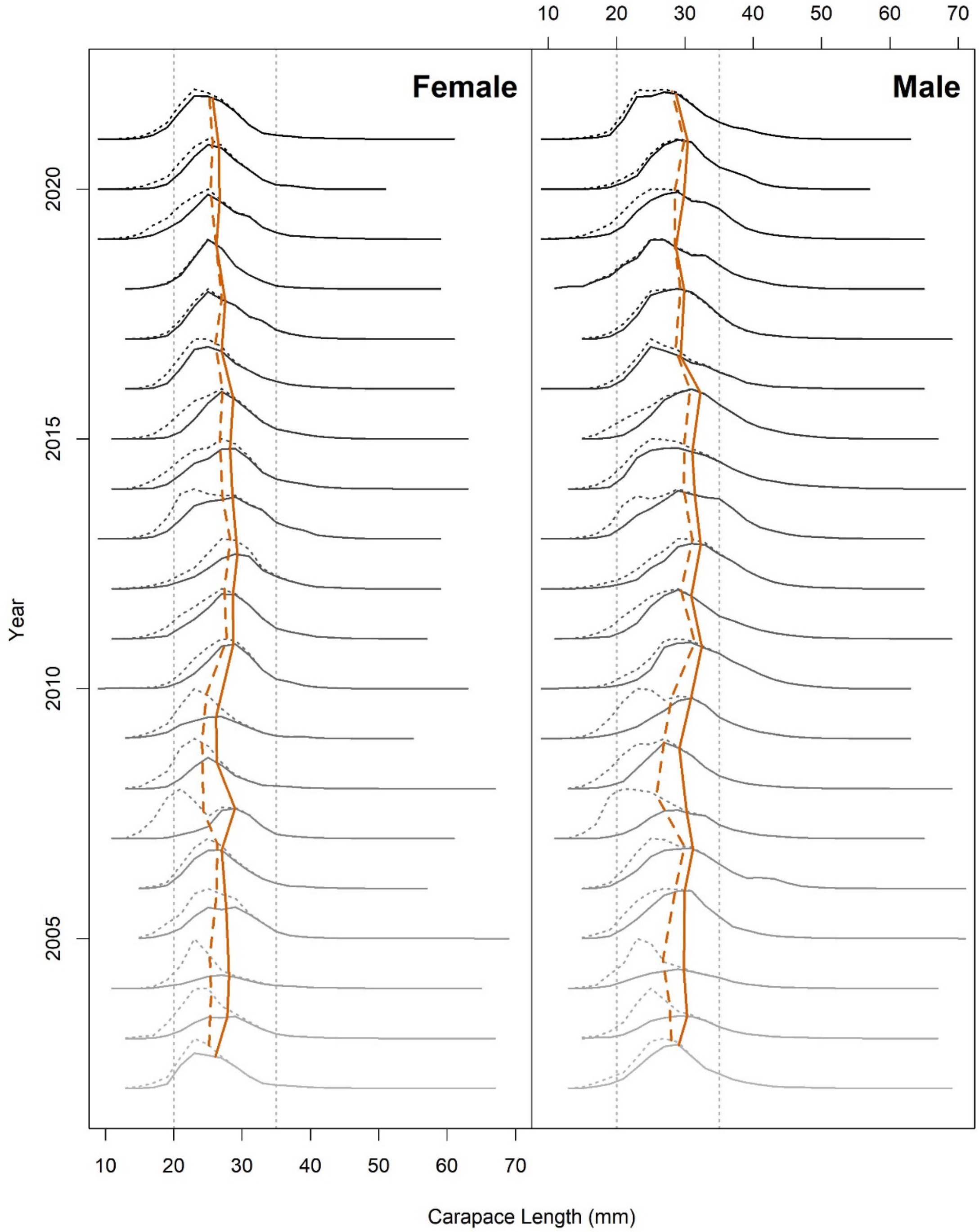


Figure 14.2.2. *Nephrops,* Clyde (FU13). Catch length–frequency distribution (dotted) and landings (solid) for *Nephrops*, 2002–2021. Mean size in catches and landings are represented by solid and dashed *orange* lines, respectively. Vertical dotted lines are minimum conservation reference size (25 mm) and 35 mm.

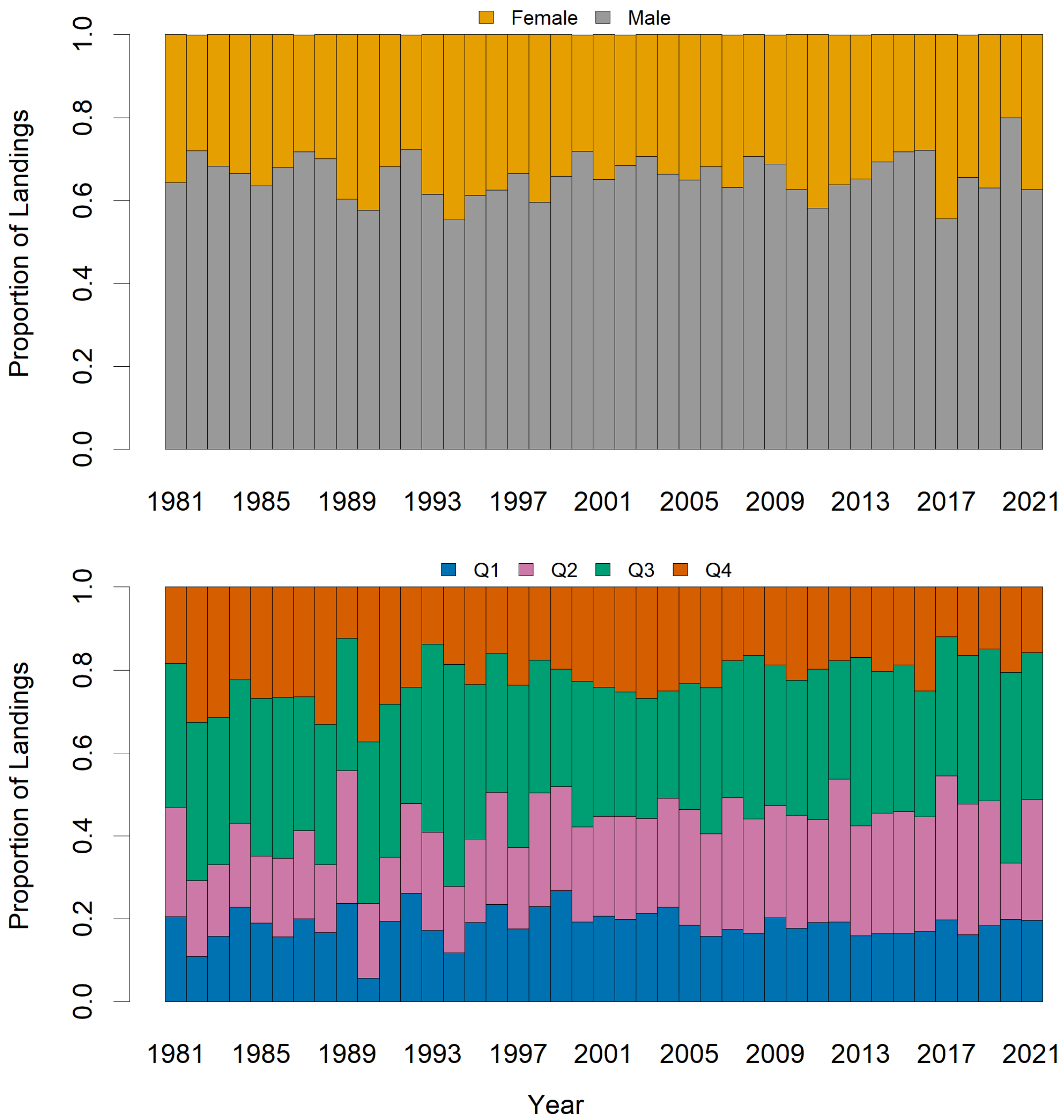


Figure 14.2.3. (a) *Nephrops*, Clyde (FU13). Proportion of landed weight by sex (*top*), by quarter (*bottom*) from Scottish trawlers.

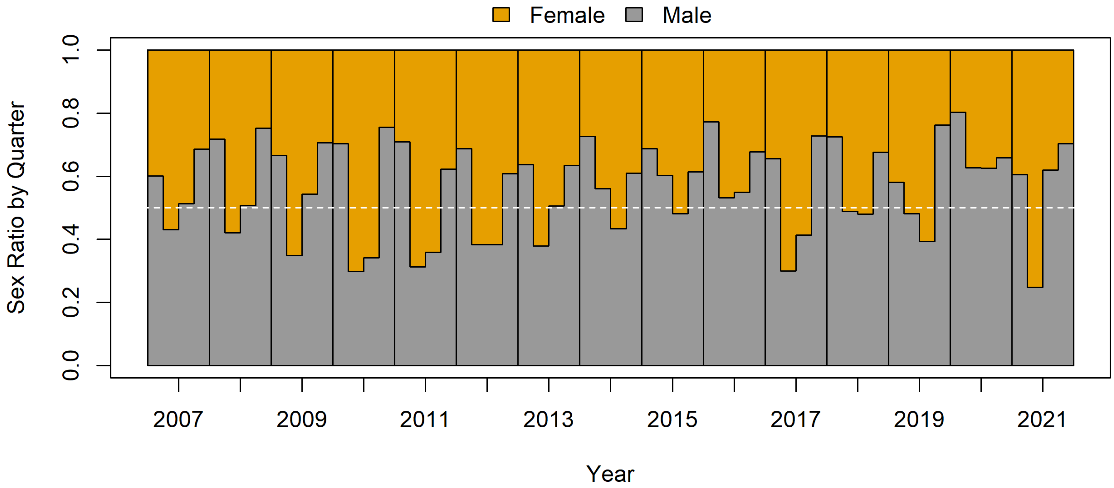


Figure 14.2.3. (b) *Nephrops,* Clyde (FU13), quarterly numeric proportions by sex (2007–2021).

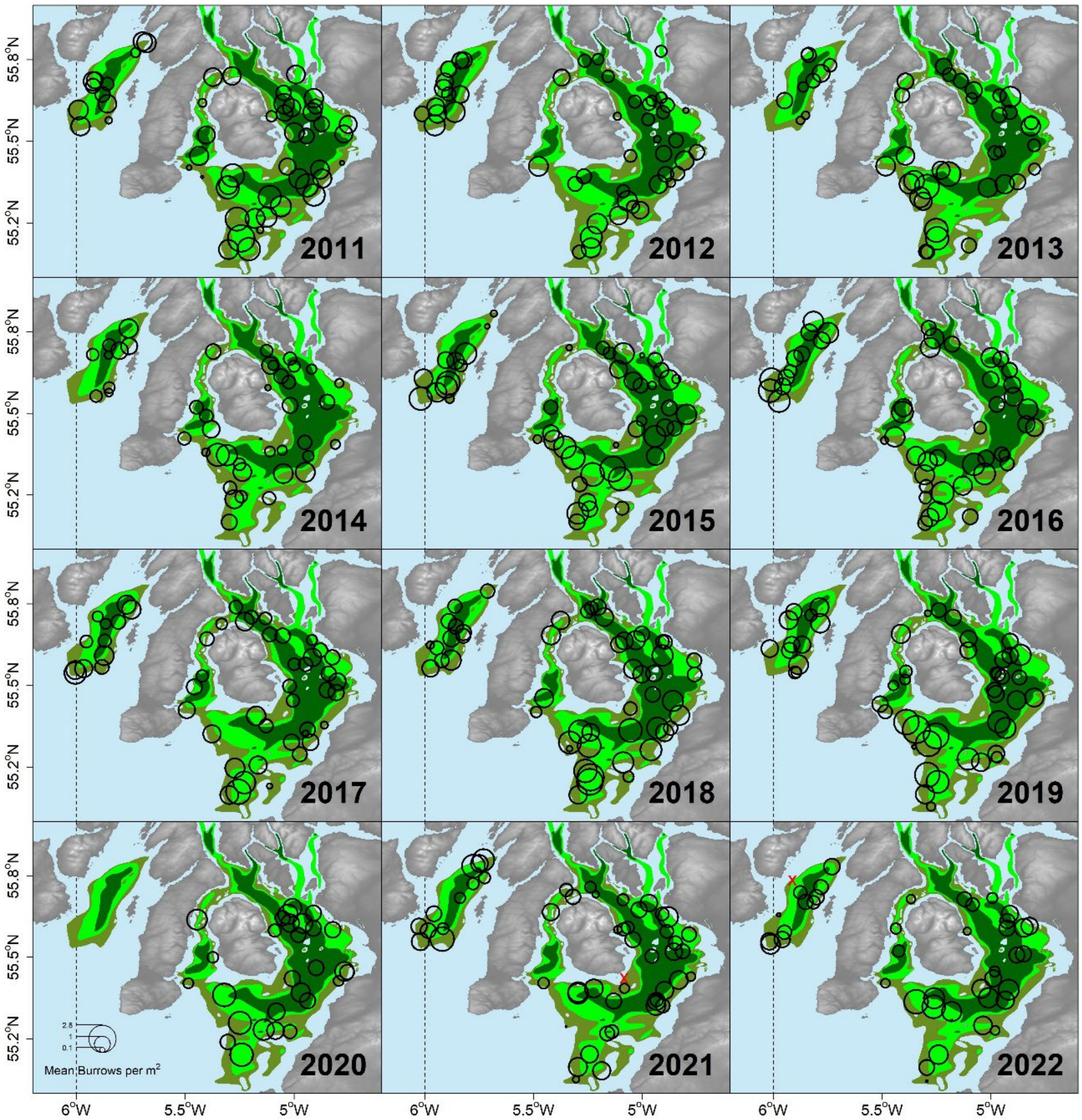


Figure 14.2.4. ***Nephrops*****, Clyde (FU13), TV survey station distribution and density (mean burrows/m²) for Firth of Clyde and Sound of Jura subareas, 2011–2022. Sound of Jura located to the east. Shaded *green* and *brown* areas represent areas of suitable sediment for *Nephrops*. Bubbles scaled the same. *Red* crosses represent zero observations.**

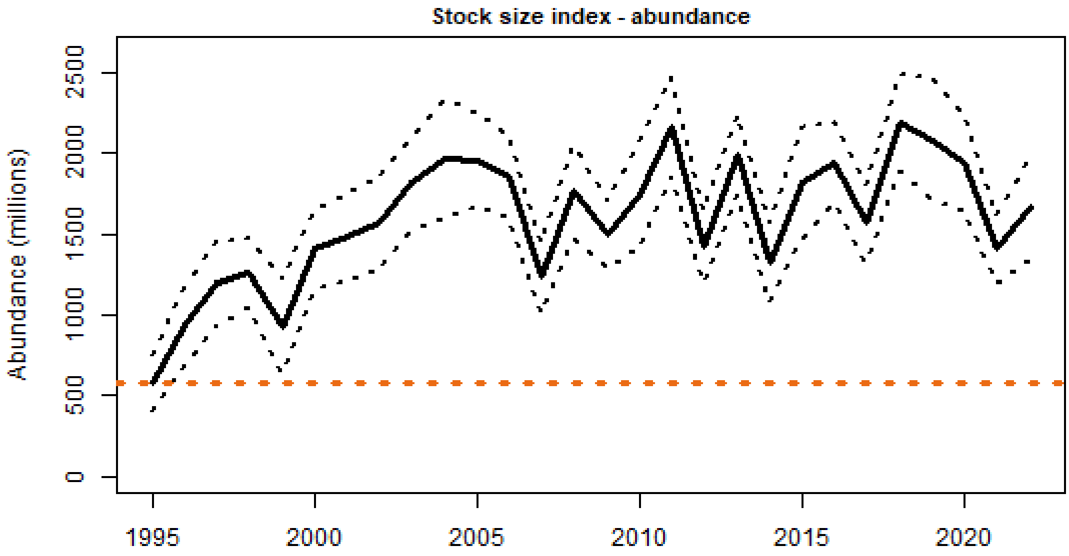


Figure 14.2.5. ***Nephrops*, Clyde (FU13): Firth of Clyde subarea. Time-series of revised TV survey abundance estimates (adjusted for bias, *solid black line*), with 95% confidence intervals (*dotted black lines*), 1995–2022. The dashed red line is the rounded $B_{trigger}$ value of 580 million individuals.**

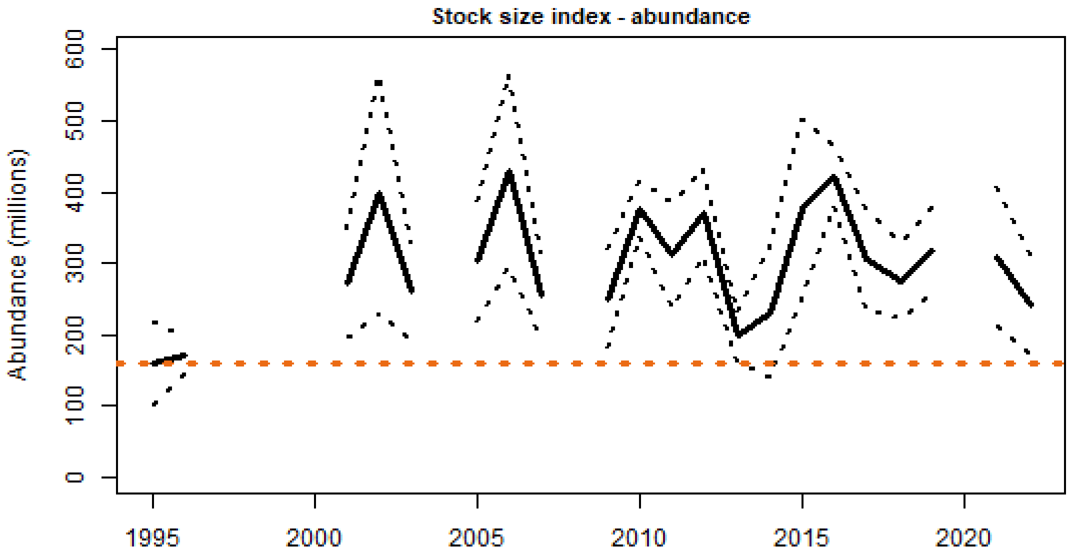


Figure 14.2.6. ***Nephrops*, Clyde (FU13): Sound of Jura subarea. Time-series of TV survey abundance estimates (adjusted for bias, *solid black line*) with 95% confidence intervals (*dotted black lines*), 1995–2022. The dashed orange line is the rounded $B_{trigger}$ value of 160 million individuals.**

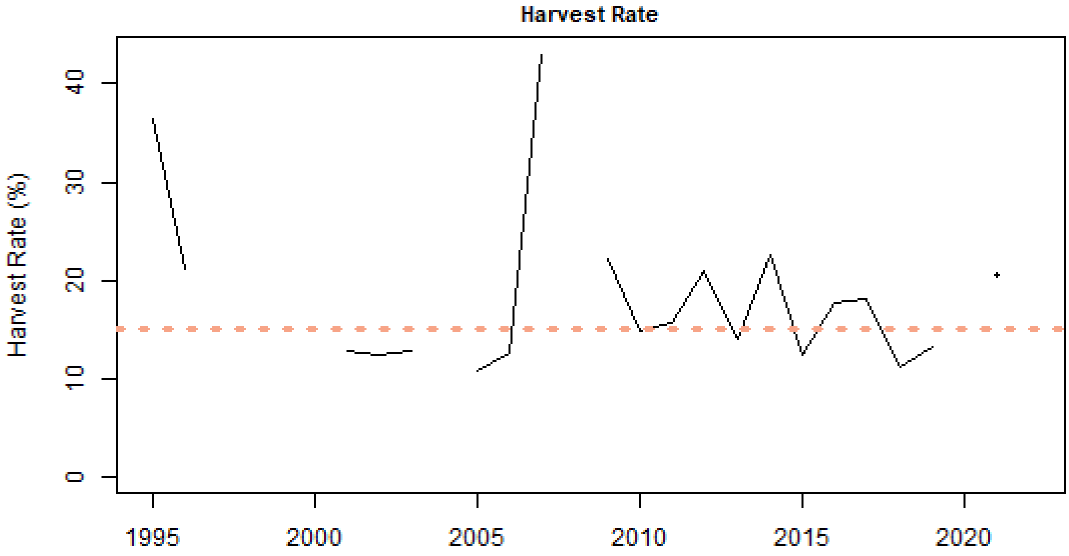


Figure 14.4.1. Clyde (FU13) *Nephrops* harvest rate, 1995–2021. The harvest rate is calculated by dead removals (both subareas combined)/TV abundances (both sub-areas combined). The dashed and solid lines are the F_{MSY} proxy harvest

rate (for the Firth of Clyde 15.1%) and the time-series of estimated harvest rates, respectively. Harvest rates prior to 2006 are considered unreliable.

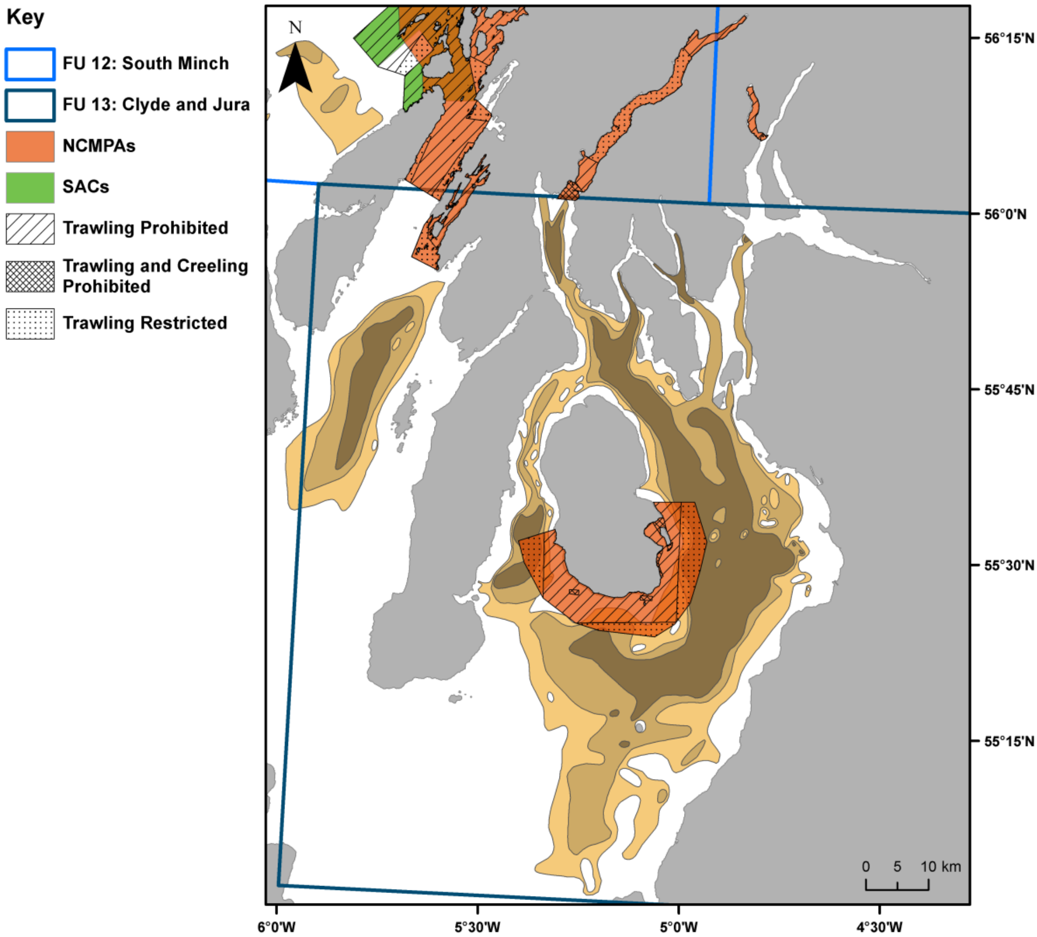


Figure 17.6.1. The area of *Nephrops* habitat (Mud, Muddy Sand and Sandy Mud) within the Clyde functional unit (FU13) relative to the areas of the Nature Conservation MPAs (NCMPAs) which fisheries management measures. Areas where demersal trawling is prohibited, restricted (i.e. vessel size restrictions or seasonal closures) and where creeling is prohibited are displayed. For more detailed information see SG (2016). Geographic Coordinate System: OSGB 1936, Datum: OSGB 1936, Projected Coordinate System: British National Grid. Coastline by Wessel and Smith (2016), MPA sites subsetted from NCMPA (SNH, 2015) and SAC (SNH, 2016) layers, management areas by SG (2017b) and functional units generated from merged ICES rectangles (ICES, 2017). Map and modified layers created using ArcGIS (ESRI, 2014).

15 *Nephrops* in Division 7.a (Irish Sea East, FU14)

15.1 *Nephrops* Subarea 7 general section

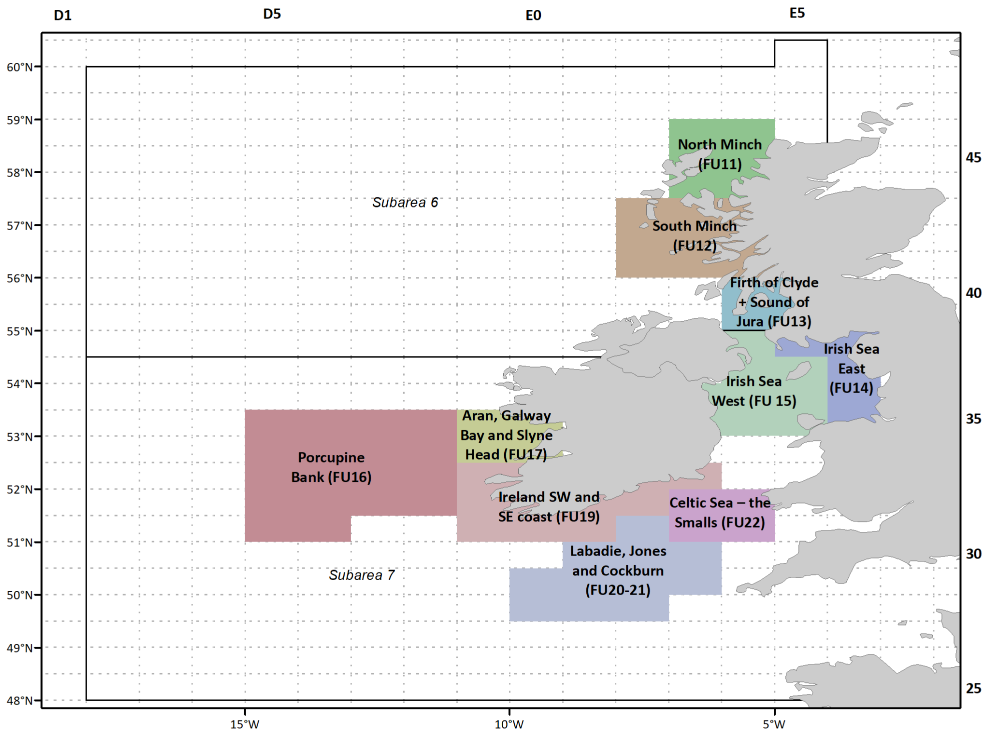
Stock description and management units

A TAC is in place for ICES Area 7 which does not correspond to the assessment units. As *Nephrops* are limited to muddy habitats the distribution of suitable sediment defines the species distribution and the stocks are therefore assessed as eight separate Functional Units. There are also some smaller catches from areas outside these Functional Units. The ICES statistical rectangles covered by the Functional Units in ICES Area 7 are listed in the table below.

FU no.	Name	ICES Divisions	ICES Statistical rectangles
14	Irish Sea East	7a	35–38E6; 38E5
15	Irish Sea West	7a	35E3, 36E3; 35–37 E4–E5; 38E4
16	Porcupine Bank	7b,c,j,k	31–35 D5–D6; 32–35 D7–D8
17	Aran Grounds	7b	34–35 D9–E0
18*	Northwest Irish Coast	7b	36–37 D9; 37E0–E1
19	Southeast and southwest Irish Coast	7a,g,j	31–33 D9–E0; 31E1; 32E1–E2; 33E2–E3
20-21	Labadie, Jones and Cockburn bank	7g,h	28 E0–E2; 29 E0–E3; 30E1–E3; 31E2
22	Smalls Ground	7g	31–32 E3–E4

*** Landings from FU18 are reported to other statistical rectangles outside FUs as these are minimal. WGCSE will monitor FU18 landings in case of any fishery developments.**

Nephrops Functional Units in Subarea 7 (FU 14–22). The TAC covers all of Subarea 7. (Note: Functional Units in Subarea 6 (FU 11–13) also shown):



Landings Obligation

From 2019, on the West Coast and around Ireland (FU 11–22), any vessels catching Nephrops had to land all *Nephrops*. High survival exemptions exist for creel caught Nephrops. *De minimis* exemptions apply to *Nephrops* vessels, for Subarea 7 allowing them to discard *Nephrops*, as long as they made up no more than 5% of the catch.

Minimum Conservation Reference Size (Minimum landing size)

Under the Landing Obligation, minimum landings sizes have been abolished. Instead a Minimum Conservation Reference Size (MCRS) for each species has been introduced. Unless exempt, *Nephrops* below the MCRS must be landed and may be sold but cannot go for human consumption. In most cases, the MCRS is the same as old MLS, being 25 mm carapace length (or over 85 mm total length) around Ireland (FUs 16–22); the MCRS is 20 mm CL (>70 mm TL) on the West coast (6.a, FUs 11–13) and the Irish Sea (7a, FUs 14–15).

The MCRS implemented for the Irish Sea at 20 mm CL is less than the rest of the ICES Area 7 (set at 25 mm CL) and applies to the Irish and UK fleets. A more restrictive regulation is adopted by the French Producers' Organisations (35 mm CL or 115 mm TL) to all French trawlers.

Management applicable in 2021 and 2022

The TAC is currently set for the whole Area 7 with a special condition for Porcupine Bank (FU 16). The TAC for 2022 is set at 17,038 tonnes, which is a decrease of 5% compared to the 18,026 tonnes set for 2021. 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.

Fishing opportunities for Norway lobster (*Nephrops norvegicus*) in Division 27.7, with specific restrictions for FU 16.

	Allowances 2021 (tonnes)		Allowances 2022 (tonnes)		Change from 2021	
	Division 27.7	FU 16	Division 27.7	FU 16	Division 27.7	FU 16
Spain	993	992	924	846	-7%	-15%
France	4,023	621	3,746	530	-7%	-15%
Ireland	6,102	1,194	5,682	1,016	-7%	-15%
Union	11,118	2,807	10,352	2,392	-7%	-15%
UK	6,908	483	6,686	412	-3%	-15%
TAC	18,026		17,038		-5%	

Sources:

Council Regulation (EU) 2021/92 of 28 January 2021 fixing for 2021 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

Council Regulation (EU) 2022/515 of 31 March 2022 amending Regulation (EU) 2022/109 fixing for 2022 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

Landings area 7

Table below gives the summary of reported landings by Functional Unit for ICES Area 7.

Year	FU 14 - Irish Sea East	FU 15 - Irish Sea West	FU 16 - Porcupine Bank	FU 17 - Aran Grounds	*FU 18 - Ireland Northwest Coast	FU 19 - Ireland Southwest and Southeast coast	FU 20–21 - Labadie, Jones, Cockburn	FU 22 - Smalls Grounds	FUs 20+21+22 - All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea 7	TAC for 7
1978	961	7,296	1,744	481						249	10,731	
1979	900	8,948	2,269	452						237	12,806	
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	15,318	
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	15,556	24,700

Year	FU 14 - Irish Sea East	FU 15 - Irish Sea West	FU 16 - Porcupine Bank	FU 17 - Aran Grounds	*FU 18 - Ireland Northwest Coast	FU 19 - Ireland Southwest and Southeast coast	FU 20–21 - Labadie, Jones, Cockburn	FU 22 - Smalls Grounds	FUs 20+21+22 - All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea 7	TAC for 7
1989	401	8,128	2,115	347		899			4,005	134	16,029	26,000
1990	563	8,300	1,895	519		754			4,290	102	16,423	26,000
1991	747	9,554	1,640	410		1077			3,295	169	16,892	26,000
1992	427	7,541	2,015	374		888			4,165	409	15,819	20,000
1993	515	8,102	1,857	372	10	905	3,466	1,182		455	16,864	20,000
1994	447	7,606	2,512	729	126	390	4,202	941		570	17,523	20,000
1995	584	7,796	2,936	867	26	695	3,536	1081		397	17,917	23,000
1996	475	7,247	2,230	528	46	888	2,822	937		623	15,796	23,000
1997	566	9,971	2,409	841	15	756	2,038	944		340	17,880	23,000
1998	388	9,128	2,155	1,410	78	827	1,713	835		514	17,048	23,000
1999	624	10,786	2,289	1,140	16	579	1,152	1,775		322	18,683	23,000
2000	567	8,370	910	880	9	696	1,778	2,890		243	16,343	21,000
2001	532	7,441	1,222	913	2	815	1,833	2,938		368	16,064	18,900

Year	FU 14 - Irish Sea East	FU 15 - Irish Sea West	FU 16 - Porcupine Bank	FU 17 - Aran Grounds	*FU 18 - Ireland Northwest Coast	FU 19 - Ireland Southwest and Southeast coast	FU 20–21 - Labadie, Jones, Cockburn	FU 22 - Smalls Grounds	FUs 20+21+22 - All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea 7	TAC for 7
2002	577	6,793	1,327	1,154	14	1,318	2,674	1,993		243	16,093	17,790
2003	376	7,052	1,064	933	16	1,239	2,953	2,065		186	15,884	17,790
2004	472	7,266	1,406	525	22	1,074	2,443	1,828		161	15,197	17,450
2005	570	6,529	2,197	778	15	712	2,469	2,533		180	15,983	19,544
2006	628	7,535	2,185	637	14	741	2,523	1,761		270	16,294	21,498
2007	959	8,424	2,074	913	3	957	2,419	2,950		206	18,905	25,153
2008	726	10,482	1,000	1,057	1	851	2,980	3,090		322	20,509	25,153
2009	693	9,166	879	626	10	868	3,145	2,185		316	17,888	24,650
2010	583	8,929	922	939	7	687	1,793	2,714		359	16,933	22,432
2011	561	10,159	1,278	659	13	643	1,237	1,636		110	16,296	21,759
2012	531	10,527	1,258	1,246	28	849	1,189	2,618		325	18,571	21,759
2013	495	8,672	1,141	1,295	0	794	1,387	2,257		194	16,235	23,605
2014	679	8,613	1,189	766	0	468	1,836	2,526		174	16,251	20,989

Year	FU 14 - Irish Sea East	FU 15 - Irish Sea West	FU 16 - Porcupine Bank	FU 17 - Aran Grounds	*FU 18 - Ireland Northwest Coast	FU 19 - Ireland Southwest and Southeast coast	FU 20–21 - Labadie, Jones, Cockburn	FU 22 - Smalls Grounds	FUs 20+21+22 - All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea 7	TAC for 7
2015	378	8,632	1,394	370	0	507	2 116	2,350		80	15,827	21,619
2016	237	7,327	2,154	641	0	590	2 453	3,329		118	16,849	23,348
2017	265	6,149	2,632	295	0	420	1,849	3,560		137	15,307	25,356
2018	263	5,756	2,751	536	0	238	1,803	1,974		200	13,521	29,091
2019	270	7,590	2,251	167	0	249	2,723	2,083		216	15,549	19,784
2020	232	6115	1899	222	0	249	413	1518		304	10887	16815
2021	519	6779	2476	498	0	415	736	1616		346	13385	18026
Average	559	8144	2105	620	16	728	2196	2073	3589	257	15869	22169

***Landings from FU18 are reported to other statistical rectangles outside FUs as these are minimal since 2013. WGCSE will monitor FU18 landings in case of any fishery developments.**

Nephrops FU14 section

Type of assessment in 2022

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 commercial fishery data follows the process defined by the inter-benchmark process and described in the stock annex (updated at WGCSE 2020). The UWTV survey undertaken in the summer 2022 forms the basis of advice for this stock.

ICES advice published 29 October 2021

"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 the years 2017–2019, catches in 2022 should be no more than 835 tonnes.

To ensure that the stock in Functional Unit (FU) 14 is exploited sustainably, management should be implemented at the FU level.

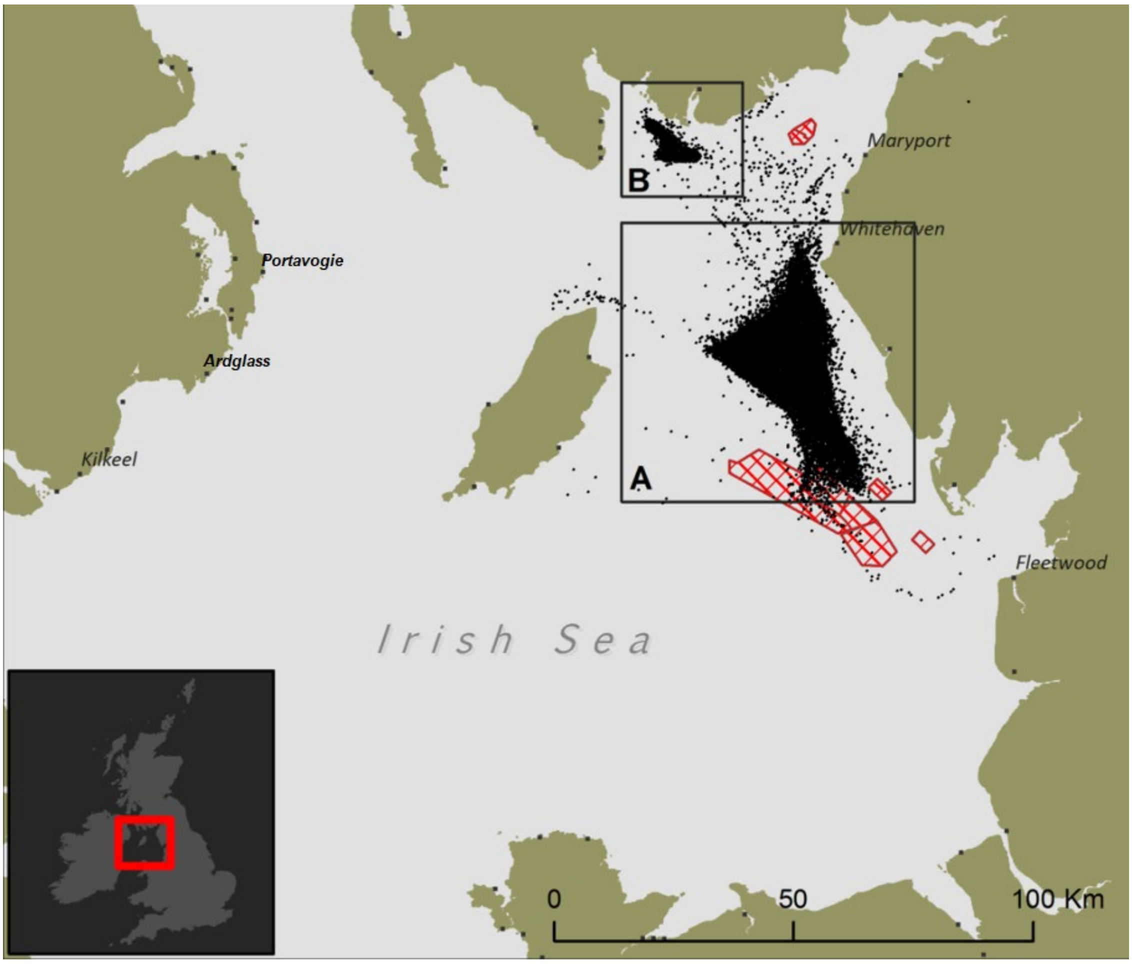
ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 7. ICES considers this plan to be precautionary when implemented at the FU level."

15.2 General

Stock description and management units

The Irish Sea East *Nephrops* stock (FU14) is in ICES Subarea 7 and comprises ICES rectangles 38E5, 38E6, 37E6, 36E6, 35E6.

In FU 14 *Nephrops* are caught on two spatially discrete grounds. Most of the fishery takes place on the main ground located between the West coast of England and Isle of Man, additionally there is also fishing activity in a small inshore ground known as Wigtown Bay.



East Irish Sea fishing grounds: A= Main fishing ground; B= Wigtown bay area. Windfarms represented by red polygons. (Source: ICES, 2015).
Main landing ports: Kilkeel, Portavogie, Ardglass, Whitehaven, Maryport

Fishery in 2021

The Eastern Irish Sea *Nephrops* fishery is relatively small compared to other FUs in the TAC area. Landings have been generally declining since 2009 (Table 3.8.2), with an isolated high of 679 tonnes in 2014 and another high of 519 tonnes in 2021. Lows were 237 and 232 tonnes in 2016 and 2020, respectively.

The fishery in FU 14 is dominated by UK vessel activity, on average accounting for 91% of the reported annual international landings since 2000. In 2021, only UK vessels reported landings from FU 14. Of these UK landings, 64.3% went into Northern Ireland (down from 80.3% in 2020), and 35.7% went into England (up from 19.2% in 2020). Unlike in 2020, no landings were reported in the Isle of Man.

The main fleets targeting *Nephrops* include single- and twin-rig otter trawlers operating out of ports in England, Wales, Northern Ireland, and the Republic of Ireland. In 2021, the fleet was split, according to landed weights, by 75.0% from Northern Irish vessels (78.7% in 2020), 22.3% from English vessels (10.9% in 2020), 2.7% from Scottish vessels (0% in 2020) and 0% from Irish vessels (10% in 2020). The TR2 gear class (otter trawls with 70 – 99 mm mesh sizes) accounted for 98.8% (99.3% in 2020) of the landings, with 1.0% (0.7% in 2020) of landings being reported from the TR1 gear class (otter trawls with ≥ 100 mm mesh sizes). The remaining 0.2% were caught in fixed pots.

A more detailed historical fishery description is provided in the stock annex.

Information from stakeholders

No additional information was provided.

15.3 Data

InterCatch

Data for 2021 were successfully uploaded to InterCatch prior to the 2022 WG meeting. According to the usual allocation procedure, English landings are allocated to English samples, Northern Irish landings are allocated to Northern Irish samples, and all remaining landings are allocated to pooled English and Northern Irish samples. Due to the impacts of the Covid-19 pandemic, no samples were available for 2020. Landings and discards length–frequency distributions for 2017 - 2019 were therefore used for the 2021 assessment. For the 2021 data year, Northern Irish samples were available and were allocated to all landings. Mean weights and discard rates for 2021 were calculated as the average of the values for 2019 and 2021.

Landings

Official landings as reported to ICES from FU14 are presented in Tables 3.8.1 and 3.8.2. 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 FU 14 appeared relatively stable fluctuating around a long-term average of about 550 t. The introduction of the UK Buyers and Sellers legislation in 2006 precludes direct comparison with previous years, as reported levels are considered to have significantly improved. Over the period 2007–2020, landings have declined considerably from the peak year of 2007 (959 t); landings in 2020 were the lowest in the period (232 t). There were no reported discards in 2020 and discarding (15 t) has been estimated based on 2017–2019 rates. In 2021, landings increased again to 519 tonnes, all into the UK, with 29 tonnes of reported discards.

Effort

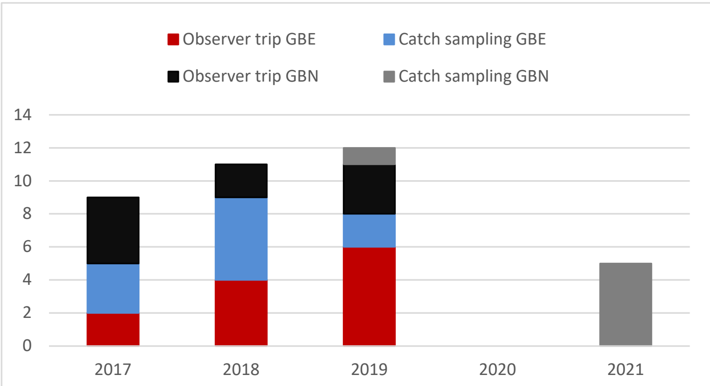
Following discussions at WGCSE, it was concluded that effort should be reported in the WGCSE report in kWdays, and LPUE should be reported in kg/kWdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. Effort calculations are likely to have been unreliable prior the introduction of the Buyers and Sellers legislation in 2006 by the UK and improvement in landings reporting.

Total UK and Irish targeted effort (70-99mm mesh with >30% *Nephrops* by weight) and LPUE is reported in Table 3.8.3 and shown in Figure 3.8.2. Until 2020, there was a general decline in targeted effort since 2007 (although 2014 did see a small rise in effort compared to 2013). In 2021, targeted effort increased again, almost tripling compared to 2020.

Within the UK targeted metier, there are significant differences between sub-fleets and changes in fleet composition may therefore unduly influence catch rate metrics. These issues need to be examined further.

Sampling Levels

Sampling levels, data aggregating and raising procedures were reviewed by IBPNeph 2015, documented in the stock annex, and examined further at WGCSE 2018. Recent sampling levels have fluctuated; prior to 2016 sample data have only been available from landings into England, however since 2016 samples have also been available from landings into Northern Ireland. In 2020, there was no sampling activity from the fishery due to impact of the Covid-19 pandemic. For 2021, only Northern Irish samples are available.



Number of observer trips on English and Northern Irish vessels, as well as the number of shore-based catch samples.

Commercial length–frequency distributions

The raised catch length distributions are shown in Figure 3.8.3. Mean individuals weights and carapace lengths are listed in Table 3.8.4. The mean sizes for both sexes from 2008 fluctuate considerably. For 2020, the mean individual weights and carapace lengths of *Nephrops* were estimated from the average of 2017-2019 values to be slightly lower than in 2019 and 2020 but higher than the record low of 2016. On the basis of Northern Irish samples, the mean weight and carapace length in landings decreased compared with the 2017–2019 average, as well as with the values in 2019, while mean weight and carapace length in discards increased compared with the previous years.

Length composition

Between 2010 and 2012, sampling levels are considered insufficient to reliably characterise the length composition of extractions. Increased sampling levels from 2013 onwards have allowed for length compositions to be constructed. For 2013 and 2014, a full revision was done through an inter-benchmark process (ICES, 2015; described in the stock annex). Data aggregating and raising procedures from 2015 to 2017 were conducted according to benchmark procedures (ICES, 2005) and referred in the stock annex. These were revised during WGCSE 2018 to account for Northern Irish sampling data since 2016 and are described further in the stock annex. No sampling activity was possible during 2020 due to the effects of COVID-19 pandemic and length composition data from 2017 to 2019 were again used to generate mean sizes. In 2021, the only samples were from Northern Ireland, which were allocated to all landings.

Sex ratio

Mature females are mainly caught in the non-berried state between moulting (which peaks in May), and spawning (which peaks in September). Females mature at about 23 mm carapace length. (Thomas and José Figueiredo, 1965).

The catch sex ratio by year is shown in Figure 3.8.5. The ratio is quite variable but average sex ratio is 56% male (1999–2019), the sex ratio for 2019 being slightly above this (62%). Sex ratio was not estimated in 2020. In 2021, the male sex ratio increased to 73%.

Mean weight explorations

The annual mean weight estimate for landings and discards is provided in Table 3.8.4 and in Figure 3.8.6. There is a substantial difference between the mean weights prior to 2011 and after 2013 (the gap being where sampling was too low to be reliable). Since 2016, NI sampling has been included and the mean weight of NI samples is considerably lower than for English sampling (e.g. for 2017-2019, mean weight of landings from English sampling was 30.9 g compared to 15.2 g in Northern Irish sampling). As a result, comparison with years prior to 2016 is not practical. Mean weights over the years 2016–2019 have been variable without trend. Mean weights were not estimated for 2020 due to no sampling. Northern Irish sampling resumed in 2021, but due to the small sizes in the Northern Irish samples, compared with the English samples, the mean individual weights and sizes for that year need to be treated with scepticism.

Discarding

Discard selection was revised at the IBP process in 2015 (ICES, 2015) and described in the stock annex. Figure 3.8.4 shows a single discard ogive fitted by pooling all years (2003–2014) and mesh sizes. Final discard selection for the East Irish Sea shows a L50= 23.54 and a L25=24.77 mm CL (Figure 4.3.4), which shows a selectivity at higher sizes compared with FU15. Due to high inter-annual variation in mean sizes of both landings and discards, the discard ogive was not updated using later 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 from 0% to 10%. Although there are no direct survivability studies available for this area, it is expected that the survivability of discarded animals should be similar to the fishery in FU15 where fishing practices are similar and both are largely spring/summer fisheries and animals discarded are exposed to warmer temperatures before being returned to the sea.

Abundance indices from UWTV surveys

Since August of 2007, the UK has 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, Dobby H., *et al*, 2021). The survey stations used in 2022 are presented in Figure 3.8.7.

Due to the construction of the windfarm in the southern part of the ground the survey area was reviewed at IBP 2015, but the protocols and standardised process to run the survey were not modified (see stock annex and IBP 2015 report ICES, 2015). The new survey area (based on a co-kriging model) is shown in Figure 3.8.8. The boundary used to define the ground limits for absolute abundance runs close to the outer survey stations.

Ground	Area Km^2	Source
Main ground 2008–2010	1032.75	WGCSE 2008
Main ground 2011–2019	1019.79	IBP 2015 – ICES, 2015
Wigtown Bay	67.21	IBP 2015 – ICES, 2015

Wigtown Bay in relation to Main ground = 6.6% * (increase from 1.9% prior to the windfarm construction).

Abundance indexes were revised back to 2011, the year where the effect of effort displacement is clearly visible due to the windfarm construction. Final updated burrow density estimates are presented in Table 3.8.6 and visualised in Figure 3.8.9 where the geo-spatial model was updated using the new area based on the co-kriging approach (1019.79 km^2) and the extrapolation to Wigtown Bay using 6.6%.

The abundance estimate for 2022 (386 million) is a decrease of 1.7% compared to the 2021 figure of 393 million (Figure 3.8.10) and 18.9% lower than the 2008–2021 average of 476 million. The surveys show a clear spatial distribution pattern, with highest densities in the centre of the patch and more variable in the areas further north and south. The grounds are fairly well delineated by consistently low-density ground to the west (Figure 3.8.9). CVs over the entire time-series (Table 3.8.6) are within the accepted precision level of 20% (ICES, 2012).

The use of the UWTV surveys for the provision of *Nephrops* management advice was extensively reviewed by WKNEPH (2009). A number of potential factors were highlighted including those due to edge effects; species burrow misidentification and burrow occupancy. Using the same process adopted at WKNEPH, a cumulative absolute conversion factor for this FU was predicted to be 1.2 for FU 14 (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.

In 2021, a new survey camera system was implemented using high-resolution stills-based footage, generally resulting in improved picture and burrow definition. Comparison of the old and new systems in other survey areas (FU 16 and FU 20-21 combined) has shown no significant difference in density estimates and previous assumptions relating to correction factors are still applied.

15.4 Assessment

Comparison with previous assessments

The methods normally used are in line with WKNEPH (ICES, 2009) and the approach taken by WGCSE for other *Nephrops* stocks in Subareas 27.6 and 27.7. This approach was inter-benchmarked at IBPNeph (ICES, 2015) and is described in the stock annex. Deviations from the standard procedure were required due to the lack of sampling data in 2020. As a result, WGCSE 2021 carried out the assessment for this stock using the same three-year average (2017–2019) for weights and discarding rates as for the 2020 assessment. For this current assessment, the average weights and discarding rates are based on 2019 and 2021 sampling data. Throughout the pandemic, the UWTV surveys were carried out as usual. Therefore, the current abundance values were used for the assessments in 2021 and 2022, according to the established procedure.

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated between abundance values of 350 and 694 million *Nephrops*. The 2022 estimate (386 million) decreased by 1.7% in relation to 2021 but is still above the MSY $B_{trigger}$ (350 million).

Table 3.8.5 and Figure 3.8.11 summarise the abundance estimated including the confidence intervals and the harvest ratios (% total removed / UWTV abundance) which have been above the F_{MSY} proxy.

15.5 Catch scenarios table

Catch scenarios table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 3.8.5 and summarised below. The calculation of catch options for FU14 follows the procedure outlined in the stock annex. The basis for the catch options:

Variable	Value	Notes
Stock abundance (2023)	386	UWTV survey 2022; individuals in millions
Mean weight in projected landings	19.9	Average 2019—2021; in grammes
Mean weight in projected discards	9.13	Average 2019—2021; in grammes
Projected discard rate	13.9	Average 2019—2021; percentage by number of the total catch
Discards survival rate*	10	Percentage by number of the discards
Dead projected discard rate	12.7	Average 2019—2021; percentage by number of the total catch

***Only applied in scenarios where discarding is allowed.**

15.6 Reference points

Reference points were defined for this stock at the IBPNeph (ICES, 2015) and proposals for F_{MSY} ranges 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. Landings, and correspondingly harvest rates, were significantly higher in 2021 than in previous years. The harvest rate in 2021 was 6.14%, with an average of 2.92% over the previous three years. Historically the available data show a maximum harvest rate of 8.2% in 2008 which is below the F_{MSY} proxy.

At the IBPNeph, a MSY $B_{trigger}$ was defined for this stock. According with this definition, $B_{trigger}$ was set for FU14 as 350 million, corresponding to the lowest observed abundance estimate from the UWTV time-series, which occurred 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)
	F_{MSY} lower	9.1% harvest rate	Average of the F at 95 % of the YPR obtained at the F_{MSY} proxy reference point	ICES (2016b)
	F_{MSY} upper	11% harvest rate	Average of the F above F_{MAX} that leads to YPR of 95 % of the maximum; capped at F_{MSY}	ICES (2016b)

15.7 Management strategies

There are no explicit management strategies for this stock.

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES Subarea 7 and also demersal stocks. The plan specifies conditions for setting fishing opportunities, depending on stock status and making use of the F_{MSY} ranges.

15.8 Quality of assessment and forecast

The quality of landings data has improved since 2012, 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 2008–2022.

In 2021, the survey camera system and reviewing method changed. Previous assumptions relating to correction factors are still applied. Comparison of the old and new systems in Functional Unit 16 has shown no significant difference in density estimates.

The revised algorithm used to derive distance covered by the sledge is considered significantly more robust than the previous algorithm.

The IBP 2015 managed to address key points:

- Revisions to the area of the *Nephrops* grounds based on new available data: VMS, UWTV data and sediment information.
- A review of fishery data and raising procedures.
- Review of Reference points: F_{MSY} proxies and MSY $B_{trigger}$.

After this revision the quality of the assessment improved. Although there are still specific uncertainties and assumptions that need to be examined further for the East Irish Sea before less conservative F_{MSY} proxies could be considered.

There are several key uncertainties and bias sources in the method proposed (these are discussed further in ICES, 2009a). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (ICES, 2007; ICES, 2008; ICES, 2009b). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate but no more precise (ICES, 2009a).

The cumulative absolute conversion factor estimates for FU14 are largely based on expert opinion. However, these were based on experience on other grounds and relatively limited experience on these grounds which would make this less reliable. The precision of these cannot yet be characterised. Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates.

The effect of this assumption on realised harvest rates has not been investigated but remains a key uncertainty.

15.9 Recommendation for next benchmark

This stock was last benchmarked by IBPNeph (ICES, 2015). WGCSE will keep the stock under close review and recommend future benchmark as required.

At IBP 2015, it was mentioned that there are specific uncertainties and assumptions that need to be examined further for the East Irish Sea before less conservative F_{MSY} proxies could be considered.

- More accurate mapping of the spatial extent of the grounds and fisheries, this includes having positional data for <12 metre vessels and more survey data in Wigtown Bay area to better define this ground. Station grid was extended to Wigtown Bay in 2016.
- For now the total abundance estimate for FU14 is based on the abundance estimates of the geospatial model for the main ground plus adding the area of Wigtown Bay. As this area is becoming a more significant fishing patch it is worth to consider the use of a separate geospatial model in this ground. This should be explored in a future benchmark work.
- Improvement of spatial coverage and sampling of landings and discards, this includes increasing the sampling levels to cover Northern Irish vessels. Northern Irish sampling has been included in the assessment since 2018
- Area specific length–weight and maturity data to validate the parameters used for this FU.
- Better knowledge of the difference in growth and population structure across the area.
- If following the current advice, the recommended catches are taken, then the stock may decrease to well below MSY $B_{trigger}$ in the short term. The basis for setting MSY $B_{trigger}$ is currently from recent history may be too high, it could also be due to recent low recruitment (transitory issue) or that the F_{MSY} is too high. As such, the $MSY_{trigger}$ reference point needs to be looked into. It was noted that the basis for MSY $B_{trigger}$ was the recent history and that the value may be too high.
- Advice is compiled for ADGNEPH in October. Lagged (one year) TV survey gives good correlation with LPUE, could this be used to calculate harvest rate rather than the in-year ratio?

15.10 Management considerations

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the Functional Unit level could allow effort and catch to be controlled in line with the scale of the resource.

There are no explicit recruitment indices.

The UWTV survey data allow for the provision of catch options and also to adopt the MSY approach. The UWTV surveys are conducted annually and a benchmark process has been adopted in 2015. In the past this stock has only been assessed biannually. These data provide the opportunity to reassess this stock more reliably on an annual basis.

15.11 References

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Table 3.8.1. Irish Sea: Landings (tonnes) by FU. In 2012 and 2013 landings outside FU for Area 7a were not provided, so have been calculated from ICES official landings for 7a minus the FU areas.

YEAR	FU14	FU15	OTHER	TOTAL
2000	567	8370	1	8938
2001	532	7441	3	7976
2002	577	6793	1	7371
2003	376	7052	3	7431
2004	472	7267	25	7764
2005	570	6554	103	7227
2006	628	7561	52	8241
2007	959	8491	83	9533
2008	676	1050	122	11306
2009	708	9198	57	9963
2010	582	8963	23	9568
2011	561	10162	61	10784
2012	531	10527	208	11266
2013	495	8672	89	9256
2014	679	8613	NA	9292
2015	378	8632	NA	9010
2016	237	7327	9	7564
2017	265	6149	0	6414
2018	268	5756	0	6024
2019	270	7590	4	7864
2020	232	6115	7	6354
2021	519	6779	20	7318

Table 3.8.2. Irish Sea East (FU14): Landings (tonnes) by country of landing and total discards, 2000–2019.

Year	Rep. Of Ireland	UK	Other Countries	Total Landings	Discards
2000	114	451	2	567	80
2001	26	506	0	532	42
2002	203	373	1	577	42
2003	69	306	1	376	11
2004	62	409	1	472	28
2005	34	536	0	570	33
2006	34	594	0	628	22
2007	86	873	0	959	47
2008	29	652	0	681	37
2009	16	692	0	708	6
2010	45	538	0	583	9
2011	31	530	0	561	0
2012	53	478	0	531	0
2013	35	460	0	495	38
2014	31	648	0	679	35
2015	88	290	0	378	18
2016	21	216	0	237	20
2017	7	258	0	265	28
2018	5	263	0	263	9
2019	9	260	0	270	15
2020	23	209	0	232	15*
2021	0	519	0	519	58

*** Based on 2017-2019 discard rates**

Table 3.8.3. Irish Sea East (FU14): Effort data for the UK and Irish trawl *Nephrops* directed fleet.

	UK direct fleet			**Irish direct fleet**		
YEAR	EFFORT (KW DAYS)	LANDINGS (TONNES)	LPUE	EFFORT (KW DAYS)	LANDINGS (TONNES)	LPUE
2006	343,249	577.2	1.7	6,932	18.3	2.8
2007	443,319	854.4	1.9	25,309	79.2	3.1
2008	366,696	628.9	1.7	8,136	14.9	1.9
2009	354,210	680.1	1.9	5,516	13.1	2.5
2010	296,097	527.3	1.8	13,496	44.6	3.3
2011	252,607	525.7	2.1	8,955	29.7	3.6
2012	215,851	452.4	2.1	21,224	52.8	2.6
2013	210,108	445.1	2.1	11,304	35.5	3.1
2014	279,606	636.8	2.3	10,259	28.5	2.8
2015	132,751	275.7	2.1	27,128	83.7	3.1
2016	109,449	214.9	2.0	9,496	21.2	2.2
2017	101,657	252.4	2.5	2,620	6.7	2.6
2018	113,740	245.8	2.2	3,042	5.2	1.7
2019	94,606	248.1	2.6	3,591	8.7	2.4
2020	61,747	203.1	3.3	7,660	22.9	3.0
2021	177,961	504.8	2.8	-	0	-

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 **	27.39	23.11	15.82	8.38	0.14
2017	29.05	24.07	18.97	9.50	0.18
2018	30.58	24.46	21.39	9.78	0.07
2019	29.49	22.90	20.93	8.40	0.12
2020 ***	29.71	23.81	20.43	9.23	0.12
2021 ****	29.35	24.09	19.56	9.07	0.17

*** Values for 2010, 2011 and 2012 are not reliable due to poor sampling.**

**** Values for 2016 revised at WGCSE 2018 due to inclusion of Northern Irish sampling in 2016 and 2017.**

***** No sampling in 2020; values for 2020 are based on 2017-2019 averages**

****** Only Northern Irish samples; values for 2021 are based on 2019 and 2021 averages**

Table 3.8.5. Irish Sea East (FU14): Sumary table for forecast inputs and historical estimates of raised landings and discards, mean weight in landings and harvest rate.

Year	Landings in number	Total discards in number	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	millions		%	tonnes	tonnes	gramme	gramme
2000	30	11	40	24.4	26.4				567	80	19.05	7.52
2001	26	5	31	15.5	17.0				532	42	20.87	7.97
2002	26	5	30	14.1	15.4				577	42	22.41	8.98
2003	13	1	14	9.0	9.9				376	11	29.39	7.64
2004	22	4	25	13.5	14.8				472	28	21.93	7.57
2005	275	4	30	11.8	13.0				570	33	21.48	8.44
2006	25	3	28	9.2	10.1				628	22	25.07	7.98
2007	40	6	46	12.5	13.8				959	47	23.94	7.33
2008	30	4	34	11.6	12.7	408	63	8.2	676	37	22.88	8.49
2009	19	1	20	3.3	3.7	350	76	5.7	707	6	36.49	8.58
2010						422	103		582			
2011						449	99		561			
2012						694	99		531			
2013	25	5	30	15.0	16.4	487	82	6.0	495	39	19.94	7.87
2014	30	4	34	9.8	10.8	449	92	7.5	679	32	22.37	9.60
2015	15	2	17	11.9	13.0	591	86	2.9	378	18	25.19	7.82
2016*	15	2	17	12.4	13.6	430	106	4.0	237	20	15.82	8.38
2017	14	3	17	16.2	17.6	580	89	2.9	265	29	18.97	9.50
2018	12	1	13	6.3	6.9	514	118	2.6	263	9	21.39	9.78
2019	13	2	14	11.1	12.2	399	69	3.6	270	15	20.93	8.40
2020 **	11	2	13	11.2	12.3	496	84	2.6	232	15	20.43	9.23
2021	21	4	24	13.5	15.0	393	78	6.1	519	58	19.56	9.07
2022						386	110					

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% 2011–2019). Due to poor sampling no estimates for 2010–2012.

*** Values for 2016 revised at WGCSE 2018 due to inclusion of Northern Irish sampling in 2016 and 2017.**
**** Removals for 2020 calculated using 2020 landings and unweighted average of mean weights from 2017-2019.**

Table 3.8.6. *Nephrops*, Irish Sea East (FU14): Results of the 2008–2020 TV surveys (values adjusted for bias).

Year	No valid stations	Mean Kriged density (no./m²)	Abundance (millions) including Wigtown Bay (1.9% 2008–2010)	Abundance (millions) including Wigtown Bay (6.6% 2011–2018)	95% CI	CV
2007			Unreliable data			
2008	32	0.38	408		63	
2009	32	0.33	350		76	
2010	26	0.4	422		103	
2011	26	0.41		449	99	11.2%
2012	26	0.64		694	99	7.3%
2013	31	0.45		487	82	8.5%
2014	34	0.41		449	92	10.4%
2015	42	0.54		591	86	7.4%
2016	48	0.40		430	106	12.6%
2017	45	0.53		580	89	7.8%
2018	46	0.47		514	118	11.7%
2019	41	0.37		399	69	9.3%
2020	43	0.46		496	84	8.6%
2021	44	0.36		393	78	10.1%
2022	46	0.38		386	110	14.6%

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% 2011–2020).

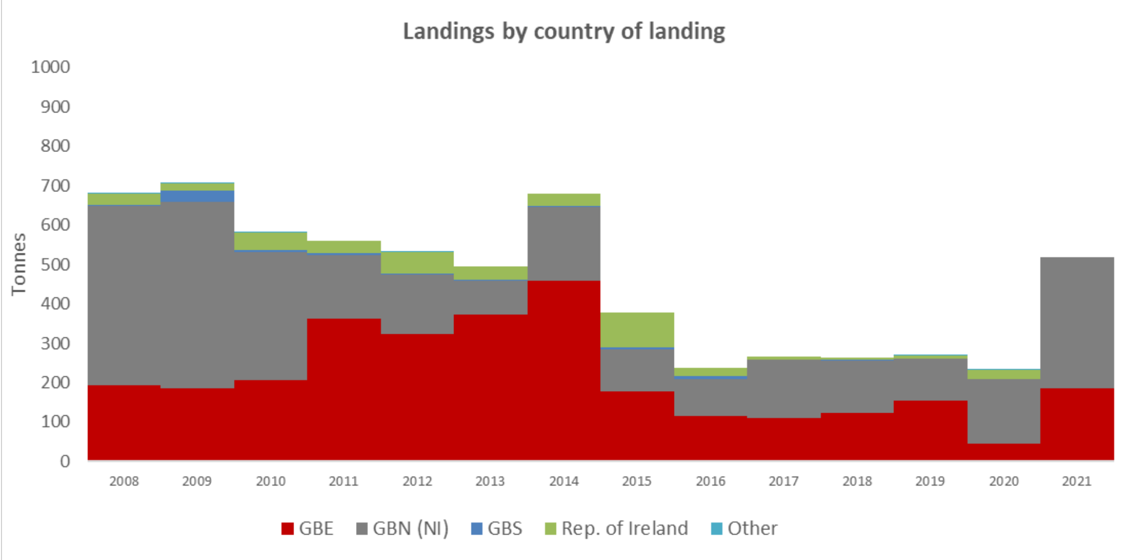


Figure 3.8.1. Irish Sea East (FU14): Landings in tonnes by country. GBE=England; GBN=Northern Ireland; GBS=Scotland; Rep. of Ireland=Republic of Ireland.

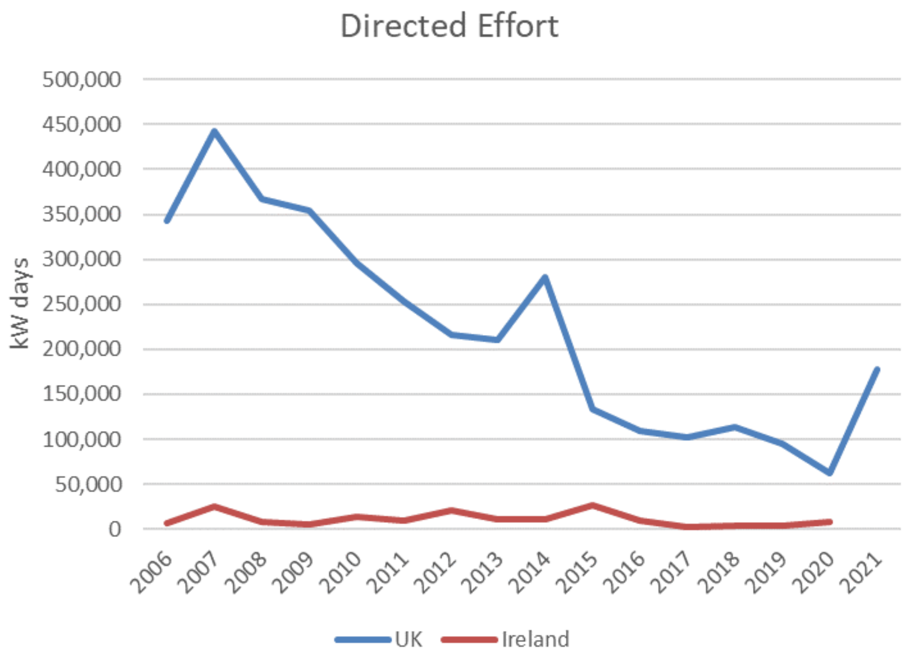


Figure 3.8.2. Irish Sea East (FU14): Effort data (KW days) for UK and Irish directed *Nephrops* fleet.

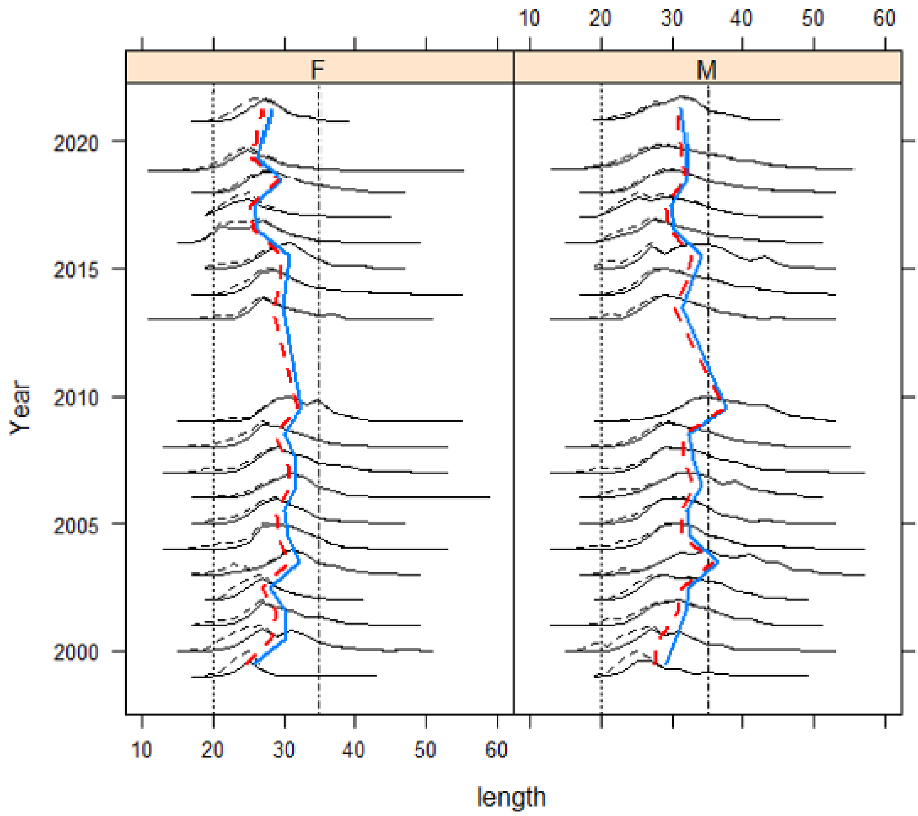


Figure 3.8.3. Irish Sea East (FU14): Length distribution of landings (solid lines) and catch (dotted lines), 2000–2021. Length frequencies for 2010–2012 are based in very poor sampling so not reliable. No sampling was carried out in 2020. Figure shows a vertical display of MLS (20 mm CL) and 35 mm CL levels.

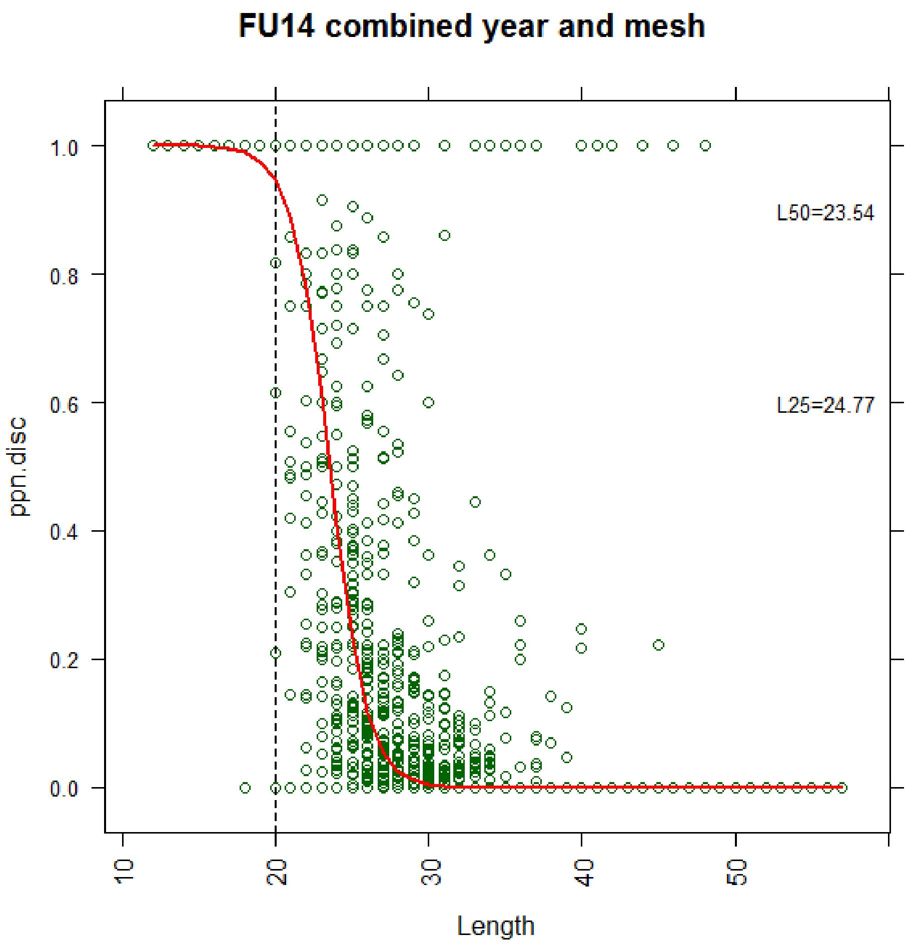


Figure 3.8.4. Irish Sea East (FU14): Final discard ogive pooled for all years (2003–2014) and mesh sizes. L50=23.54 and L25=24.77, (IBPNeph 2015).

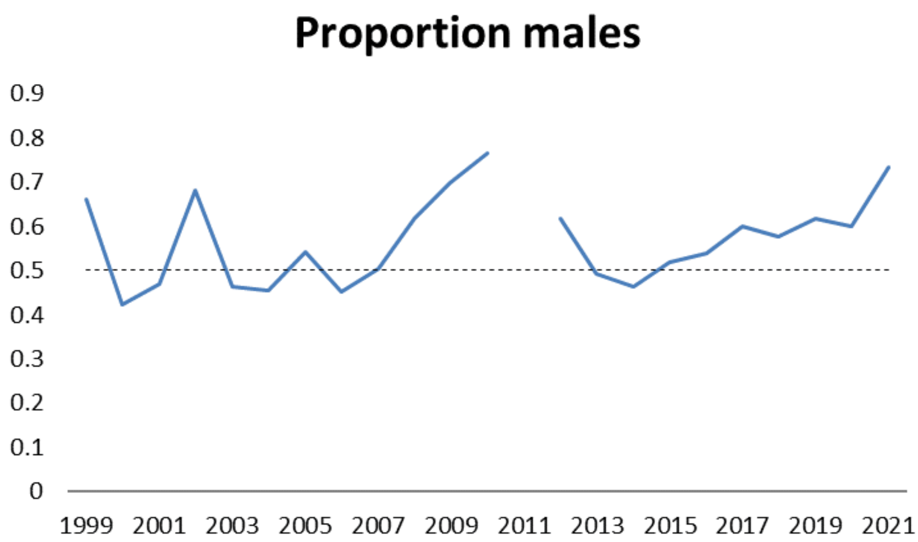


Figure 3.8.5. Irish Sea East (FU14): Proportion of males in catch since 1999. Between 2010 and 2012 due to poor sampling levels estimates of sex ratio are not reliable. No sampling was carried out in 2020

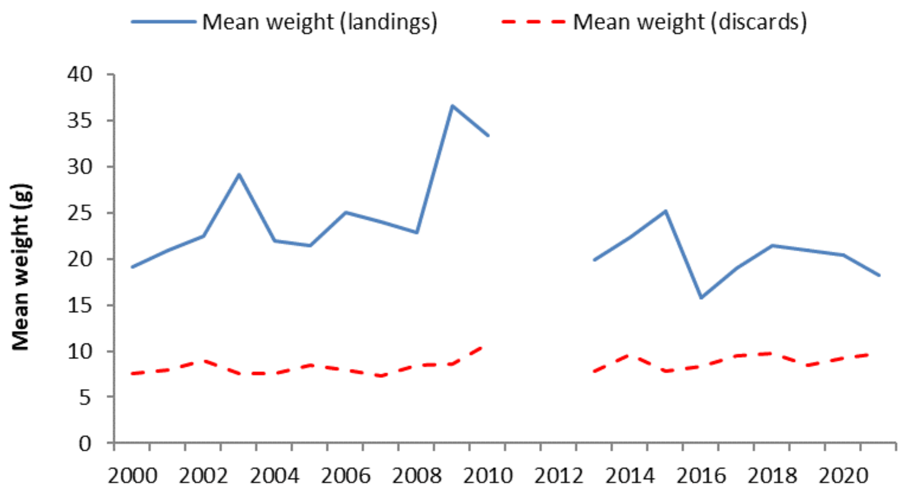


Figure 3.8.6. Irish Sea East (FU14): Mean weight (g) combined by sex for total annual landings and discards. Values for 2010, 2011 and 2012 are not reliable due to poor sampling. NI sampling included from 2016. Average of 2017-2019 sampling used for 2020

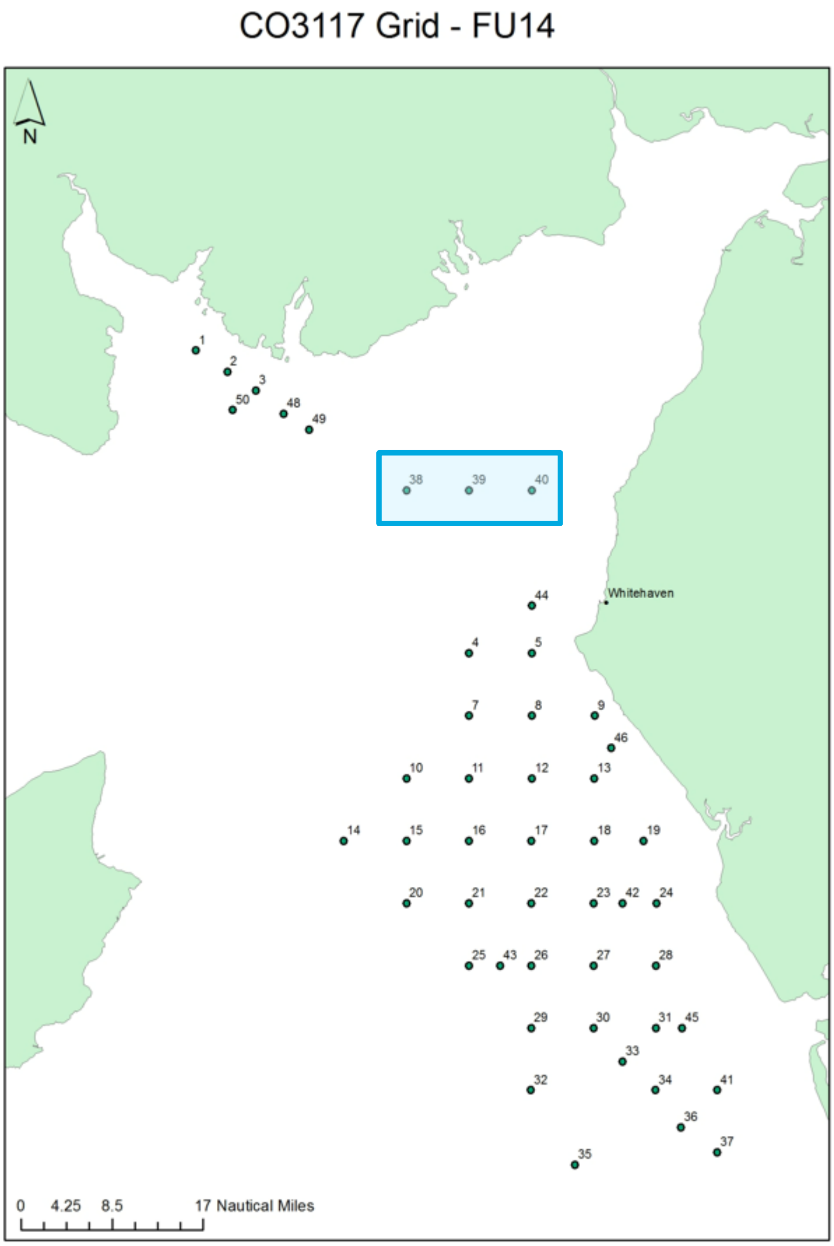


Figure 3.8.7. Irish Sea East (FU14): UWTV Survey stations for 2022. Highlighted stations 38—40 were not surveyed due to the presence of wind turbines.

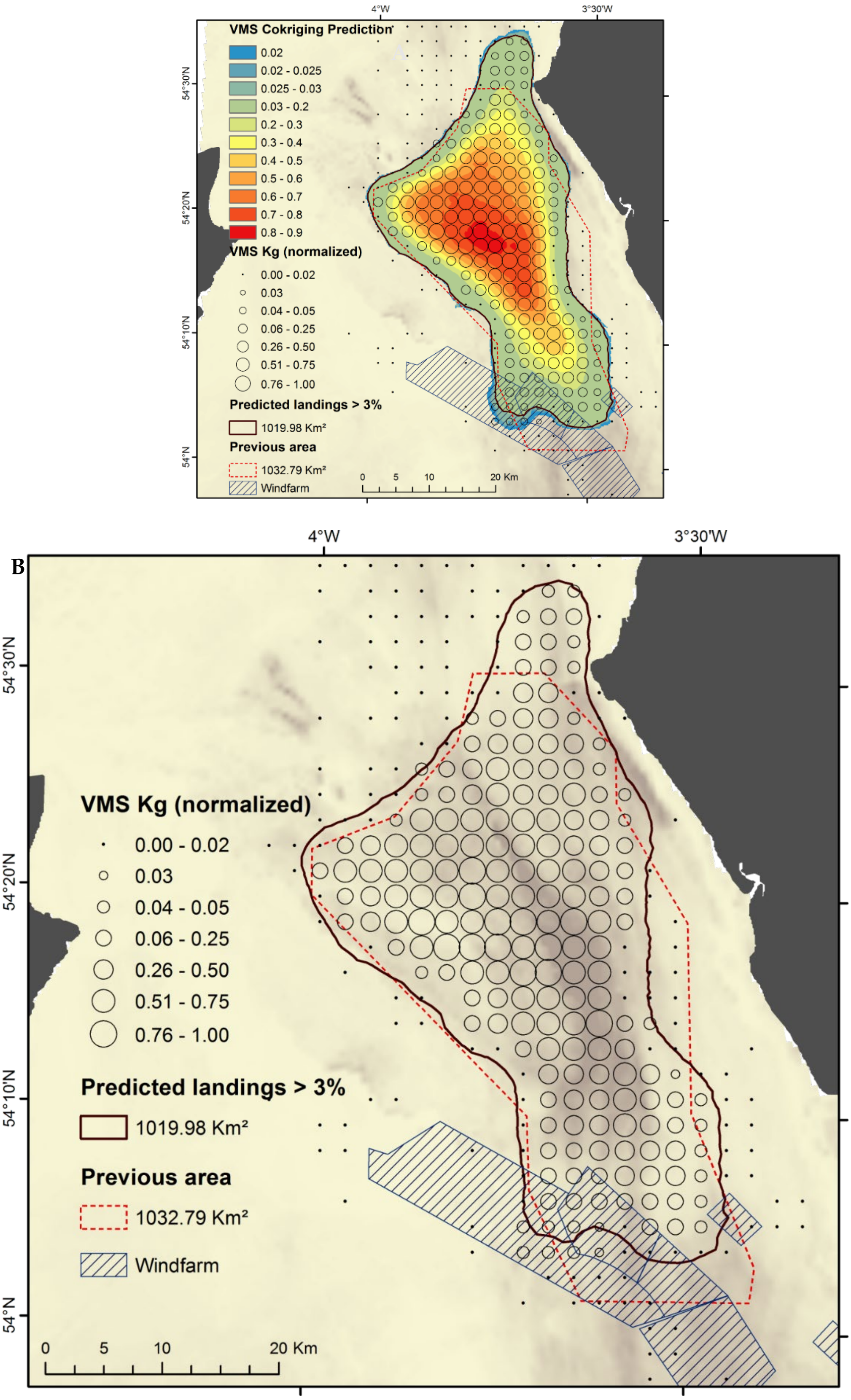
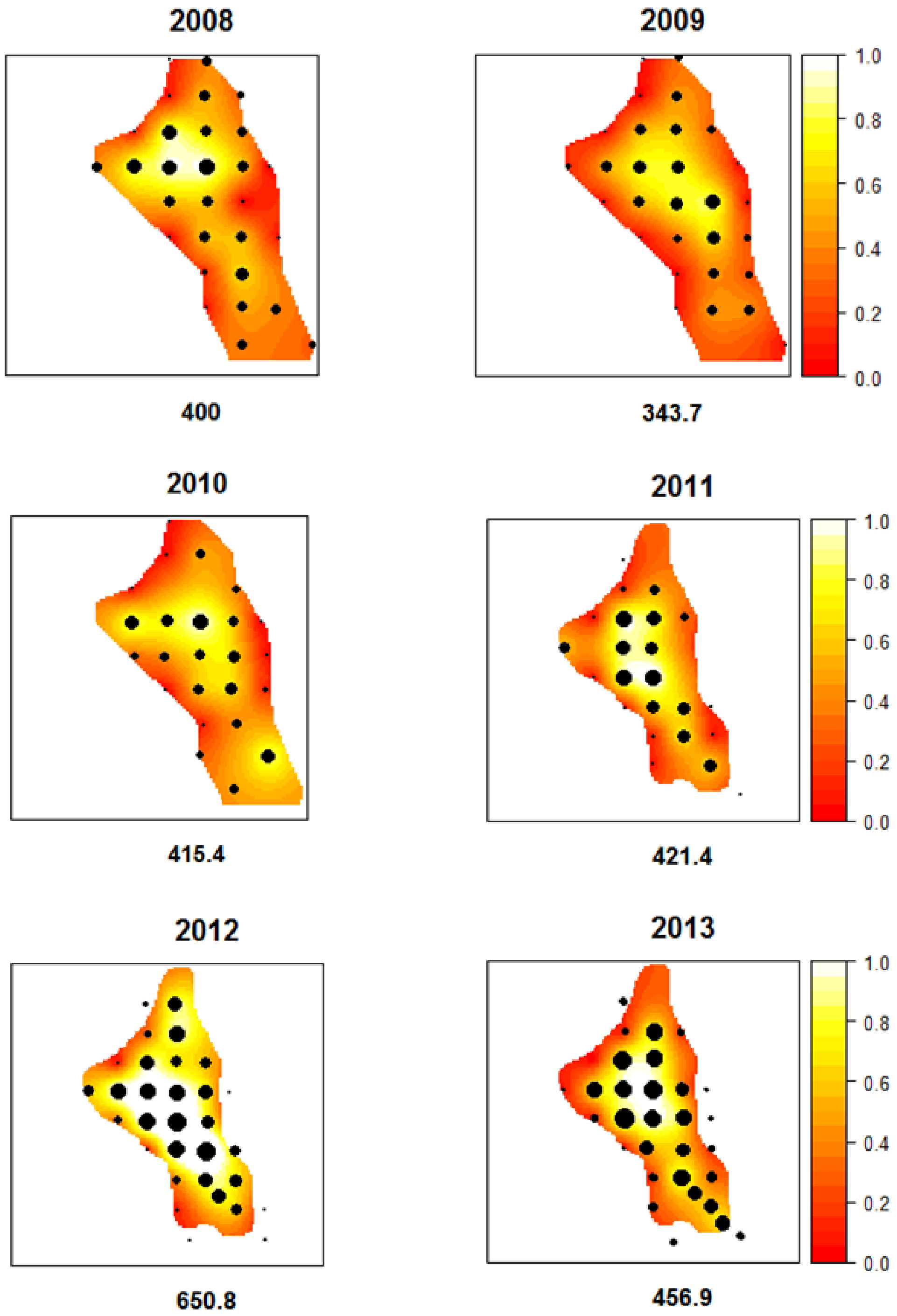
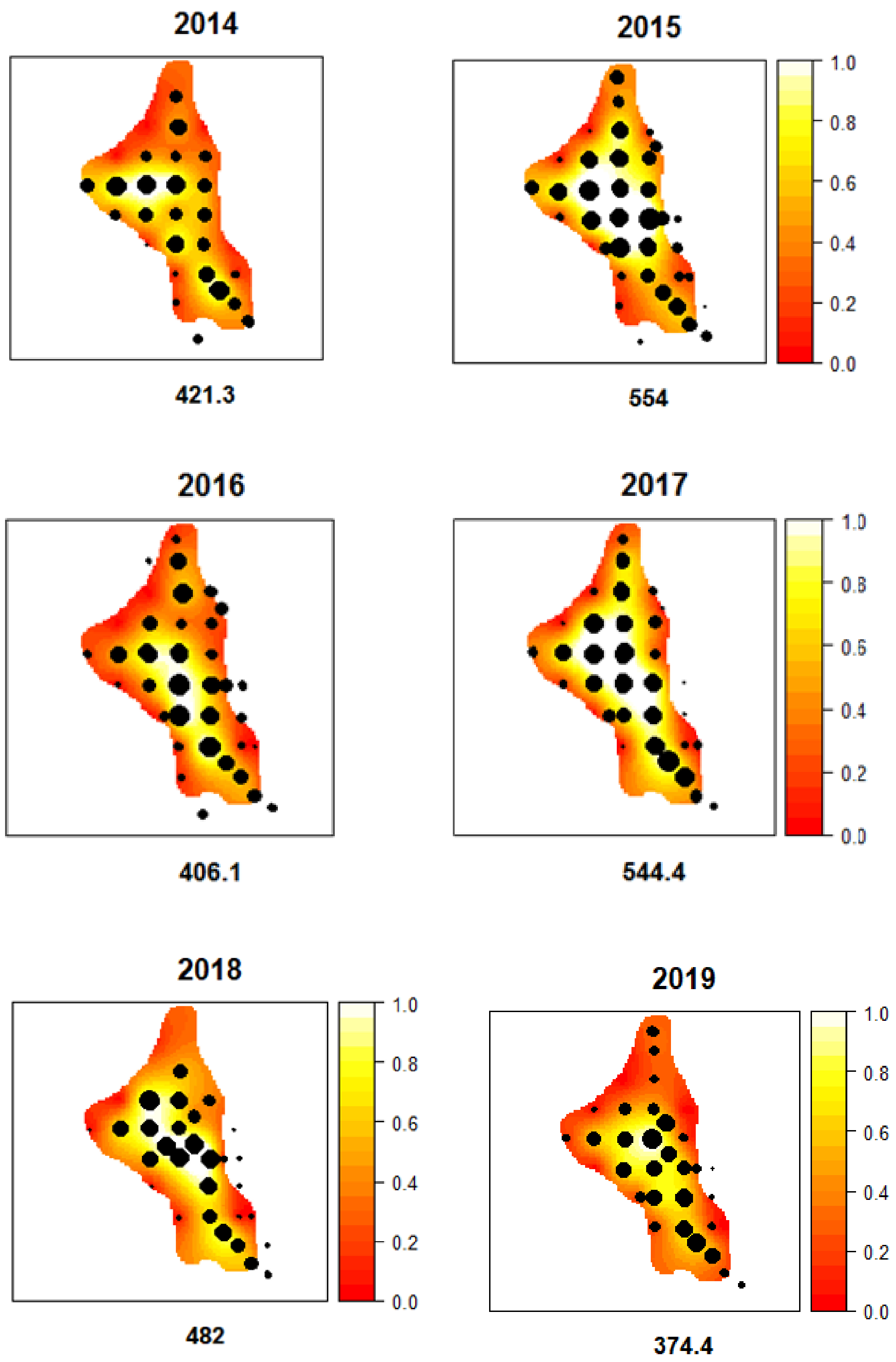


Figure 3.8.8. Irish Sea East (FU14): Co-kriging approach. Interpolation result of VMS (cut off 3%), survey density (2013–2015) data and mud distribution. A - model output; B - final polygon.


2008
400
2009
343.7
2010
415.4
2011
421.4
2012
650.8
2013
456.9
1.0
0.8
0.6
0.4
0.2
0.0


2014
421.3
2015
554
2016
406.1
2017
544.4
2018
482
2019
374.4
1.0
0.8
0.6
0.4
0.2
0.0

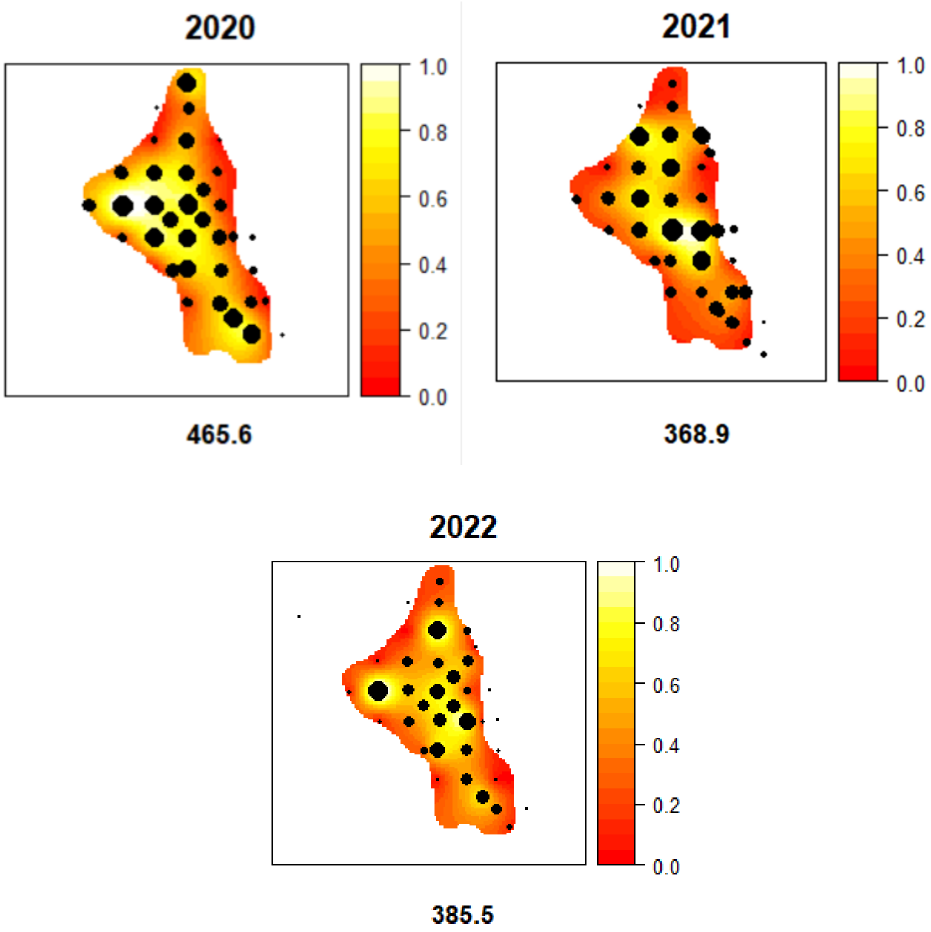


Figure 3.8.9. Irish Sea East (FU14): Burrow density estimates from the UWTV Survey (individuals / m².) Abundance estimates (millions) given at the bottom of each plot are adjusted with the cumulative absolute conversion factor (but does not contain the additional area for Wigtown Bay). Area of ground = 1032.75 Km² for 2008–2010 and 1019.79 Km² for 2011–2022.

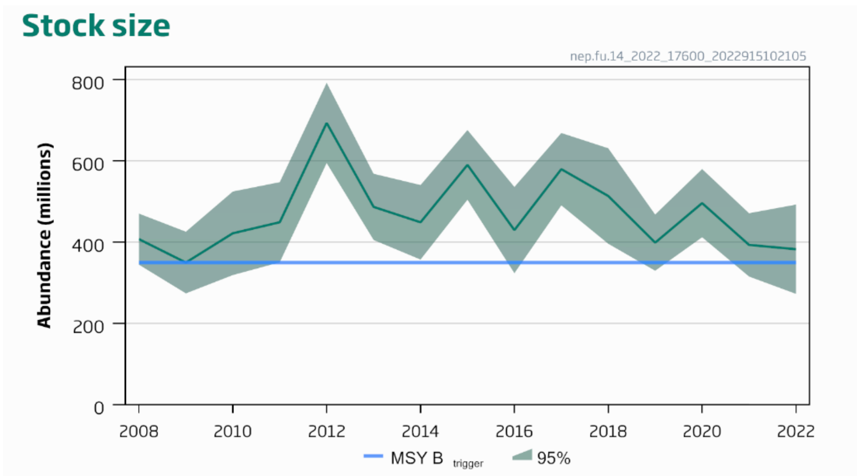


Figure 3.8.10. Irish Sea East (FU14): Abundance from the UWTV Survey. The shading indicates the 95% confidence interval. $B_{trigger}$ is set at 350 million (blue line).

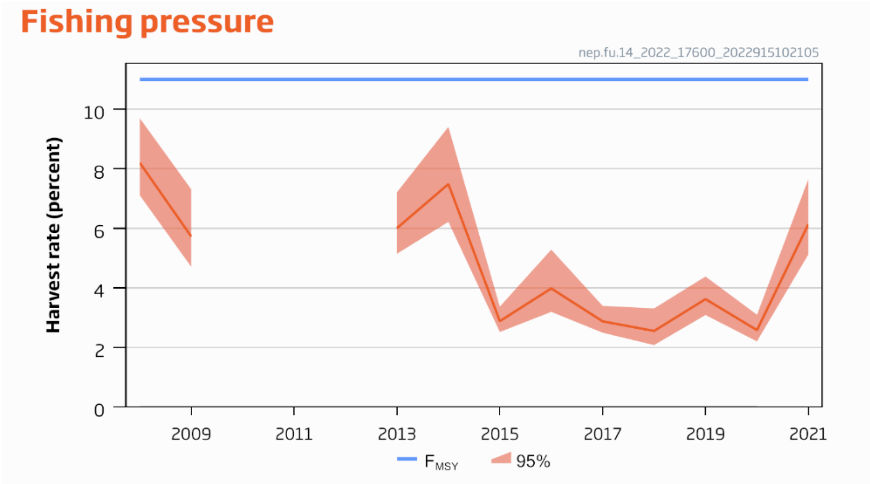


Figure 3.8.11. Irish Sea East (FU14): Harvest Rate (% dead removed/UWTV abundance). The blue line indicates F_{MSY} proxy (11%). Between 2010 and 2012, due to poor sampling levels, harvest rate estimates are not reliable.

16 Norway lobster (*Nephrops norvgicus*) 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 2021 and forms the basis of advice for this stock in the autumn.

ICES advice applicable to 2022

"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 the years 2018–2020, catches in 2022 should be no more than 11 785 tonnes.
To ensure that the stock in Functional Unit (FU) 15 is exploited sustainably, management should be implemented at the FU level.
ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 7. ICES considers this plan to be precautionary when implemented at the FU level."

16.1 General

Stock description and management units

The Irish Sea West (FU15) is comprised of ICES rectangles 35E3–E5, 36E3–E5, 37E3–E5 and 38E4 within 7a. It is included in ICES Area 7 together with the Irish Sea East (FU14), Porcupine Bank (FU16), Aran Grounds (FU17) northwest Irish Coast (FU18), southeast and southwest Irish Coast (FU19), NW Labadie, Baltimore and Galley, and Jones and Cockburn (FU20-21) and the Smalls (FU22).

A TAC is in place for ICES Area 7 which does not correspond to the assessment units. As *Nephrops* are limited to muddy habitats the distribution of suitable sediment defines the species distribution and the stocks are therefore assessed as seven separate Functional Units. The TAC for Area 7 is shown in the tables below.

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* compared to other functional units. The UK (Northern Ireland) and Ireland are the main countries involved in the FU15 *Nephrops* fishery.

The fishery in 2021

The *Nephrops* fishery in the Irish Sea west is economically one of the most important in ICES Area 7 and is mainly prosecuted by vessels from UK (Northern Ireland) and Ireland. Working Group landings from FU15 are presented in Table 16.1 and Figure 16.1. The total declared international

Nephrops landings reported from FU15 in 2021 was 6779 t, which was a decrease increase from 2019. The low levels of landings in 2019 (6115 t) are considered to reflect behavioural changes due to the COVID-19 pandemic (Table 16.1). There has been a trend for Irish, since 2012, and more recently Northern Irish vessels to switch to multi (quad) rig trawls and in general a reduction of single-rig vessel effort. 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. The introduction of highly selective gears suggests a reduction in bycatch rates of non-target fish species of around 30%. Quad-rig vessels are thought to increase *Nephrops* catch rates by around 30% whilst further reducing fish bycatch of ~30% due to the lower headline height. In 2021 there was small increase in LPUE in 2021 for Northern Irish vessels whilst the LPUE for Irish vessels remained stable (Table 16.2).s

Further general information on the fishery can be found in the stock annex.

Information from stakeholders

No information from stakeholders.

16.2 Data

Commercial size composition data for landings and discards were provided by Northern Ireland and Ireland. Other biological data used in the assessment were as listed in the stock annex compiled by the Benchmark meeting WK*NEPH* (2009).

InterCatch

Data were available in InterCatch and used to derive assessment input data.

Landings

Working Group landings from FU15 are presented in Table 16.1 and Figure 19.1. The total declared international *Nephrops* landings reported from FU15 in 2021 was 6779 t. Landings are derived primarily from Ireland and Northern Ireland. In 2021 there was significant impact of COVID-19 on the behaviour of fishers due to movement and social restrictions as well as market changes due to changing levels of demand.

Effort

Effort by the UK fleet remained relatively stable since 2002 following a steady decline from the early 1990s. There was a further marginal reduction in effort and lpue time-series for Ireland (Table 16.3) compared to 2016, with effort at the lowest reported value in the series. In previous years these interannual fluctuations have been attributed to the high mobility and flexibility, in terms of fishing in other areas within the TAC area, whereas the Northern Irish effort is mostly concentrated on FU15. Fishing activity from the Irish fleet in FU15 increasingly concentrates on good fishing periods during the year, resulting in a larger and increasing lpue. The lpue and effort lpue series for Northern Ireland are updated to provide kW days (kWd) and lpue as kg/kWd. A change to e-logbooks and recording of fishing hours after 2013 means that the recent data are not comparable with the historic series. Recent lpue and effort after 2013 has remained stable. The lpue for the Northern Irish and Irish fleets in 2021 were similar 2.71 kg/kWd and 2.84 kg/kWd but both increases since 2018 from 2.56 kg/kWd and 2.7 kg/kWd.

Sampling levels

Sampling of catches was impacted by COVID-19 in 2020 with cessation of sampling in the second quarter. Sampling resumed fully in 2021 and comparable levels to pre-2020 levels. Fisher self-sampling for Northern Irish vessels achieved 256 samples collected from the reference fleet, with 134, 66, 48 and 8 samples in quarters 1–4 respectively. The number of discard and catch samples collected from the Irish fleet was 0, 10, 22 and 2 samples collected in quarters 1–4 respectively. These rates correspond to one sample per 20.3 t landed by the Northern Irish fleet and one sample for every 44.4 t landed by the Irish fleet. Sampling levels due to changes in the schemes to adapted to COVID-19 impacts on working and social distancing requirements.

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 16.1). 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 16.2).

Sex ratio

The sex ratio by year is shown in Figure 16.3. This shows some fluctuations over time. In general, the sex ratio in landings and catches are biased toward males, with a geomean of 56.2% males in landings (1986–2020) and 52.4% in catches (1986–2020). There was little bias toward males in catches was observed in 2021 comprising 58% in landings and 52%. Historically 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 16.4). This corresponds with the emergence of mature females from the burrows to mate in summer. There is no evidence of a recent trend toward decreasing mean weights (Figure 16.5), however compared to the early part of the time-series mean weights have decreased. The mean weights in landings (2016–2021) and mean weights in discards (2016–2020) are used in the basis for calculating catch options (Section 19.4).

Discards

Annual discard rates are estimated using unsorted catch and discards sampling. Unsorted catches and samples of retained catch are provided by vessels. The catch sample is partitioned into landings and discards using a discard selection ogive. This selection ogive can be derived per sample or as aggregation of samples within a quarter or year when sampling rates are low. Sampling effort is stratified weekly, but quarterly aggregations are used for quarterly length frequencies and discard estimates. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate raising factors. Discarding practice is highly variable, mainly driven by market demand, and was 26.5% of the catch by number in 2021 (Table 16.6). 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 16.7. 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. Details of the survey methodology are available in WGNEPS (ICES, 2016). Figure 16.6 shows the distribution of stations sampled in 2022. In 2022 the survey was completed on both the RV Corystes (82 stations) and Celtic Explorer (13 stations). In 2021 there was change to using High Definition 'still' image cameras to collect footage onboard the RV Corystes, this was used agin in 2022. This change provides significantly improved image quality. A similar change has also taken place in other functional units in ICES area 7. A trial in FU 16 showed no significant different in the burrow estimates derived from standard video imagery and high definition still imagery. In 2022 97 stations were completed, footage form 3 stations was not collected because of the presence of static fishing gear preventing the deployment of the camera. Figures 16.7–16.10 are contour plot of the krigged-density estimates for FU15 over the period 2003–2022. The resulting krigged burrow abundance estimate was 4498 million burrows. This was a similar result of that obtained in 2019 of 4775 million burrows. A violin plot of the burrow densities observed in the survey (2003–2022) is shown in Figure 16.11. 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 0.74 burrow/m^2. Confidence in the survey estimates and design are assured through the maintained low coefficient of variation on the burrow estimates. This low coefficient of variation, despite the loss of three survey stations supports that the survey provides high quality information

The use of the UWTV surveys for the provision of *Nephrops* management advice was extensively reviewed by WKNEPH (ICES, 2009) and potential biases were highlighted including those due to edge effects; species burrow misidentification and burrow occupancy. A cumulative bias correction factor estimated for FU15 was 1.14 which means the TV survey is likely to overestimate *Nephrops* abundance by 14%.

Nephrops trawl surveys

In addition to UWTV surveys Northern Ireland have completed spring (April) and summer (August) *Nephrops* trawl surveys since 1994 and provide data on catch rates, size composition and biological data from fixed stations in the western Irish Sea as detailed in the Stock Annex (Stock Annex Figure 1). Survey cpue has remained stable over time. Mean carapace length-by-sex (from the trawl survey) shows inter-annual variation fluctuating around mean with no apparent trend over time (Figure 16.12).

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 16.13), but showed a deviating trend, especially in 2010. The longer time-series of the trawl survey shows that catch rates in the last few years (2005–2009, 2011) are close to the mean of the series when UWTV burrow abundances were in the range of 5–6 billion burrows. The reduction in the 2010 trawl estimate, that showed a conflicting trend to the UWTV abundance, is most likely associated with the survey taking place in suboptimal tidal conditions. Usually the trawl survey coincides with slack tides, but this was not optimal in 2010 due to availability of the ship and synchronisation with the UWTV survey.

16.3 Assessment

Comparison with previous assessments

The assessment approach used by WGCSE 2022 is consistent with that set out in the stock annex and WK*NEPH* (WK*NEPH*, 2009). Since the most recent three years of sampling data were available, three-year averages of mean weights in the landings and proportions retained in the fishery have been used. This is in line with the procedure used for other stocks in areas 6 and 7 by WGCSE.

State of the stock

The stock size is estimated to show a decrease, but within the limits previously observed for the stock. The harvest ratio in 2021 (15.4%) and remains below F_{MSY} (18.1) (Figure 16.14). This stock has previously sustained landings at around 9000 t for many years. The stock increased until 2003, with a general decrease until 2014 and has increased since then. The most recent UWTV abundance estimate of 4498 million in 2022 follows a period (2016–2017) of above average size. The geometric mean of current series is 4908 million. Figure 16.14 is the stock summary plot for FU15. Recent harvest rates have fluctuated around F_{MSY}, but is estimated as 15.4 in 2021, having decreased from 19.9 in 2015 (Table 16.6). The stock is estimated to be above $MSYB_{trigger}$ (3000 million).

16.4 Catch option table

Catch option table inputs are presented in Table 16.6 and summarised below. A three year average (2019–2021) of mean weight in the landings and proportion of removals retained was used.

A stock abundance prediction for 2023 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 2021 UWTV survey.

The basis for the catch options.

Variable	Value	Notes
Stock abundance (2023)	4498	UWTV survey 2022; numbers of individuals in millions
Mean weight in projected landings	15.0	Average 2019–2021; in grammes
Mean weight in projected discards	8.07	Average 2019–2021; in grammes
Projected discard rate	26.5	Average 2019–2021; percentage by number of the total catch
Discard survival rate	10.0	Percentage by number of the discards

16.5 Reference points

A decision-making framework for the choice of F_{MSY} proxy reference points is available in the introduction to the *Nephrops* ICES advice sheets. The current F_{MSY} proxy reference points for FU15 *Nephrops* was evaluated at WKMSYRef4. The MSY reference point for FU15 *Nephrops* is the F_{max} for combined sexes. No precautionary reference points have been defined for *Nephrops* stocks. Whereas the F_{MSY} proxy reference points were chosen with the intent that they should lead to a low probability of stock overfishing.

Previously the cpue data from the trawl surveys were scaled to the UWTV index to provide a $B_{trigger}$ approximation based on the mean of the five lowest survey catch rates in the time-series (Figure 16.8), this is still accepted as an appropriate $B_{trigger}$ for FU15.

Stock code	MSY Flower	F_{MSY}	MSY Fupper with AR	MSY $B_{trigger}$	MSY Fupper with no AR
nep-15	12.4	18.2	18.2	3000*	18.2

***Abundance in millions.**

16.6 Management strategy

As yet there are no explicit management strategies for this stock.

16.7 Quality of assessment and forecast

Uncertainties in the survey, mean weight in the landings and discard rates are not taken into account in the deterministic catch option. There is some variability in these over time.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009). These have led to a revision in the historical time-series of survey abundance estimates for FU15, which was presented to last year's Working Group. Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al*., 1996).

Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that was more accurate but no more precise (WK*NEPH* 2009). The survey estimates themselves are very precisely estimated (CVs 2–5%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU15 are largely based on expert opinion (see Stock Annex). The precision of these bias corrections cannot yet be characterised but is likely to be higher than that observed in the survey.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. These parameters are quite variable, in future years the uncertainty in these key parameters should be estimated.

The quality of landings data has improved since 2007 with the implementation of sales notes and buyers and sellers legislation. Prior to that there were concerns that landings were underreported. The harvest ratio may be under estimated prior to 2007.

16.8 Recommendations for next benchmark

WGCSE will keep the stock under review and recommend future benchmark as required.

16.9 Management considerations

The FU15 *Nephrops* fishery first developed in the late 1950s. Since then it has sustained landings of around 8500 t for more than 30 years. Fishing effort in the past has been very high but has declined somewhat in recent years. The environment in the Western Irish Sea is very suitable for *Nephrops* with a large mud patch and gyre, which retains the larvae over the mud patch thus ensuring good recruitment. The ground can be characterised as an area of very high densities of small *Nephrops*. All available information indicates that size structure of catches appears to have changed little since the fishery first began.

The *Nephrops* trawl fisheries take bycatches of other species, especially juvenile whiting, but also cod. Catches of these species should be reduced to as low as possible because of the poor status of these stocks. A conditional national licence has been introduced by Ireland since March 2012, making the use of grids or separator panels mandatory for all TR2 boats fishing in the Irish Sea. Around 55% of the Irish vessels use separator trawls and while 45% have opted to use Swedish grids to reduce bycatch. Additionally, there has been a trend for Irish vessels to switch to multi (quad) rig trawls. Provisional data suggest 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. During 2016-2020 the EU landing obligation was applied to all catches of Norway lobster fisheries in ICES Subarea 7 with exemptions for high survival. From 2020, this stock is still under a landing obligation and there are still exemptions in place. Observations from the 2016–2020 fishery indicate that discarding above the minimum conservation reference size (MCRS) continues and has not changed markedly (Figure 3). ICES is providing advice for 2022 assuming average discard rates as observed over the last three years. This is considered to be the most realistic assumption.

16.10 References

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Table 16.1. Irish Sea West (FU15): Landings (tonnes) by country, 2000–2018.

Year	Ireland	Isle of Man	UK	Other countries	Total
2000	3433	0	4937	0	8370
2001	2689	3	4749	0	7441
2002	2291	1	4501	0	6793
2003	2709	4	4352	0	7065
2004	2786	13	4470	1	7270
2005	2133	0	4420	0	6554
2006	2051	1	5508	1	7561
2007	2767	0	5724	0	8491
2008	3132	50	7323	2	10508
2009	2343	1	6855	0	9198
2010	2578	0	6384	0	8963
2011	3575	2	6584	0	10162
2012	3794	3	6732	0.2	10529
2013	2465	31	6175	0.2	8672
2014	2938	0**	5676	0.0	8613
2015	2199	0**	6433	0.3	8632
2016	1609	0**	5715	3	7327
2017	1253	0**	4896	0	6150
2018	1387		4369	0	5756
2019*	1859		5731	0	7590
2020	1555		4560		6115
2021	1512		5267		6779

*** provisional. **included in UK landings.**

Table 16.2. Irish Sea West (FU15): Catches and landings (tonnes), effort ('000 hours trawling), cpue and lpue (kg/hour trawling) Republic of Ireland *Nephrops* Directed Trawlers 2000–2019.

Year	Landings (Kg)	Effort (Hours)	Effort (days)	Effort (kwdays)	lpue
1995	1706969	44459	3516	835977	2.041885
1996	1406140	31409	2326	607785	2.313549
1997	2801501	60502	4518	1124379	2.491599
1998	2696979	52277	4051	1053491	2.560039
1999	4031508	73786	5260	1367903	2.947217
2000	3227565	61936	4396	1199896	2.68987
2001	2428587	51111	3435	939387	2.585289
2002	2015965	46072	2900	873563	2.307749
2003	1620391	47704	3120	878568	1.844355
2004	2586760	52673	3500	1033073	2.503946
2005	2111185	50825	3414	1003901	2.102981
2006	2031881	53461	3535	1084251	1.873995
2007	2728841	52550	3575	1056291	2.583419
2008	3165781	49218	3401	1027919	3.079796
2009	2333433	34651	2368	706178	3.304312
2010	2505061	36504	2546	739345	3.388218
2011	3554343	47640	3229	921298	3.857972
2012	3725318	49313	3560	966006	3.856413
2013	2269336	33818	2571	682793	3.323608
2014	2449612	40371	3007	852740	2.872635
2015	2119880	35898	2733	756719	2.80141
2016	1529418	28249	2301	556452	2.748516
2017	1120690	22516	1749	410628	2.729208
2018	1363911	27084	1919	535002	2.549353
2019	1803134	33981	2304	700132	2.57542
2020	1517909	25717	2250	570314	2.661534
2021	1517909	25717	2250	570314	2.661534

Table 16.3. Irish Sea West (FU15): Landings (tonnes), effort (‘000 hours trawling), lpue (kg/hour trawling), effort (‘000 kW days) and lpue (kg/kWd) of Northern Ireland *Nephrops* trawlers, 2000–2019.

Year	Landings	Effort ('000 hours)	lpue ('000 hrs)	kW days ('000)	lpue kWd
2000	4758	168.7	28.2		
2001	4587	163.7	28.0		
2002	4495	130.8	34.4		
2003	4146	136.1	29.0		
2004	4273	144.3	29.6		
2005	4235	138.4	30.6		
2006	5356	144.1	37.2		
2007	5512	126.9	43.4		
2008	7056	141.4	49.9		
2009	6487	134.7	48.2		
2010	5888	141.1	41.7		
2011	5952	132.7	44.9		
2012	5865	137.8	42.6		
2013	5605	135.7	41.3	2151.9	2.60
2014	5190	114.6	45.3	2111.2	2.46
2015	6396			1962.6	3.26
2016	5638			2107.3	2.68
2017	4789			1904.3	2.51
2018	4293			2079.3	2.06
2019	5539			2166.5	2.56
2020	4550			1852.0	2.46
2021	5201				

*** provisional.**

Table 16.4. Irish Sea West (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Northern Ireland catches, landings and discards, 2000–2018.

Year	Catches		Landings		Discards	
	Males	Females	Males	Females	Males	Females
2000	27.7	24.5	29.4	26.3	22.5	22.6
2001	25.7	23.6	26.1	24.4	21.7	21.2
2002	26.7	24.1	26.7	24.9	21.8	21.7
2003	na	na	na	na	na	na
2004	na	na	na	na	na	na
2005	na	na	na	na	na	na
2006	na	na	na	na	na	na
2007	na	na	na	na	na	na
2008	25.9	24.6	26.9	25.5	21.4	21.5
2009	27.7	25.1	29.3	26.5	23.6	23.2
2010	28.3	25.6	29.5	26.3	23.2	22.8
2011	27.6	26.0	29.3	27.7	22.6	22.8
2012	26.8	24.3	27.7	25.4	21.7	21.1
2013	26.2	24.2	27.2	25.4	21.5	21.3
2014	26.3	23.9	27.1	24.9	21.1	20.6
2015	25.3	23.4	26.8	24.7	21.6	21.3
2016	25.9	24.3	26.9	25.5	22.3	21.8
2017	27.0	24.8	28.0	26.1	22.9	22.5
2018	27.6	25.1	28.8	26.6	23.3	22.5
2019	27.1	24.1	27.9	24.8	22.6	21.7
2020	27.5	26.5	29.1	28.1	22.6	22.5
2021	27.4	26.3	29.0	27.9	22.3	22.4

na = not available.

Table 16.5. Irish Sea West (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Republic of Ireland catches, landings and discards, 2000–2018.

Year	Catches		Landings		Discards	
	Males	Females	Males	Females	Males	Females
2000	29.1	27.1	32.2	29.7	24.3	24.0
2001	26.7	24.8	28.6	27.0	23.0	22.2
2002	28.9	25.4	30.2	27.8	24.6	23.6
2003	27.7	24.9	29.7	26.9	24.0	23.1
2004	28.1	26.1	29.7	27.8	23.9	23.7
2005	28.5	26.8	30.1	29.1	23.9	23.2
2006	27.7	25.5	29.5	27.1	23.8	23.1
2007	27.7	25.4	29.8	27.9	24.0	23.3
2008	27.4	24.6	28.9	26.6	22.0	21.4
2009	28.5	26.3	30.5	29.2	24.3	23.4
2010	28.0	25.9	29.6	27.6	23.8	23.3
2011	27.0	25.7	28.8	27.3	23.7	23.5
2012	26.8	25.6	28.3	27.0	23.2	23.0
2013	26.3	25.1	27.4	26.5	23.1	22.6
2014	27.7	24.9	29.2	26.3	23.6	23.3
2015	27.7	25.7	29.5	27.4	24.4	24.0
2016	26.0	25.0	27.3	26.4	23.5	23.3
2017	27.2	25.0	28.1	26.2	23.4	22.6
2018	27.4	24.9	29.8	22.8	24.6	22.8
2019	27.9	25.0	29.5	27.0	22.8	22.3
2020	28.0	26.3	29.7	27.9	24.1	24.1
2021	27.9	25.8	29.6	28.4	23.2	23.9

Table 16.6. 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	UWTV abundance estimate	95% Confidence Interval	Landings in number	Total discards in number*	Removals in number	Harvest rate (by number)	Landings	Total discards*	Discard rate (by number)	Dead discard rate (by number)	Mean weight in landings	Mean weight in discards
	Millions		millions			%	tonnes		%		grammes	
2003	5485	0.027	404	291	666	12.1	7065	2659	41.9	39.3	17.5	9.14
2004	5547	0.03	416	218	612	11.0	7270	1993	34.4	32.0	17.5	9.14
2005	5673	0.044	346	157	488	8.6	6554	1412	31.2	29.1	18.9	8.99
2006	5402	0.041	467	261	701	13.0	7561	2285	35.9	33.4	16.2	8.75
2007	5150	0.034	511	375	848	16.5	8491	3246	42.3	39.7	16.6	8.66
2008	4288	0.025	755	191	927	21.6	10508	1421	20.2	18.6	13.9	7.44
2009	4623	0.026	567	335	868	18.8	9198	2934	37.1	34.7	16.2	8.76
2010	4990	0.031	572	180	733	14.7	8963	1539	23.9	22.0	15.7	8.55
2011	4871	0.023	644	332	943	19.4	10162	2683	34.0	31.7	15.8	8.08
2012	5062	0.029	771	258	1003	19.8	10529	1871	25.1	23.1	13.7	7.25
2013	4310	0.027	662	229	867	20.1	8672	1590	25.7	23.6	13.1	6.94
2014	4593	0.025	641	198	819	17.8	8613	1418	23.6	21.7	13.4	7.16
2015	4373	0.029	620	280	872	19.9	8643	2228	31.1	28.9	13.9	7.96

Year	UWTV abundance estimate	95% Confidence Interval	Landings in number	Total discards in number*	Removals in number	Harvest rate (by number)	Landings	Total discards*	Discard rate (by number)	Dead discard rate (by number)	Mean weight in landings	Mean weight in discards
	Millions		millions			%	tonnes		%		grammes	
2016	5076	0.03	562	245	783	15.4	7327	1939	30.4	28.2	13.0	7.91
2017	5312	0.03	426	152	563	10.6	6150	1222	26.3	24.3	14.4	8.04
2018	4932	0.03	360	145	491	10.0	5756	1231	28.7	26.6	16.1	7.43
2019	4404	0.03	536	154	675	15.3	7590	1159	22.3	20.5	14.2	7.54
2020	4775	0.03	371	153	509	10.7	6115	1294	29.2	27.1	15.5	8.64
2021	4733	0.04	440	172	595	12.4	6779	1379	28.1	26.0	15.4	8.02
2022	4498	0.03										

Table 16.7. Irish Sea West (FU15): Results from NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003–2020.

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%

Ground	Year	Number of stations	Mean Density (No./M^2)	Domain Area (km^2)	Estimate (billions)	CV on Burrow estimate
	2017	101	0.90	5304	5.3	3%
	2018	100	0.85	5791	4.9	3%
	2019	100	0.76	5370	4.4	3%
	2020	99	0.82	5791	4.8	3%
	2021	95	0.78	5790	4.7	4%

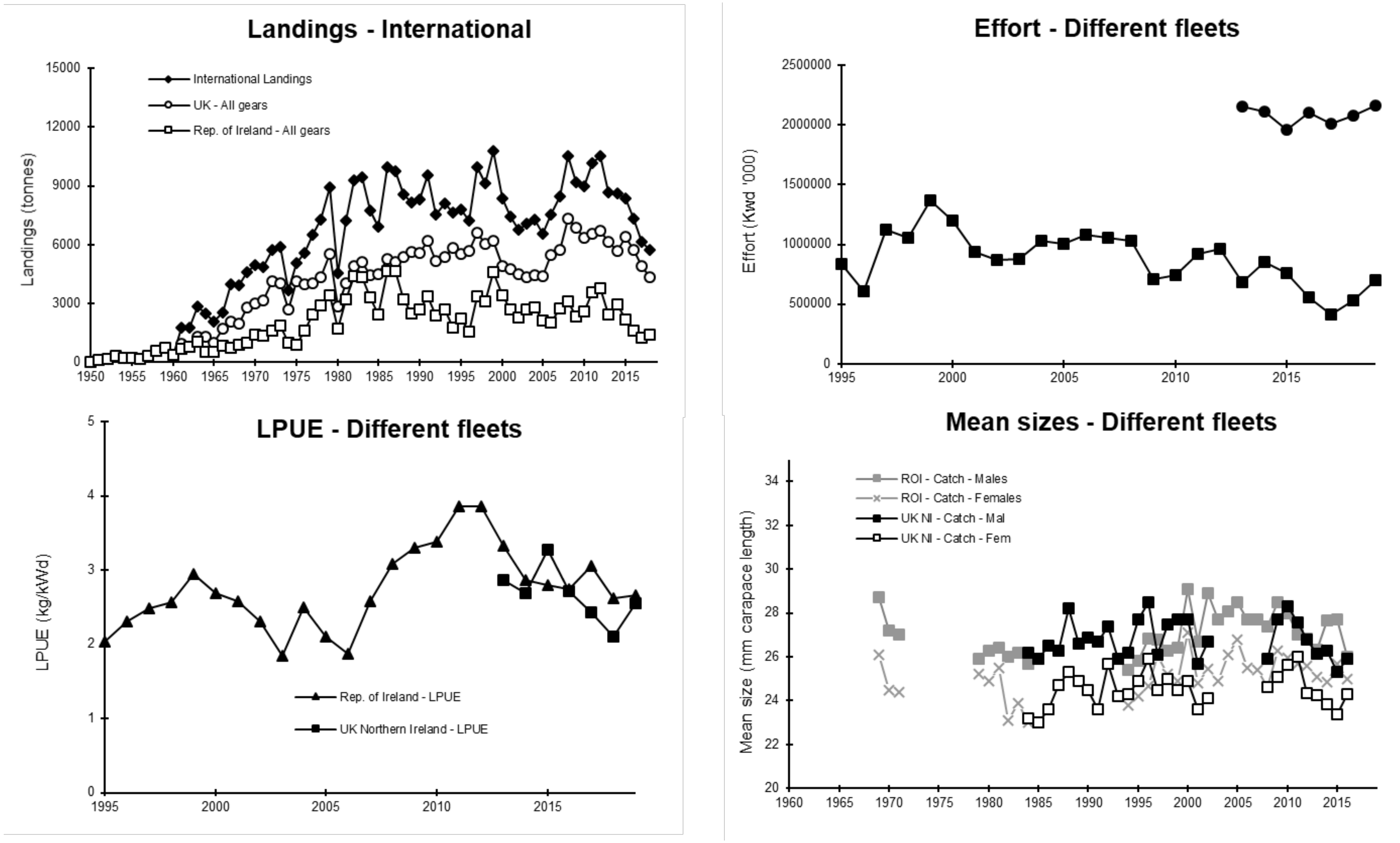

Figure 16.1. Irish Sea West (FU15): Long-term trends in landings, effort, lpue, and mean sizes of *Nephrops*. [The quality of landings data has improved since 2007 with the implementation of sales notes and buyers and sellers legislation, which result in misleading lpue trend plots pre- and post-2007].

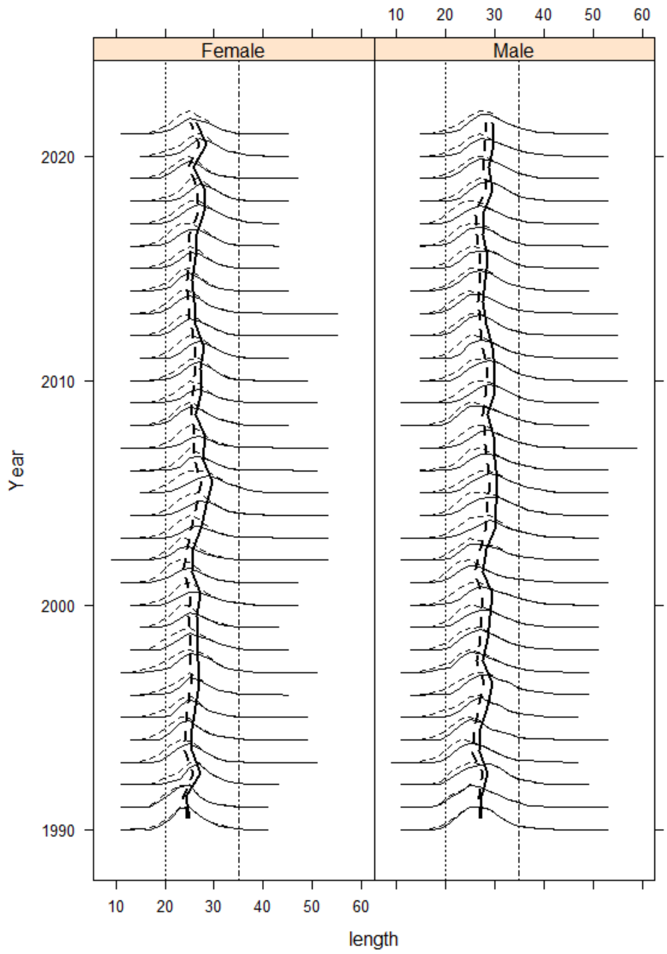

Figure 16.2. Irish Sea West (FU15): Length distributions in the landings (solid) and catches (dotted) 1986–2022.

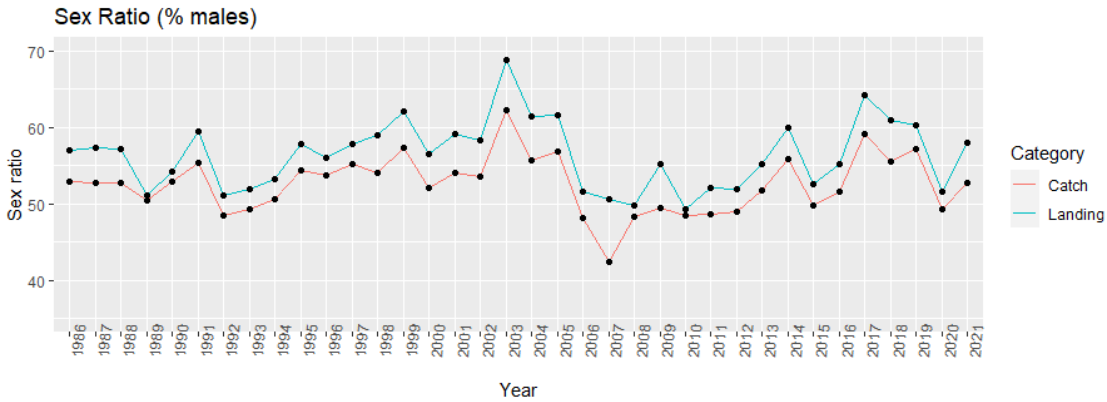

Figure 16.3 ***Nephrops*** **in FU15 (Irish Sea West). Sex ratio (percentage of males) of landings and discards (1986–2020).**

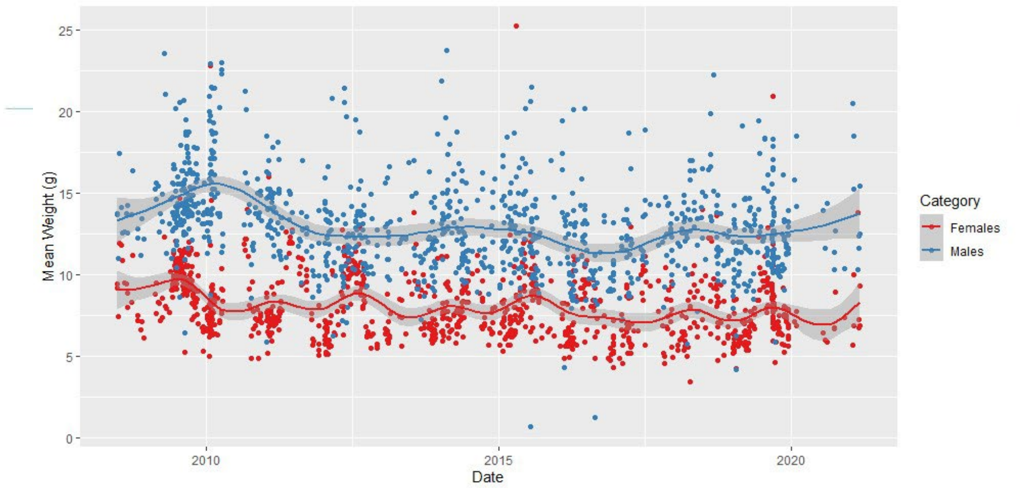

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Figure 16.4 ***Nephrops*** **in FU15 (Irish Sea West).Mean weight in catch samples by sex with GAM loess smoother (k=20).**

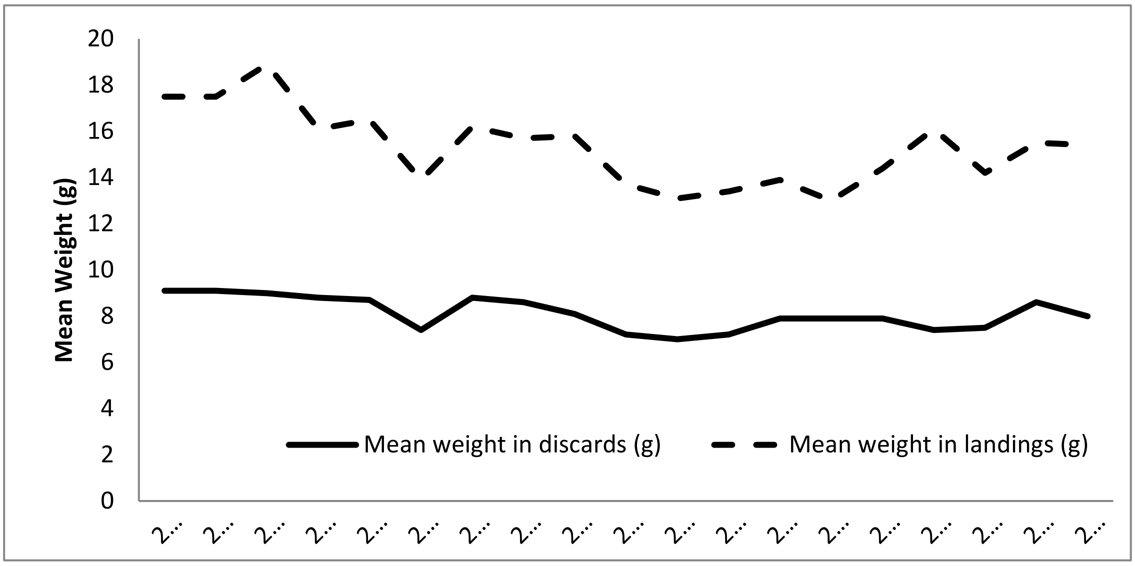


Figure 16.5 ***Nephrops*** **in FU15 (Irish Sea West). Mean weight in landings and discards.**

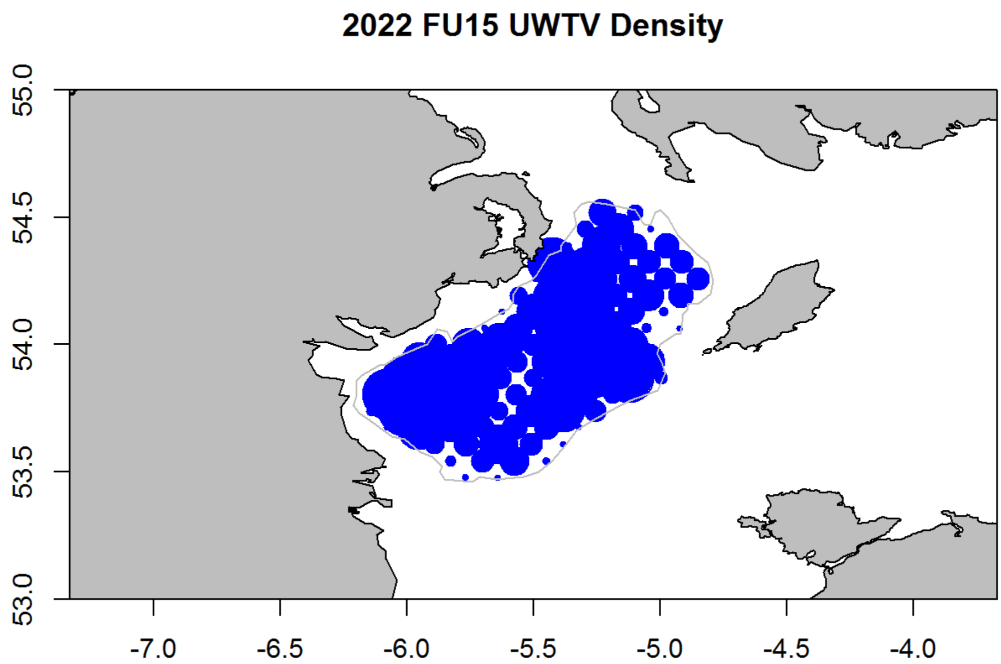


Figure 16.6. Irish Sea West (FU15): 2022 UWTV survey stations, symbol size reflects the burrow density.

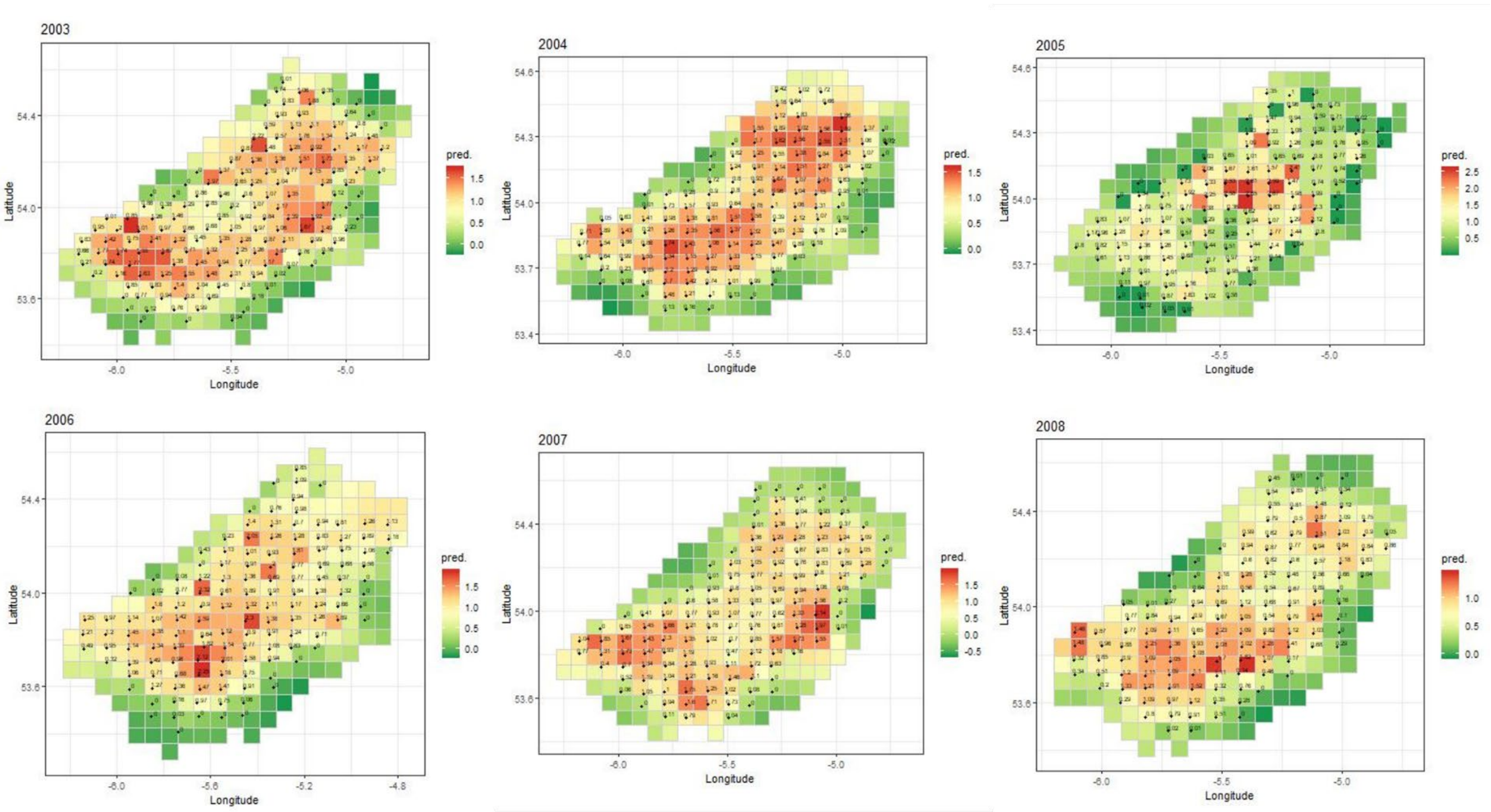


Figure 16.7. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2003–2008.

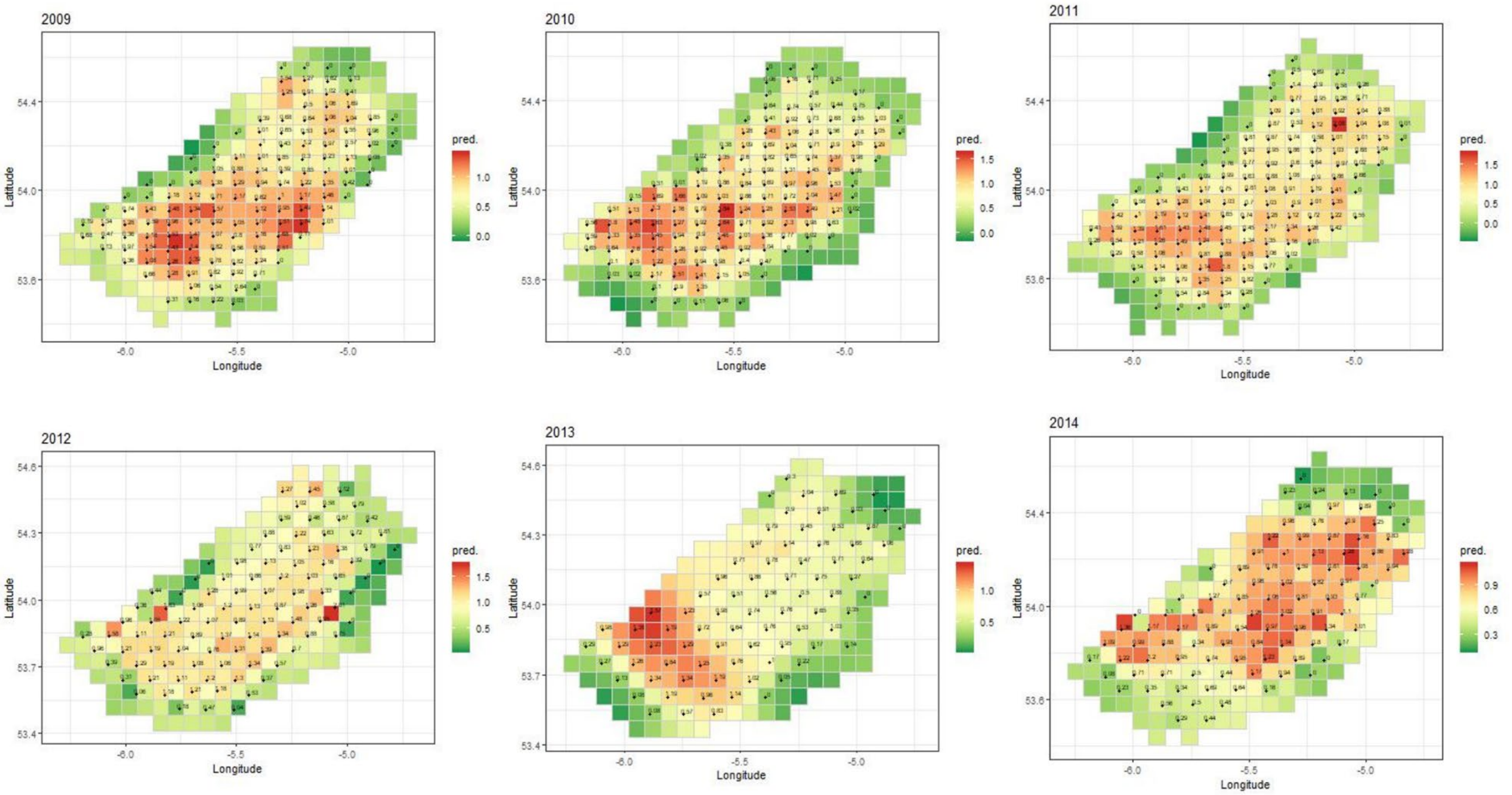


Figure 16.8. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2009–2014.

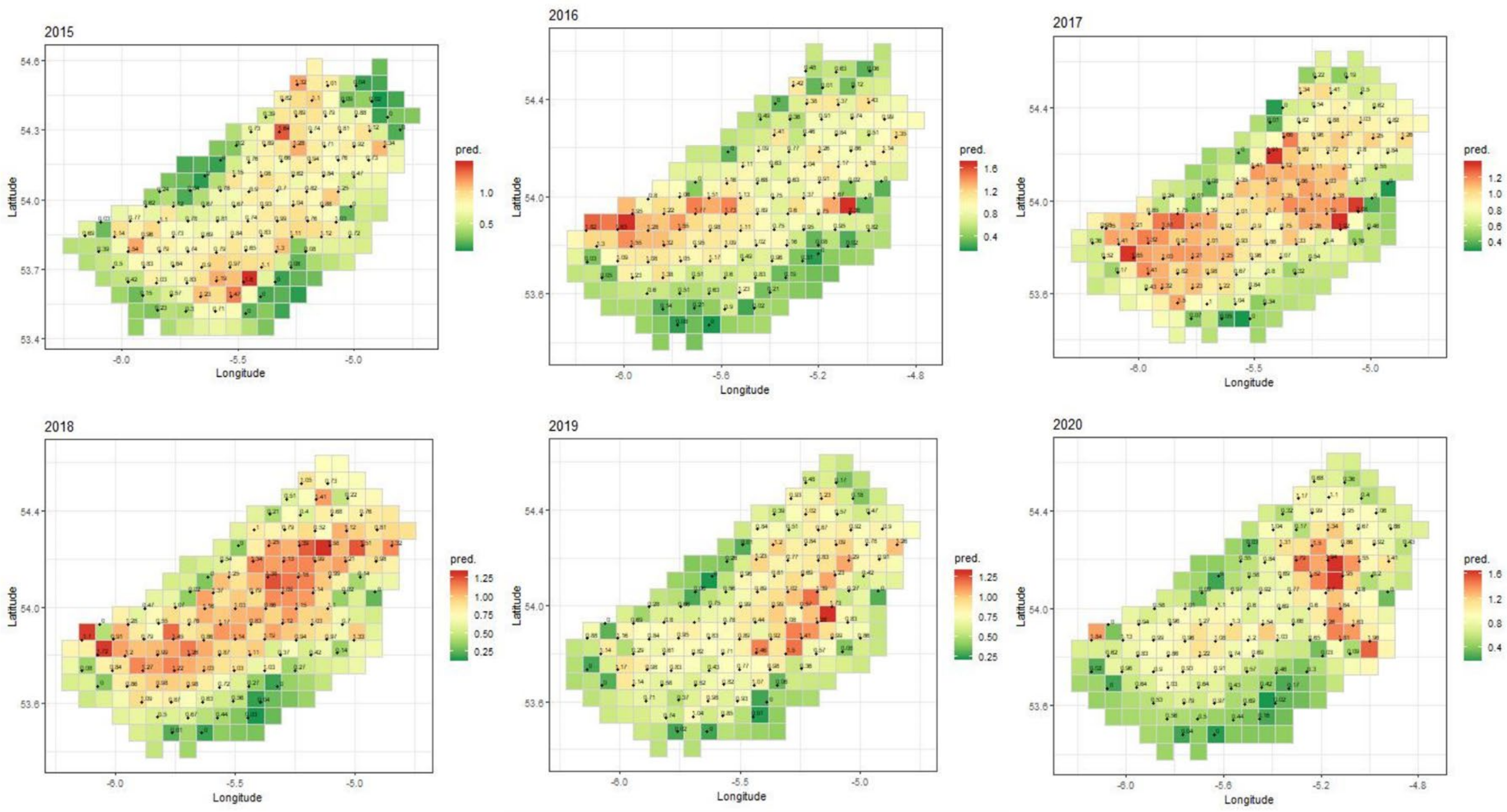


Figure 16.9. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2009–2020.

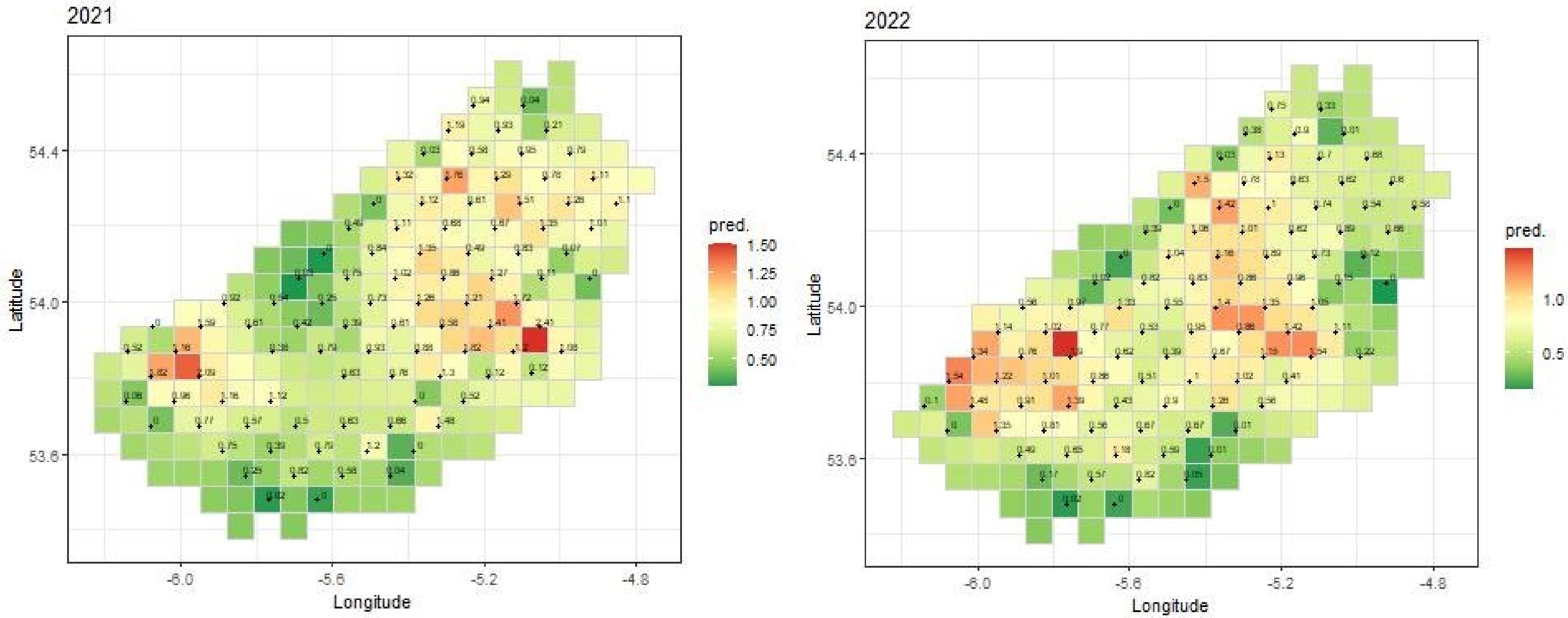


Figure 16.10. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea for 2021 and 2022

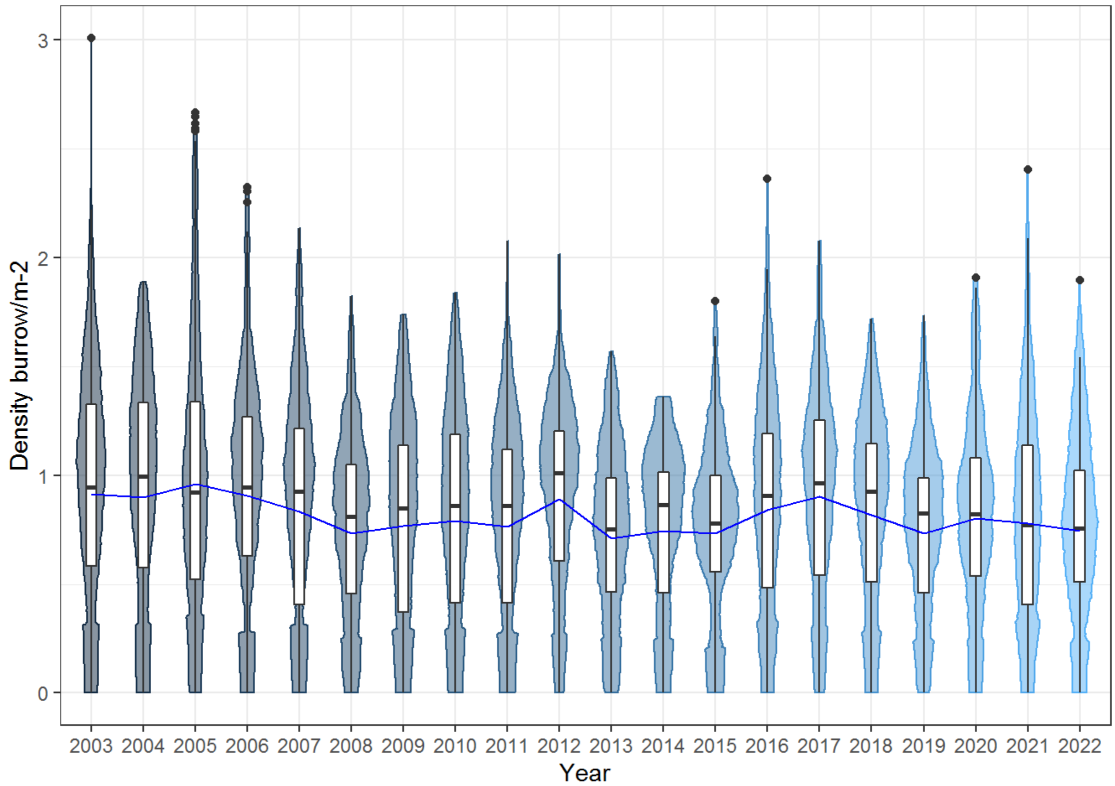


Figure 16.11. Irish Sea West (FU15): Box and kite plot of burrow density observed during UWTV survey 2003–2022.

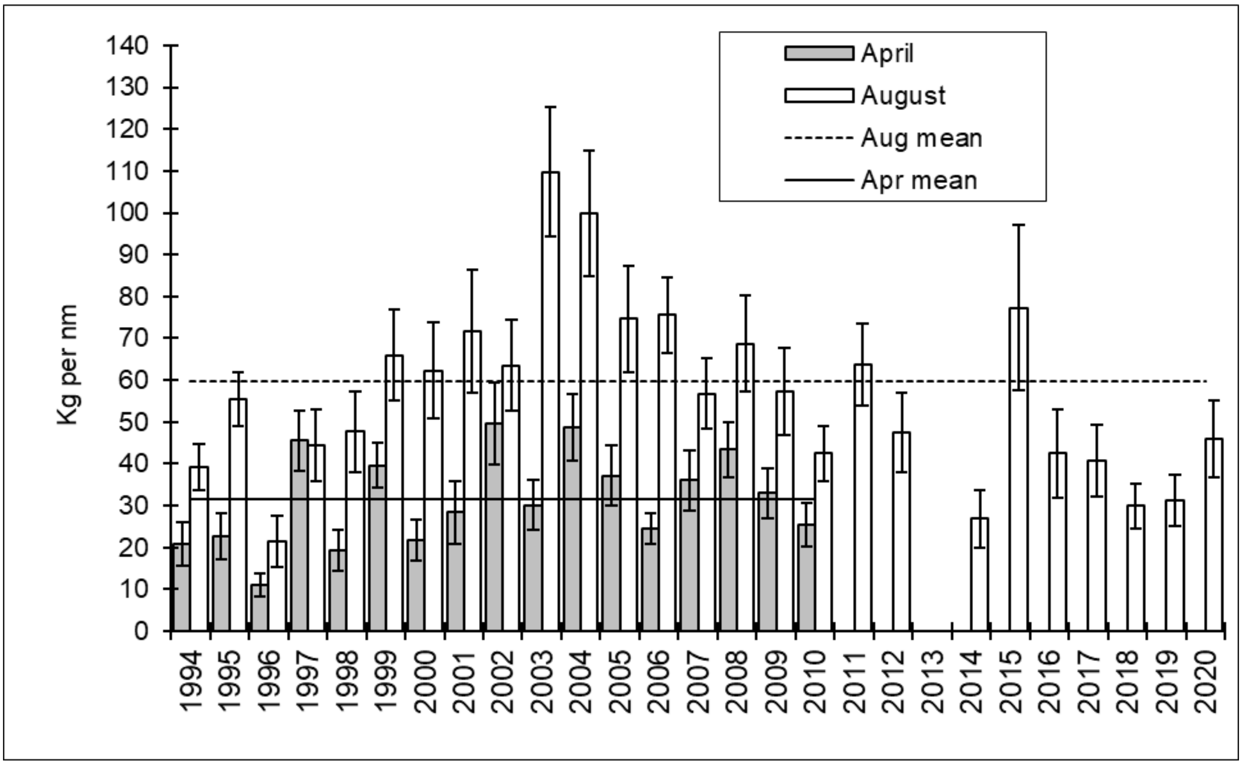


Figure 16.12 Irish Sea West (FU15): *Nephrops* catches (kg per nm) from NI trawl surveys. No data available in 2013 due to ship breakdown.

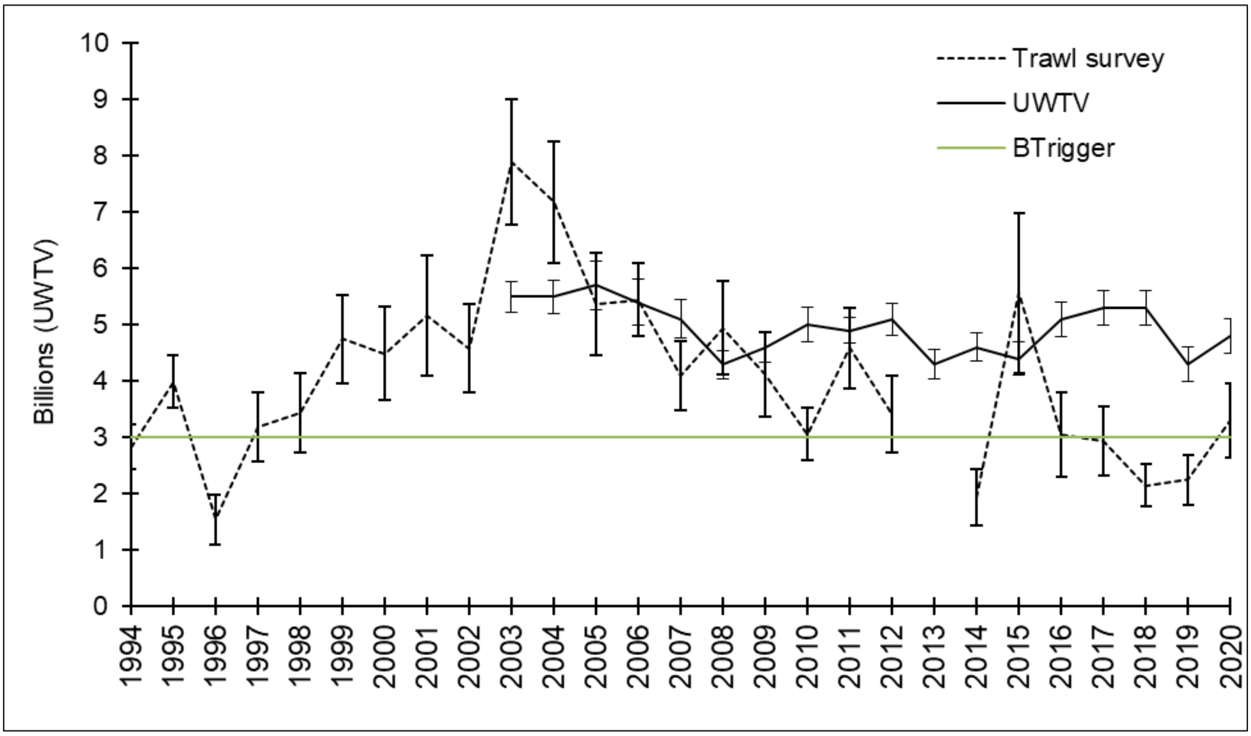


Figure 16.13. Irish Sea West (FU15): Revised UWTV index and scaled trawl survey. Cpue along with $B_{trigger}$ based upon mean of five lowest trawl survey values. Abundance figures have not been bias corrected.

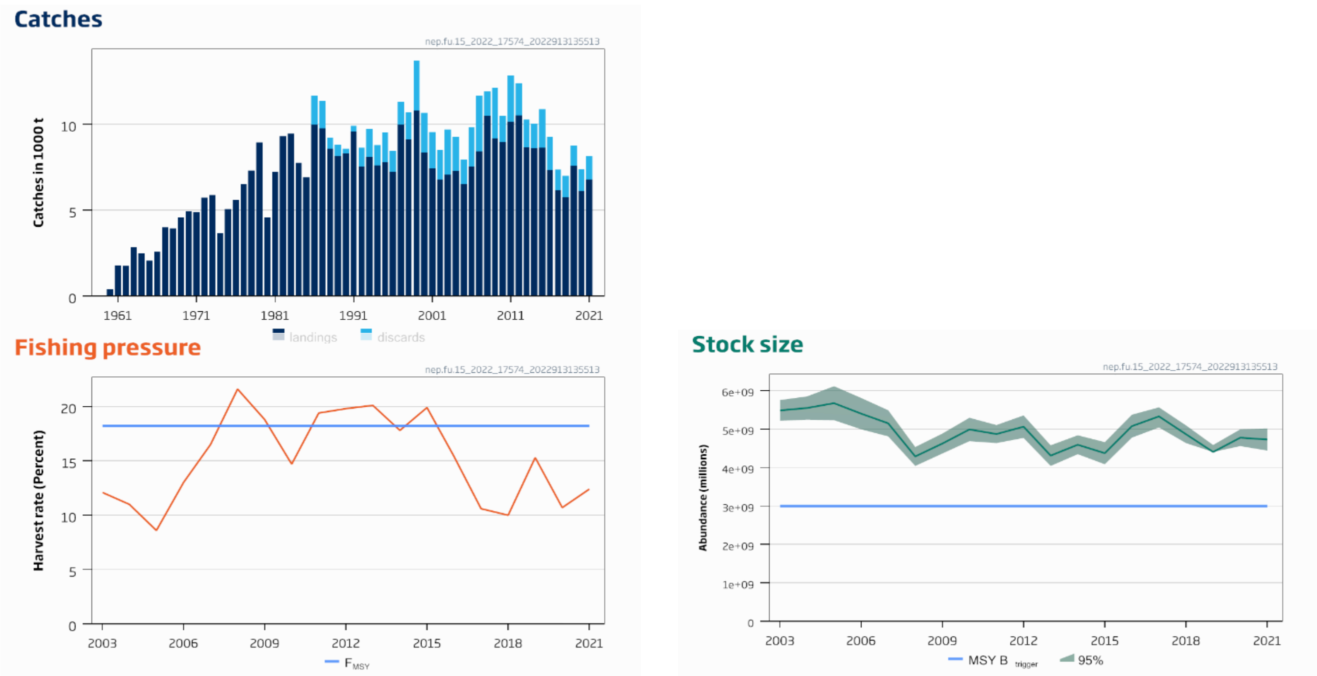


Figure 16.14 Norway lobster in Division 7.a, Functional Unit 15. Summary of the stock assessment. Catches (discard data are only available from 1986), harvest rate (sum of landings and dead discards in numbers, divided by total abundance), survey abundance (Underwater TV, billions; SSB proxy; 95% confidence intervals). Harvest rates between 2003 and 2006 may be underestimated because of underreporting of landings. Orange lines represent MSY Btrigger and the F_{MSY} harvest rate.

17 Norway lobster (*Nephrops norvegicus*) in divisions 7.b–c and 7.j–Km Functional Unit 16 (west and southwest of Ireland)

Type of assessment in 2022

Available data on the fishery for 2021 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; however, mean weight calculations for 2020 and 2021 deviated from the stock annex and are detailed in 17.4 Data section below.

ICES advice applicable to 2021

"ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, and assuming zero discards, catches in 2021 that correspond to the F ranges in the MAP are between 2653 tonnes and 3290 tonnes. The entire range is considered precautionary when applying the ICES advice rule.
To ensure that the stock in Functional Unit (FU) 16 is exploited sustainably, management should be implemented at the functional unit level."

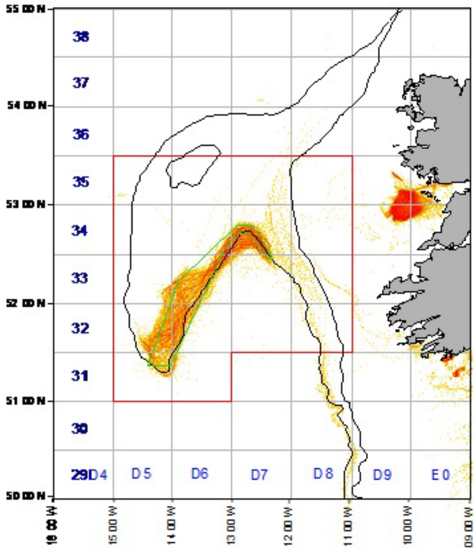
ICES advice applicable to 2022

"ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, and assuming zero discards, catches in 2022 that correspond to the F ranges in the MAP are between 2261 and 2804 tonnes. The entire range is considered precautionary when applying ICES advice rule.
To ensure that the stock in FU 16 is exploited sustainably, management should be continued at the FU level."

17.1 General

Stock description and management units

The TAC area is Subarea 7, since 2011 an 'of which' clause was introduced specifically for the Porcupine Bank (FU16) see Table 20.1. The Functional Unit for assessment includes some parts of the following ICES divisions 7.b, c, j, and k. The exact stock area is shown on the map below and includes the following ICES Statistical rectangles: 31–35 D5–D6; 32–35 D7–D8.



The FU16 outlined by the red line. The closed area from 1 May–31 July since 2010 (reduced to only May since 2013) is shown with a green line. Irish *Nephrops* directed fishing effort between 2006–2009 derived from integrated VMS and logbook information is shown as a heat map.

Management applicable to 2021 and 2022

TAC in 2021

Council Regulation (EU) 2021/92 of 28 January 2021 fixing for 2021 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters.

Species:	Norway lobster *Nephrops norvegicus*		Zone:	7 (NEP/07.)
Spain	993	(1)	Analytical TAC	
France	4 023	(1)		
Ireland	6 102	(1)		
Union	11 118	(1)		
United Kingdom	6 908	(1)		
TAC	18 026	(1)		

(1) Special condition: within the limits of the abovementioned quotas, no more than the quantities given below may be taken in the following zone:

Functional Unit 16 of ICES Subarea 7 (NEP/*07U16):

Spain	992
France	621
Ireland	1 194
Union	2 807
United Kingdom	483
TAC	3 290

TAC in 2022

Council Regulation (EU) 2022515 of 31 March 2022 amending Regulation (EU) 2022109 fixing for 2022 the fishing opportunities for certain fish stocks and groups of fish stocks applicable in Union waters and for Union fishing vessels in certain non-Union waters.

Species:	Norway lobster *Nephrops norvegicus*		Zone:	7 (NEP/07.)
Spain	924	(1)	Analytical TAC	
France	3 746	(1)		
Ireland	5 682	(1)		
Union	10 352	(1)		
United Kingdom	6 686	(1)		
TAC	17 038	(1)		

(1) Special condition: within the limits of these quotas, no more than the quantities given below may be taken in the following zone:

Functional unit 16 of ICES subarea 7 (NEP/*07U16)

Spain	846
France	530
Ireland	1 016
Union	2 392
United Kingdom	412

17.2 Closed area restrictions

A seasonal closed area has been in place for three months May 1–31 July between 2010–2012 (shown in the map above and coordinates below). The period of the EU regulatory closure was reduced to only one month between 2013 and 2019 (Council Regulation 2019/124, *Article 13*).

The following TCMs are in place for *Nephrops* in 7 (excluding 7.a) after EC 850/98 in operation since 2000. Minimum Landing Sizes (MLS); total length >85 mm, carapace length >25 mm, tail length >46 mm. Although it is legal to land smaller prawns from this fishery, marketing restrictions imposed by producer organizations in France mean smaller *Nephrops* (<35 mm CL or 115 mm whole length) are not retained in this fishery.

The mesh size restrictions apply to towed gears in 7.b–k targeting *Nephrops and* are given in Section 7.1. Vessels mainly used 80–99 mm mesh to target *Nephrops* on the Porcupine Bank.

The landing obligation applied since 2016 for certain vessels that matched the criteria set out in the discard plans: https://ec.europa.eu/fisheries/cfp/fishing_rules/discards_en

17.3 Fishery in 2021

WGCSE reviewed effort trends for Irish vessels that accounted for 65% of the total landings in 2021. The Irish fishery in 2021 took place up to April, after which the fishery was closed, but was reopened from October to December. In 2017 the industry reported very good catches of *Nephrops* but commented that the mean size declined significantly; however, mean sizes increased in 2018 and 2019, decreased again in 2020 and increased in 2021 (Figure 20.4).

Effect of regulations

Prior to 2011 TACs and quotas were applied to the whole Subarea 7, so the FU16 fishery was not 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 area misreporting in the past and the risk of discarding. An unallocated component related to area misreporting was included in the assessment from 2011 to 2017. Since 2018, following the implementation of new legislation limiting fishing trips to single functional units, misreporting was not included in the assessment.

Information from stakeholders

The provision of grade information by individual fishers and coops remains a highly important assessment input. However, in 2020 and 2021 graded information was not used in the assessment.

Year	% of Irish landings where grade data were provided
2011	60%
2012	45%
2013	57%
2014	33%
2015	44%
2016	49%
2017	31%
2018	31%
2019	50%

The industry collaborated with the development of an Irish Fisheries Science Research Partnership survey in 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.

[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.

17.4 Data

InterCatch

Data were available in InterCatch and used on a trial basis.

Landings

Total international landings increased by 30% in 2021 to 2476 t (Figure 20.1 and Table 20.2). From 2011 to 2017 total landings for FU16 had included "unallocated landings" from other FU due to misreporting. Since 2018 no reallocation has been applied as there was no information concerning misreporting.

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by WKNEPH 2013, and are documented in the stock annex. Recent sampling rate is provided in Table 20.3.

Since 2010 landings length distributions have been reconstructed using the methods outlined in the stock annex. This involves using samples of the grade length structure from Irish sampling and estimates of the volume of each commercial size grade provided by the fishing industry. This was used to reconstruct Irish LFDs; landings by other fleets, which accounted for ~23% of the total landings from 2010 to 2019, were unsampled.

In 2020 and 2021, due to the low sampling levels of graded landings caused by COVID-19 restrictions, efforts were made to adapt the sampling programme. Unsorted catch samples were collected from five and 12 *Nephrops* fishing trips, respectively in 2020 and 2021.

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 2019 was similar to 2018. The mean lengths by sex and year are presented in Table 20.4. These figures and tables are not updated for 2020 and 2021.

Sex ratio

Previous *Nephrops* working groups have highlighted stability in sex ratio as an important indicator for *Nephrops* stocks. The landings and fishery-independent survey catches show a dramatic switch in the sex ratio for this stock with larger proportions of females in the catches of 2008 and 2009 (Figure 20.3). Both the commercial and survey data indicate that sex ratio switched back to a more usual situation since 2010 with males accounting for larger proportions of the catch/landings.

Nephrops moult once a year shortly after hatching of eggs in April or May. There is a 24-hour period after moulting when the male *Nephrops* can mate with the female (Farmer, 1974). If there are insufficient males in the population to mate with the recently moulted females, this can result in a change in female behaviour whereby unmated females concentrate on feeding and growth instead of reproduction. This so called "sperm limitation" hypothesis could explain the sex ratio changes observed in the Porcupine *Nephrops*. WKNEPH 2013 examined the available scientific data on proportions of females mated observed on the Spanish survey. These results showed high proportions of unmated females and a high L_{50} for mated females in catches in 2009. Simulations were also carried out to investigate the densities at which sperm limitation may become an issue given plausible ranges of stock density, sex ratios, search radii. The conclusion was that at the densities recently observed on the Porcupine Bank that sperm limitation was a real possibility.

Mean weight explorations

The mean weights in the landings are shown for the full time-series in Figure 20.4 and Table 20.5. In 2020 and 2021, due to COVID-19 restrictions, mean weight calculations deviated from the stock annex and were estimated using the average mean weights of catch samples from five *Nephrops* fishing trips.

Discards

There are few historical estimates of discards for this stock. Irish sampling up to 2016 observed very minimal discarding (mainly limited to small and damaged individuals <5% by number). Four Irish trips were sampled in 2016. Discards were not recorded on one of these trips. However, on the other three trips, discards were estimated to be around 8%, 9% and 15% by number (3%, 3% and 6% by weight). In 2017 there were two trips where discards were recorded, 17% and 43% by number. In 2018 discards were observed on one of the two trips (74% by number) no discards were observed on the other trip. In 2019, discards were observed in two of the four trips (13% and 29% by number). In 2020 discards were observed in two of the five trips. In 2021 discards were observed in four of the 12 trips. The discarding observed on these trips is likely not reflective of the overall discard pattern as the skippers advised the scientist on board that they had increased their discards to remain within quota during the observed trip. This means that the current discard pattern is unknown, but can be no longer considered negligible.

A detailed examination of discard estimates was provided in Spain in 2014. No estimate was provided in InterCatch by Spain since 2015.

Abundance indices from UWTV surveys

Operational details of the 2022 UWTV survey are available (Aristegui *et al*., 2022). These surveys use the standard UWTV methodology and conforms to WGNEPS best practice and guidelines, documented in Dobby H., *et al*., 2021. WKNEPH 2013 recommended that these surveys could be used for assessment and provision of catch options. The results are given in Table 20.6. Further detail of the survey is provided in the annex and annual survey reports are available at http://oar.marine.ie/handle/10793/59.

Trawl surveys

The longest time-series of fishery-independent source of data is from the Spanish Porcupine trawl survey 2001–2021 (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. Data from 2021 survey for this report was taken from Velasco *et al.* (in draft).

Distribution of *Nephrops* catches and biomass in Porcupine surveys between 2001 and 2021 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 from 2015 to 2018, decreased in 2019 and 2020, and increased again in 2021 (Figure 20.6).

The size structure of the catches in the survey shows two things: a lower mean size than in the commercial fleets and an increasing trend in mean size for both sexes up to 2008. In 2009, there is large reduction of mean size in both sexes due to a recruiting year class with a modal length at around 27 mm (possibly the 2006 year class). Tracking of cohorts was carried out at WKNEPH 2013 but the results are inconclusive (ICES, 2013). The survey showed increased recruitment between 2013 and 2019 with significantly increased catch rates of individuals <24 mm (Figure 20.7). This has also led to increase catch rates of juveniles and adult *Nephrops* since 2016.

An Irish Fisheries Science Research Partnership (IFSRP) survey was developed in collaboration with the Irish fishing industry to obtain data from the closed area in 2010–2012. Details of the design and methodology are presented in Stokes and Lordan (2011). The survey uses both commercial gear (Comm) and a baca trawl similar to the SpPGFS-WIBTS-Q4. WKNEPH concluded that the IFSRP trawl survey is too short (with changes in coverage, gears and vessels) to draw an inference about cpue changes reflecting changing stock abundance (ICES, 2013). The surveys carried out between 2010–2012 provided very useful data on population structure across the ground as well as data on grade structure and maturity-at-length.

Commercial cpue

In the past the *Nephrops* fishery on the Porcupine Bank was both seasonal and opportunistic with increased targeting during periods of high *Nephrops* emergence and good weather. Freezing of catches at sea has become increasingly prevalent since 2006, and the fishery now operates throughout the year, mainly targeting larger more valuable *Nephrops* in lower volumes. Fishing effort has fluctuated considerably in the recent past in response to availability of *Nephrops*.

Effort and lpue/cpue data are generally not standardized, and hence do not take into account vessel capacity, efficiency, seasonality or other factors that may bias perception of lpue/cpue and abundance trends over the longer term. WKNEPH concluded that effort and lpue series should be maintain in the WGCSE report for information purposes (ICES, 2013). WGCSE 2016 recommended presenting the effort in KWDays and lpue in tonnes/ KWDays. Any inferences about changes in stock abundance from these data, should take account of the quality and bias concerns raised above.

These data are presented by country in Table 20.7.

17.5 Stock assessment

Comparison with previous assessments

This assessment is based on UWTV approach outlined in WKNEPH 2013 and using parameter in the stock annex (ICES, 2013). This year's assessment has been updated based on the results of the August 2022 UWTV survey (Aristegui *et al.* 2022).

State of the stock

The UWTV results are shown in Table 20.6. In 2017 the harvest rate was above FMSY for the first time. However, since 2018 the harvest rate has been below FMSY again, due to relatively high abundance estimates on UWTV surveys since 2018, and to the increase in mean weight in the landings, which resulted in a decrease in the landed numbers. Total abundance increased in 2022, and it is the highest value in the time-series.

Catch options table

The inputs to the catch options are given below. At this point, it is not possible to estimate the numbers and mean weights of discards in the fishery, although there are indications that discards have increased since 2016.

Variable	Value	Notes
Stock abundance (2023)	1363	UWTV survey 2022; numbers of individuals in millions
Mean weight in projected landings	44.8	Average 2019 - 2021; in grammes
Mean weight in projected discards	-	Unknown
Projected discard rate	-	Unknown
Discards survival rate	-	Not applicable

17.6 Reference points

New reference points were evaluated by WKMSYREF4 (ICES, 2016a) and advised by ICES (2016b). The F_{MSY} for this stock was increased from 5.0% to 6.2%. The F_{MSY} for this stock is based on $F_{0.1}$ for both sexes combined given the low density of *Nephrops* on the Porcupine Bank.

Stock code	MSY Flower*	F_{MSY}*	MSY F_{upper}* with AR	MSY $B_{trigger}$	MSY F_{upper}* with no AR
nep-16	5.0%	6.2%	6.2%	Not defined	6.2%

*** Harvest rate (HR).**

17.7 Management strategies

The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters applies to this stock. The plan specifies conditions for setting fishing opportunities depending on stock status and for making use of the FMSY range for the stock. ICES considers the MAP to be precautionary when implemented at the FU level. Full details of the plan are described in EU (2019).

17.8 Quality of assessment and forecast

The main quality considerations for this stock are related to mean weight and discarding. The mean weight for this stock has been fluctuating, the most recent estimates maybe overestimate due to the non-inclusion of discards. The mean weight declined from 2014 to 2017 as strong year classes recruit to the fishery. Since 2017 a recent mean weight in the landing was considered the most appropriate basis in the calculation of catch scenarios. In previous years a long-term mean weight was used.

There is good evidence from surveys and length structure of landings that recruitment improved between 2015 and 2017, and this resulted in a reduction in mean weight in the stock in those years. As expected, the mean weight increased in 2018 and 2019 as the stronger cohorts grows;

it decreased in 2020, but increased again in 2021. Currently there is no methodology to take this into account in the calculation of catch options.

Up to 2015 discarding was considered negligible for this functional unit. Since 2016 the amount of discards observed on catch sampling trips have increased. This may be temporary linked to incoming recruitment. Sampling levels are insufficient to estimate total discards accurately, and projections assume no discards. The main concern is that the mean weight derived from the landings grades maybe bias due to unknown discarding levels. Not including discards in the assessment results in an underestimate of the actual fishing pressure. The current estimate is just below FMSY.

The UWTV survey provides abundance since 2012 (except 2015) with high precision, but the time-series is still too short to provide an MSY $B_{trigger}$ for this FU. The 2022 UWTV survey sampled 88% of the planned stations; this is considered to have had minimal impact on the abundance estimate and quality of the survey, based on burrow densities in adjoining areas and comparing coefficients of variation from the current and previous survey years.

The landings are considered fairly well estimated up to 2021 (an unallocated component related to area misreporting was included from 2011 to 2017).

17.9 Recommendation for next benchmark

This stock was benchmark in 2013 at WK*NEPH*. WGCSE will keep the stock under close review and recommend future benchmark as required.

17.10 Management considerations

There is a separate catch limit for Functional Unit (FU) 16 within the wider TAC for Subarea 7. This has resulted in very restrictive quotas for some vessels which increased area misreporting and the risk of discarding from 2011 to 2017. Area misreporting diminished in 2018 with the introduction of a national legislation restricting Irish vessels' fishing areas, where since March 2018 Irish vessels targeting *Nephrops* in subareas 6 and 7 may only fish in either of (1) Subarea 6 and Subarea 7, excluding FU16, or (2) FU16 of Sub-area 7 (Fisheries Management Notice No. 20 of 2018). Given the vulnerability of this stock to over exploitation the separate catch limit for Functional Unit (FU) 16 should remain in place.

A seasonal closed area (May 1–July 31) has been in place since 2010. The period of the closure was reduced to one month, May, since 2013. There hasn't been an ICES evaluation of the impact of this closure and whether it provides a conservation benefit over and above catch limits. Some sectors of the fishing industry want to extend the period of closure because they believe that this is a more effective conservation measure than catch limits.

Productivity of deep-water *Nephrops* stocks is generally lower than that in shelf waters, though individual *Nephrops* grow to relatively large sizes and attain high market prices. Other deep-water *Nephrops* stocks off the Spanish and Portuguese coast have collapsed and have been subject to recovery measures for several years e.g. FU25, 26, 27 and 31. Recruitment in *Nephrops* populations in deep water may be more sporadic than for shelf stocks with strong larval retention mechanisms. This makes these stocks more vulnerable to over exploitation and potential recruitment failure as has been observed on the Porcupine Bank in the early 2000s.

From 2019 vessels using highly selective gears in Subarea 7 can be exempted from the landings obligation on the basis of the high survival exemption (see discard plans). It is unknown if *Nephrops* discarded on the Porcupine Bank could actually survive the discarding process.

Discarding by the *Nephrops* trawl fishery is around 50% of the total catch by weight. The main species that are discarded by weight are blue mouth-red fish, blue whiting and argentines (Marine Institute and Bord Iascaigh Mhara, 2011).

17.11 References

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Velasco, F., Baldó, F. and González-Herraiz, I., in draft. Report on *Nephrops* results from Porcupine Bank 2021 Bottom Trawl Survey

Table 20.1. ***Nephrops*** **Porcupine Bank (FU 16): Of which catch limit.**

Year	France	Ireland	Spain	UK	Total
2011	241	454	377	188	1260
2012	238	457	380	185	1260
2013	340	653	543	264	1800
2014	349	671	557	271	1848
2015	349	671	558	272	1850
2016	349	671	558	272	1850
2017	586	1124	935	455	3100
2018	516	992	825	401	2734
2019	500	959	798	388	2645
2020	498	957	795	387	2637
2021	621	1194	992	483	3290
2022	530	1016	846	412	2804

Table 20.2. ***Nephrops*** **Porcupine Bank (FU 16): Landings (tonnes) by country.**

Year	France	Ireland	Spain	UK (E& W)	UK (NI)	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

Year	France	Ireland	Spain	UK (E& W)	UK (NI)	UK (Scotland)	Unallocated	Total
1994	1088	512	809	103				2512
1995	1234	971	579	152				2936
1996	1069	508	471	182				2230
1997	1028	653	473	255				2409
1998	879	598	405	273				2155
1999	1047	609	448	185				2290
2000	351	227	213	120				910
2001	425	369	270	158				1222
2002	369	543	276	139				1327
2003	131	307	489	108		29		1064
2004	289	494	468	126		28		1406
2005	397	754	681	208		156		2197
2006	462	731	636	201		155		2185
2007	302	1060	384	146		183		2074
2008	26	562	234	41		138		1000
2009	4	356	348	13		159		879
2010	4	579	240	10		90		922
2011	8	643	182	23		122	301	1278
2012	0.46	605	198	0		134	320	1258
2013	5.8	651	132	1		118	234	1141
2014	3	813	129	0		96	148	1189
2015	3	744	84	0		109	454	1394
2016	35	1052	58	1		160	849	2154
2017	63	743	73	4	245	131	1373	2632
2018	81	2079	158	8	280	144	0	2751
2019	54	1529	112	7	325	201	0	2229
2020	41	1516	82	1	259	<1	0	1899
2021	49	1611	318	1	329	169	0	2476

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
2010	0		0		3	Graded Landings
2011	0		0		2	Graded Landings
2012	0		0		3	Graded Landings
2013					3	Graded Landings
2014					3	Graded Landings
2015					3	Graded Landings
2016					4	Graded Landings
2017					2	Graded Landings
2018					2	Graded Landings
2019					4	Graded Landings
2020					5	Unsorted Catch
2021					12	Unsorted Catch

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 1981–2021.

Year	Spain Landings		Ireland Landings		France Landings		Porcupine Survey Catch	
	Males	Females	Males	Females	Males	Females	Males	Females
1981	39.9	34.5	-	-	-	-	-	-
1982	40.9	34.8	-	-	-	-	-	-
1983	40.8	34.0	-	-	-	-	-	-
1984	39.7	33.1	-	-	-	-	-	-
1985	38.7	33.5	-	-	-	-	-	-
1986	40.7	36.4	-	-	-	-	-	-
1987	39.3	35.0	-	-	-	-	-	-
1988	40.7	38.3	-	-	-	-	-	-
1989	40.5	36.8	-	-	-	-	-	-
1990	41.0	36.1	-	-	-	-	-	-
1991	39.4	34.5	-	-	-	-	-	-
1992	39.2	34.1	-	-	-	-	-	-
1993	41.6	36.1	-	-	-	-	-	-
1994	40.8	36.5	-	-	-	-	-	-
1995	41.3	36.6	40.7	36.5	43.2	38.3	-	-
1996	41.6	35.1	34.6	35.3	41.7	38.9	-	-
1997	39.7	34.8	35.9	34.5	41.9	38.4	-	-
1998	41.1	34.6	37.2	35.6	41.9	38.4	-	-
1999	41.5	35.7	36.6	33.7	43.1	39.1	-	-
2000	41.1	34.8	na	na	45.3	40.5	-	-
2001	41.1	36.3	37.8	35.4	45.4	39.4	36.0	28.9
2002	39.7	35.3	36.1	38.5	45.3	40.3	37.5	31.7
2003	41.4	37.8	44.5	36.2	46.2	38.9	39.7	30.9
2004	43.5	38.5	43.5	35.7	46.4	41.5	39.9	30.5
2005	43.4	38.1	46.9	40.6	45.9	41.0	45.1	33.8
2006	43.9	38.0	na	na	48.9	41.4	44.3	35.0

Year	Spain Landings		Ireland Landings		France Landings		Porcupine Survey Catch	
	Males	Females	Males	Females	Males	Females	Males	Females
2007	43.7	41.0	na	na	48.3	43.8	45.9	37.8
2008	51.0	40.6	43.3	37.5	na	na	48.8	38.7
2009	43.0	42.7	44.1	40.1	na	na	32.6	28.9
2010	na	na	43.2	40.4	na	na	36.3	31.8
2011	na	na	39.5	38.4	na	na	39.0	33.6
2012	na	na	41.1	38.1	na	na	41.1	30.8
2013	na	na	42.9	38.9	na	na	37.6	25.1
2014	na	na	45.1	40.9	na	na	36.4	31.0
2015	na	na	40.3	39.7	na	na	35.5	32.7
2016	na	na	37.8	37.3	na	na	32.2	27.8
2017	na	na	35.7	32.9	na	na	34.1	26.8
2018	na	na	38.8	35.3	na	na	35.0	28.2
2019	na	na	41.3	36.2	na	na	35.2	29.3
2020	na	na	na	na	na	na	37.5	29.0
2021	na	na	na	na	na	na	34.6	29.8

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	46.4
1990	38.9	1895	48.67
1991	37.3	1640	43.98
1992	47	2015	42.84
1993	38.5	1857	48.29
1994	54.4	2512	46.15
1995	65.5	2936	44.79
1996	52.9	2230	42.15
1997	59.1	2409	40.73
1998	49.9	2155	43.16
1999	52.3	2290	43.76
2000	15.1	910	60.13
2001	24.6	1222	49.65
2002	32	1327	41.49
2003	18.4	1064	57.76
2004	21.5	1406	65.28
2005	31.5	2197	69.84
2006	28.7	2185	76.24
2007	29.2	2074	71.05
2008	17.9	1000	55.89
2009	16.5	879	53.19
2010	14.1	922	65.32
2011	27.9	1278	45.81
2012	25.0	1258	50.36
2013	19.8	1141	57.54
2014	17.3	1189	68.54

Year	Numbers (millions)	Weight Landed (Tonnes)	Mean Weight in landings (gr)
2015	27.4	1394	50.86
2016	53.5	2154	40.29
2017	84.9	2632	31.01
2018	66.2	2751	41.55
2019	42.2	2251	53.38
2020	49.6	1899	38.26
2021	57.8	2476	42.82
	Average 2019–2021		44.82

Table 20.6. *Nephrops* Porcupine Bank (FU16): Assessment summary.

Year	UWTV abundance estimate	95% Confidence Interval	Landings in number	Total discards in number*	Removals in number	Harvest rate (by number)**	Landings	Total discards*	Discard rate (by number)	Dead discard rate (by number)	Mean weight in landings	Mean weight in discards
	Millions					%	tonnes		%		grammes	
2012	787	79	25	0	25	3.2	1258	0	0	0	50.4	NA
2013	768	61	20	0	20	2.6	1141	0	0	0	57.5	NA
2014	722	35	17	0	17	2.4	1189	0	0	0	68.5	NA
2015	NA	NA	27	0	27	3.3***	1394	0	0	0	50.9	NA
2016	958	68	53	NA	53	5.6	2154	NA	NA	NA	40.3	NA
2017	850	90	85	NA	85	10.0	2632	NA	NA	NA	31.0	NA
2018	1117	92	66	NA	66	5.9	2751	NA	NA	NA	41.6	NA
2019	1010	101	42	NA	42	4.2	2251	NA	NA	NA	53.4	NA
2020	1264	94	50	NA	50	3.9	1899	NA	NA	NA	38.3	NA
2021	1018	92	58	NA	58	5.7	2476	NA	NA	NA	42.8	NA
2022	1363	91										

***Discarding up to 2015 was considered to be negligible. Discard estimates are not available since 2016 and are therefore not included in the assessment.**

**** Values since 2016 onwards may be underestimated owing to insufficient discard data.**

***** The harvest rate is estimated based on a linear interpolation of abundance, as no survey was carried out in this year.**

NA = not available.

Table 20.7. ***Nephrops*** **Porcupine Bank (FU16): Effort and lpue for the various different fleets exploiting the stock 1971–2021.**

Year	Spain[1]		France[2]		Ireland[3]	
	Effort ('000's Hrs)	Lpue (kg/hr)	Effort[2] ('000's Hrs)	Lpue (>10%) (kg/hr)	Effort[3] ('000's KwDays)	Lpue (t/KWdays)
1980	318	9				
1981	272	12				
1982	237	17				
1983	196	14	18	35		
1984	194	13	30	35		
1985	200	14	33	36		
1986	162	9	28	38		
1987	174	10	24	26		
1988	180	9	22	27		
1989	173	8	14	23		
1990	159	9	15	23		
1991	138	7	19	18		
1992	96	9	32	21		
1993	80	9	36	22		
1994	80	10	38	28		
1995	67	9	42	30	584.9	1.4
1996	58	8	41	26	192.5	1.59
1997	57	8	41	25	327.3	1.26
1998	56	7	40	22	284.6	1.59
1999	53	8	43	21	278	1.29
2000	47	5	23	14	92.8	1.25

Year	Spain[1]		France[2]		Ireland[3]	
	Effort ('000's Hrs)	Lpue (kg/hr)	Effort[2] ('000's Hrs)	Lpue (>10%) (kg/hr)	Effort[3] ('000's KwDays)	Lpue (t/KWdays)
2001	44	6	24	15	230.2	1.12
2002	54	5	18	18	339.8	1.3
2003	66	5	7	19	294.7	0.8
2004	59	10	9	25	569.2	0.68
2005	60	13	15	26	756.2	0.83
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	na	na	411.3	0.83
2010	42	6	na	na	704.1	0.81
2011	na	na	na	na	986.9	0.63
2012	15	na	na	na	817.1	0.63
2013	na	na	na	na	885.7	0.92
2014	na	na	na	na	1019.8	0.92
2015	na	na	na	na	1219.2	0.99
2016	na	na	na	na	1359.3	1.43
2017	na	na	na	na	1328.9	1.59
2018	na	na	na	na	1721.2	1.21
2019	na	na	na	na	1463.3	1.01
2020	na	na	na	na	1468.3	0.97
2021	na	na	na	na	1647.1	0.94

[1] = Effort and lpue between 1980 and 2010 was estimated based on fishing days in 7. Effort in 2012 was based on logbooks for FU16.

2 = Effort and lpue for vessels where <10% of landed value was *Nephrops*.

3 = Effort and lpue for vessels where 30% of the landed weight was *Nephrops*.

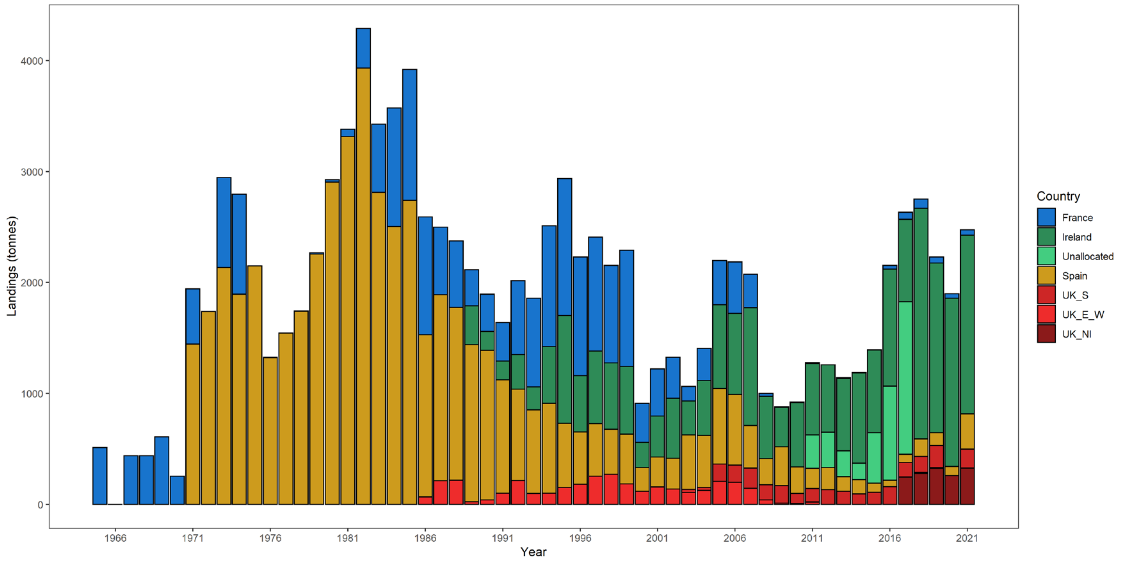


Figure 20.1. *Nephrops* in FU16 (Porcupine Bank). WG's best estimates of landings in tonnes by country.

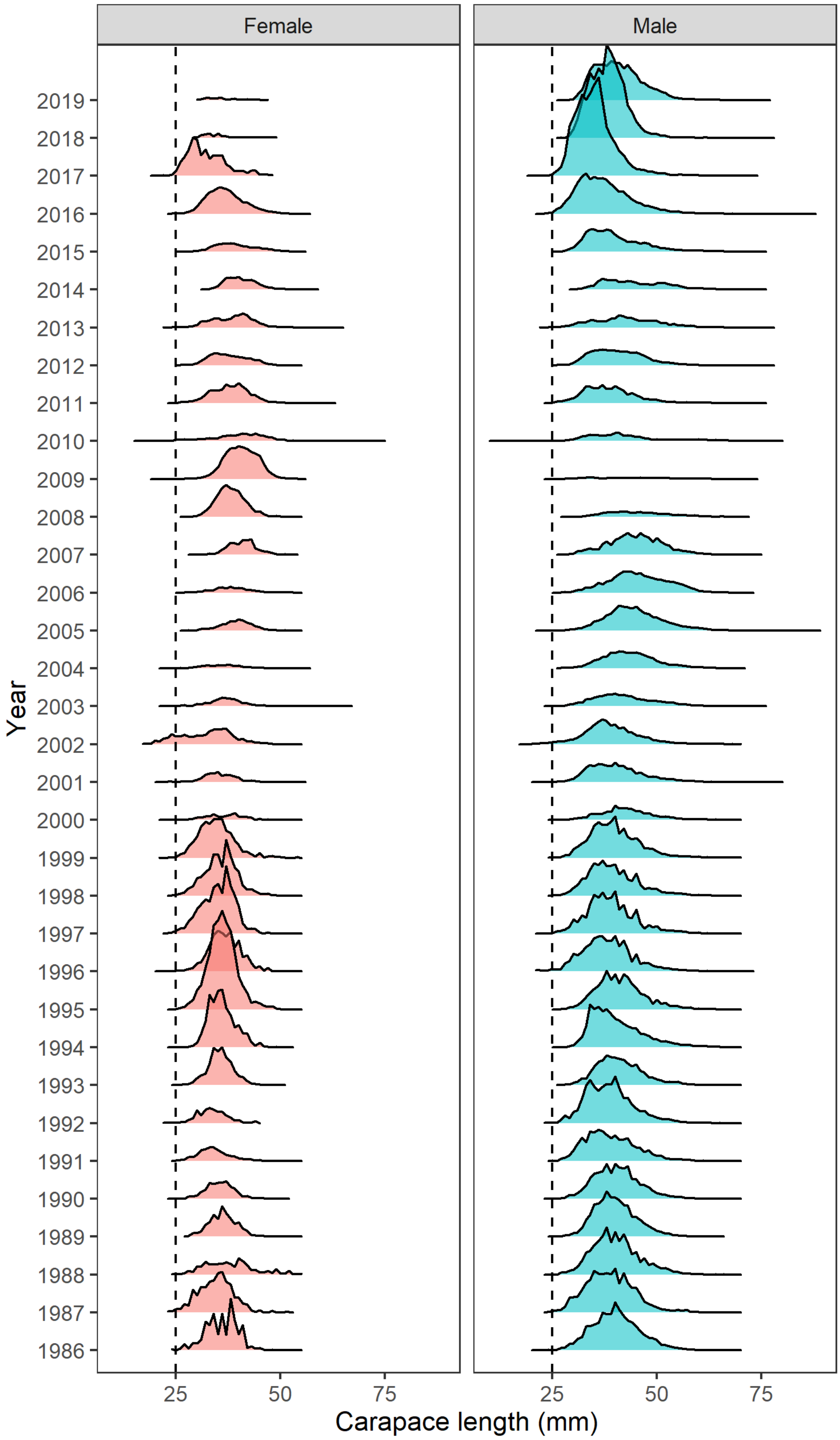


Figure 20.2. ***Nephrops*** **in FU16 (Porcupine Bank). Female and male length distributions of raised international landings. Vertical dashed lines refer to Minimum Landing Size (25 mm).**

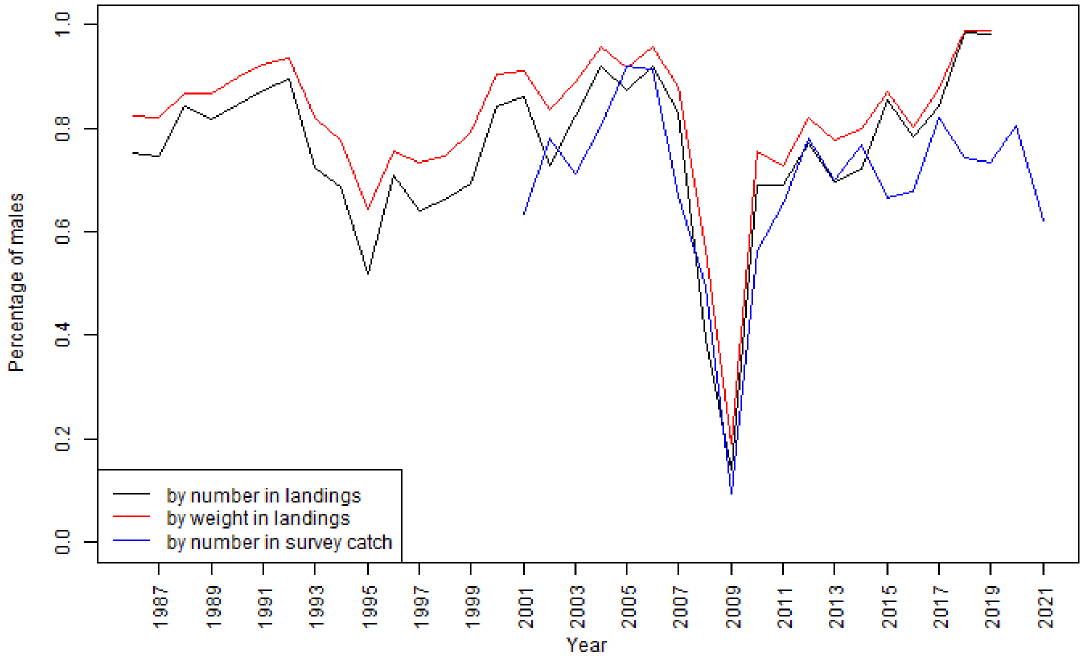


Figure 20.3. ***Nephrops*** **in FU16 (Porcupine Bank). The percentage males in the landings and survey over time.**

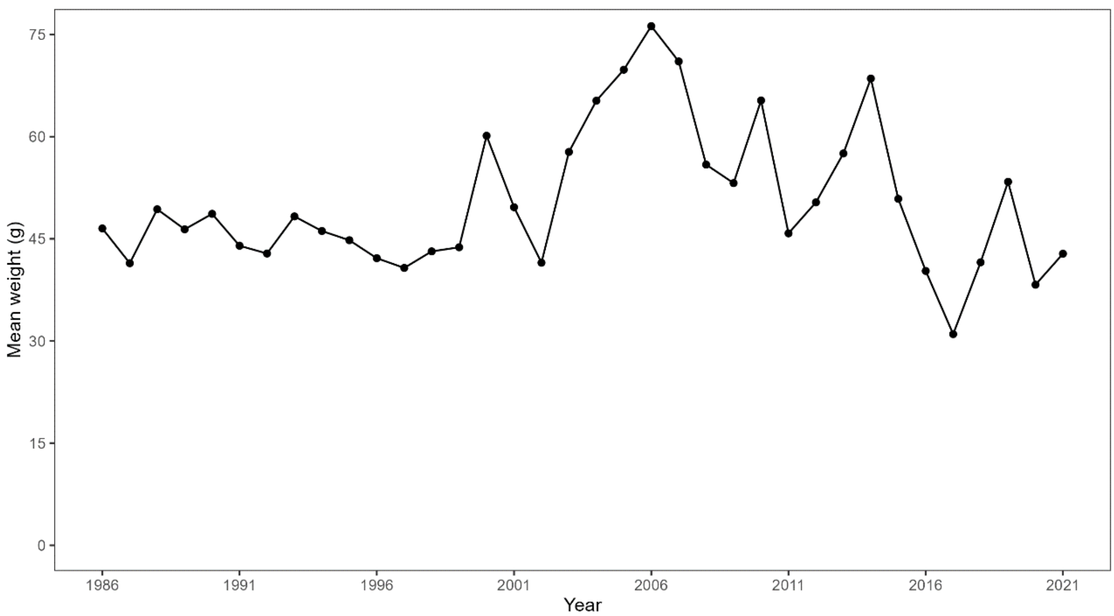


Figure 20.4. ***Nephrops*** **in FU16 (Porcupine Bank). Mean weight in the commercial landings.**

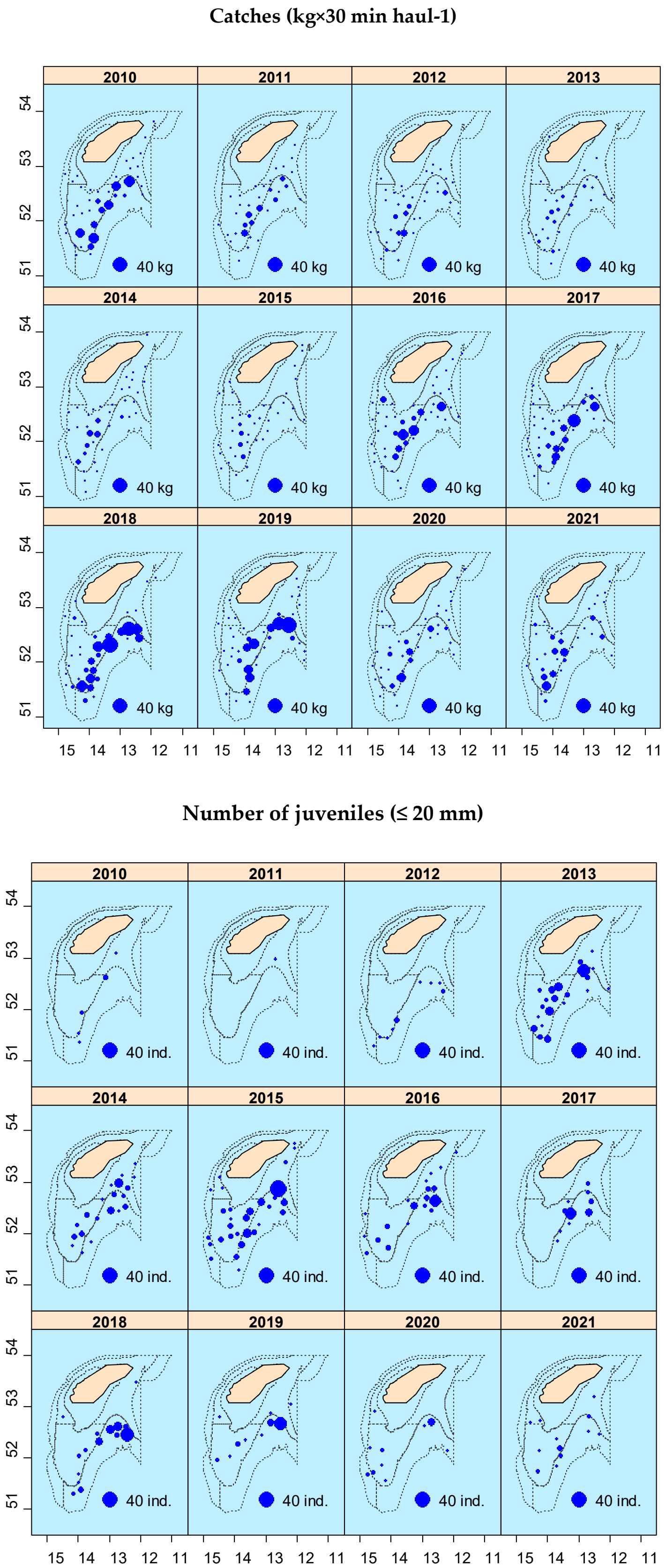


Figure 20.5. ***Nephrops*** **in FU16 (Porcupine Bank). Geographic distribution of** ***Nephrops norvegicus*** **in Porcupine surveys between 2010 and 2021. Top panel: catches (kg×30 min haul-1). Bottom panel: Number of juveniles (≤ 20 mm carapace length). (Velasco** ***et al.*** **in draft)**

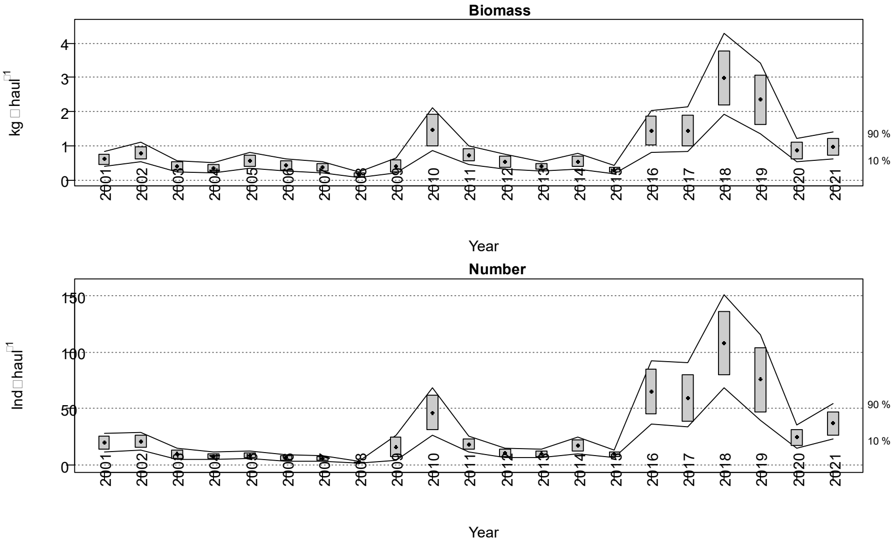


Figure 20.6. *Nephrops* in FU16 (Porcupine Bank). Evolution of *Nephrops norvegicus* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified abundance index. Lines mark boot-strap confidence intervals (α = 0.80, bootstrap iterations = 1000). (Velasco *et al.* in draft)

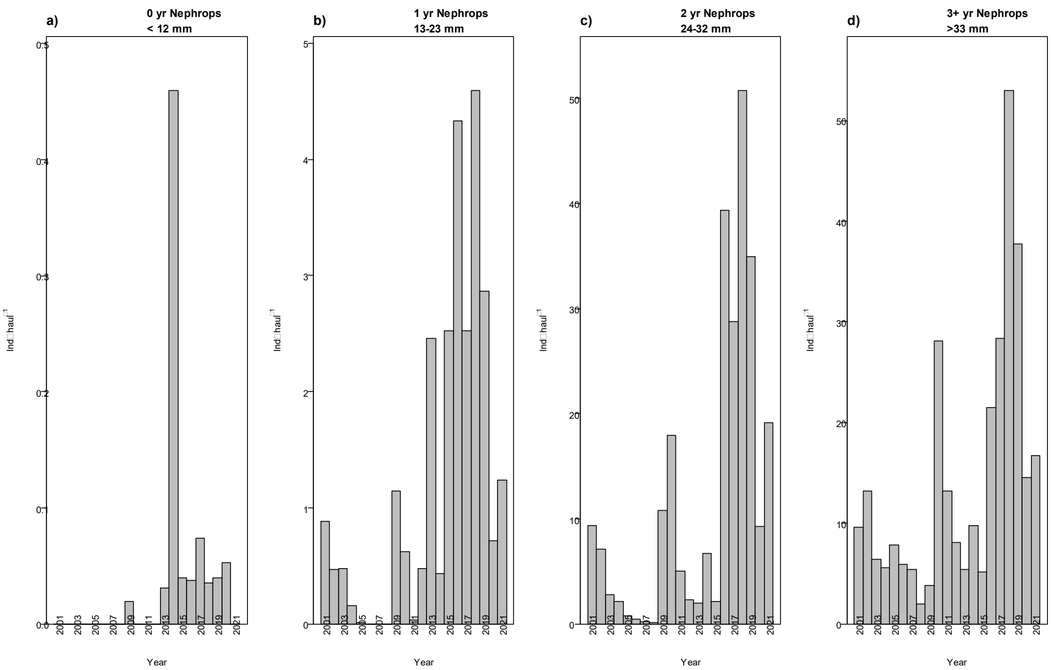


Figure 20.7. Abundance of a) 0 year *Nephrops* (<12 mm), b) 1 year *Nephrops* (13-23 mm), c) 2 years *Nephrops* (24-32 mm) and 3+ Nephrops (>33 mm) in Porcupine survey 2001-2021. (Velasco *et al.* in draft)

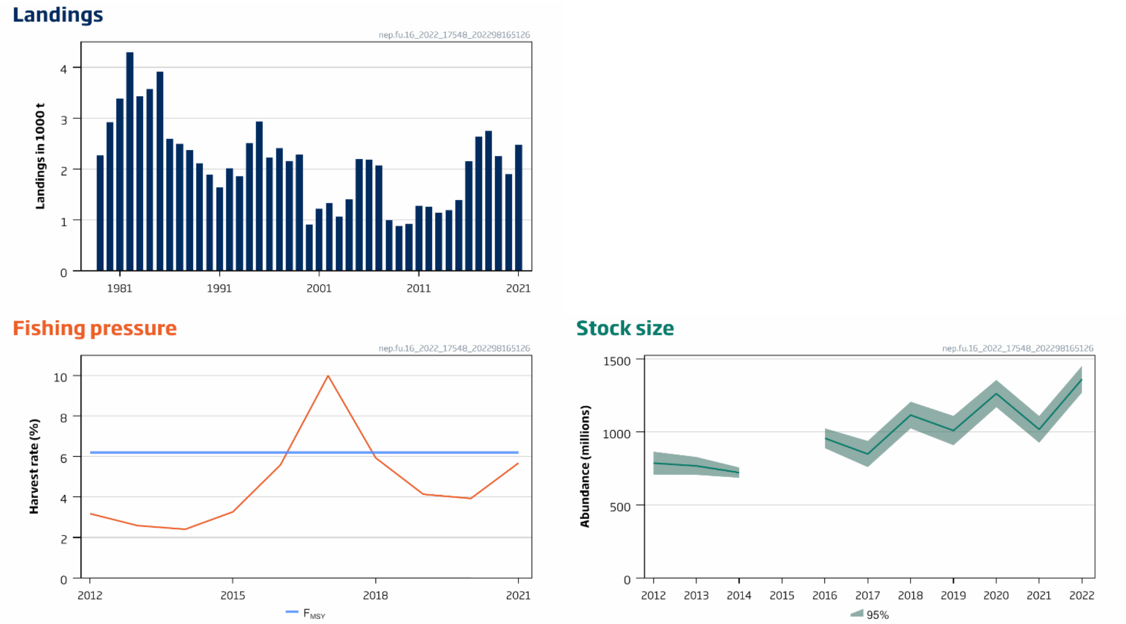


Figure 20.8. ***Nephrops*** **in FU16 (Porcupine Bank). Summary of stock status for Porcupine** ***Nephrops*****.**

18 Norway lobster (*Nephrops norvegicus*) in Division 7.b, Functional Unit 17 (west of Ireland, Aran grounds)

Type of assessment in 2022

This stock was inter-benchmarked in September 2015 by correspondence (ICES, 2016a). The assessment and catch options follow the agreed procedures set out in the stock annex.

ICES advice applicable to 2021

"ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2021 that correspond to the F ranges in the MAP are between 443 tonnes and 508 tonnes, assuming recent discard rates. The entire range is considered precautionary when applying the ICES advice rule.

To ensure that the stock in Functional Unit (FU) 17 is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2022

"ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2018–2020, catches in 2022 that correspond to the F ranges in the MAP are between 313 and 360 tonnes.

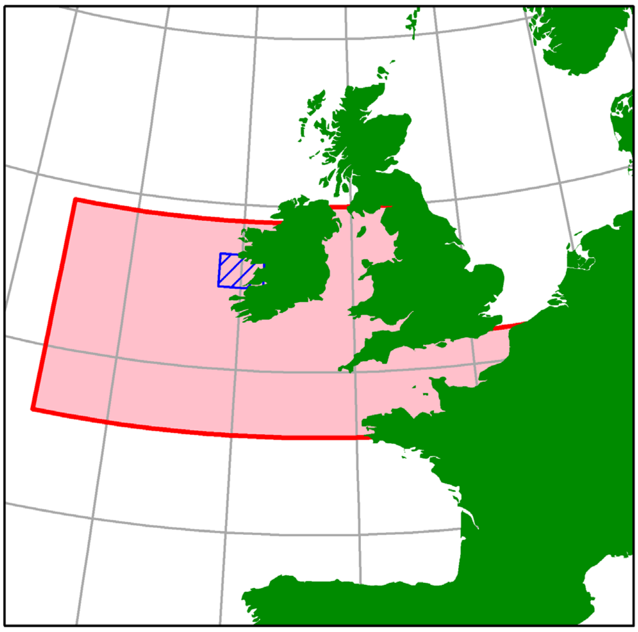
To ensure that the stock in Functional Unit (FU) 17 is exploited sustainably, management should be implemented at the FU level."

18.1 General

Stock description and management units

The Aran Grounds *Nephrops* stock (FU17) covers ICES rectangles 34–35 D9–E0 within 7.b. This stock is included as part of the TAC Area 7 *Nephrops* which includes the following stocks: Irish Sea East and West (FU14, FU15), Porcupine Bank (FU16), northwestern Irish Coast (FU18), south-eastern and south-western 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, 2016a).

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 had been relatively stable from 1995 to 2018, but it decreased in 2019 and 2020 to half, and increased again to previous numbers in 2021. 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 2021

In recent years several newer vessels specializing in *Nephrops* fishing have participated periodically in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. There has been a trend for Irish vessels to switch to multi (quad) rig trawls since 2012. These vessels are more efficient at catching *Nephrops* (BIM, 2014).

Information from stakeholders

Voluntary effort restriction were put in place by the Irish fishing industry in April and May 2015. These measures reduced catches and effort significantly on the stock in advance of the 2015 UWTV survey.

18.2 Data

InterCatch

Data were available in InterCatch and used for catch data only.

Landings

The reported landings time-series is shown in Figure 21.2.1 and Table 21.2.1. The 2021 landings increased by about 124% from those made in 2020 and amounted to 498 t.

Effort

The IBPNeph 2015 reviewed Irish commercial landings and effort data in detail. They concluded that effort should be reported in the WGCSE report in KWdays and lpue should be reported in KG/kwdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. The time-series of effort and lpue is updated in Figure 21.2.2 and Table 21.2.2. There was a significant decline in lpue and effort in 2015 due to the local management efforts put in place in April and May. In 2016 effort level increased to values similar to those observed previously prior to 2011. However, since 2017 effort levels have declined, reaching in 2020 the lowest values in the data series, and increasing slightly in 2021.

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. Given the low level of landings in recent years, it has been challenging to obtain sufficient samples to provide robust estimates of mean weights.

Commercial length–frequency distributions

The raised catch length distributions are shown in Figure 21.2.4. The mean length of females decreased in 2018, increasing the discard rate for females. Female lengths increased in 2019 and 2020 to similar values of 2017, and they decreased again in 2021, but not to the levels of 2018.

Sex ratio

In 2021 the difference on the proportion of males between the catches and the landings is similar to values from 2017 to 2019 (Figure 21.2.5). Sex ratio has a distinct seasonal pattern with lowest male proportions in the samples in May and June. Males dominate the catches in the autumn and winter.

Mean weight explorations

Explorations of the mean weight in the catch samples by sex shows a strong cyclical pattern in females, which corresponds with the emergence of mature females from the burrows to mate in summer (Figure 21.2.6). The annual mean weight estimate for landings and discards is shown in Figure 21.2.7. The mean weight estimates have been relatively stable from 2011, where main change occurred in 2008–2011. In 2020 the discards mean weight increased significantly, but in 2021 it decreased to similar values of previous years.

Discarding

Table 21.2.4 gives weights, numbers and proportions of the landings and discard raised internationally according to the stock annex. A 25% discard survival rate is assumed in line with other *Nephrops* stocks in the Celtic sea (see stock annex) as the basis for the catch scenarios. Gear selectivity trials by Bord Iascaigh Mhara (BIM, 2017) reported a 64% survivor rate for *Nephrops* caught in a trawl with a SELTRA selectivity device in the outer Galway Bay area.

Abundance indices from UWTV surveys

The spatial extent of the *Nephrops* grounds in FU17 was re-defined by IBPNeph 2015 and the total abundance estimates were revised using a new procedure (ICES, 2016a). The redefinition of the polygons in FU17 resulted in ~30% increase in overall area from 1007 km² to 1320 km² (stock annex). The 2022 UWTV survey was not deemed robust enough for the assessment because of the reduced number of stations completed due to disruption to the survey schedule (Aristegui et al., 2022). As such, the stock size is unknown for 2022. The assessment and advice is therefore based on the 2021 UWTV survey.

The spatial distributions of burrow densities are shown in Figure 21.2.8. The densities have fluctuated considerably over the time-series and throughout the Aran grounds. In general, the densities are higher towards the middle-western side of the ground and there is a notable trend towards lower densities towards the east. On the south-western boundary, there are often high densities close to the boundary. In this area, there is a sharp transition from mud to rocky substrate.

The summary statistics from this geostatistical analysis are given in Table 21.2.5 and plotted in Figure 21.2.10. The geostatistical abundance estimate adjusted is derived using the mean of the krigged grid where the mean of the observations is reported in Table 21.2.5. In recent years the Aran Grounds accounted for ~92% of the total estimated burrow abundance from FU17 (Table 21.2.5). Galway Bay accounted for ~5% and Slyne Head for ~3% (Table 21.2.6). The Galway Bay estimates fluctuate widely but are highly correlated with the Aran ground (Figure 21.2.9). Estimates for the Slyne Head ground also fluctuate considerably but show no significant correlation with the other areas except for the peaks of 2010, 2015 and 2018 (Figure 21.2.9).

Aran ground abundance estimate's CV (Table 21.2.5) has been always well below the recommendation of 20% by SGNEPS (ICES, 2012). The CV on the abundance estimates for Galway Bay and Slyne Head have also stayed low (Table 21.2.6) and within the recommendation, showing the surveys are precise. Figure 21.2.10 and Table 21.2.7 show the total abundance estimate for FU17 with the IBPNeph proposed MSY $B_{trigger}$. The 2022 abundance estimate is based on the 2021 UWTV survey, and thus has not changed from last year's 331 million, which is below the MSY $B_{trigger}$ (540 million).

18.3 Assessment

Comparison with previous assessments

The WGCSE 2022 carried out an UWTV based assessment for this stock. The methods used were very much in line with WKNEPH (ICES, 2009a) and the approach taken for other *Nephrops* stocks in 6 and 7 by WGCSE. This approach was inter-benchmarked at IBPNeph (ICES, 2016a).

State of the stock

The stock size is unknown for 2022. The assessment and advice is therefore based on the 2021 UWTV survey. UWTV abundance estimates suggest that the stock size has fluctuated widely with an overall declining trend and is below MSY $B_{trigger}$ since 2012 (except 2015 and 2018). The 2021 estimate was lowest observed in the time-series and was below the MSY $B_{trigger}$. The 2021 abundance remained below the average of the series (geomean [2002–2019]: 617 million). Harvest rate [calculated as (landings + dead discards)/abundance estimate] was below the $F_{MSYproxy}$ from 2017 to 2020, and increased up to $F_{MSYproxy}$ in 2021 (Table 21.3.1 and Figure 21.3.1).

18.4 Catch scenario table

Catch scenario table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 21.3.1 and summarised below. The calculation of catch options for the Aran Grounds follows the procedure outlined in the stock annex.

The basis for the catch scenarios.

Variable	Value	Notes
Stock abundance (2023)	331	UWTV survey 2021; numbers of individuals in millions
Mean weight in projected landings	22.4	Average 2008–2021; in grammes
Mean weight in projected discards	11.4	Average 2008–2021; in grammes
Projected discards	24.1	Average 2019–2021; percentage by number
Discards survival	25	Percentage by number

Given the fluctuations observed in mean weights for landings and discards (Figure 21.2.7) an average from 2008 to the most recent year is used in the calculation of catch options as set out in the stock annex. The discard rates and proportions for the last three years are used to account for recent on-board retention practices (this is also according to the stock annex).

18.5 Reference points

New reference points were defined for this stock at the IBPNeph (ICES, 2016a) and no new proposals were made by WKMSYRef4 (ICES, 2016b). For *Nephrops* stocks MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased. This corresponds to the abundance observed in 2008 rounded to the nearest 10 = 540 million individuals (Figure 21.2.10 and Table 21.2.7).

The F_{MSY} proxy was revised during the benchmark in 2015. The observed burrow density has declined, from high (>0.8 individuals m^{-2}) at the start of the series to medium density (~0.3 individuals m^{-2}) towards the end of the time-series. The nature of the fishery has also changed, from a continuous fishery throughout the year to a fishery which is more concentrated on sporadic periods of high catch rates. For these reasons a harvest rate consistent with a combined sex $F_{0.1}$ = 8.5% is considered an appropriate proxy for F_{MSY}.

These should remain under review by WGCSE and may be revised while data become available.

18.6 Management strategies

As yet there are no explicit management strategies for this stock but there have been some discussions among the fishing industry and scientists about developing a long-term plan for the management of the Aran fishery. Sustainable utilization of the *Nephrops* stock will form the cornerstone of any management strategy for this fishery.

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES Subarea 7 and also demersal stocks.

18.7 Quality of assessment and forecast

Biological sampling for this stock is adequate. From 2002 to 2021 a dedicated annual UWTV survey has provided abundance estimates for the Aran Grounds with high precision. However, in 2022 the UWTV survey was not deemed robust enough for the assessment because of the reduced number of stations completed due to disruption to the survey schedule. The area of the Aran Grounds was revised in 2015, resulting in a recalculation of the abundance time-series which now also includes Galway Bay and Slyne Head. A number of other biological parameters such as mean weights and length distributions have also been revised. The revisions were made as part of an inter-benchmark process and have improved the quality of the assessment.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. From 2016, fisheries catching *Nephrops* in Subarea 7 are covered by the EU landings obligation (EU, 2015). Creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 5% discard rate by weight for the trawl fishery in 2019 (reduced from 6% in 2018 and 7% in both 2016 and 2017). The average discard rate by weight for FU17 over the last three years is 12.4%. Catch advice and scenarios are provided this year on the assumption that discarding is assumed to continue at recent average.

Irish discard survival experiments indicate that the trawl discard survival may be around 64% (BIM, 2017). As a result, an exemption from the landings obligation based on high survivability has been granted by the European Commission. ICES continues to use the survival rate of 25% (ICES, 2016c) as the survival rates estimated by BIM (2017) have not been evaluated by ICES.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*Neph* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009b; WGNEPS 2014; WKNEPS 2016d; Dobby *et al.*, 2021). 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 (ICES, 2009a).

Landings data were adjusted to take into account landings that had been misreported from FU16 from 2011 to 2017. This adjustment is thought to be reasonably accurate (See Section 18).

18.8 Recommendation for next benchmark

This stock was last benchmarked by IBPNeph (ICES, 2016a). WGCSE will keep the stock under close review and recommend future benchmark as required.

18.9 Management considerations

A meeting was held with stakeholders in March 2015 to discuss the state of the Aran *Nephrops* stock. In response to this meeting voluntary effort limits were put in place for April, May and June 2015. These voluntary measures have significantly reduced effort and catches on the Aran grounds in 2015 before the UWTV survey.

Small whole *Nephrops* are the main species comprising the discards. The main fish species discarded are haddock, hake, whiting, megrim and dogfish (Anon, 2011).

The ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level. Management at the Functional Unit level could provide controls to ensure effort and catch were in line with resources available.

18.10 References

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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

Year	France	Rep. of Ireland	UK	Total
2003	0	933	0	933
2004	0	525	0	525
2005	0	778	0	778
2006	0	637	0	637
2007	0	913	0	913
2008	0	1050	7	1057
2009	0	625	0	625
2010	0	930	9	939
2011	0	659	0	659
2012	0	1246	0	1246
2013	0	1295	0	1295
2014	0	766	0	766
2015	0	370	0	370
2016	0	641	0	641
2017	0	295	0.4	295
2018	0	494	42	536
2019	0	162	4	167
2020	0	188	34	222
2021	0	490	8	498

Table 21.2.2. *Nephrops* in FU17 (Aran Grounds). Effort data for the Irish otter trawl *Nephrops* directed fleet.

Year	Effort (Kw Days)	Landings (Kgs)
1995	286,939	522,007
1996	174,030	312,421
1997	260,676	442,218
1998	445,308	940,902
1999	366,839	782,407
2000	293,684	561,244
2001	362,754	586,462
2002	350,346	798,744
2003	492,284	801,813
2004	355,673	420,652
2005	396,202	708,540
2006	337,503	618,515
2007	460,396	905,282
2008	512,245	1,052,077
2009	319,873	613,220
2010	441,080	910,346
2011	332,300	667,564
2012	488,721	1,139,413
2013	571,916	1,239,469
2014	460,818	774,097
2015	232,190	461,409
2016	396,502	578,420
2017	277,117	258,052
2018	233,793	483,723
2019	136,278	148,795
2020	91,263	177,895
2021	184,881	444,551

Table 21.2.3. *Nephrops* in FU17 (Aran Grounds). Sampling levels.

Year	Quarter	Number of samples		Numbers Measured	
		Catch	Discards	Catch	Discards
2008	1	2	3	565	1376
2008	2	9	8	2224	3758
2008	3	5	4	1266	1834
2008	4	3	3	889	1733
2009	1	3	3	800	1184
2009	2	6	6	1685	1978
2009	3	6	6	2260	2726
2009	4	2	2	1491	1149
2010	1	4	4	3322	2322
2010	2	8	7	3577	2957
2010	3	2	2	951	742
2010	4	6	4	3209	1802
2011	1	7	7	3755	3537
2011	2	7	7	7399	6617
2011	3	4	2	3531	2386
2011	4	5	5	2440	2271
2012	1	3	3	1538	1250
2012	2	17	15	6481	5113
2012	3	0	0	-	-
2012	4	5	5	2333	1945
2013	1	10	9	3108	2983
2013	2	11	11	3733	3733
2013	2	3	3	1163	1263
2013	4	7	7	2956	1779
2014	1	3	3	1208	1223
2014	2	12	12	5365	3563
2014	3	2	2	786	499
2014	4	8	8	3542	2760

Year	Quarter	Number of samples		Numbers Measured	
		Catch	Discards	Catch	Discards
2015	1	2	2	827	611
2015	2	2	2	961	664
2015	3	0	0	-	-
2015	4	2	2	1047	1388
2016	1	5	4	2292	876
2016	2	11	11	4756	3383
2016	3	6	5	3020	2048
2016	4	6	6	1389	1311
2017	1	3	3	1214	845
2017	2	6	4	2911	1569
2017	3	2	1	1018	223
2017	4	3	3	1176	839
2018	1	3	3	1224	1241
2018	2	8	8	3179	2971
2018	3	1	1	467	388
2018	4	6	6	1894	2487
2019	1	3	3	1151	1368
2019	2	5	5	1552	1441
2019	3	2	2	628	480
2019	4	2	2	519	558
2020	1	4	4	1037	984
2020	2	5	5	1706	1666
2020	4	1	0	302	0
2021	1	3	3	740	778
2021	2	5	4	1558	1059

Table 21.2.4. *Nephrops* in FU17 (Aran Grounds). Raised landings and discard weight and numbers by year.

Year	Landings (t)	Discards (t)	Landings in number ('000s)	Discards in number ('000s)	Discards by weight (%)	Discards by number (%)
2008	1057	248	48,162	22,074	19.0	31.4
2009	626	129	24,935	9,487	17.1	27.6
2010	939	224	37,341	15,246	19.3	29.0
2011	659	92	31,950	8,542	12.2	21.1
2012	1246	86	61,076	8,292	6.5	12.0
2013	1295	129	60,016	12,034	9.1	16.7
2014	766	48	33,882	5,038	5.9	12.9
2015	370	15	17,693	1,622	3.8	8.4
2016	641	69	30,231	6,375	9.7	17.4
2017	295	38	13,269	3,605	11.3	21.4
2018	536	106	22,049	10,490	16.5	32.2
2019	167	21	7,568	2,098	11.1	21.7
2020	222	54	9,516	3,525	19.5	27.0
2021	498	88	22,750	7,049	15.0	23.6

Table 21.2.5. *Nephrops* in FU17 (Aran Grounds). Results summary table for geostatistical analysis of UWTV survey.

Ground	Year	Number of stations	Mean Density adjusted** (burrow/m²)	Domain Area (km²)	Geostatistical Abundance Estimate adjusted (millions burrows)	CV on Burrow estimate %
Aran Grounds	2002	49	0.79	1196	947	3
	2003	41	0.94	1196	1118	6
	2004	64	1.08	1196	1297	3
	2005	70	0.81	1196	972	2
	2006	67	0.46	1196	556	3
	2007	71	0.69	1196	828	2
	2008	63	0.41	1196	494	3
	2009	82	0.52	1196	627	2
	2010	87	0.63	1196	752	2
	2011	76	0.51	1196	609	2
	2012	31*	0.33	1196	397	3
	2013	31*	0.33	1196	390	4
	2014	33*	0.28	1196	332	4
	2015	34*	0.40	1197	480	4
	2016	34*	0.29	1197	343	3
	2017	31*	0.31	1196	377	3
	2018	33*	0.40	1196	488	3
	2019	31*	0.39	1196	458	4
	2020	34	0.29	1196	359	4
	2021	34*	0.26	1196	311	4

*** reduced isometric grid.**

**** mean density of the observations.**

Table 21.2.6. *Nephrops* in FU17 (Galway Bay and Slyne Head). Results summary table for analysis of UWTV survey. Random stratified estimates given for these grounds only.

Ground	Year	Number of stations	Mean Density adjusted (burrow/m²)	Domain Area (km²)	Raised Abundance Estimate adjusted (millions burrows)*	CV on Burrow estimate %
Galway Bay	2002	7	1.18	79.0	93.1	7
	2003	3	1.30	79.0	102.6	16
	2004	8	1.17	79.0	92.2	14
	2005	4	1.30	79.0	103.0	11
	2006	3	0.74	79.0	58.8	9
	2007	5	0.91	79.0	71.8	8
	2008	5	0.40	79.0	31.6	4
	2009	8	0.71	79.0	56.3	4
	2010	10	1.24	79.0	97.6	11
	2011	6	0.55	79.0	43.2	12
	2012	4	0.64	79.0	50.9	10
	2013	5	0.37	79.0	29.6	10
	2014	3	0.50	79.0	39.8	6
	2015	5	0.71	79.0	55.8	15
	2016	7	0.32	79.0	25.1	7
	2017	5	0.20	79.0	15.8	4
	2018	5	0.41	79.0	32.5	17
	2019	5	0.29	79.0	22.8	11
	2020	5	0.34	79.0	27.2	13
	2021	5	0.15	79.0	11.5	2
	2022*	5	0.19	79.0	14.8	3

* 2022 abundance estimate for Galway Bay was not used in the assessment, as the rest of the stations in the Aran Grounds and Slyne Head were not completed due to disruption to the survey schedule.

Ground	Year	Number of stations	Mean Density adjusted (burrow/m²)	Domain Area (km²)	Raised Abundance Estimate adjusted (millions burrows)*	CV on Burrow estimate %
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	0.27	39.1	10.8	3
	2017	4	0.27	39.1	10.7	4
	2018	5	0.84	39.1	33.0	12
	2019	5	0.29	39.1	11.5	8
	2020	5	0.19	39.1	7.4	4
	2021	5	0.23	39.1	9.1	2

***estimated as no survey data available for these years.**

Table 21.2.7. *Nephrops* in FU17. Results summary table for analysis of UWTV survey for the combined grounds.

Year	Abundance (Millions)	Upper bound	Lower bound
2002	1070	1154	985
2003	1246	1434	1059
2004	1410	1517	1302
2005	1092	1154	1030
2006	627	703	551
2007	920	982	858
2008	541	588	494
2009	696	739	653
2010	879	926	831
2011	672	720	624
2012	468	520	417
2013	441	506	376
2014	383	440	327
2015	556	627	484
2016	379	420	339
2017	404	445	362
2018	554	637	471
2019	493	558	427
2020	394	453	335
2021	331	362	301
2022	331*		

*** 2022 abundance estimate used in the assessment was based on 2021 UWTV survey abundance estimate.**

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. n/a = not available due to non-cooperation with sampling programmes.

Year	UWTV abundance estimate	95% Confidence Interval	Landings in number	Total discards in number*	Removals in number	Harvest rate (by number)***	Landings	Total discards*	Discard rate (by number)	Dead discard rate (by number)	Mean weight in landings	Mean weight in discards
	millions					%	tonnes		%		grammes	
2002	1070	84	55	18	68	6.3	1154	192	24.5	19.6	21.2	10.8
2003	1246	187	44	18	58	4.6	933	183	29.3	23.7	21.2	10.0
2004	1410	108	29	11	38	2.7	525	112	28.2	22.9	18.1	9.9
2005	1092	62	42	20	57	5.2	778	182	31.7	25.9	18.4	9.2
2006	627	76	n/a	n/a	50	7.9	637	n/a	n/a	n/a	n/a	n/a
2007	920	62	n/a	n/a	57	6.2	913	n/a	n/a	n/a	n/a	n/a
2008	541	47	48	22	65	12.0	1057	248	31.4	25.6	21.94	11.23
2009	696	43	25	9	32	4.6	625	129	27.6	22.2	25.12	13.63
2010	879	47	37	15	49	5.6	939	224	29.0	23.4	25.16	14.70
2011	672	48	32	9	38	5.7	659	92	21.1	16.7	20.62	10.75
2012	468	52	61	8	67	14.4	1246	86	12.0	9.2	20.40	10.39
2013	441	65	60	12	69	15.7	1295	129	16.7	13.1	21.59	10.73
2014	383	57	34	5	38	9.8	766	48	12.9	10.0	22.62	9.56

Year	UWTV abundance estimate	95% Confidence Interval	Landings in number	Total discards in number*	Removals in number	Harvest rate (by number)***	Landings	Total discards*	Discard rate (by number)	Dead discard rate (by number)	Mean weight in landings	Mean weight in discards
	millions					%	tonnes		%		grammes	
2015	556	71	18	2	19	3.4	370	15	8.4	6.4	20.91	9.13
2016	379	41	30	6	35	9.2	641	69	17.4	13.7	21.21	10.85
2017	404	41	13	4	16	4.0	295	38	21.4	16.9	22.23	10.46
2018	554	83	22	10	30	5.4	536	106	32.2	26.3	24.33	10.11
2019	493	66	8	2	9	1.9	167	21	21.7	17.2	22.00	9.94
2020	394	59	10	4	12	3.1	222	54	27.0	21.7	23.31	15.29
2021	331	31	23	7	28	8.5	498	88	23.6	18.9	21.88	12.48
2022	331*											

*** 2022 abundance estimate used in the assessment was based on 2021 UWTV survey abundance estimate.**

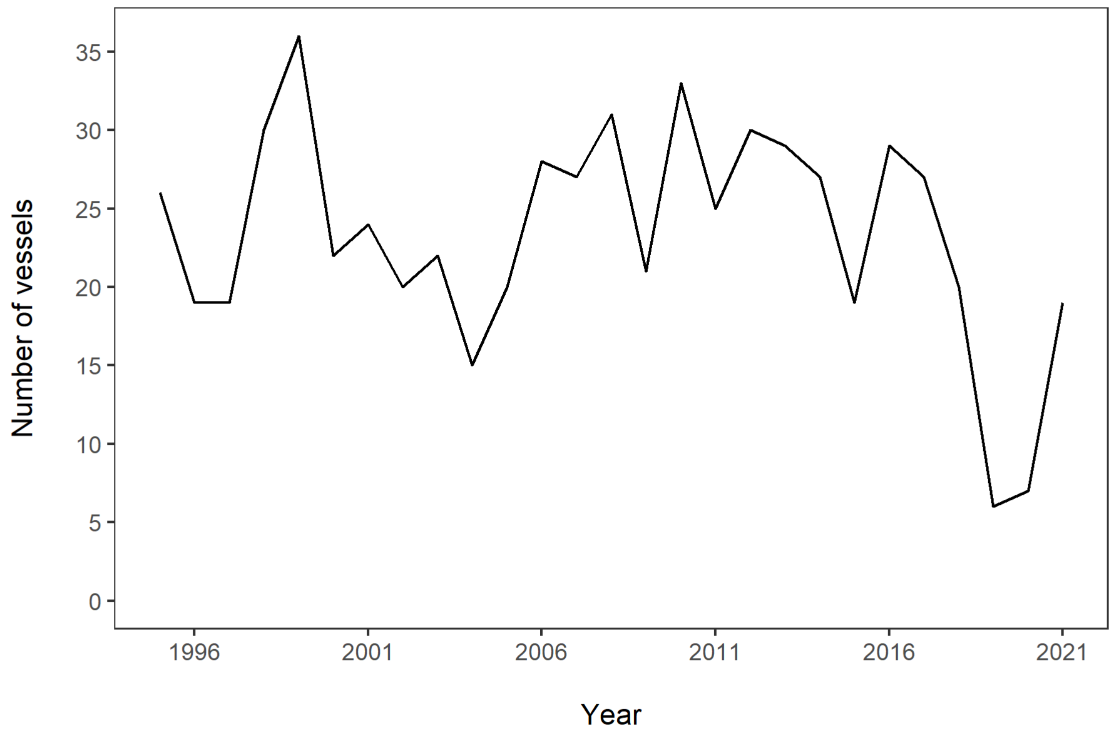


Figure 21.1.1. *Nephrops* in FU17 (Aran Grounds). Time-series of the number of Irish vessels reporting landings of *Nephrops* from FU17 with a >10 t threshold.

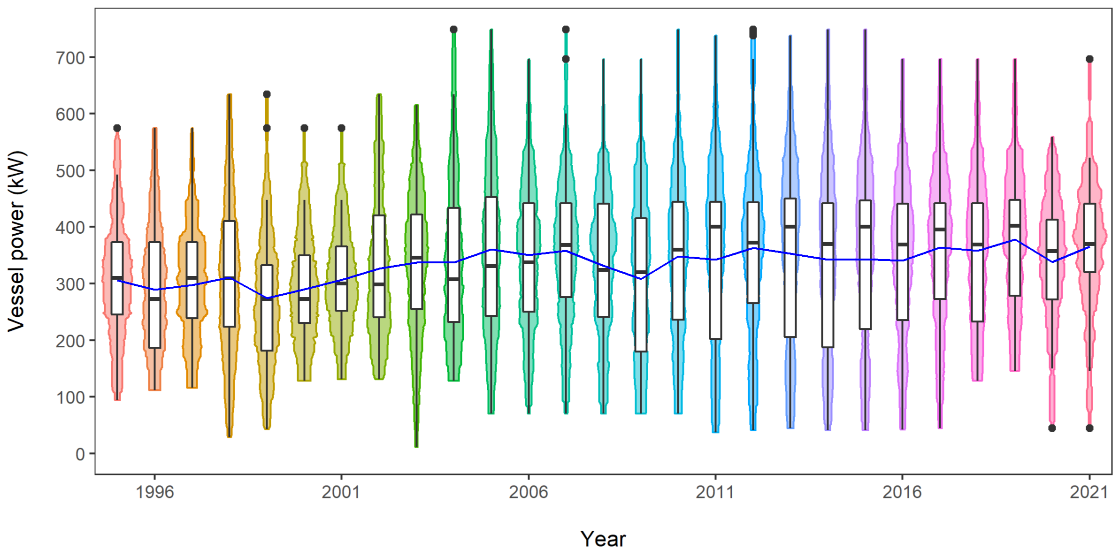


Figure 21.1.2. *Nephrops* in FU17 (Aran Grounds). Combined box and kite plot of Irish vessel's power on the Aran Grounds by year. The blue line indicates the mean.

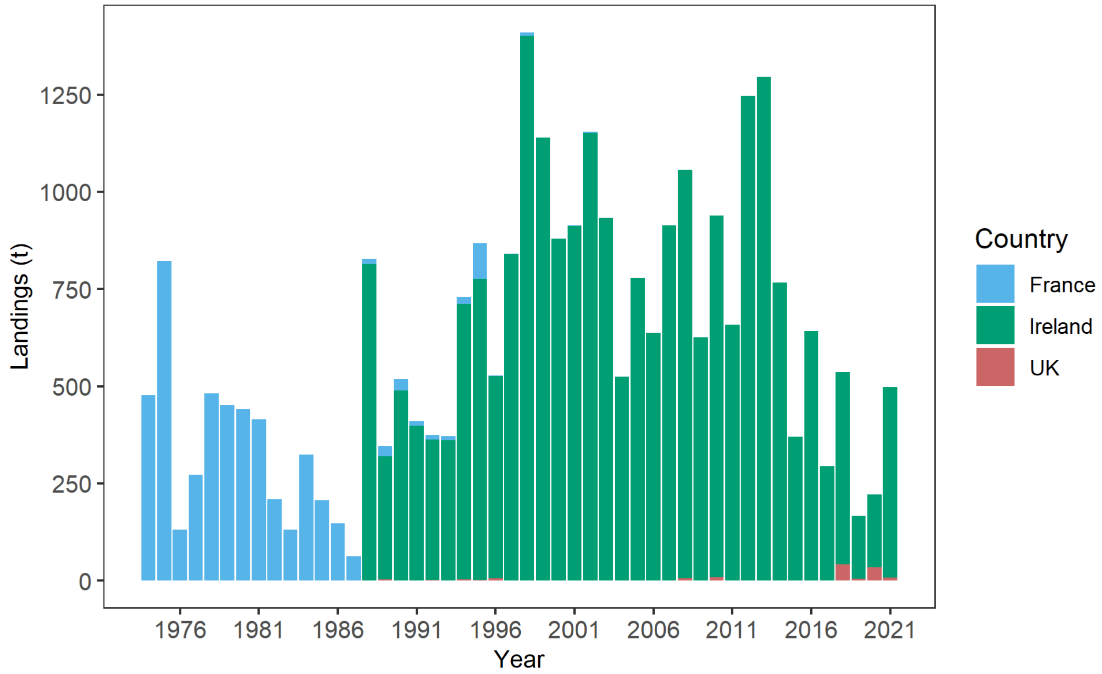


Figure 21.2.1. ***Nephrops*** **in FU17 (Aran Grounds). Landings in tonnes by country.**

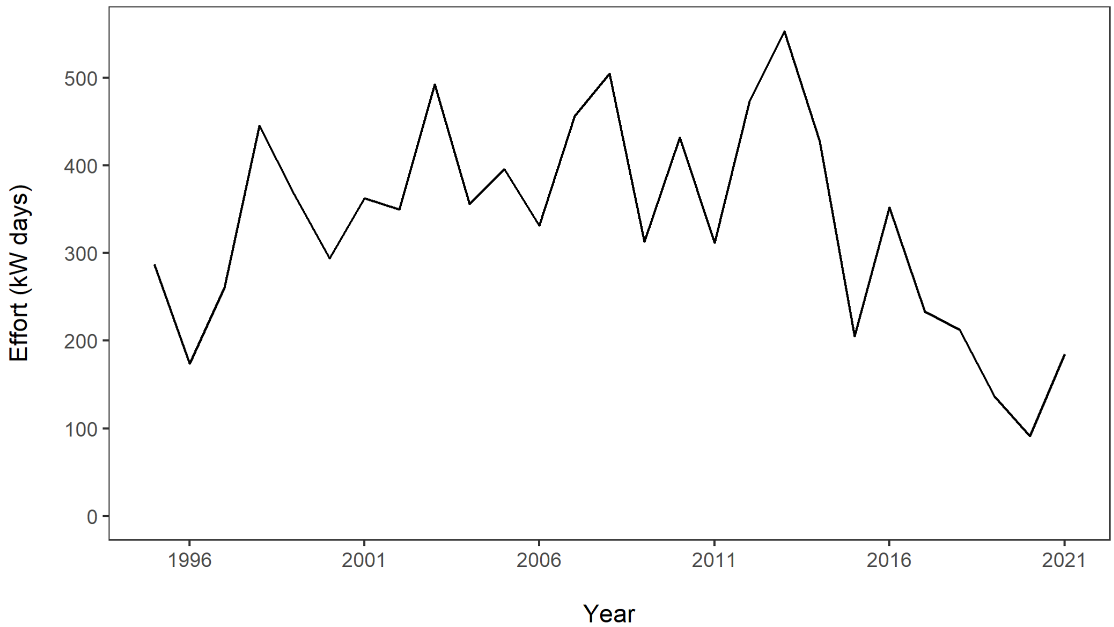


Figure 21.2.2. ***Nephrops*** **in FU17 (Aran Grounds). Effort data (kW days) for Irish directed** ***Nephrops*** **fleet.**

Figure 21.2.3. *Nephrops* FU17 (Aran Grounds). Sampling levels for the Aran grounds.

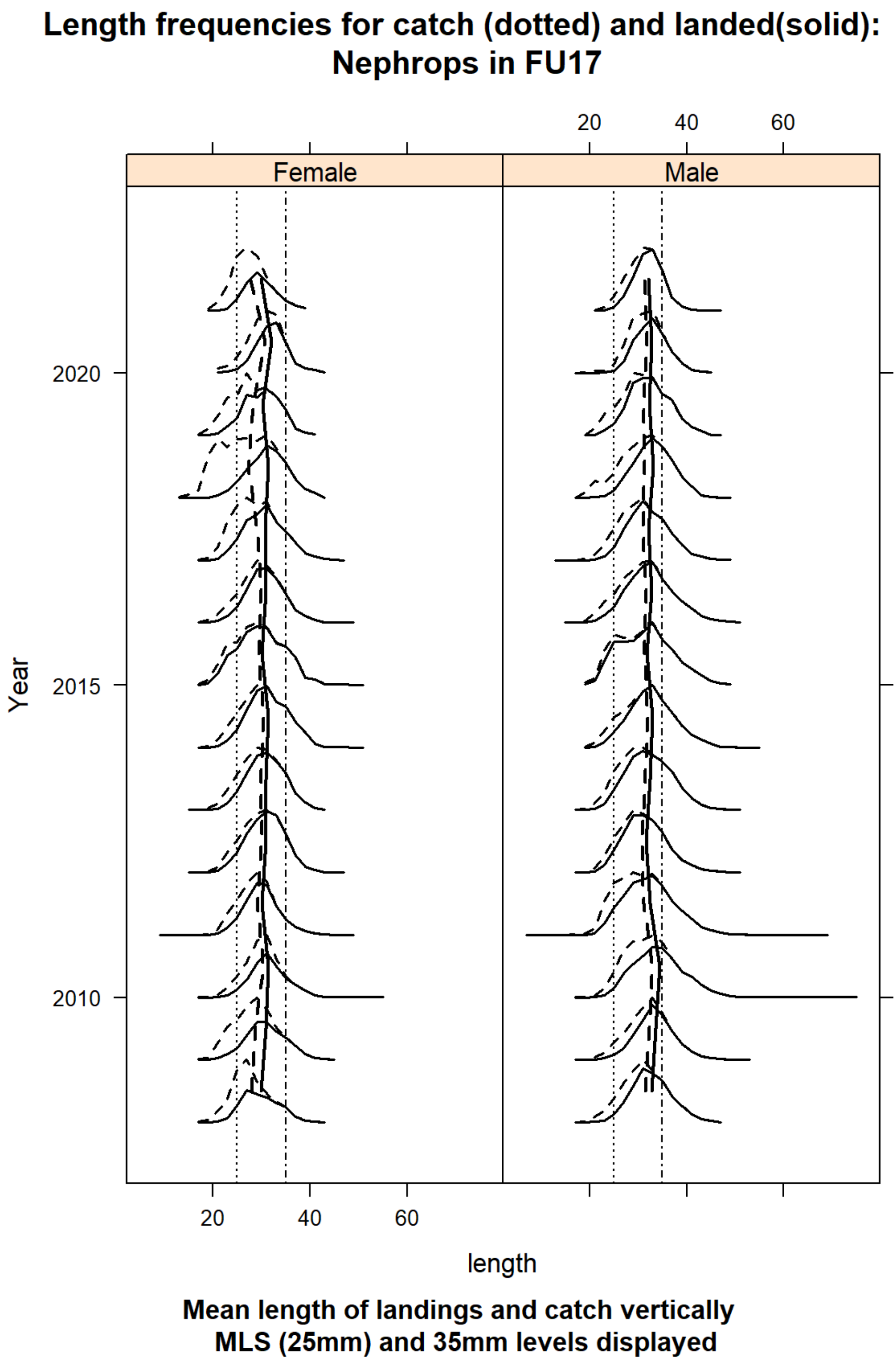


Figure 21.2.4. ***Nephrops*** **FU17 Aran Grounds. Annual length composition of catches (dotted line) and landings (solid line) for females (left) and males (right) from 2008 (bottom) to 2020 (top). Annual mean length of catches (dotted vertical line) and landings (solid vertical line) are also shown. Minimum Landing Size (25 mm) and 35 mm levels are also displayed with vertical lines.**

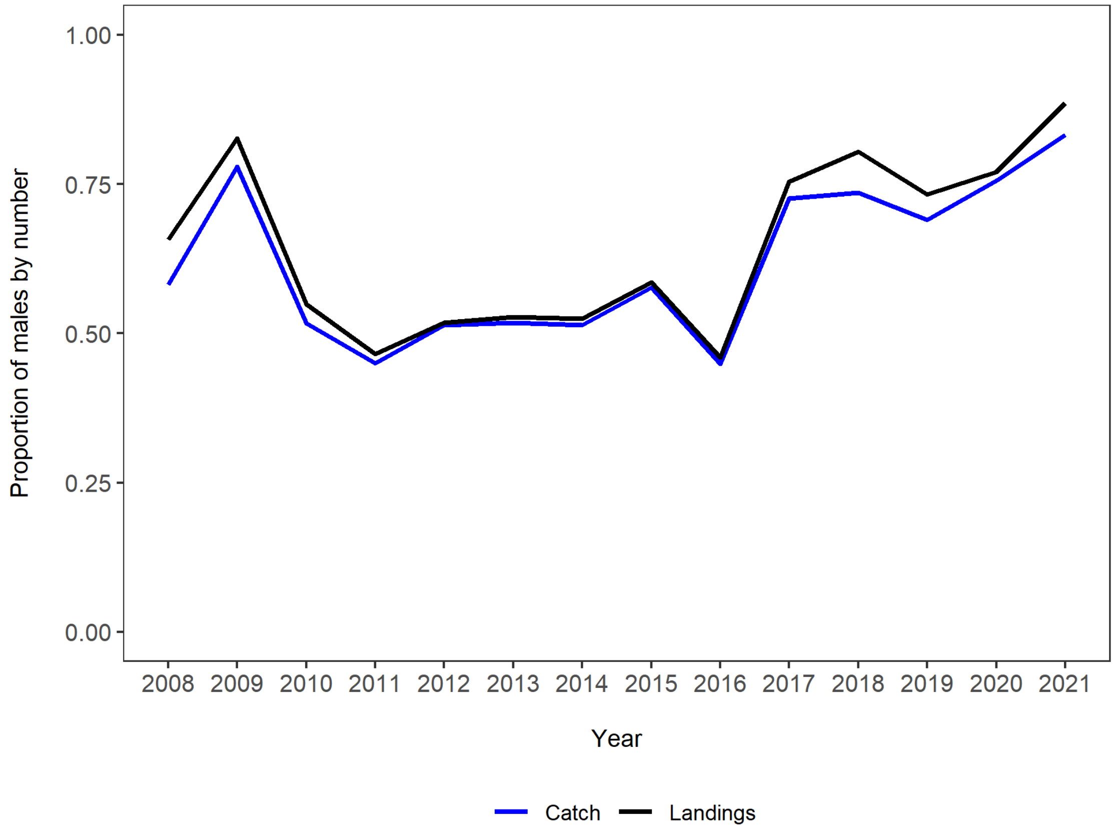


Figure 21.2.5. ***Nephrops*** **FU17 (Aran Grounds). Proportion of males by number in the catch (blue) and landings (black).**

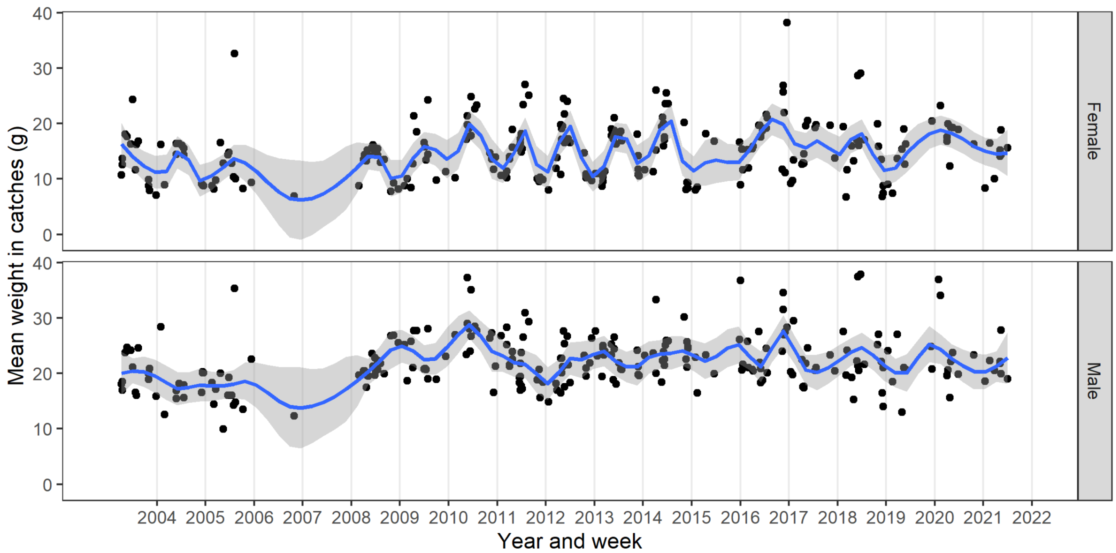


Figure 21.2.6. ***Nephrops*** **FU17 (Aran Grounds). Mean weight in catch samples by sex showing cyclical trends.**

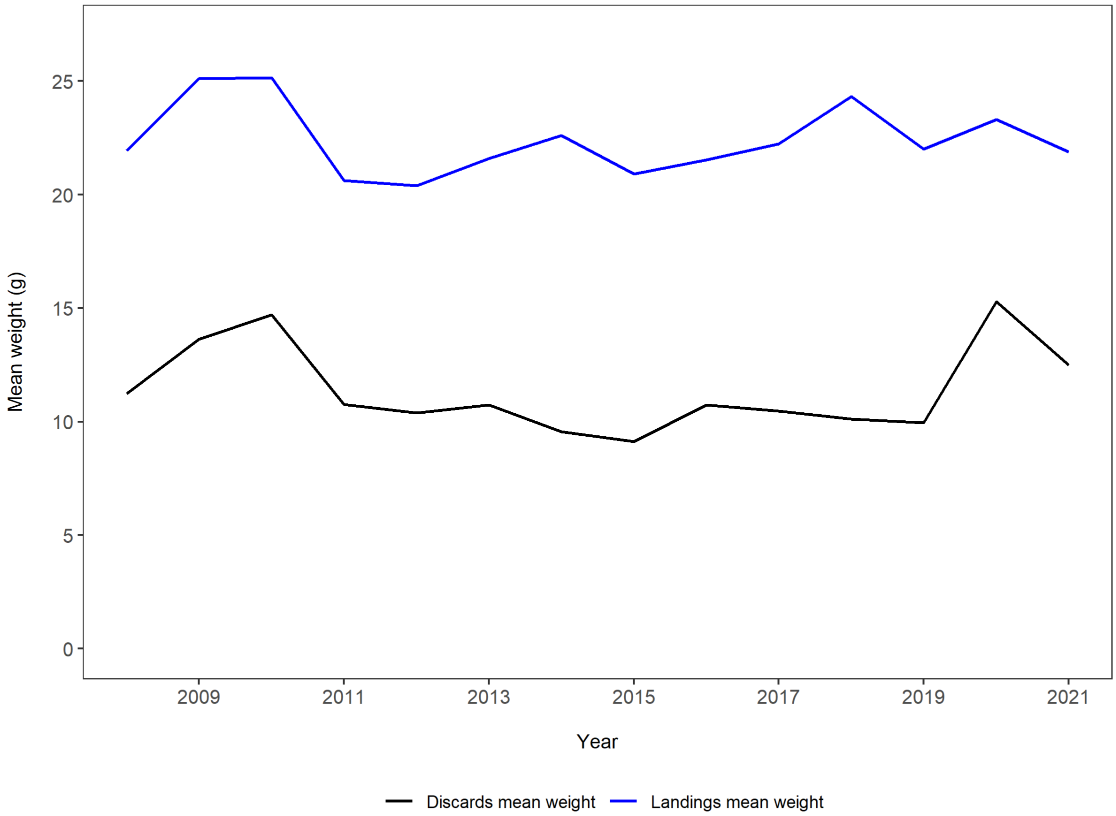


Figure 21.2.7. *Nephrops* FU17 (Aran Grounds). Annual mean weight (g) estimates of landings (blue) and discards (black).

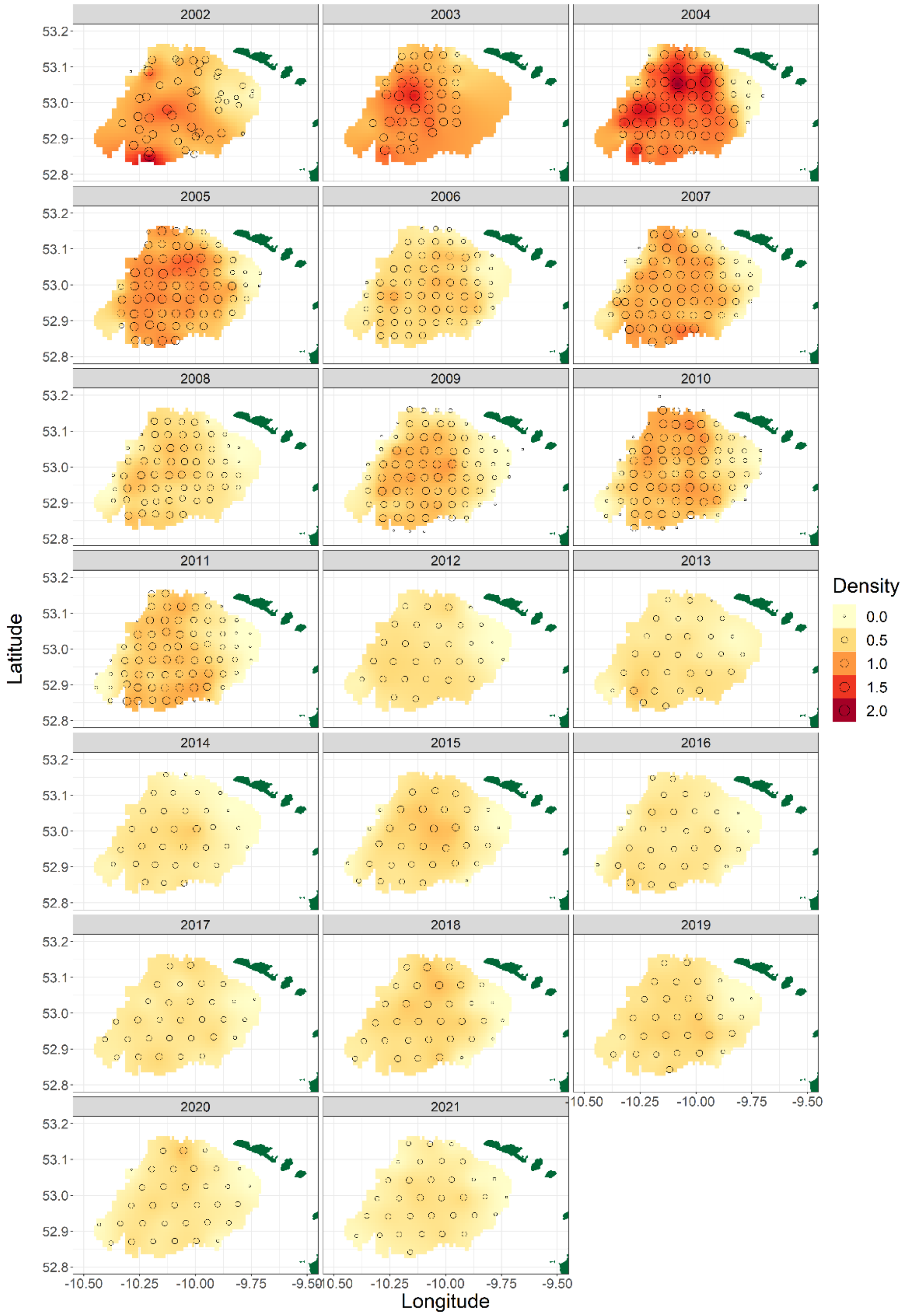


Figure 21.2.8. *Nephrops* **in FU17 (Aran Grounds). Contour plots of the krigged density estimates for the Aran Ground UWTV surveys from 2002 (top left) to 2021 (bottom). No UWTV survey in 2022.**

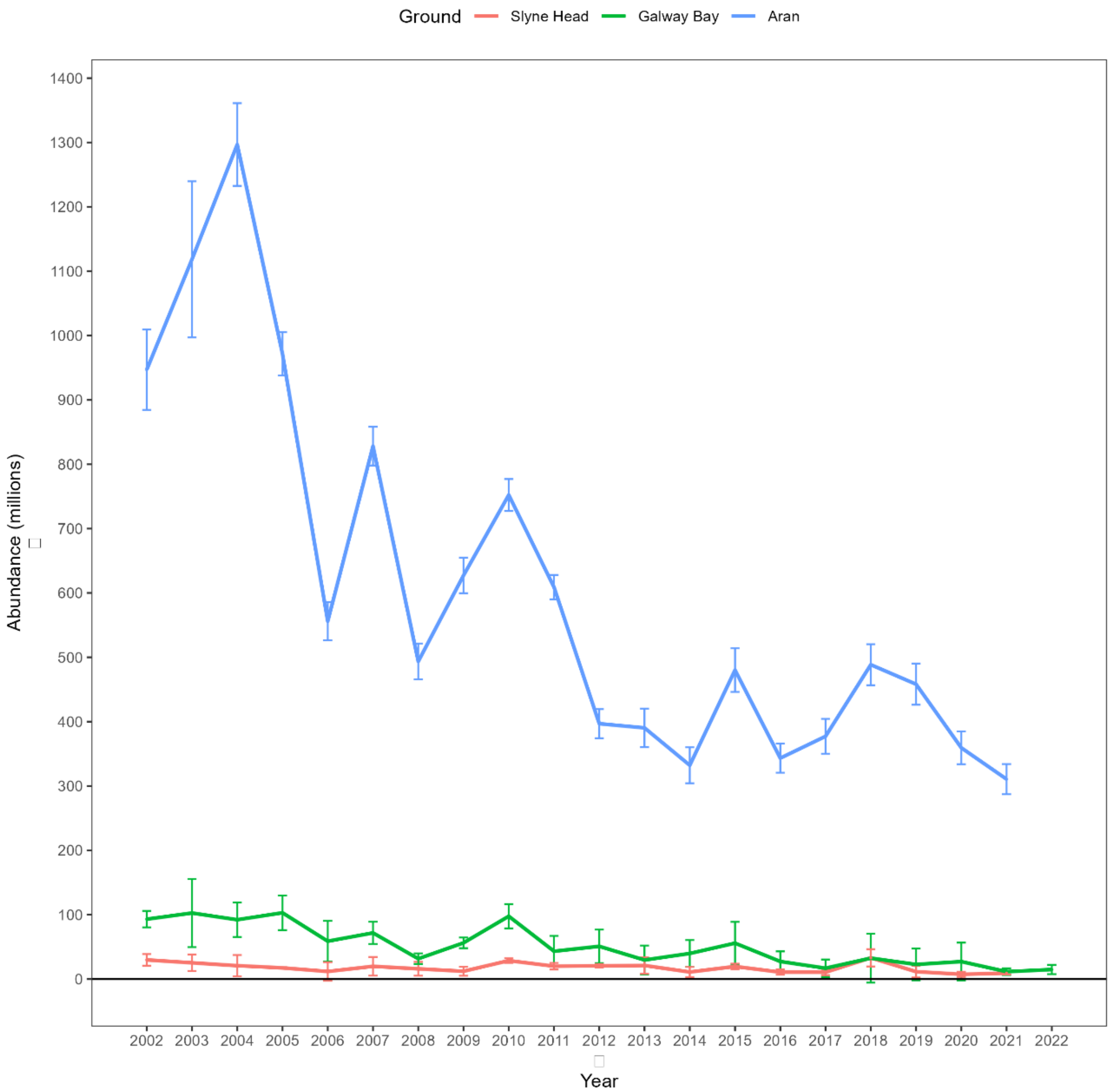


Figure 21.2.9. *Nephrops* FU17 Aran Grounds. *Nephrops* burrow estimates in FU17 Aran (blue), Galway Bay (green) and Slyne Head (red) grounds 2002–2021. 2022 UWTV was only carried out in Galway Bay.

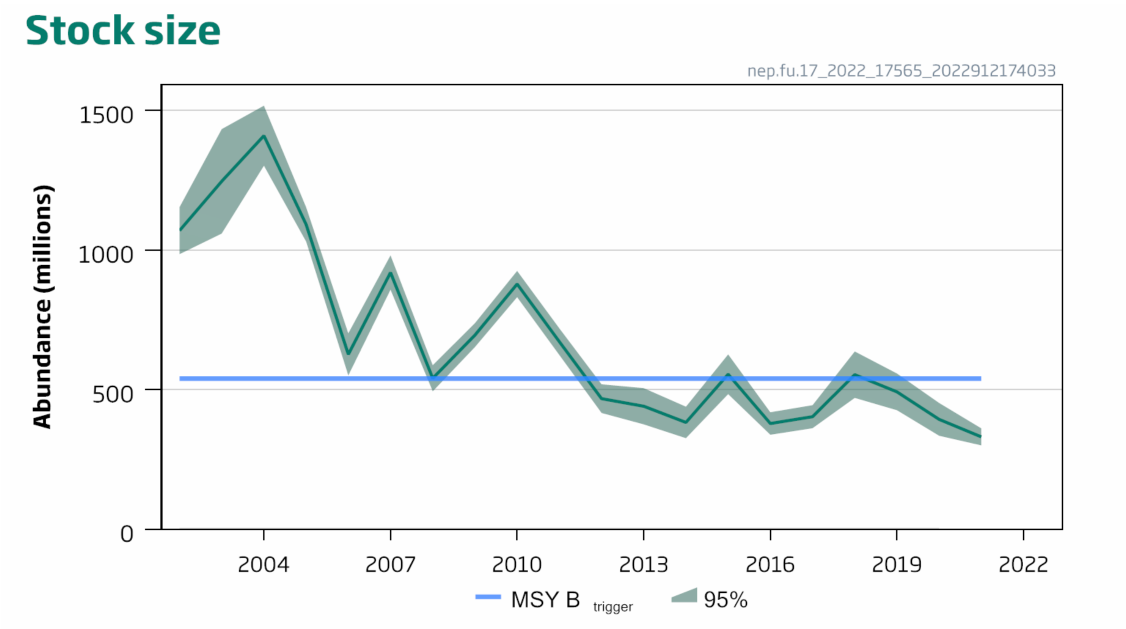


Figure 21.2.10. Time-series of total abundance estimates for FU17.

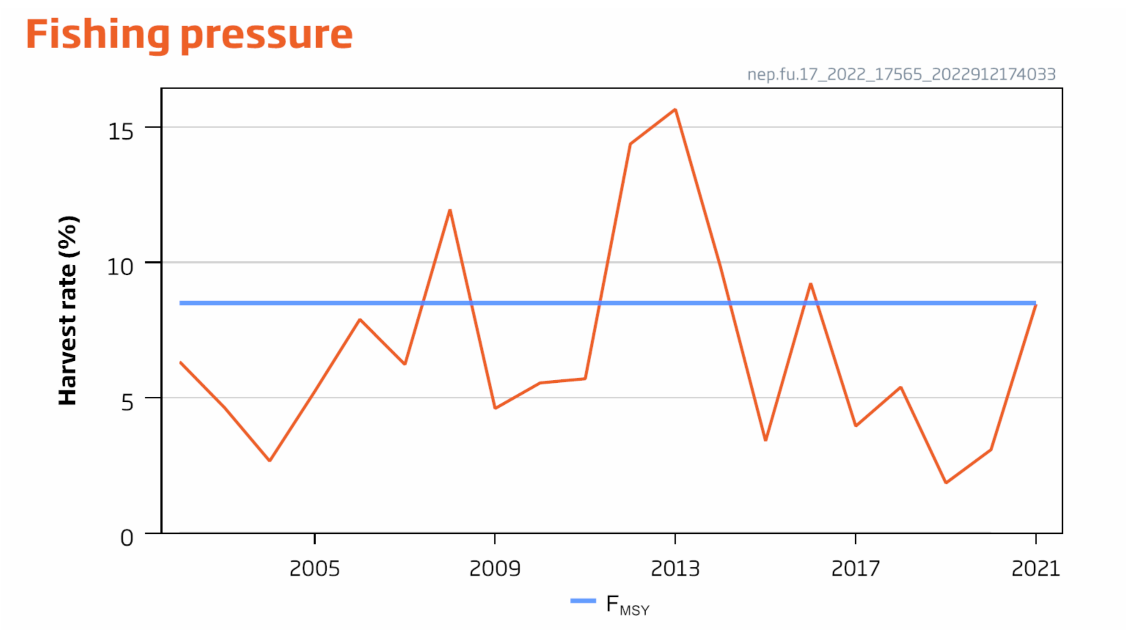


Figure 21.3.1. *Nephrops* FU17 Aran Grounds. Harvest Rate represented by red line (% dead removed/UWTV abundance).

19 Norway lobster (*Nephrops norvegicus*) in divisions 7.a, 7.g and 7.j, Functional Unit 19 (Irish Sea, Celtic Sea, eastern part of southwest of Ireland)

Type of assessment in 2022

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. This stock assessment is available in the ICES Transparent Assessment Framework (TAF) here.

ICES advice applicable to 2021

"ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2021 that correspond to the F ranges in the MAP are between 531 tonnes and 595 tonnes, assuming recent discard rates. The entire range is considered precautionary when applying the ICES advice rule.
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 2022

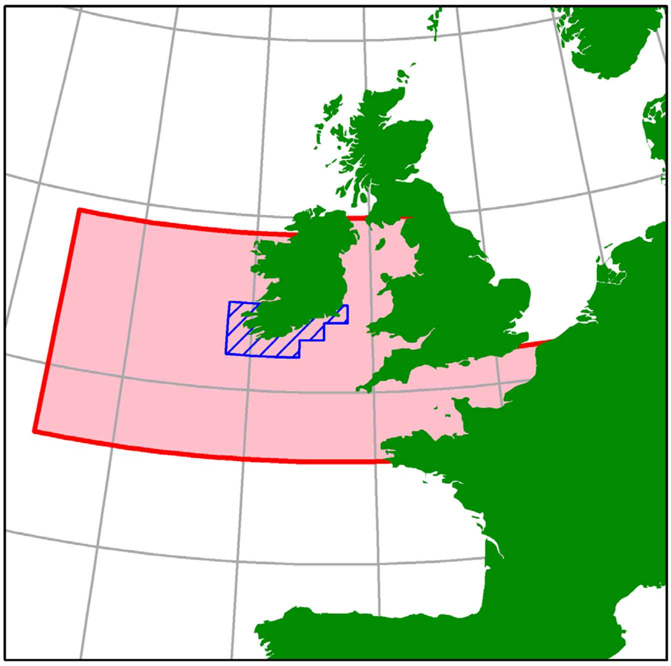
"ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2018–2020, catches in 2022 that correspond to the F ranges in the MAP are between 337 and 378 tonnes.
To ensure that the stock in Functional Unit (FU) 19 is exploited sustainably, management should be implemented at the FU level."

19.1 General

Stock description and management units

In FU19 *Nephrops* are caught on a large number of spatially discrete small inshore grounds and on some larger grounds further offshore and of these the 'Galley ground 4' and around Cork channels appear to be the most important (see Figure 19.1.1). 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 19.1.2. The numbers of vessels has been relatively stable from 1995 except since 2018, where there was a sharp decrease that has levelled. The time-series of vessel power is shown as a box and kite plot in Figure 19.1.3.

Fishery in 2021

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 five vessels in 2021.

Information from stakeholders

None available.

19.2 Data

InterCatch

All data were available in InterCatch and used for catch data only. French catch data provided directly by the national expert and not extracted from InterCatch.

Landings

Landings data for FU19 are summarized in Table 19.2.1. Ireland, France and the UK report landings for FU19. Landings data for Ireland were revised back to 2008 which resulted in minor revisions in the order of 1 to 5 % (stock annex). These revised data has been used in the assessment this year. The Republic of Ireland landings have fluctuated considerably throughout the time-series, with a marked dip in 1994 (Table 19.2.1; Figure 19.2.1). The highest landings in the time-series were observed in 2002–2004 (>1000 t). Landings in 2005 and 2006 have been below average for the series. In 2017 landings decreased by approximately 30% for the Irish fleet and were below the series average. This can be explained due to the poor weather conditions in quarter 1 which hampered fishing activities of smaller vessels and the larger vessels maximising effort in other FUs. There was a minor revision to 2018 landings for Ireland. Landing in 2021 were at a similar level to that reported in 2016. 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 1.1 t in 2020. There was a minor revision to the 2019 UK(E&W) landings due to a code error (from 1.4 t to 1.1 t). Landings from the UK are minor < 0.5 t in 2020. This had a minimal effect on combined international data workup for that fishery year (Table 19.3.1.).

Total landings for years 2019 (value 249.1477 t) and 2020 (value 248.9602 t) are the same (249 t) due to rounding.

WGCSE 2022 discovered a code error in year 2019 assessment where the international scaling was not carried out fully. This revision was presented to WGCSE 2022 and resulted in changes to numbers in landings, discards, removals, harvest rate and mean weights for year 2019. Table 19.3.1 is updated to reflect this change.

This data revision affects advice issued by WGCSE 2021 where the input year range is recent three year average (2018, 2019, 2020).

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 1995–2021 for all vessels and vessels >18 metres total length. (Table 19.2.2; Figure 19.2.2). For vessels >18 effort (since early 2000s) has fluctuated with an overall decreasing trend in recent three years. This can be explained by fleet mobility where vessels target *Nephrops* in this area in periods of good emergence. For vessels <18 effort has decreased in 2017 to 2019 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 21.2.3 and Table 21.2.3. Sampling levels in 2021 were good and are comparable to recent levels.

Commercial length–frequency distributions

Length–frequency data of the landings were collected on a regular basis from 2002 to 2020. Spatial and temporal coverage is problematic with landings from FU19 coming from several discrete grounds (see stock annex.) The sampling intensity and coverage has varied over the time-series (see stock annex). Since 2008 sampling has been good although the majority of the samples come from Bantry Bay recently. Also sampling of the discards is quite sparse over the time-series and are difficult to obtain due to the spatial coverage of the grounds. The catch samples from 2008 to 2021 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 19.2.4. 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 19.2.5). 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 all grounds combined (Figure 19.2.6). 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 19.2.7. The landings mean weight estimates increased in 2019 and then show a decrease in 2020.

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 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 catch data were split using this selection ogive for the time series to date.

Discard rates range between 25–86% of total catch by weight and 40–80% of total catch by number (Table 19.2.4). These high discard rates are very high compared with other FUs. This is because the fleet is mainly smaller inshore vessels with limited space for extra crew. On-board "tailing" of the smaller *Nephrops* is not usually practised and the bigger *Nephrops* are picked from catches. There is no information on discard survival rate in this fishery but a 25% discard survival rate is assumed in line with other *Nephrops* stocks in the Celtic Sea.

Gear selectivity trials by Bord Iascaigh Mhara (BIM, 2017) reported a 64% survivor rate for *Nephrops* caught in a trawl with a SELTRA selectivity device in the outer Galway Bay area.

Table 19.3.1 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 [U5917] of *Nephrops* stocks around Ireland and elsewhere are documented by WKNEPHTV (ICES, 2007), WKNEPHBID (ICES, 2008), SGNEPS (ICES, 2009; 2010; 2012), WGNEPS (ICES, 2013; 2014; 2015; 2016a; 2017; 2018a, 2020, 2021, 2022), WKNEPS (ICES, 2016b; 2018b), Leocádio, A., *et al*, 2018 and Dobby H., *et al*, 2021. SGNEPS 2012 (ICES, 2012) recommended that a CV (or relative standard error) of <20% as an acceptable precision level for UWTV survey estimates of abundance. 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 19.1.1. 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 19.2.5). Helvick patches 2 and 3 were also amalgamated and renamed Helvick 2 based on the information from the VMS data.

From 2011 to 2022 an average of 42 stations have been completed annually. The survey design is based on randomly picked stations from the ground polygons and the sampling effort on each ground was determined by relative area.

All grounds except Galley Ground 4 in 2011 and Galley Ground 1 in 2012 were covered by the TV survey. Since 2015 a new patch Kenmare Bay was surveyed.

Detailed summary statistics for the various *Nephrops* patches in FU19 over the time-series are presented in Table 21.2.6. The mean density varies across the different patches, but there is some consistency to the estimates over time. In 2022 all discrete grounds were covered by the TV survey (Doyle *et al.*, 2022).

The 2022 mean density estimates vary between patches from the lowest value 0.04 (no./m²) observed at Kenmare Bay to the highest observed at 0.39 (no./m²) at Galley ground 2 (Table 19.2.6, Figure 19.2.8). The overall mean density for FU19 in 2022 is 0.13 (no./m²) which is the lowest observed in the time-series (Table 19.2.7).

Figure 19.2.9 and Table 19.2.7 shows the total abundance estimate for FU19 with the WKMSYRef4 proposed MSY $B_{trigger}$ (ICES, 2016XX, ICESYY). The 2022 abundance estimate was 4% lower than in 2021 and at 259 million is below the MSY $B_{trigger}$ (430 million) with a RSE of 14% 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-Q4: IGFS-WIBTS-Q4 [G7212] from 2003–2021 are available (Stokes *et al.*, 2014; ICES, 2015). These data were investigated for trends in indicators such as possible recruitment signals (Figure 19.2.10). The mean size of males and females in from the survey was fairly stable over time at 33 mm for males and 25 mm for females.

19.3 Assessment

Comparison with previous assessments

The WGCSE 2019 carried out an UWTV based assessment for this stock. The methods used were very much in line with WK*NEPH* (ICES, 2009) and the approach taken for other *Nephrops* stocks in 6 and 7 by WGCSE. This approach was benchmarked at WKCELT 2014 (ICES, 2014).

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated with a declining trend in the recent five years. The 2022 estimate is the lowest observed and is below the MSY $B_{trigger}$. The 2022 abundance remains below the average of the series (geomean: [2011–2022]: 401 million).

Table 19.3.1 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 19.3.1.and Figure 19.3.1 summarize recent harvest ratios which have been below the F_{MSY} proxy for the last three years.

19.4 Catch scenario table

Catch scenario table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 19.3.1 and summarised below.

The basis for the catch options:

Variable	Value	Notes
Stock abundance (2023)	259	Numbers of individuals (millions); UWTV survey 2022
Mean weight in projected landings	27.2	Average 2019–2021in grammes
Mean weight in projected discards	13.5	Average 2019–2021 in grammes
Projected discards	48.6	Proportion by number; average 2019–2021
Discards survival	25	Proportion by number
Projected dead discards	41.5	Proportion by number; average 2019–2021

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 2022 UWTV survey. This will be presented in October 2022 for the provision of advice.

19.5 Reference points

WKMSYRef4 updated the F_{MSY} reference points for FU19 (ICES, 2016XX; 2016YY) on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. The updated harvest rate calculated at 9.3% is expected to deliver high long-term yield with a low probability of recruitment overfishing. This is close to the harvest rate of 8.1% calculated by WKCELT (ICES, 2014)

This stock previously did not have MSY $B_{trigger}$ specified, the time-series and range of indicator biomass is also limited such that direct use of B_{loss} is considered too close to equilibrium biomass. The workshop proposed to use the 5% interval on the probability distribution of indicator biomass assuming a normal distribution, which is analogous to the 5% on B_{MSY} proposed for finfish stocks assuming these *Nephrops* FU have been exploited at a rate close to near HR_{MSY}. The MSY $B_{trigger}$ for FU 19 is 434 million individuals rounded to 430 million.

These reference points shown in text table below should remain under review by WGCSE should improved data become available.

Stock code	MSY Flower*	FMSY*	MSY Fupper* with AR	MSY Btrigger	MSY Fupper* with no AR
nep-19	8.3%	9.3%	9.3%	430***	9.3%

*** Harvest rate (HR).**

***** Abundance in millions.**

19.6 Management strategies

No specific management plan exists for this stock.

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES subarea 7 and also demersal stocks.

19.7 Quality of assessment and forecast

Biological sampling for this stock is improving given the spatial distribution of the *Nephrops* mud patches. A number of other biological parameters such as mean weights and length distributions have also been revised. The revisions were made as part of the benchmark process and have improved the quality of the assessment.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. For FU19 deterministic estimates of the mean weight in the landings and discard rates for 2019–2021 are used although there is some variability of these over time.

From 2016, fisheries catching *Nephrops* in Subarea 7 are covered by the EU landings obligation (EU, 2015). Creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 5% discard rate by weight for the trawl fishery in 2019 (reduced from 6% in 2018 and 7% in both 2016 and 2017).

Irish discard survival experiments indicate that the trawl discard survival may be around 64% (BIM, 2017). As a result, an exemption from the landings obligation based on high survivability has been granted by the European Commission. The average discard rate by weight for FU19 over the last three years is 32%. Catch advice and scenarios are provided this year on the assumption that discarding is assumed to continue at the recent average.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009; WGNEPS 2014). Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al.*, 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise WK*NEPH* (ICES, 2009). Different densities are apparent on the various different grounds within this FU. For the 2022 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 0.13 with a RSE of around 14% which is below the 20% threshold recommended by SGNEPS (ICES, 2012). The cumulative bias estimates for FU19 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterized, but is likely to be lower than that observed in the survey.

Landings data are adjusted to take into account landings that have been misreported from FU16 since 2011. This adjustment is thought to be reasonably accurate (See Section 19).

19.8 Recommendations for next benchmark

This stock was benchmarked by ICES in February 2014 (ICES, 2014). WGCSE will keep the stock under close review and recommend future benchmark as required.

19.9 Management considerations

The trends from the fishery (landings, effort, mean size, etc.) appear to show a decline. The UWTV abundance and mean density estimates vary between the discrete patches and population dynamics between these are not fully understood. The 2022 survey result is the lowest observed in the time-series.

In recent years several newer vessels specializing in *Nephrops* fishing have participated in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. Since the introduction of effort management associated with the cod long-term plan (EC 1342/2008) there have been concerns that effort will be displaced towards FU19 and other *Nephrops* grounds where effort control has not been put in place.

Nephrops fisheries in this area are fairly mixed also catching megrim, anglerfish and other demersal species. There are also some catches of hake, and in the offshore parts of the area. The *Nephrops* grounds in FU19 coincide with an important nursery area for juvenile hake and anglerfish among other species (ICES, 2009).

19.10 References

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Table 19.2.1. *Nephrops* in FU19 (SW and SE Ireland). Landings in tonnes by country. The figures in the table are rounded. Calculations were done with unrounded inputs and computed values may not match exactly when calculated using the rounded figures in the table.

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	694
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	1240
2004	76	997	1	1074
2005	62	648	2	712
2006	65	675	1	741
2007	63	894	0	957
2008	46	790	15	851
2009	55	798	15	868
2010	14	660	13	687
2011	23	619	1	643

Year	FU 19			
	France	Rep. of Ireland	UK	Total
2012	11	837	1	849
2013	4	783	6	794
2014	6	459	3	468
2015	5	502	0	507
2016	4	583	3	590
2017	4	412	4	420
2018	4	229	5	238
2019	2	247	1	249
2020	1	247	1	249
2021	1	413	1	415

Table 19.2.2. *Nephrops* in FU19 (SW and SE Ireland). Irish *Nephrops* directed effort (Kw Days) and landings. Irish Fleet - *Nephrops* trawlers (>30% landings weight)

Year	All Vessels		Vessels >18 m	
	kW days ('000)	Landings Tonnes	kW days ('000)	Landings Tonnes
1995	222.0	380	80.7	121
1996	178.6	355	55.6	86
1997	161.0	306	53.9	101
1998	329.6	498	144.6	189
1999	182.9	236	42.3	47
2000	142.0	217	56.2	86
2001	193.3	397	89.1	139
2002	506.7	883	323.7	446
2003	555.9	693	318.8	364
2004	488.1	558	303.0	311
2005	405.0	471	220.6	219
2006	424.2	478	208.8	186
2007	558.8	713	287.4	262
2008	534.1	643	288.1	319
2009	472.0	613	224.5	243
2010	382.2	494	103.7	114
2011	337.3	449	142.9	167
2012	355.5	541	91.9	126
2013	336.1	571	88.6	133
2014	213.6	332	52.1	74
2015	244.6	393	85.5	118
2016	287.3	558	111.2	233
2017	118.2	425	111.4	179
2018	71.6	107.1	24.1	29.9
2019	91.4	145.9	31.6	37.5

Year	All Vessels		Vessels >18 m	
	kW days ('000)	Landings Tonnes	kW days ('000)	Landings Tonnes
2020	72.3	133.4	12.7	19.1
2021	125	261	29	47

Table 19.2.3. *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

Year	Quarter	Number of samples			Numbers Measured		
		Catch	Discards	Landings	Catch	Discards	Landings
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 19.2.3. Continued.

Year	Quarter	Number of samples			Numbers Measured		
		Catch	Discards	Landings	Catch	Discards	Landings
2017	1	4	4	0	1860	1283	0
2017	2	3	3	0	1572	1281	0
2017	3	2	2	0	998	943	0
2017	4	4	2	0	1200	785	0
2018	1	1	1	0	304	380	0
2018	2	7	7	0	3579	3230	0
2018	3	1	1	0	255	275	0
2018	4	1	1	0	370	404	0
2019	1	4	5	0	1630	2222	0

Year	Quarter	Number of samples			Numbers Measured		
		Catch	Discards	Landings	Catch	Discards	Landings
2019	2	3	3	0	1275	1398	0
2019	3	0	0	0	0	0	0
2019	4	4	4	0	1810	1798	0
2020	1	2	2	0	728	702	0
2020	2	7	7	0	3095	2855	0
2020	3	1	1	0	489	404	0
2020	4	3	4	0	1671	1900	0
2021	1	2	2	0	842	782	0
2021	2	5	5	0	2530	2484	0
2021	3	3	3	0	1497	1326	0
2021	4	4	4	0	2363	2415	0

Table 19.2.4. *Nephrops* in FU19 (SW and SE Ireland). Landings and estimated discards by weight.

	Female		Male		Both sexes
Year	Landings (t)	Discards (t)	Landings (t)	Discards (t)	% Discard
2008	99	29	691	69	11.0
2009	117	106	681	141	23.7
2010	138	98	522	148	27.2
2011	169	155	450	250	38.9
2012	190	202	647	265	35.8
2013	259	210	525	220	35.4
2014	106	71	353	87	25.6
2015	79	64	423	101	24.8
2016	154	91	429	100	24.7
2017	133	58	280	79	24.9
2018	71	27	157	40	22.9
2019	66	48	181	63	31.1
2020	40	46	207	89	35.3
2021	83	63	331	109	29.4

Table 19.2.5. *Nephrops* in FU19 (SW and SE Ireland). Landings and estimated discards by number.

	FEMALE NUMBERS '000S		MALE NUMBERS '000S		BOTH SEXES
Year	Landings	Discards	Landings	Discards	% Discard
2008	3,893	1,781	19,516	3,255	17.7
2009	5,819	8,250	20,324	8,793	39.5
2010	6,276	8,147	16,001	10,117	45.1
2011	7,295	12,895	16,900	18,192	55.7
2012	9,266	17,635	22,540	19,108	53.6
2013	11,680	18,945	17,399	17,034	55.3
2014	4,862	5,647	11,183	5,572	41.1
2015	3,706	5,255	13,111	6,462	41.1
2016	6,877	6,761	12,610	6,668	40.8
2017	5,295	4,400	9,022	5,044	39.7
2018	2,908	1,866	5,197	2,454	34.8
2019	2,970	3,909	6,023	4,474	48.2
2020	2,006	3,971	7,595	6,026	51.0
2021	3,701	5,133	10,817	7,481	46.5

Table 19.2.6. *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 19.2.7. *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 (burrow/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	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

Year	Ground	N	Mean Density	sd	se	ci
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
2016	Bantry	4	0.20	0.07	0.04	0.12
2016	Cork Channels	10	0.21	0.11	0.03	0.08
2016	Galley Grounds 1	2	0.03	0.01	0.01	0.08
2016	Galley Grounds 2	2	0.53	0.12	0.09	1.11
2016	Galley Grounds 3	4	0.16	0.12	0.06	0.19
2016	Galley Grounds 4	14	0.17	0.20	0.05	0.12
2016	Helvick 1	2	0.38	0.08	0.06	0.70
2016	Helvick 2	2	0.07	0.09	0.06	0.81
2016	Kenmare Bay	2	0.24	0.15	0.11	1.33
2017	Bantry	3	0.29	0.15	0.09	0.37
2017	Cork Channels	10	0.25	0.20	0.06	0.14
2017	Galley Grounds 1	2	0.24	0.11	0.08	1.00
2017	Galley Grounds 2	2	0.63	0.06	0.04	0.55
2017	Galley Grounds 3	3	0.45	0.12	0.07	0.30
2017	Galley Grounds 4	15	0.16	0.16	0.04	0.09
2017	Helvick 1	2	0.46	0.07	0.05	0.66
2017	Helvick 2	2	0.16	0.23	0.16	2.03

Year	Ground	N	Mean Density	sd	se	ci
2017	Kenmare Bay	2	0.16	0.22	0.16	1.97
2018	Bantry	4	0.06	0.02	0.01	0.04
2018	Cork Channels	10	0.11	0.11	0.04	0.08
2018	Galley Grounds 1	2	0.06	0.01	0.01	0.10
2018	Galley Grounds 2	2	0.19	0.19	0.14	1.75
2018	Galley Grounds 3	4	0.11	0.09	0.05	0.14
2018	Galley Grounds 4	14	0.07	0.08	0.02	0.05
2018	Helvick 1	2	0.11	0.10	0.07	0.92
2018	Helvick 2	2	0.06	0.03	0.02	0.28
2018	Kenmare Bay	2	0.07	0.03	0.02	0.25
2019	Bantry	4	0.13	0.04	0.02	0.06
2019	Cork Channels	10	0.16	0.17	0.06	0.13
2019	Galley Grounds 1	2	0.12	0.17	0.12	1.57
2019	Galley Grounds 2	2	0.66	0.38	0.27	3.40
2019	Galley Grounds 3	4	0.21	0.14	0.07	0.23
2019	Galley Grounds 4	14	0.18	0.23	0.06	0.13
2019	Helvick 1	2	0.34	0.27	0.19	2.46
2019	Helvick 2	2	0.00	0.00	0.00	0.00
2019	Kenmare Bay	2	0.27	0.10	0.07	0.88
2020	Bantry	0.31	0.11	0.05	0.17	0.31
2020	Cork Channels	0.13	0.20	0.06	0.14	0.13
2020	Galley Grounds 1	0.13	0.10	0.07	0.87	0.13
2020	Galley Grounds 2	0.43	0.24	0.17	2.14	0.43
2020	Galley Grounds 3	0.20	0.15	0.08	0.24	0.20
2020	Galley Grounds 4	0.10	0.10	0.03	0.06	0.10
2020	Helvick 1	0.24	0.05	0.04	0.48	0.24
2020	Helvick 2	0.06	0.08	0.06	0.73	0.06
2020	Kenmare Bay	0.18	0.12	0.09	1.11	0.18
2021	Bantry	4	0.09	0.03	0.01	0.04

Table 19.2.7. Continued.

Year	Ground	N	Mean Density	sd	se	ci
2021	Cork Channels	10	0.20	0.19	0.06	0.14
2021	Galley Grounds 1	2	0.08	0.06	0.04	0.54
2021	Galley Grounds 2	2	0.31	0.10	0.07	0.87
2021	Galley Grounds 3	4	0.22	0.13	0.06	0.20
2021	Galley Grounds 4	14	0.09	0.07	0.02	0.04
2021	Helvick 1	2	0.09	0.08	0.05	0.69
2021	Helvick 2	2	0.08	0.05	0.04	0.48
2021	Kenmare Bay	2	0.05	0.03	0.02	0.30
2022	Bantry	4	0.08	0.06	0.03	0.10
2022	Cork Channels	10	0.10	0.13	0.04	0.09
2022	Galley Grounds 1	2	0.06	0.01	0.01	0.13
2022	Galley Grounds 2	2	0.39	0.26	0.19	2.35
2022	Galley Grounds 3	4	0.17	0.05	0.03	0.08
2022	Galley Grounds 4	14	0.15	0.11	0.03	0.07
2022	Helvick 1	2	0.14	0.00	0.00	0.02
2022	Helvick 2	2	0.08	0.08	0.06	0.74
2022	Kenmare Bay	2	0.04	0.05	0.04	0.46

Table 19.2.7. *Nephrops* in FU19 (SW and SE Ireland). Summary statistics for FU19 combined over the time-series.

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*							
2008*							
2009*							
2010*							
2011	35	0.34	0.26	665	836	494	13
2012	40	0.3	0.18	594	705	484	9
2013	40	0.25	0.26	487	648	326	17
2014	40	0.32	0.31	636	823	448	15
2015	39	0.24	0.2	482	608	356	13
2016	42	0.2	0.17	399	498	299	13
2017	41	0.25	0.20	499	619	379	12
2018	42	0.09	0.09	176	229	124	15
2019	42	0.20	0.21	386	514	259	17
2020	42	0.16	0.16	320	412	227	15
2021	42	0.14	0.13	270	347	193	15
2022	42	0.13	0.12	259	332	185	14

*No TV survey from 2007 to 2010.

Table 19.3.1. *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). * 2019 revision due to code error.

Year	Landings in number	Total discards* in number	Removals in number	Discard Rate number	Dead discard rate number	UWTV abundance estimate	95% Conf. intervals	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	**millions**	**millions**	**%**	**%**	**millions**	**millions**	**%**	**tonnes**	**tonnes**	**grammes**	**grammes**
2006	26.2	2.6	28.1	8.9	6.8	na	na	na	741	37	28.3	14.4
2007	30.8	1.5	31.9	4.8	3.6	na	na	na	957	26	31.1	17
2008	25.2	5.4	29.3	17.7	13.9	na	na	na	851	105	33.7	19.4
2009	28.4	18.5	42.3	39.5	32.8	na	na	na	868	269	30.5	14.5
2010	23.2	19.0	37.4	45.1	38.1	na	na	na	687	257	29.6	13.5
2011	25.8	32.4	50.1	55.7	48.5	665	171	7.5	643	409	24.9	12.6
2012	32.3	37.3	60.2	53.6	46.4	594	111	10.1	849	473	26.3	12.7
2013	29.5	36.5	56.8	55.3	48.1	487	161	11.7	794	436	26.9	11.9
2014	16.3	11.4	24.9	41.1	34.4	636	188	3.9	468	161	28.6	14.1
2015	17.0	11.8	25.9	41.1	34.3	482	126	5.5	507	167	29.8	13.8
2016	19.7	13.6	29.9	40.8	34.1	399	99	7.5	590	193	29.9	14.2
2017	14.6	9.6	21.8	39.7	33.1	499	120	4.4	420	139	28.8	14.5
2018	8.4	4.5	11.8	34.8	28.6	176	53	6.7	238	71	28.2	15.7
2019*	9.1	8.5	15.4	**48.2**	**41.1**	386	127	4.0	249	112	**27.4**	**13.3**
2020	9.7	10.1	17.2	**51**	**43.9**	320	93	5.4	249	136	**25.8**	**13.5**
2021	14.6	12.7	24.1	**46.5**	**39.4**	270	77	8.9	415	173	**28.5**	**13.6**
2022						**259**	**73**					
Average 2019–2021				**48.6**	**41.5**						**27.2**	**13.5**

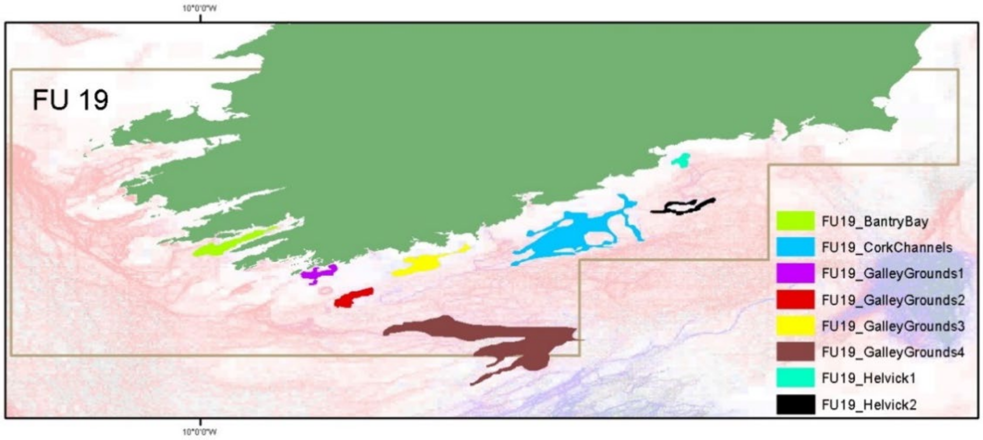


Figure 19.1.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Revised discrete patches overlaid on overlaid on proportion of** ***Nephrops*** **in the Irish landings overlaid on international OTB effort (red=0%** ***Nephrops*****; blue=50–60%** ***Nephrops*****; grey=unknown (no Irish landings).**

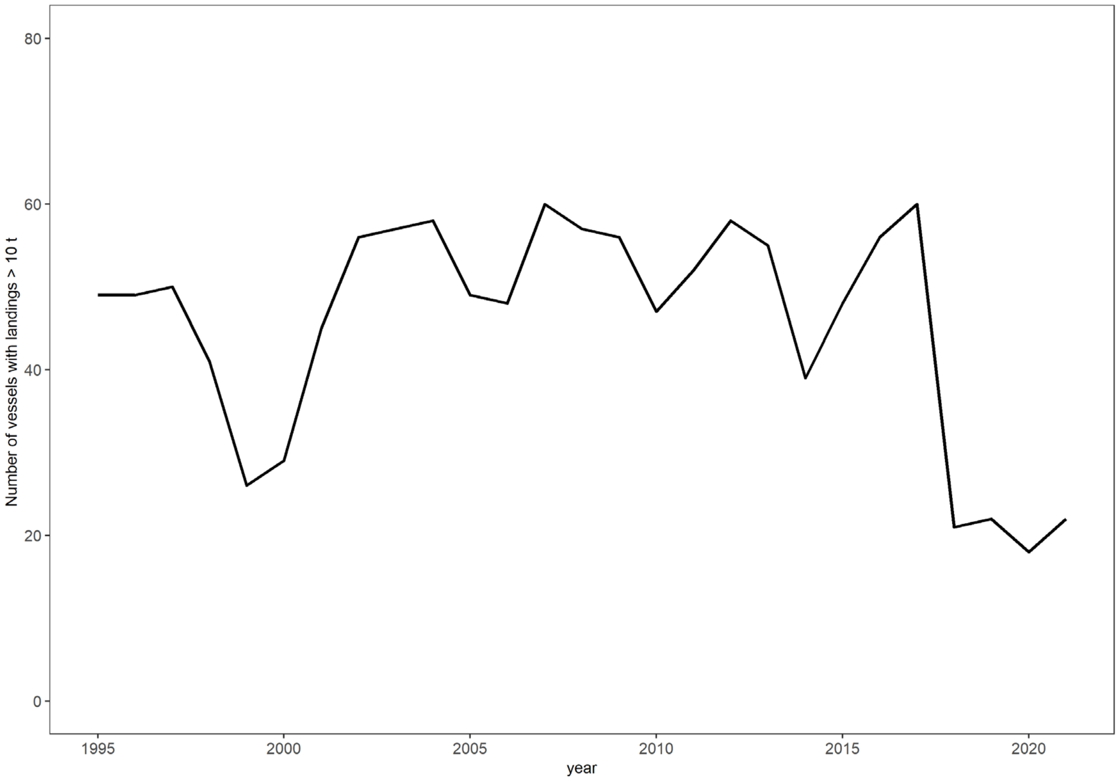


Figure 19.1.2. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Time-series of the number of Irish vessels reporting landings of** ***Nephrops*** **from FU19 with a >10 t threshold.**

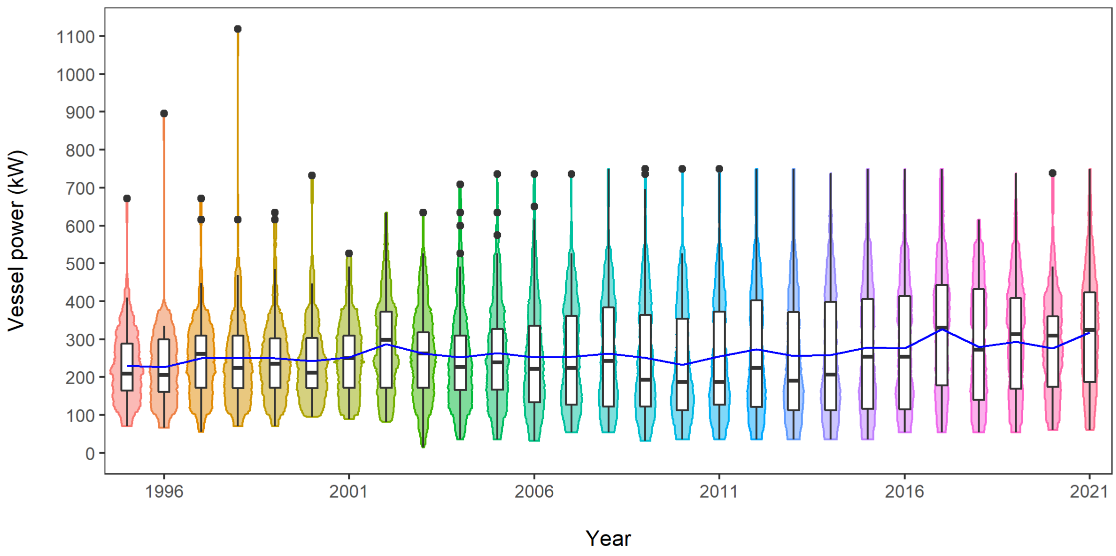


Figure 19.1.3. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Combined box and kite plot of vessel power by year. The blue line indicates the mean.**

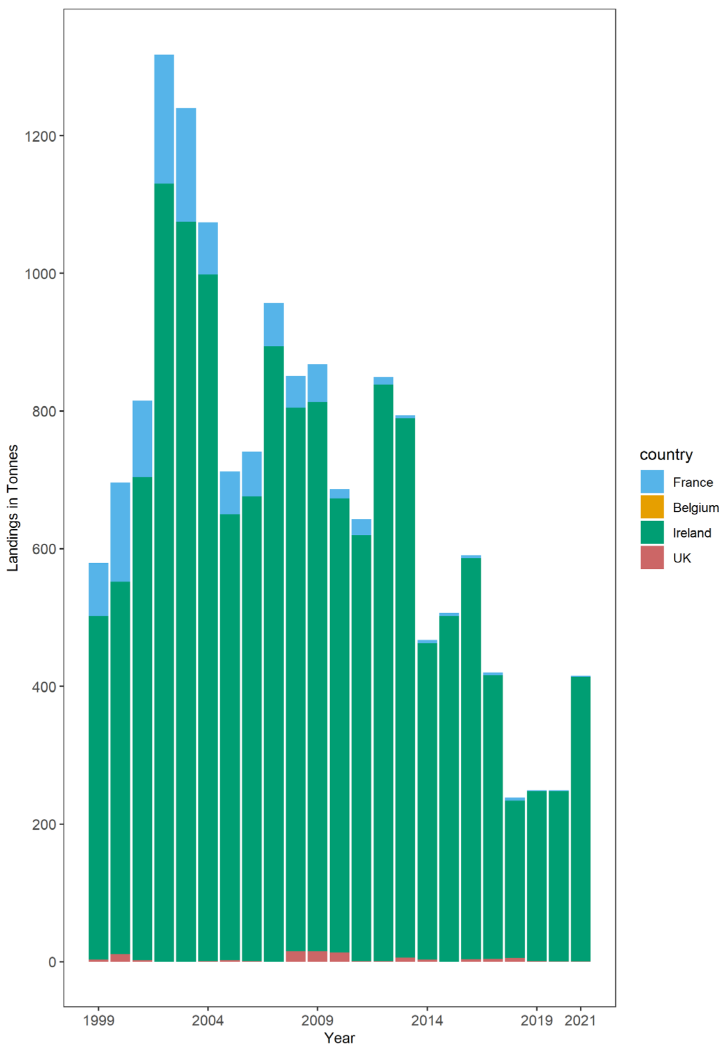


Figure 19.2.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Landings in tonnes by country.**

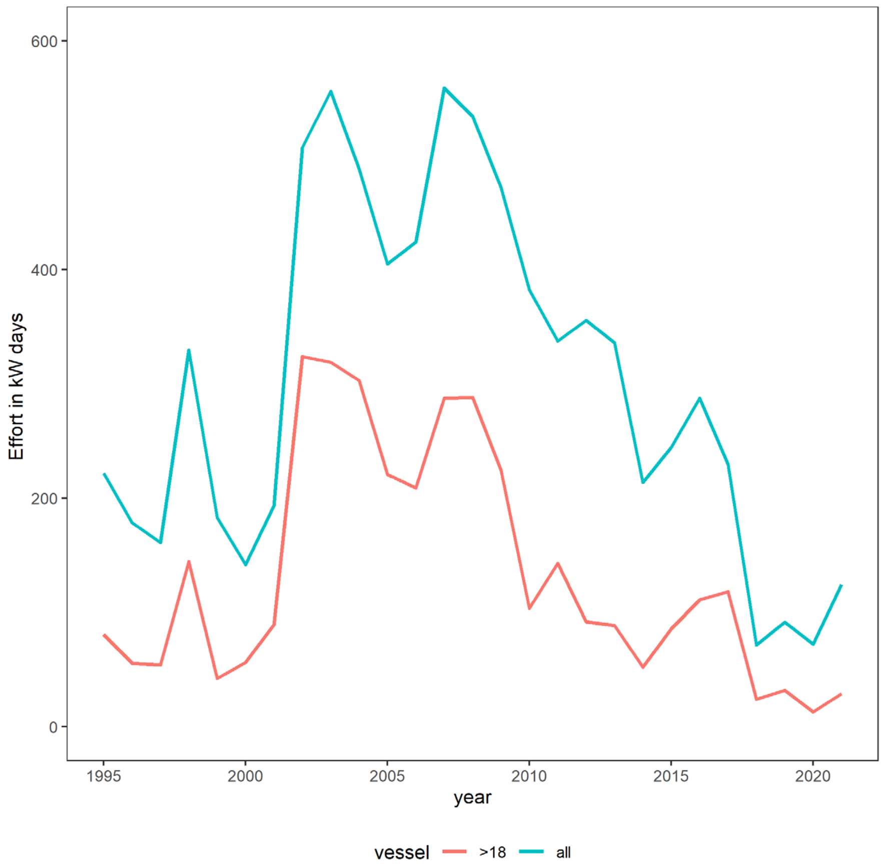


Figure 19.2.2. *Nephrops* in FU19 (Ireland SW and SE Coast). Trawl effort for Irish OTB vessels where >30% of landed weight was *Nephrops.*

Figure 19.2.3. *Nephrops* in FU19 (Ireland SW and SE Coast). Sampling levels for FU19.

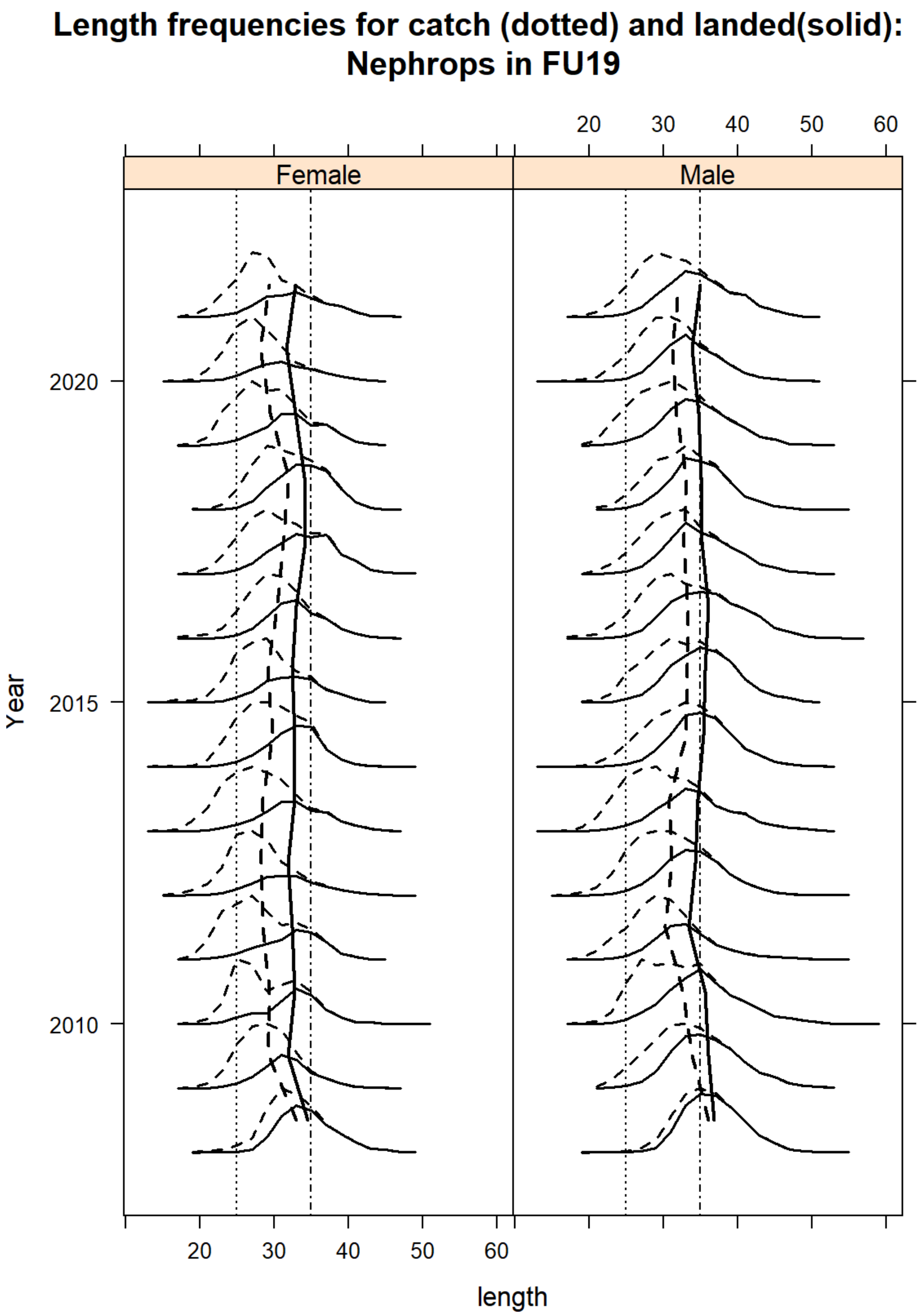


Figure 19.2.4. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches (dotted) and whole landings (solid) by sex 2002–2021. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and 35 mm CL.**

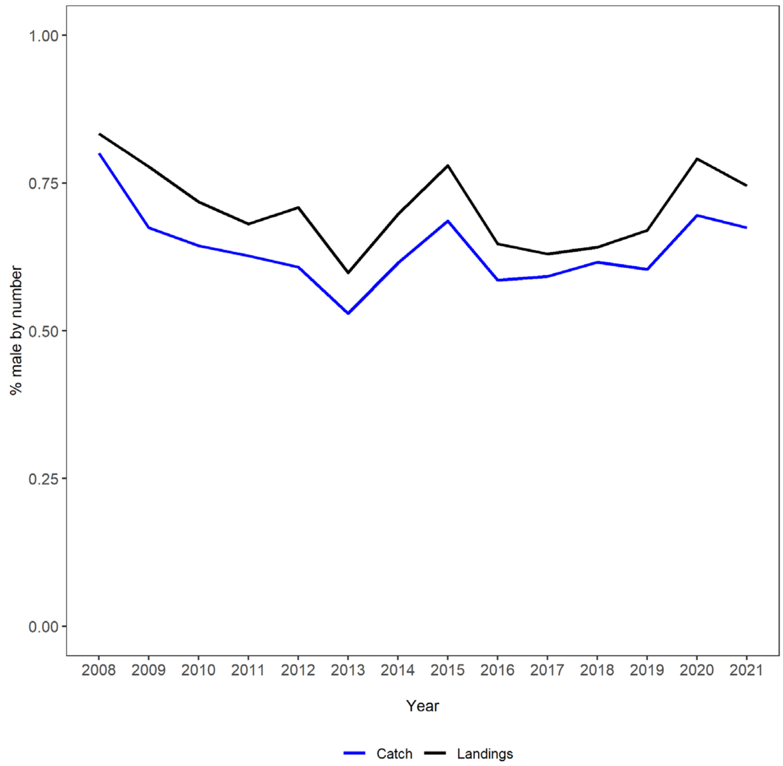


Figure 19.2.5. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Annual sex ratio of landings (2008–2020) and catch (2008–2021).**

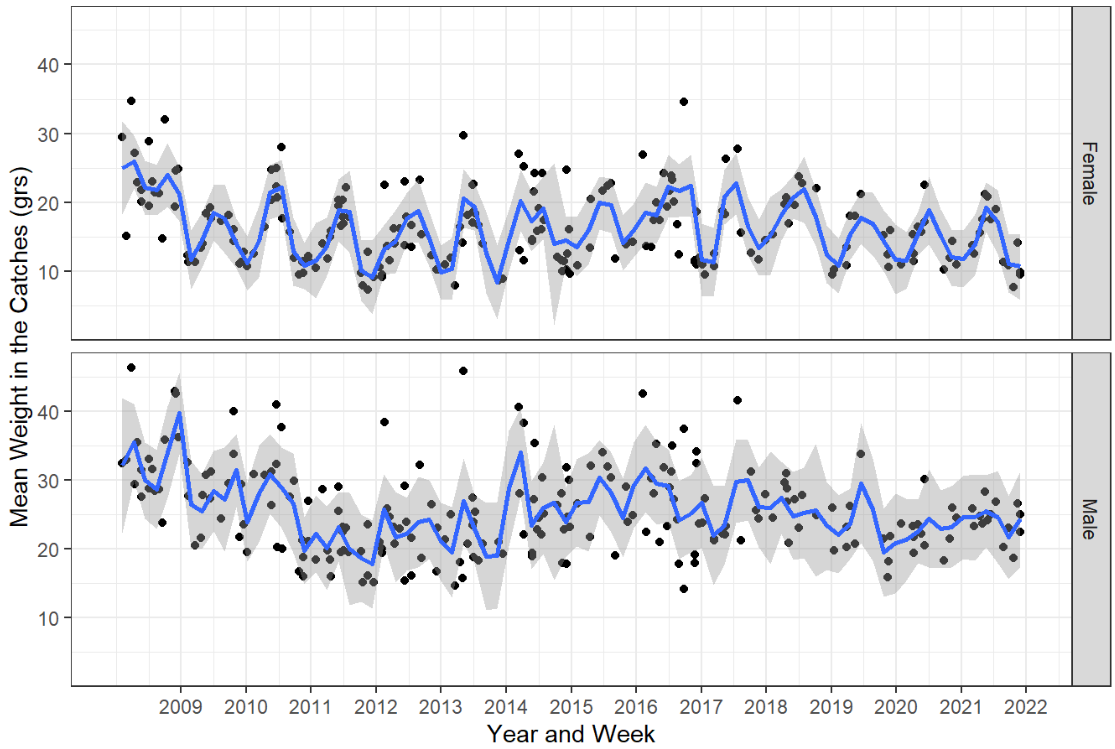


Figure 19.2.6. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean weight in catch data for all grounds in FU19 by sex with loess smoother and showing cyclical trends.**

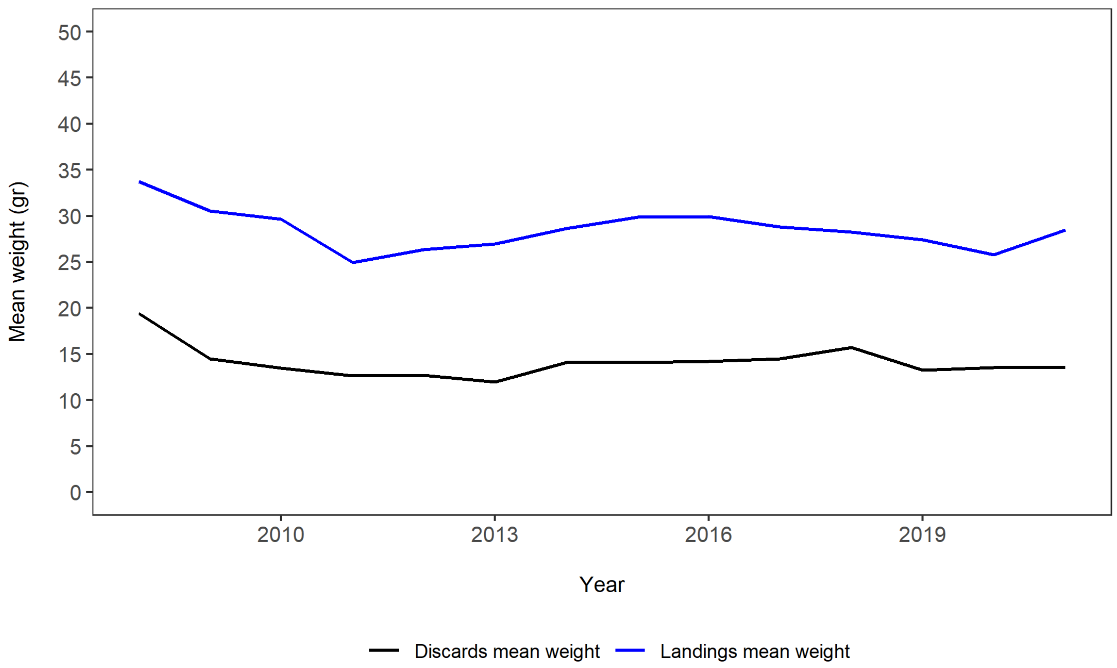


Figure 19.2.7. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Annual estimated mean weights (gr) in the landings and discards.**

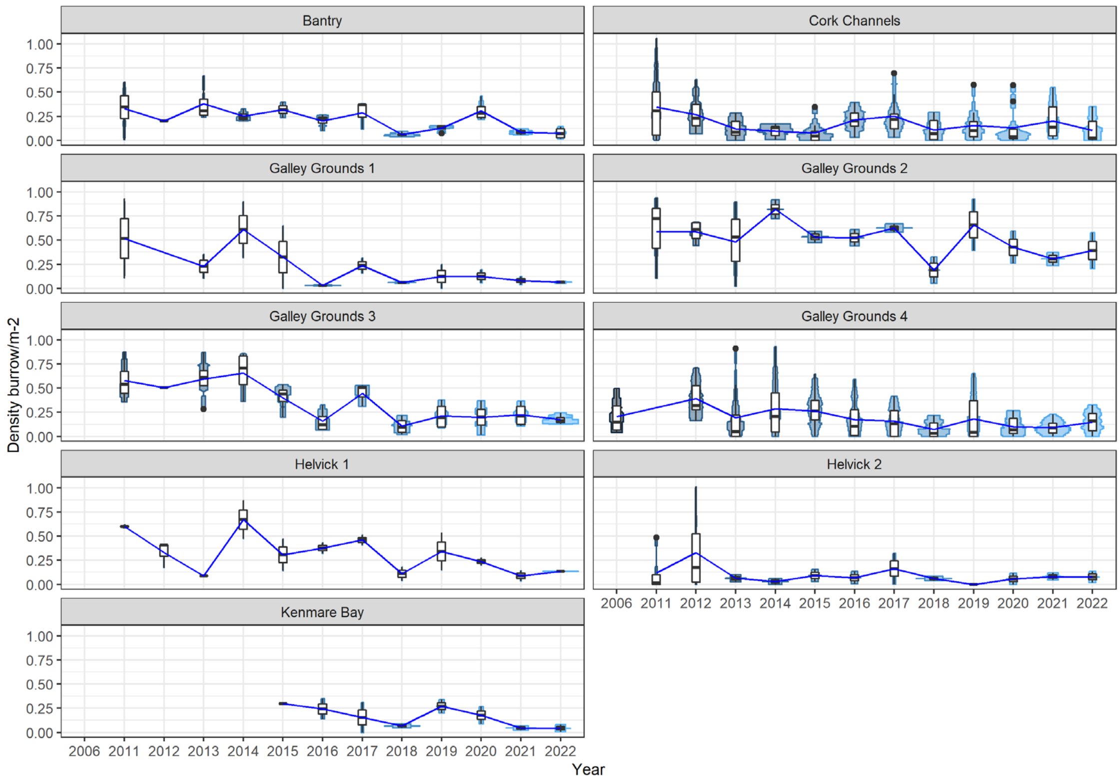


Figure 19.2.8. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Violin and box plot a of adjusted burrow density (burrow/m²) distributions by year from 2006–2022. The blue line indicates the mean density over time. The horizontal black line represents the median, white box is the interquartile range, the black vertical line is the range and the black dots are outliers. No estimate available for Galley Ground 4 in 2011, Galley Ground 1 in 2012. No TV survey from 2007 to 2010.**

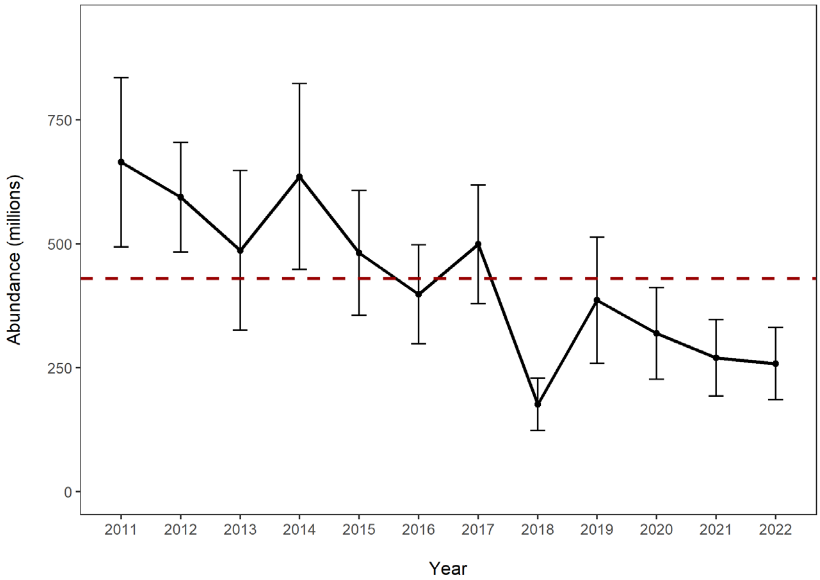


Figure 19.2.9. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Time-series of total abundance estimates for FU19 (error bars indicate 95% confidence intervals) and $B_{trigger}$ is dashed line.**

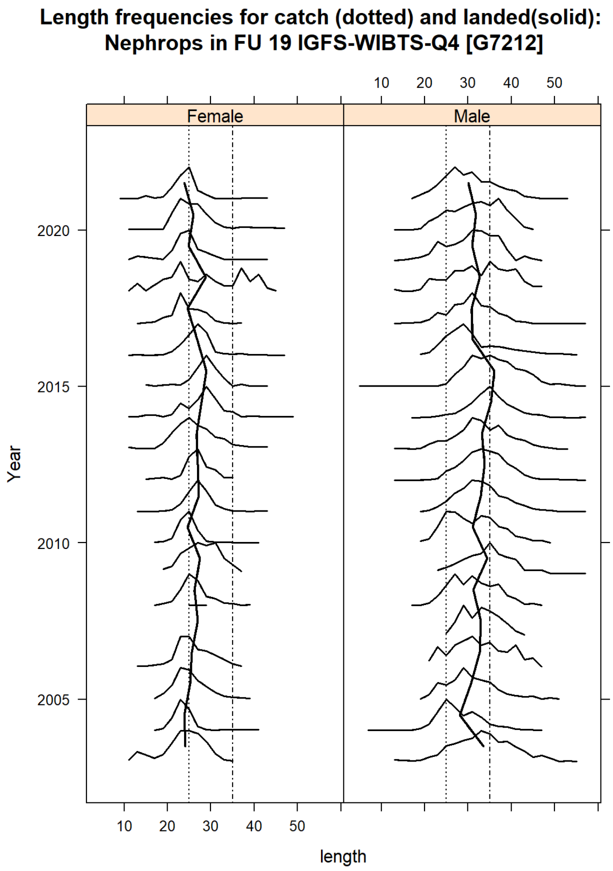


Figure 19.2.10. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches by sex from IGFS- WIBTS-Q4 [G7212] Irish survey 2003–2021. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and 35 mm CL.**

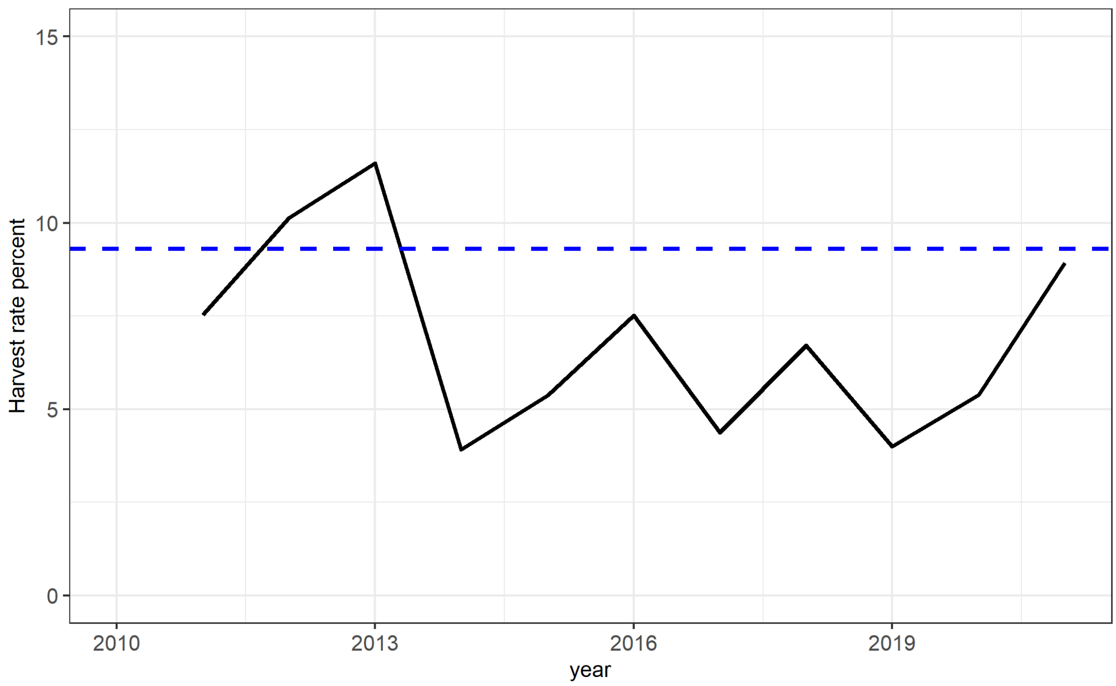


Figure 19.3.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

20 Norway lobster (*Nephrops novegicus*) in divisions 7.g and 7.h, Functional Units 20 and 21 (Celtic Sea)

Type of assessment in 2022

A full UWTV based assessment was carried out and catch options based on the stock-specific F_{MSY} reference point estimated by WGCSE 2016 using the methods applied to other *Nephrops* stocks at WKFMSYREF4 (ICES, 2016) and a newly proposed MSY $B_{trigger}$ estimate (ICES, 2021a; Annex 3). This stock assessment is available in the ICES Transparent Assessment Framework (TAF) here.

ICES advice applicable to 2021

"ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2021 that correspond to the F ranges in the MAP are between 1682 tonnes and 1710 tonnes, assuming recent discard rates. The entire range is considered precautionary when applying the ICES advice rule.

To ensure that the stock in functional units 20 and 21 is exploited sustainably, management should be implemented at the level of the combined functional units 20 and 21."

ICES advice applicable to 2022

"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 the years 2018–2020, catches in 2022 should be no more than 1978 tonnes.

To ensure that the stock in functional units (FUs) 20–21 is exploited sustainably, management should be implemented at the level of the combined FU 20–21.

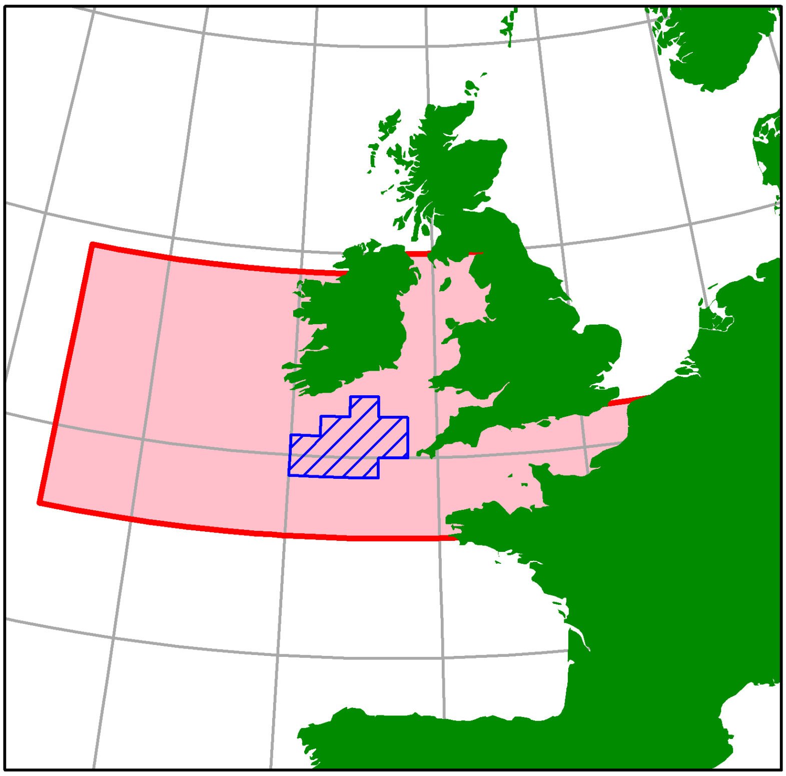
ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 7. ICES considers this plan to be precautionary when implemented at the FU level."

20.1 General

Stock description and management units

The FU20–21 *Nephrops* stock is included in the whole ICES Area 7 together with Irish Sea East and West [FU14, FU15], Porcupine Bank [FU16], Aran Islands [FU17], northwest Irish Coast [FU18], southeast and southwest Irish Coast [FU19], Smalls [FU22]. The TAC is set for Subarea 7 which does not correspond to the stock area.

Historically FU20–22 fishery and sampling data covered an amalgamation of several spatially distinct mud patches; FU20 NW Labadie, Baltimore and Galley, FU21 Jones and Cockburn and FU22 the Smalls. WGCSE 2013 recommended that FU20–22 should be split into FU20–21 combined and FU22 for the purposes of assessment and advice provision. There is evidence that the Celtic Sea *Nephrops* patches are linked in meta-population sense (O'Sullivan *et al.*, 2015). However, fishing mortality and biological parameters (density, growth, M, etc.) may vary across the different patches. The map below shows FU20–21 assessment area (blue) and TAC area (red). There is no evidence that the individual functional units belong to the same stock. See Section 18 for details on *Nephrops* in Subarea 7 general section.



Ecosystem aspects

Details of the ecosystem on FU20–21 are provided in the stock annex updated by WKCELT.

Fishery description

Ireland, France and the UK are the main countries involved in the FU20–21 *Nephrops* fishery. In the early 2000s the Republic of Ireland fleet had on average less than 10% of the landings and this has increased to over 80% from this FU in recent 3 year period. A description of this fleet is given in the stock annex. The fishery on FU20–21 grounds operates throughout the year with a seasonal trend, weather permitting, and has expanded in the mid-2000s. The time-series of numbers of vessels with landings greater than 10 tonnes is updated in Figure 20.1.1. The time-series of vessel power is shown as a box and kite plot in Figure 20.1.2. In recent years the Irish fleet have increased landings from the southern part of the grounds (see stock annex). Recently 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).

French trawlers targeting *Nephrops* in the Celtic Sea operate mainly in the FU20–21. France dominated in the landings in the early 2000s on average 90% of landings and this has decreased to about 14% in recent times (2019–2021). 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 4 % of the landings from this FU in recent times (2019–2021) with highest landings recorded in 2018 (411 t).

Fishery in 2021

Ireland

In 2021, 53 Irish vessels reported landings from FU2021. Of these, 32 vessels reported landings in excess of 10 t which is a significant reduction compared to previous years

Landings by metier is quite mixed compared to other *Nephrops* fishery, however, since 2020 there was a significant decrease in landings by metier OTB_CRU-100_119 as shown in Figure 20.1.3 with the majority of landings now taken by the OTB_DEF_100-119 metier. *The reason for this is not known and will be investigated.*

France

In 2021, 29 French vessels reported landings from FU20–21 where many of these switch between FU20–21 and FU22 within a trip. Of these 5 vessels reported landings in excess of 10 t.

UK

10 UK (E&W) vessels reported landings for FU20–21.

Information from stakeholders

None presented.

20.2 Data

InterCatch

Data were available in InterCatch and used for catch data only. French data were provided directly by the national expert and not extracted from InterCatch.

Landings

The reported landings time-series is shown in Figure 20.2.1 and Table 20.2.1.

The reported Irish landings from FU20-21 have increased since the mid-2000s to the highest in the Irish time-series in 2019 (2219 t). In 2020 and 2021 Irish landings were the lowest values reported since 2005. French landings have gradually decreased since the early 2000s to the present reported landings of 114 t. Reported landings from the UK have fluctuated with an increasing trend since 2015. There was revision to the 2019 UK(E&W) landings from 551 t to 276 t due to a code error and these revised data are now used. Minor landings were reported by the UK (9 t) and Belgium (3 t) in 2021.

The overall fishing profile remains typically seasonal with the majority of the Irish and UK landings coming from the second quarter (see stock annex).

Effort

Effort data are available for the Irish *Nephrops* directed fleet in FU2021 from 1995–2021. 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 than effort data uncorrected for vessel power. Effort data are available from 1995 for the Irish otter trawl *Nephrops* directed fleet. In 2021, this fleet accounted for ~90% of the Irish landings compared with an average of 70% over the time period. Effort shows a generally increasing trend since the mid-2000s with a sharp decrease between 2015 and 2017 and also since 2020. (Figure 20.2.2 and Table 20.2.2).

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 20.2.3). Data not reported for 2021.

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 sampling levels is shown in Table 20.2.4, and remains sparse due to the offshore nature of the fishery although good progress is being made by Ireland in recent years.

There was a revision to the Ireland 2019 sampling data set due to the inclusion of a valid sample that was discovered as a result of QA process of a SQL server migration. The inclusion of this sample data to the 2019 Ireland fishery data summary had a minor impact on the assessment summary. The details data of this revision was presented to the WGCSE 2020 meeting and was accepted.

Commercial length–frequency distributions

Prior to 2012 there was insufficient Irish sampling to generate length–frequency distributions although since then sampling levels have improved. For France limited data were available for 1997 and 2010–2013. In 2019 sampling data was not used due to quality issues (see stock annex for details). In 2020 one sample was available but not deemed useful for assessment purposes. In 2021 two samples were available but again not deemed useful for assessment.

Length–frequency distributions of landings and discards for both countries from 2012 to 2021 are presented in Figure 20.2.3 along with the European minimum conservation reference size (25 CL mm) and French (35 CL mm) minimum landings size also shown. In 2019 France provided sample data numbers and raised data, however, it was not included in the assessment this year due to data quality issues. In 2020 sampling data were not available from France due to the COVID-19 pandemic and also the quite low level of participation in the fishery.

In 2020 there is a lack of small individuals in the catch in 2020 from Irish sampling the reason for this is unclear at present.

The short series on LFDs for both countries shows that the LFDs differ between the two countries. A higher proportion of the French catch consists of large individuals (>35 mm) - on average 70% compared to 41% for the Irish fishery for the available comparable time-series.

Sex ratio

The sex ratio is male biased from the available French and Irish sampling data (Table 20.2.5).

Mean weight explorations

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 20.2.6). The working group accepted the French dataset, and this is used to calculate the estimated annual mean weights in the landings and discards.

The length–weight relationship as described in stock annex is used 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 20.2.7). The estimated annual mean weights in the landings and discards by country and also combined scaled to the international landings is shown in Table 20.2.8 and Figure 20.2.4). There is a big decline in 2016 to 2017 which coincides with the very high UWTV estimate of abundance – which could indicate a strong year class.

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 data are used to derive length distributions and selection ogives. Figure 20.2.5 shows the annual discard ogive from the Irish sampling used to partition the catch. The lack of smaller individuals was also evident in the 2020 discard ogive. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate annual raising factors. The sampling intensity and coverage has varied over the short time-series, and is relatively poor compared to other *Nephrops* stocks, but is considered adequate for stock assessment purposes.

Estimated discard rates range between 12–41% of total catch by number and 7–27% of total catch by weight in the Irish fishery shown in Table 20.2.7. The 2020 discard rates could be related to a change in this fishery mainly comprised of OTB_DEF metiér, however, this will be investigated further. 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 20.2.6.

Estimated discard rates for both countries combined in shown in Table 20.2.8 and these range between 24–52% of total catch by number and 14–31% of total catch by weight. Discard rate of females tends to be higher due to the smaller average size and market reasons as is observed in other *Nephrops* fisheries.

There is no information on discard survival rate in this fishery. 25% is assumed in line with other *Nephrops* stocks in the Celtic Sea (Charuau *et al*., 1982).

Gear selectivity trials by Bord Iascaigh Mhara (BIM, 2017) reported a 64% survivor rate for *Nephrops* caught in a trawl with a SELTRA selectivity device in the outer Galway Bay area.

Table 20.3.1 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 usually employed for UWTV surveys [U5917] of *Nephrops* stocks around Ireland and elsewhere and are documented by WKNEPHTV (ICES, 2007), WKNEPHBID (ICES, 2008), SGNEPS (ICES, 2009; 2010; 2012), WGNEPS (ICES, 2013; 2014; 2015; 2016a; 2017; 2018a, 2020, 2021, 2022), WKNEPS (ICES, 2016b; 2018b), Leocádio, A., *et al*, 2018 and Dobby H., *et al*, 2021.

SGNEPS (ICES, 2012) recommended that a CV (or relative standard error) of <20% is an acceptable precision level for UWTV survey estimates of abundance. UWTV surveys conducted in 2012 are deemed exploratory as stations were chosen based on areas heavily fished by vessels (Doyle *et al*., 2013). These are likely to give biased estimates 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 2013–2021 surveys.

A review of the kriging analyses by two different software packages for survey years 2013 and 2014 was investigated as part of the transition of the assessment to the ICES TAF process This was reviewed by an external expert. The results from SURFER and RGeostats software were very close and full details are available on the ICES TAF stock GitHub repo and also in Annex 3 (ICES, 2021a). The summary statistics from the RGeostats software are now used in the assessment for those years. 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 2022 full survey coverage was achieved. The geo-statistical analysis for years 2013 to 2022 follows the steps documented in Doyle *et al*., 2022.

The 2022 mean burrow density was 0.10 burrows/m^2 compared with 0.12 burrows/m^2 in 2021. The 2022 geostatistical abundance estimate was 1032 million a 14% decrease on the abundance for 2021 with a CV of 5% which is well below the upper limit of 20% recommended by SGNEPS 2012. There was a slight decrease in densities observed in 2022. Figure 20.2.6 shows the krigged contour and density plots for the time-series. The summary statistics from this geostatistical analysis are given in Table 20.2.9 and plotted in Figure 20.2.7. The geostatistical abundance estimate adjusted is derived using the mean of the krigged grid, where the mean of the observations is reported in Table 20.2.9. 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 FU20–21: French groundfish survey EVHOE-WIBTS-Q4 [G9527] since 1997 and Irish groundfish survey-Q4: IGFS-WIBTS-Q4 [G7212] commenced in 2003 (Stokes *et al.,* 2014). These provide information on length–frequency compositions, mean size in the catches, cpue of *Nephrops* in FU20–21 (ICES, 2015). The mean size of the catches is stable over the time-series except in 2006 and 2008 which signals recruitment into the fishery in 2006 and 2007 as shown by the Irish IBTS survey in Figure 23.2.8 and the French IBTS survey (Figure 23.2.9). There is also a signal of recruitment in 2018 mean size from IGFS survey. There is no 2017 length dataset for EVHOE due to research vessel breakdown.

20.3 Assessment

Comparison with previous assessments

The WGCSE 2021 carried out a full UWTV based assessment for this stock using the stock-specific reference points were estimated by the 2016 working group based on methods for other

Nephrops stocks used by WKMSYREF4 (ICES, 2016). This is in accordance with recommendations by WKCELT 2014 where data improvements have been made for this stock such as:

- complete survey coverage of the stock area giving quality assured density estimates and abundance estimates conforming to WGNEPS recommendations; and also
- improved sampling data achieving better coverage and robust estimates of the various parameters need to calculate catch options (e.g. mean weight in the landings and discards, discard percentage in numbers).
- Proposal of MSY $B_{trigger}$ based on seven years of survey data.

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated over the time-series. The 2022 estimate is a decrease from 2021 estimate by 14%.

The 2022 estimate is above the newly proposed MSY $B_{trigger}$ (450 million). The 2022 estimate (1032 million) is below the average of the series (geomean [2014–2022]: 1610 million).

Table 23.3.1 and Figure 23.3.1 summarize recent harvest rates which have been below the F_{MSY} proxy except in 2019 where the harvest rate is 19.2% which is a result of the low stock abundance estimate and high catches.

20.4 Catch scenario table

Catch scenario table inputs and estimates of mean weight in landings and harvest ratios are presented in Table 23.3.1 and summarised below.

In line with previous practice an average (2019–2021) of mean weights is used to account for this variability. Three year average (2019–2021) of proportion of removals retained was used as is standard for other *Nephrops* stocks.

The basis for the catch scenario:

Variable	Value	Notes
Stock abundance (2023)	1032	Numbers of individuals (millions); UWTV survey 2022
Mean weight in projected landings	30.3	Average 2019–2021 in grammes
Mean weight in projected discards	16.2	Average 2019–2021 in grammes
Projected discards	17.3	Proportion by number; Average 2019–2021
Discards survival	25	Proportion by number
Projected dead discards	13.7	Proportion by number; Average 2019–2021

A prediction of landings for the FU20–21 using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the stock annex will be made on the basis of the 2022 UWTV survey. This will be presented in October 2022 for the provision of advice.

20.5 Reference points

New reference points were estimated by WGCSE 2016 using the same method and approach used at WKMSYREF4 (ICES, 2016). The detailed analysis is available in working document 11

(WGCSE, 2016). In the case of FU20–21 there is a limited number of years for which length–frequency data were available, so the three-year moving window could only be applied to give two estimates. The resulting potential F_{MSY} harvest rates and ranges are given in the following table.

YEAR	FMAX	FMAX.LOW	FMAX.UP	F35	F35.LOW	F35.UP	F0.1	F0.1.LOW	F0.1.UP
2012	9.12	6.51	12.60	11.03	6.11	13.21	5.91	5.08	15.11
2013	9.45	6.71	13.26	11.17	6.30	13.78	6.10	5.23	15.93

Given the low density in the area and combined sex $F_{0.1}$ was considered and appropriate F_{MSY} proxy.

STOCK CODE	MSY FLOWER*	FMSY*	MSY FUPPER*WITH AR	MSY BTRIGGER	MSY FUPPER*WITH NO AR
nep-2021	5.9%	6.0%	6.0%	Not defined	6.0%

*** Harvest rate (HR).**

At WGCSE 2021 MSY $B_{trigger}$ estimate was proposed using the same method and process used at WKMSYREF4 (ICES, 2016). The detailed analysis is available and was externally reviewed (ICES, 2021a; Annex 3). The estimate was based data on survey years 2014 to 2021 excluding year 2017 and value is given in table below:

STOCK CODE	MSY $B_{TRIGGER}$
nep-2021	450 million

20.6 Management plans

There is no specific management plan for the FU 20–21 *Nephrops.*

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES subarea 7 and also demersal stocks. There is currently no agreement with the UK regarding this plan.

20.7 Quality of assessment and forecast

Since the benchmark in 2014 UWTV and sampling coverage has been improving in this area. There are now nine years of full UWTV survey coverage (2014–2022). Since 2019 the survey camera system and reviewing method changed where a new HD system is used (ICES, 2019). A comparison showed no significant difference in density estimates between the new (HD) and the old method (SD) for FU 2021 (ICES, 2022b). Previous assumptions relating to correction factors are still applied for this FU 20-21.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009; WGNEPS 2014 and Dobby et al, 2021). Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al.*, 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise (WK*NEPH*, 2009). The survey estimates themselves are very precisely estimated (CVs ~5%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU20–21 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised, but is likely to be lower than that observed in the survey.

At WGCSE 2018, the group recommended that a review of historical survey data should be undertaken given the large fluctuations observed in the short time-series to date for this survey, that is, to randomly check 20% of UWTV stations in years 2016 and 2017. This process was conducted in July 2018 during the FU20–21 UWTV survey. The analysis was presented to WGNEPS (2018a) and subsequently to the 2019 WGCSE meeting where full details are available in R-markdown (ICES, 2018a; Annex 7). Results are briefly summarised here. The analyses showed a low increase in the review counts for 2016 stations comparing them with the survey counts (3.8% increase), and a high decrease in the review counts for 2017 stations comparing them with the survey counts (30.8% decrease). Next the review count data were swapped with the survey count data and abundance was calculated for both years using the “RGeostats” package (Renard D. *et al.*, 2015), following the same procedure that was carried out in those years previously. The geo-statistical results showed an increase of 4.6% in 2016 abundance estimate (from 1879 million to 1966 million), and a decrease of 4% in 2017 abundance estimate (from 4428 million to 4250 million). The geo-statistical CVs were in the order of 3.7% to 4.4%, which are well below the upper limit recommendation of 20% (ICES, 2012).

Following this analysis WGNEPS 2018 recommended to include guidelines on quality control where there are large unexplained fluctuations between abundance estimates from previous years in the manual for *Nephrops* underwater TV surveys (Dobby et al., 2021). In that it is recommended to review 20% of the survey stations, and when the partial review differs more than 20% from the survey counts, then a full review of the survey should be considered.

These were also followed in 2019 given the substantial decrease observed. A random selection of 20% of UWTV stations were reviewed. Full details are available in R-markdown (ICES, 2019). The results showed an overall increase in the review counts for these selected stations comparing them with the survey counts (15.5% increase). This process confirmed the observed low density estimates which are used to calculate the abundance estimate for determining catch scenarios for 2020.

Sampling of landing and discards for FU20–21 remains low but there is a limited number of years for which length–frequency data were available so the three year moving window could only be applied to give two estimates to calculate F_{MSY} reference points.

French and Irish trawlers cover different areas and have presented contrasting features over the last decade. The French fleet moved gradually from the "Smalls" Ground (mainly 31E3) to the "Labadie" (30E2, increase of 28E2 in the early 2010s, although no trend is revealed within FU20–21 throughout the overall time-series): in the late 1990s, more than 40% of French landings were reported from the "Smalls" area whereas by the end of 2000s the contribution of this rectangle became minor (less than 10%). Irish vessels have increased their production on FU20–21 since the mid-2000s and a gradual expansion towards the southern rectangles is obvious during the recent years (stock annex).

20.8 Recommendations for next benchmark

This stock was last benchmarked by WKCELT (ICES, 2014). WGCSE will keep the stock under close review and recommend future benchmark as required.

20.9 Management considerations

The indications are the *Nephrops* in FU20–21 are well exploited now relative to the past. Overall effort in the French fishery has declined to less than 25% of the peak effort observed in the early 1990s whereas there has been a big increase in Irish effort over the recent years with sharp decline in 2020.

Overall the Irish fishery in the area expanded with the exception of 2020, 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 with constraints linked to fuel prices.

In recent years several newer vessels specializing in *Nephrops* fishing have participated in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates.

From 2016, fisheries catching *Nephrops* in Subarea 7 are covered by the EU landings obligation (EU, 2015). A high survivability exemption applies to creel fisheries from the landings obligation. Irish discard survival experiments indicate that the trawl discard survival may be around 64% (BIM, 2017). As a result, an exemption from the landings obligation based on high survivability has been granted by the European Commission. The average discard rate by weight for FU20–21 over the last three years is 10%. Catch advice and scenarios are provided this year on the assumption that discarding is assumed to continue at the recent average.

UWTV survey coverage has improved. A new survey point available by autumn 2022 provides a more up to date estimate of density and abundance. The most up to date survey information is used as an abundance estimate 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.

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Table 20.2.1. *Nephrops* FU 20–21. Landings in tonnes by country.

	FU 20–21 Landings (t)				
Year	France	Rep. of Ireland	UK	Belgium	Total
1995	3419	117	na		3536
1996	2721	101	na		2822
1997	1957	81	na		2038
1998	1583	130	na		1713
1999	1051	83	18		1152
2000	1661	107	10		1778
2001	1750	69	14		1833
2002	2559	104	11		2674
2003	2796	148	9		2953
2004	2140	299	4		2443
2005	2008	455	6		2469
2006	2066	450	7		2523
2007	1816	600	3		2419
2008	2036	937	7		2980
2009	1930	1202	13		3145
2010	975	756	62		1793
2011	566	637	34		1237
2012	453	708	28		1189
2013	486	844	57		1387
2014	465	1342	29		1837
2015	355	1620	141		2116
2016	477	1531	445		2453
2017	341	1113	395	0.2	1849
2018	195	1197	411	0.2	1803
2019	218	2219	286	0.1	2723
2020	75	336	2	0.03	413
2021	114	610	9	3	736

Table 20.2.2. *Nephrops* FU 20–21. Effort data for the Irish otter trawl *Nephrops* directed fleet. Effort for vessels where 30% of the landed weight was *Nephrops*.

Year	Effort ('000's KwDays)	Landings (tonnes)
1995	57	104
1996	49	74
1997	40	59
1998	56	102
1999	37	48
2000	39	62
2001	29	45
2002	78	165
2003	82	86
2004	159	164
2005	255	360
2006	301	348
2007	402	512
2008	562	920
2009	801	1,249
2010	498	633
2011	424	535
2012	357	534
2013	445	672
2014	885	1,170
2015	1,180	1,542
2016	920	1,404
2017	704	1,004
2018	695	1,084
2019	1,185	2,153
2020	184	245
2021	342	443

Table 20.2.3. ***Nephrops*** **FU 20–21. Effort data for the French fleet. * data not available.**

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

Year	Effort France ('000 hrs)	Lpue France (kg/hr)
2011	52	12
2012	42	13
2013	48	12
2014	36	15
2015	35	11
2016	35	15
2017	34	11
2018	21	10
2019	22	11
2020	12.5	6.1
2021*		

Table 20.2.4.a. *Nephrops* FU 20–21. Sampling levels by Ireland.

IRELAND		Number of Samples			Numbers Measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
2009	2	1	0		489	0	
2010	2	1	0		461	0	
2011	2	1	0		270	0	
2012	1	8	5	1	2,654	2,024	1,747
2013	1	1	1		319	423	
2013	2	9	7	1	2,514	2,038	2,187
2014	2	2	2		718	782	
2015	1	0	0	1	0	0	1,724
2015	2	6	6	2	2,714	3,997	3,204
2015	3	0	0	4	0	0	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
2017	1	2	1	1	722	297	1,616
2017	2	7	4	1	2,813	1,035	365
2017	3	3	1		1,154	296	
2017	4	12	7		3,631	1,983	
2018	1	3	3		987	1,036	
2018	2	17	17		6,691	5,742	
2018	3	2	0		389	0	
2018	4	2	1		544	369	
2019	1	8	6		2,691	3,103	
2019	2	12	10		4318	3,738	
2019	3	1	1		373	520	
2019	4	0	0		0	0	

Table 20.2.4.a. *Nephrops* FU 20–21. Sampling levels by Ireland.

IRELAND		Number of Samples			Numbers Measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
2020	1	11	9		3,412	1,934	
2020	2	10	8		3,581	2,448	
2020	3	2	0		689	0	
2020	4	0	0		0	0	
2021	1	9	5		2,987	1,495	
2021	2	14	10		5,991	3,807	
2021	3	4	3		1,897	1,277	
2021	4	1	1		349	376	

Table 20.2.4.b. *Nephrops* FU 20–21. Sampling levels by France.

FRANCE		Number of Samples			Numbers Measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
2012	1		31	9		391	1431
2012	2		13	8		198	1202
2012	3		47	8		667	1155
2012	4		6	6		16	860
2013	1		0	12		0	1362
2013	2		68	72		1,120	3151
2013	3		16	68		131	1917
2013	4		2	14		12	1303
2014	1		0	10		0	1221
2014	2		40	47		1,127	3536
2014	3		20	33		458	1934
2014	4		0	9		0	1360
2015	1		2	14		60	1508
2015	2		24	44		520	3249
2015	3		1	9		1	1366
2015	4		0	9		0	1357
2016	1		3	44		464	3164
2016	2		4	42		519	1263
2016	3		1	25		217	1971
2016	4		2	20		5	1935
2017	1		3	46		429	1659
2017	2		3	80		852	2390
2017	3		2	9		84	344
2017	4		1	23		307	952
2018	1		8	8		460	36
2018	2		9	9		1190	254
2018	3		30	30		1140	105
2018	4		10	10		149	19

FRANCE		Number of Samples			Numbers Measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
2019	1		8	12		588	51
2019	2		9	21		1,501	46
2019	3		30	5		486	32
2019	4		10	3		631	27
2020*	all		na	na		na	na
2021*	all		na	na		na	na
2022*	all		na	na		na	na

***No sampling due to low level fishery participation.**

Table 20.2.5. *Nephrops* FU 20–21. Sex ratio in the landings by country based on available sampling.

Ireland			
Year	Females ('000s)	Males ('000s)	% Males in Landings
2012	1,171	25,304	96
2013	8,369	15,596	65
2014	13,650	25,503	65
2015	8,930	39,078	81
2016	15,807	23,835	60
2017	11,836	29,183	71
2018	15,967	28,486	64
2019	23,578	51,264	68
2020	2,768	9,124	77
2021	4,539	12,770	74

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	8,815	91
2017	1,119	5,110	82
2018	1,863	3,605	66
2019*	-	-	-
2020**	-	-	-
2021**	-	-	-

***Sampling data provided but not used due to quality issues.**

****No sampling due to low level fishery participation.**

Table 20.2.6. *Nephrops* FU 20–21. Landings and discards by number and weight (t), dead discard rate and discard rate by number, discard rate by weight and estimated mean weights (grs) in the landings and discards for France. 25% discards survival.

France										
Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	Discard Rate weight	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	%	tonnes	tonnes	gramme	gramme
2012	10.9	17.8	24.2	55.1	62.1	41.5	453	322	41.7	18.1
2013	9.3	10.0	16.9	44.7	51.9	26.6	486	176	52.2	17.6
2014	10.6	37.0	38.4	72.4	77.7	55.8	465	588	43.8	15.9
2015	7.4	7.7	13.2	43.9	51.1	31.7	355	165	48.1	21.4
2016	9.6	3.2	12.0	19.7	24.7	16.2	477	92	49.5	29.1
2017	6.2	5.9	10.7	41.6	48.7	26.2	341	121	54.8	20.5
2018	5.5	4.7	9.0	39.0	46.1	32.3	195	93	35.6	19.9
2019*	-	-	-	-	-	-	-	-	-	-
2020**	-	-	-	-	-	-	-	-	-	-
2021**	-	-	-	-	-	-	-	-	-	-

***Sampling data provided but not used due to quality issues.**

****Sampling data not available due to low level fishery participation.**

Table 20.2.7. *Nephrops* FU 20–21. Landings and discards by number and weight (t), dead discard rate and discard rate by number, discard rate by weight and estimated mean weights (grs) in the landings and discards for Ireland. 25% discards survival.

Ireland										
Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	Discard Rate weight	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	%	tonnes	tonnes	gramme	gramme
2012	26.5	17.5	39.6	33.1	39.7	22.6	708	207	26.7	11.9
2013	24.2	8.3	30.5	20.5	25.6	14.0	844	137	34.9	16.4
2014	39.1	17.6	52.3	25.3	31.1	14.8	1342	233	34.3	13.3
2015	47.9	18.6	61.9	22.5	27.9	13.3	1620	248	33.8	13.4
2016	39.6	27.5	60.3	34.2	41.0	26.9	1531	564	38.6	20.5
2017	41.0	9.2	47.9	14.4	18.4	9.7	1113	120	27.1	13.0
2018	44.5	11.9	53.4	16.8	21.2	14.4	1197	201	26.9	16.9
2019*	74.8	29.2	96.7	22.6	28.1	16.5	2219	439	29.7	15.0
2020	11.9	1.7	13.1	9.5	12.3	7.6	336	28	28.2	16.7
2021	17.3	2.3	19.0	8.9	11.5	6.3	572	38	33.0	17.0

***2019 data revision due to valid sample inclusion.**

Table 20.2.8. *Nephrops* FU 20–21. Landings and discards by number and weight (t), dead discard rate and discard rate by number, discard rate by weight and estimated mean weights (grs) in the landings combined by both countries based on available sampling and scaled to international landings. 25% discards survival.

Combined and scaled to the international landings										
Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	Discard Rate weight	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	%	tonnes	tonnes	gramme	gramme
2012	38.2	36.1	65.3	41.4	48.5	31.3	1,189	542	31.1	15.0
2013	34.8	19.2	49.2	29.3	35.6	19.1	1,387	327	39.9	17.0
2014	50.6	55.5	92.2	45.2	52.3	31.2	1,836	834	36.3	15.0
2015	59.4	28.1	80.5	26.2	32.2	17.3	2,116	442	35.7	15.7
2016	60.2	37.5	88.3	31.8	38.4	24.6	2,453	801	40.7	21.4
2017	60.1	19.2	74.5	19.4	24.3	14.2	1,849	306	30.8	15.9
2018	64.7	21.5	80.8	20.0	25.0	17.5	1,803	381	27.9	17.7
2019*	91.8	35.8	118.7	22.6	28.1	16.5	2,723	539	29.7	15.0
2020	14.6	2.0	16.2	9.5	12.3	7.6	413	34	28.2	16.7
2021	22.3	2.9	24.4	8.9	11.5	6.3	736	49	33.0	17.0

***2019 data revision due to valid sample inclusion for Ireland and revision to UK landings.**

Table 20.2.9. *Nephrops* FU 20–21. Results summary table for geo-statistical analysis of UWTV survey.

Ground	Year	Number of stations	Mean Density** (burrows/m²)	Domain Area (Km²)	Geostatistical Abundance Estimate adjusted (millions burrows)	CV on Burrow estimate (%)	Analysis Method software
FU 2021	2012	54	0.57		nr	nr	na
	2013*	55	0.16	10, 014	1640	8.1	RGeostats
	2014	98	0.19	10, 014	2021	3.9	RGeostats
	2015	96	0.2	10,014	2003	3.2	RGeostats
	2016	93	0.18	10,014	1879	4.3	RGeostats
	2017	86	0.44	10,014	4428	3.8	RGeostats
	2018	96	0.27	10,014	2721	4.0	RGeostats
	2019	95	0.06	10,014	617	4.8	RGeostats
	2020	97	0.10	10,014	1020	4.8	RGeostats
	2021	97	0.12	10, 014	1202	3.9	RGeostats
	2022	92	0.10	10, 014	1032	4.8	RGeostats

*** 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.

**** mean density adjusted of the observations.**

Table 20.3.1. ***Nephrops*** **FU 20–21. Short-term catch options prediction inputs and recent estimates of mean weight in landings and harvest rates. Cells in bold indicates inputs to catch option calculations.**

Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Proportion number	Discard Proportion 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	41.4	48.5				1189	542	31.1	15.0
2013	34.8	19.2	49.2	29.3	35.6	1640	261	3.0	1387	327	39.9	17.0
2014	50.6	55.5	92.2	45.2	52.3	2021	154	4.6	1836	834	36.3	15.0
2015	59.4	28.1	80.5	26.2	32.2	2003	129	4.0	2116	442	35.7	15.7
2016	60.2	37.5	88.3	31.8	38.4	1879	157	4.7	2453	801	40.7	21.4
2017	60.1	19.2	74.5	19.4	24.3	4428	332	1.7	1849	306	30.8	15.9
2018	64.7	21.5	80.8	20.0	25.0	2721	212	3.0	1803	381	27.9	17.7
2019	91.8	35.8	118.7	22.6	28.1	617	58	19.2	2723	539	29.7	15.0
2020	14.6	2.0	16.2	9.5	12.3	1020	96	1.6	413	34	28.2	16.7
2021	22.3	2.9	**24.2**	8.9	11.5	1202	92	**2.0**	736	49	33.0	17.0
Average 2019–2021				**13.7**	**17.3**						**30.3**	**16.2**

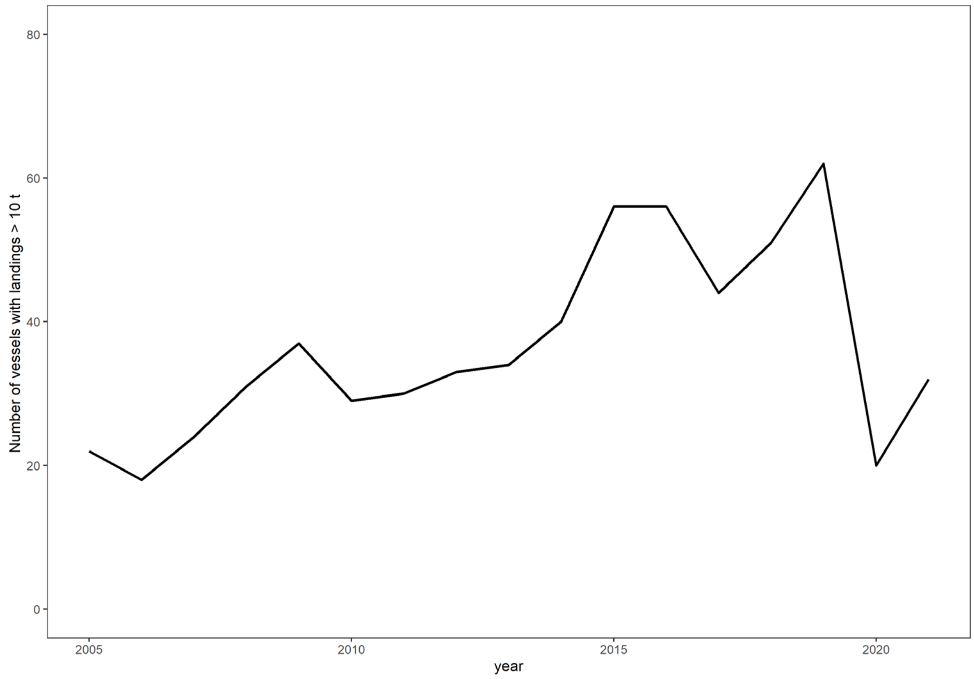


Figure 20.1.1. *Nephrops* FU 20–21. Number of Irish vessels reporting landings >10 t by year.

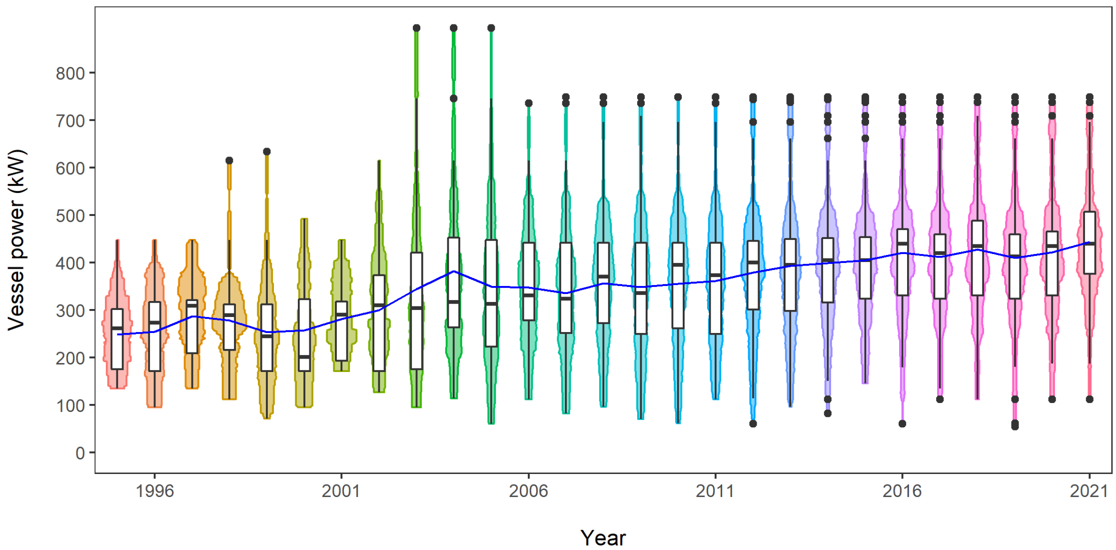


Figure 20.1.2. *Nephrops* FU 20–21. Combined box and kite plot of vessel power on the FU20–21 grounds by year. The blue line indicates the mean.

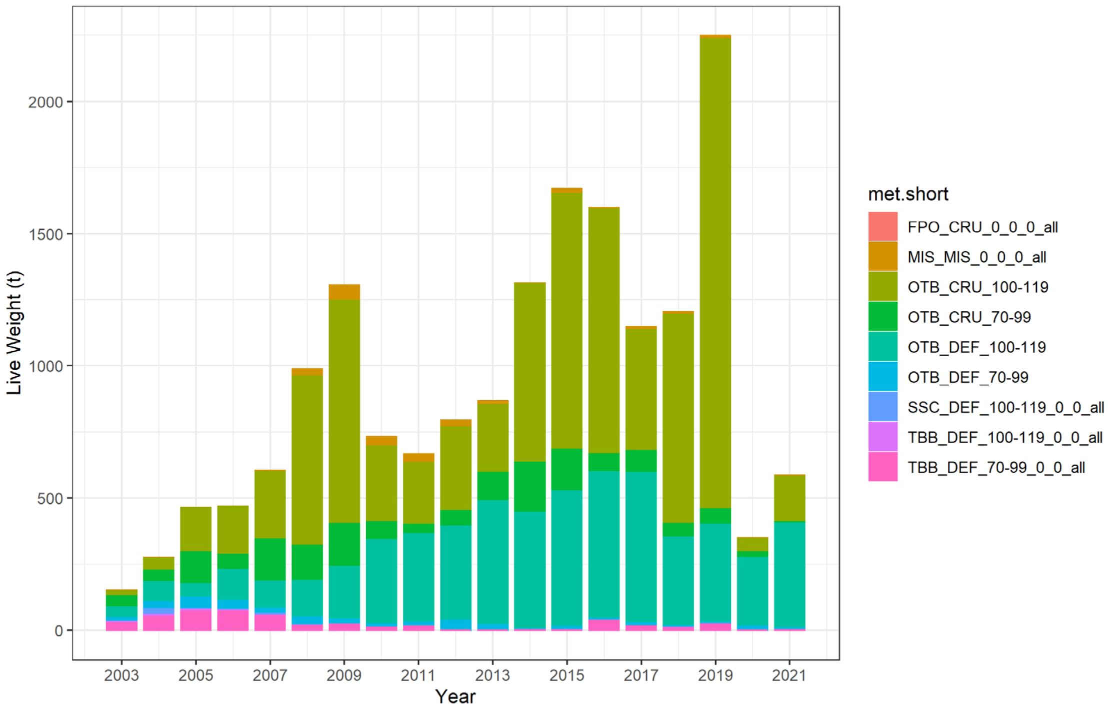


Figure 20.1.3. ***Nephrops*** **FU 20–21. Irish Landings by DCF Metiér.**

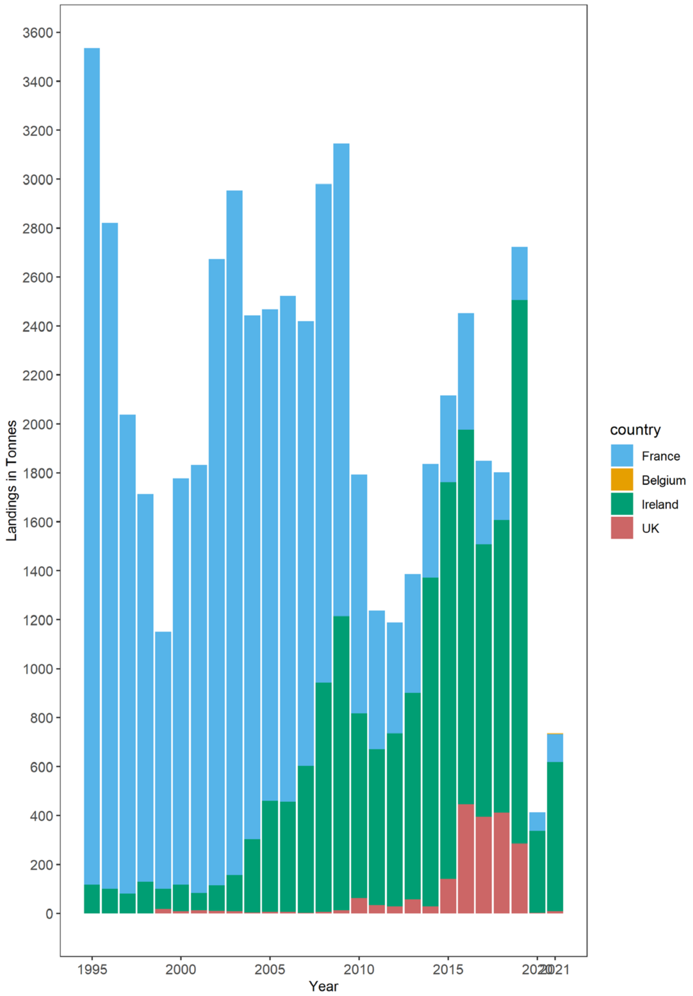


Figure 20.2.1. ***Nephrops*** **FU 20–21. Landings in tonnes by country.**

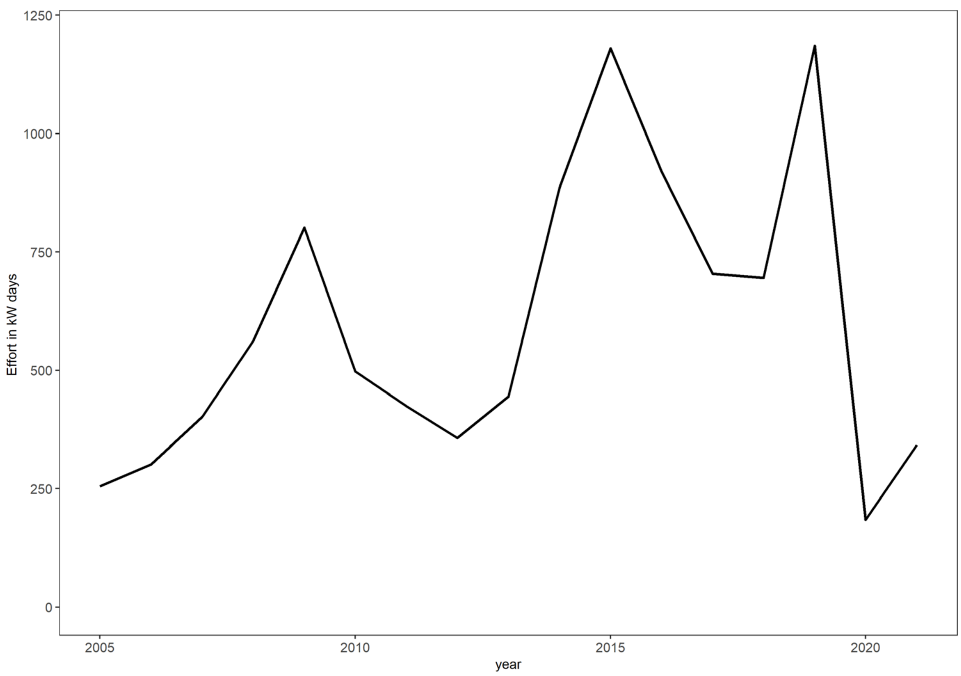


Figure 20.2.2. ***Nephrops*** **FU 20–21. Effort data (Kw days) for the Irish otter trawl** ***Nephrops*** **directed fleet.**

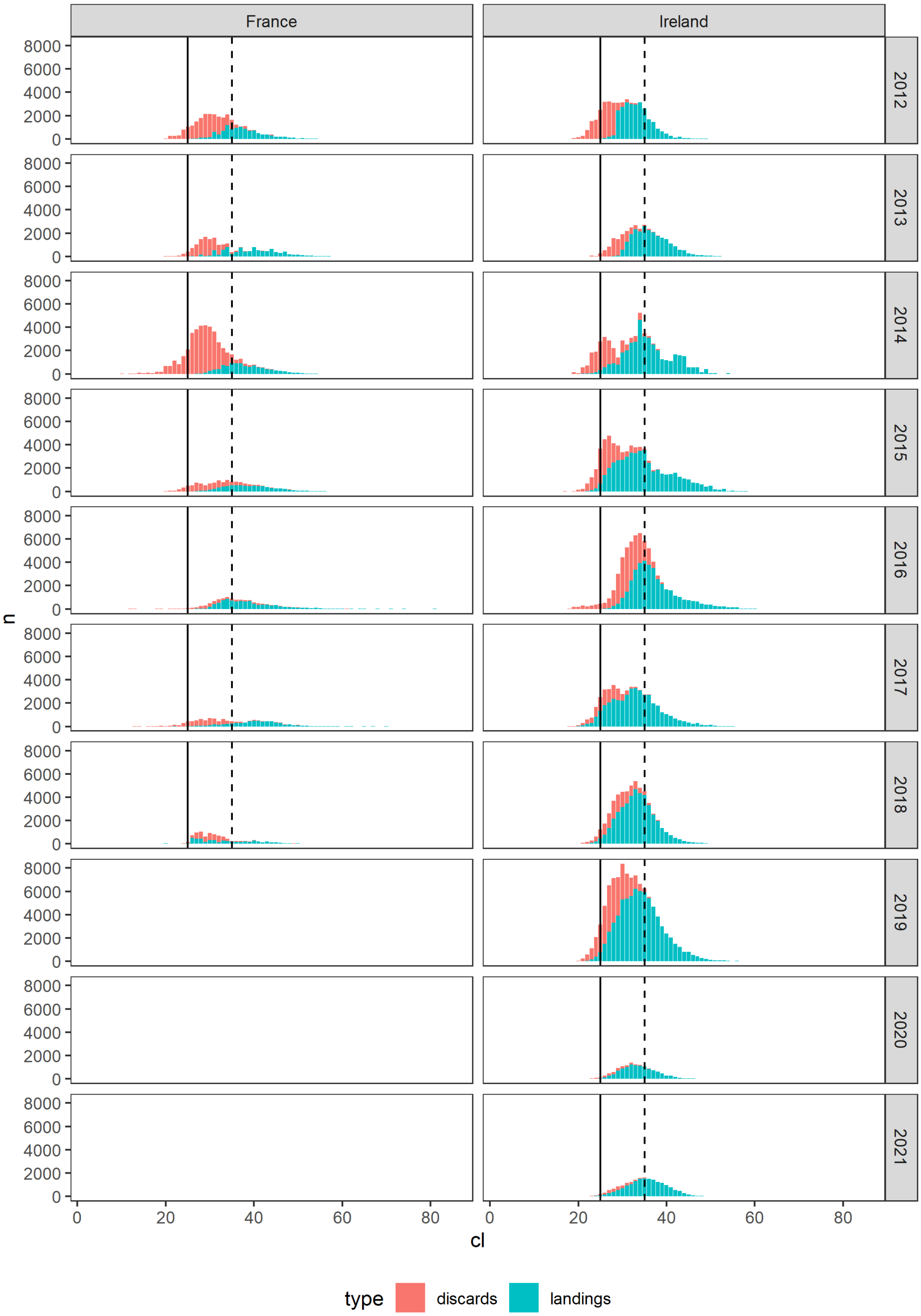


Figure 20.2.3. ***Nephrops*** **FU 20–21. Commercial length–frequency distribution by country. Minimum conservation reference size of 25 CL mm (European MCR) and 35 CL mm (French MLS) displayed. 2019 data provided by France but not included in the assessment. Data not available for France since 2020 due to low fishery participation.**

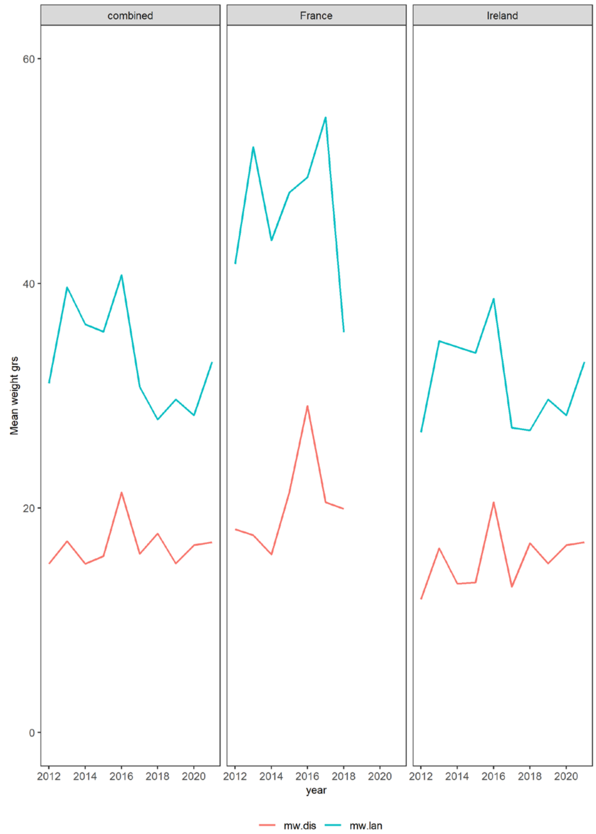


Figure 20.2.4. ***Nephrops*** **FU 20–21. Annual mean weights (gr) in the landings (blue line) and discards (red line) by country and combined scaled to international landings.**

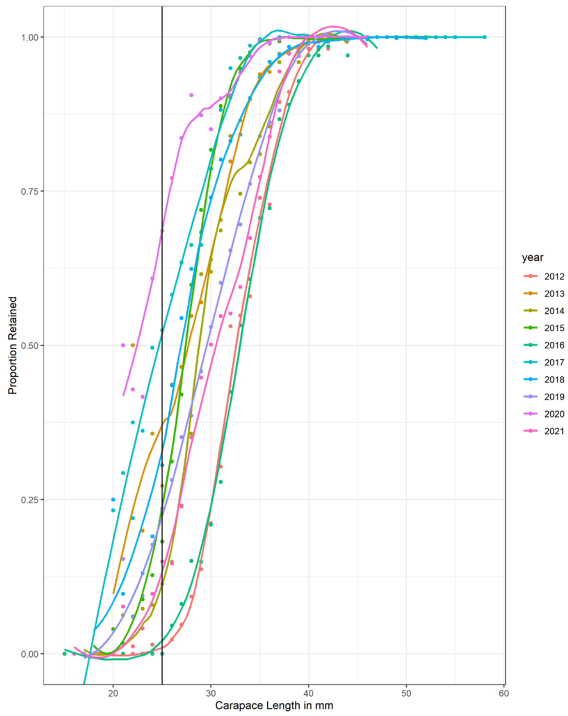


Figure 20.2.5. ***Nephrops*** **FU 20–21. Annual discard ogive derived from Irish sampling. Minimum landing size of 25 CL mm (European MCR) as black line.**

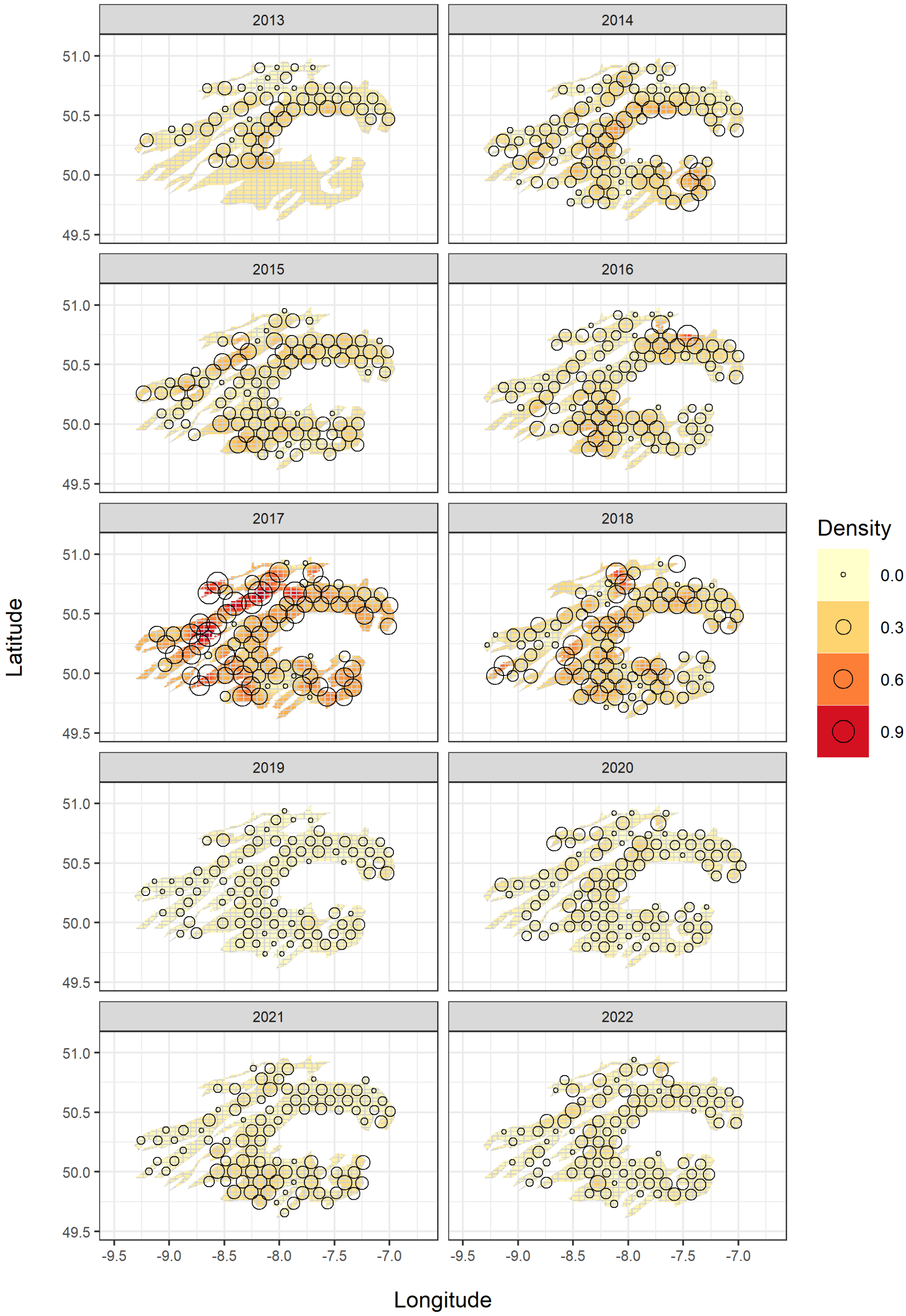


Figure 20.2.6. *Nephrops* FU 20–21. Contour plots of krigged density estimates for the UWTV surveys from 2013 to 2022.

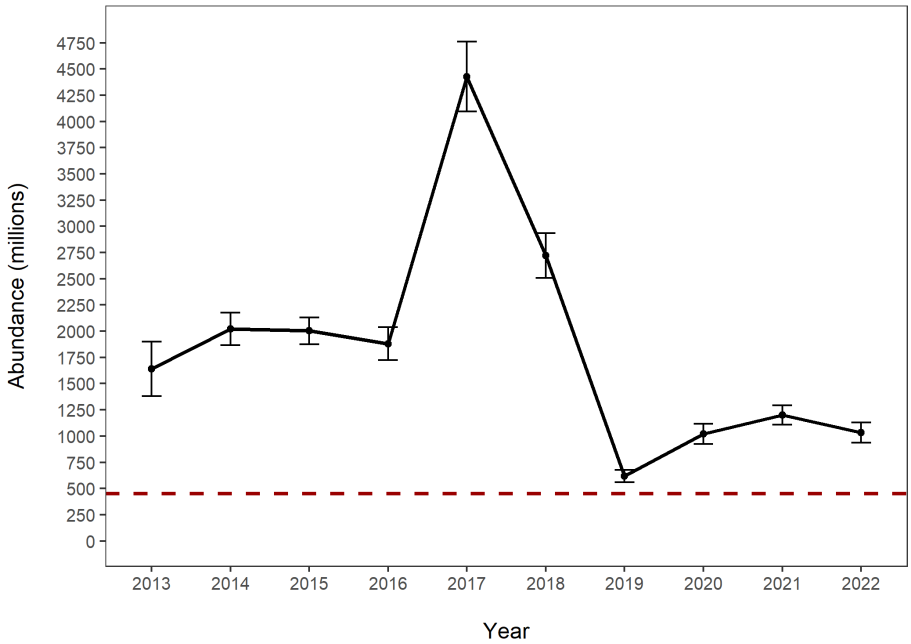


Figure 20.2.8. ***Nephrops*** **FU 20–21. Time-series of abundance estimates (millions burrows) for FU20–21 (error bars indicate 95% confidence intervals) and MSY $B_{trigger}$ is dashed line.**

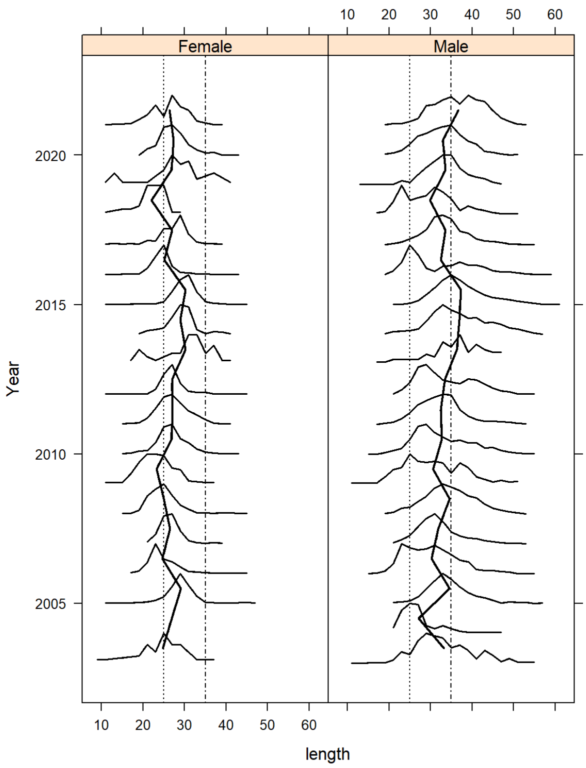


Figure 20.2.9. ***Nephrops*** **FU 20–21. Mean size trends for catches by sex from the IGFS- WIBTS-Q4 [G7212] Irish survey. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and 35 mm CL.**

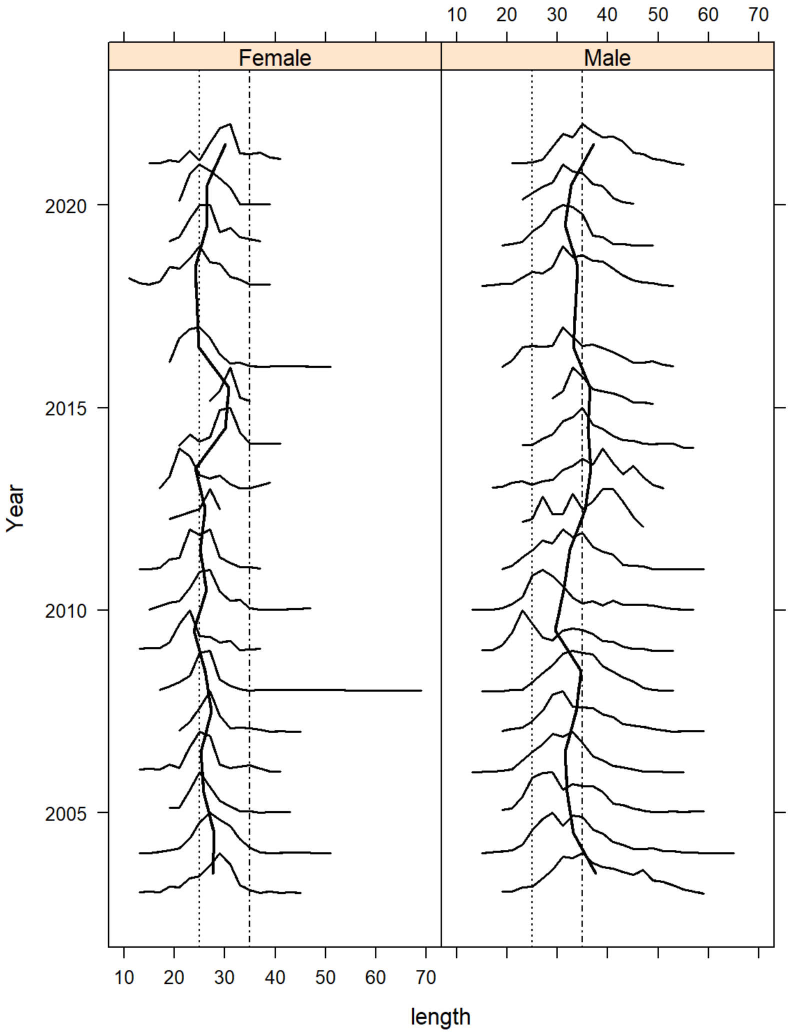


Figure 20.2.10. ***Nephrops*** **FU 20–21. Mean size trends for catches by sex from the EVHOE- WIBTS-Q4 [G9527] French survey. No survey data available for 2017. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and 35 mm CL.**

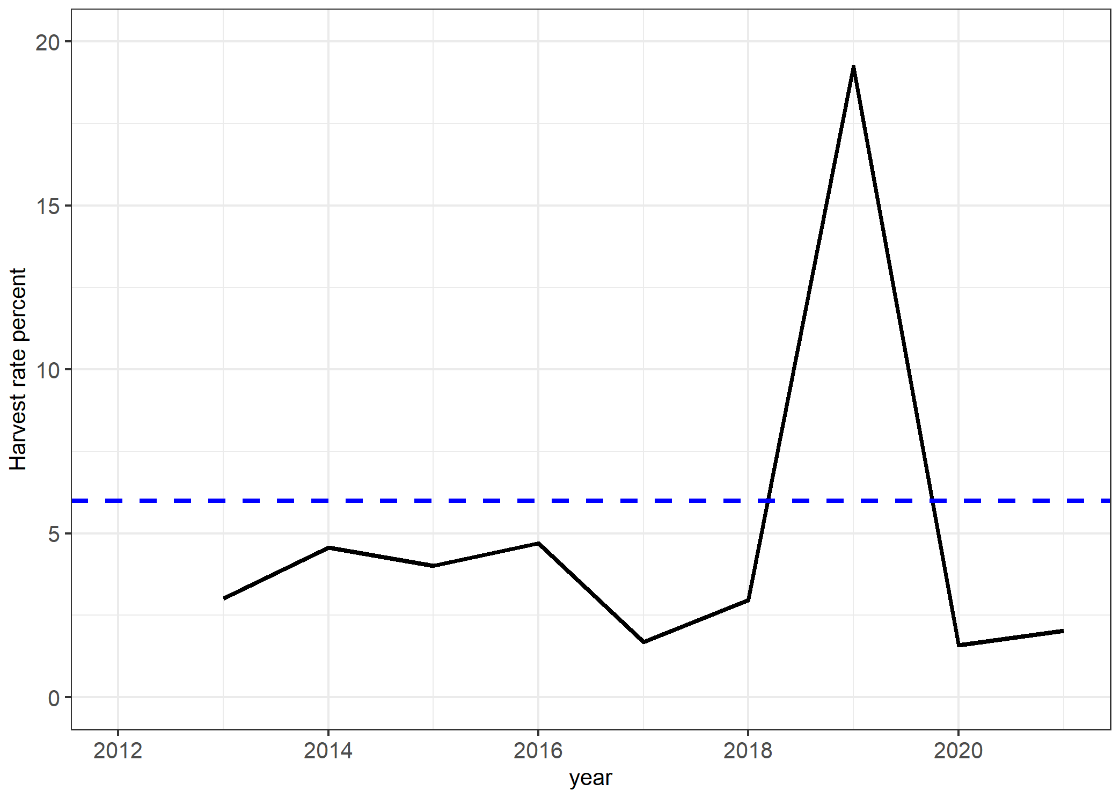


Figure 20.3.11. ***Nephrops*** **FU 20–21. Harvest rate (% dead removed / UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

21 Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.f, Functional Unit 22 (Celtic Sea, Bristol Channel)

Type of assessment in 2022

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 2022and the new survey will form the basis of advice for this stock in the autumn. This stock assessment is available in the ICES Transparent Assessment Framework (TAF) here.

ICES advice applicable to 2021

"ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2021 that correspond to the F ranges in the MAP are between 1238 tonnes and 1560 tonnes, assuming recent discard rates. The entire range is considered precautionary when applying the ICES advice rule.
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 2022

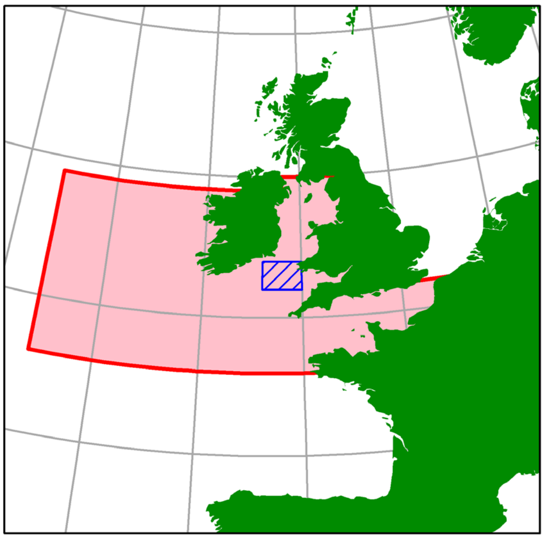
"ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2018–2020, catches in 2022 should be no more than 1257 tonnes.
To ensure that the stock in Functional Unit (FU) 22 is exploited sustainably, management should be implemented at the FU level.
ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 7. ICES considers this plan to be precautionary when implemented at the FU level."

21.1 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 Irish fleet had on average over 70% of the landings and this has increased to over 85% from this FU in recent times. A description of this fleet is given in the stock annex. The time-series of numbers of vessels is updated in Figure 21.1.1. The numbers of vessels has been decreasing in recent years where the highest number was recorded in 2016. The time-series of vessel power is shown as a box and kite plot in Figure 21.1.2.

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 <1% in recent times. 80–90% of the FU22 French landings come from ICES statistical rectangle 31E3.

UK fleet had on average ~10% of the landings in recent year and is mainly UK-Northern Irish vessels in this fishery.

Fishery in 2021

In 2021, 60 Irish vessels reported landings from FU22. Of these, 52 vessels reported landings in excess of 10 t. Vessels >18 m account for 90% of the landings in 2021. 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 2021, ten French trawlers reported landings for FU22. French vessels switch between FU20–21 and FU22. In 2021, one Northern Ireland and UK-Scotland and five 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.

21.2 Data

InterCatch

Data were available in InterCatch and used for catch data only. French catch data provided directly by the national expert.

Landings

There was a 3% increase in 2020 landings reported by Ireland which affected quarter 1 and 3 only. The sample data was revised using this updated landings data and used in the assessment this year.

The reported landings time-series by country is shown in Figure 21.2.1 and Table 21.2.1. The reported Irish landings from FU22 have increased since 2000. In 2020 the landings increased from 2019 by 23% to approximately 1448 t. French landings have gradually decreased since the early 2000s to the present. Reported landings from the UK have fluctuated with a decrease in 2020. Northern Ireland had the highest landings at 16 t followed by England and Wales reporting 6 t. Belgium reported minimal landings <2.5 t in general from this FU.

Effort

In line with WGCSE 2015 recommendation effort is reported in Kwdays and lpue reported in t/Kwdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. The effort series is based on the same criteria for FU15, 16, 17, 22 and 20–21 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks. Effort data are available for the Irish *Nephrops* directed fleet in FU22 from 1995–2021. The time-series of effort and lpue is updated in Figure 21.2.2 and Table 21.2.2.

Effort shows an increasing trend since the early 2000s (Table 21.2.2. and Figure 21.2.2) with a decreasing trend since 2018.

Sampling levels

Dedicated sampling of landings and discards began in 2003 by Ireland. Sampling levels in 2021 were good (Figure 21.2.3).

Sampling and Raising Procedure Review

The national sample raising procedures for FU22 were reviewed and fully documented through an R markdown document (Annex 3, ICES, 2018 and stock annex). Annual discard ogives are calculated and are applied to quarterly length distributions and then raised to total quarterly landings before aggregation. A further raising procedure is applied to raise the annual sampled Irish data, where this addresses quarters with missing length samples. Next the international raising factor is applied. This raising procedure is used to assess this stock and to calculate mean weights, sex ratio and discard rates as inputs for catch scenarios and advice. A minor data revision to 2018 sample data was presented to WGCSE 2020 and resulting calculations were accepted. The revision to 2020 landings data for Ireland resulted in an increase in numbers in landings, discards and removals. This resulted in an increase in the harvest rate for 2020 to 10.1% (previous 9.7%) which was still below F_{MSY}.

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 increased in the recent 3 years for both sexes. The mean size of *Nephrops* in the catch has remained relatively stable since 2005 (Figure 21.2.5). 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 2006 UWTV [U5917] and IGFS-WIBTS-Q4 [G7212].

Sex ratio

The sex ratio by year is shown in Figure 21.2.6. This shows some fluctuations over time. The sex ratio has a distinct seasonal pattern (Figure 21.2.7) with lowest male proportions in the samples in May and June. Males dominate the catches in the autumn and winter.

Mean weight explorations

Explorations of the mean weight in the catch samples by sex shows a strong cyclical pattern in the females (Figure 21.2.7). 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 [U5917] and IGFS-WIBTS-Q4 [G7212] (Figure 21.2.11). The annual mean weight estimate for landings and discards is shown in Figure 21.2.8. The mean weight estimates in the landings show an increasing trend since 2019.

Discarding

Since 2003 discard rates have been estimated using unsorted catch and discards sampling. This involves unsorted catch and discard samples being provided by vessels or collected by observers at sea on discard trips. The catch sample is partitioned into landings and discards using an on-board discard selection ogive derived for the discard samples. Sampling effort is stratified monthly, but annual aggregations are used to derive length distributions and selection ogives. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate quarterly raising factors. The sampling intensity and coverage has varied over the time-series, but overall has been good.

Discard rates range between 9–39% of total catch by weight and 15–52% of total catch by number (Table 21.2.4). Discard rate of females tends to be higher due to the smaller average size and market reasons. There is no information on discard survival rate in this fishery. 25% is assumed in line with other *Nephrops* stocks in the Celtic Sea (Charuau *et al.*, 1982). Highest discard rates were observed in 2007 as a result of the recruitment into the fishery in 2006.

Gear selectivity trials by Bord Iascaigh Mhara (BIM, 2017) reported a 64% survivor rate for *Nephrops* caught in a trawl with a SELTRA selectivity device in the outer Galway Bay area.

Table 21.3.1 gives weights, numbers and mean weights of the landings and discard raised internationally according to the stock annex.

Surveys

Abundance indices from UWTV surveys

The methods used during the survey were similar to those employed for UWTV surveys [U5917] of *Nephrops* stocks around Ireland and elsewhere are documented by WKNEPHTV (ICES, 2007), WKNEPHBID (ICES, 2008), SGNEPS (ICES, 2009; 2010; 2012), WGNEPS (ICES, 2013; 2014; 2015; 2016a; 2017; 2018a, 2020, 2021, 2022), WKNEPS (ICES, 2016b; 2018b), Leocádio, A., *et al*, 2018 and Dobby H., *et al*, 2021.

SGNEPS 2012 (ICES, 2012) recommended that a CV (or relative standard error) of <20% is an acceptable precision level for UWTV survey estimates of abundance. This allowed sampling intensity to be reduced from around 90 stations in the past to around 41 on the Smalls grounds in 2022 which allowed survey coverage of other FUs. A randomised isometric grid design was employed with UWTV stations at 4.5 nmi intervals, whereas previously a 3.0 nmi square grid was used. Operational details of the 2022 UWTV survey are available (Doyle *et al*., 2022).

Seven stations in FU22 were not surveyed successfully in 2015 due to very poor visibility conditions encountered as a result of strong tides. WKCELT 2014 concluded that WGCSE or WGNEPS should make recommendations on the most appropriate fill in procedure to be adopted in cases when stations could not be surveyed. WGCSE 2015 agreed the following procedure for this case: Two buffer zones of 1 nmi and 2 nmi distance were generated around the missing stations. The counts and mean of historic density estimates within the 1 and 2 nmi buffers were calculated. The standard kriging procedure was carried out and summary results were computed for the 1 and 2 nmi “fill-ins”. Finally the mean of historic densities within 2 nmi buffer of the planned stations were used in the calculation of the 2015 abundance.

The blanked krigged contour plot and posted point density data are shown in Figure 21.2.9. The krigged contours correspond very well to the observed data. In general, the densities are higher in the central area of the ground with a localised hotspot centrally and also in the southwestern leg. Densities and abundance have remained stable for most of the time-series with the exception of the first year and 2017, which were the highest in the series. The 2022 mean density 0.31 burrows/m^2 is approximately 30% increase compared with density 0.23 burrows/m^2 in 2021. The summary statistics from this geostatistical analysis are given in Table 21.2.5 and plotted in Figure 21.2.10. The geostatistical abundance estimate adjusted is derived using the mean of the krigged grid where the mean of the observations is reported in Table 21.2.5.

The 2022 estimate of 895 million burrows is below the MSY $B_{trigger}$ (990 million). The estimation variance of the survey as calculated by EVA is very low (CVs in the order <9%).

Groundfish survey data

The Irish groundfish survey IGFS-WIBTS-Q4 [G7212] and French EVHOE- WIBTS-Q4 [G9527] survey operate in the Celtic Sea (Stokes *et al*., 2014; ICES, 2017b). These provide 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 21.2.11 and 21.2.12). This signal of recruitment was also picked up during the 2006 UWTV [U5917] survey (Doyle *et al*., 2012). The groundfish surveys in the Celtic Sea provide a useful indicator of recruitment in this FU.

21.3 Assessment

Comparison with previous assessments

The WGCSE 2021 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 shows a recent declining trend with a an increase in 2022. The 2022 estimate is below the MSY $B_{trigger}$ (990 million). The 2022 estimate (895 million) is below the average of the series (geomean [2006–2022]: 1125 million).

Harvest rate is calculated as (landings + dead discards)/(abundance estimate). Table 21.3.1 and Figure 21.3.1 summarize recent harvest rates. Recent harvest rates have fluctuated due to recruitment pulses into the fishery in 2006 and 2010 and is currently 10.7% which is below F_{MSY}.

21.4 Catch scenarios table

Catch scenario table inputs and historical estimates of mean weight in landings and harvest rates are presented in Table 21.3.1 and summarised below.

Since 2003, mean weight in the landings has varied between 18–27 grammes (Figure 21.2.8). WGCSE 2019 decided that given the stability in mean weights in the recent years, the recent three year average of mean weights is to be used to calculate catch scenarios. The three year average (2019–2021) of proportion of removals retained was used as is standard for other *Nephrops* stocks. The estimate harvest rate has also varied a lot, from 6–27% with 2007 being the highest observed (Figure 21.3.1). This is a result of recruitment into the fishery in 2006 and 2007.

The basis for the catch scenarios:

Variable	Value	Notes
Stock abundance (2023)	895	Number of individuals (million); UWTV survey 2022
Mean weight in projected landings	25.9	Average 2019–2021 in grammes
Mean weight in projected discards	13.4	Average 2019–2021 in grammes
Projected discards	20.4	Proportion by number; average 2019–2021
Discards survival	25	Proportion by number
Projected dead discards	16.2	Proportion by number; average 2019–2021

A prediction of landings for 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 2022 UWTV survey. This will be presented in October 2022 for the provision of advice.

21.5 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's have been exploited at a rate close to near HR_{MSY}. The MSY $B_{trigger}$ for FU22 is 987 million individuals rounded to 990 million.

Stock code	MSY F_{lower}*	F_{MSY}*	MSY Fupper* with AR	MSY $B_{trigger}$	MSY Fupper* with no AR
nep-22	10.2%	12.8%	12.8%	990***	12.8%

*** Harvest rate (HR).**

***** Abundance in millions.**

21.6 Management strategies

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to Norway lobster (*Nephrops norvegicus*) by functional unit in ICES subarea 7 and also demersal stocks. There is currently no agreement with the UK regarding this plan.

21.7 Quality of assessment and forecast

Since 2006, a dedicated annual UWTV survey has provided abundance estimates for FU22 with high precision. There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009; WGNEPS 2016, WGNEPS 2018b). Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al.*, 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise (WK*NEPH* 2009). The survey estimates themselves are very precisely estimated (CVs 2–9%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU22 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised, but is likely to be lower than that observed in the survey.

In 2015, there is added uncertainty, not accounted for in the model or CV estimate, because 17% of the planned TV stations could not be successfully surveyed due to poor visibility on the seabed. However, the spatial distributions of densities have been fairly consistent over time and the overall density has also been relatively stable. The fill in procedure used to generate density estimates for the seven missing stations should be a good approximation.

A review of sampling and raising procedures was presented to WGCSE 2018 and is accepted as the current method to calculate the fishery dependant inputs FU22 (Annex 3, ICES, 2018 and stock annex).

In the provision of catch scenarios based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. Given the recent stability in mean weights in landings and unwanted catch - for FU22 deterministic estimates of the mean weight in the landings and discard rates for 2019–2021 are used by the WG. Previously the full time series was used to account for the variability over time where this had occurred when large recruitments are observed in the stock as was the case in 2006 and 2007.

From 2016, fisheries catching *Nephrops* in Subarea 7 are covered by the EU landings obligation with several exemptions (EU, 2015). The average discard rate by weight for FU22 over the last three years is 12%. Irish discard survival experiments indicate that the trawl discard survival may be around 64% (BIM, 2017). As a result, an exemption from the landings obligation based on high survivability has been granted by the European Commission. Catch advice and scenarios are provided this year on the assumption that discarding is assumed to continue at the recent average.

Landings data are adjusted to take into account landings that have been misreported from FU16 since 2011. This adjustment is thought to be reasonably accurate (See Section 20).

Sampling and discard estimates have improved over the time-series.

21.8 Recommendation for next benchmark

This stock has not been formally benchmarked by ICES although the approach used has. WGCSE recommends that the issue list below can be addressed through an inter-bench process:

- The biological parameters used as inputs to the SCA should be reconsidered; growth parameters, length-at-maturity and natural mortality.
- The historical time-series of landings and effort by rectangle should be disaggregated and options for standardisation of lpue investigated.
- Historical sampling and groundfish survey data in this FU should also be disaggregated as far as possible back in time, and investigated for useful trends and signals.

21.9 Management considerations

The trends from the fishery (landings, effort, mean size, etc.) appear to show stock is exploited. The UWTV abundance and mean density estimates show some fluctuations in burrow abundance in the recent years. 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 survey and IGFS-WIBTS-Q4. Recent harvest rates for the FU22 Smalls fluctuate and suggest the stock is exploited below F_{MSY}.

A new survey point available in September 2022 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 2022.

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 and 2020 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 targetted whiting fishery also overlaps with the *Nephrops* fishery in this area, but this has negligible bycatch of *Nephrops*.

21.10 References

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Table 21.2.1. *Nephrops* in FU22 (Smalls Grounds). Landings in tonnes by country.

FU 22 Landings (t)					
Year	France	Rep. of Ireland	UK	Belgium	Total
1999	1034	741	0		1775
2000	1192	1687	11		2890
2001	882	2054	2		2938
2002	598	1392	3		1993
2003	799	1257	10		2065
2004	454	1349	26		1828
2005	478	1987	68		2533
2006	293	1442	19	7	1761
2007	216	2716	13	5	2950
2008	301	2539	241	9	3090
2009	258	1609	306	12	2185
2010	129	2219	351	15	2714
2011	64	1521	44	7	1636
2012	65	2506	41	6	2618
2013	83	2054	107	12	2257
2014	29	2428	61	8	2526
2015	9	2215	121	5	2350
2016	5	2967	354	3	3329
2017	7	2815	737	1	3560
2018	3	1639	331	1	1974
2019	9	1884	187	2	2083
2020	3	1491	22	2	1518
2021	<1	1537	69	10	1611

Table 21.2.2. *Nephrops* in FU22 (Smalls Grounds). Effort data for the Irish otter trawl *Nephrops* directed fleet.

Year	Effort ('000s Kw Days)	Landings (tonnes)	lpue (t/KwDays)
1995	552	1226	2.2
1996	412	1010	2.5
1997	474	1096	2.3
1998	524	1353	2.6
1999	292	620	2.1
2000	586	1335	2.3
2001	789	1964	2.5
2002	615	1298	2.1
2003	639	1000	1.6
2004	620	981	1.6
2005	986	1882	1.9
2006	855	1374	1.6
2007	1131	2677	2.4
2008	1047	2501	2.4
2009	702	1605	2.3
2010	962	2198	2.3
2011	724	1497	2.1
2012	970	2260	2.3
2013	902	1849	2.0
2014	915	2182	2.4
2015	971	2076	2.1
2016	1270	2761	2.2
2017	1229	2712	2.2
2018	748	1509	2.0
2019	786	1736	2.2
2020	681	1408	2.1
2021	666	1450	2.2

Table 21.2.4. *Nephrops* in FU22 (Smalls Grounds). Landings and discards weight and numbers by year from Irish sampling programme.

Year	Landings (t)	Discards (t)	Landings ('000s numbers)	Discards ('000s numbers)	Discard by weight (%)	Discard by number (%)
2003	1257	438	57.9	41.1	25.8	41.5
2004	1349	149	52.1	9.7	9.9	15.6
2005	1987	1292	93.6	100.9	39.4	51.9
2006	1442	372	82.0	37.0	20.5	31.1
2007	2716	1755	152.1	166.5	39.3	52.3
2008	2539	237	118.0	21.4	8.5	15.3
2009	1609	274	67.7	24.3	14.5	26.4
2010	2219	520	99.6	36.4	19.0	26.8
2011	1521	183	55.7	12.2	10.7	18.0
2012	2506	332	115.2	30.0	11.7	20.7
2013	2054	452	85.1	36.5	18.1	30.0
2014	2428	442	96.3	32.1	15.4	25.0
2015	2215	424	107.6	41.8	16.1	28.0
2016	2967	463	142.7	47.7	13.5	25.1
2017	2815	336	130.0	31.0	10.7	19.2
2018	1639	279	81.2	25.3	14.5	23.7
2019	1884	237	73.1	17.3	11.2	19.2
2020	1491	283	58.3	21.1	15.9	26.5
2021	1537	142	58.4	10.8	8.5	15.6

Table 21.2.5. *Nephrops* in FU22 (Smalls Grounds). Results summary table for geostatistical analysis of UWTV survey.

Year	Number of stations	Mean Density adjusted** (burrows/m²)	Domain Area (km²)	Geostatistical Abundance Estimate adjusted (millions burrows)	CV on Burrow estimate %
2006	100	0.49	2962	1503	2.4
2007	107	0.37	2955	1136	5.7
2008	76	0.36	2698	1114	5.6
2009	67	0.36	2824	1093	5.0
2010	90	0.37	2861	1141	3.9
2011	107	0.41	2881	1256	2.9
2012*	47	0.49	2934	1498	8.1
2013*	41	0.41	2975	1254	7.2
2014*	52	0.53	2970	1622	8.4
2015*	40	0.49	3064	1363	7.0
2016*	41	0.31	3063	866	6.6
2017*	40	0.55	3063	1600	4.9
2018*	42	0.31	3063	876	9.0
2019*	41	0.40	3063	1121	6.4
2020*	40	0.27	3063	750	8.0
2021*	42	0.23	3063	656	6.7
2022*	41	0.31	3063	895	6.5

*** reduced isometric grid 4.5 nmi**

**** mean density adjusted of the observations.**

Table 21.3.1. *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 scenario calculations).

Year	Landings in number millions	Total discards in number* millions	Removals in number millions	Dead Discard Rate number %	Discard Rate number %	UWTV abundance estimate millions	95% Confidence Interval	Harvest rate %	Landings tonnes	Total discards* tonnes	Mean weight in landings gramme	Mean weight in discards gramme
2003	95.2	67.6	145.8	34.7	41.5	NA	NA	NA	2,065	720	21.7	10.7
2004	70.7	13.1	80.5	12.2	15.6	NA	NA	NA	1,828	202	25.9	15.4
2005	119.3	128.6	215.7	44.7	51.9	NA	NA	NA	2,533	1648	21.2	12.8
2006	100.2	45.2	134.1	25.3	31.1	1503	70	8.9	1,761	454	17.6	10.1
2007	165.2	180.9	300.8	45.1	52.3	1136	126	26.5	2,950	1906	17.9	10.5
2008	143.6	26.0	163.1	12.0	15.3	1114	123	14.6	3,090	289	21.5	11.1
2009	92.0	33.0	116.8	21.2	26.4	1093	108	10.7	2,185	371	23.7	11.3
2010	121.8	44.5	155.2	21.5	26.8	1141	88	13.6	2,714	636	22.3	14.3
2011	60.0	13.2	69.8	14.1	18.0	1256	72	5.6	1,636	196	27.3	14.9
2012	120.3	31.4	143.9	16.3	20.7	1498	239	9.6	2,618	347	21.8	11.1
2013	93.5	40.1	123.6	24.3	30.0	1254	177	9.9	2,257	497	24.1	12.4
2014	100.2	33.4	125.2	20.0	25.0	1622	268	7.7	2,526	460	25.2	13.8

Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	millions		%	tonnes	tonnes	gramme	gramme
2015	114.1	44.4	147.4	22.6	28.0	1363	180	10.8	2,350	450	20.6	10.1
2016	160.2	53.5	200.3	20.0	25.1	866	112	23.1	3,329	519	20.8	9.7
2017	164.4	39.2	193.7	15.2	19.2	1600	153	12.1	3,560	424	21.7	10.8
2018	97.8	30.4	120.6	18.9	23.7	876	154	13.8	1,974	336	20.2	11.0
2019	80.9	19.2	95.2	15.1	19.2	1121	141	8.5	2,083	262	25.8	13.7
2020	59.4	21.5	75.5	21.3	26.5	750	118	10.1	1518	288	25.6	13.4
2021	61.4	11.4	69.9	12.2	15.6	656	87	10.7	1616	149	26.3	13.1

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
Average 2019-2021				**16.2**	**20.4**						**25.9**	**13.4**

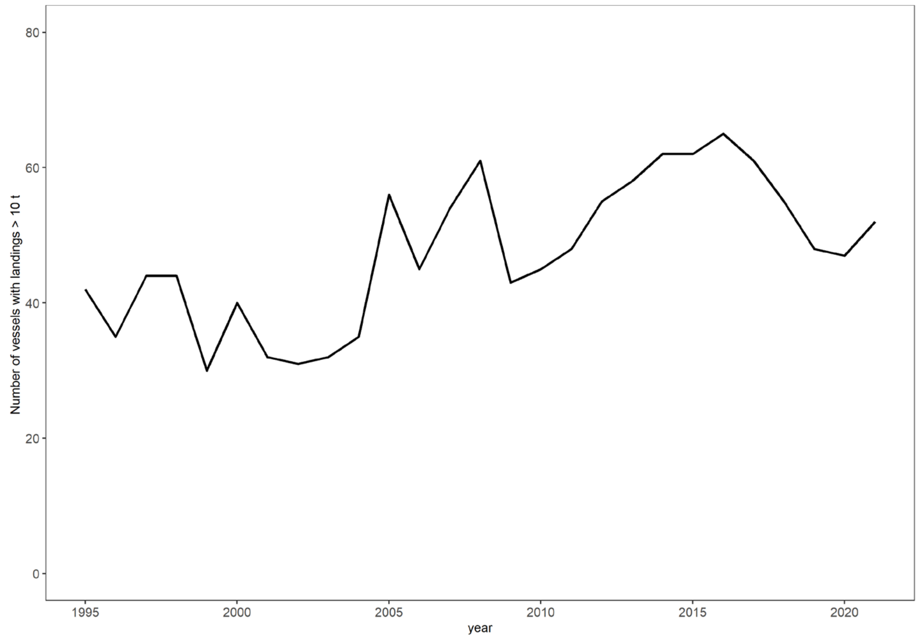

Figure 21.1.1. *Nephrops* in FU22 (Smalls Grounds). Time-series of the number of Irish vessels reporting landings of *Nephrops* from FU22 with a >10 t threshold.

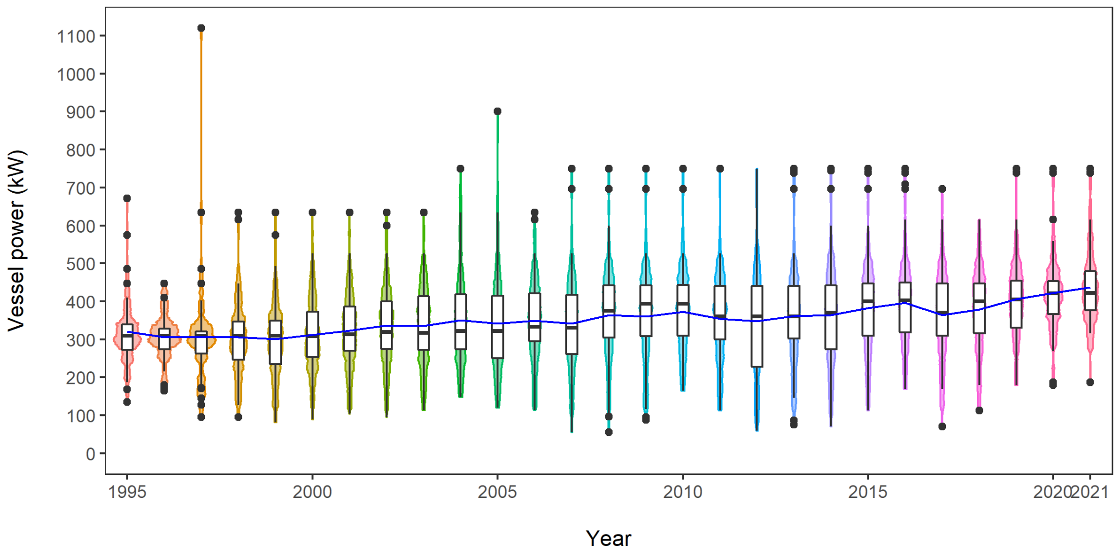

Figure 21.1.2. *Nephrops* in FU22 (Smalls Grounds). Combined box and kite plot of vessel power on the Smalls Grounds by year. The blue line indicates the mean.

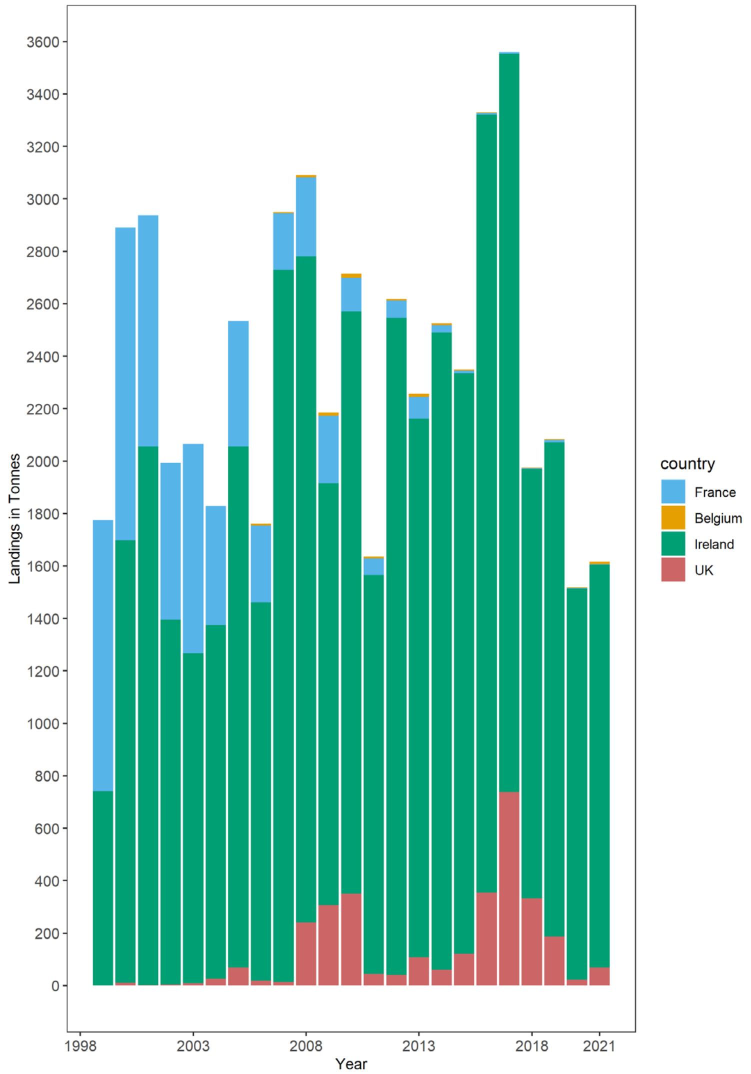

Figure 21.2.1. ***Nephrops*** **in FU22 (Smalls Grounds). Landings in tonnes by country.**

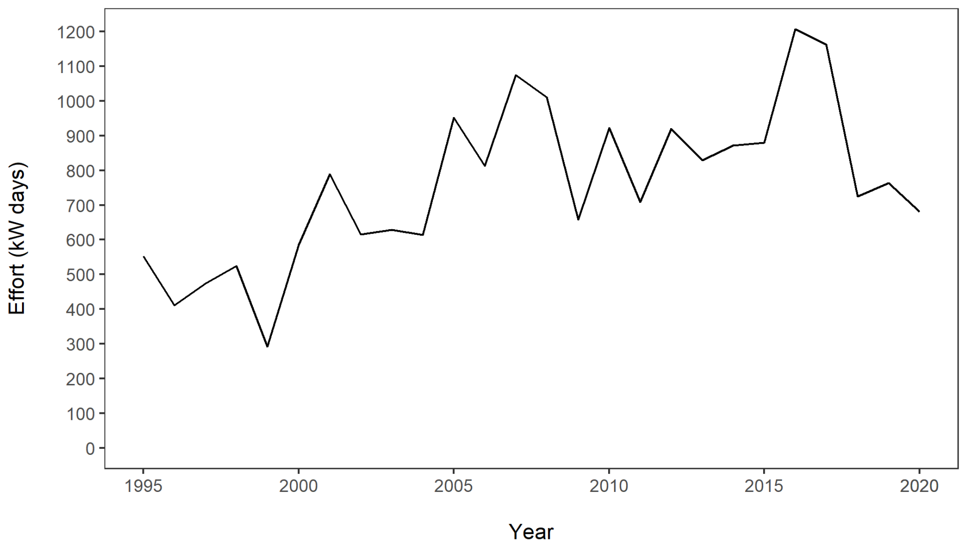

Figure 21.2.2. ***Nephrops*** **in FU22 (Smalls Grounds). Fishing effort Kw days for the Irish otter trawl** ***Nephrops*** **directed fleet (30% of** ***Nephrops*** **weight in total landings).**

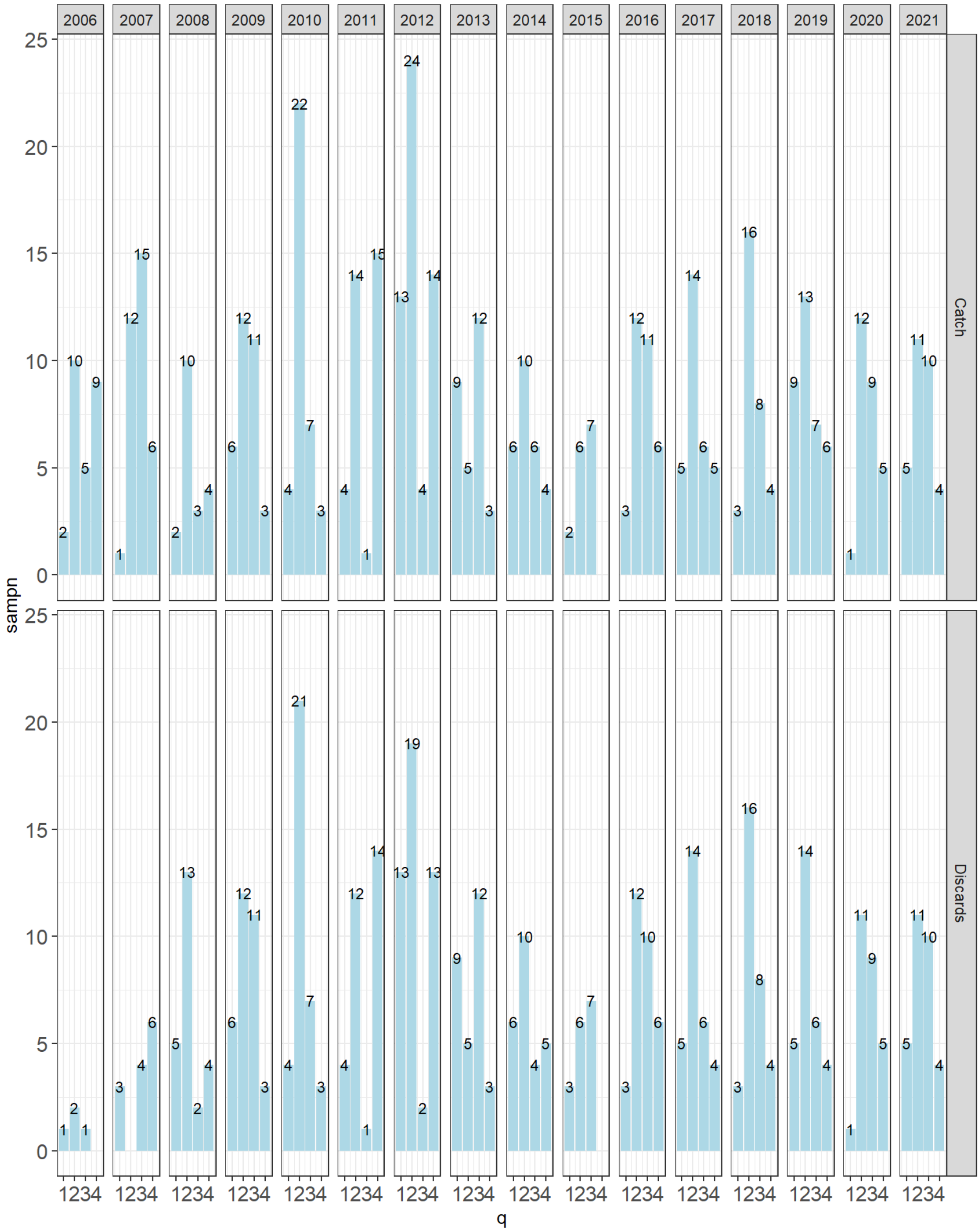

Figure 21.2.3. ***Nephrops*** **in FU22 (Smalls Grounds). Sampling levels (numbers) by year and quarter and sample type.**

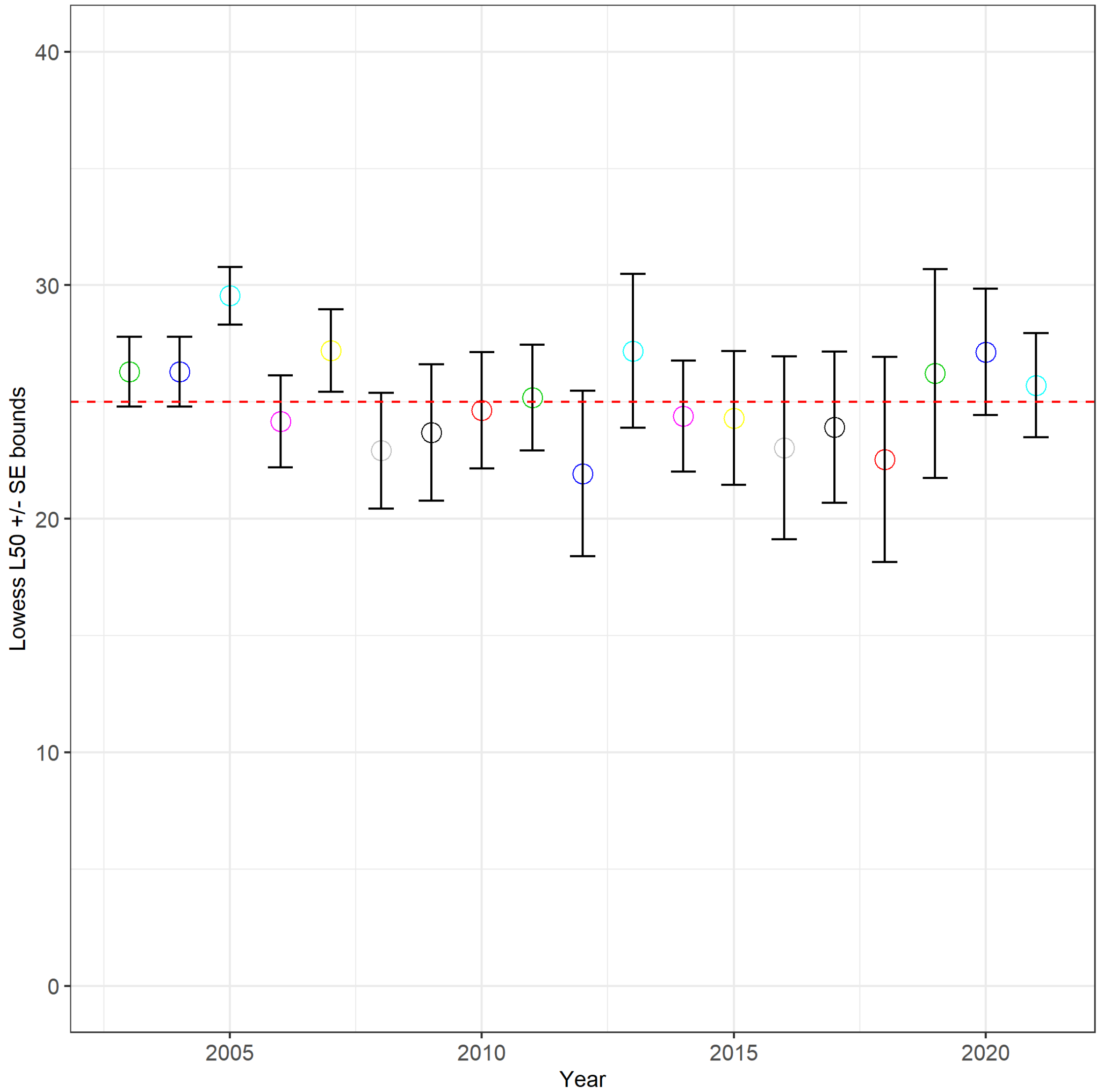

Figure 21.2.4. *Nephrops* in FU22 (Smalls Grounds). The annual estimated L_{50} with standard error bounds for the on-board retention ogives for samples from the Smalls grounds. Minimum conservation size (MCR) 25 Carapace Length (CL mm) shown as dashed line.

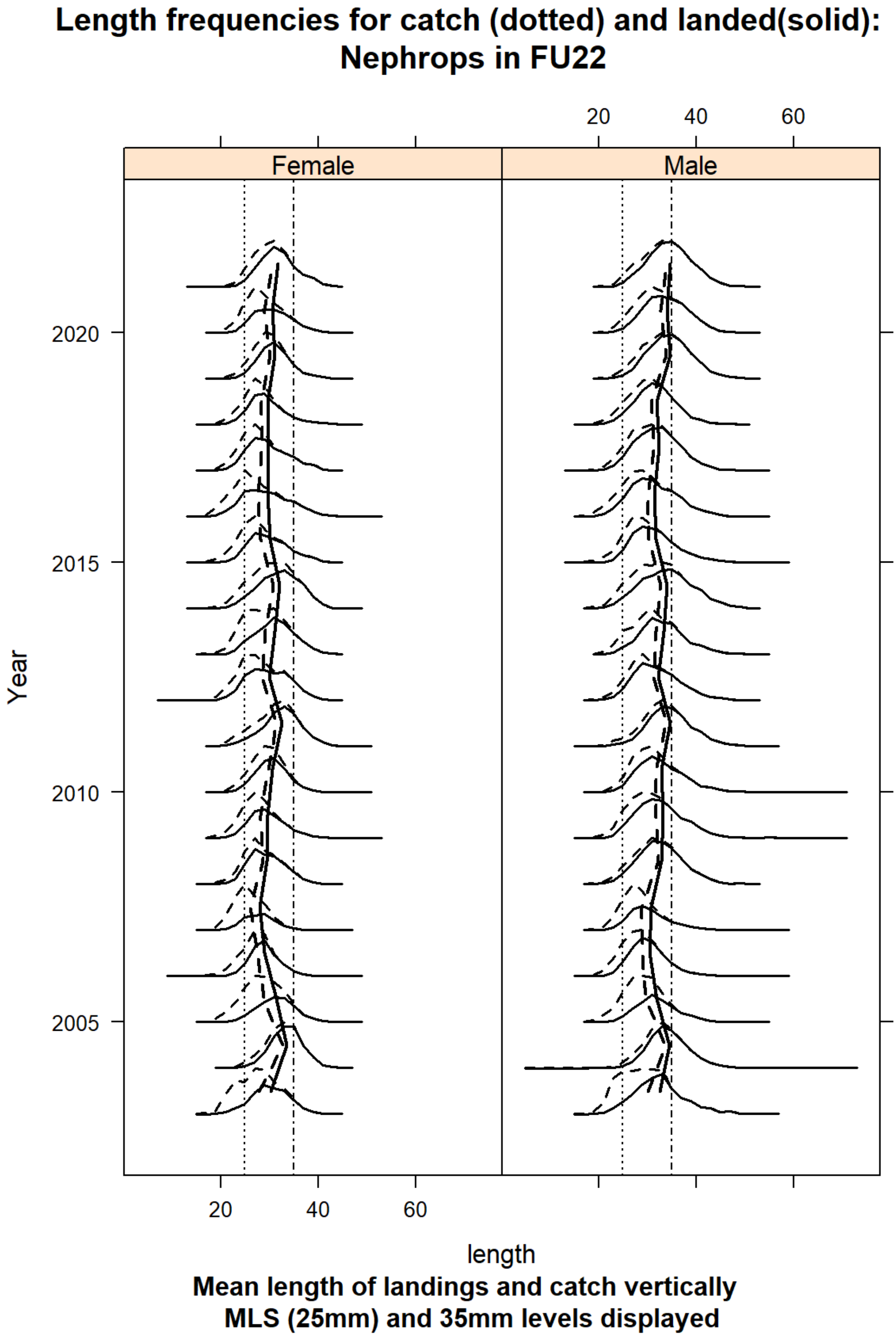

Figure 21.2.5. ***Nephrops*** **in FU22 (Smalls Grounds). Mean size trends for catches and whole landings by sex over the time-series.**

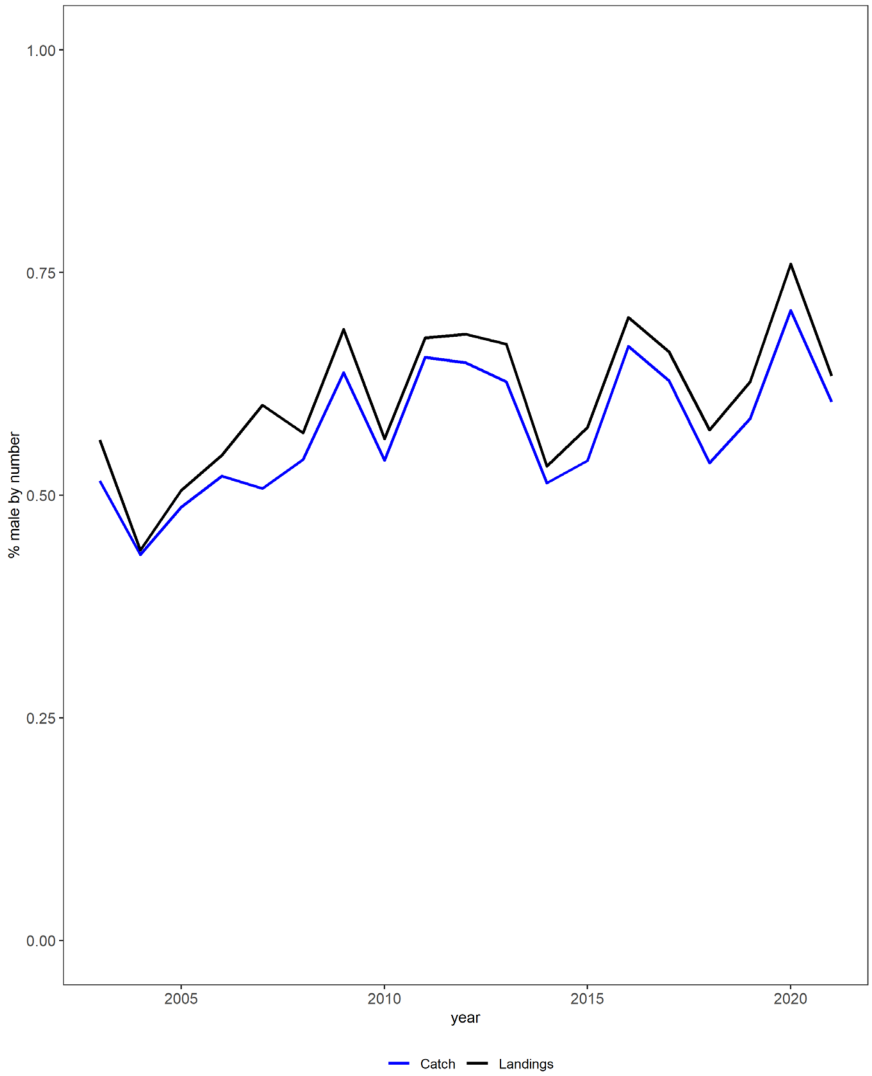

Figure 21.2.6. *Nephrops* in FU22 (Smalls Grounds). Sex ratio of the percentage males over the time-series.

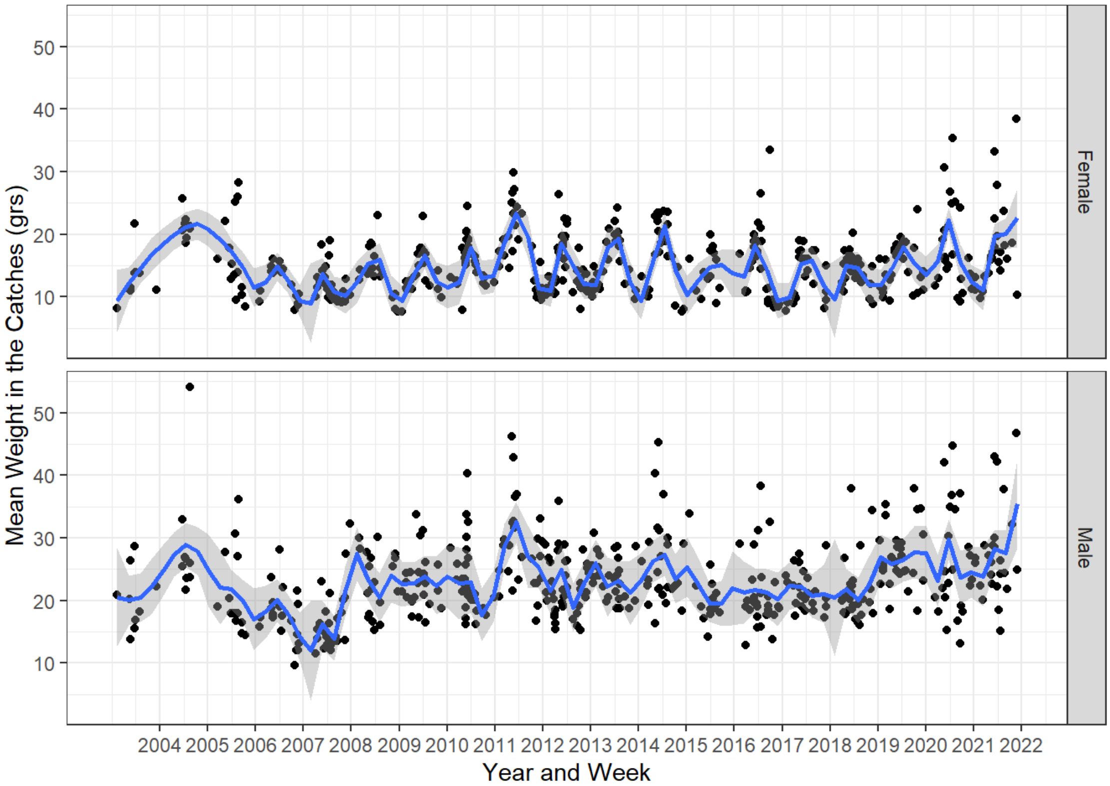

Figure 21.2.7. ***Nephrops*** **in FU22 (Smalls Grounds). Mean weight in catch samples by sex with loess smoother and showing cyclical trends.**

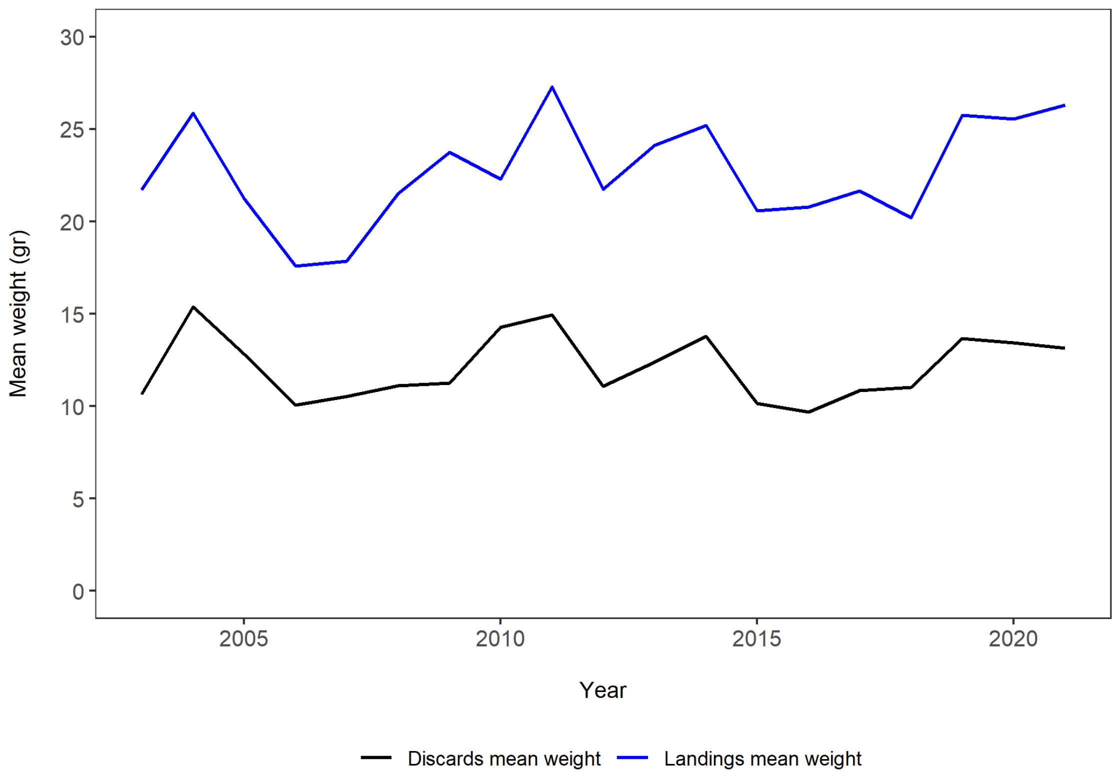

Figure 21.2.8. *Nephrops* in FU22 (Smalls Grounds). Annual mean weights (gr) in the landings and discards.

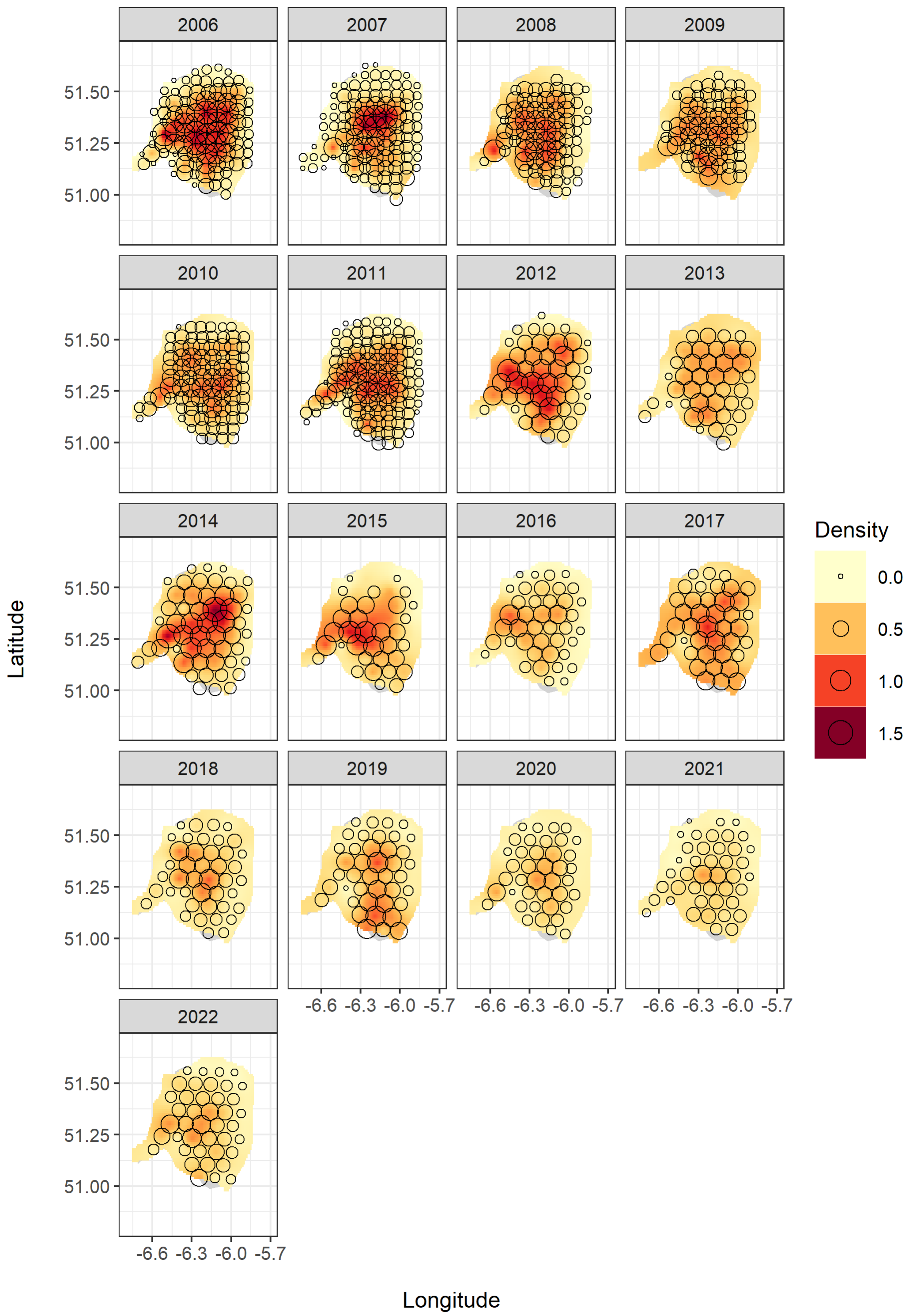

Figure 21.2.9. ***Nephrops*** **in FU22 (Smalls Grounds). Contour plots of the krigged density estimates for the UWTV surveys over the time-series.**

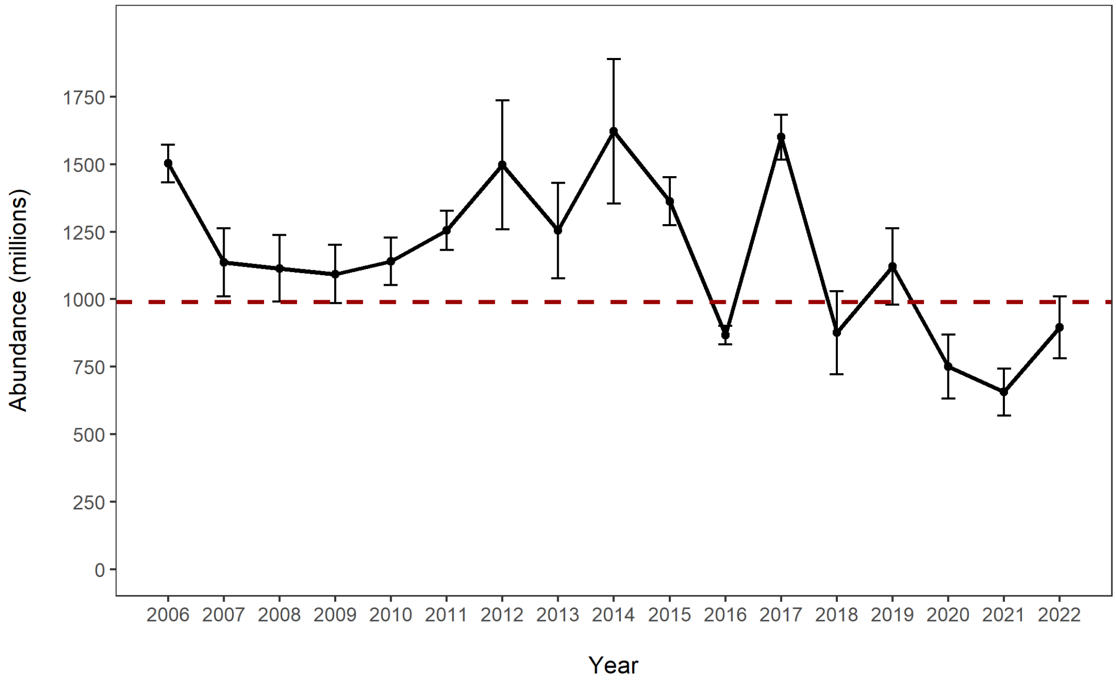

Figure 21.2.10. ***Nephrops*** **in FU22 (Smalls Grounds). Time-series of abundance estimates for FU22 (error bars indicate 95% confidence intervals) and MSY $B_{trigger}$ is dashed line.**

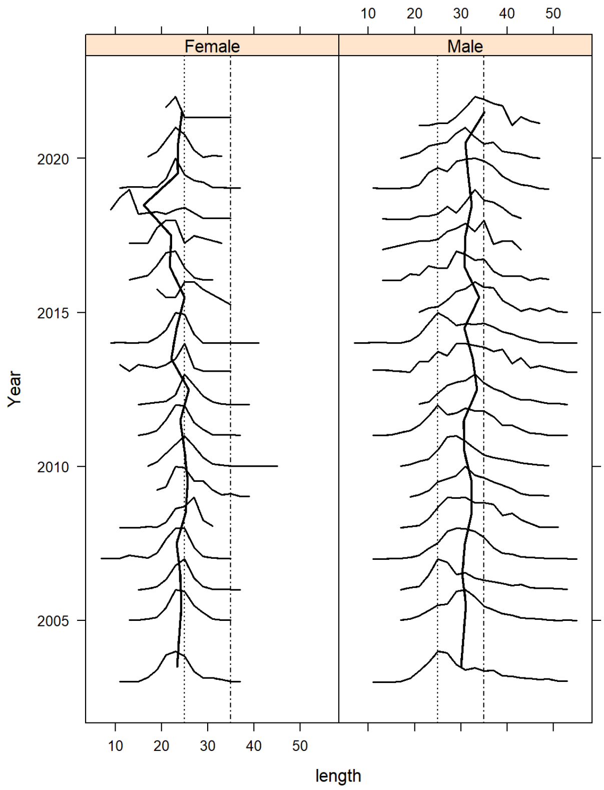

Figure 21.2.11. ***Nephrops*** **in FU22 (Smalls Grounds). Mean size trends (Carapace length CL mm) for catches by sex from IGFS-WIBTS-Q4 [G7212]. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and 35 mm CL.**

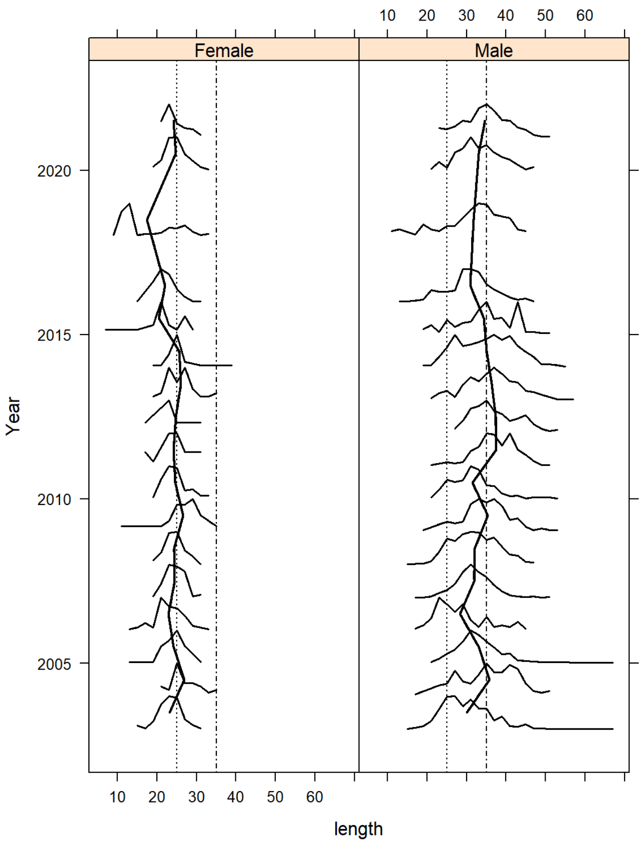

Figure 21.2.12. Nephrops in FU22 (Smalls Grounds). Mean size trends (Carapace length CL mm) for catches by sex from EVHOE- WIBTS-Q4 [G9527] French survey. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and 35 mm CL.

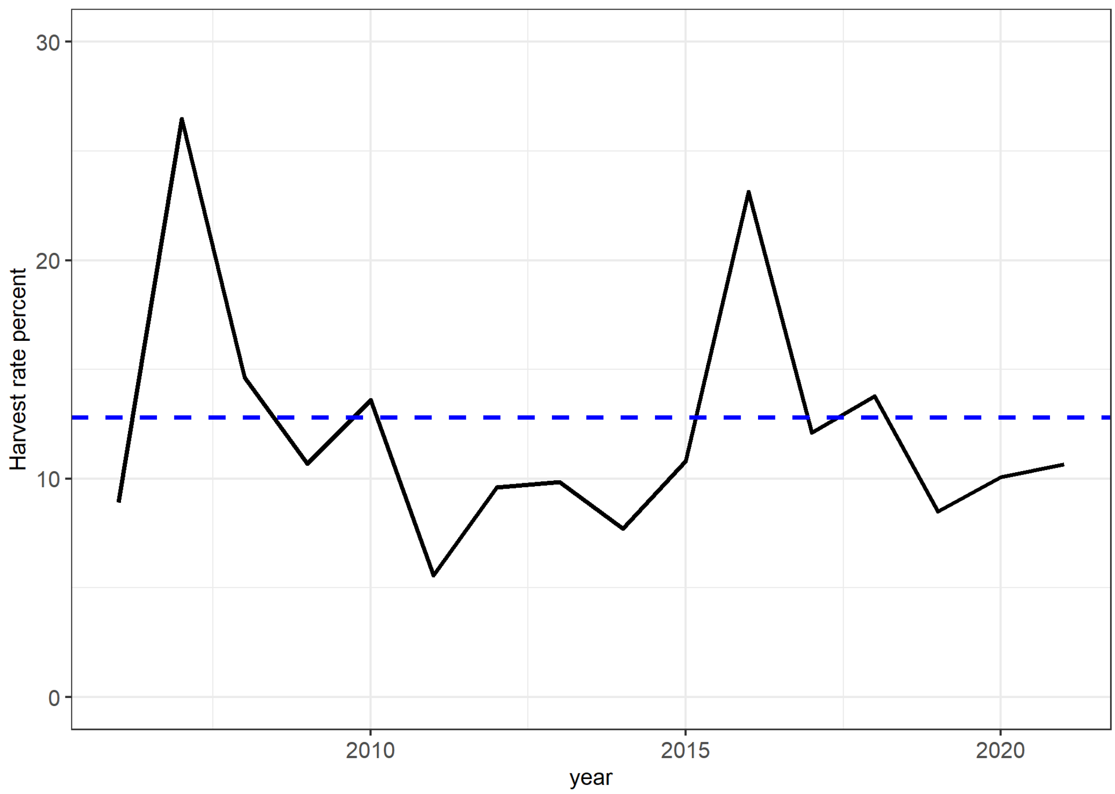

Figure 21.3.1. *Nephrops* in FU22 (Smalls Grounds). Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.

22 Norway lobster (*Nephrops norvegicus*) in divisions 8.a and 8.b, Functional Units 23-24 (northern and central Bay of Biscay)

The section for Norway lobster (*Nephrops norvegicus*) in divisions 8.a and 8.b, Functional Units 23-24 (northern and central Bay of Biscay) is found in the 2022 report from the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE).

22 Norway lobster (*Nephrops norvegicus*) in Division 9.a, Functional Unit 30 (Atlantic Iberian waters East and Gulf of Cadiz)

The section for Norway lobster (*Nephrops norvegicus*) in Division 9.a, Functional Unit 30 (Atlantic Iberian waters East and Gulf of Cadiz) is found in the 2022 report from the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE).

23 Plaice (*Pleuronectes platessa*) in divisions 7.b–c (West of Ireland)

Type of assessment in 2020

No assessment was performed.

23.1 General

Stock Identity

Plaice in 7.b are mainly caught by Irish vessels on sandy grounds in coastal areas. Plaice catches in 7.c are negligible. There are two distinct areas in which plaice are caught by Irish vessels in 7.b: an area around Galway Bay and an area in the north of 7.b, which extends into 6.a (the Stags and Broadhaven Ground). During 1995–2000 a large proportion of the 7.bc plaice landings were taken from the Stags Grounds (Rectangles 37D8, 37D9, 37E0 and 37E1). The landings and LPUE in this area have dropped sharply since 2000, in line with a general decrease of LPUE in Division 6.a. Plaice in this area appear to be more linked with 6.a than populations further south. The landings and LPUE on the Aran grounds appear to have been more or less stable since the start of the logbooks' time-series in 1995 (WD 1, WGCSE 2009). It is not known how much exchange there is between plaice on the Aran grounds and those on the Stags ground. The commercial LPUE time-series may not be reflective of overall stock abundance due to changing fishing practices.

Data

The time-series of official landings is presented in Table 23.1 and Figure 23.1.

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. In 2021, 13 size classes were sampled, however, there were only two sampling trips. Figure 23.2 describes the length–frequency distribution of the discard trips, and the contribution of these length classes to hauls and trips.

Table 23.1. 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	1965	0	417	2	99	0	518		
1909	0	0	0	49	0	49	1966	0	0	1	127	0	128		
1910	0	0	0	36	0	36	1967	0	182	2	112	0	296		
1911	0	0	2	54	0	56	1968	0	403	0	89	0	492		
1912	0	0	1	40	0	41	1969	0	281	2	99	0	382		
1913	0	0	0	54	0	54	1970	0	124	0	110	0	234		
1914	0	0	0	85	0	85	1971	0	0	1	89	0	90		
1915	0	0	1	23	0	24	1972	0	110	0	124	0	234		
1916	0	0	0	22	0	22	1973	0	60	1	124	0	185		
1917	0	0	0	36	0	36	1974	0	45	1	106	0	152		
1918	0	0	0	29	0	29	1975	0	10	0	153	0	163		
1919	0	0	1	32	0	33	1976	0	9	0	133	0	142		
1920	0	0	25	15	0	40	1977	0	4	0	135	0	139		
1921	0	0	9	34	0	43	1978	0	16	0	122	0	138		
1922	0	0	1	37	0	38	1979	0	6	0	117	2	125		
1923	0	0	1	30	0	31	1980	0	12	0	142	65	219		
1924	0	0	4	166	0	170	1981	0	9	4	135	58	206		
1925	0	0	5	28	0	33	1982	0	8	4	122	22	156		
1926	0	13	10	42	0	65	1983	0	37	0	108	7	152		
1927	0	126	14	45	0	185	1984	0	2	6	110	0	118		
1928	0	40	7	35	0	82	1985	0	10	7	150	0	167		
1929	0	262	25	31	0	318	1986	0	11	5	114	0	130		
1930	0	96	6	44	0	146	1987	0	13	1	153	0	167		
1931	0	238	8	58	0	304	1988	0	9	2	157	0	168		
1932	0	411	19	76	0	506	1989	0	1	14	159	0	174		
1933	0	595	29	29	0	653	1990	0	11	92	130	0	233		
1934	0	406	31	33	0	470	1991	0	9	3	179	0	191		
1935	0	249	18	33	0	300	1992	0	3	9	180	0	192		
1936	0	265	47	37	0	349	1993	0	2	3	191	0	196		

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1937	0	242	59	25	0	326	1994	0	1	5	200	0	206		
1938	0	359	25	20	0	404	1995	0	5	2	239	0	246		
1939	0	0	0	24	0	24	1996	0	1	2	248	0	251	-11	240
1940	0	0	0	47	0	47	1997	0	3	0	206	0	209	4	213
1941	0	0	0	43	0	43	1998	0	0	1	160	0	161	22	183
1942	0	0	0	41	0	41	1999	0	0	2	157	0	159	13	172
1943	0	0	0	29	0	29	2000	0	31	0	99	0	130	-22	108
1944	0	0	0	42	0	42	2001	0	8	0	70	0	78	9	87
1945	0	0	0	30	0	30	2002	0	17	2	51	0	70	1	71
1946	0	0	5	32	0	37	2003	0	7	0	56	2	65	7	72
1947	5	0	9	36	0	50	2004	0	14	0	39	1	54	1	55
1948	0	0	8	47	0	55	2005	0	12	0	25	0	37	1	38
1949	0	0	20	63	0	83	2006	0	11	0	20	1	32	-2	30
1950	0	289	16	42	0	347	2007	0	12	0	23	0	35	-1	34
1951	0	100	12	31	0	143	2008	0	9	0	21	1	31	4	35
1952	0	120	18	46	0	184	2009	0	7	0	45	0	52	1	53
1953	0	340	8	48	0	396	2010	0	6	0	27	0	33	0	33
1954	0	273	5	72	0	350	2011	0	2	0	16	0	18	-2	16
1955	0	111	3	96	0	210	2012	0	9	0	20	0	29	-3	26
1956	0	174	1	64	0	239	2013	0	3	0	15	0	18	0	18
1957	0	80	1	60	0	141	2014	0	6	0	17	0	23	0	23
1958	0	204	0	71	0	275	2015	0	7	0	15	0	22	0	22
1959	0	392	5	54	0	451	2016	0	11	0	17	0	29	0	29
1960	0	197	3	46	0	246	2017	0	1	0	11	0	12	0	12
1961	0	182	0	30	0	212	2018	0	5	<1	22	0	27	0	27
1962	0	239	0	42	0	281	2019	0	<1	0	8	0	9	0	9
1963	0	471	2	67	0	540	2020	0	<0.5	0	6	<0.5	6	0	6
1964	0	427	2	66	0	495	2021	0	<0.5	0	3	<0.5	3	1	4

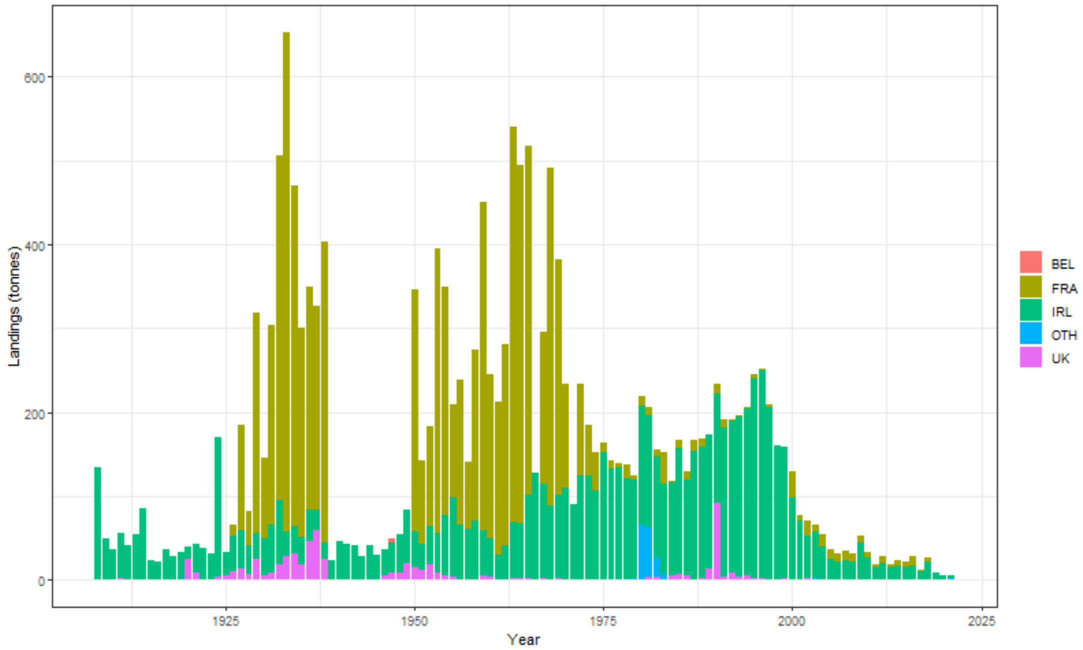

Figure 23.1. Landings of plaice in 7.bc as officially reported to ICES (1908–2019).

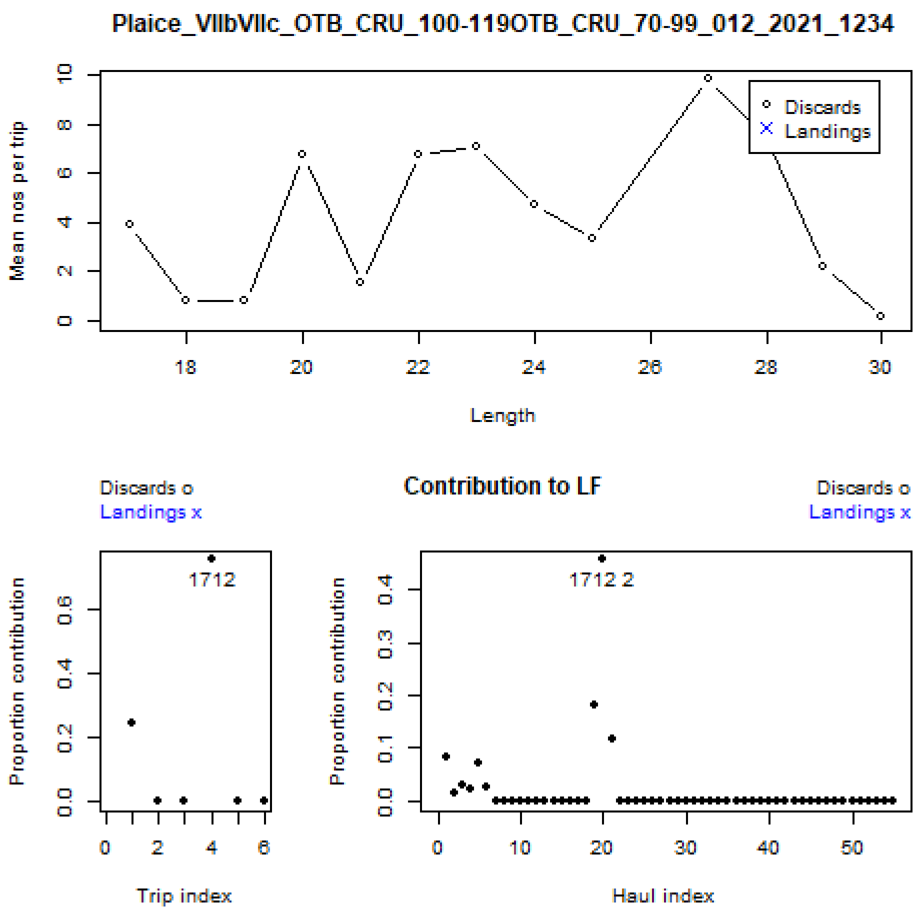

Figure 23.2. Estimated age distribution of plaice 7.bc in 2021 based on Irish sampling (landings in blue, discards in black).

24 Plaice in Division 27.7.a (Irish Sea)

Type of assessment in 2022

WKIrish3 (ICES, 2017) benchmarked this assessment and choose the SAM model, including estimates of discards-at-age into the catch matrix. A baseline run of the model was performed using discards since 1981 reconstructed according to the medium discard scenario (ICES, 2017).

ICES advice applicable to 2021

ICES advises that when the MSY approach is applied, catches in 2021 should be no more than 2846 tonnes.

http://ices.dk/sites/pub/Publication%20Reports/Advice/2020/2020/ple.27.7a.pdf

ICES advice applicable to 2022

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 the years 2018–2020, total catches in 2022 should be no more than 2747 tonnes.

Advice for 2022 is available at:

https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2021/2021/ple.27.7a.pdf

During the working group the advice for 2022 was updated to 2925 as a result of the revision of the Northern Ireland survey index.

24.1 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 2021 and 2022

Management of plaice in Division 27.7.a is by TAC and there is a Minimum Conservation Reference Size (MCRS) of 27 cm in force. The agreed TACs and associated implications for plaice in Division 27.7.a are detailed in the tables below.

2021

Species:	Plaice *Pleuronectes platessa*	Zone:	7a (PLE/07A.)
Belgium	62	Analytical TAC	
France	27	Article 8(2) of this Regulation applies	
Ireland	1 069		
The Netherlands	19		
Union	1 177		
United Kingdom	1 455		
TAC	2 846		

(Source: Council Regulation (EU) 2021/1239, ANNEX IA)

2022

Species:	Plaice *Pleuronectes platessa*	Zone:	7a (PLE/07A.)
Belgium	60	Analytical TAC Article 8(2) of this Regulation applies	
France	26		
Ireland	1 031		
Netherlands	19		
Union	1 136		
United Kingdom	1 404		
TAC	2 747		

(Source: Council Regulation (EU) 2022/515, ANNEX IA)

The fishery in 2021

National landings data reported to ICES and Working Group estimates of total landings are given in Table 24.1. A summary by gear is given below.

Catch (2021)		Landings			Discards		
77% dead	23% surviving	Beam trawl	Otter trawl	Other gear types	Beam trawl	Otter trawl	Other gear types
		68%	31%	<1%	20%	80%	<1%
668 tonnes		276 tonnes			392 tonnes		
					60% dead		40% surviving

The TAC for 2021 was 2846 tonnes and the working group estimate of landings in 2021 was 276 tonnes. The poor uptake of the quota is not a consequence of an inability to catch sufficient quantities of plaice greater than the MCRS but rather is most likely due to the limited market demand and poor value of the catch.

Landings (based on working group estimates) by the Irish, NI, UK and Belgian fleets comprised approximately 38%, 3.6%, 22% and 36% respectively of total landings in 2021. The landings of plaice are mainly split between beam trawlers (68%; primarily Belgian vessels then Irish vessels) targeting sole, and otter trawlers (31%; Irish and UK vessels). Historically, otter trawling was dominated by UK vessels fishing for whitefish, but in recent years, many vessels have switched to target *Nephrops* (Figure 24.1). 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 24.4 and 24.5).

A general description of the fishery can be found in the stock annex and also in 'Other Relevant Data' section below.

24.2 Data

Landings

National landings data reported to ICES and Working Group estimates of total landings are given in Table 24.1. 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 24.2a). Age compositions of landed fish are available for Belgian beam trawl, Irish beam and otter trawl and English otter trawl (Figure 24.5).

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. Age compositions of discarded fish are available for Belgian beam trawl and Irish otter trawl, discard estimates are also available for Northern Irish otter trawl. Discard rates for unsampled fleets are taken from the sampled fleets separately for fisheries targeting demersal fish and *Nephrops*. For 2021 however, discard estimates for the English fleets are calculated using the English *Nephrops* average discard rate (2017–2019) due to concerns that the discarding practices of Northern Irish and Irish *Nephrops* fleets were not applicable to this fleet, and would have implied an unrealistically large amount of discards (Figure 24.4). Age compositions of discarded fish are available for Belgian beam trawl (used for gears targeting demersal fish) and Irish otter trawl (used for gears targeting *Nephrops*) (Figure 24.5).

WKFLAT (ICES, 2011) first estimated total international discards-at-age and introduced them to the assessment of the stock for the first time. Due to limitations in the data available by gear type, discards for Ireland, France and Northern Ireland, for the years 2004–2011 were raised using UK estimates on the basis of equivalent gear types. A raising factor based on tonnages landed for these countries was calculated and applied to the UK(E&W) estimates of discard numbers. Finally, these estimates were added to those calculated for Belgium to give estimates of total international discard numbers-at-age.

There is a considerable historic time period (1981–2003) for which no international raised discard estimates are available. The method for reconstructing discards prior to 2004 is based on size-varying discard rates and is documented in Annex 4 of the WKIrish3 report (ICES, 2017).

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 24.1, Figure 24.2b) 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 (60% and 81% average discard in weight and in numbers respectively, since 2004).

Biological

Landings numbers-at-age are given in Table 24.5 and plotted in Figure 24.2a. Weights-at-age in the landings are given in Table 24.6. Discard weights-at-age are given in Table 24.7 and weights-at-age in the stock in Table 24.8. 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 MCRS.

Surveys

All available tuning data are shown in Tables 24.2, 24.3 (a and b) and 24.4. 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) (B6596) and the two NIGFS-WIBTS spawning biomass indices based on ground fish surveys (NIGFS-WIBTS-Q1 (G7144) and NIGFS-WIBTS-Q4 (G7655)). For more information see WGNSDS (ICES, 2004). The UK (E&W)-BTS-Q3 index was revised by WKFLAT 2011 to include stations in the western Irish Sea and in St George's Channel. A second revision was conducted in 2017 to correct for some inconsistency in the index calculation This revision did not substantially change the trend of the biomass index (see WD Cambiè and Earl, 2017 in WGCSE 2017 report).

Reviews of the UK (E&W)-BTS-Q3 mean standardised CPUE trends have indicated that the survey has good internal consistency in monitoring trends across the stock area. For the entire Irish Sea, the biomass index calculated from the UK (E&W)-BTS-Q3 (Figure 24.3, right) indicates two periods of upwards trend, 1993–2003 and from 2007–2015. It is however, detected to have dropped from 2016. An increase of numbers in older ages is observed until around 2015, followed by a steep decline (Figure 24.3, left). The NIGFS-WIBTS surveys show similar increases in biomass between 1993 and 2003 and then a further increase subsequently until most recent years.

In 2022, an error was discovered in the calculation of the tuning index from the NIGFS-WIBTS (Autumn and Spring), going back four years for the Autumn series and three years for the Spring series. The most recent datapoints were not calculated in the same units as previously, and so had to be corrected. The revision increased these data points by a factor of 3. An update of the 2021 assessment using the corrected data led to the SSB at the start of the interim year being revised up by 13% and a minor improvement to the model fit.

The NIGFS-WIBTS survey strata can be disaggregated into western (Strata 1–3) and eastern (Strata 4–7) subareas, where the subareas are divided by the deep trench that runs roughly north–south to the west of the Isle of Man (Figure 24.6, Tables 24.3a and b).

The SSB of plaice in the Irish Sea was also independently estimated using the Annual Egg Production Method (AEPM), according to Armstrong *et al.*, 2001 methodology.

Year	SSB (tonnes)	Catch/SSB harvest rate
1995	9081	
2000	13 303	
2006	14 417	15.16
2008	14 352	12.77
2010	15 071	19.5

Catch (discards available from 2004) to egg survey biomass ratios indicate historically that the plaice in the Irish Sea has been lightly exploited. Splitting the SSB estimates from the AEPM into eastern and western Irish Sea areas (Figure 24.7) also indicates that the perceived increase in plaice biomass is due to increased production in the eastern Irish Sea only (for more details see stock annex).

In summary, the UK (E&W)-BTS-Q3 in September, the NIGFS-WIBTS-Q4 index in October (but not NIGFS-WIBTS-Q1 March), and the AEPM indicate a sustained increasing trend 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 24.7).

Commercial CPUE

Age-based tuning data available for this assessment, comprise three commercial fleets: the UK(E&W) otter trawl fleet (UK(E&W) OTB, from 2008), the UK(E&W) beam trawl fleet (UK(E&W) BT, from 1989) and the Irish otter trawl fleet (IR-OTB, from 1995). Due to inconsistencies in the available tuning fleets, Irish Sea plaice assessments since 2004 have omitted these indices. For more information, see WGNSDS 2004. The effort and catch by these commercial fleets has been very low in recent years and the CPUE data are no longer considered informative.

Other relevant data

Table 24.2 and Figure 24.1 show that effort levels have decreased since 2002 for the majority of fleets. Both the UK otter and beam trawl fleets are close to their lowest recorded effort levels in time-series extending back to 1972 and 1983 respectively. Effort by UK *Nephrops* trawlers has greatly increased in the years 2006–2014 but has decreased in the last years. However, this fleet is now the dominant UK fleet in terms of hours fished in 27.7.a. Belgian vessels operating in Division 7 typically move in and out of the Irish Sea, depending on the season, from specifically the Bristol Channel and Celtic Sea, the Bay of Biscay and the southern North Sea.

Since 2013, a problem with the gear effort information (000s hours fished) reported for the UK (E&W) commercial beam trawl fleet has been registered. Effort information from this fleet is largely missing as a result of a larger component of the fleet using the EU electronic logbook system to report its activities. Gear effort information reporting has not been mandatory with this system to date. As a result, few trips reported their gear effort information rendering the overall effort reported and resulting LPUE unusable. However, an initial inspection of an alternate effort indicator for this gear (days fished) suggests that UK beam trawl effort in 2013, 2014, 2015, 2016, and 2017 is at the level observed in 2012. The otter trawl fleet effort reporting was unaffected by this as these vessels were not reporting their landings via this method in these years.

24.3 Historical stock development

Model: Age-based analytical assessment (State–space Assessment Model, SAM) that uses landings and discards (Nielsen and Berg, 2014).

Software: R version 4.0.2 with additional packages (version in parenthesis):

stockassessment (0.11.0); FLCore (2.6.18); reshape (0.8.9); ggplot2 (3.3.5); Cairo (1.5.15); doParallel (1.0.17); TMB (1.8.1); devtools (2.4.3).

Model options chosen

The AP model (Aarts and Poos, 2009) was replaced by SAM. WGCSE (ICES, 2016) agreed that the AP model was not the definitive assessment tool for Irish Sea plaice but a temporary solution to the fitting of datasets which included recent discards estimates but for which historic discard information was not available. Reconstructed values of historic discards (prior 2004) were provided in the WKIrish3 (ICES, 2017). The SAM model incorporates the estimated historic discards and is used to run the assessment since 2017.

The model runs were performed using the R package 'stockassessment'. Settings for this update stock assessment are given in the table below. The update assessment follows the same procedure as in the stock annex (ICES, 2017). A baseline run of the model was performed using discards since 1981 reconstructed according to the medium discard scenario (ICES, 2017). Discard survival was set at 40%, and natural mortality followed a Lorenzen curve, scaled to 0.12.

Input data types and characteristics

Commercial catch-at-age data. Discards values available from 2004. Estimates of discards reconstructed for 1981–2003 (ICES, 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.

Final update assessment

WKIrish3 (ICES, 2017) benchmarked this assessment and included estimates of discards-at-age into the catch matrix.

The assessment settings are shown in the following table. Historic settings are given in the stock annex.

Assessment year		2018	2019	2020	2021	2022
Assessment model		SAM	SAM	SAM	SAM	SAM
Tuning fleets	UK (E&W)-BTS-Q3	Survey omitted	Survey omitted	Survey omitted	Survey omitted	Survey omitted
	Extended UK (E&W)-BTS-Q3	1993–2017, ages 1–7	1993–2018, ages 1–7	1993–2019, ages 1–7	1993–2019, ages 1–7	1993–2021, ages 1–7
	UK(E&W) BTS Mar	Survey omitted	Survey omitted	Survey omitted	Survey omitted	Survey omitted
	UK(E&W) OTB	Series omitted	Series omitted	Series omitted	Series omitted	Survey omitted
	UK(E&W) BT	Series omitted	Series omitted	Series omitted	Series omitted	Survey omitted
	IR-OTB	Series omitted	Series omitted	Series omitted	Series omitted	Survey omitted
	NIGFS-WIBTS-Q1	1992–2017	1992–2018	1992–2019	1992–2020	1992–2021
	NIGFS-WIBTS-Q4	1992–2017	1992–2018	1992–2019	1992–2020	1992–2021
Selectivity model		Correlated random walk	Correlated random walk	Correlated random walk	Correlated random walk	Correlated random walk
Discard fraction		Estimated by WKIrish3	Estimated by WKIrish3	Estimated by WKIrish3	Estimated by WKIrish3	Estimated by WKIrish3
Landings N at age		1981–2017, ages 1–8+	1981–2018, ages 1–8+	1981–2019, ages 1–8+	1981–2020, ages 1–8+	1981–2021, ages 1–8+
Discards N at age		1981–2017, ages 1–8+	1981–2018, ages 1–8+	1981–2019, ages 1–8+	1981–2020, ages 1–8+	1981–2021, ages 1–8+

The estimated selectivity patterns split into the landed and discarded components are shown in Figure 24.8. Until early 1990s, the landings selectivity had the highest values for fish aged 4 (indicating that 4-year aged fish were selected). This selectivity shifted to age 5 in late the 1990s and early 2000s, due to the increase of the MCRS in 1998 (from 250 mm to 270 mm). Since late 2000s landings gradually fell over time to very low values relative to the discard pattern, which became dominant and expanded to the older aged fish during the most recent years.

The catchability of the UK(E&W)-BTS-Q3 survey is elevated for ages 1 and 2 and reflects the nature of the survey, which was designed as a recruit index (Figure 24.9).

Diagnostic output from the SAM model is shown in Figure 24.10. In the catch residuals, negative values are apparent in ages 8+ from 1998. A year effect in 2004 is present in the UK(E&W)–BTS-Q3 residuals (which is the first year for which discard data are available). A pattern of negative residuals between 2004 and 2009 is present in the residuals of the NIGFS-WIBTS due to large fluctuations in the SSB indices, which are due potentially to variable catchability of the survey.

Recruitment is estimated to be fluctuating without an overall trend until 2015, and then estimated at its lowest values in 2017–2021. 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 24.11).

The estimated SSB from the SAM model shows an increasing trend from 1995 until 2004–2005, followed by a drop in 2006 and 2007. This change in SSB trend from 2004 is probably due to the inclusion of more reliable discards values since 2004, when international raised discard estimates became available. Since 2012, SSB has increased reaching the highest value of the whole time-series in 2016, followed by a significant in estimated SSB since then. The SSB trends are largely in agreement with independent SSB estimates from the Annual Egg Production Method (AEPM), up to the most recent estimate in 2010, as well as showing a similar trend to the survey data used in the assessment (NIGFS-WIBTS-Q1 and -Q4; UK(E&W)-BTS-Q3, Figure 24.12).

Estimates of numbers-at-age in the landings, discards and population, and fishing mortality numbers-at-age are given in Tables 24.9–24.12. A summary plot for the SAM assessment is shown in Figure 24.13 and the time-series estimates for F_{bar}, SSB and recruitment are given in Table 24.13.

Comparison with previous assessments

In 2017, the Aarts and Poos model was replaced by the state–space assessment model (SAM). The assessment used the Lorenzen M scaled to 0.12, and the most recent maturity ogive for the survey.

The methodology provided is as robust as possible and does not currently appear to suffer from a serious retrospective pattern (Figures 24.14 and 24.15). The ten assessment model configurations compared in WKIrish3 (ICES, 2017) perform similarly in terms of temporal trends in SSB, recruitment, catch and F_{bar}. Small retrospective bias in SSB in 2004 likely resulted from the introduction of discards estimates based on samples collected from that year (prior to 2004, discards estimates are reconstructed values based on size-varying discard rates). A Mohn’s rho analysis for a five-year peel resulted in values of 2.8% for recruitment, 2.2% for SSB and -3.8% for F_{bar}.

State of the stock

Trends in F_{bar} SSB, recruitment and catch, for the full time-series, are shown in Table 24.13 and Figure 24.13. The assessment consistently estimates that fishing mortality declined from high levels in the 1980s and early 1990s to very low levels, having been <0.1 since 2013. Since 2012, SSB has increased reaching the highest value of the whole time-series in 2016, whereas it has slightly decreased in 2017. Estimated recruitments are highly variable. An increasing trend was present until 2015 although it seems to have dropped to the lowest values in 2017–2020. Catch has decreased to low levels and, since 2006, the majority of the catch has been discarded (60% in weight and 81% and number respectively, averaged since 2004).

24.4 Short-term projections

Forecasting takes the form of short-term stochastic projections. A total of 1000 samples are generated from the estimated distribution of survivors. These replicates are then simulated forward according to model and forecast assumptions (see table below), using the usual exponential decay equations, but also incorporating the stochastic survival process (using the estimated survival standard deviation) and subject to different catch-options scenarios. Recruitment in the intermediate year (2022) was taken as the median from a distribution about the assessment estimate. Estimates of recruitment for intermediate year and subsequent years were resampled from the 2015–2021 year classes, reflecting recent low levels of recruitment. These re-sampled recruitments are used in SAM forecasts in order to evaluate future stock dynamics.

Initial stock size	Starting populations are simulated from the estimated distribution at the start of the intermediate year (including covariances)
Maturity	Average of final three years of assessment data
Natural mortality	Average of final three years of assessment data
F and M before spawning	Both taken as zero
Weight at age in the catch	Average of final three years of assessment data
Weight at age in the stock	Assumed to be the same as weight-at-age in the catch
Exploitation pattern	Fishing mortalities taken as a three-year average
Stock recruitment model used	Recruitment for the intermediate year onwards is sampled, from 2015 to the final year of catch data
Procedures used for splitting projected catches	An average of final three years of landing fractions are used in the forecast period Discard values are raised to include the live portion. Discard numbers multiplied by 5/3 to account for discard survival. Total catch is sum of three components: landings, discards assumed to die, and discards assumed to survive

F estimates 2017–2019 has fluctuated around similar values, with further decline in 2020. F *status quo*, Fsq, has been estimated by averaging the F over 2019–2021 (0.064).

A full management options table is provided in Table 24.15, based on the intermediate year assumption in Table 24.14. Note that the values that appear in the catch scenarios are medians from the distributions that result from the stochastic forecast. Implementing the management plan for this stock with F_{MSY}=0.196 leads to a total catch of 2039 t (967 t of landings and 1072 t of discards including dead and survivors) in 2023 and SSB of 12629 t in 2024.

24.5 Medium-term projections

There are no medium-term projections for this stock.

24.6 MSY explorations

The reference points for this stock were estimated in 2018 (ICES, 2018) as ICES request for EU western waters stocks and are presented in the table below. in 2021, ICES changed the basis for F_{pa} to $F_{p.05}$, and the updated F_{pa} value is shown in the table below.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	8757 tonnes	Lower 5th percentile of B F_{MSY}	ICES (2018)
	F_{MSY}	0.196	Stochastic simulations with segmented regression from the entire time-series (1981–2017)	ICES (2018)
	$F_{MSY\ lower}$	0.133	F at 95% MSY (below FMSY), based on simulation using a segmented regression stock–recruitment relationship (EqSim)	ICES (2018)
	$F_{MSY\ upper}$	0.293	F at 95% MSY (above FMSY), based on simulation using a segmented regression stock–recruitment relationship (EqSim)	ICES (2018)
Precautionary approach	B_{lim}	3958 tonnes	B_{loss} = minimum SSB observed	ICES (2018))
	B_{pa}	5294 tonnes	$B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.177$	ICES (2018)
	F_{lim}	0. 50	F with 50% probability of SSB < B_{lim}	ICES (2018)
	F_{pa}	0.403	$F_{p.05}$; the F that leads to SSB ≥ B_{lim} with 95% probability	ICES (2018)
Management plan	SSB_{mgt}	Not appli-cable		
	F_{mgt}	Not appli-cable		

Yield per Recruit analysis

There are no yield per recruit analyses for this stock.

24.7 Management plans

There are no management plans for this stock.

24.8 Uncertainties and bias in assessment and forecast

The assessment was benchmarked in 2017 (WKIrish3), which resulted in the SAM model being fitted using catches based on reconstructed estimates of discards prior to 2004. This discard reconstruction introduces additional uncertainty in the model. The model estimates of stock development since 2004 are more reliable as based on direct discard estimates. The SAM model considered only the dead portion of the discards (60%), but in the forecast the estimates are raised to include the surviving discards. The Mohn's rho measure of retrospective bias for this assessment is low (Section 24.3).

The assessment indicates that recruitment and F have both been falling in recent years, and as a result the average age of catches has been increasing. An increasing amount of the stock is contained within the modelled plusgroup (47% in the last five years is age 8+). Consequently, the assessment and forecast have increased uncertainty and a pattern of retrospective adjustment of terminal year SSB downwards is seen in the recent history of the assessment.

24.9 Recommendations for next benchmark

There is evidence of substantial substock structure and incorporating information about the differences in growth and maturity between the east and west sides of the Irish Sea, as well as by sex should be explored.

Incorporating data on changes in maturity and natural mortality over time, linked to the decreasing in weights-at-age observed in survey data, should also be considered. There is evidence of a decline in weight-at-age from the commercial landings data and survey data. The UK(E&W)-BTS-Q3 survey data also indicate declines in length-at-age and maturity-at-age.

Creating age-based indices for the NI groundfish surveys would improve the assessment.

Ecosystem information ought to be explored.

Type	Problem/Aim	Work required	Data required	Expertise required
Sampling	The split between OTB and BTT has changed, and sample raising may not adequately reflect the changed split	Review consistency of sample raising to ensure the change of OTB/BTT is accurately and consistently reflected in the raised samples	Data already available in InterCatch	Catch sampling expertise
Assessment method	The assessment indicates that recruitment and F have both been falling in recent years, and as a result the average age of catches has been increasing. An increasing amount of the stock is contained within the modelled plusgroup (47% in the last five years is age 8+). Consequently, the assessment and forecast have increased uncertainty and a pattern of retrospective adjustment of terminal year SSB downwards is seen in the recent history of the assessment.	Recompile age distributions with a higher plusgroup, test effect of different Catchability assumptions in this age group. Consider whether F_{bar} age range needs changing. Possible recalculation of reference points	Landings data by age, as disaggregated as possible. Should be available post 2004 in InterCatch, but historic data availability unknown	Historic catch age composition raising
Other issues	Fits to NIGFS indices use SSB indices, assuming constant selectivity for all age/length	Explore whether age/length compositions can inform the selectivity of the survey and whether this can be included in the assessment	Survey age/length compositions	Survey index compilation experts

Type	Problem/Aim	Work required	Data required	Expertise required
Biological parameters	Natural mortality and maturity may be connected with size which has varied substantially over time and between parts of the stock.	Investigate whether time varying biological parameters can be derived and used in this stock	stock size data, relationships between M and stock size, relationships between maturity and stock size. Has the catch split changed between East and West of the area, and does this affect average M and maturity?	

24.10 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).

24.11 References

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Table 24.1. Plaice in Division 7.a. History of official landings and ICES estimates of discards. Weights are in tonnes.

Year	Belgium	France	Ireland	Netherlands	UK (NI, Eng.&Wales)	UK (Isle of Man)	UK (Scotland)	Total official landings	Discards
1994	332	13	547	-	1082	14	63	2051	
1995	327	10	557	-	1050	20	60	2024	
1996	344	11	538	69	878	16	18	1874	
1997	459	8	543	110	798	11	25	1954	
1998	327	8	730	27	679	14	18	1803	
1999	275	5	541	30	687	5	23	1566	
2000	325	14	420	47	610	6	21	1443	
2001	482	9	378	-	607	1	11	1488	
2002	636	8	370	-	569	1	7	1591	
2003	628	7	490	-	409	1	9	1544	
2004	431	2	328	-	369	0	4	1134	1031
2005	566	9	272	-	422	0	1	1270	1210
2006	343	2	179	0	413	0	0	937	1254
2007	194	2	194	0	412	0	-	802	1744
2008	157	2	102	0	300	1	1	563	1268
2009	197	0	73	0	184	1	2	457	1132
2010	138	0	89	0	147	0	3	377	2561
2011	332	0	118	0	146	0	0	596	603
2012	236	0	107	0	164	0	0	507	1010
2013	144	0	103	0	92	0	0	339	725
2014	100	0	123	0	59	0	0	282	943
2015	115	0	244	0	80	0	0	439	572
2016	82	0	541	-	56	-	-	679	437
2017	77	0	446	-	62	1	-	585	852
2018	53	0	316	-	66	-	-	435	395
2019	168	0	[c]	-	57	0	-	255[c]	537
2020*	84	-	177	-	70	2	-	333	271
2021*	103	0	107	-	70	1	-	281	392

*** Preliminary.**

[c] Incomplete/missing due to part of the data being unavailable under national GDPR clauses.

Table 24.2. Irish Sea plaice: English standardised LPUE and effort, Belgian beam trawl LPUE and effort and Irish otter trawl LPUE and effort series.

Year	CPUE			LPUE							Effort							
	UK(E&W) Beam trawl survey[1]			UK (E&W)[2]				Belgian[5]	Irish[7]		UK (E&W)					Belgian	Irish[9]	
	March	September Prime only	September Extended	Otter[3] Trawl	Otter[4] Trawl	Beam[3] Trawl	Beam[4] Trawl	Beam Trawl	Otter Trawl	Beam Trawl	Otter[3] Trawl	Otter[4] Trawl	Beam Trawl	Beam[4] Trawl	Nephrops[3] Trawl	Beam Trawl	Otter Trawl	Beam Trawl
1972				6.96				9.8			128.4					6.8		
1973				6.33				9.0			147.6					16.5		
1974				7.45				10.4			115.2					14.2		
1975				7.71				10.7			130.7					16.2		
1976				5.03				5.8			122.3					15.1		
1977				4.82				5.3			101.9					13.4		
1978				6.77		4.88		6.9			89.1		0.9			12.0		
1979				7.18		15.23		8.0			89.9		1.7			13.7		
1980				8.24		8.98		8.6			107.0		4.3			20.8		
1981				6.87		4.91		7.1			107.1		6.4			26.7		
1982				4.92		1.77		4.4			127.2		5.5			21.3		
1983				5.32	1021	3.08	0	7.8			88.1	1716.5	2.8	0		18.5		
1984				7.77	1472	6.98	810	6.8			103.1	7932.1	4.1	263		13.6		
1985				9.97	1946	25.70	5487	8.8			102.9	6930.8	7.4	428.1		21.9		
1986				9.27	1597	4.21	753	8.7			90.3	6693.2	17.0	1122.9		38.3		
1987				7.20	1479	3.57	963	8.2			130.6	9008.9	22.0	1178.5		43.2		
1988		392		5.02	1060	3.05	743	6.3			132.0	8292.4	18.6	1019.2		32.7		
1989		253		5.51	1109	13.59	2559	6.2			139.5	16161.4	25.3	1344.5		36.7		
1990		239		5.93	1074	12.02	3011	7.2			117.1	7724.5	31.0	1473.1		38.3		
1991		157		4.79	916	10.56	2807	7.5			107.3	7081.1	25.8	1211.3		15.4		
1992		188		4.20	719	9.99	2303	11.9			96.8	6671.8	23.4	908.1		23.0		
1993	91	235	149	3.97	667	9.50	2220	5.0			78.9	6013.1	21.5	826.9		24.4		
1994	128	225	132	4.90	770	7.79	1020	9.2			43.0	3060	20.1	1451.6	0	31.6		
1995	134	169	109	5.08	806	7.69	1001	9.5	3.2	17.3	43.1	3357	20.9	1429.4	0	27.1	80.1	8.5
1996	-[6]	210	111	5.37	732	12.96	2587	11.8	4.1	19.0	42.2	3085.1	13.3	894.3	0	22.2	64.7	6.2
1997	147	262	148	5.25	662	7.66	944	13.9	3.1	13.7	39.9	2903.3	10.8	784.4	0	29.3	92.0	9.9
1998	113	249	146	5.00	657	5.66	766	12.3	3.7	22.3	36.9	2620.6	10.4	696	0	23.8	93.5	11.5
1999	-[6]	264	151	5.38	632	7.76	895	7.1	2.3	23.2	22.9	1803.5	11.0	778.9	0	37.2	109.7	14.7
2000	-[6]	357	169	5.02	828	13.04	1773	7.8	2.0	13.8	27.0	2034.9	6.3	410.7	0	27.0	82.6	11.4
2001		281	147	3.35	539	8.33	1017	9.2	2.9	14.0	33.0	2352.9	12.5	767.4	0	41.9	77.4	13.1
2002		340	200	5.66	840	5.46	445	7.4	2.8	7.9	24.8	1774	8.0	535.1	0	52.5	77.4	17.7
2003		503	247	2.60	414	3.76	400	7.5	4.1	9.5	23.9	1728.3	14.0	863.7	0	48.7	73.8	18.6
2004		540	249	3.17	472	4.20	255	11.2	2.1	8.6	23.5	1727	7.4	419.9	0	36.1	72.5	14.2
2005		367	177	4.85	540	4.67	381	12.8	2.0	8.0	16.7	1313.6	11.6	627.8	1	42.1	68.97	14.7
2006		356	166	6.50	610	2.19	202	10.8	1.4	6.2	5.2	478.5	4.6	280.1	10.9	28.9	66.84	12.2
2007		432	190	17.94	756	4.22	550	6.9	1.3	6.1	4.4	397.2	3.2	193.5	12.6	23.8	75.86	14.2
2008		416	189	9.03	469	4.47	267	9.5	0.9	5.1	2.7	320.4	1.3	98	11.5	12.4	59.94	9.5
2009		467	199	6.46	338	1.21	169	10.1	1.1	3.8	1.5	157.7	0.46	24.9	10.0	14.7	42.8	7.6
2010		400	164	11.55	371	14.39	151	7.9	1.0	4.8	1.0	151	0.19	10.2	9.2	15.2	45.8	9.4
2011		417	140	4.35	183	11.95	701	17.3	1.2	6.8	0.69	72.7	1.56	91.2	8.6	16.4	54.5	8.1
2012		460	188	0.74	276	7.25	164	14.9	1.0	5.0	0.4	85	0.9	60.7	12.1	14.5	58.3	7.2
2013		550	207	7.41	236	-[8]	0	14.0	1.6	5.4	0.3	31.9	-[8]	1.3	10.6	8.9	42.6	5.0
2014		592	255	-	87	-[8]	0	13.9	1.5	8.3	-	16.1	-[8]	0.4	8.3	5.1	47.8	6.0
2015		564	230	-	0	-[8]	48	20.4	3.3	8.6	-	0	-[8]	0.9	4.5	4.6	39.8	8.3
2016		582	220	-	0	-[8]	0	26.4	4.6	32.8	-	0	-[8]	3.9	2.5	2.5	33.4	7.9
2017		525	170	-	244	-[8]	0	17.1	11.3	35.4	-	160.7	-[8]	0	0.3	4.2	12.1	7.5
2018		554	139	-	237	-[8]	0	14.6	8.4	19.5	-	238	-[8]	0	-	3.5	13.6	9.6
2020		-	-	-	1239	-[8]	277	5.9	4.5	10.6	-	73	-[8]	199	-	13.6	13.3	10.4
2021		265	-	-	852	-[8]	203	6.6	1.4	9.6	-	194	-[8]	223	-	14.3	13.2	8.9

1 Kg/100km. Sept Prime: ISS/ISN Traditional Prime Stations Only. Sept Extended: ISS/ISN/ISW/SGC All Stations.
2 Whole weight (kg) per corrected hour fished, weighted by area
3 '000 hours fished (corrected for fishing power GRT)
4 days fished
5 Corrected for fishing power (HP) [data for 1999-2010, replaced at 2011WG following recalculation at WKFLAT 2011]
6 Carhelmar survey, Kg/100km not available
7 All years updated in 2007 due to slight historical differences
8 Effort not reported in hours for this fleet, see Section 6.7.2 for more detail
9 '000s hours
Fishing power corrections are detailed in Appendix 2 of the 2000 working group report

Table 24.3a. Irish Sea plaice: NIGFS-WIBTS-Q1 indices of relative biomass trends by region in spring.

NIGFS-WIBTS-Q1	ESTIMATED MEAN ABUNDANCE (kg/3 miles)			ESTIMATED STANDARD ERROR		
Mar (Spring)	Combined	West	East	Combined	West	East
Year	Str 1–7	Str 1–3	Str 4–7	Str 1–7	Str 1–3	Str 4–7
1992	8.35	5.47	9.20	3.45	1.96	4.44
1993	12.36	18.43	10.54	2.14	4.78	2.39
1994	9.65	4.47	11.09	2.43	1.46	3.12
1995	7.27	4.79	7.64	1.24	0.83	1.59
1996	7.29	12.60	5.70	1.64	5.71	1.28
1997	13.87	14.72	13.54	3.19	5.68	3.77
1998	10.40	13.32	9.00	2.73	7.10	2.84
1999	10.71	13.53	9.59	1.81	4.92	1.84
2000	12.92	26.29	8.88	4.11	17.00	1.66
2001	12.06	18.03	9.92	1.41	4.25	1.31
2002	15.27	27.95	11.17	2.53	8.39	2.14
2003	20.97	40.71	15.09	6.11	23.98	3.44
2004	8.55	5.69	9.40	1.74	1.21	2.24
2005	11.10	19.43	8.62	1.93	5.99	1.76
2006	7.85	12.14	6.39	1.39	4.62	1.16
2007	6.25	14.47	3.80	1.27	4.80	0.83
2008	4.46	5.11	4.57	0.76	1.23	0.91
2009	7.90	7.85	7.86	1.27	2.04	1.53
2010	19.40	8.77	17.30	1.86	2.70	2.28
2011	16.34	26.20	13.03	3.51	10.11	3.41
2012	14.22	21.47	11.05	2.37	7.48	2.13
2013	21.89	28.98	16.57	3.74	8.04	4.21
2014	11.43	10.96	9.65	2.04	4.82	2.22
2015	22.81	22.57	18.66	2.84	7.18	3.01
2016	34.52	30.29	35.77	7.17	9.95	8.82
2017	16.10	14.85	16.47	3.16	3.90	3.70
2018	19.26	22.86	18.18	4.11	10.19	4.39
2019	16.42	19.83	15.40	3.41	6.18	4.03
2020	17.69	12.84	19.13	3.47	3.79	4.36
2021	13.25	11.27	13.85	2.91	4.91	3.48

Table 24.3b. Irish Sea plaice: NIGFS-WIBTS-Q4 indices of relative biomass trends by region in autumn.

NIGFS-WIBTS-Q4	ESTIMATED MEAN ABUNDANCE (kg/3 miles)			ESTIMATED STANDARD ERROR		
Oct (Autumn)	Combined	West	East	Combined	West	East
Year	Str 1–7	Str 1–3	Str 4–7	Str 1–7	Str 1–3	Str 4–7
1992	4.81	2.31	5.55	0.92	1.10	1.15
1993	4.48	2.08	5.20	1.00	0.87	1.27
1994	8.73	5.49	9.69	2.30	2.83	2.86
1995	4.17	5.50	3.77	1.13	2.23	1.31
1996	8.68	8.85	8.63	2.25	5.94	2.33
1997	7.93	5.76	8.58	2.24	2.59	2.80
1998	5.33	3.68	5.82	1.46	2.48	1.74
1999	5.81	4.30	6.26	1.67	3.08	1.97
2000	9.75	2.20	12.00	5.76	1.13	7.47
2001	13.85	2.30	17.30	6.57	1.67	8.51
2002	9.80	5.90	10.97	3.91	3.61	4.97
2003	18.01	7.52	21.14	5.84	4.16	7.48
2004	7.79	1.64	9.63	1.80	0.81	2.33
2005	11.35	3.41	13.72	4.51	2.18	5.82
2006	6.61	2.56	7.82	1.53	1.42	1.94
2007	7.15	4.07	8.07	1.41	2.00	1.73
2008	8.68	3.28	10.27	2.20	2.09	2.78
2009	12.44	4.06	15.01	2.59	3.12	3.23
2010	15.58	5.83	18.53	5.26	5.21	6.65
2011	14.48	5.39	15.94	3.55	2.66	4.55
2012	16.05	17.89	15.65	4.43	11.16	4.68
2013	17.90	13.55	19.09	4.33	11.27	4.51
2014	22.18	27.67	20.35	7.61	24.88	6.52
2015	18.21	11.15	20.31	4.39	8.76	5.06
2016	17.57	0.95	22.53	4.52	0.43	5.86
2017	18.55	2.96	23.20	4.25	1.59	5.50
2018	21.62	20.66	21.90	5.57	18.24	4.77
2019	16.63	9.50	18.76	4.06	6.89	4.86
2020	18.07	3.39	22.45	4.09	1.98	5.29
2021	14.34	4.06	17.41	3.31	2.08	4.25

Table 24.4. Irish Sea plaice: UK (E&W)-BTS-Q3 biomass index (extended area). Ages in bold are those used in the assessment (ages 1–7).

Year	Distance towed (kms)	0	1	2	3	4	5	6	7	8	9+
1993	292.77	0.13	4.64	4.03	0.82	0.43	0.03	0.04	0.08	0.01	0.02
1994	218.65	0.33	4.13	2.48	1.42	0.28	0.10	0.03	0.02	0.03	0.04
1995	218.65	0.78	5.56	1.96	0.84	0.41	0.07	0.05	0.02	0.00	0.03
1996	222.36	0.26	5.79	2.17	0.53	0.19	0.20	0.05	0.02	0.00	0.02
1997	218.65	0.96	5.47	2.91	1.26	0.30	0.16	0.17	0.05	0.02	0.03
1998	218.65	0.56	4.50	4.26	1.09	0.38	0.21	0.08	0.06	0.01	0.04
1999	214.95	1.86	3.96	3.91	1.99	0.68	0.29	0.09	0.07	0.03	0.05
2000	218.65	1.22	8.74	2.80	1.47	1.11	0.47	0.12	0.09	0.03	0.04
2001	214.95	0.83	5.99	3.62	1.11	0.60	0.54	0.11	0.06	0.02	0.01
2002	214.95	0.23	6.46	4.94	2.27	0.88	0.53	0.48	0.10	0.04	0.04
2003	211.24	2.07	6.12	5.85	2.61	1.58	0.58	0.38	0.25	0.07	0.07
2004	214.95	1.09	8.07	5.36	3.94	1.88	1.15	0.21	0.19	0.13	0.10
2005	211.24	1.75	3.76	4.75	1.98	1.42	0.80	0.48	0.11	0.09	0.06
2006	214.95	3.56	5.01	3.45	2.46	1.10	0.79	0.36	0.20	0.02	0.07
2007	214.95	1.15	7.97	4.47	1.66	1.20	0.65	0.33	0.25	0.14	0.06
2008	200.12	1.22	4.68	5.71	2.03	1.15	0.82	0.31	0.12	0.08	0.05
2009	214.95	1.23	4.74	3.40	3.30	0.99	0.66	0.63	0.16	0.11	0.20
2010	211.24	2.01	6.22	4.31	2.05	1.44	0.66	0.54	0.36	0.20	0.19
2011	211.24	1.02	6.73	4.28	1.75	1.00	1.08	0.47	0.27	0.24	0.37
2012	214.95	1.40	6.52	6.37	1.71	1.03	0.47	0.53	0.30	0.14	0.42
2013	214.95	2.04	4.33	5.05	3.08	1.60	1.07	0.47	0.44	0.20	0.42
2014	214.95	1.56	7.82	6.85	3.13	2.16	0.99	0.77	0.44	0.20	0.28
2015	214.95	1.02	6.16	6.88	2.60	1.80	1.04	0.66	0.37	0.19	0.50
2016	211.24	0.18	2.91	5.97	3.95	2.45	1.61	0.96	0.74	0.45	0.58
2017	214.95	0.03	1.35	4.77	2.81	2.23	1.84	0.75	0.59	0.38	0.26
2018	214.95	0.36	1.97	2.75	2.28	1.51	1.37	1.24	0.75	0.56	0.27
2019	214.95	0.33	3.02	4.50	2.31	1.48	1.22	1.00	0.90	0.41	0.20
2020	0	-	-	-	-	-	-	-	-	-	-
2021	214.95	0.23	1.77	2.50	1.49	0.72	0.55	0.44	0.28	0.23	0.06
Year	Distance towed (kms)	0	1	2	3	4	5	6	7	8	9+

Table 24.5. Irish Sea plaice: Landings number-at-age 1 to 8+ (thousands), where rows are years 1981–2021 and columns are ages 1 to 8+.

IRISH SEA PLAICE

1 2

1981 2021

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
0	4	24	145	206	241	209	520
0	6	84	110	201	178	151	358
0	11	53	145	273	219	187	356
2	17	24	118	192	168	150	287
0	30	80	146	154	106	127	199

Table 24.6. Irish Sea plaice: Landings weight-at-age 1 to 8+ (kg), where rows are years 1981–2021 and columns are ages 1 to 8+

IRISH SEA PLAICE

1 3

1981 2021

1 8

1

0.069	0.176	0.267	0.376	0.512	0.592	0.678	1.085
0.201	0.274	0.284	0.348	0.421	0.545	0.650	0.889
0.232	0.261	0.290	0.319	0.368	0.426	0.484	0.699
0.260	0.290	0.330	0.380	0.470	0.560	0.660	0.964
0.290	0.310	0.340	0.390	0.470	0.540	0.630	0.851
0.270	0.280	0.340	0.420	0.500	0.540	0.630	0.980
0.260	0.290	0.315	0.370	0.440	0.520	0.610	0.916
0.230	0.260	0.300	0.370	0.460	0.550	0.680	1.243
0.227	0.272	0.321	0.374	0.430	0.491	0.555	0.761
0.200	0.257	0.316	0.376	0.439	0.504	0.570	0.747
0.247	0.267	0.295	0.332	0.377	0.431	0.494	0.652
0.169	0.218	0.274	0.337	0.407	0.484	0.568	0.799
0.260	0.270	0.292	0.328	0.375	0.436	0.508	0.690
0.156	0.207	0.268	0.338	0.416	0.504	0.600	0.816
0.189	0.224	0.262	0.329	0.353	0.406	0.461	0.699
0.204	0.223	0.270	0.333	0.398	0.493	0.584	0.837
0.205	0.233	0.241	0.286	0.354	0.410	0.510	0.620
0.185	0.226	0.249	0.316	0.353	0.410	0.468	0.655
0.205	0.236	0.250	0.300	0.375	0.457	0.483	0.615
0.000	0.259	0.270	0.307	0.337	0.429	0.437	0.623
0.232	0.233	0.271	0.334	0.396	0.439	0.571	0.764
0.228	0.271	0.267	0.308	0.386	0.476	0.518	0.673
0.000	0.235	0.289	0.335	0.383	0.458	0.567	0.678
0.214	0.239	0.258	0.297	0.347	0.416	0.543	0.571
0.235	0.245	0.265	0.292	0.322	0.394	0.441	0.632
0.200	0.256	0.265	0.282	0.321	0.378	0.425	0.568
0.000	0.280	0.266	0.281	0.320	0.371	0.416	0.481
0.246	0.228	0.257	0.281	0.311	0.364	0.431	0.553
0.000	0.257	0.256	0.265	0.305	0.330	0.395	0.482
0.000	0.260	0.265	0.282	0.301	0.356	0.392	0.492
0.236	0.251	0.257	0.283	0.298	0.354	0.404	0.513
0.117	0.259	0.254	0.281	0.299	0.318	0.345	0.430
0.249	0.245	0.249	0.267	0.297	0.330	0.386	0.417
0.181	0.250	0.282	0.300	0.336	0.373	0.457	0.492
NA	0.183	0.264	0.287	0.299	0.340	0.403	0.617
0.113	0.149	0.229	0.318	0.422	0.362	0.433	0.660
0.166	0.222	0.273	0.345	0.370	0.405	0.442	0. 505
0.000	0.292	0.327	0.353	0.345	0.398	0.399	0.465
0.108	0.251	0.270	0.283	0.288	0.350	0.379	0.509
0.107	0.130	0.190	0.280	0.331	0.360	0.363	0.390
0	0.253	0.281	0.295	0.299	0.342	0.343	0.388

Table 24.7. Irish Sea plaice: Discards weight-at-age 1 to 8+ (kg), where rows are years 1981–2021 and columns are ages 1 to 8+.

IRISH SEA PLAICE

1 23

1981 2021

1 8

1

0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.057	0.115	0.145	0.164	0.211	0.290	0.238	0.210
0.099	0.117	0.134	0.179	0.178	0.277	0.644	0.356
0.141	0.113	0.141	0.145	0.162	0.210	0.274	0.077
0.044	0.081	0.113	0.140	0.150	0.205	0.219	0.243
0.096	0.097	0.116	0.135	0.151	0.173	0.217	0.170
0.033	0.080	0.119	0.147	0.165	0.196	0.232	0.276
0.083	0.101	0.138	0.183	0.201	0.140	0.194	0.225
0.077	0.098	0.116	0.141	0.157	0.168	0.164	0.176
0.026	0.038	0.081	0.119	0.162	0.200	0.157	0.182
0.064	0.069	0.094	0.116	0.144	0.157	0.181	0.181
0.056	0.067	0.084	0.120	0.128	0.150	0.152	0.153
0.088	0.059	0.079	0.101	0.095	0.126	0.152	0.136
0.136	0.103	0.109	0.120	0.146	0.161	0.155	0.170
0.093	0. 080	0. 118	0. 124	0. 128	0. 153	0. 137	0. 157
0.022	0.053	0.075	0.109	0.142	0.143	0.146	0.202
0.054	0.062	0.082	0.104	0.127	0.136	0.167	0.149
0.513	0.081	0.103	0.121	0.133	0.150	0.157	0.151
0.040	0.095	0.121	0.1387	0.167	0.172	0.204	0.258

Table 24.8. Irish Sea plaice: New stock weights-at-age modified to include discard element (kg), where rows are years 1981–2021 and columns are ages 1 to 8+.

IRISH SEA PLAICE

1 4

1981 2021

1 8

1

0.087	0.124	0.190	0.351	0.509	0.592	0.678	1.085
0.091	0.141	0.210	0.327	0.418	0.545	0.650	0.889
0.097	0.173	0.231	0.303	0.366	0.426	0.484	0.699
0.100	0.196	0.275	0.362	0.467	0.560	0.660	0.964
0.089	0.203	0.293	0.374	0.468	0.540	0.630	0.851
0.098	0.171	0.292	0.401	0.497	0.540	0.630	0.980
0.102	0.208	0.266	0.353	0.437	0.519	0.610	0.916
0.104	0.171	0.250	0.351	0.456	0.549	0.680	1.243
0.100	0.183	0.261	0.352	0.425	0.490	0.555	0.761
0.090	0.172	0.253	0.349	0.431	0.502	0.570	0.747
0.140	0.165	0.230	0.305	0.369	0.429	0.494	0.652
0.106	0.159	0.209	0.302	0.395	0.481	0.568	0.799
0.097	0.141	0.209	0.291	0.363	0.434	0.508	0.690
0.101	0.134	0.193	0.299	0.400	0.501	0.600	0.816
0.091	0.138	0.184	0.289	0.340	0.404	0.461	0.699
0.091	0.130	0.181	0.286	0.377	0.488	0.583	0.837
0.091	0.118	0.168	0.247	0.335	0.406	0.509	0.620
0.088	0.116	0.148	0.223	0.305	0.399	0.466	0.655
0.100	0.125	0.150	0.216	0.321	0.444	0.480	0.615
NA	0.121	0.157	0.222	0.300	0.420	0.436	0.623
0.091	0.119	0.161	0.239	0.352	0.431	0.569	0.764
0.088	0.114	0.161	0.228	0.347	0.467	0.517	0.673
NA	0.115	0.165	0.234	0.335	0.448	0.566	0.678
0.070	0.131	0.169	0.217	0.304	0.407	0.540	0.570
0.103	0.127	0.161	0.238	0.234	0.377	0.454	0.602
0.141	0.122	0.162	0.175	0.256	0.323	0.417	0.564
0.044	0.084	0.123	0.167	0.209	0.290	0.335	0.377
0.096	0.100	0.131	0.168	0.204	0.279	0.397	0.285
0.033	0.081	0.125	0.173	0.213	0.266	0.333	0.413
0.083	0.101	0.140	0.191	0.211	0.190	0.226	0.290
0.078	0.104	0.137	0.182	0.221	0.271	0.334	0.364
0.026	0.038	0.088	0.142	0.199	0.246	0.232	0.294
0.065	0.071	0.098	0.133	0.185	0.240	0.292	0.363
0.056	0.068	0.089	0.135	0.153	0.194	0.214	0.296
0.088	0.060	0.083	0.115	0.130	0.163	0.269	0.515
0.133	0.105	0.117	0.152	0.240	0.259	0.307	0.522
0. 093	0. 081	0. 121	0. 145	0. 163	0.198	0.223	0. 303
0.022	0.054	0.098	0.138	0.199	0.253	0.269	0.39
0.054	0.062	0.088	0.127	0.180	0.218	0.304	0.427
0.063	0.084	0.106	0.151	0.198	0.240	0.269	0.298
0.040	0.01	0.131	0.170	0.227	0.236	0.289	0.381

Table 24.9. Irish Sea plaice: Estimated landed numbers-at-age (thousands).

year\age	1	2	3	4	5	6	7	8	total
1981	22	1742	5939	2984	837	222	105	236	12087
1982	27	715	3288	3082	1358	330	137	213	9150
1983	51	2924	2494	3211	1521	648	211	252	11312
1984	41	3159	5179	1182	1054	459	299	252	11625
1985	4	2357	6152	3301	614	429	262	340	13459
1986	31	1652	5280	2942	1287	344	371	308	12215
1987	62	3717	5317	5252	1341	1072	123	338	17222
1988	46	2923	5040	2552	1400	750	316	405	13432
1989	24	1735	5945	2671	854	436	214	364	12243
1990	15	1019	2715	2935	1132	465	259	223	8763
1991	180	2008	1506	1929	1205	465	182	226	7701
1992	151	1958	3209	1435	1358	903	388	294	9696
1993	28	910	1649	1357	474	556	377	302	5653
1994	97	1146	2173	1309	644	318	245	263	6195
1995	21	961	1703	1936	764	318	138	157	5998
1996	37	856	1345	1196	943	370	128	135	5011
1997	28	830	1590	1513	1003	482	285	257	5988
1998	6	691	1739	1025	612	476	403	385	5336
1999	68	803	1505	1294	696	280	196	242	5083
2000	0	450	1174	1284	686	212	219	203	4228
2001	14	374	1138	1083	767	409	178	166	4130
2002	1	206	940	1482	842	539	318	170	4497
2003	0	286	1031	1314	707	415	253	222	4227
2004	8	198	967	1104	705	247	114	186	3529
2005	6	228	708	1177	890	461	204	213	3888
2006	5	180	620	550	684	346	220	218	2823
2007	0	64	351	860	507	401	151	164	2497
2008	1	99	386	389	409	215	141	119	1757
2009	0	13	204	374	351	272	117	120	1451
2010	0	7	75	271	306	193	160	115	1127
2011	2	53	199	357	483	305	194	191	1785
2012	0	8	150	292	301	367	218	226	1561
2013	1	16	87	203	166	149	144	165	931
2014	3	6	65	165	160	143	70	158	772
2015	0	1	43	93	185	210	149	349	1030
2016	14	14	58	162	224	346	180	482	1479
2017	0	4	24	145	206	241	209	519	1348
2018	0	6	84	109	201	178	151	358	1087
2019	0	11	53	145	273	219	187	356	1245
2020	2	17	24	118	192	168	150	287	959
2021	0	30	80	146	154	106	127	199	842

Table 24.10. Irish Sea plaice: Estimated discarded numbers-at-age (thousands). All discards are included (dead and alive portions).

year\age	1	2	3	4	5	6	7	8	total
1981	451	4589	7613	377	7	0	0	0	13037
1982	765	2570	3062	375	14	0	0	0	6786
1983	724	3771	1457	346	18	1	0	0	6316
1984	532	3218	1970	102	11	1	0	0	5834
1985	508	2572	1781	232	5	1	0	0	5098
1986	495	2707	1572	228	12	1	0	0	5015
1987	668	2962	1917	446	14	2	0	0	6010
1988	360	3903	2081	249	21	2	0	0	6615
1989	240	1987	2710	290	17	2	0	0	5246
1990	604	1278	1398	403	34	3	0	0	3719
1991	364	3363	980	348	50	4	0	0	5109
1992	528	2124	2661	342	75	9	1	0	5740
1993	460	3187	1726	358	29	6	1	0	5767
1994	406	2849	2606	353	45	4	0	0	6265
1995	507	2502	2423	561	59	4	0	0	6057
1996	1205	3086	2329	417	94	7	0	0	7138
1997	935	7406	3079	619	116	11	1	0	12166
1998	686	6642	9665	1364	215	31	6	0	18609
1999	582	4459	7451	1734	247	18	4	0	14495
2000	0	3763	4922	1558	193	10	3	0	10449
2001	513	2934	4078	1201	186	16	1	0	8931
2002	490	3399	3168	1558	188	21	1	0	8825
2003	0	3281	3685	1623	204	19	1	0	8813
2004	85	1381	3570	1679	324	19	1	0	7059
2005	198	2844	2793	1096	1392	78	14	26	8441
2006	854	2775	2964	1968	479	170	12	2	9224
2007	837	4704	4892	3568	947	381	104	127	15560
2008	831	4393	3188	1354	837	171	27	278	11079
2009	56	2862	4318	1318	677	251	71	60	9613
2010	980	4066	4113	3254	2853	638	836	359	17099
2011	540	1344	1134	888	589	245	79	151	4970
2012	219	4415	3492	1755	800	567	329	274	11851
2013	238	1610	3066	1633	450	163	122	49	7331
2014	1027	1886	2710	1843	1149	591	274	218	9697
2015	18	1348	1659	1104	896	997	170	93	6285
2016	101	300	858	831	430	364	149	189	3222
2017	45	529	1057	1376	1198	1118	530	723	6576
2018	321	1464	823	814	524	235	159	143	4482
2019	167	2147	1729	990	549	352	103	105	6142
2020	9	289	511	501	395	227	128	177	2237
2021	186	951	1112	577	184	175	82	10	3278

Table 24.11. Irish Sea plaice: Estimated population numbers-at-age (thousands).

year\agege	1	2	3	4	5	6	7	8	total
1981	17044	19824	17536	7247	2022	694	329	765	65460
1982	22045	12863	13265	7693	3283	1011	393	655	61207
1983	23466	20215	8030	6385	3326	1661	568	635	64287
1984	22715	20854	14122	3416	2747	1506	882	691	66934
1985	21205	20162	14440	7173	1562	1418	817	927	67704
1986	21558	17818	14600	6979	3456	790	823	995	67019
1987	20833	19476	12300	7445	3122	1795	406	1032	66408
1988	15812	19946	13071	5348	2944	1391	857	795	60165
1989	12910	13498	14450	5954	2177	1277	644	858	51767
1990	15754	9495	9170	7424	2738	1066	665	782	47094
1991	16149	14163	5696	4552	3645	1365	552	778	46900
1992	17592	12822	9531	2505	2095	1996	748	739	48028
1993	15873	16302	7677	4114	869	861	1061	755	47511
1994	15159	12373	11548	3522	1642	491	431	924	46091
1995	17792	10973	7597	5505	1533	778	275	703	45155
1996	21761	13662	6861	3516	2863	922	408	590	50582
1997	22635	17734	9717	3895	2070	1792	661	686	59190
1998	19868	20706	12001	4776	2207	1236	1069	898	62761
1999	19050	16969	15272	6356	2548	1301	839	1185	63519
2000	23845	14769	11762	9235	3608	1431	977	1311	66937
2001	24174	18810	10518	6915	5695	2012	940	1511	70575
2002	24688	20704	14967	7069	4721	4109	1488	1684	79429
2003	22155	22016	16429	10947	4423	3338	2874	2257	84438
2004	20893	17612	17215	11422	7267	2574	2223	3231	82437
2005	18137	18437	12956	10751	7351	4635	1773	3530	77569
2006	22440	15197	14568	8524	6309	4323	2874	3375	77611
2007	26127	18466	11937	10472	5455	3707	2995	4009	83167
2008	21325	22970	13076	8323	7325	3396	2219	4671	83305
2009	17967	16559	18247	9051	6224	5899	2450	4764	81162
2010	23232	16045	12769	13115	7279	5110	4969	5540	88060
2011	26850	17655	11534	8233	9089	5325	3783	7521	89991
2012	24072	24546	14183	9408	6040	6875	4330	8589	98044
2013	23785	20492	19435	11882	7990	5101	5501	9365	103553
2014	27392	21906	17564	15190	9934	6985	4744	11470	115185
2015	17302	23508	17759	13808	11427	8718	5559	13213	111294
2016	14284	15389	18813	15642	11653	9826	7830	15267	108704
2017	10582	13312	13344	15115	13665	9670	8190	17888	101763
2018	12406	11029	11440	10741	11593	10897	8006	17693	93805
2019	11245	12400	10196	9472	8805	9493	9079	17401	88092
2020	8749	9300	8765	7457	7219	6636	7814	19036	74976
2021	9261	8610	8361	6628	5536	5410	4963	18552	67321

Table 24.12. Irish Sea plaice: Estimated fishing mortality-at-age.

year\age	1	2	3	4	5	6	7	8	F_{bar} (3-6)
1981	0.020	0.270	0.642	0.681	0.574	0.477	0.423	0.423	0.594
1982	0.020	0.265	0.630	0.675	0.572	0.480	0.426	0.426	0.589
1983	0.021	0.282	0.673	0.727	0.622	0.527	0.468	0.468	0.637
1984	0.019	0.250	0.593	0.646	0.558	0.479	0.428	0.428	0.569
1985	0.018	0.242	0.575	0.633	0.551	0.478	0.428	0.428	0.560
1986	0.019	0.251	0.596	0.663	0.583	0.513	0.456	0.456	0.589
1987	0.022	0.295	0.697	0.780	0.688	0.605	0.531	0.531	0.692
1988	0.022	0.291	0.681	0.767	0.687	0.610	0.539	0.539	0.686
1989	0.020	0.260	0.597	0.668	0.600	0.535	0.475	0.475	0.600
1990	0.021	0.265	0.596	0.658	0.591	0.523	0.464	0.464	0.592
1991	0.022	0.277	0.613	0.672	0.599	0.525	0.462	0.462	0.602
1992	0.027	0.335	0.738	0.819	0.738	0.642	0.562	0.562	0.734
1993	0.024	0.298	0.651	0.724	0.665	0.584	0.510	0.510	0.656
1994	0.025	0.302	0.645	0.704	0.643	0.562	0.491	0.491	0.638
1995	0.024	0.291	0.608	0.644	0.576	0.495	0.430	0.430	0.581
1996	0.024	0.281	0.572	0.588	0.511	0.433	0.374	0.374	0.526
1997	0.025	0.286	0.575	0.583	0.501	0.421	0.363	0.363	0.520
1998	0.024	0.282	0.568	0.571	0.486	0.406	0.347	0.347	0.508
1999	0.020	0.227	0.452	0.451	0.380	0.311	0.259	0.259	0.398
2000	0.017	0.191	0.378	0.376	0.315	0.255	0.207	0.207	0.331
2001	0.015	0.164	0.326	0.328	0.275	0.220	0.174	0.174	0.287
2002	0.012	0.139	0.275	0.281	0.237	0.186	0.143	0.143	0.245
2003	0.010	0.116	0.227	0.233	0.197	0.152	0.112	0.112	0.202
2004	0.008	0.089	0.173	0.178	0.150	0.114	0.081	0.081	0.154
2005	0.011	0.118	0.224	0.227	0.191	0.143	0.098	0.098	0.196
2006	0.013	0.137	0.248	0.246	0.204	0.149	0.098	0.098	0.212
2007	0.015	0.154	0.272	0.266	0.219	0.159	0.102	0.102	0.229
2008	0.012	0.123	0.212	0.206	0.170	0.124	0.079	0.079	0.178
2009	0.009	0.091	0.157	0.153	0.129	0.096	0.061	0.061	0.134
2010	0.013	0.131	0.222	0.218	0.185	0.139	0.087	0.087	0.191
2011	0.009	0.086	0.144	0.143	0.123	0.095	0.060	0.060	0.126
2012	0.009	0.085	0.143	0.143	0.125	0.098	0.062	0.062	0.127
2013	0.006	0.058	0.096	0.096	0.085	0.068	0.043	0.043	0.086
2014	0.006	0.059	0.097	0.099	0.089	0.073	0.046	0.046	0.089
2015	0.004	0.037	0.062	0.066	0.062	0.054	0.035	0.035	0.061
2016	0.004	0.033	0.055	0.058	0.055	0.049	0.032	0.032	0.054
2017	0.005	0.042	0.068	0.072	0.068	0.059	0.038	0.038	0.067
2018	0.006	0.049	0.076	0.075	0.067	0.055	0.035	0.035	0.068
2019	0.006	0.055	0.083	0.082	0.071	0.057	0.035	0.035	0.073
2020	0.004	0.038	0.058	0.057	0.050	0.040	0.025	0.025	0.051
2021	0.006	0.051	0.077	0.074	0.063	0.049	0.029	0.029	0.066

Table 24.13. 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 stock biomass (TSB, tonnes) and dead catch tonnage (the sum of landings and 60% of discards).

Year	Recruitment (thousands)			SSB (t)			F_{bar} (3–6)			TSB (t)			Dead catch (t)		
	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High
1981	11478	17044	25310	5650	7057	8814	0.452	0.594	0.78	10469	12830	15723	3177	4384	6049
1982	15679	22045	30995	5521	6792	8356	0.459	0.589	0.757	10369	12476	15010	3104	4069	5336
1983	16814	23466	32751	5030	6092	7378	0.497	0.637	0.817	10721	12917	15563	3045	3908	5017
1984	16365	22715	31529	6322	7676	9319	0.444	0.569	0.729	13051	15784	19090	3522	4550	5878
1985	15322	21205	29348	6924	8417	10232	0.438	0.56	0.716	13655	16510	19961	3873	5024	6516
1986	15547	21558	29892	7419	9019	10964	0.463	0.589	0.749	13906	16684	20018	4165	5382	6954
1987	14943	20833	29044	6984	8431	10176	0.546	0.692	0.878	13703	16421	19678	4411	5667	7281
1988	11429	15812	21876	6533	7901	9556	0.54	0.686	0.872	12263	14661	17528	4016	5133	6560
1989	9099	12910	18316	5806	7055	8573	0.471	0.6	0.764	10713	12894	15519	3344	4338	5627
1990	11449	15754	21678	5293	6436	7826	0.466	0.592	0.752	9300	11115	13284	2913	3755	4842
1991	11815	16149	22074	4247	5125	6185	0.475	0.602	0.762	9036	10775	12849	2371	3012	3825
1992	12996	17592	23814	4226	5099	6153	0.586	0.734	0.92	8384	9979	11876	2677	3392	4298
1993	12063	15873	20886	3538	4278	5174	0.519	0.656	0.83	7532	8980	10705	2198	2778	3512
1994	11477	15159	20024	3682	4508	5519	0.506	0.638	0.805	7411	8875	10629	2271	2873	3634
1995	13516	17792	23419	3200	3927	4820	0.457	0.581	0.738	6672	7988	9564	1886	2384	3013
1996	16486	21761	28724	3430	4237	5234	0.412	0.526	0.673	7224	8676	10419	1826	2288	2865
1997	17177	22635	29828	3597	4435	5469	0.409	0.52	0.661	7727	9291	11172	1945	2441	3064
1998	15099	19868	26142	3859	4790	5946	0.393	0.508	0.655	7989	9644	11643	2063	2598	3272
1999	14368	19050	25258	4435	5565	6982	0.303	0.398	0.525	8911	10834	13173	1968	2479	3122
2000	17726	23845	32076	4852	6151	7796	0.243	0.331	0.45	9145	11215	13753	1761	2240	2850
2001	18163	24174	32175	5808	7467	9602	0.209	0.287	0.395	10468	12955	16032	1766	2225	2803

Year	Recruitment (thousands)			SSB (t)			F_{bar} (3–6)			TSB (t)			Dead catch (t)		
	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High
2002	18432	24688	33067	6766	8806	11461	0.177	0.245	0.338	11613	14565	18267	1768	2218	2783
2003	16386	22155	29955	7980	10527	13886	0.143	0.202	0.287	13033	16606	21158	1729	2195	2787
2004	15564	20893	28048	7999	10579	13990	0.107	0.154	0.222	12678	16237	20796	1339	1719	2208
2005	13532	18137	24308	7837	10324	13602	0.139	0.196	0.278	12535	15893	20152	1582	2007	2547
2006	16854	22440	29878	7019	9283	12276	0.151	0.212	0.296	12330	15548	19605	1500	1893	2388
2007	19368	26127	35246	5793	7676	10171	0.164	0.229	0.319	8841	11267	14359	1290	1632	2066
2008	16000	21325	28422	5839	7714	10192	0.128	0.178	0.247	10167	12835	16204	1118	1405	1765
2009	13288	17967	24293	6619	8830	11778	0.095	0.134	0.189	9296	11993	15473	885	1132	1449
2010	17379	23232	31057	6732	8828	11577	0.135	0.191	0.269	10723	13547	17114	1273	1642	2118
2011	19947	26850	36143	7887	10606	14262	0.09	0.126	0.178	11999	15453	19901	950	1199	1513
2012	17988	24072	32215	6617	8952	12112	0.091	0.127	0.178	8638	11332	14866	754	951	1199
2013	17763	23785	31849	8021	10870	14730	0.061	0.086	0.121	11476	14950	19476	649	819	1034
2014	19734	27392	38021	8126	10961	14785	0.064	0.089	0.125	11533	15014	19546	689	870	1097
2015	12734	17302	23508	10482	14562	20230	0.043	0.061	0.086	13716	18377	24621	554	705	898
2016	10637	14284	19183	15157	20726	28342	0.038	0.054	0.077	19374	25733	34179	737	934	1184
2017	7741	10582	14464	11551	15705	21352	0.047	0.067	0.094	14340	19013	25210	685	866	1095
2018	9162	12406	16799	12609	17324	23801	0.048	0.068	0.097	14197	19209	25990	679	861	1092
2019	8214	11245	15395	11862	16532	23040	0.052	0.073	0.104	13631	18600	25381	627	800	1020
2020	6011	8749	12733	9617	13383	18625	0.035	0.051	0.075	11360	15430	20959	372	481	620
2021	6256	9261	13709	9167	13064	18618	0.046	0.066	0.095	10842	15012	20787	449	585	761

Table 24.14 Short-term forecast. Annual catch options. Intermediate year assumptions.

Variable	Value	Notes
$F_{ages\ 3–6}$ (2022)	0.064	$F_{sq}=F_{average\ (2019-2021)}$
SSB (2023)	13514	Tonnes; Fishing at *status quo* (F_{sq}).
Rage 1 (2022 and 2023)	11245	Median resampled recruitment (2015–2021) as estimated by a stochastic projection; in thousands.
Total catch (2022)	680	Tonnes; Fishing at F_{sq} plus surviving discards.
Projected landings (2022)	322	Tonnes; Assuming average discard pattern (2019–2021).
Projected discards (2022)	357	Tonnes; Assuming average discard pattern (2019–2021).
Discard survival rate	40%	Catchpole *et al*. (2015).
Projected surviving discards (2022)	143	Tonnes; Assuming average discard pattern (2019–2021) where 40% of the discards survive.
Projected dead discards (2022)	214	Tonnes; Assuming average discard pattern (2019–2021) where 40% of the discards survive.

Table 24.15. Short-term forecast. Annual catch options. All weights are in tonnes.

Basis	Total catch (2023)	Projected landings (2023)	Projected Surviving discards (2023)	Projected dead discards (2023)	Total projected discards* (2023)	F_{total} (2023)	$F_{projected\ landings}$ (2023)	$F_{projected\ discards}$** (2023)	SSB (2024)	% SSB change ***	% advice change^
ICES advice basis											
MSY approach F_{MSY}	2039	967	429	643	1072	0.196	0.061	0.135	12629	−6.5	−30
Other scenarios											
$F_{MSY\ lower}$	1418	672	298	447	745	0.133	0.042	0.091	13169	-2.5	-52
$F_{MSY\ upper}$	2945	1397	620	929	1549	0.29	0.091	0.20	11901	-11.9	0.70
F_{pa}	3903	1851	821	1231	2052	0.40	0.126	0.28	11089	-17.9	33
F = 0	0	0	0	0	0	0	0	0	14305	5.9	-100.0
F = F_{lim}	4649	2205	978	1467	2445	0.50	0.155	0.34	10468	-23	59
SSB_{2024} = B_{lim}	13047	6187	2744	4116	6860	2.33	0.73	1.60	3958	-71	350
SSB_{2024} = B_{pa}	11370	5391	2391	3587	5978	1.75	0.55	1.21	5294	-61	290
SSB_{2024} = $MSY_{Btrigger}$	6895	3269	1450	2175	3625	0.81	0.25	0.56	8757	-35	140
Rollover advice	2925	1387	615	923	1538	0.29	0.091	0.20	11913	-11.8	0.0
F = F_{2022}	696	330	146	220	366	0.064	0.020	0.044	13745	1.70	-76
SSB_{2024} = SSB_{2023}	990	469	208	312	520	0.091	0.029	0.063	13514	0	-65

*** Dead + surviving projected discards.**

**** $F_{projected\ discards}$ concerns dead projected discards only.**

***** SSB 2024 relative to SSB 2023.**

^ Advice value for 2023 relative to the advice value for 2022 (2925 tonnes).

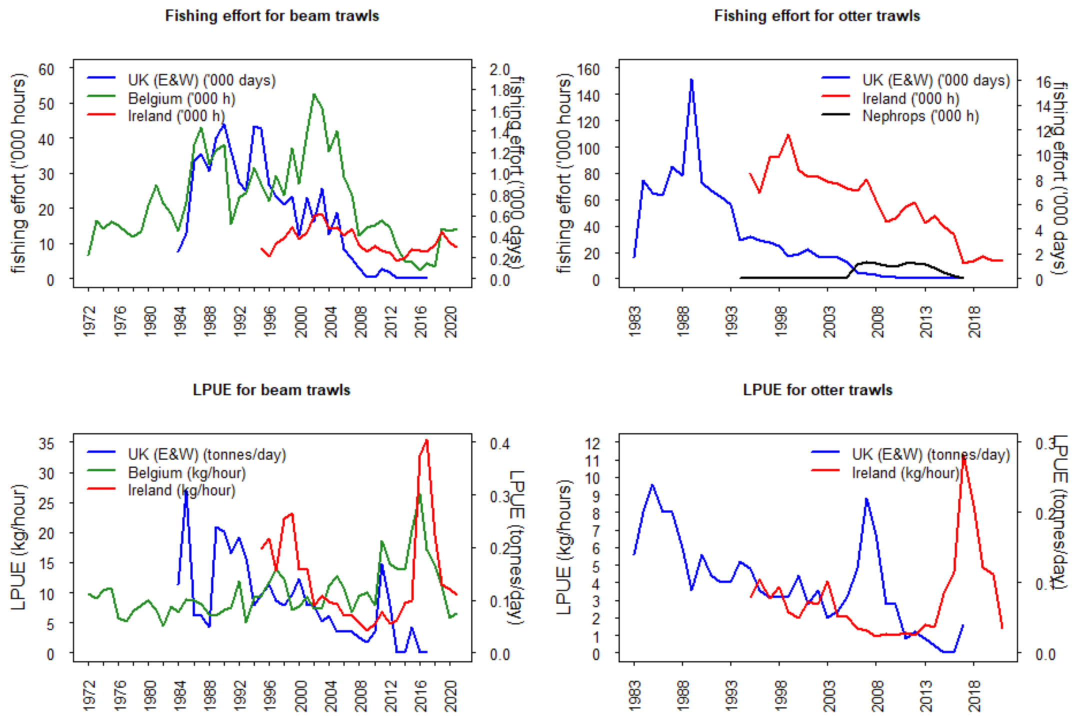


Figure 24.1. Irish Sea plaice: Effort and LPUE for commercial fleets from UK (E&W), Ireland and Belgium.

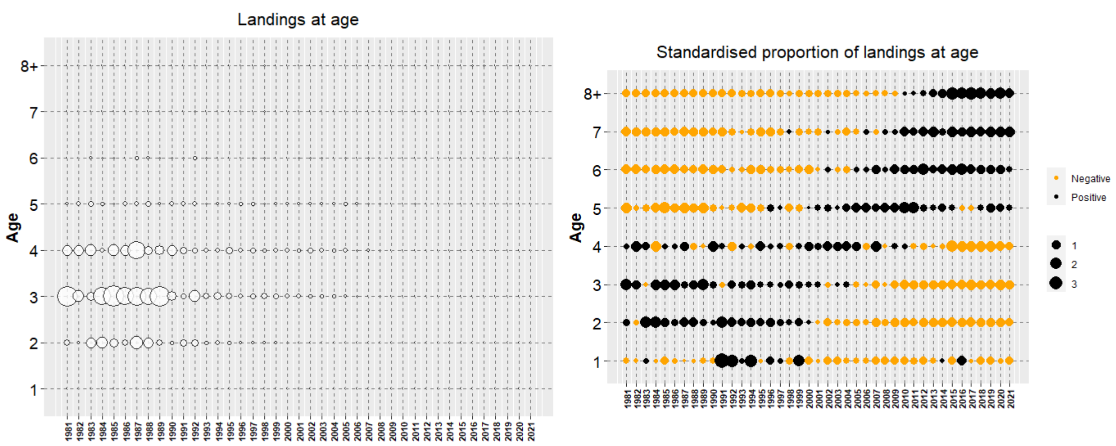


Figure 24.2a. Landings-at-age data (left) and mean standardised proportion-at-age (right, black bubbles are positive values and orange bubbles are negative). Mean standardised proportion-at-age = [(proportion-at-age in year) – mean (proportion-at-age over all years)] / STDEV(proportion-at-age over all years).

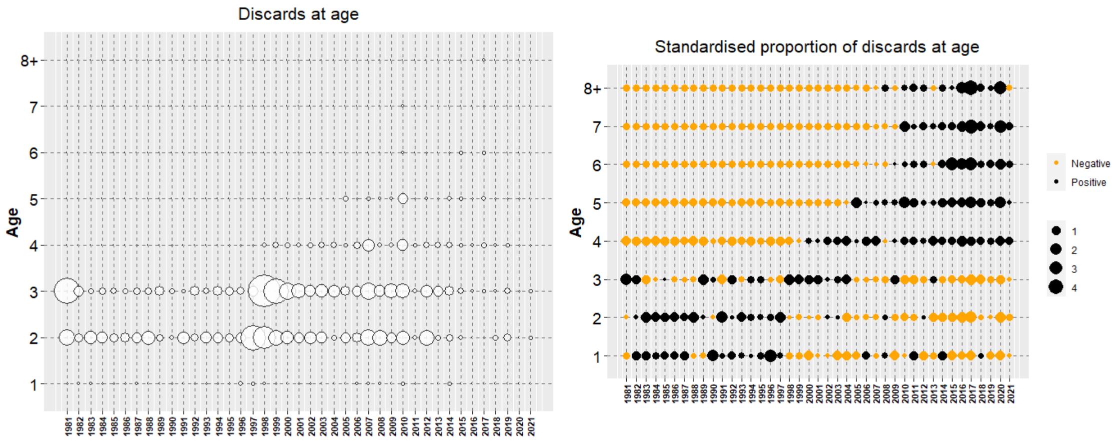


Figure 24.2b. Discards-at-age data (left) and mean standardised proportion-at-age (right, black bubbles are positive values and orange bubbles are negative). Mean standardised proportion-at-age = [(proportion-at-age in year) – mean (proportion-at-age over all years)] / STDEV(proportion-at-age over all years).

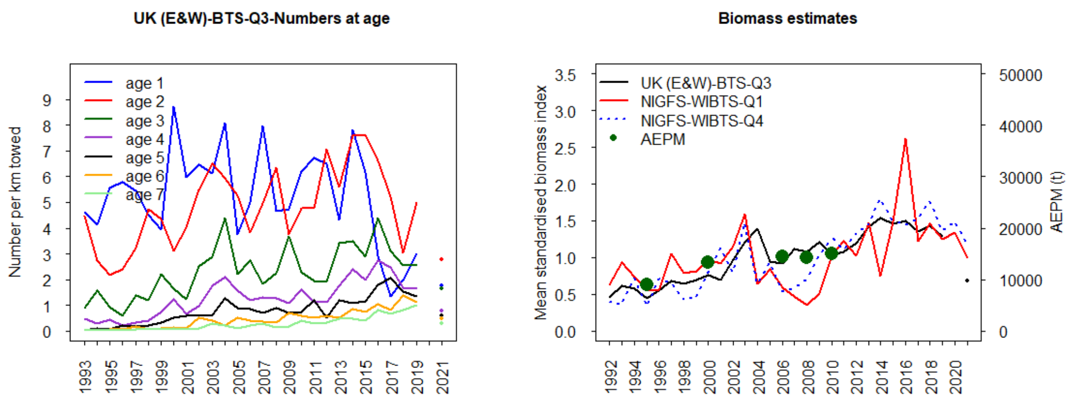


Figure 24.3. Left: UK(E&W)-BTS-Q3 (extended area) cpue by age (circles in 2021 due to missing data in 2020). Right: standardised indices of SSB derived from NIGFS-WIBTS, biomass from UK(E&W)-BTS-Q3 (extended area) (black circle in 2021 due to missing data in 2020) and the SSB estimates from the Annual Egg Production Methods (circles, right).

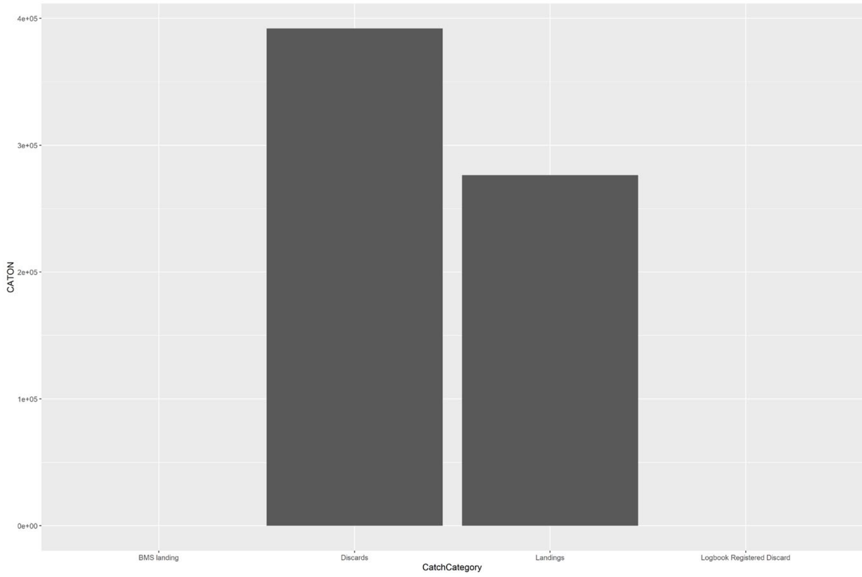


Figure 24.4. Make up of catch estimates from InterCatch.

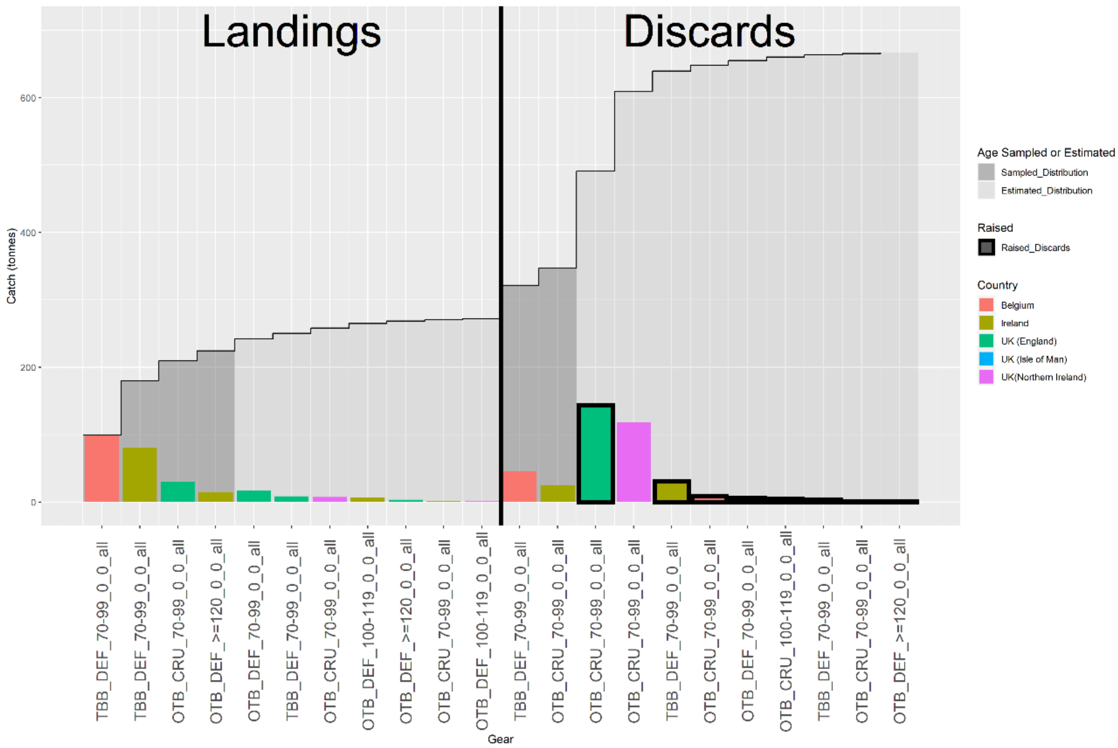


Figure 24.5. Catch sampling for landings (left) and discards (right) by country and gear type. Gears contributing less than 1 tonne are excluded for clarity.

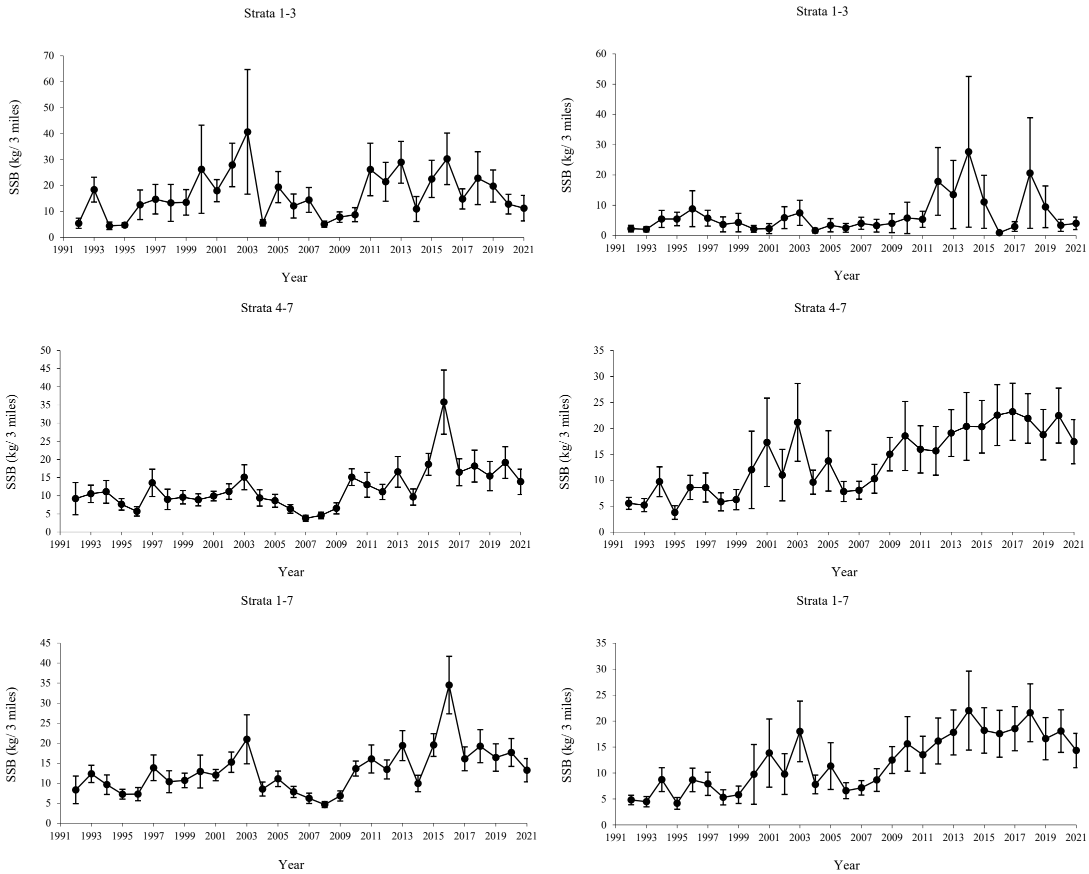


Figure 24.6. Northern Irish Groundfish Survey SSB indices split into spring (left hand panels) and autumn (right hand panels) sampling by western strata (1–3), eastern strata (4–7) and total survey area (strata 1–7) with confidence intervals (± 1 standard error, vertical lines).

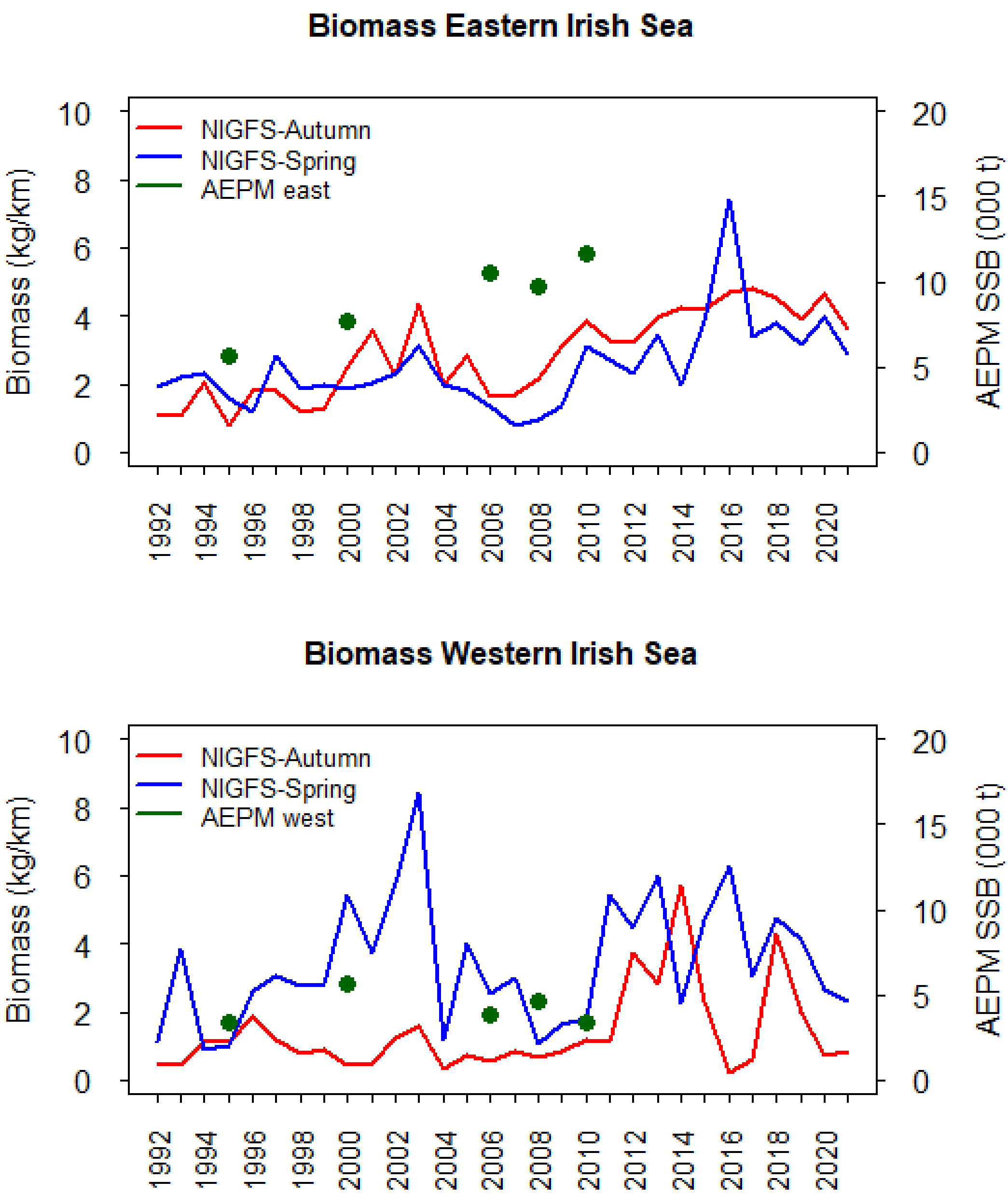


Figure 24.7. Trends in biomass indices (kg per km towed) the NIGFS-WIBTS-Q1 and -Q4 (blue and red lines respectively) in the eastern Irish Sea (top) and the western and southern Irish Sea (bottom). Also shown (green dots, right axis) are the estimates of SSB from the Annual Egg Production Method (AEPM) from Armstrong *et al.* (2001).

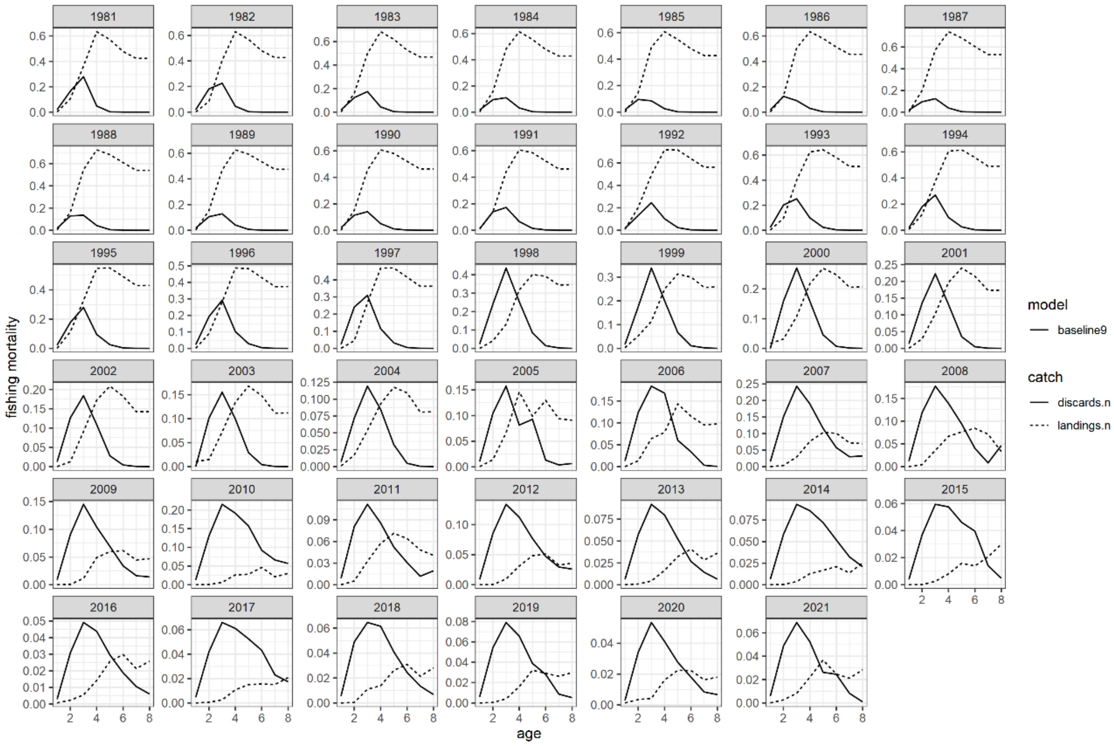


Figure 24.8. Selectivity of the fishery split into the landed (dashed) and discarded (solid) components as estimated by the SAM model, where the x-axis shows age and the y-axis gives the fishing mortality-at-age split by the proportion of fish (by number) discarded and landed at-age.

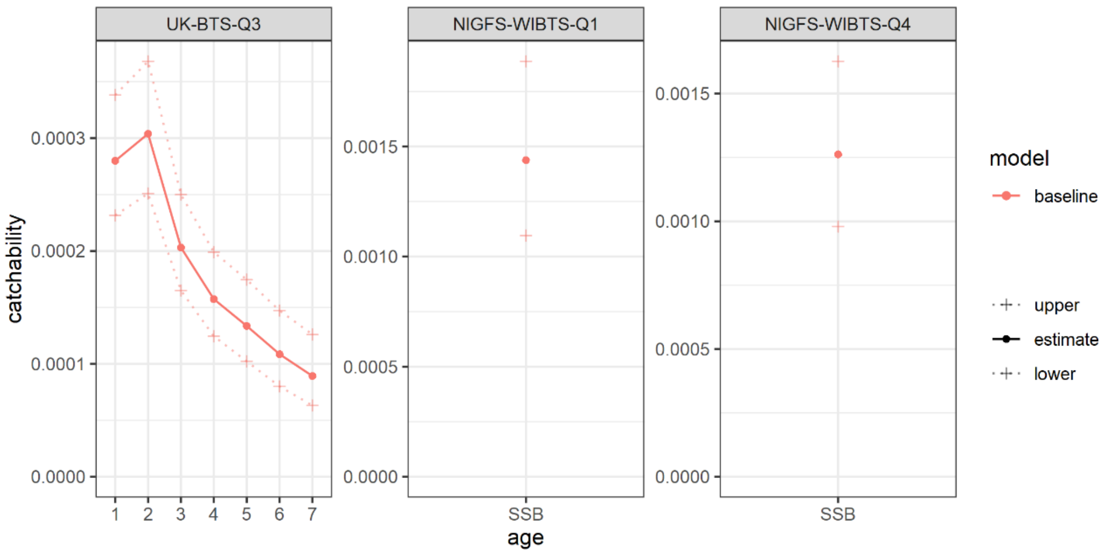


Figure 24.9. Catchability for the UK (E&W)-BTS-Q3 extended index by age, NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 as estimated by the SAM model.

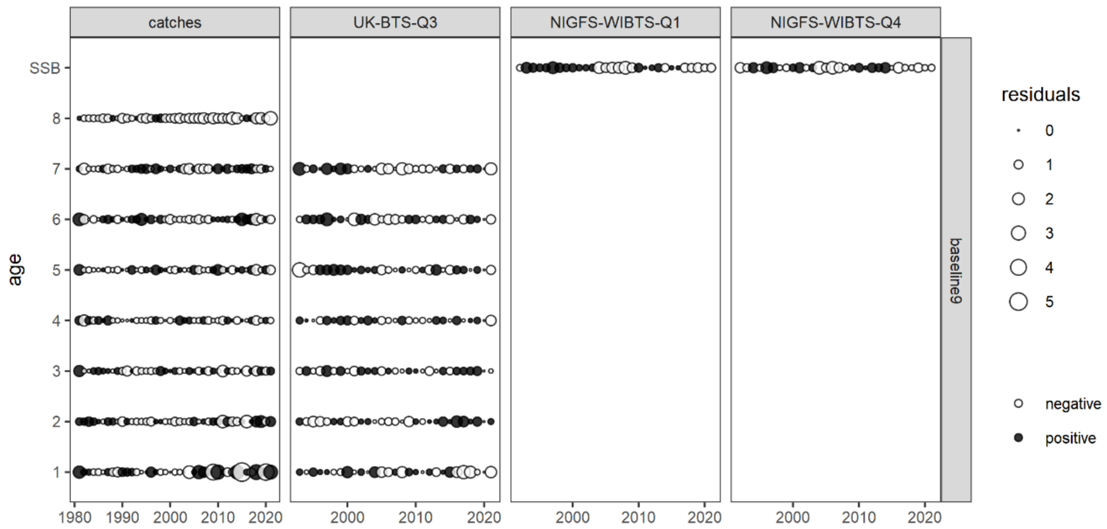


Figure 24.10. Residuals in fits to catch and survey data from the baseline model. Expected values were estimated by the SAM model.

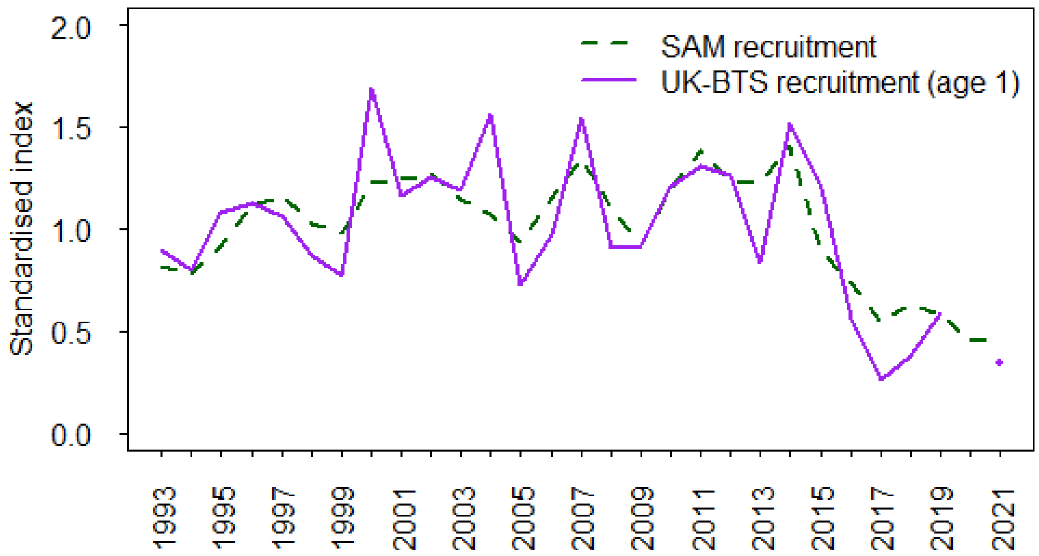


Figure 24.11. Comparison of the standardised age 1 index from the UK (E&W)-BTS-Q3 extended area (purple and purple cycle due to missing data in 2020) and the standardised recruitment (green dashed line) estimated by the SAM model.

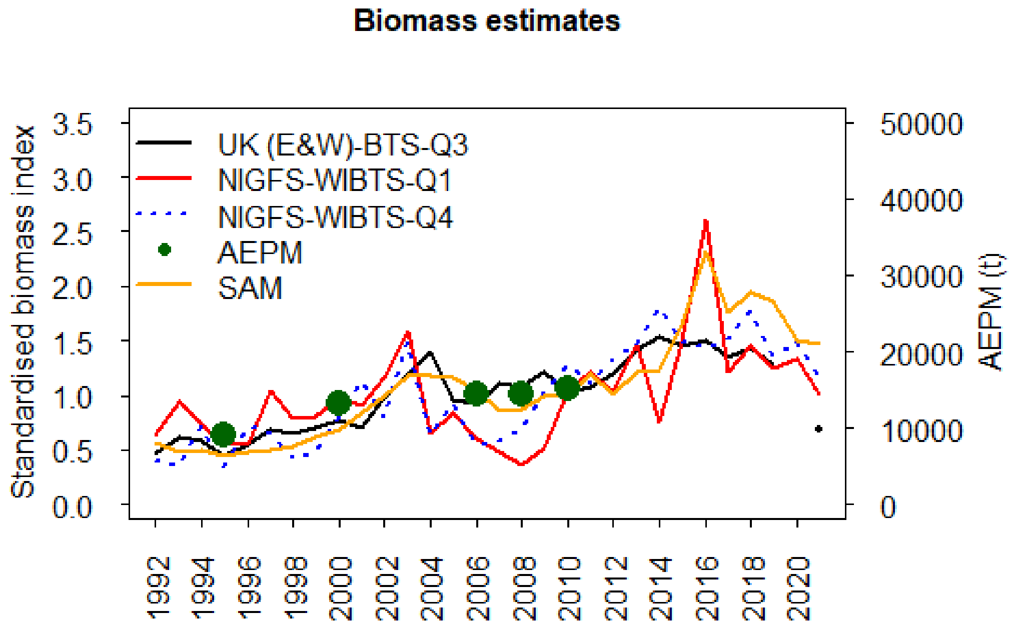


Figure 24.12. SAM model estimates of mean standardised SSB (orange line) overlaid with standardised NIGFS in spring (red) and autumn (blue dashed) relative SSB indices, standardised biomass (ages 1–4) from the UK(E&W)-BTS (black solid line and black cycle due to missing data in 2020) and AEPM SSB index (circles, right axis). Standardized: minus mean and divided by standard deviation.

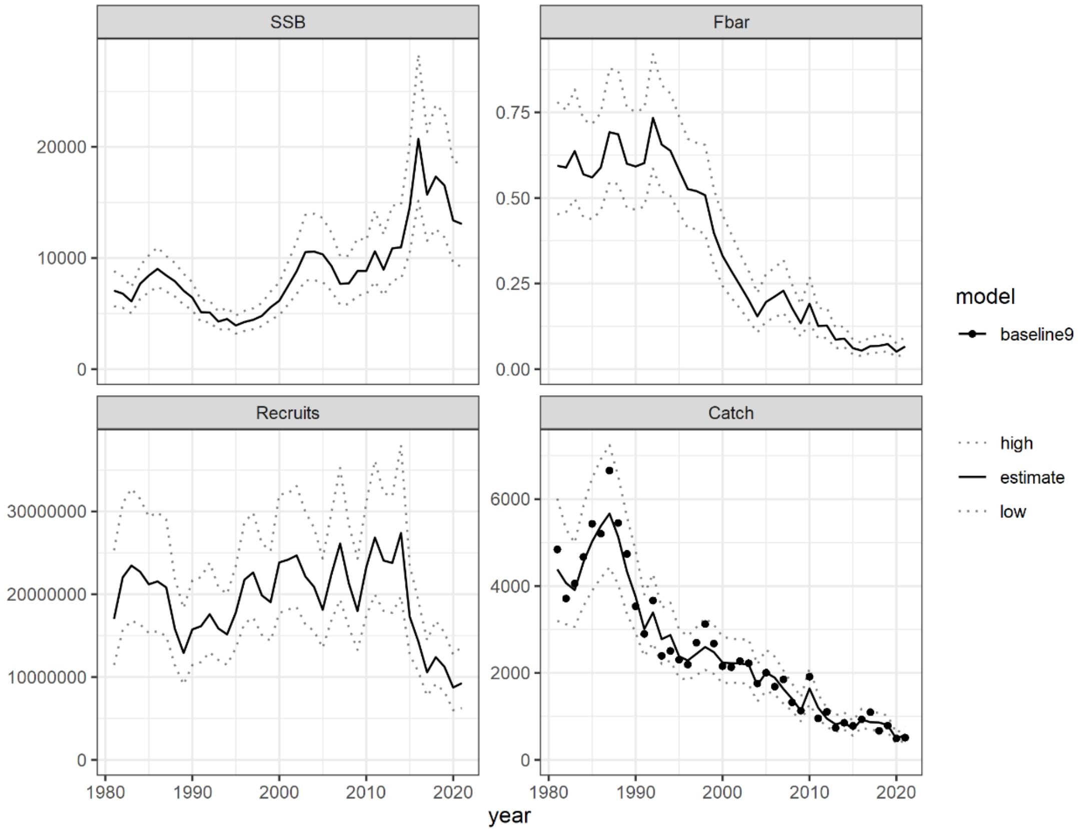


Figure 24.13. Modelled SSB (tonnes, top left), recruitment (thousands, bottom left), F_{bar} (ages 3–6, bottom right) catch tonnage (bottom right) using the SAM model. Error dashed lines indicate 2 × standard deviation.

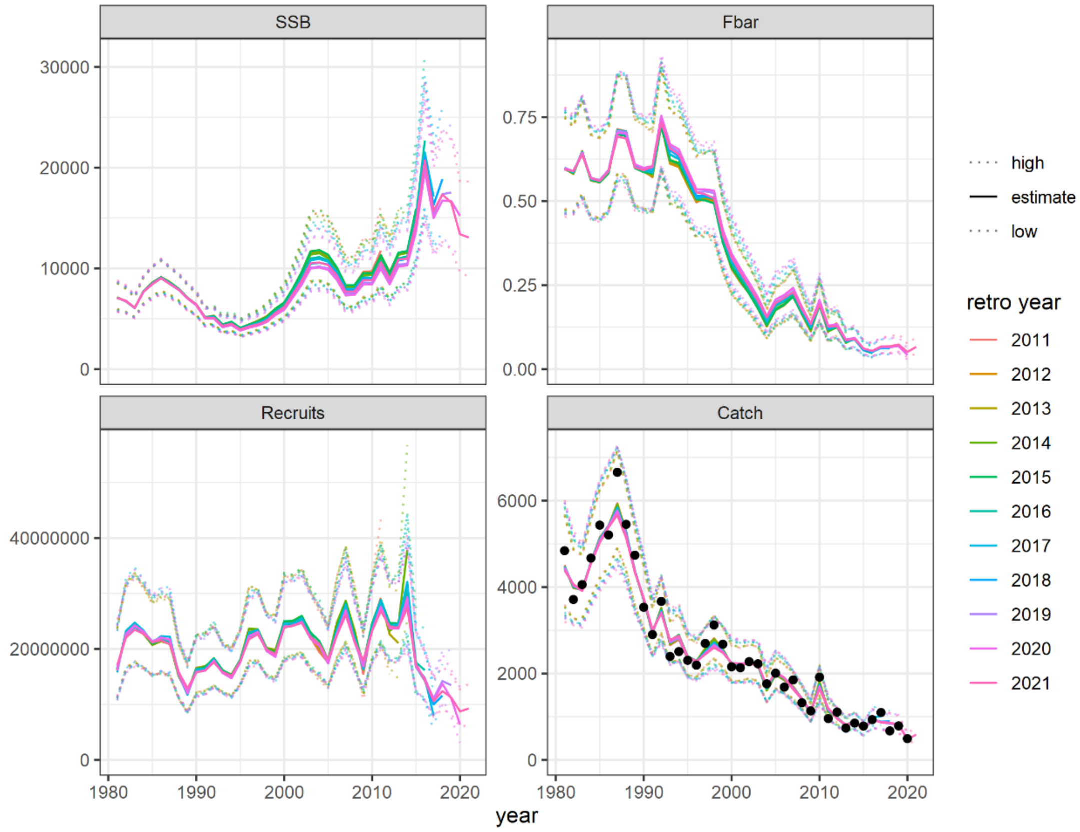


Figure 24.14. Retrospective assessments for years 2011–2021 from the baseline model. SSB (tonnes, top left), recruitment (thousands, bottom left), F_{bar} (ages 3–6, bottom right) catch tonnage (bottom right). Error dashed lines indicate 2 × standard deviation.

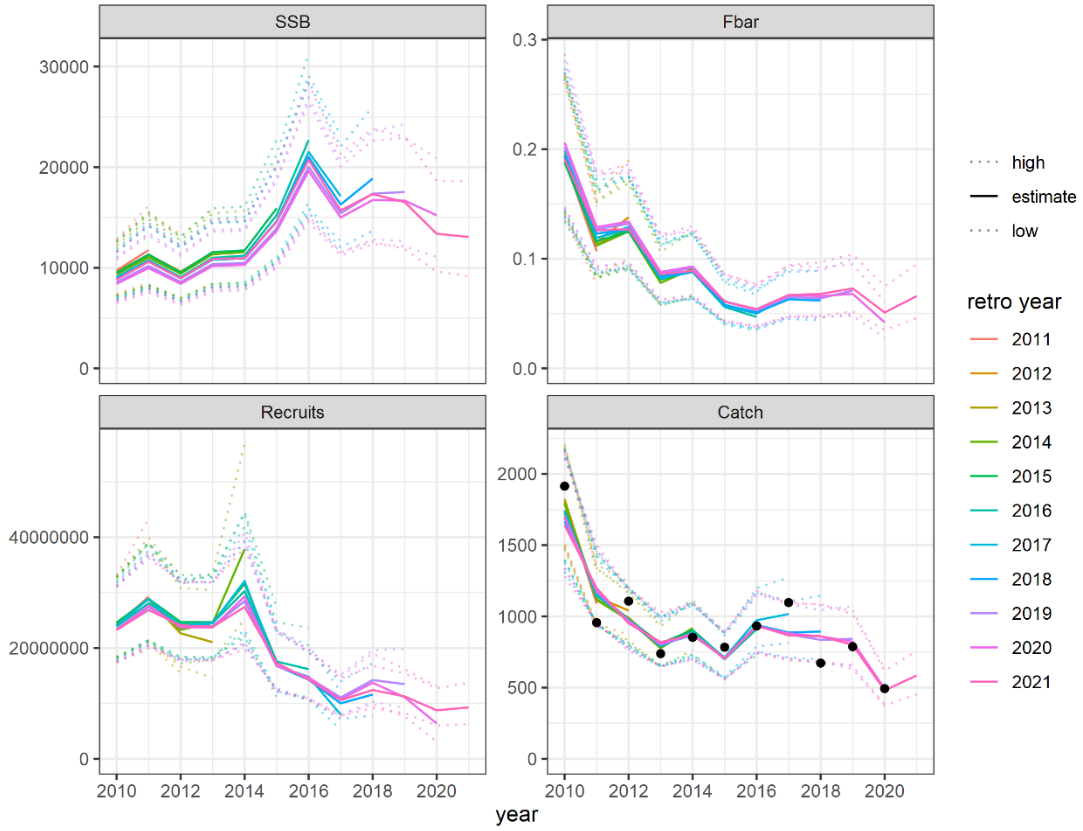


Figure 24.15. Retrospective assessments for years 2011–2021 from the baseline model, showing final 11 years. SSB (tonnes, top left), recruitment (thousands, bottom left), F_{bar} (ages 3–6, bottom right) catch tonnage (bottom right). Error dashed lines indicate 2 × standard deviation.

25 Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel

Type of assessment in 2021

Last year's assessment report is available at: https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2021/WGCSE_publication%20with%20multiple%20files/WGCSE2021_25%20Plaice%207e.pdf.

ICES advice applicable to 2022

Last year's advice is available at https://doi.org/10.17895/ices.advice.7822 and stated:

ICES advises that when the precautionary approach is applied, catches in 2022 should be no more than 1742 tonnes.

25.1 Impact of the COVID-19 pandemic

The plaice in Division 7.e stock, its fishery, and data sampling were largely unaffected by the implications of the COVID-19 pandemic in 2021.

25.2 ICES Transparent Assessment Framework

The Division 7.e plaice stock is included in the ICES Transparent Assessment Framework (TAF, https://taf.ices.dk, https://github.com/ices-taf). All WGCSE assessments since 2019 are available from the ICES TAF GitHub page (please note, access to these repositories is so far restricted to ICES and members of WGCSE). The current WGCSE 2022 assessment is available from https://github.com/ices-taf/2022_ple.27.7e_assessment.

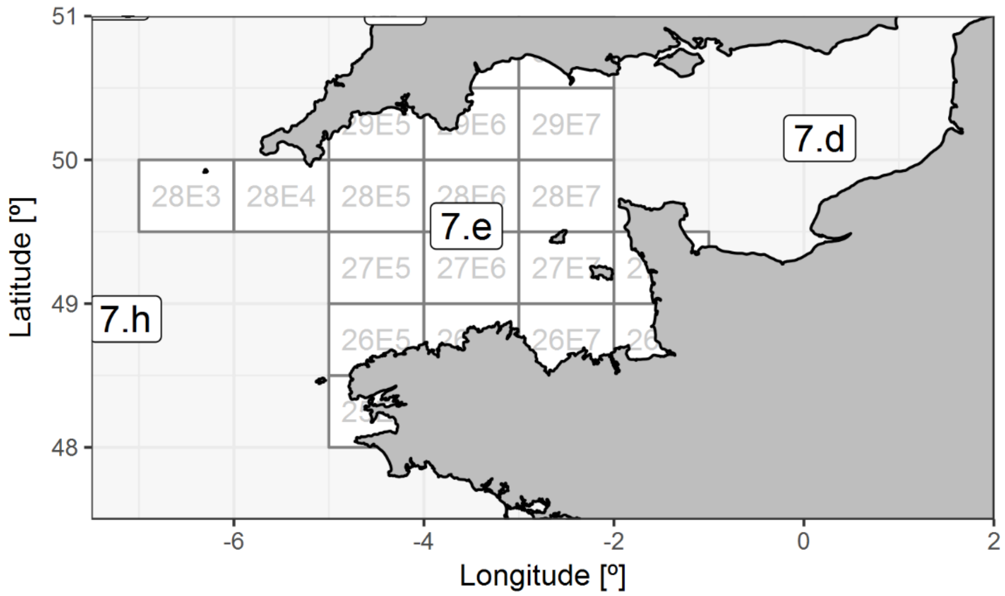
All changes since last year's assessment can be accessed with the following link: https://github.com/ices-taf/2022_ple.27.7e_assessment/compare/de247c6...main.

The TAF repository includes all input data, R scripts for processing data, preparing and running the stock assessment and advice rule, and scripts for creating all figures and tables presented in this report.

25.3 General

25.3.1 Stock description and management units

The ICES advice 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 (ICES, 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.

25.3.2 Management applicable to 2021 and 2022

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 2021 (in tonnes)

Species	**Plaice** *Pleuronectes platessa*	**Zone:**	**7d and 7e** (PLE/7DE.)
Belgium	1537	Analytical TAC	
France	6850	Article 8(2) of this Regulation applies	
Union	8387		
United Kingdom	3533		
TAC	11 920		

(Source: Council Regulation (EU) 2021/1239, EU, 2021).

The TAC and the national quotas by country for 2021

Species	Plaice *Pleuronectes platessa*	Zone:	7d and 7e (PLE/7DE.)
Belgium	1310	Analytical TAC	
France	4366	Article 8(2) of this Regulation applies	
Union	5676		
United Kingdom	2717		
TAC	9138		

(Source: Council Regulation (EU) 2022/515, EU, 2022).

25.3.3 Landing obligation

The EU landing obligation was phased in between 2019 and 2021 for plaice in 7.e with a discard plan defined in the Commission Delegated Regulation (EU) 2018/2034 (EU, 2018) and Commission Delegated Regulation (EU) 2019/2239 (EU, 2019) and referring to Regulation (EU) No 1380/2013 (EU, 2013). According to this discard plan, the landing obligation applies to plaice in 7.e. since 1 January 2019. There are, however, survivability exemptions for plaice when caught with specific gears. This includes all (a) trammelnets (gear codes GTR, GTN, GEN, GN) and (b) otter trawls (gear codes OTT, OTB, TBS, TBN, TB, PTB, OT, PT, TX). Furthermore, Commission Delegated Regulation (EU) 2018/2034 (EU, 2018a) set a provisional exemption for 2019, including BT2 beam trawls (i.e. 80 mm to 120 mm mesh size) for (c) vessels with a maximum engine power greater than 221 kW and fitted with a flip-up rope or benthic release panel, and (d) for vessels with a maximum engine power of 221 kW or a maximum length of 24 m, when fishing within 12 nautical miles of the coast and with average tow durations of no more than 1:30 hours (Commission Delegated Regulation (EU) 2018/2034, Article 6, EU, 2018a).

This provisional exemption was extended to 2020 in Commission Delegated Regulation (EU) 2019/2239 (EU, 2019) and points (c) and (d) extended to beam trawls irrespective of mesh size (Commission Delegated Regulation (EU) 2019/2239, Article 6, EU, 2019).

Prior to introducing the landing obligation, a substantial part of the plaice 7.e catches has been discarded and not accounted for in the stock assessment. In the first year of the phasing in of the landing obligation, the exemptions are likely to cover most of the plaice catches, and the impact on fishing or stock assessment is likely to be negligible. In the following years of the discard plan, the situation should be closely monitored because of potential changes in the landings data and composition, which might affect the stock assessment.

25.4 Data

25.4.1 InterCatch

International catch data are collated on the ICES InterCatch platform (https://intercatch.ices.dk). In the Western English Channel, plaice is taken mainly as bycatch in beam trawls targeting sole and anglerfish. In 2021, 71.2% of the landings were taken by beam trawls, 21.7% by otter trawls, 4.1% by gillnets and 2.9% by other gears. Of the total international landings, 85.6% were taken by the UK, 6.6% by France, 7.7% by Belgium, and 0.1% by the Netherlands (Table 25.1, Figures 25.1 and 25.2).

This stock is the smaller of the two plaice stocks that make up the larger TAC Area 7.d–e. The official landings from this stock amounted to 15% of the TAC in 2019, 14% in 2020 and 15% in 2021. The combined catches of plaice in 7.d-e accounted for 50% of the TAC in 2019, 74% in 2020, and 34% in 2021.

25.4.2 Landings

National landings data reported to ICES and estimates of total landings used by the Working Group are given in Table 25.1. Total international plaice landings in Division 7.e were 1275 t in 2020 and 1331 t in 2021, an increase of 4%.

In addition to the estimated 2021 landings for Division 7.e, an extra of 72 tonnes (98 tonnes in 2020) were 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 (ICES, 2010), and the migration correction was revised at WKPLE 2015 (ICES, 2015a). The process is described in the Stock Annex. A reciprocal correction is made to the 7.d plaice stock. Figure 25.3 shows the total annual landings split by divisions 7.e and 7.d.

25.4.3 Discards

Although discards have not been used in the assessment of 7.e plaice historically, some discard data are available. Discard tonnages are available within InterCatch and were provided by the UK(E&W) for the years 2012–2021, France for 2014–2021, Belgium for 2012–2013 and 2015–2021, the Netherlands for 2015–2019 and Ireland for 2017–2021 (zero discards reported).

Discard coverage and sampling are generally at a high level for this stock. Discard estimates were provided for 88% of the landings in 2019, 23% in 2022 (impacted by Covid restrictions on sampling), and 91% in 2021. Of these discard estimates, age samples were provided for 89% in each of the years 2019, 2020, and 2021.

In analogy to the landings, the discards are also uplifted by a migration correction from 7.d. For 2021, 95 tonnes (15% of the mature quarter 1 plaice discards in 7.d) were added, resulting in total discards of 211 tonnes for the 7.e plaice stock.

For historical consistency reasons, Figure 25.4 shows various discard rates for plaice in 7.e. Since WGCSE 2017, the discard rate has been calculated as the contribution of total discards (raised, including migration correction) to the total plaice landings (including migration component), and this discard rate was 13.1% in 2021 (Figure 25.5).

25.4.4 Sampling

Sampling levels for this stock have been high in recent years.

This year, all nations (apart from Scotland and the Belgian beam trawl fleet) provided data disaggregated by fleet and by quarter, and these were all uploaded into the ICES InterCatch database. Quarterly age compositions for landings in 2021 were available from the UK (England) and were provided for four fleets (GNS_DEF_all_0_0_all Q3, Q4; OTB_DEF_>=120_0_0_all Q1, Q2, Q3 Q4; OTB_DEF_70-99_0_0_all Q1, Q2, Q3, Q4; and TBB_DEF_70-99_0_0_all Q1, Q2, Q3, Q4), Belgium for one fleet (TBB_DEF_70-99_0_0_all, annual), and France for two fleets (OTB_DEF_100-119_0_0 Q3; OTB_DEF_70-99_0_0 Q3). Sampling levels for landings and discards were good for plaice and age samples covered 91% of the total reported international landings and 89% for discards. Figure 25.6 visualises age samples and gives details about the number of samples and age readings in 2021.

Additional landings data were available by quarter/fleet from Belgium, France, Ireland (0 landings), the Netherlands (<1t), UK (E+W, Guernsey) and UK Scotland (annual, <1 t). These datasets were aggregated to an international age-structured catch using the ICES InterCatch platform.

Length compositions were provided by the UK (E&W), Belgium and France and covered 91% of all submitted landings. Figure 25.7 visualises age samples and gives details about the number of samples and length readings in 2021.

An additional age composition representing the migration adjustment (15% of the mature component of quarter 1 catches for 7.d) was supplied on request by the WGNSSK stock coordinator for the 7.d plaice stock.

The method for deriving 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. Landings numbers-at-age (including the migration element) are given in Figure 25.9. Landings and stock weights-at-age are plotted in Figures 25.9 and 25.10.

Catch weights are assumed to be mid-year values, and stock weights are interpolated back (in year) to 1 January, as standard for this stock (Figure 25.9).

25.4.5 Revisions

No revisions to data prior to 2021 were provided in 2022.

25.4.6 Biological

The natural mortality and the maturity ogives used were identical to previous assessments and as described in the Stock Annex.

25.4.7 Surveys

Two surveys currently provide abundance estimates to the Working Group (Figure 25.11, Figure 25.12, Table 25.2, and Figure 25.13 for internal consistency).

25.4.7.1 UK Fisheries Science Partnership

The UK Western Channel sole and plaice survey (previously called Fisheries Science Partnership survey; UK-FSP, quarter 3, ICES survey code B4381, Burt *et al.*, 2022) conducted another survey of sole and plaice abundance in the Western English Channel in 2021. The survey uses two 4 m beam trawls with 80 mm nominal codend mesh and focuses on the area around the English coast. 83 out of 90 tows were completed in 2021. 497 plaice otoliths were collected for aging in 2021.

For this survey, catch rates are reported standardised as numbers and biomass (kg) per hour per meter of beam length.

The plaice biomass from the FSP survey has been decreasing since 2014 and 2021 is the first increase in biomass since then. Plaice were encountered at 95% of the survey stations, with a similar distribution to previous years, with greater numbers in Bigbury Bay and Lyme Bay (Figure 25.14, Burt *et al.*, 2022). Plaice catches comprised mainly fish aged 2–4.

Internal consistency (cohort tracking) is acceptable for this survey for ages three and above (Figure 25.13).

25.4.7.2 Q1SWBeam

The second survey used for sole is the Quarter 1 South West Beam trawl (Q1SWBeam, also called Q1SWECOS, ICES survey code B2732), which started in 2006. This survey deploys two 4 m beam trawls and uses a fully random stratified approach. In contrast to the FSP survey, the Q1SWBeam covers the entire western English Channel and, if conditions permit, adjacent areas. In 2021, 78 out of 81 tows were completed in the western English Channel.

For this survey, only standardised abundance (numbers-at-age) are reported regularly.

Plaice are mainly caught along the English coast with small or zero catches elsewhere in the western English Channel. Plaice catches are mainly comprised of fish aged 3 and 4. Cohort tracking is moderate for ages 3 to 7 (Figure 25.13). There is no statistically significant correlation ($p<0.05$) between the catches-at-age 2 and 3, between 6 and 7, 7 and 8, and 8 and 9.

25.4.7.3 Commercial fleet effort and LPUE

UK(E&W) beam trawl and otter trawl time-series are shown in Figure 26.15.

UK(E&W) beam trawl effort is relatively stable at high levels since the early 2000s but the landings increased substantially between 2015 and 2016 but have been decreasing since.

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 this is that the LPUE otter trawl index is calculated only with vessels of at least 12 m length, and in 2016 only smaller vessels deploying otter trawls reported any activity. Due to a change in the database system, no values are available for the otter trawl fleet after 2016, consistent with the earlier period.

25.5 ICES advice considerations

Since 2015, this stock has been classified as category 3 data-limited by ICES for advice purposes. Until 2021, ICES advice was provided following the 2012 data-limited stocks framework (ICES, 2012) and the catch advice was based on the "2 over 3" rule (method 3.2 in ICES, 2012). The stock trend used in the 2 over 3 rule was based on the SSB estimate of a landings only XSA assessment.

In 2022, ICES rolled out new data-limited advice rules for category 3 stocks developed by ICES WKLIFE X (ICES, 2020). Consequently, the advice for this plaice stock is based on the new framework (ICES, 2022).

25.6 Choice of method for providing advice

The choice of method for providing advice for plaice is based on the new ICES technical guidelines for stocks in categories 2 and 3 (ICES, 2022).

The first step in choosing a method is considering whether a surplus production model (such as SPiCT, Pedersen and Berg, 2017) has been fit successfully to the stocks and whether the model fit meets acceptance criteria. In previous years, WGCSE has conducted extensive explorations of SPiCT for this plaice stock. However, this was not successful. The model exhibited very large uncertainty and was sensitive to the first and last year of data used in the model. Alternative model configurations, fixing parameters, or including priors on model parameters did not lead to a suitable model. Consequently, SPiCT was rejected by WGCSE as this model does not appear to be able to model the stock dynamics appropriately.

For this stock, an index of abundance, as well as length data, are available. Following ICES (2022), the choice of the method then depends on the individual growth rate (quantified by the von Bertalanffy growth model parameter k).

25.6.1 von Bertalanffy growth parameters

Individual growth parameters were estimated by fitting a von Bertalanffy growth model to stock-specific age–length data:

$$L_t = L_\infty\left(1 - e^{-k(t-t_0)}\right)$$

For this stock, age–length data were available from UK commercial catch sampling and from the Q1SWBeam survey. The commercial data include older fish but are lacking younger ages. Conversely, the Q1SWBeam data include younger ages but lack older individuals. Consequently, the two data sources were combined. This approach is appropriate because the fish come from the same area (ICES Division 7.e) and were caught with similar gears (the Q1SWBeam uses a beam trawl with 80 mm mesh size, the majority of the commercial fishery is taken by beam trawls with mesh size 70–99 mm). The growth model was fit to annual data for 2006–2021 (Figure 25.16, Table 25.3). There has been little variability in the growth model in recent years. For more robust model estimates, the von Bertalanffy model was also fit to the combined data from the last five years (2017–2021), where the data from different years and data sources were weighted equally. This resulted in the following von Bertalanffy individual growth parameters:

von Bertalanffy parameter	L_∞	k	t_0
value	58.5 cm	0.11 year^{-1}	-2.3 years

Following ICES (2022), this means that the "rfb rule" should be applied because k<0.32 year^{-1}.

25.7 Application of the rfb rule

In 2022, WGCSE applied the rfb rule (Fischer *et al.*, 2020, 2021a,b, ICES, 2020, 2022) to plaice in Division 7.e.

The rfb rule is an empirical harvest control rule meant to be applied to empirical data and not estimates from a population model. Consequently, the previously used XSA assessment was discontinued and the rfb rule was directly applied to empirical data (survey and catch data).

The rfb rule is defined as

$$A_{y+1} = A_y\, r\, f\, b\, m,$$

where A_{y+1} is the new advised catch for year $y + 1$, A_y the previously advised catch, r a biomass ratio following the trend in a biomass index, f a fishing pressure proxy using catch length data, b a biomass safeguard protecting against low stock size, and m a multiplier ensuring long-term precautionary exploitation.

The rfb rule includes a conditional and asymmetric uncertainty cap restricting changes in A_{y+1} relative to A_y to $+20\%$ and -30%, but is only implemented if $b = 1$. Furthermore, the rfb rule provides biennial catch advice, i.e. once set, the advice is kept for two years.

The rfb rule was applied according to the 2022 ICES guidelines (ICES, 2022) and the following sections describe how the components of the rfb rule were derived.

25.7.1 Component A_y

The rfb rule derives the catch advice by adjusting the previously advised catch. However, the rfb rule is meant to adjust realised catches affecting a fish stock. Figure 25.17 shows a comparison of historical catch and ICES advised catches. In recent years, the advised catch has been above the realised catches, but the advised catches have been decreasing. The estimated catch for 2021 is close to the advised catch for 2022. Therefore, using the ICES catch advice for 2022 in the rfb rule appears appropriate:

$$A_y = A_{2021} = 1742 \text{ tonnes} \qquad \text{(source: ICES advice 2021; ICES, 2021)}$$

25.7.2 Component r

Component r of the rfb rule informs on the biomass trend of the stock. Two survey indices exist for plaice: UK-FSP and Q1SWBeam. The UK-FSP survey was selected for application in the rfb rule because (1) it occurs later in the year in quarter 3 and therefore provides a more recent estimate of stock biomass, (2) it had a higher contribution compared Q1SWBeam in previous stock assessment model fits and shows better internal consistency (cohort tracking, see Figure 25.13) and appears more robust and less susceptible to noise in the data, (3) it covers the main habitat for plaice, and (4) it is the only survey for which a time-series of standardised biomass estimates (in kg per hour per metre of beam) are available. For the biomass index, only ages 2–8 were considered because these were the ages previously selected in age-structured assessments and younger as well as older fish might not be fully selected and likely provide more noise than signal.

Component r of the rfb rule is calculated as (ICES, 2022):

$$r = \frac{\sum_{i=y-2}^{y-1} I_i/2}{\sum_{i=y-5}^{y-3} I_i/3} = \frac{\sum_{i=2020}^{2021} I_i/2}{\sum_{i=2017}^{2019} I_i/3} = \frac{0.81}{1.10} = 0.74,$$

where I is the biomass of the UK-FSP survey, aggregated over ages 2–8. Figure 25.18 illustrates the biomass index and the calculation of r.

25.7.3 Component f

Component f of the rfb rule is a proxy for the fishing pressure and uses catch length data. Catch length distributions were generated from InterCatch following the same raising and allocation principles as for the age distributions. Figure 25.19 illustrates international catch (landings and discards) length distributions for 2014–2021.

Component f requires the definition of length at first capture L_c. L_c was calculated annually for 2014–2021 following the ICES guidelines (ICES, 2022), which define L_c as the first (smallest) length class for which the catch numbers are at or above the mode of the distribution (the length class with the highest catch numbers). L_c showed little variability over the years (26–27 cm, Table 25.4, Figure 25.19) and the average over 2017–2021 was used as the final $L_c = 26.4$ cm.

The annual mean length in catch L_{mean}, for length classes above L_c was calculated as the mean of length classes above L_c, weighted by the catch numbers per length class (Table 25.4, Figure 25.19).

The mean catch length can be compared to an MSY proxy reference length to infer fishing pressure on the stock. $L_{F=M}$ is used as a reference length (ICES, 2022), and calculated as:

$$L_{F=M} = 0.75L_c + 0.25L_\infty = 0.75 \times 26.4 \text{ cm} + 0.25 \times 58.5 \text{ cm} = 34.4 \text{ cm}$$

This is an approximation and assumes $M/k = 1.5$, and was used for plaice because natural mortality M is not known reliably. L_∞ and L_c used here are average over the last five years. This ensures a more robust estimation and means that $L_{F=M}$ is assumed constant over time.

L_{mean} can then be compared to $L_{F=M}$ (Figure 25.19, 25.20). L_{mean} was below $L_{F=M}$ for 2014–2021, which indicates overfishing of the plaice 7.e stock, a perception that is supported by exploratory age-structured stock assessment models.

Component f of the rfb rule is calculated as:

$$f = \frac{L_{\text{mean}}}{L_{F=M}} = \frac{L_{2021}}{L_{F=M}} = \frac{32.3 \text{ cm}}{34.4 \text{ cm}} = 0.94$$

25.7.4 Component b

The biomass safeguard (component b) protects against low stock size and includes a biomass index trigger value (I_{trigger}). The same biomass index as for component r is used for b. In the absence of better knowledge, I_{trigger} is based on the lowest observed biomass index value (I_{loss}):

$$I_{\text{trigger}} = I_{\text{loss}} \times 1.4 = I_{2007} \times 1.4 = 0.28 \text{ kg hr}^{-1} \text{ m beam}^{-1} \times 1.4 = 0.39\text{kg hr}^{-1} \text{ m beam}^{-1}$$

Component b is then calculated as (ICES, 2022):

$$b = \min\left\{1, \frac{I_{y-1}}{I_{\text{trigger}}}\right\} = \left\{1, \frac{I_{2021}}{I_{\text{trigger}}}\right\} = \min\left\{1, \frac{1.03}{0.39}\right\} = 1$$

25.7.5 Component m

The multiplier m is set depending on the von Bertalanffy parameter k (ICES, 2022):

$$m = \begin{cases} 0.95, & \text{if } k < 0.20 \text{ year}^{-1} \\ 0.90, & \text{if } 0.20 \leq k < 0.32 \text{ year}^{-1} \end{cases}$$

and because for plaice $k < 0.20 \text{ year}^{-1}$, m is set to:

$$m = 0.95.$$

25.7.6 Combining the rfb rule's components

The catch advice with the rfb rule is calculated as

$$A_{y+1} = A_y \, r \, f \, b \, m = 1742 \text{ tonnes } \times 0.74 \times 0.94 \times 1 \times 0.95 = 1146 \text{ tonnes}$$

However, the rfb rule is used in combination with a conditional uncertainty cap (+20%, −30%), implemented only when $b = 1$. For plaice in 2022, $b = 1$, and the uncertainty cap was considered. The change in the advised catch would be a reduction of more than 30% ($r \times f \times b \times m = 0.67 \times 0.94 \times 1 \times 0.95 = 0.66$, i.e. −34%). This means the final catch advice is capped:

$$A_{y+1} = A_y \times 0.7 = 1742 \text{ tonnes} \times 0.7 = 1219 \text{ tonnes}$$

This leads to the final catch advice for the 7.e plaice stock of 1219 tonnes in each of the years 2023 and 2024 (biennial advice).

Table 25.5 summarises the ICES catch advice and also provides the advice corresponding to ICES Division 7.e.

25.8 Legacy XSA assessment

In previous years, WGCSE conducted a landings-only XSA assessment and the SSB estimates from this assessment were used to inform the 2 over 3 rule. This assessment is not used anymore for the ICES advice because the rfb rule is applied to empirical data. Furthermore, the XSA assessment does not include discards despite substantial discarding for 7.e plaice. Nevertheless, this "legacy" XSA assessment has been updated at WGCSE 2022. The results are shown in Figure 25.21, residuals in Figure 25.22, and a retrospective analysis in Figure 25.23.

The output of this XSA assessment should be considered with caution because it ignores discards and exhibits a large retrospective pattern.

25.9 Exploratory SAM assessment

Since last year (WGCSE 2021), an exploratory assessment using the state–space stock assessment model SAM (Nielsen and Berg, 2014) has been conducted in parallel. This assessment includes discards (including reconstructed discards prior to 2012 where no InterCatch discard estimates are available). This assessment is briefly presented here. Please note that this SAM assessment for 7.e plaice was never benchmarked or reviewed, is not used for providing advice, and should be considered exploratory only.

The model uses total catches (including discards) from 1980–2021, the two survey indices (Q1SWBeam, 2006–2021, ages 2–9; UK-FSP, 2003–2021, ages 2–8) and other input data previously used for XSA (biological data such stock weights, natural mortality, maturity, etc.). The assessment uses SAM's default model configuration; the only exception is that the last two ages for the UK-FSP survey and the last three ages for the Q1SWBeam survey are linked to mimic the model configuration previously adopted for XSA.

Figure 25.24 shows a summary of the results of this SAM assessment. The reference points were derived at WGCSE by running an EqSim model. This SAM assessment indicates strong overfishing ($F>F_{MSY}$).

Figure 25.25 illustrates model diagnostics. The SAM model exhibits a minor retrospective pattern (Figure 25.25a, Mohn'r rho for SSB is +8.3%, for F -9.8%), minor rescaling when removing either survey (Figure 25.25b), residuals (Figure 25.25c) and process residuals (Figure 25.25d) appear appropriate, is robust to alternative initial parameters in the model fitting process (Figure 25.25e), and simulating data from the model and refitting SAM (Figure 25.25f) leads to replicates within the estimated uncertainty boundaries.

25.10 Management plans

There is no management plan in place for this stock apart from the EU multiannual plan for the region.

25.11 Uncertainties

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 the stock structure and the mixing rate during the spawning period. Additional data are also needed to determine if the current mixing rate remains valid given the increased abundance of plaice stocks in the English Channel in recent years.

France had to revise their 2018 discard data previously due to inaccuracies in the raising procedure. However, the same procedure has already been used in previous years, which have not been revised.

25.12 Recommendations for the next benchmark

The 7.e plaice is relatively data-rich for an ICES category 3 data-limited stock. There are no major concerns for this stock to provide advice following category 3 methods. However, should the stock be upgraded in the future, this section provides an overview of potential issues. An updated issue list is kept on the ICES system for rolling issues (https://sid.ices.dk/Manage/rollingissues.aspx).

Most of the following points have been described in previous reports and are repeated this year.

A benchmark assessment was developed for this stock at WKFLAT 2010 (ICES, 2010), and an inter-benchmark meeting (IBPWCFlat2, ICES, 2015b) subsequently convened in 2015 to revise the input data and update the XSA assessment settings. Nevertheless, any future benchmark meeting will need to consider the following issues.

Since 2017, ICES asked for the additional application of data-limited methods for category 3 stocks. This had massively increased the workload for the stock coordinator and assessor, but with little benefit for this stock. Upgrading this stock to category 1 was considered desirable and feasible within a reasonable time frame. In 2022, due to the application of the rfb rule, the need to apply additional exploratory data-limited methods has disappeared.

The decisive reason for downgrading the stock to category 3 in 2015 was unacceptable retrospective patterns in the XSA assessment. For the application of an analytical assessment, the following issues need to be considered:

- A discard time-series should be developed and included in the assessment as discarding was substantial in recent years.
- Discards, including age compositions, are now routinely estimated within InterCatch and exist for 2012–2021. Some UK discards data prior to 2012 exist but are not used so far. The discard time-series should be extended back in time, as it has been done for other plaice and similar stocks. An exploratory assessment with a historical discard guestimation has been conducted since WGCSE 2020 and indicates considerably higher fishing mortality in recent years than the previous landings only assessment.
- Including discards in the assessment might require a reparameterisation of XSA settings and exploring alternative age-structured assessment models, such as SAM.
- Biological data such as natural mortality and maturity ogives are time-invariant in the current assessment and borrowed from other plaice stocks (divisions 7.fg and 7.a). There have been benchmarks for other plaice stocks, and a similar approach could be made for plaice in 7.e. The natural mortality used for plaice in 7.e was originally borrowed from

plaice in Division 7.a. The values for plaice in 7.a have been changed recently, but the original values are still used for plaice in 7.e.

Furthermore, the following points should be considered:

- Smoothing of stock and catch weights. The raw catch weights are corrected for migration from 7.d and then smoothed using a polynomial function of second degree. Even though the fit seems 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.
- Cohort tracking in the Q1SWBeam index is only mediocre.
- Investigate the addition of age composition information from the French and Belgian fleets. These fleets collectively accounted for about 16% of the total landings of this stock. In particular, the inclusion of French data would add information on the stock dynamics on the French coast.
- In 2019/2020 there was a revision of the Q1SWBeam survey index, with changes to station validities and the calculation of the index. This should be further reviewed.
- France revised the 2018 discard data due to an issue with the raising procedure. However, the same procedure has been used for previous which have not been revised.
- The landings only XSA assessment is again exhibiting larger retrospective patterns. These patterns are reduced when discards are included in the assessment.

25.13 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 the 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.

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%, the average of 2003–2021, taking the age structure of the population into account). As the mixing rate of the two plaice stocks is uncertain, this calculation provides only an approximation.

The total allowable catch (TAC) for the management area has not always been following scientific recommendation for the combined divisions 7.e and 7.d. for 2016 has been doubled compared to 2015 but was reduced slightly in the following years.

25.14 Stock assessment audit

The 2021 stock assessment for this stock has been audited internally within WGCSE, and no issues were found.

25.15 References

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25.16 Tables

Table 25.1. Plaice in 7.e. History of official landings by country and ICES estimates of landings and discards. All weights are in tonnes.

Year	Belgium	Netherlands	France	UK (E &W) incl. CI's	Others	Official total	Total*	7.e stock caught in 7.d**	ICES estimated landings	Discards***
1976	5	-	323	312	-	640	640	-	640	
1977	3	-	336	363	-	702	702	-	702	
1978	3	-	314	467	-	784	784	-	784	
1979	2	-	458	515	-	975	977	-	977	
1980	23	-	325	609	9	966	1079	99	1178	
1981	27	-	537	953	-	1517	1501	175	1676	
1982	81	-	363	1109	-	1553	1688	190	1878	
1983	20	-	371	1195	-	1586	1495	219	1714	
1984	24	-	278	1144	-	1446	1547	211	1758	
1985	39	-	197	1122	-	1358	1441	236	1677	
1986	26	-	276	1389	-	1691	1810	268	2078	
1987	68	-	435	1419	-	1922	1958	314	2272	
1988	90	-	584	1654	-	2328	2458	377	2835	
1989	89	-	448	1712	-	2249	2358	384	2742	
1990	82	-	N/A	1891	2	1977	2593	392	2985	
1991	57	-	251	1326	-	1634	1848	335	2183	
1992	25	-	419	1110	14	1568	1624	258	1882	
1993	56	-	284	1080	24	1444	1417	197	1614	
1994	10	-	277	998	-	1285	1156	248	1404	
1995	13	-	288	857	-	1158	1031	216	1247	
1996	4	-	279	855	-	1138	1044	222	1266	
1997	6	-	329	1038	1	1374	1323	260	1583	
1998	22	-	327	892	1	1242	1131	215	1346	
1999	12	-	194	947	-	1153	1299	244	1543	
2000	4	-	360	926	< 1	1290	1281	345	1625	

Year	Belgium	Netherlands	France	UK (E &W) incl. CI's	Others	Official total	Total*	7.e stock caught in 7.d**	ICES estimated landings	Discards***
2001	12	-	303	797	-	1112	1106	204	1310	
2002	27	-	242	978	< 1	1247	1257	215	1472	
2003	39	-	216	985	-	1240	1277	110	1387	
2004	46	-	184	912	-	1142	1212	126	1337	
2005	48	-	198	887	-	1133	1203	117	1319	
2006	52	-	223	965	< 1	1239	1313	97	1411	
2007	84	-	202	680	-	966	1003	143	1146	
2008	66	-	148	679	-	893	976	135	1112	
2009	53	2	191	731	-	977	923	101	1024	
2010	51	2	227	843	-	1123	1092	116	1208	
2011	141	3	274	936	-	1354	1334	83	1417	
2012	134	2	224	1004	< 1	1364	1366	126	1492	448
2013	97	1	221	1041	-	1360	1351	121	1472	351
2014	41	-	323	976	-	1340	1341	149	1490	1133
2015	111	1	224	912	1	1249	1246	178	1424	1276
2016	145	< 1	204	1430	-	1780	1777	235	2013	618
2017	151	< 1	153	1605	1	1911	1915	213	2128	821
2018	143	3	118	1377	3	1644	1644	236	1880	633
2019	73	2	97	1351	< 1	1523	1520	204	1725	366
2020^	73	1	79	1122	-	1276	1275	98	1373	514
2021^	107	1	90	1129	-	1327	1331	72	1403	211

***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 official landings.

Table 25.2. Plaice in 7.e. Tuning fleet data available. Not all years and ages as shown here are used.

```
ple.27.7e WGCSE 2022
103
FSP-7e
2003 2021
1 1 0.75 0.80
1 27
1              0.0209264878   0.3436560706   0.343947876    0.2157155878   0.0410732591
               0.0419902913   0.0509084187   0.0337008819   0.0219208295   0.002110558
               0.0009455344   0.0004947213   7.72432e-05    3.546e-05      0
               3.546e-05      0              3.546e-05      0.000191009    0              0
               0              0              0              0              0              0
1              0.0066803368   0.2116598105   0.8405063532   0.1704899676   0.2827197449
               0.0296774344   0.0182410083   0.0461270347   0.0114017102   0.0026218442
               0.0008434715   0.0001982425   0.0001604926   0              0.0001907966   0
               0              0              0.0001228108   0              0              0
               0              0              0              0              0
1              0.0084930716   0.3271099173   0.4255951803   0.2404409927   0.0900371664
               0.0395287705   0.0127361504   0.0174592138   0.0371790541   0.0070178609
               0.0043464537   0              0              0              0.0006865187
               0.0006011272   0.0005708894   0              0.0005994339   0.0014134667   0
               0              0              0              0              0              0
1              0.0264706605   0.6226160902   0.4216897498   0.1859126341   0.099837907
               0.0442377935   0.0213837161   0.0045703626   0.0063647949   0.0140975761
               0.0015007319   0.0043230363   0              0              0.0005854935   0
               0              0.0006888159   0              0              0              0
               0              0              0              0              0
1              0              0.117014537    0.2742350811   0.1567513605   0.0653599832
               0.026616889    0.008325896    0.0058923584   0.0054585815   0.005636939
               0.0019316523   0.002303838    0.0022915293   0              0              0
               0              0              0              0              0              0
               0              0              0              0              0
1              0.0017564806   0.4978930589   0.2151254659   0.1256971005   0.0317951547
               0.0192553747   0.0153145058   0.0046815159   0.001905926    0.0005279613
               0.000223455    0.0001864931   7.71115e-05    2.43906e-05    2.83303e-05
               2.43906e-05    0              2.83303e-05    2.83303e-05    2.83303e-05    0
               0              0              0              0              0              0
1              0.0211943046   0.4353288543   0.4422219627   0.1528394796   0.0598128665
               0.0331030404   0.0226941756   0.0079648565   0.0033431925   0.0013018772   0
               0.0026037544   0              0              0              0              0
               0              0              0              0              0              0
               0              0              0              0
1              0.0647388571   0.7402133171   0.5829812879   0.3845761643   0.0479189382
               0.0415029509   0.0119952249   0.0061701869   0.0023009922   0.0047470993
               0.0011504961   0.006622702    0              0              0              0
               0              0              0              0              0              0
               0              0              0              0              0
1              0.0037734254   1.0381082519   0.8021298636   0.3142975263   0.1105006712
               0.0103245315   0.018145561    0.0132876218   0.0020727868   0.0020056082
               0.0016435966   9.86201e-05    6.33593e-05    0.0029840585   0
               0.0011857569   0              3.52608e-05    0              0              0
               0              0              0              0              0              0
1              0.0496877714   0.3213266702   1.2434797508   0.5819533643   0.1364606529
               0.1347918963   0.0121371085   0.0144254043   0.0115270917   0.0025913556
               0.0051989993   0.0049471333   0              0              0              0
               0              0              0              0              0              0
               0              0              0              0              0
1              0              0.2266890224   1.4641865697   1.2671043524   0.4403084123
               0.2032552981   0.0755061094   0.0275649015   0.0077368789   0.0037886636   0
               0.0012684957   0.0012684957   0              0              0              0
               0.0012684957   0              0              0              0              0
               0              0              0              0
1              0.03548275     1.319797284    1.6647790616   2.1308293497   0.8328568122
               0.6237114226   0.1572964824   0.0350538578   0.0371484109   0
               0.0035336667   0.00265025     0              0              0.0011778889   0
               0              0              0              0              0              0
               0              0              0              0              0
1              0.0016784148   0.8297622663   1.257130266    0.9233582109   1.0196856517
               0.5143815562   0.1222225484   0.0129019851   0.0566548058   0.0023922088
               0.0093314682   4.40921e-05    2.2046e-05     2.2046e-05     0
               2.2046e-05     0              2.2046e-05     0              0              0
               0              0              0              0              0              0
1              0.0033568296   0.3887210579   1.50073462     0.8157445965   0.3896522219
               0.3426977969   0.2351356472   0.0186050167   0.056730528    0
               0.0098937394   0              0.0028762403   0              0              0
               0              0              0              0              0              0
               0              0              0              0              0
1              0.0083920741   0.2734688532   0.5985856837   1.5809798468   0.3446727423
               0.4536494278   0.2886734237   0.0563499887   0.1485529321   0.013814645
               0.0264081583   0.0106433051   0.0054248655   0              0.0033568296   0
               0              0              0              0              0              0
               0              0              0              0              0
1              0              0.2730774994   0.765289223    0.9806866884   0.6563497784
               0.1850327432   0.1112903326   0.0873483927   0.0302633863   0.0263229229
               0.0030350849   0.0017983016   0              0              0              0
```

	0	0	0	0	0	0
	0	0	0	0	0	
1	0.000373087	0.1741186522	0.4982278185	0.5246850208	0.4820598027	
	0.3039476624	0.1153367817	0.0630658514	0.0315684791	0.01902716	
	0.0124644406	0	0.0012684957	0.0015856197	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.7236873888	0.6876859008	0.286551445	0.1324310278	
	0.0833516837	0.0646730791	0.0146861296	0.0183201245	0.0088404566	
	0.0073055273	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0.00211269	0.9929342784	1.7363595162	1.1438702468	0.1841311612	
	0.0630358958	0.0510755065	0.0349013699	0.0058015804	0.008438062	
	0.0073611358	0.0031734158	0.0031734158	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
Q1SWBeam						
2006 2021						
1 1 0 0.25						
1 27						
1	1.84355	39.0324	28.978	22.789	6.4116	
	2.0366	0.2017	0.1706	0.3412	0.64363	0
	0.42633	0.22583	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0		
1	0.86782	16.0343	35.474	17.601	4.9816	
	4.1461	1.6719	3.5545	0.2503	4.42522	
	0.2503	2.73176	1.43235	0.2503	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0.78546	34.0493	14.432	5.388	7.7622	
	1.1251	1.4744	2.178	1.979	0	
	0.87797	0.12102	0.18772	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	1.54002	60.3357	50.609	16.203	15.6705	
	4.8047	4.7493	0.4567	0.2861	0.45666	
	0.45666	0	1.86925	0	2.47554	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	1.15633	46.939	38.568	27.266	3.2952	
	4.1844	6.4977	0.8659	0.3754	0	0
	0.18772	0	4.58514	0	0	0
	0	0.14928	0	0	0	0
	0	0	0	0		
1	1.80958	59.7233	106.793	41.826	7.3508	
	6.3969	4.5944	0.4679	1.5832	0.11377	
	0.35757	0	0.11919	0.11919	0.11919	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	10.4168	55.348	34.255	11.0874	
	7.7031	11.5037	0.3472	3.2114	0	0
	0.21454	0	0	0.1644	0	0
	0	0	0	0	0	0
	0	0	0	0		
1	0.30036	18.0693	94.898	71.939	16.1513	
	4.4771	2.337	1.0774	1.9311	0	0
	0	0.13968	0	0	0	
	0.12637	0	0	0	0	0
	0	0	0	0	0	
1	1.01423	68.7637	155.902	195.574	70.5165	
	10.792	1.4612	2.9894	0.9387	0.48829	
	0.28101	0.15884	0.1706	0	0	0
	0.15884	0	0	0	0	0
	0	0	0	0	0	
1	0	45.2386	48.128	25.168	37.4127	
	21.7209	5.1873	2.273	1.0775	2.08315	0
	1.23777	0	0.18772	0	0.1976	0
	0	0	0	0	0	0
	0	0	0	0		
1	0.22085	21.6309	243.345	66.815	39.6987	
	40.1547	29.5983	7.9856	17.8855	0	
	8.59375	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	17.263	84.717	194.995	39.4563	
	37.3536	18.272	3.4646	6.9322	0.50248	
	0.65697	0	0.38299	0	0.2503	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	9.0674	40.928	32.98	49.1506	
	19.0937	13.197	12.3342	8.2191	1.41506	
	1.03906	0.13269	0	0.13269	0	0
	0	0	0	0	0	0
	0	0	0	0	0	

1	0	18.5742	40.702	52.361	43.0245	
	51.7778	21.8301	5.9516	4.1325	0.94572	
	0.55842	0	0	0.23838	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	47.2232	66.046	34.599	19.2905	
	8.3288	6.0213	4.6533	3.5152	1.35155	
	3.19601	0.14679	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	29.891	109.811	79.129	17.2037	
	6.5559	5.8824	1.7811	1.045	0.37545	
	0.18474	0	0.11942	0.1976	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
FSP-7e-biomass						
2003 2021						
1 1 0.75 0.80						
1 27						
1	0.005293577	0.121542899	0.153069038	0.109777405	0.02724899	
	0.030440689	0.039405188	0.023256499	0.021299359	0.003012324	
	0.001693233	0.000998533	0.000116896	5.67789e-05	0	
	5.67789e-05	0	5.67789e-05	0.000412429	0	0
	0	0	0	0	0	0
1	0.001294171	0.064029538	0.327665102	0.088965348	0.145804905	
	0.019175154	0.01406247	0.045491867	0.009358115	0.004607872	
	0.001141269	0.000207496	0.00017526	0	0.000296993	0
	0	0	0.000240839	0	0	0
	0	0	0	0	0	
1	0.001834264	0.111584597	0.162368193	0.11579134	0.054922714	
	0.027075454	0.010259167	0.017859677	0.034554905	0.007686843	
	0.006065153	0	0	0	0.001218691	
	0.000962531	0.001353022	0	0.001294305	0.002771882	0
	0	0	0	0	0	0
1	0.004986995	0.18835206	0.153217512	0.097268733	0.060978776	
	0.028978287	0.015872993	0.004062249	0.006358017	0.015281921	
	0.002559487	0.003623002	0	0	0.000347422	0
	0	0.001102939	0	0	0	0
	0	0	0	0	0	
1	0	0.034677413	0.103862469	0.070882913	0.039117126	
	0.02017179	0.007948558	0.003676961	0.005215244	0.005702262	
	0.002246861	0.004195415	0.001280989	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0.000762555	0.165757719	0.09611746	0.070482203	0.023197206	
	0.016585008	0.014802254	0.005977404	0.00156398	0.00075609	
	0.000306786	0.00031644	0.000118364	3.14036e-05	5.55573e-05	
	3.14036e-05	0	5.55573e-05	5.55573e-05	5.55573e-05	0
	0	0	0	0	0	0
1	0.004328708	0.154089593	0.197184164	0.080551521	0.040774069	
	0.030526187	0.018386791	0.007170953	0.005353153	0.00255305	0
	0.003877076	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0		
1	0.007795399	0.222343894	0.24054883	0.200768822	0.032681993	
	0.028385365	0.011556535	0.006137064	0.002962591	0.00716298	
	0.002042332	0.003041061	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0.000392661	0.283172819	0.275995973	0.143226456	0.067072751	
	0.006345669	0.019907033	0.010975028	0.002894182	0.002763981	
	0.002248034	0.000153348	9.68876e-05	0.004214009	0	
	0.001537756	0	5.646e-05	0	0	0
	0	0	0	0	0	0
1	0.008807035	0.081378624	0.400587835	0.235678139	0.076449968	
	0.080259232	0.013262699	0.009394429	0.011571324	0.002465811	
	0.005859429	0.004732132	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.049342684	0.401684632	0.466537624	0.206912371	
	0.108655459	0.054254917	0.020215075	0.010110847	0.003552844	0
	0.001455044	0.001455044	0	0	0	0
	0.003290293	0	0	0	0	0
	0	0	0	0		
1	0.0041401	0.296033996	0.456780968	0.717682874	0.340722206	
	0.261575403	0.079435747	0.025108143	0.029091589	0	
	0.004970024	0.001837137	0	0	0.000926584	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0.000166693	0.185697599	0.396768066	0.354955458	0.432597481	
	0.254028547	0.077329369	0.012734295	0.037467198	0.001575026	
	0.013224445	7.06007e-05	3.53004e-05	3.53004e-05	0	
	3.53004e-05	0	3.53004e-05	0	0	0
	0	0	0	0	0	0
1	0.000257249	0.088731125	0.432170069	0.33029376	0.187015182	
	0.180552834	0.125276737	0.013959313	0.045946967	0	
	0.00886356	0	0.001943963	0	0	0

	0	0	0	0	0	0
	0	0	0	0	0	
1	0.000716617	0.063625731	0.168860623	0.550867194	0.152306457	
	0.207245338	0.155649866	0.03381067	0.09188589	0.012446502	
	0.019714288	0.010609453	0.005307667	0	0.003212512	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.066152	0.212699658	0.326325231	0.283598616	
	0.105983836	0.068842772	0.069157464	0.022306102	0.023142302	
	0.003509849	0.003526564	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	3.70533e-05	0.039324415	0.147795101	0.176720127	0.205196314	
	0.15664294	0.069133305	0.045915506	0.021835755	0.017404333	
	0.010495682	0	0.001633223	0.000688378	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.142339922	0.17957078	0.099796	0.063359982	
	0.049534859	0.047201656	0.017829374	0.019932615	0.008423159	
	0.009645627	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0.000113987	0.16918976	0.391374814	0.296746707	0.075908191	
	0.032207573	0.033996438	0.02900624	0.006577623	0.008533158	
	0.005266963	0.005390231	0.003227407	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	

Table 25.3. Plaice in 7e. von Bertalanffy growth parameters.

Year	k (year^{-1})	L_∞ (cm)	t_0 (years)
2006	0.14	57.97	-2.09
2007	0.20	52.96	-1.28
2008	0.23	47.53	-1.43
2009	0.19	52.38	-1.43
2010	0.21	53.59	-1.07
2011	0.15	58.64	-1.43
2012	0.17	56.71	-1.04
2013	0.14	60.02	-1.61
2014	0.15	56.18	-1.15
2015	0.12	62.35	-1.66
2016	0.11	59.99	-2.28
2017	0.11	58.88	-1.91
2018	0.15	54.06	-1.28
2019	0.12	56.54	-1.98
2020	0.11	62.42	-2.53
2021	0.08	61.58	-3.39
2017–2021	0.11	58.51	-2.30

Table 25.4. Plaice in 7e. Parameters of the commercial catch length distribution. The table shows length at first capture L_c and mean length in the catch L_{mean} above L_c.

Year	Annual L_c (cm)	L_c (cm) (used for L_{mean})	L_{mean} (cm)
2015	26	26.4	32.7
2016	26	26.4	33.7
2017	27	26.4	33.0
2018	26	26.4	33.1
2019	26	26.4	34.4
2020	26	26.4	32.6
2021	27	26.4	32.3
2017–2021	26.4		

Table 25.5. Plaice in 7e. The basis for the catch options for 2021. Note that one catch option is provided for stocks in ICES data categories 3–6. The values presented here are the values presented during the working group.

Division 7.e plaice stock		
Previous catch advice A_y (advised catch for 2022)	1742 tonnes	
Stock biomass trend		
Index A (2020, 2021)	0.81 kg hr^{-1} m beam^{-1}	
Index B (2017, 2018, 2019)	1.10 kg hr^{-1} m beam^{-1}	
r: Stock biomass trend (index ratio A/B)	0.74	
Fishing pressure proxy		
Mean catch length (L_{mean}=L_{2021})	32.3 cm	
MSY proxy length ($L_{F=M}$)	34.4 cm	
f: Fishing pressure proxy relative to MSY proxy ($L_{2021}/L_{F=M}$)	0.94	
Biomass safeguard		
Last index value (I_{2021})	1.03 kg hr^{-1} m beam^{-1}	
Index trigger value ($I_{trigger}$=I_{loss}×1.4)	0.39 kg hr^{-1} m beam^{-1}	
b: Index relative to trigger value, min{$I_{2021}/I_{trigger}$, 1}	1	
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)	0.95	
Uncertainty cap (+20%/-30% compared to A_y, only applied if b≥1)	Applied	0.70
Discard rate	27%	
Catch advice for 2023 and 2024 (A_y × uncertainty cap)	1219 tonnes	
Projected landings corresponding to advice**	894 tonnes	
% advice change^	-30%	
Plaice in Division 7.e		
Proportion of Division 7.e stock landings caught in Division 7.e (2003–2021)	0.91	
Catch of plaice in Division 7.e corresponding to the advice for the stock	1104 tonnes	
Projected landings of plaice in Division 7.e corresponding to the advice for the stock**	809 tonnes	

*** The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table.**

**** [Advised catch for 2023] × [1 – discard rate].**

^ Advice value for 2023 relative to the advice value for 2022 (1742 tonnes).

25.17 Figures

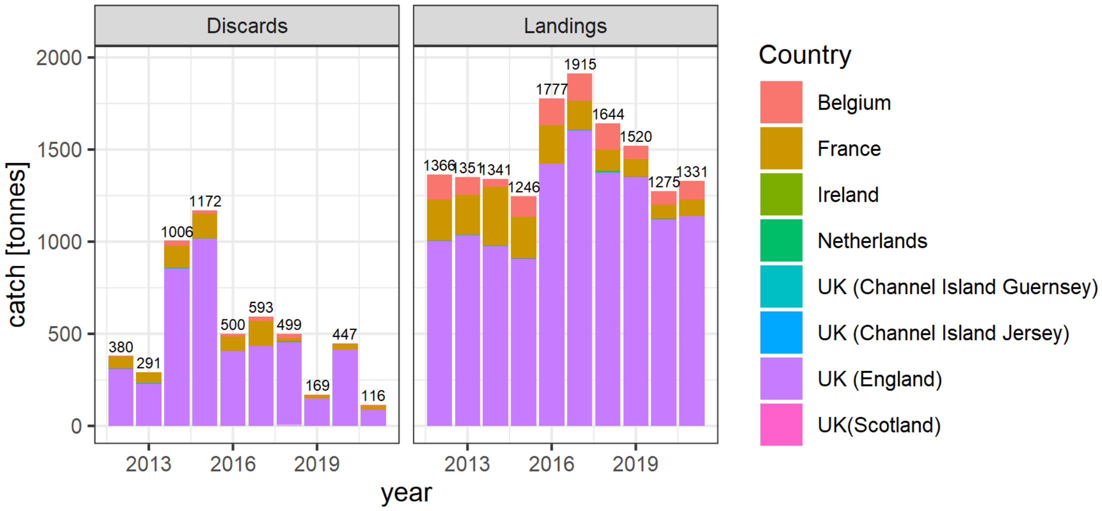

Figure 25.1. Plaice in 7.e. International landings and discards by country as extracted from InterCatch.

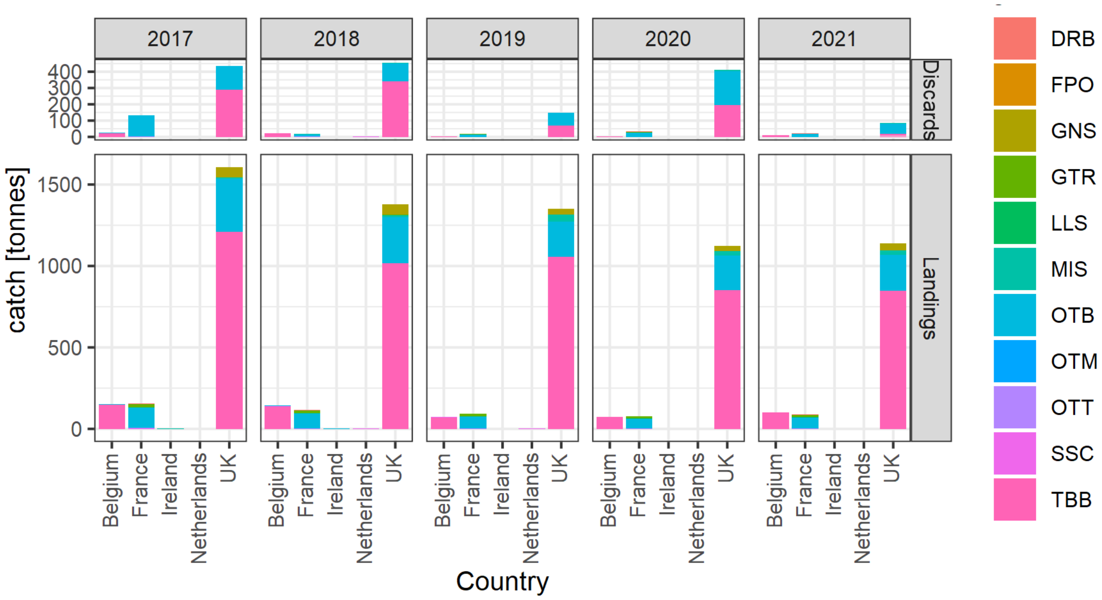

Figure 25.2. Plaice in 7.e. International landings and discards reported to InterCatch per country and fleet.

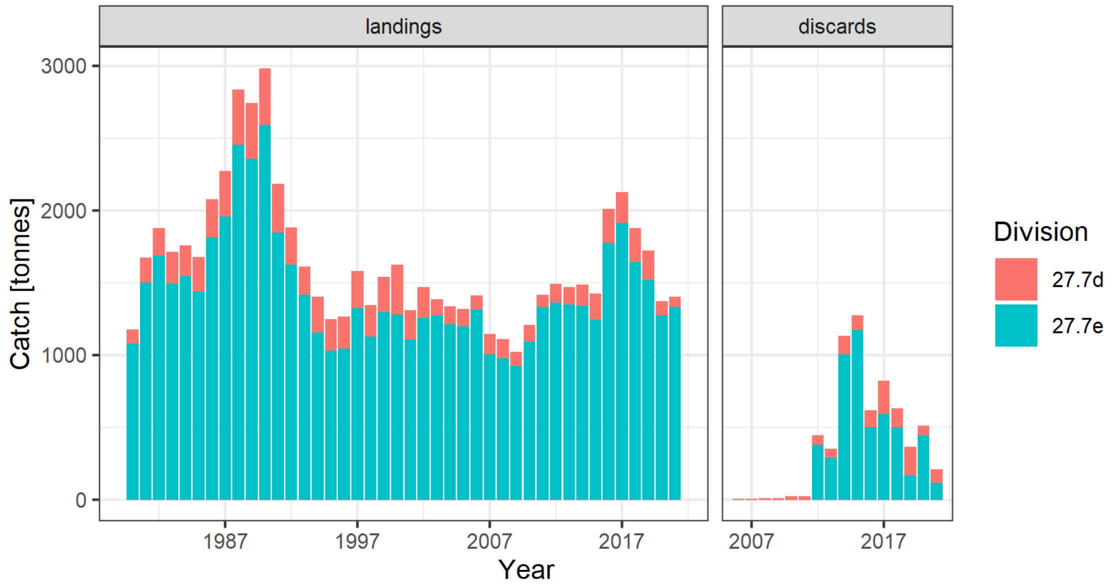

Figure 25.3. Plaice in 7.e. Landings and discards of the plaice 7.e stock disaggregated by the 7.e and the migration component from 7.d. Discard data are only available starting from 2012 for the Division 7.e.

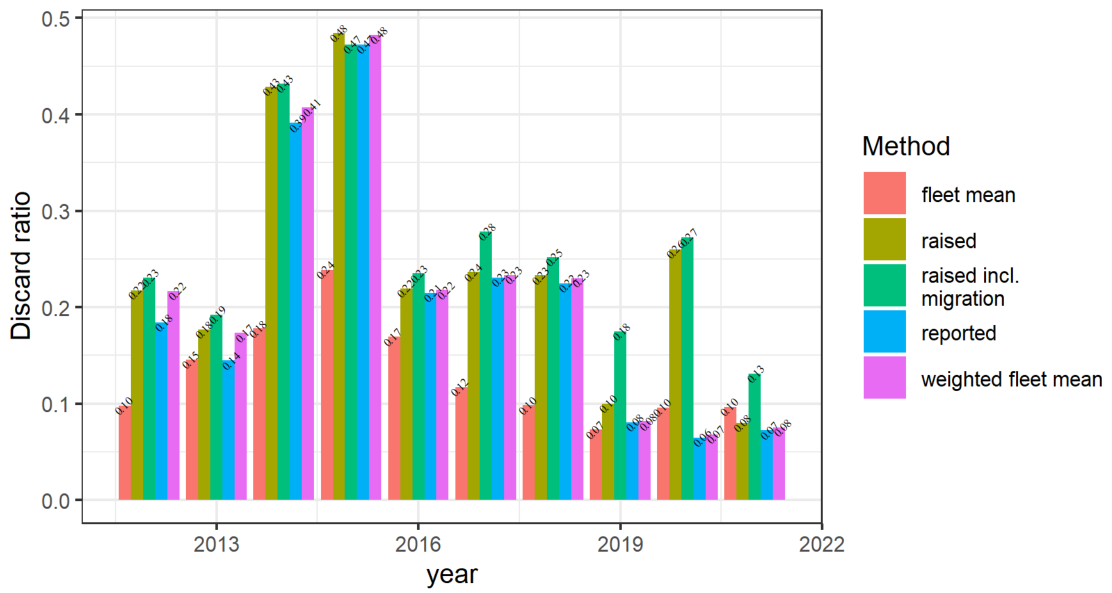

Figure 25.4. Plaice in 7.e. Discard rates. "Fleet mean" is the mean of the ratios for all fleets which reported discards, "reported" is the proportion of reported discards in the reported catches, "weighted fleet mean" is the mean of the ratios for all fleets which reported discards weighted by the catch 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.

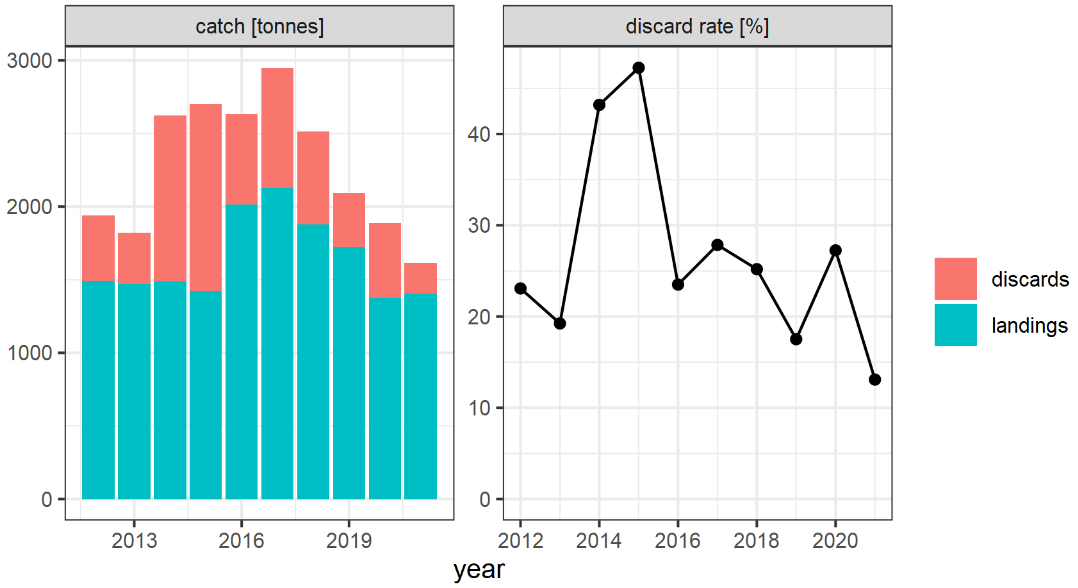

Figure 25.5. Plaice in 7.e. Landings, Discards and discard rate.

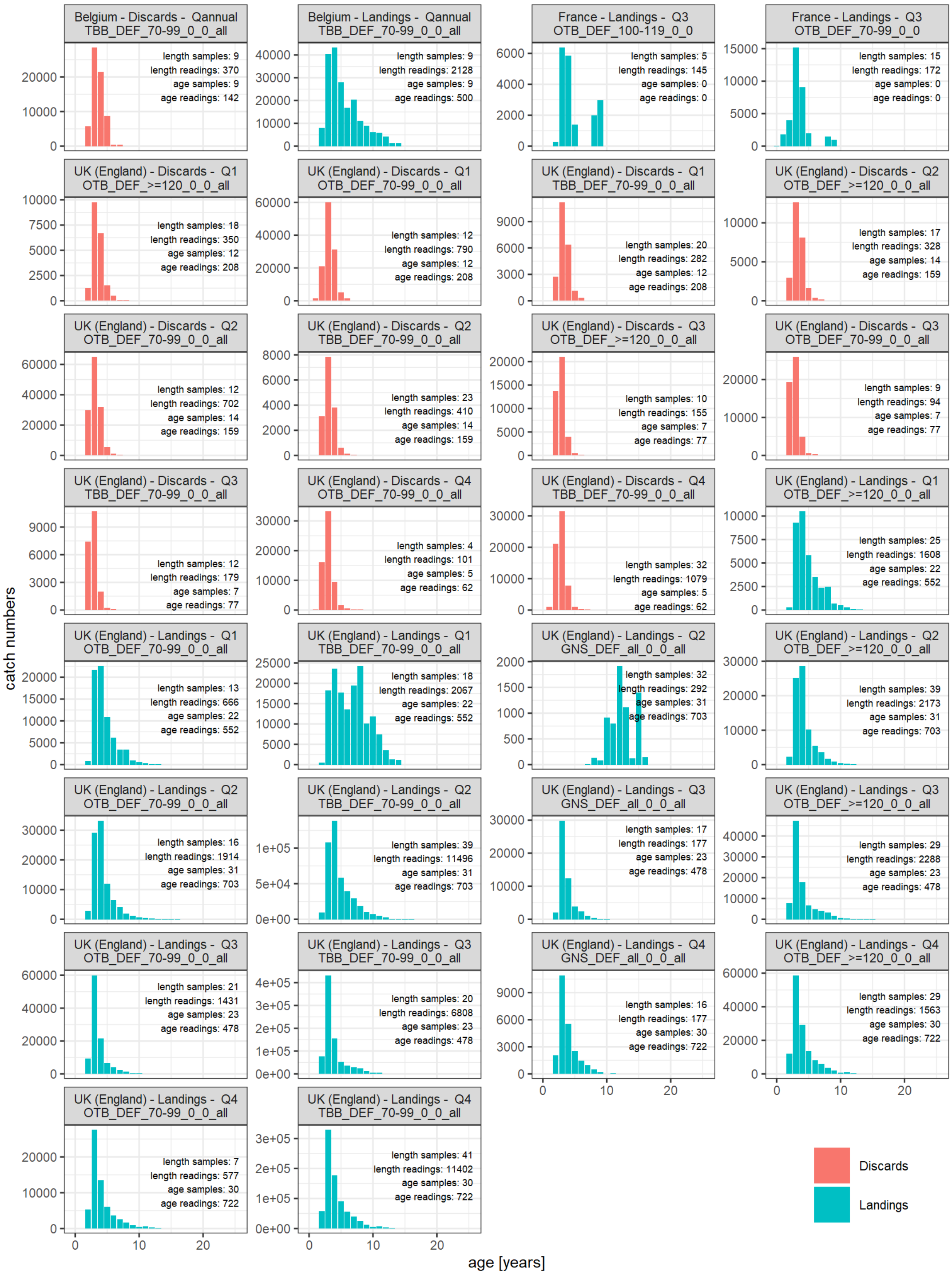

Figure 25.6. Plaice in 7.e. Age samples from InterCatch. The numbers are raised to fleet level.

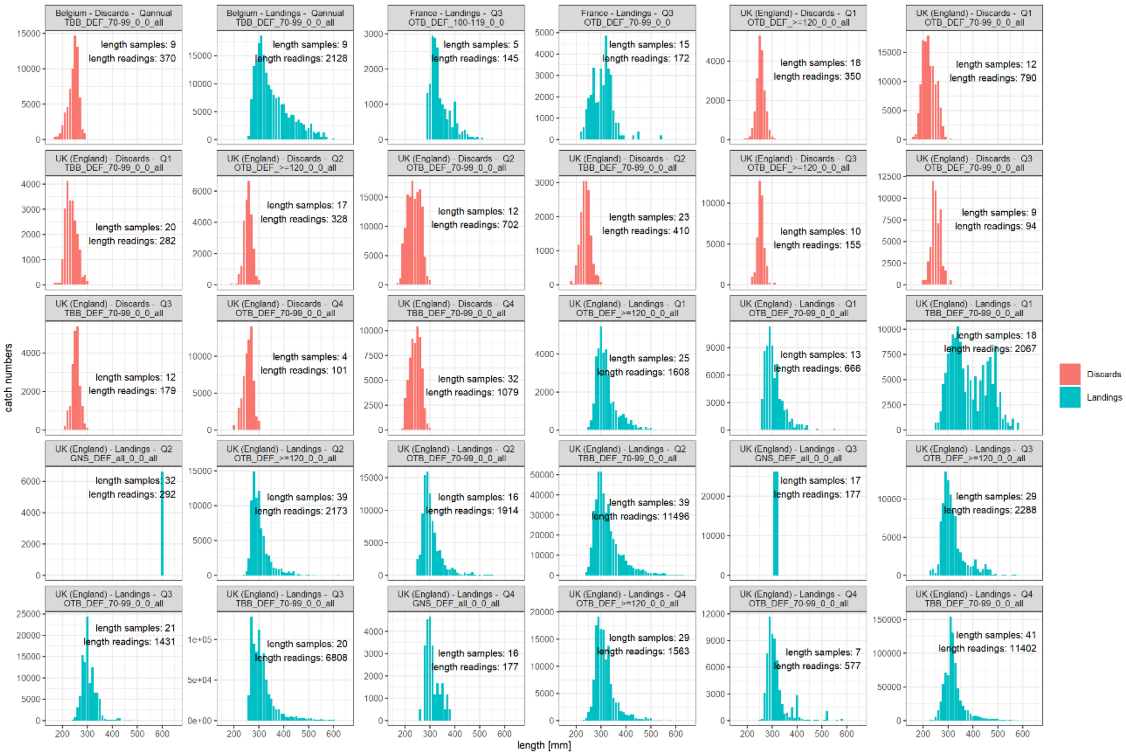

Figure 25.7. Plaice in 7.e. Length samples from InterCatch. The numbers are raised to fleet level.

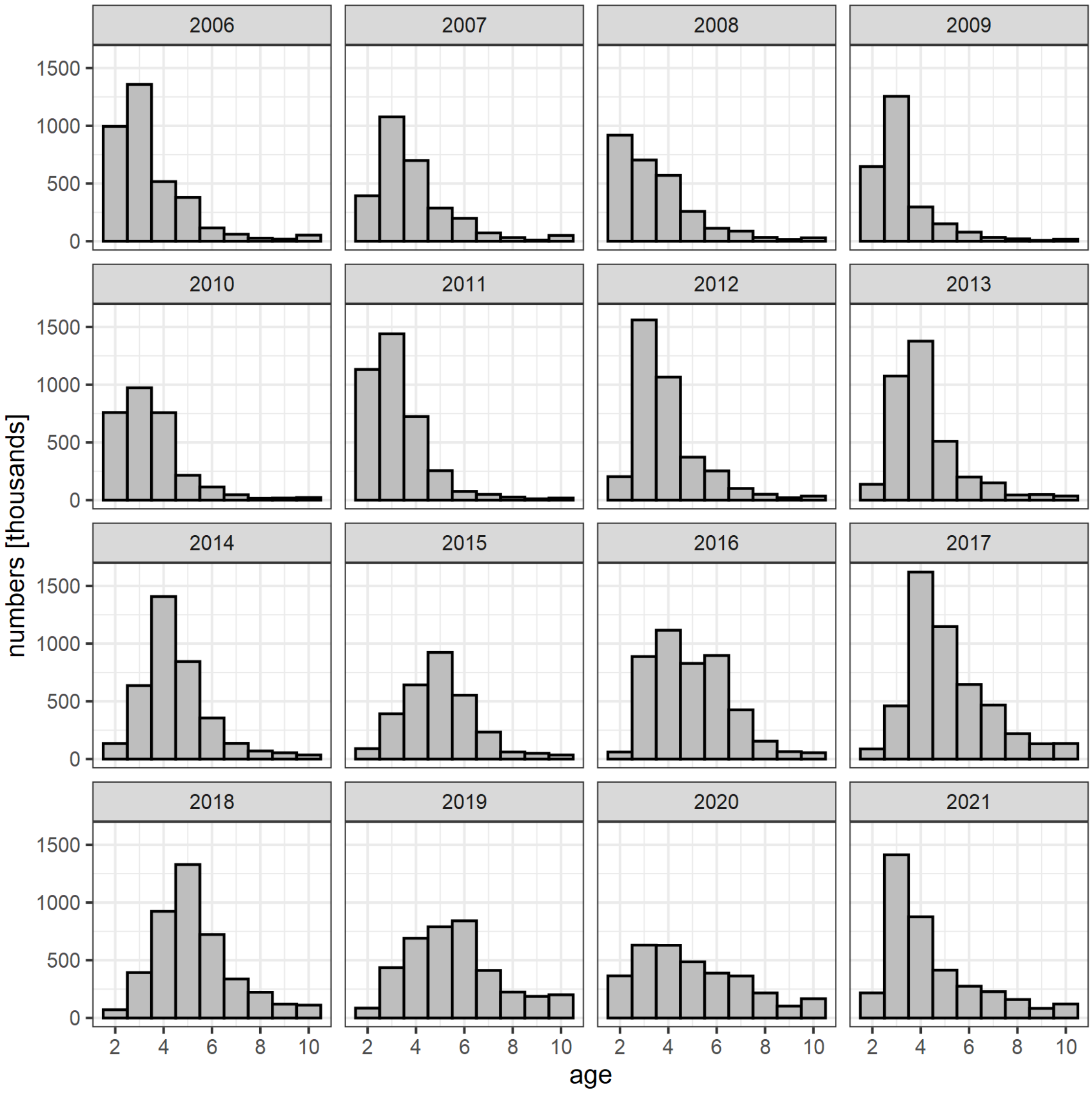

Figure 25.8. Plaice in 7.e. Landings age distribution.

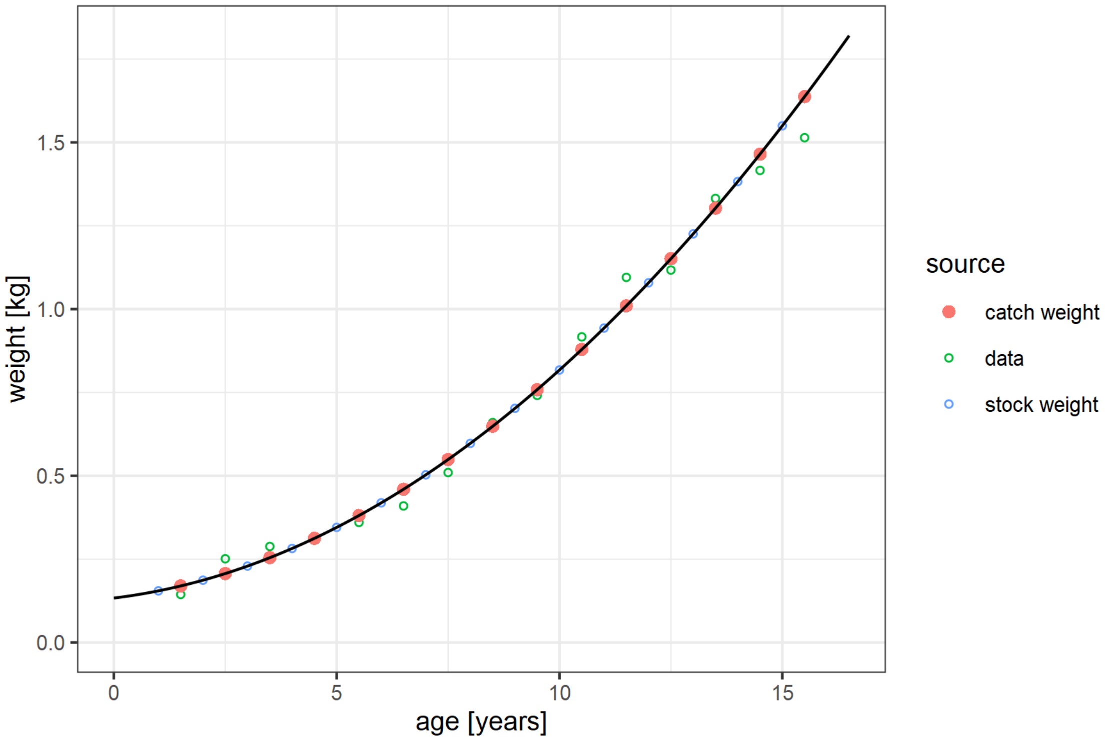

Figure 25.9. Plaice in 7.e. Derivation of the stock and catch (landings) weights by applying a polynomial model to the raw InterCatch weights-at-age.

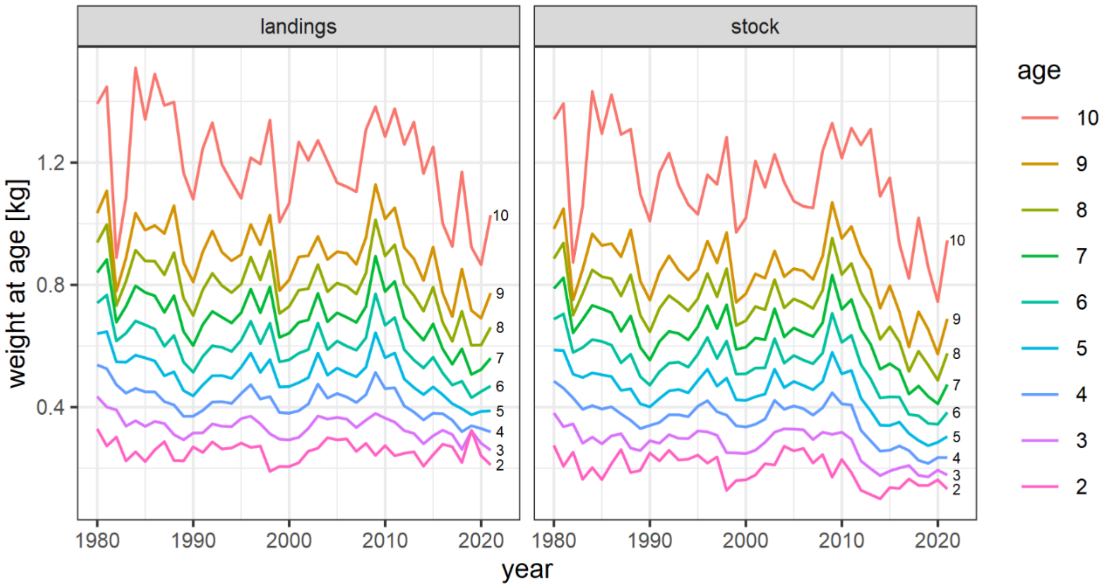

Figure 25.10. Plaice in 7.e. Landings and stock weights-at-age used in the assessment.

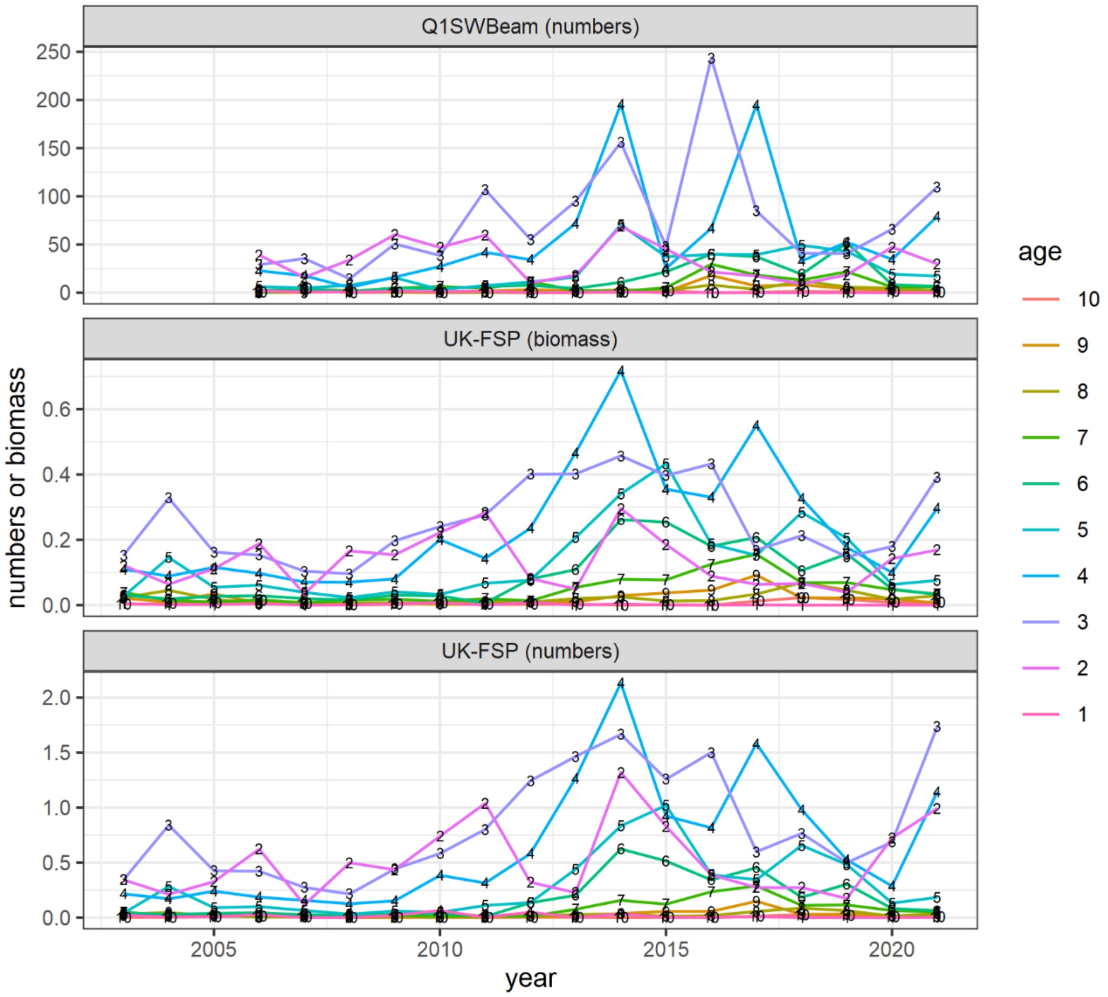

Figure 25.11. Plaice in 7.e. Scientific tuning information from the two surveys. For the UK-FSP survey, numbers and biomass are shown.

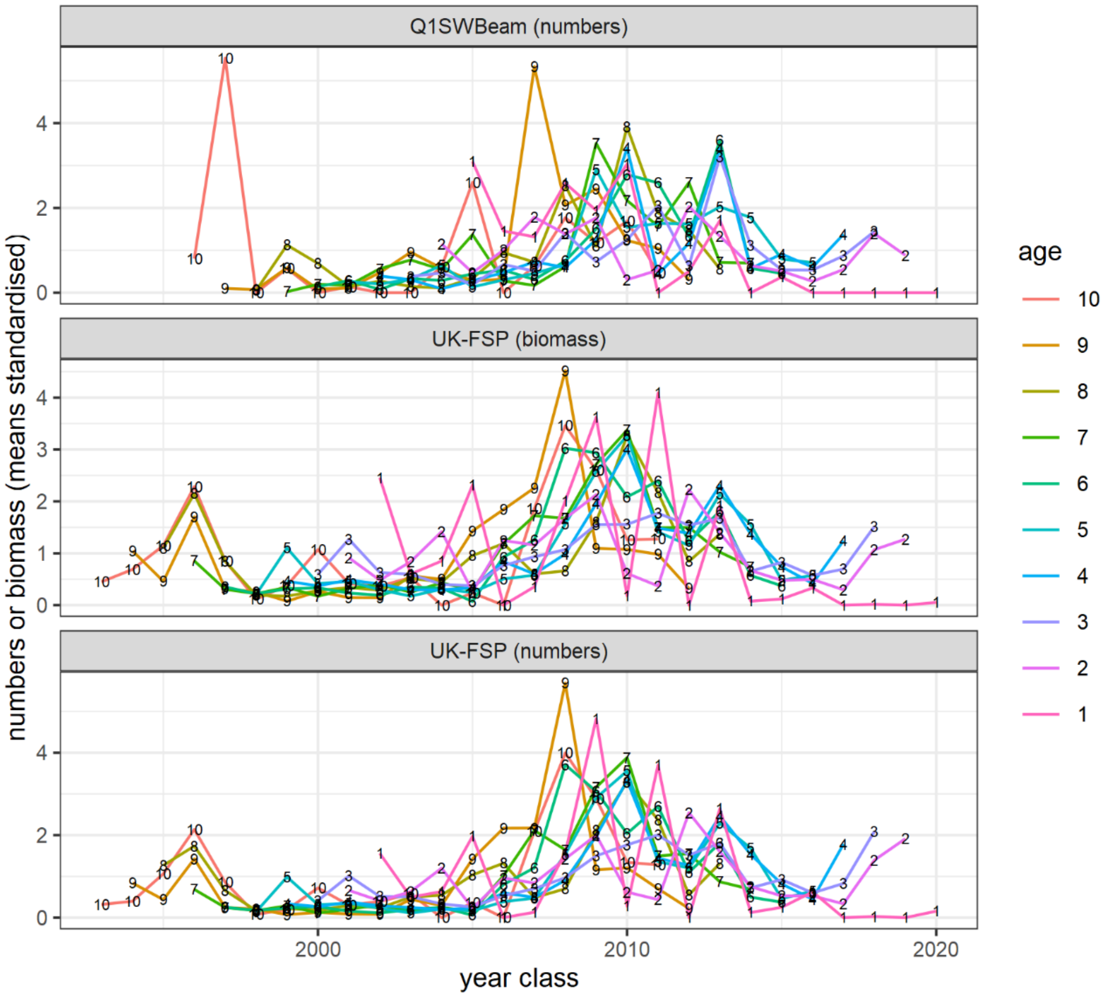

Figure 25.12. Plaice in 7.e. Scientific tuning information from the two surveys, standardised to the mean of the time-series and cohort-wise. For the UK-FSP survey, numbers and biomass are shown.

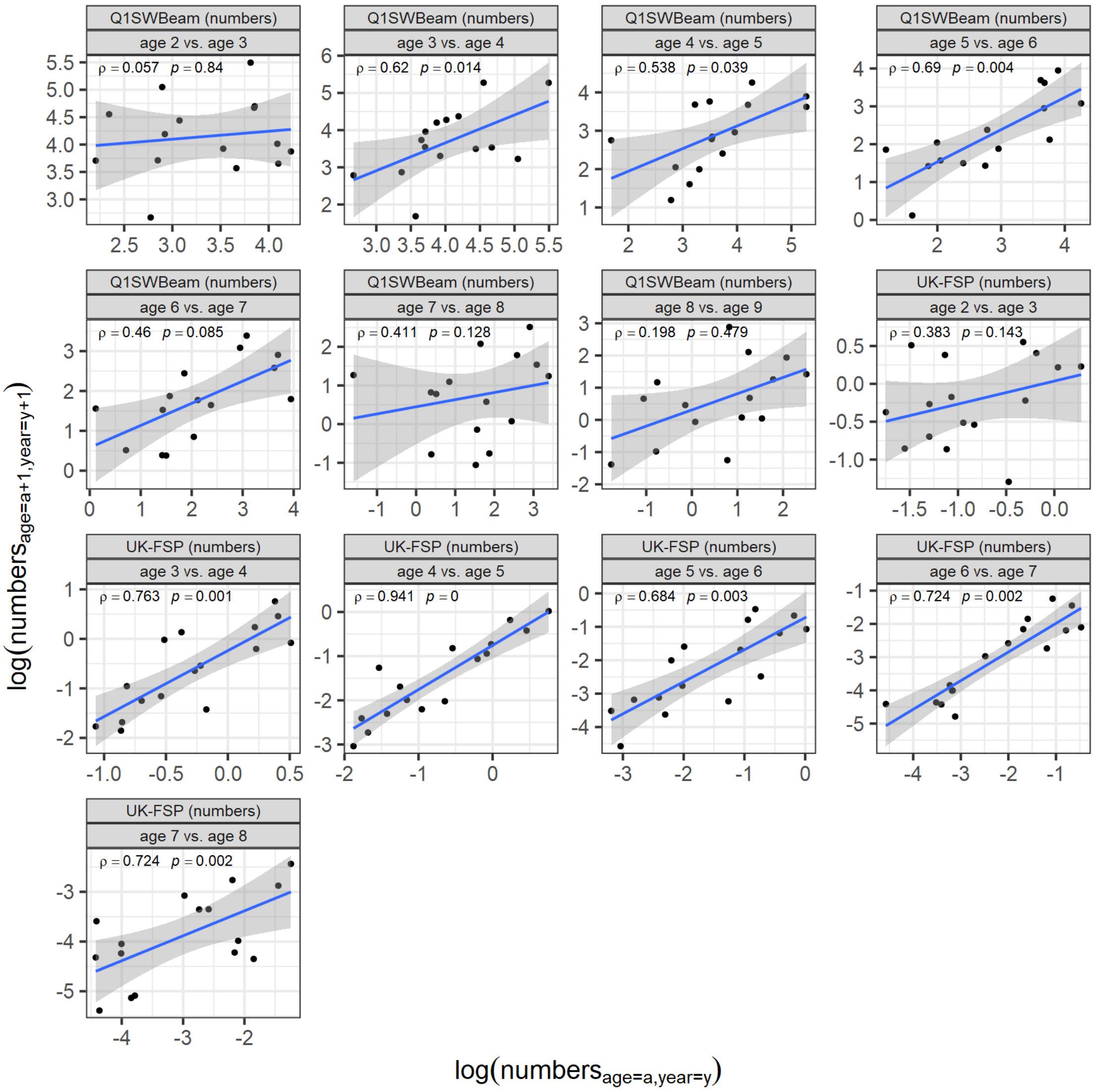

Figure 25.13. Plaice in 7.e. Internal consistency of the two survey time-series including correlation analysis.

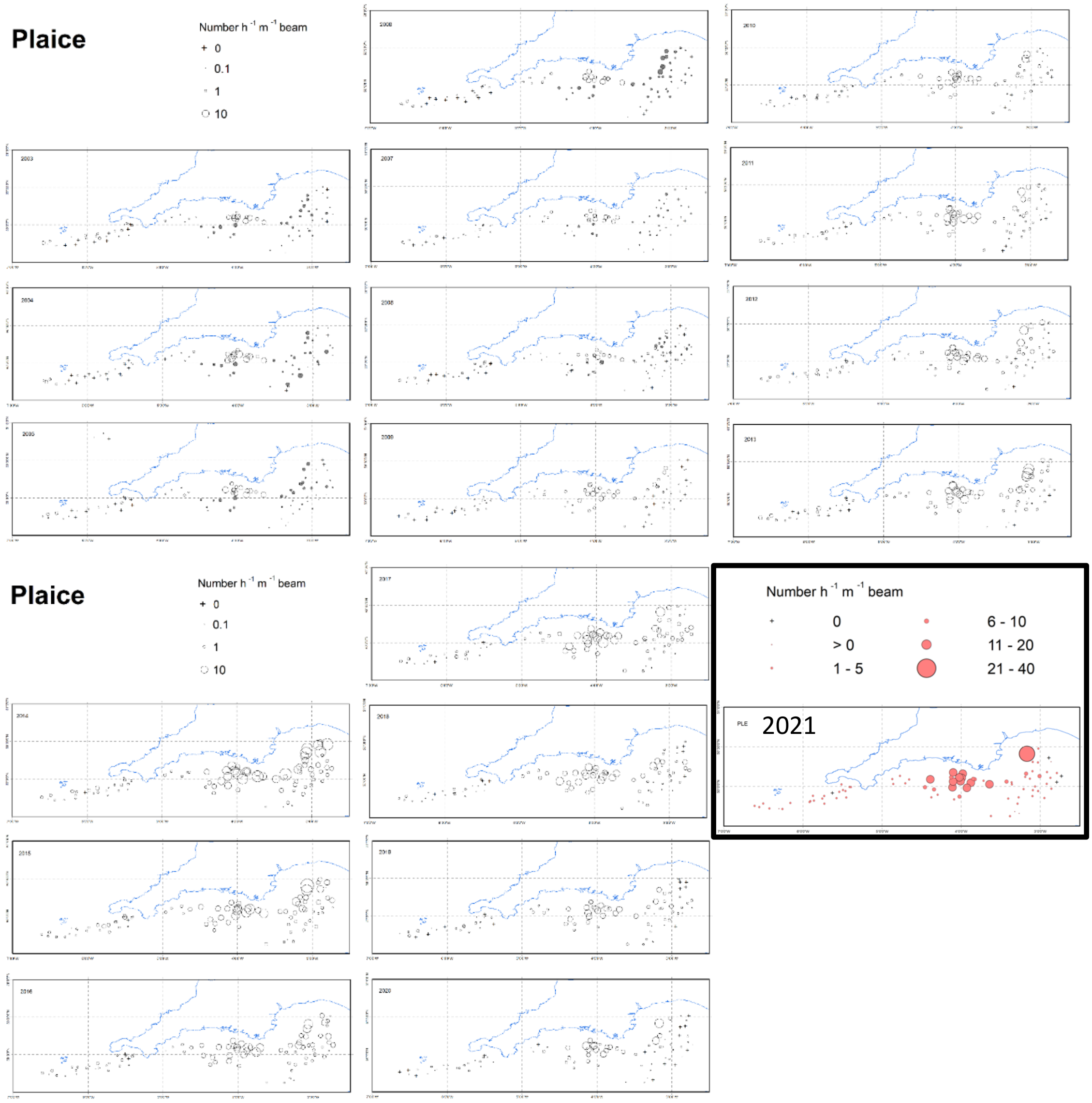

Figure 25.14. Plaice in Division 7.e. Plaice catch rates during FSP "Western Channel Sole and Plaice" surveys, 2003–2020 (number h^{-1} m beam^{-1}). Open circles: FV Nellie and FV Carhelmar tows; filled black circles: FV Lady T Emiel tows. Please note that 2021 numbers are not to scale. Source: Burt *et al*. (2021, 2022).

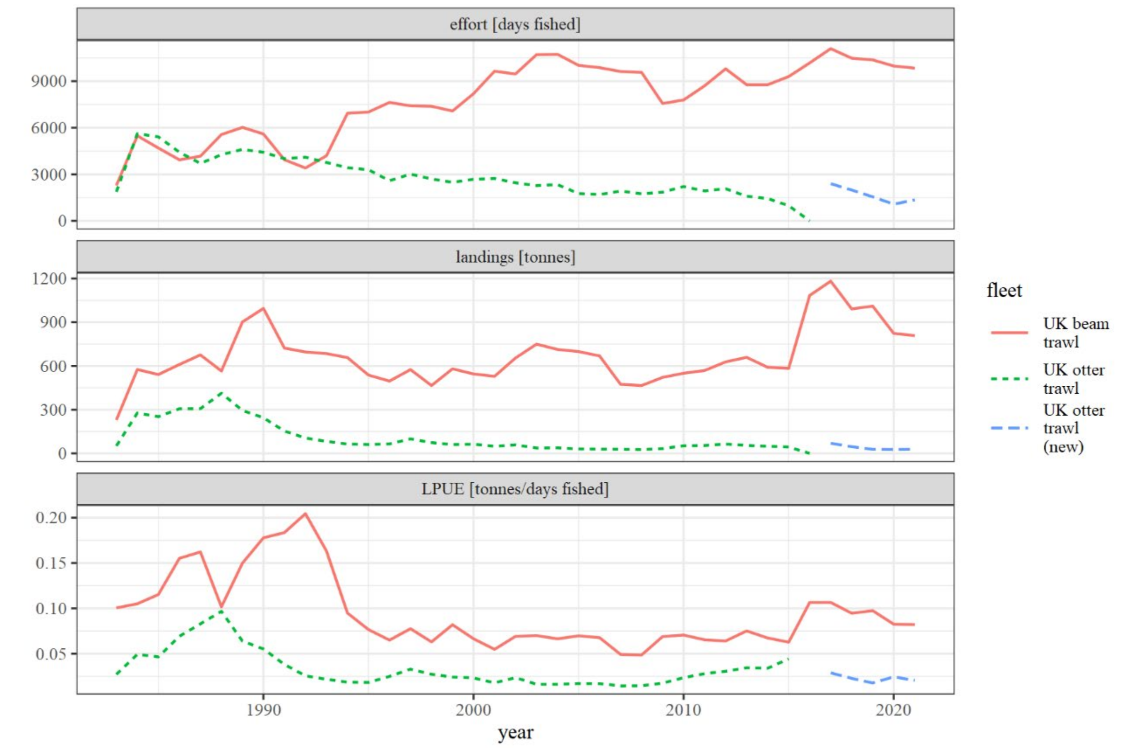

Figure 25.15. UK commercial LPUE time-series. LPUE values are only shown for historical reasons but were not used in the assessment.

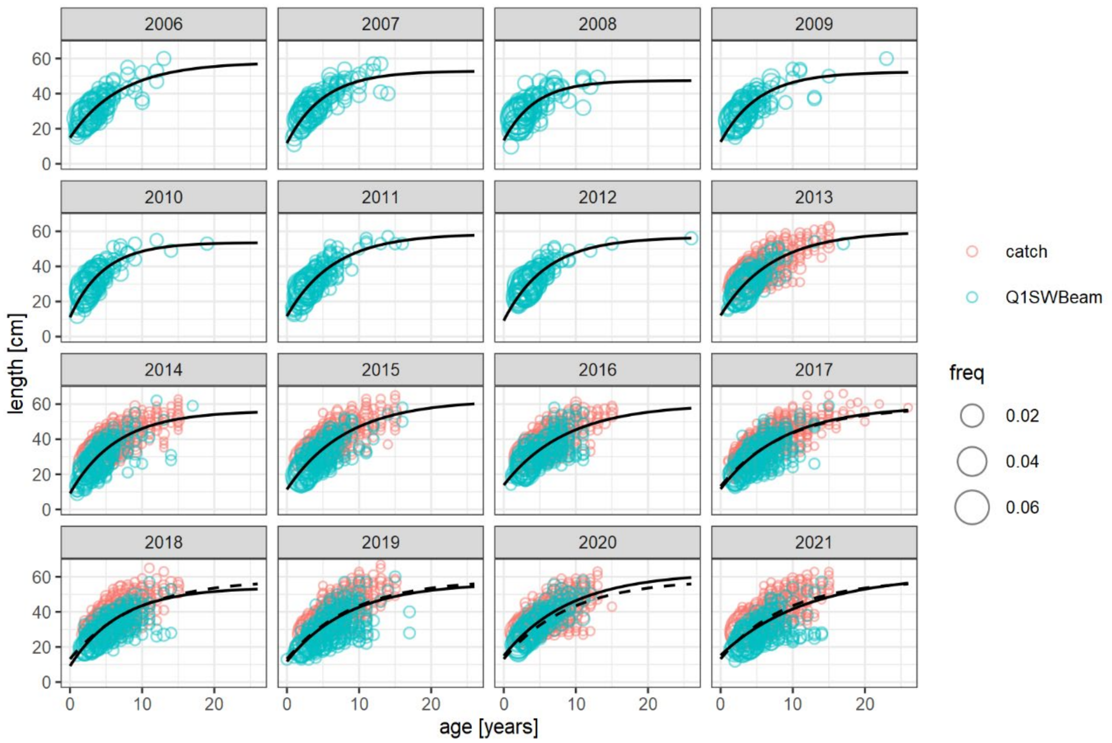

Figure 25.16. Plaice in 7.e. Age–length keys. The red circles represent data from sampling of the UK commercial catches and blue/green circles represent the fish aged from the Q1SWBeam survey. Solid black curves indicate annual fits of a von Bertalanffy growth function, dashed lines a fit to the combined data from the last five years (2017–2021).

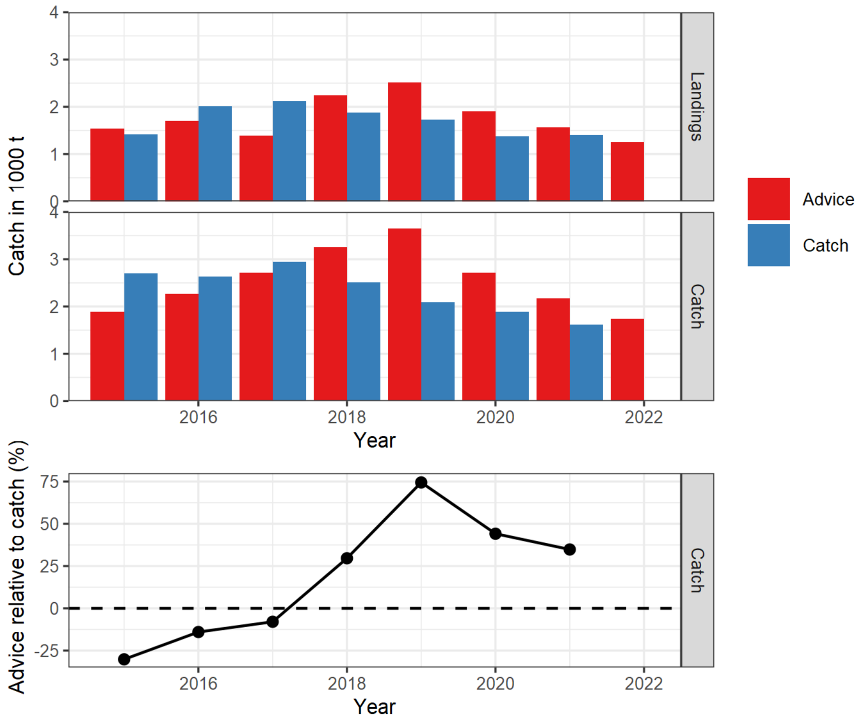

Figure 25.17. Plaice in 7.e. Comparison of historical catch and ICES advice.

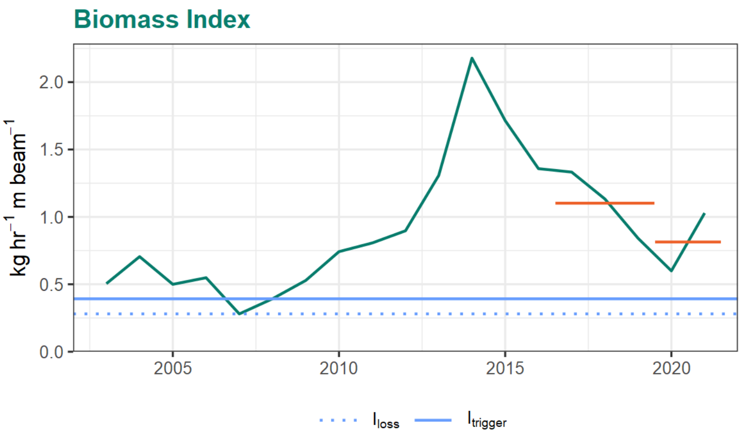

Figure 25.18. Plaice in 7.e. The biomass index used in the rfb rule. The biomass index is based on the UK-FSP surey and includes ages 2–8.

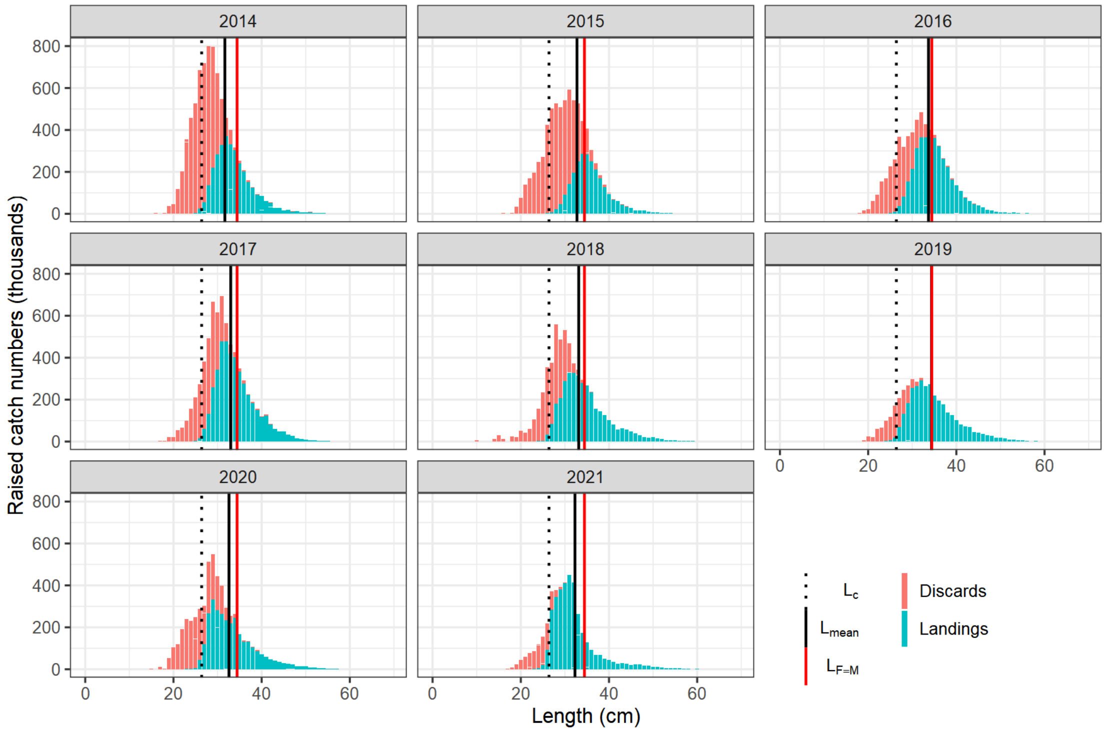

Figure 25.19. Plaice in 7.e. Total international length frequencies for 2014–2021 as raised within InterCatch for landings and discards including Length of first capture (Lc, calculated as first length class where the abundance is bigger or equal to half of maximum abundance) and mean length in the catch (Lmean, mean length above Lc).

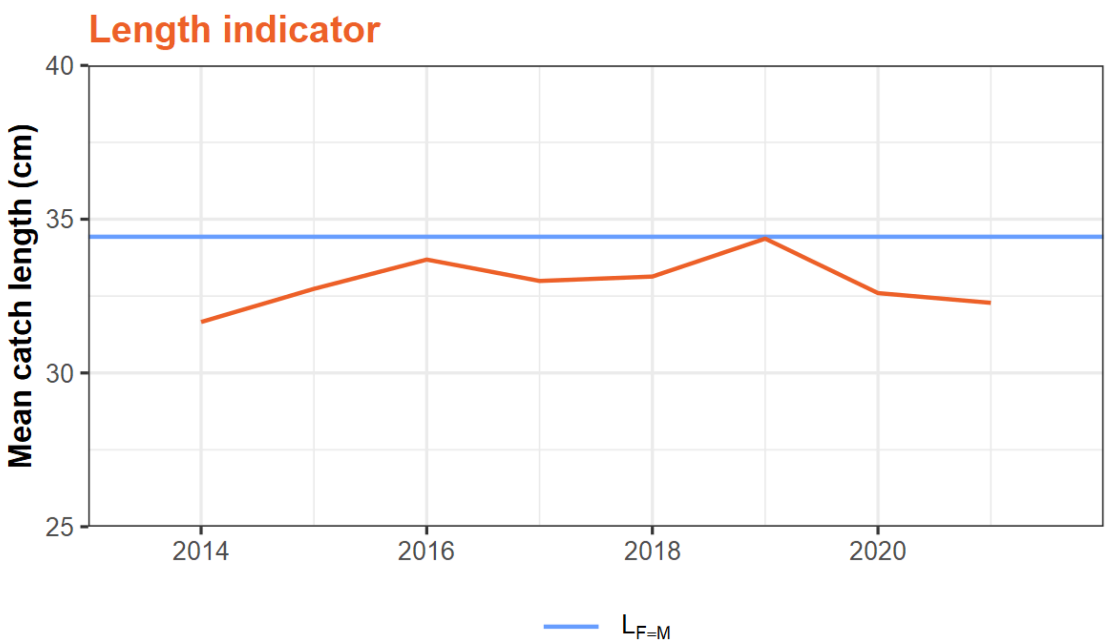

Figure 25.20. Plaice in 7.e. Mean catch length in comparison to the MSY proxy reference length $L_{F=M}$.

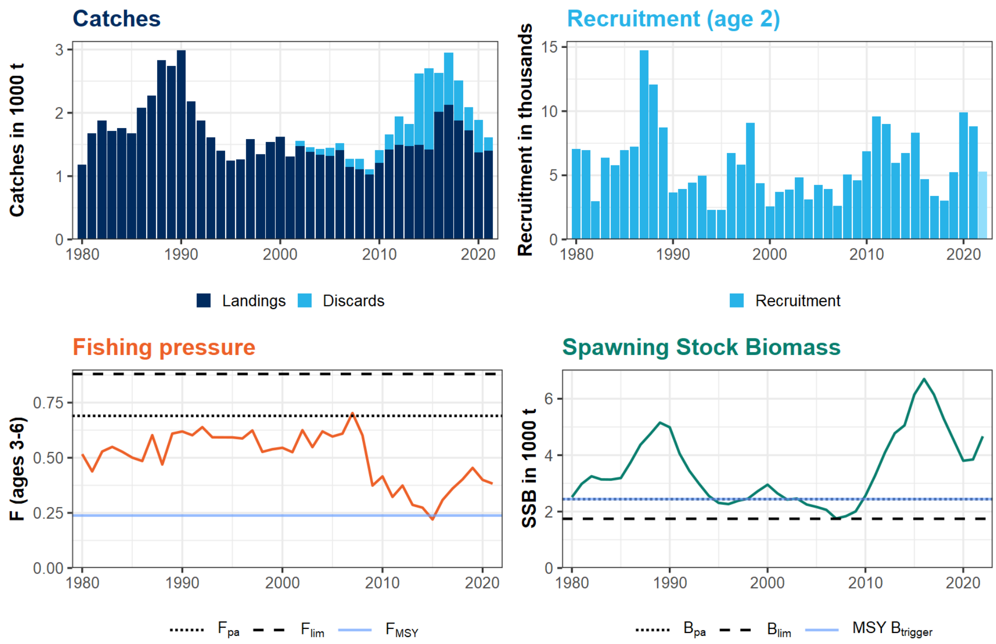

Figure 25.21. Plaice in 7.e. Summary of the legacy XSA landings-only assessment. Reference points in this assessment are from ICES WKMSYREF4 (ICES, 2016). Please note that this assessment is not used for advice purposes.

Figure 25.22. Plaice in 7.e. Residuals of the legacy XSA landings-only assessment. Please note that this assessment is not used for advice purposes.

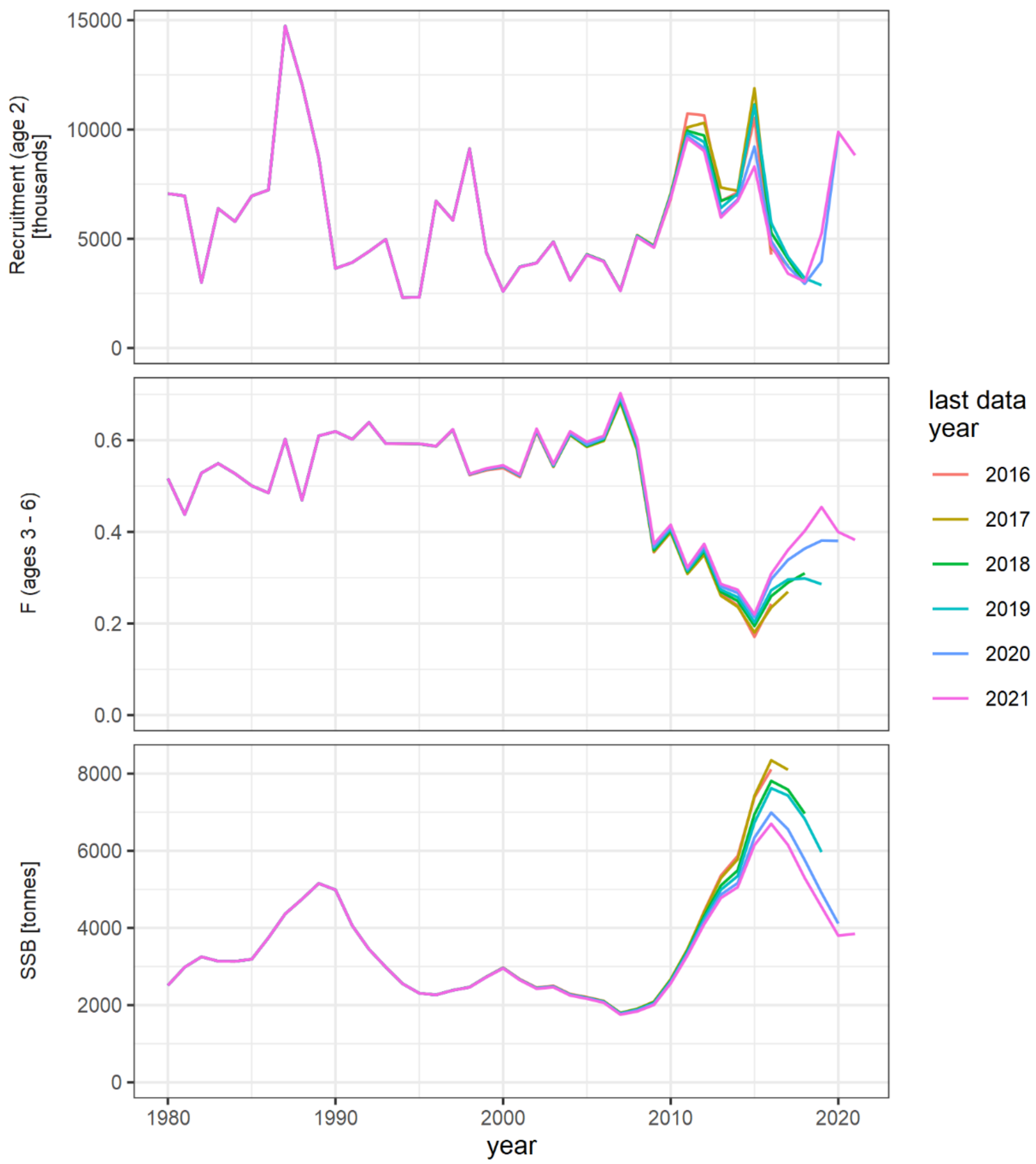

Figure 25.23. Plaice in 7.e. Retrospective analysis of the legacy XSA landings-only assessment. Please note that this assessment is not used for advice purposes.

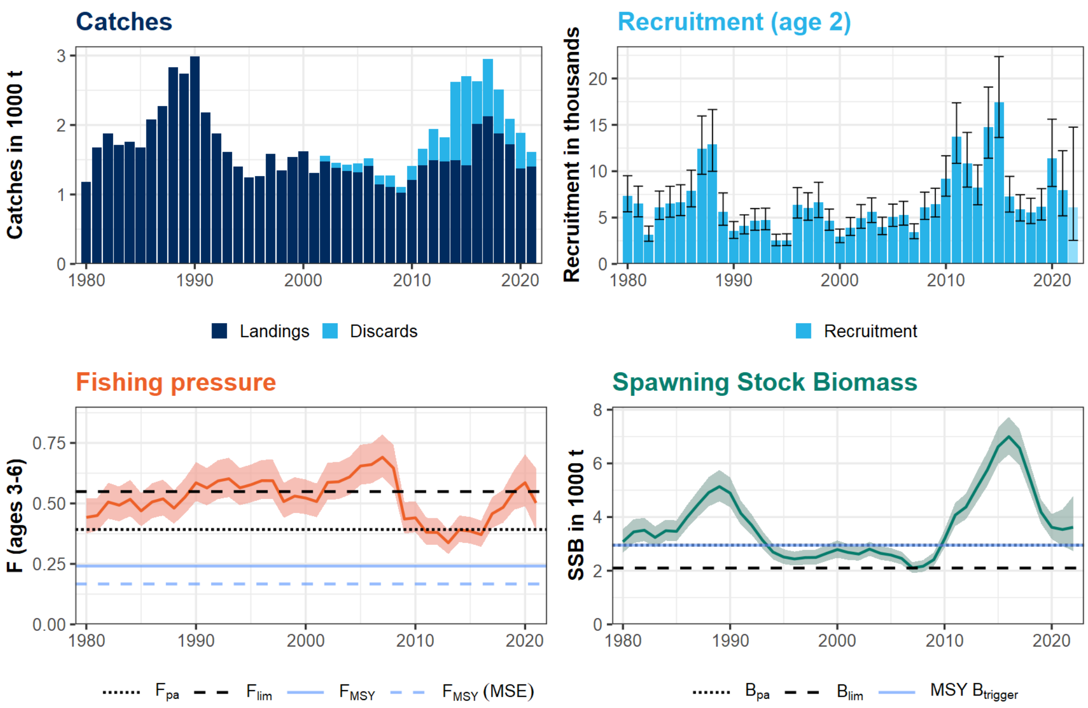

Figure 25.24. Plaice in 7.e. Summary of an exploratory SAM assessment. Please note that this assessment is not used for advice purposes.

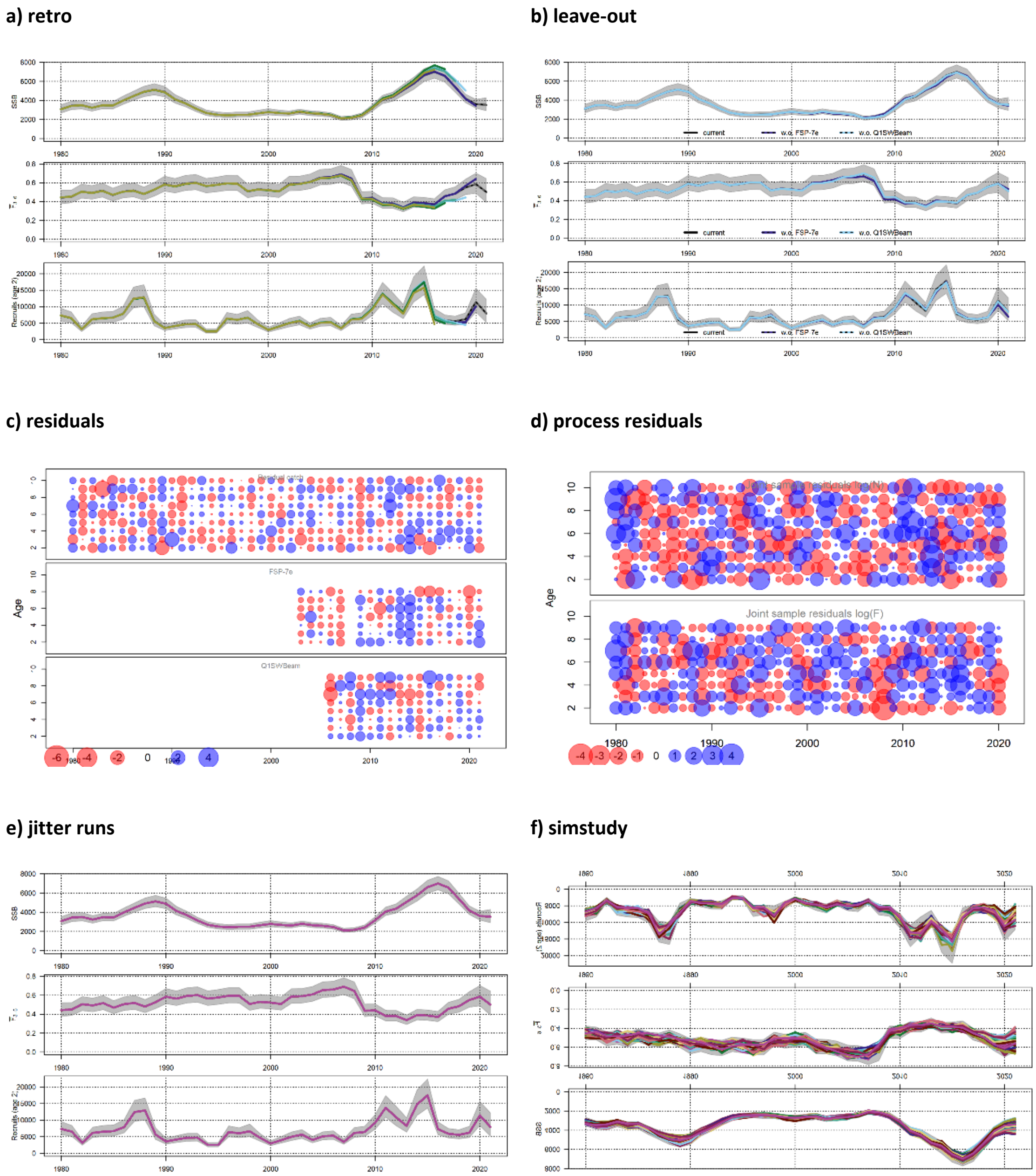

Figure 25.25. Plaice in 7.e. Model diagnostics of the exploratory SAM assessment. Please note that this assessment is not used for advice purposes.

26 Plaice in Divisions 7.f–g (Celtic Sea)

26.1 Type of assessment in 2022

In February 2022 the stock was benchmarked, and the State–Space Assessment Model (SAM) was suggested for the stock to be assessed as the Category 1. However, WGCSE rejected this approach due uncertainties with natural mortality and doubts in model configuration. A SPiCT model although it converged, there was a very large uncertainty and unsatisfactory diagnostics. WGCSE concluded that the stock to be assessed as the category 3 with the application of ICES technical guidance for harvest control rules the rfb was applied. The advice is based on the recent advised catches, multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard, and a precautionary multiplier. Mean catch length (L_{MEAN}) in recent years was below of the MSY proxy length ($L_{F=M}$) reference point, and biomass index was below the index trigger value. Because of this the -30% uncertainty cap was not applied.

ICES advice applicable to 2021

Based on the ICES approach for data-limited stocks, ICES advises that catches in 2021 should be no more than 1911 tonnes.

General stock description and management units

A TAC is allocated to ICES areas 7.f–g which corresponds to the stock area.

Management applicable to 2021

TACs and quotas set for 2021 (source COUNCIL REGULATION (EU) No 1239/2021)

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium	360
France	648
Ireland	240
United Kingdom	480
Total EU	1249
Total TAC	1911

TACs and quotas set for 2022 (source COUNCIL REGULATION (EU) No 109/2022)

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium	379
France	686
Ireland	105
Total EU	1170
United Kingdom	441
Total TAC	1735

Fishery in 2021

As usual the main fishery was concentrated on the Trevose Head ground off the north Cornish coast and around Land's End with most of the catch being taken in the eastern part of the area (Figure 26.1). Plaice was harvested throughout the year, with the highest amount of fish landed in Q3 and the lowest in Q1. The fleets harvesting plaice in the Celtic Sea primarily involved vessels from Belgium, France, Ireland and the UK with negligible amounts taken by Netherlands and Spain. In 2021 Belgium reported 56.2%% of the landings, France 10.9%, Ireland 22.4% and the UK 10.3%. The contribution of individual countries to total landings was similar to 2013–2020. The Working Group estimated that total international landings for 2021 were 468 t with the reconstructed total catch (including discards) being estimated as 846 t. It is 56.7% lower than the TAC of 1911 t, which also included discards (Table 26.1). Discards represented some 44.6% of the catch.

Most of the catch (80.1%) were taken by beam trawlers, and 17.9%; by bottom otter trawlers. Other gears accounted for 2.0%. Effort and lpue of fishing fleets are presented in Tables 26.2–26.4.

26.2 Data

Landings

International catch data are collated on the ICES InterCatch platform (https://intercatch.ices.dk). All landings are reported and recreational catch is supposed to be negligible.

Discards

Discarding with this fishery is considered high (Table 26.1). During the 2022 working group, discard information was made available as annual summaries for Belgium and Ireland, and on quarterly basis for France and UK. If sampling information was not available, discard estimates were calculated based on the discard rates of similar fleets in terms of gear and time (quarter /annual). WG estimates of discards, show a steady increase from 2004 (when estimates started) to a peak in 2013, after which discard levels have remained variable but high, with discard estimates regularly exceeding landings, where they were lower than landings. Data from national discard sampling programmes are summarised in Figures 26.2–26.4.

Biological information

Age compositions for 2021 were supplied at an annual or quarterly disaggregation for Belgium, Ireland, and UK(E+W), providing a sampling coverage of 81.6% for the total landings and 77.4% for the discards.

Figure 26.4 compares the landings and discard numbers-at-age (where data are available). A strong recruitment cohort that appeared first in 2012 as 2 y.o., in 2015 attained the age of 5 y.o. and began to predominate in landings, being still important in 2017 as 7 y.o fish. The next moderately strong generation (2 y.o. in 2015) in 2017 represented important part of both landings and discards being the most abundant age group in 2018 when 5 y.o. (Figure 26.4). Another reasonably abundant generation (3 y.o. in 2018) in 2019 was the most abundant group In recent years, the bulk of catches was represented by fish born in 2017–2018 (2–3 y.o in 2020 and 3-4 y.o. in 2021). Numbers- and weights-at-age for landings, discards and the stock used in the assessment are presented in Tables 26.5 and 26.7.

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 were obtained by WKFLAT (2011) and used to update the catch weights and stock weights files (Tables 26.6 and 26.9). Now weights-at-age of landings are coming from landings of Belgium, Ireland and United Kingdom age and integral values were estimated using ICES InterCatch web-based system.

Discard weight-at-age

Discard length and weight-at-age raw data were available for Belgium, Ireland and United Kingdom and integral values were estimated using ICES InterCatch web-based system (Tables 26.7 and 26.8).

Stock weight–at–age

Where discard estimates were available from 2004 onwards, a revised set of stock weights-at-age were calculated. The stock weights were derived from the total international landings weights-at-age and the discard weights-at-age averaged by numbers-at-age from the respective datasets. Prior to 2004, a revised set of stock weights-at-age based on international landings data was produced. These new values were based on collected weight data with a SOP correction (Table 26.9).

Natural mortality and maturity

Estimates of natural mortality and maturity were not used in this assessment.

Surveys

Indices of abundance from the UK(E&W)-BTS-Q3 beam trawl survey in 7.f and the Irish IBTS survey (IGFS-WIBTS-Q4) in 7.g are presented in Table 26.10. Both surveys show consistent trends of the stock increases and decreases (Figure 26.5). The UK(E&W)-BTS-Q3 started in 1988 and was always used for tuning the AP model. The Irish Celtic Explorer IBTS survey (IGFS-WIBTS-Q4) time-series started in 2003 and was not used in earlier years. Both survey time-series were used for the stock trends-based advice in the years 2015, 2016 and 2017 and for SPiCT in 2018–2020.

In 2022, before applying rfb rule the UK(E&W)-BTS-Q3 survey and IGFS-WIBTS-Q4 survey total biomass indices were standardised and compared. The UK BTS was chosen for the assessment as carried out by a proper gear efficiently catching flatfish occurs and across the area of maximum abundance (Figure26.5).

Commercial landings per unit of effort

Commercial indices of abundance from the different fisheries provide contradictory trends (Figures 26.6 and 26.7), due to varying discarding practices in the fleets, and the discarding of fish above minimum conservation reference size. Therefore, these LPUEs, regardless their precision and objectiveness, could not be considered as proxies for adult fish abundance. However, in 2018 and particularly in 2019–2021 the situation began to return to normal when most of fish of commercial size was retained (Figure 26.8).

Belgium beam-trawling fleet takes the largest portion of catch. Therefore, it potentially might be the most reliable source of LPUE data to be used in an age-structured model. However, the Belgian landings and effort data are influenced by policy decisions, particularly often changing limits of how much plaice might be taken per fishing days depending on season, year and boat size. The resulting LPUE therefore should only be used for indicative purposes and be considered qualitatively (Nimmegeers *et al*., 2021).

Other relevant data

There were no early closures of the fishery for plaice in 2021. Misreporting is not considered to be a problem in this stock. Recent research on discard survival in the English Channel has indicated that discard mortality of adult plaice captured by beam trawl varied with season, fish size and other factors like vessel type (Revill *et al*., 2013; Depestele *et al*., 2014; Uhlmann *et al*., 2016 a,b). Therefore, significant amounts (4 to 93%, mostly <50% in Belgian beam trawlers and mean 48% in French beam trawlers) might survive discarding which has been confirmed by several (3–15) days of observations in captivity (Depestele *et al*., 2014; Uhlmann *et al*., 2016 a). The survival estimate for the UK otter trawl fishery in the Western Channel was 47–63% and for the trammel net fishery 71–72%. The discard survival was also estimated as 19–20% for the North Sea UK otter trawl fishery and 4–15% in the Western Channel UK beam trawl fishery (Catchpole *et al*., 2015). Smaller undersized plaice that represent the bulk of discards are likely to have relatively higher mortality as with other flatfish species (review: Hendrikson, Nies, 2007). Generally, discard survival is expected to be ~40% (Catchpole *et al*., 2015). There is no formal mixed-fishery analysis for this area, but plaice in 7.fg is considered to be primarily a bycatch of the targeted sole fishery, so changes in effort in the directed sole fishery as well as multiannual management measures (EU 2019) will impact fishing mortality on plaice.

26.3 Stock assessment

Assessment model

WKFLAT (2011) agreed that the model that will be used as a temporary basis for the assessment and provision of advice for the Celtic Sea plaice is AP model (Aarts and Poos, 2009). This was selected on the basis that it was the only model available to WKFLAT which reconstructs the historic discarding rates (derived from the survey dataseries).

WKFLAT (2011) concluded that:

1) Due to the change in estimated fishing mortality when discards are included within the model fit, discards should be retained within the assessment model structure.
2) Given that the time-series of discard data, to which the models are fitted, is short and that, consequently, there are likely to be changes in the management estimates as discard data are added in subsequent years, no definitive model structure can be recommended at this stage in the development process.
3) The most flexible of the models TVS_PTVS should be used as the basis for advice; in terms of relative changes in estimated total fishing mortality and biomass.
4) The other two models which provide similar structures should continue to be fitted at the WG to provide sensitivity comparisons.
5) As the dataseries are extended, a final model selection can be then determined.

In 2013, no assessment was presented for this stock given that the "preferred" Aarts and Poos (2009) model failed to converge and other model variants could not provide realistic representations of observed landings and discards. Consequently, WGCSE 2013 decided to avoid the use of the "preferred" TV_PTVS AP model variant and instead focus on assessing the stock using trends derived from the fishery-independent UK(E&W) beam trawl survey. Trends derived from the UK(E&W) beam trawl survey were selected for the basis of advice given that this survey most appropriately covered the spatial extent of the stock and well represented the mean age (2–5) landed in the fishery. The UK(E&W) beam trawl survey was used to infer trends in recruitment, stock size (spawning–stock biomass) and fishing mortality.

In 2014 corrected TV_PTVS Aarts and Poos (2009) model converged and produced realistic results and confirmed conclusions derived in 2013 from the fishery-independent UK(E&W) beam trawl survey. In 2015–2017 all three model variants converged, but only of the "preferred" TV_PTVS AP variant provided estimations consistent with the previous run, observed catches and landings. However, trends of both UK(E&W)-BTS-Q3 beam trawl and IGFS-WIBTS-Q4 surveys on one hand (Table 26.10) and data on LPUEs of commercial fleets (Tables 26.2–26.4) produced conflicting signal that resulted in asymmetrical distribution of residuals. Because of this, the ICES stock advice was based on both surveys' CPUE trends.

Independently of WGCSE, the stock status was explored in 2015 by WKLIFE using a biomass dynamic model (SPiCT) (ICES, 2016 a). As discard data were not available prior 2004, the group approximated the total catch values from 1977 to 2003. An adjustment was made to the data by applying the 2004 discard ratio back in time (landings prior to 2004 were multiplied by K=1.54). These total catch data were combined with CPUE trends of both surveys expressed in two mean-standardized biomass index series of +3-year-old plaice, which were considered to reflect "exploitable biomass" for this stock.

Results of modelling were found to be sensitive to truncating the catch to ensure 100% overlap between the survey and catch time-series. In this case, truncation lead to a ~60% increase in B_{MSY} and ~30% decrease in F_{MSY}, whereas CVs were hugely increased (by ~200% and ~75% respectively). Therefore, the time-series was not truncated. Estimation of the observation error corresponding to the catch (β) and survey (α) was tried, but the model did not converge when trying to estimate both of these, so α was fixed at 1, while β was estimated. Under all these assumptions the results indicated current stock status (2015) to be well above the biomass reference point 0.5 B_{MSY}, and F (2015) to be well be F_{MSY} (ICES, 2016a).

In 2017, the ICES framework for category 3.2 stocks was applied (ICES, 2012; 2016 b–d). As the previous ICES advice used both catch/landings and biomass index series, the stock was investigated by applying SPiCT. The SPiCT results were chosen to support the basis for advice using comparison of the two latest biomass index (B/ B_{MSY}) values (index A) with the three preceding values (index B), multiplied by the recent advised catch. The same approach was used later in 2018–2021.

In February 2022, the stock was benchmarked, and the State–Space Assessment Model (SAM) was suggested for the stock to be assessed as the Category 1. The stock assessment from the benchmark is available from stockassessment.org:

Library(stockassessment)

fit_online <- fitfromweb(“plaice7fg_001”) (Figure 26.9)

The working group in May 2022 found two important issues with applied parameters.

The model configuration assumed that the F-at-age lognormal random walks are not correlated across ages which are not explained or justified in the (draft) benchmark report. In practice it led to the fishing mortality trajectories being very smooth throughout the history (Figure 26.9).

The correlation might be included with an AR1 process (the default for SAM): conf_F <- fit$conf

conf_F$corFlag <- 2

pars_F <- stockassessment::defpar(fit$data, conf_F)

fit_F <- sam.fit(data = fit$data, conf = conf_F, parameters = pars_F)

and compare to the benchmark model (Figure 26.10):

par(mar = c(2, 4.5, 0.5, 0.5))

plot(c(benchmark = fit, correlatedF = fit_F))

It would lead to substantial changes in SSB and F in recent years (Figure 26.10). Also, it causes a strong retrospective pattern (Figure 26.11) with high Mohn’s Rho.

mohn(retro_F)

##	R(age 1)	SSB	F_{bar}(3–6)
##	-0.1963765	0.5278464	-0.3554554

In the benchmark model, the recruitment in the assessment is modelled as a constant, which also was not justified. However, removing this assumption only slightly changes the model output.

On another hand there was a notable influence coming from the choice of natural mortality in the estimation of reference points. The WKNSCS Benchmark 2022 meeting reviewed a model incorporating natural mortality estimates taken from the plaice assessment in the Irish Sea, Division 27.7a (ple.27.7a). A second variant was subsequently established (Ple.7fg_disc on Stock-assessment.org), using natural mortality estimates used in the assessment of plaice in the English Channel (ple.27.7d), calculated using the Gislason equation, which were notably higher. These were used as data were not appropriate (lacking older ages) for the Celtic Sea (27.7fg) stock. In both model variants, natural mortality was specified for each of the modelled age classes (1 to 10 year olds) and fixed across the full time-series.

For the SAM model seen by the benchmark process WKNSCS (low natural mortality), the MSY $B_{trigger}$ reference point is notably higher, while B_{lim} and $B_{trigger}$, lower than the alternative model. F reference points are all lower (Table 26.11).

The premise for this is that with the lower natural mortality values, taken from the English Channel in the original run, a greater proportion of total mortality in the SAM assessment model is being attributed to fishing pressure and therefore suggest that F has been relatively high and has been limiting stock development. It suggests if fishing pressure were reduced a large development of the stock would result, and a high yield even at a much lower F than is currently observed.

A SPiCT model was also explored, although it converged, there was a very large uncertainty and unsatisfactory diagnostics. Therefore, WGCSE concluded that the stock to be assessed as the category 3 with the application of ICES technical guidance for harvest control rules the rfb was applied. The rfb rule is an empirical harvest control rule meant to be applied to empirical data and not estimates from a population model.

The rfb rule is defined as:

$$A_{y+1} = A_y \; r \; f \; b \; m,$$

where A_{y+1} is the new advised catch for year $y + 1$, A_y the previously advised catch, r a biomass ratio following the trend in a biomass index, f a fishing pressure proxy using catch length data, b a biomass safeguard protecting against low stock size, and m a multiplier ensuring long-term precautionary exploitation (ICES, 2022).

The rfb rule includes a conditional and asymmetric uncertainty cap restricting changes in A_{y+1} relative to A_y to $+20\%$ and -30%, but is only implemented if $b = 1$. Furthermore, the rfb rule provides biennial catch advice, i.e. once set, the advice is kept for two years (ICES, 2022).

Growth rates were estimated using data from Belgium commercial samples and both UKBTS and IGFS surveys (Figure 26.12). Mean coefficient k of von Bertalanffy for 2016–2020 equation was 0.0985 and as k<0.2 the rfb rule method 2.1 with m=0.95 should be applied (ICES, 2022). The length structure was obtained from InterCatch for a period of 2018–2021, age data were obtained from UK and Ireland research surveys and catches of Belgian beam trawlers for a period 2000–2021. CPUE of UKBTS survey for a period of 1988–2021 expressed in total catch (kg) per 100 km of towed distance was used as the index of abundance. Lc was stable during recent years being 26.3–30.1 cm, below MSY proxy length ($L_{F=M}$) =30.2 cm (Figure 26.13). As the recent advices were very different from actual catches, the rfb harvest control rule was based on catches as this rule is meant to adjust realised catches influencing the stock (Fischer *et al.*, 2020).

The advice is based on the recent advised catches, multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard, and a precautionary multiplier. The stability clause was not applied because the recent biomass index value was below MSY $B_{trigger}$. The discard rate (average 2019–2021) was 38%. The resulted advice is provided in the table below.

Mean catch last three years (C_y)	**793 tonnes**
Biomass index trend	
Index A (2020–2021)	58.9 kg / 100 km
Index B (2017–2019)	89.9 kg / 100 km
r: Stock biomass trend (index ratio A/B)	0.655
Fishing pressure proxy	
Mean catch length ($L_{mean}=L_{2021}$)	26.3 cm
MSY proxy length ($L_{F=M}$)	30.2 cm
f: Fishing pressure proxy relative to MSY proxy ($L_{2021}/_{LF=M}$)	0.937
Biomass safeguard	
Last index value (I_{2021})	49.3 kg / 100 km
Index trigger value ($I_{trigger} = I_{loss}$ x 1.4)	57.0 kg / 100 km
b: index relative to trigger value, min{$I_{2021}/I_{trigger}$, 1}	0.87
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability	
m: multiplier (generic multiplier based on life history)	0.95
Uncertainty cap (+20%/-30% compared to A_y, only applied if b≥1)	Not applied
Discard rate	38%
Catch advice for 2023 and 2024 [C_y x r x f x b x m]	402 tonnes
% advice change**	-73%

State of the stock

Index of the stock biomass is estimated to have been increasing between 2005 and 2015 and from 2016 went into decline descending by 2021 to values close to the lowest observed (Figure 26.5).

26.4 Short-term projections

The short-term projections for the stock are not established.

26.5 Precautionary approach reference points

Mean catch length (L_{MEAN}) in recent years was below of the MSY proxy length ($L_{F=M}$) reference point established as 30.2 cm TL, and last index value was below the index trigger value established as 57.0 kg / 100 km. Because of this the -30% uncertainty cap was not applied.

Year	Lmean, cm	Lc, cm	$L_{F=M}$, cm
2018	29.5	24	30.2
2019	30.1	24	30.2
2020	26.7	24	30.2
2021	26.3	22	30.2

26.6 Management plans

The EU has proposed a multiannual management plan for the Western Waters (EU, 2018). However, this stock was excluded from the final version (EU 2019, approved on 05/03/2019 Meeting n°3676 - https://www.consilium.europa.eu/en/meetings/env/2019/03/05/). Therefore, there is no management plan for Celtic Sea plaice.

26.7 Uncertainties in assessment and forecast

In spite of the COVID-19 pandemic, the sampling levels of landed catch and discards as seen in contribution of sampled and unsampled landings and discards to final assessment (Figure 26.3) in 2021 was sufficient to provide reliable information on the length- and age structure of the stock.

From 2003 onwards, discard sampling for Ireland, Belgium, France and the UK(E&W) has been improved under the Data Collection Regulation. Discarding remained too high (exceeding landings) in this fishery until 2019, thereby compromising the effectiveness of quota management on landings. In 2019–2021 landings first time exceeded discards. It is difficult to predict fishing fleet behaviour, as it is a commercial species of a low value taken mostly as a bycatch to fishery for sole, and to lesser extent, to *Nephrops*.

26.8 References

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Table 26.1. Plaice in divisions 7.f–g. Nominal landings (t) as reported to ICES, and total landings as used by ICES WGCSE.

	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	188	216	188	210	203	185	182	185	243
UK	61	63	55	54	45	45	41	25	25	27
France	104	70	NA	136	98	125	106	155	111	108
Ireland	58	64	63	63	67	76	80	49	59	52
Total reported	417	385	NA	442	420	450	412	411	381	430
Discards	1288	583	608	670	1107	1123	1274	772	778	571
Unallocated	-7	52	-1	-9	7	-8	-2	-1	0	0
Landings used by WG	410	437	481	442	427	442	414	410	381	431
Catch as used by WG	1698	1020	1089	1112	1534	1565	1688	1183	1159	1002
	2017	**2018**	**2019**	**2020**	**2021**					
Belgium	179	204	263	332	263					
UK	38	40	45	47	48					
France	108	127	84	47	51					
Spain			1	<1	0.5					
Netherlands			<1	<1	<1					
Ireland	63	51	C*	110	105					
Total reported	388	422	394 C*	536	468					
Discards	895	508	189	357	378					
Unallocated	1	0	-2	0	2					
Landings used by WG	389	422	642	536	470					
Catch as used by WG	1284	930	831	893	468					

C Incomplete / missing due to part of the data being unavailable under national GDPR clauses.

Table 26.2. Plaice in divisions 7.f–g: lpue and cpue for UK(E&W) fleets.

	LANDINGS PER UNIT OF EFFORT (LPUE) kg\day						EFFORT, fishing days					
	VIIf		VIIg EAST		VIIg WEST		VIIf		VIIg EAST		VIIg WEST	
	lpue		lpue		lpue		Effort		Effort		Effort	
	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM
YEAR		TRAWL		TRAWL		TRAWL	(Days fished)	(Days fished)	(Days fished)	(Days fished)	(Days fished)	(Days fished)
1983	86.39	30.33	71.84	54.85	0	75.69	620	195	82	149	0	8
1984	79.67	99.69	94.5	106.65	0	66.96	1723	901	316	298	0	129
1985	115.93	122.91	119.63	174.39	67.62	233.25	1493	1101	206	285	23	92
1986	119.81	113.62	103.37	183.72	49.93	380.2	1125	973	334	180	35	29
1987	131.27	114.34	223.13	291.3	33.68	446.46	1211	1681	364	187	26	26
1988	232.51	247.91	217.11	356.02	48.43	670.38	838	1102	351	77	20	36
1989	130.84	138.62	137.76	293.89	86.54	575.3	966	861	327	125	15	7
1990	75.55	88.83	59	166.69	78.13	147.13	1229	1256	435	165	24	194
1991	48.2	93.83	44.9	73.4	42.22	109.4	1066	1667	306	483	45	104
1992	49.33	57.2	41.29	69.8	45	70.04	898	1420	303	633	435	90
1993	43.85	69.98	23.83	65.14	56.64	32.85	836	1669	251	694	30	135
1994	39.67	40.41	31.76	49.39	10.7	70.61	623	2219	225	610	19	116
1995	41.81	43.01	30.91	54.05	61.67	37.12	580	2303	196	694	30	128
1996	38.8	33.67	26.25	27.49	6.15	11.82	593	2391	341	560	105	220

	LANDINGS PER UNIT OF EFFORT (LPUE) kg\day						EFFORT, fishing days					
	VIIf		VIIg EAST		VIIg WEST		VIIf		VIIg EAST		VIIg WEST	
	lpue		lpue		lpue		Effort		Effort		Effort	
	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM
YEAR		TRAWL		TRAWL		TRAWL	(Days fished)	(Days fished)	(Days fished)	(Days fished)	(Days fished)	(Days fished)
1997	34.61	31.01	21.37	33.42	17.47	7.5	577	2661	370	770	122	146
1998	21.86	26.07	15.53	15.33	5.12	12.65	517	2846	385	591	94	159
1999	35.6	26.62	20.65	12	5.14	11.96	395	3058	176	1461	235	312
2000	32.09	16.1	40.58	11.64	3.35	10.1	284	3133	187	1007	160	200
2001	34.02	16.69	32.3	15.26	4.66	11.04	309	3172	187	1155	179	91
2002	19.78	15.64	48.8	20.81	7.43	4.81	416	2652	123	463	170	60
2003	23.45	18.24	8.19	20.78	4.48	1.49	696	2669	51	772	124	158
2004	18.77	15.54	8.66	7.81	3.09	3.39	641	2503	198	923	125	178
2005	11.2	11	2.14	8.25	0.25	1.33	876	1968	21	618	154	116
2006	21.21	12.77	5.91	15.19	0.64	0.58	924	1330	23	630	233	70
2007	14.79	17.93	20.42	10.58	1.71	5.9	798	1407	31	518	219	12
2008	18.01	21.2	21.1	10.22	0.08	1.72	711	1202	109	290	229	5
2009	14.4	15.66	11.58	14.77	1.63	0.76	656	1105	244	266	296	48
2010	14.09	27.93	12.88	11.82	0.31	1.06	565	1162	84	327	469	78
2011	11.11	32.98	5.43	17.11	2.09	0.76	525	868	8	180	353	111
2012	10.96	17.7	3.11	9.38	0.67	0.51	543	1408	138	275	487	102

	LANDINGS PER UNIT OF EFFORT (LPUE) kg\day						EFFORT, fishing days					
	VIIf		VIIg EAST		VIIg WEST		VIIf		VIIg EAST		VIIg WEST	
	lpue		lpue		lpue		Effort		Effort		Effort	
	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM
YEAR		TRAWL		TRAWL		TRAWL	(Days fished)	(Days fished)	(Days fished)	(Days fished)	(Days fished)	(Days fished)
2013	6.4	12.29	0.89	8.18	0.44	0.61	280	1611	72	265	37	77
2014	5.76	15.52	7.43	10.61	0.08	2.5	156	959	10	131	176	24
2015	18.82	11.87	37.87	14.58	0	3.65	79	726	3	245	165	56
2016	0	14.91	0	9.57	0.07	0.05	136	915	0	396	329	34
2017	24.98	18.57	2.97	10.28	0.05	2.47	93	986	95	514	193	74
2018	11.1	19.53	27.1	7.77	0.93	10.7	127	1071	71	440	210	15
2019	19.62	32.97	11.95	26.73	1.11	8.58	169	981	34	255	277	8
2020	8.4	34.41	2.31	26.41	0	0.17	100	1012	10	346	40	99
2021	6.36	23.68	35.1	17.14	17.35	0.16	155	1260	22	540	28	102

Table 26.3. 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	26.71	3.70
2009	140.76	30.84	4.56
2010	127.15	32.74	3.88
2011	159.03	41.41	3.84
2012	165.73	46.25	3.58
2013	155.973	45.159	3.454
2014	155.317	31.271	4.967
2015	165.17	31.792	5.195
2016	212.01	32.34	6.556
2017	169.03	33.35	5.07
2018	186.861	31.48	5.94
2019	226.443	32.033	7.131
2020	293.355	41.699	7.035
2021	244.64	36.182	6.761

Table 26.4. Plaice in Divisions 7.f–g: lpue and effort for Irish otter trawl, beam and seine fleets in 7.g.

	IR-OTB-7G			IR-SCC-7G		
Year	Landings (t)	Effort (000 hr)	lpue (kg/h)	Landings (t)	Effort (000 hr)	lpue (kg/h)
1995	94.23	63.56	1.48	9.55	6.43	1.49
1996	133.66	60.04	2.23	14.20	9.73	1.46
1997	119.84	65.10	1.84	38.79	16.13	2.40
1998	96.72	72.30	1.34	21.38	14.94	1.43
1999	60.05	51.66	1.16	10.40	8.01	1.30
2000	26.78	60.60	0.47	11.40	9.90	1.15
2001	23.82	69.43	0.34	10.93	16.33	0.67
2002	42.30	77.69	0.54	16.42	20.86	0.79
2003	26.35	86.79	0.30	13.80	20.91	0.66
2004	26.62	96.99	0.27	5.04	19.38	0.26
2005	22.78	124.40	0.18	6.47	14.81	0.44
2006	25.17	119.23	0.21	5.10	14.79	0.34
2007	30.99	136.52	0.23	4.76	15.82	0.30
2008	39.17	125.81	0.31	8.38	11.65	0.72
2009	43.81	137.11	0.32	7.98	8.19	0.98
2010	44.29	140.65	0.31	10.71	9.69	1.11
2011	44.68	120.33	0.37	11.12	11.01	1.01
2012	43.21	121.08	0.35	18.41	14.15	1.30
2013	31.91	118.13	0.28	11.10	12.06	0.84
2014	26.00	127.40	0.22	7.60	12.00	0.61
2015	33.34	132.69	0.25	8.36	9.28	0.90
2016	34.80	148.17	0.23	9.37	10.44	0.90
2017	40.86	135.98	0.30	10.49	9.75	1.08
2018	33.64	105.81	0.32	8.13	9.69	0.84
2019	33.89	103.89	0.33	16.40	14.26	1.15
2020	54.63	89.91	0.61	17.45	13.59	1.28
2021	52.04	83.90	0.62	25.13	14.80	1.70

		IR-TBB-7G					
Year	Landings (t)	Effort (000 hr)	lpue (kg/h)	Year	Landings (t)	Effort (000 hr)	lpue (kg/h)
1995	37.92	20.78	1.83	2009	6.96	37.96	0.18
1996	53.02	26.76	1.98	2010	6.56	40.22	0.16
1997	94.59	26.25	3.35	2011	6.71	35.33	0.19
1998	122.13	35.25	3.46	2012	33.63	40.33	0.83
1999	25.80	40.87	0.63	2013	32.32	38.48	0.84
2000	12.62	37.03	0.34	2014	12.50	37.80	0.33
2001	4.80	39.71	0.12	2015	12.10	37.79	0.32
2002	7.08	31.62	0.22	2016	9.83	39.55	0.25
2003	9.37	49.26	0.19	2017	12.39	35.21	0.35
2004	6.17	54.86	0.11	2018	9.62	37.42	0.26
2005	9.49	49.65	0.19	2019	20.32	34.08	0.60
2006	14.46	60.48	0.24	2020	43.20	29.14	1.48
2007	21.18	55.86	0.38	2021	49.07	31.57	1.55
2008	14.18	37.22	0.38				

Table 26.5. 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
AGE\YEAR	**2017**	**2018**	**2019**	**2020**	**2021**					
1	0	3	4	1	0					
2	33	32	28	98	56					
3	57	143	85	155	339					
4	380	122	248	190	328					
5	167	393	187	256	147					
6	112	160	336	229	179					
7	145	92	215	337	93					
8	56	89	63	163	134					
+gp	35	62	83	145	136					
TOTALNUM	985	1096	1249	1574	1412					

Table 26.6. 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
AGE\YEAR	**2017**	**2018**	**2019**	**2020**	**2021**					
1	0.231	0.198	0.206	0.185						
2	0.279	0.229	0.231	0.225	0.221					
3	0.289	0.262	0.277	0.245	0.256					
4	0.325	0.297	0.306	0.275	0.272					
5	0.370	0.326	0.337	0.31	0.311					
6	0.426	0.407	0.377	0.318	0.346					
7	0.460	0.468	0.376	0.358	0.403					
8	0.590	0.515	0.513	0.415	0.442					
+gp	0.7620	0.739	0.809	0.594	0.551					
SOPCOFAC	1.0400	0.978	1.03	1.005	0.999					

Table 26.7. Plaice in divisions 7.f–g. Discards numbers-at-age.

Discard numbers-at-age Numbers 10^3														
AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0	0	0	455	572	542	1829	73	671	385	960	142	614	83
2	0	0	0	360	1211	2584	3331	3595	985	2719	2656	2496	1283	987
3	0	0	0	641	441	750	3408	632	2041	1017	1429	1950	3581	1672
4	0	0	0	171	118	74	814	393	761	550	1019	502	1004	3195
5	0	0	0	68	41	47	81	69	399	345	501	179	231	454
6	0	0	0	3	12	12	32	4	44	54	45	163	32	173
7	0	0	0	4	4	1	11	1	4	8	99	58	44	77
8	0	0	0	1	22	1	9	1	5	0	56	25	11	27
+gp	0	0	0	0	0	0	0	0	0	0	0	8	8	36
TOTALNUM	0	0	0	1703	2421	4011	9515	4768	4910	5078	6765	5523	6808	6704
TONSLAND	0	0	0	274	321	453	1288	583	608	670	1107	852	1260	1158
SOPCOFAC	0	0	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Discard numbers-at-age Numbers 10^3							
AGE\YEAR	2015	2016	2017	2018	2019	2020	2021
0	-	-	0	0	0	0	0
1	38	29	169	3	29	13	0
2	1527	224	739	92	260	448	273
3	1253	1610	1078	587	157	673	1114
4	753	615	1257	444	328	388	643
5	1106	229	478	668	149	394	172
6	303	209	312	346	111	169	165
7	54	34	147	307	38	148	154
8	33	15	32	11	0	32	51
+gp	80	9	13	103	8	26	18
TOTALNUM	5145	2974	4225	2561	1080	2291	2590
TONSLAND	870	591	895	508	189	536	378
SOPCOF %	1.03	1.03	0.99	1.00	1.00	1.00	0.99

Table 26.8. Plaice in divisions 7.f–g. Discards weights-at-age.

Discard weights-at-age (kg)														
AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0	0	0	0.123	0.095	0.064	0.088	0.092	0.088	0.085	0.118	0.104	0.097	0.040
2	0	0	0	0.152	0.127	0.107	0.126	0.11	0.127	0.125	0.148	0.124	0.129	0.112
3	0	0	0	0.177	0.154	0.154	0.159	0.154	0.127	0.143	0.173	0.167	0.180	0.160
4	0	0	0	0.194	0.188	0.176	0.163	0.172	0.127	0.149	0.168	0.192	0.233	0.181
5	0	0	0	0.212	0.202	0.201	0.204	0.211	0.143	0.163	0.225	0.239	0.277	0.214
6	0	0	0	0.337	0.344	0.242	0.249	0.282	0.194	0.189	0.304	0.247	0.459	0.227
7	0	0	0	0.23	0.403	0.395	0.368	0.365	0.2	0.445	0.339	0.238	0.380	0.300
8	0	0	0	0.455	0.419	0.349	0.425	0.283	0.257	0.523	0.389	0.337	0.312	0.470
+gp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.713

Discard weights-at-age (kg)							
AGE\YEAR	2015	2016	2017	2018	2019	2020	2021
0			0.058				
1	0.12	0.148	0.14	0.105	0.084	0.095	0.081
2	0.124	0.153	0.147	0.126	0.118	0.127	0.127
3	0.143	0.177	0.186	0.150	0.169	0.143	0.139
4	0.171	0.205	0.225	0.188	0.196	0.161	0.146
5	0.219	0.261	0.258	0.182	0.180	0.172	0.158
6	0.315	0.288	0.324	0.207	0.183	0.18	0.183
7	0.208	0.341	0.271	0.324	0.159	0.187	0.16
8	0.204	0.416	0.29	0.350	0.258	0.298	0.163
+gp	0.529	0.462	0.442	0.873	0.182	0.196	0.177

Table 26.9. 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

AGE\YEAR	**2017**	**2018**	**2019**	**2020**	**2021**
0	0.058				
1	0.14	0.150	0.099	0.102	0.081
2	0.153	0.152	0.129	0.144	0.143
3	0.191	0.172	0.207	0.162	0.166
4	0.248	0.212	0.243	0.198	0.189
5	0.286	0.235	0.267	0.227	0.228
6	0.350	0.270	0.328	0.26	0.268
7	0.365	0.357	0.344	0.306	0.251
8	0.482	0.498	0.512	0.396	0.365
+gp	0.675	0.838	0.588	0.555	0.507

Table 26.10. Plaice in divisions 7.f–g: Survey abundance indices (numbers per hour).

IGFS (Numbers per hour)							
2003	2021						
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	26.2	13.0	15.2	3.0	5.0
1	1.1	13.8	33.6	13.9	9.2	9.0	4.2
1	0.8	11.5	12.8	13.0	10.8	3.7	4.6
1	0.1	5.5	9.8	6.6	7.9	3.2	3.2
1	1.6	7.2	5.8	13.1	5.8	5.1	4.0
1	0.8	8.1	7.0	5.1	5.9	3.8	6.6
1	0.6	27.7	30.5	17.4	5.6	4.4	5.1

E+W BTS (numbers per 100 km towed)					
1995 2021					
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	26.360	454.080	162.340	52.370	76.660
1	12.520	163.100	268.260	102.300	27.500
1	11.490	104.1	137.39	121.110	91.87
1	4.15	45.26	90.2	58.1	75.08
1	114.94	138.97	38.18	15.37	11.19
1	7.17	113.19	139.61	42.71	11.95
1	37.87	44.4	76.06	42.6	7.11

Table 26.11. SAM-estimated reference points.

reference point	value at low m	value at high m	rationale
MSY $B_{trigger}$	1882 t	2,885t	Lower 5th percentile of B_{MSY}; in tonnes
F_{MSY}	0.147	0.468	Stochastic simulations with segmented regression
$F_{MSYLower}$	0.098	0.258	Median lower point estimates of Stochastic simulations
$F_{MSYUpper}$	0.228	0.803	Median upper point estimates of Stochastic simulations
B_{lim}	1344 t	2061 t	Lowest observed SSB
B_{pa}	1882 t	2885 t	B_{lim} combined with the assessment error
F_{lim}	1.17	1.51	F with 50% probability of SSB less than B_{lim}
F_{pa}	0.84	1.08	F_{lim} combined with the assessment error

Figure 26.1. Spatial distribution of plaice landings in the area 7fg in 2009–2020 showing relative importance of the different ICES rectangles. Circle size is proportional to the percentage of the total annual landings taken from a particular rectangle.

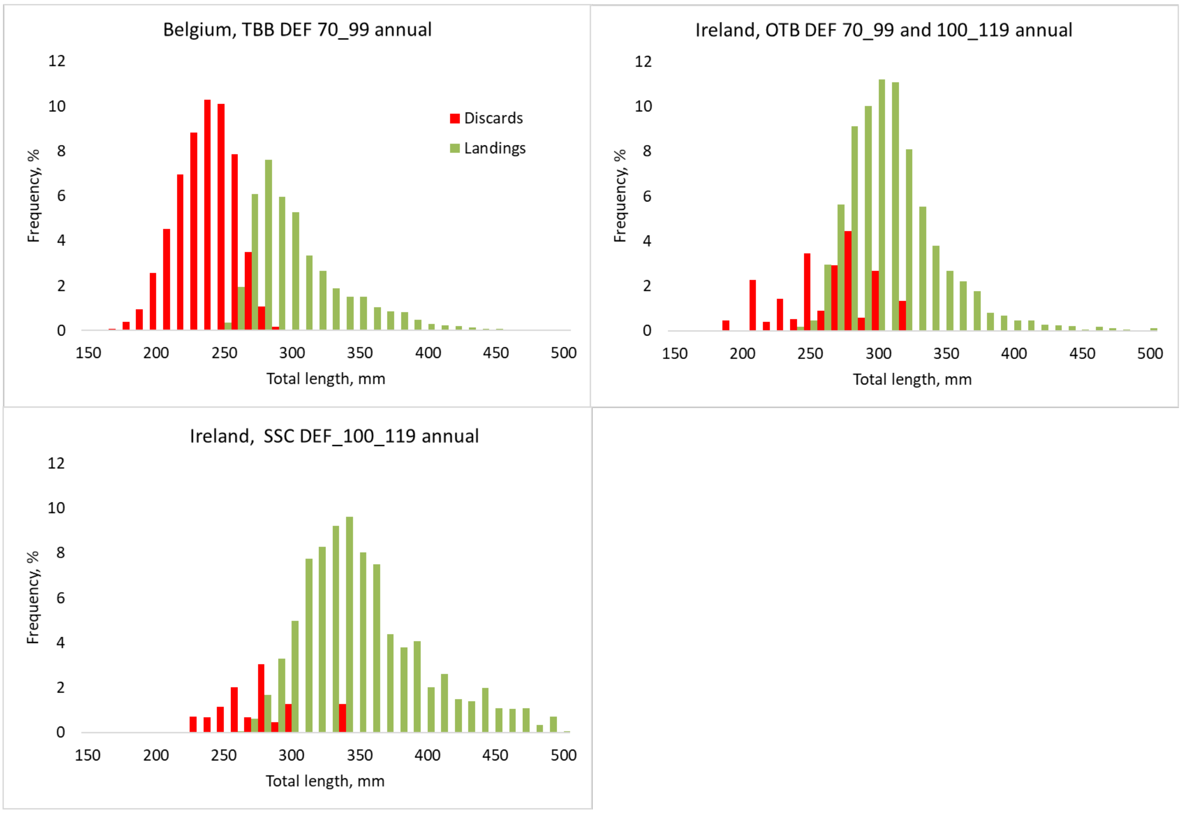


Figure 26.2. Plaice in divisions 7.f–g: Landing and discards by different metiers when both landings and discards were sampled simultaneously. As the minimum conservation reference size is 270 mm, it is seen that no nearly no fish of commercial size was discarded.

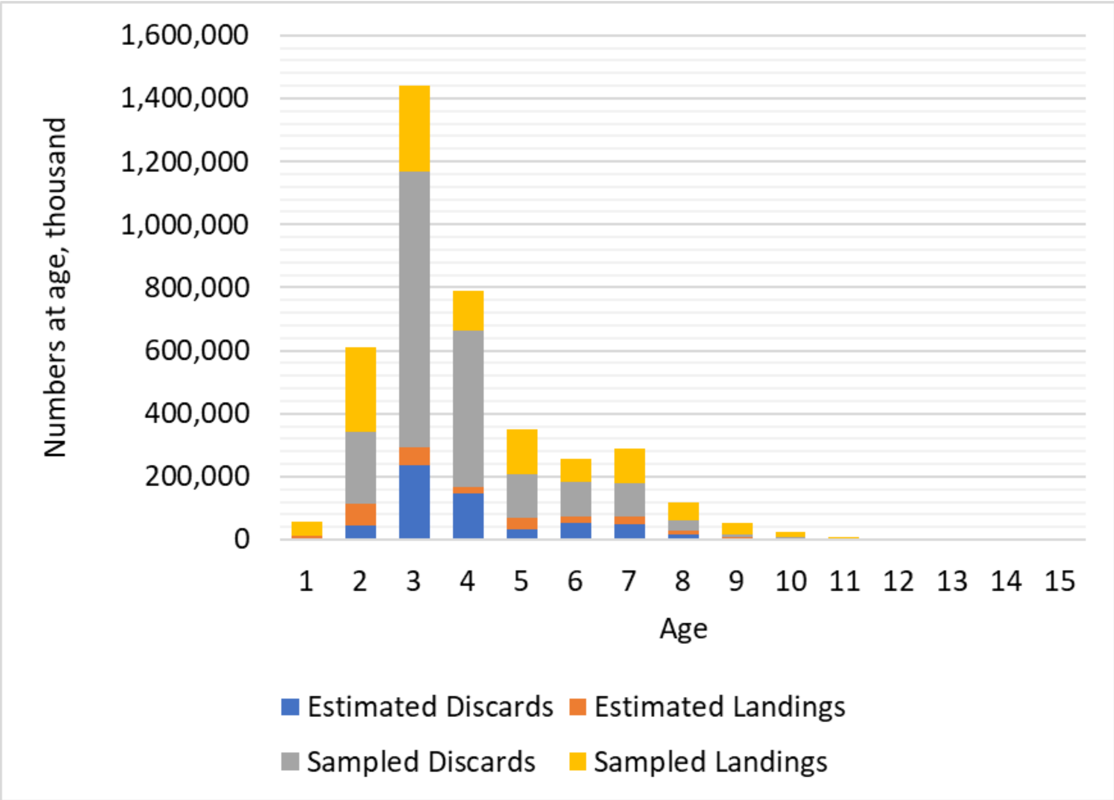


Figure 26.3. Plaice in divisions 7.f–g: Contribution of sampled and unsampled landings and discards to final assessment catch numbers-at-age in 2021.

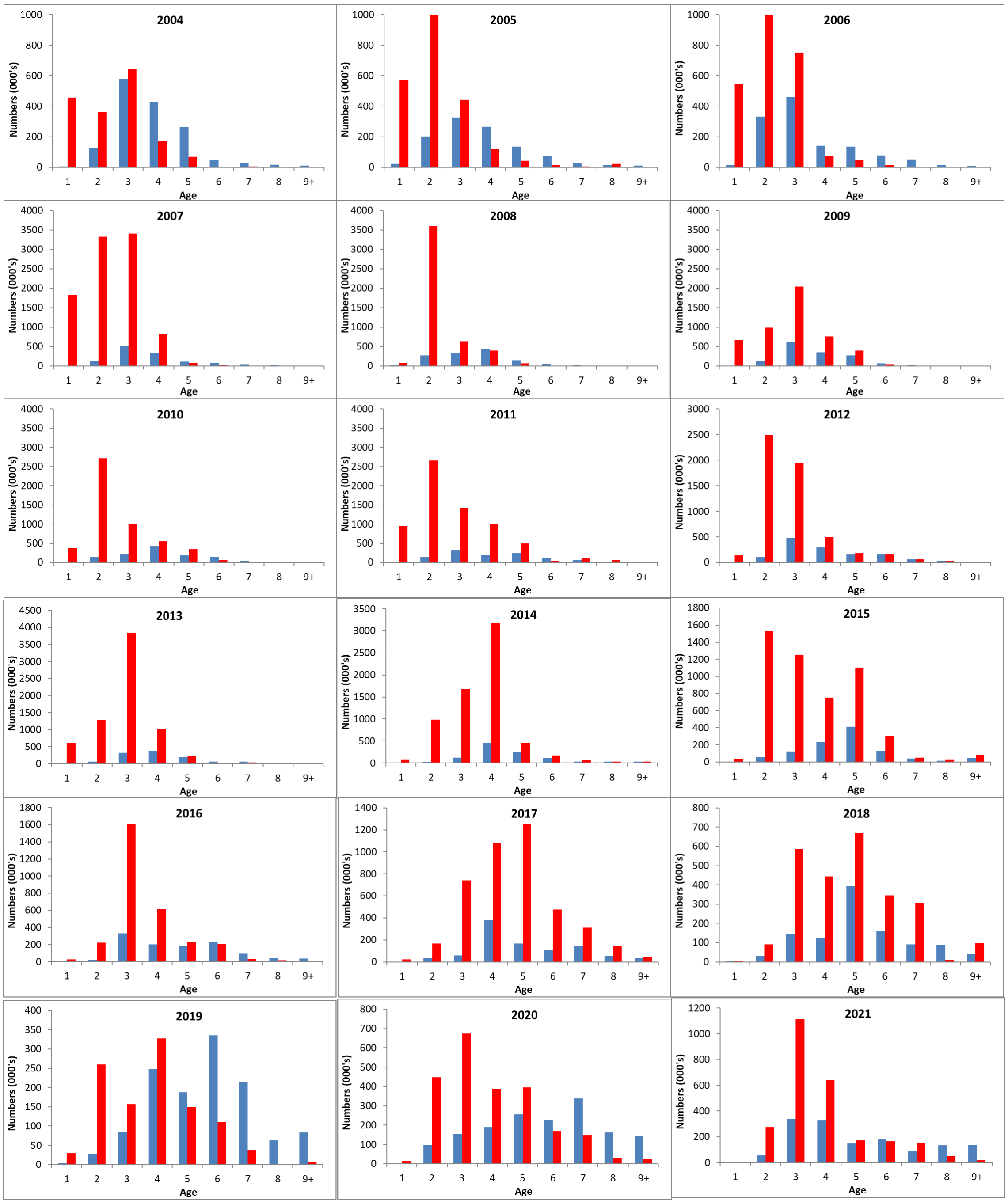


Figure 26.4. Plaice in divisions 7.f–g: Age composition of international landings (blue) and discards (red) from 2004 to 2021.

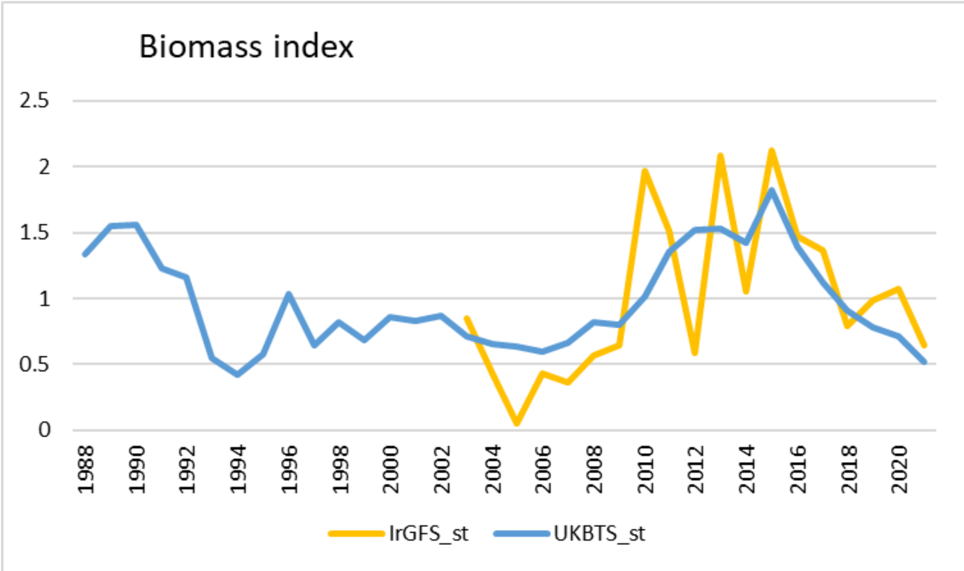


Figure 26.5. Plaice in divisions 7.f–g: Trends standardised cpues (kg/100 km towed) of surveys.

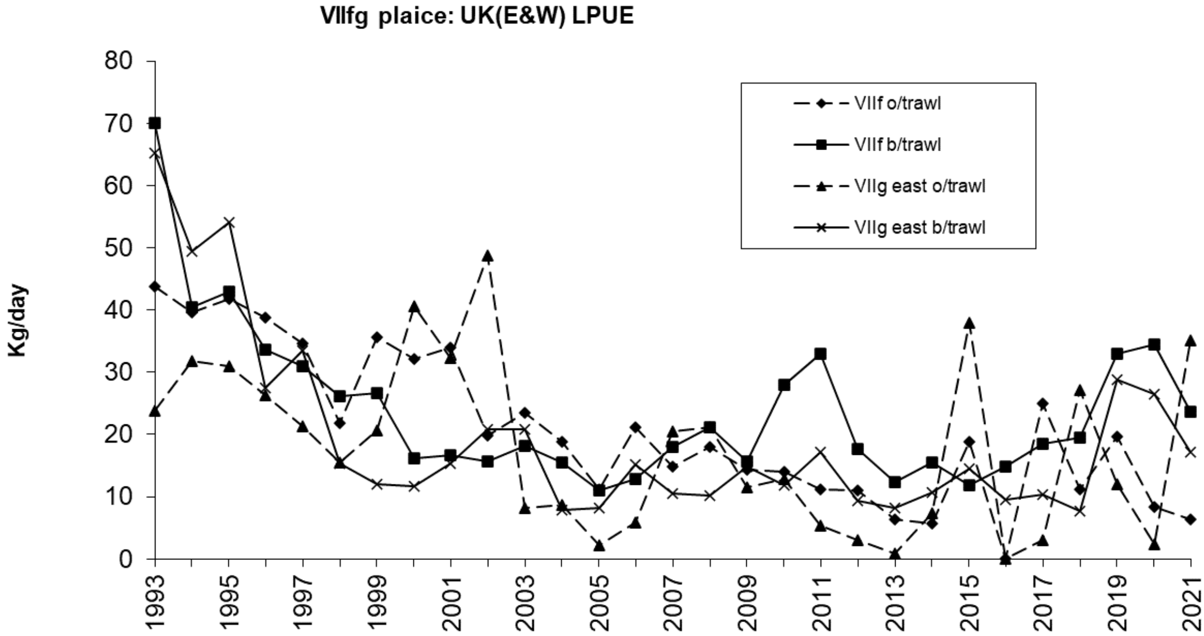
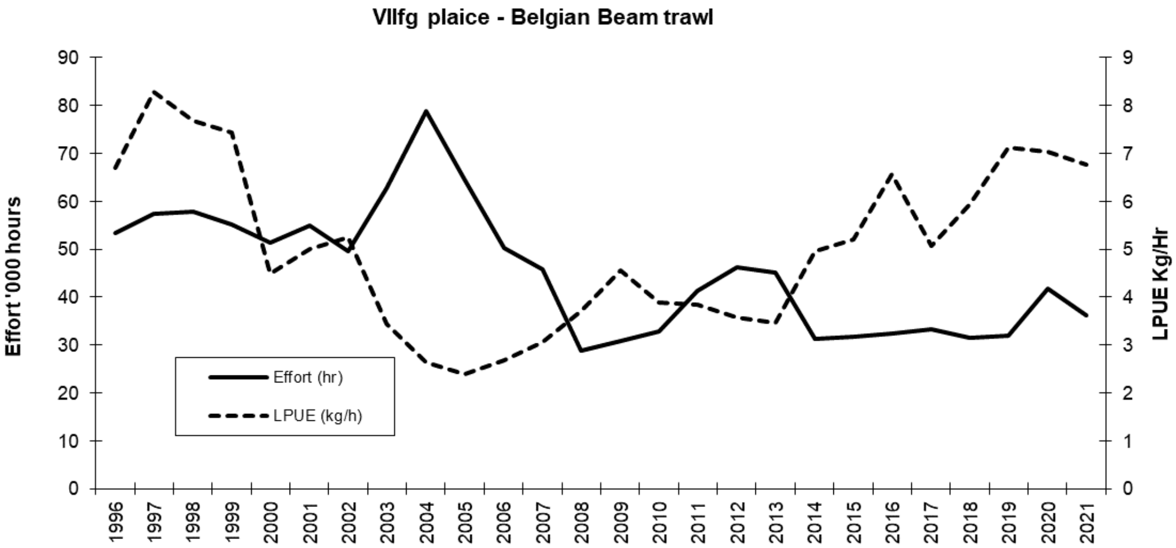
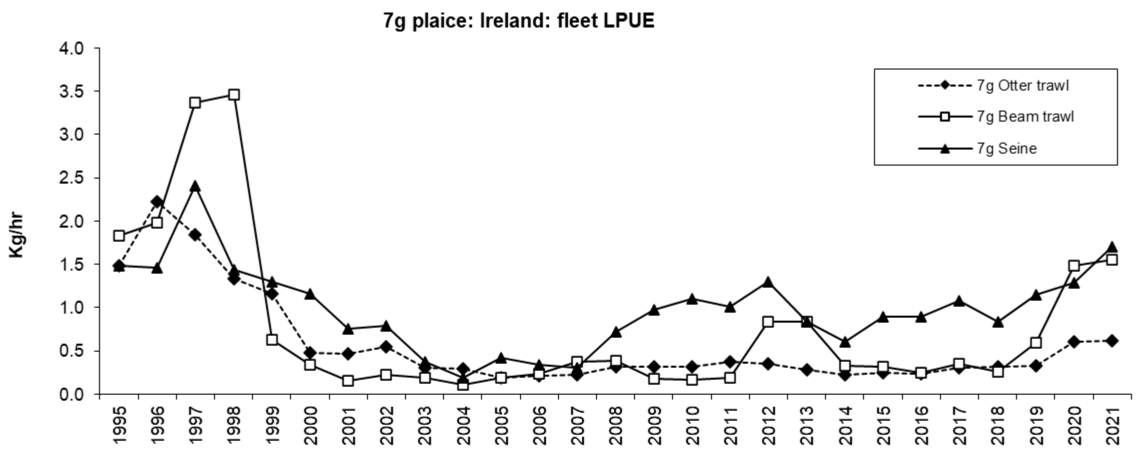


Figure 26.6. Plaice in divisions 7.f–g: Trends in CPUE by the UK fleets.





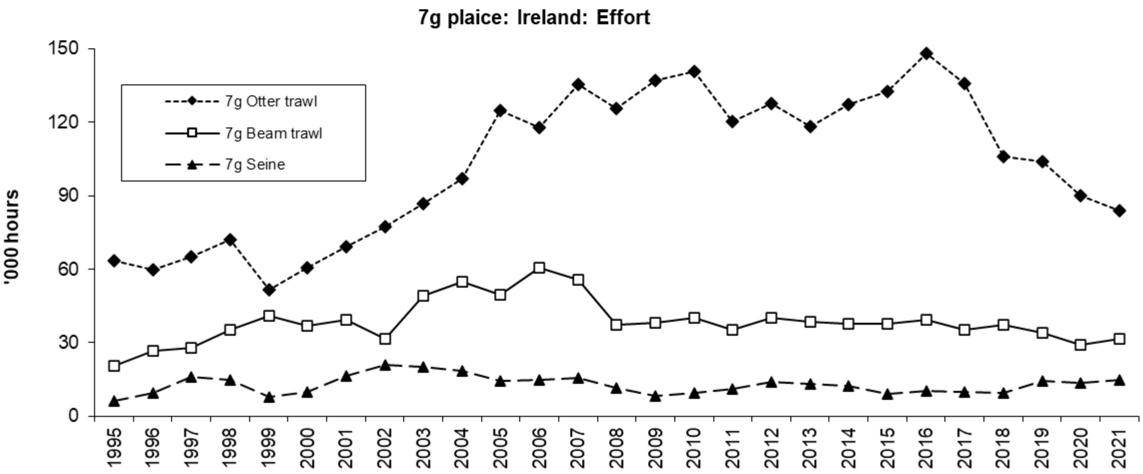


Figure 26.7. Plaice in divisions 7.f–g: Trends in CPUE by the EU fleets.

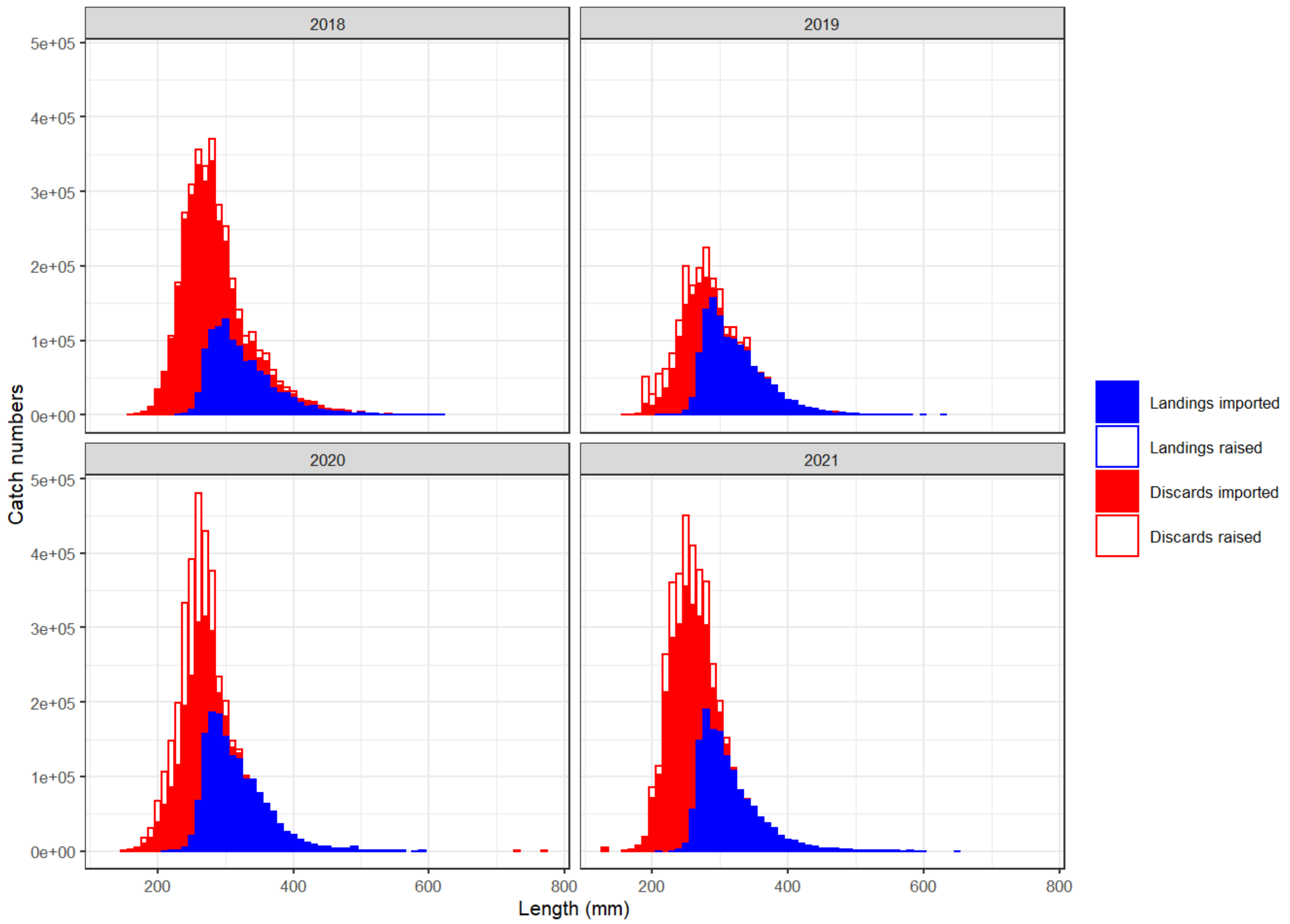


Figure 26.8. Plaice in divisions 7.f–g: Raised size structure of landings and discards in 2018–2021.

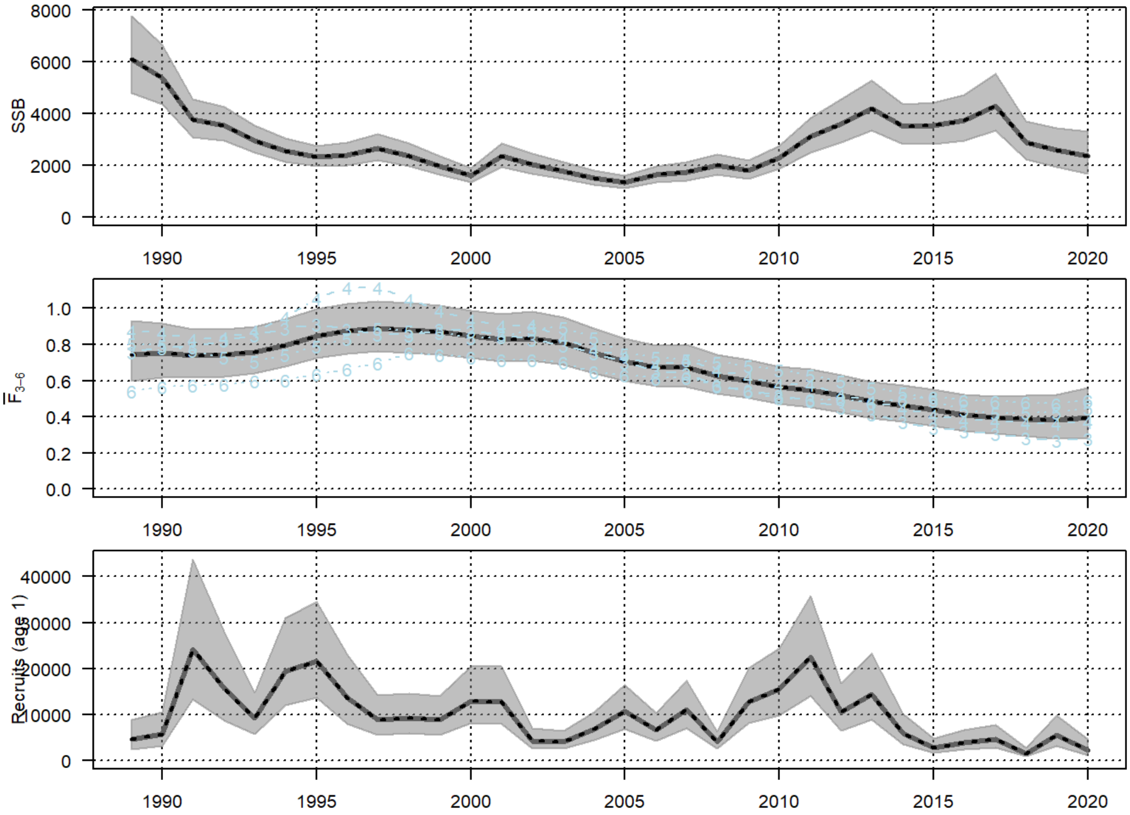


Figure 26.9. Plaice in divisions 7.f–g: Performance of the SAM model at the benchmark 2022.

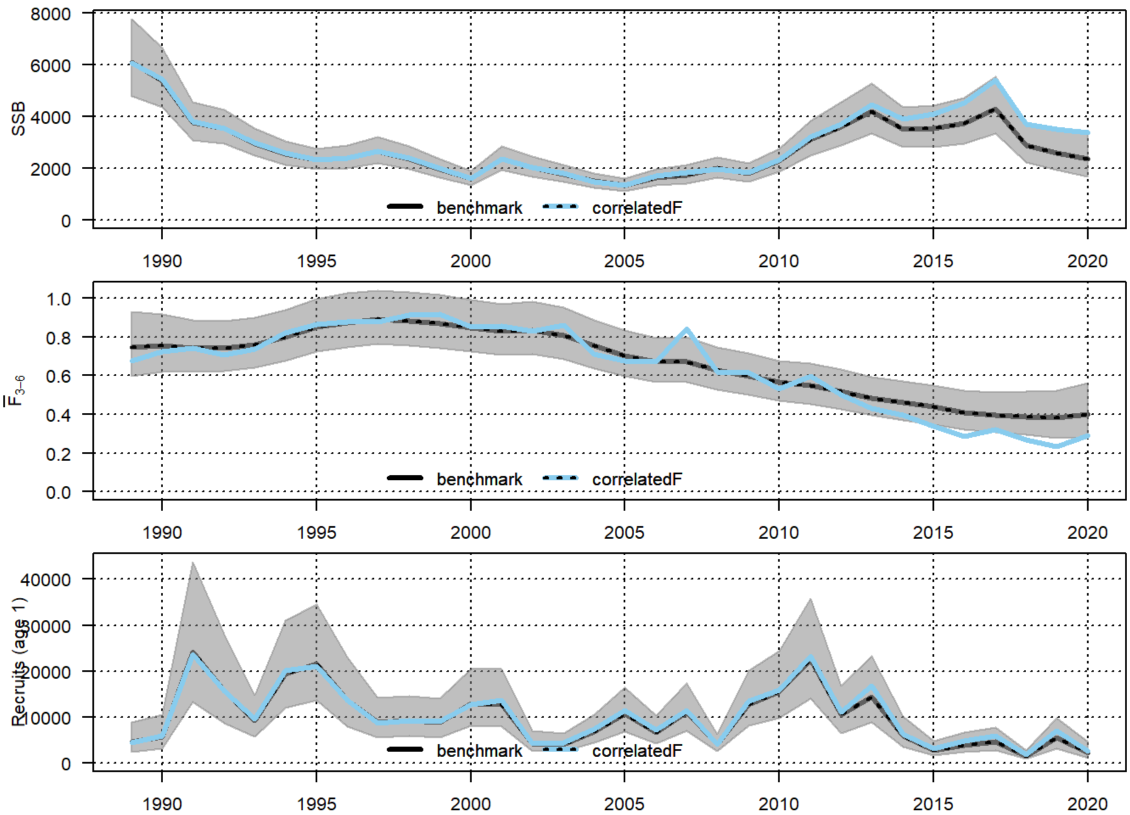


Figure 26.10. Plaice in divisions 7.f–g: Performance of the SAM model with correlation of fishing mortalities between ages.

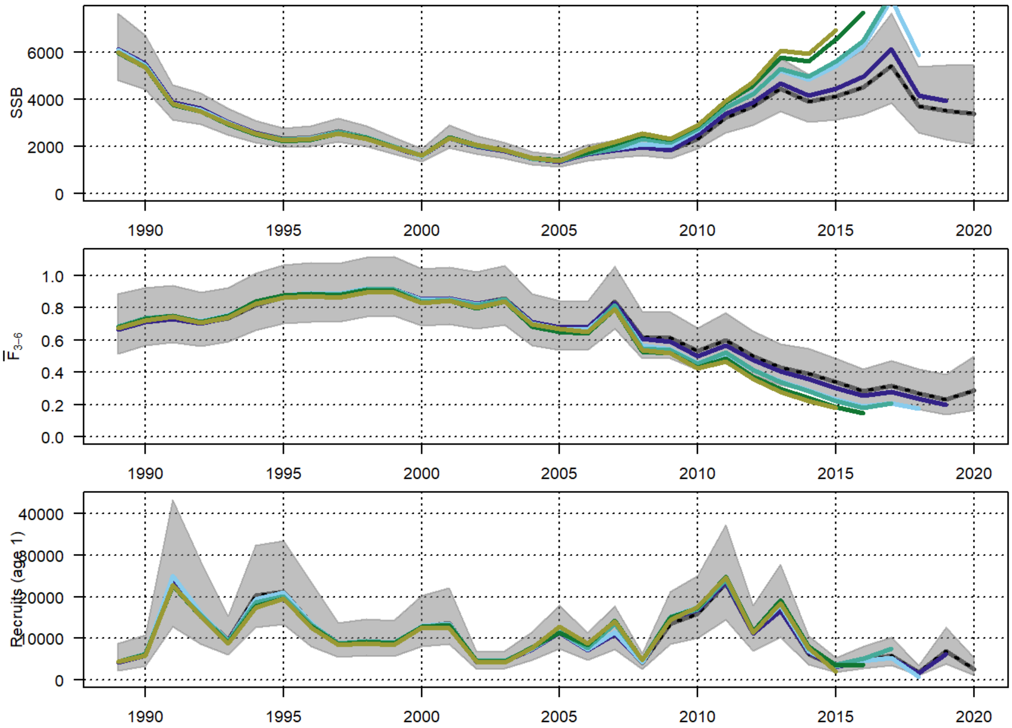


Figure 26.11. Plaice in divisions 7.f–g: Retrospective pattern in SAM with correlation of fishing mortalities between ages.

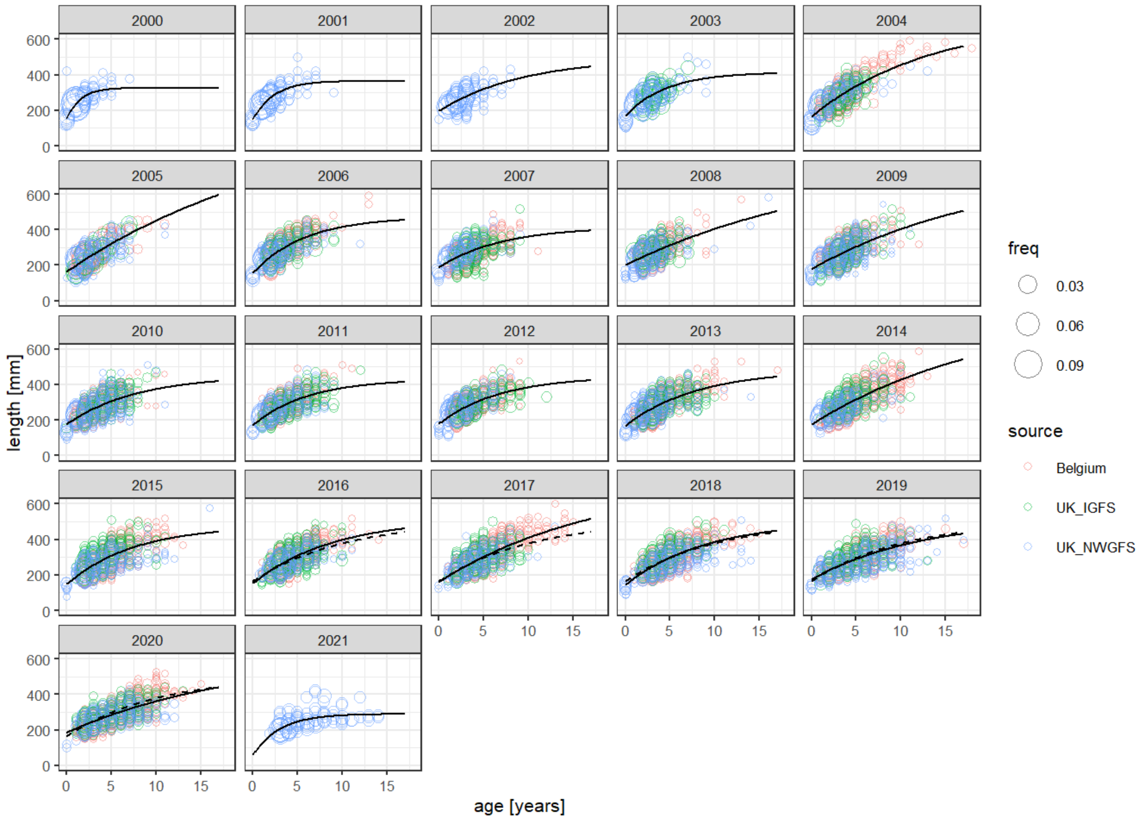


Figure 26.12. Ple 7 f&g. Growth curves in 2000–2020 (data for 2021 are scarce).

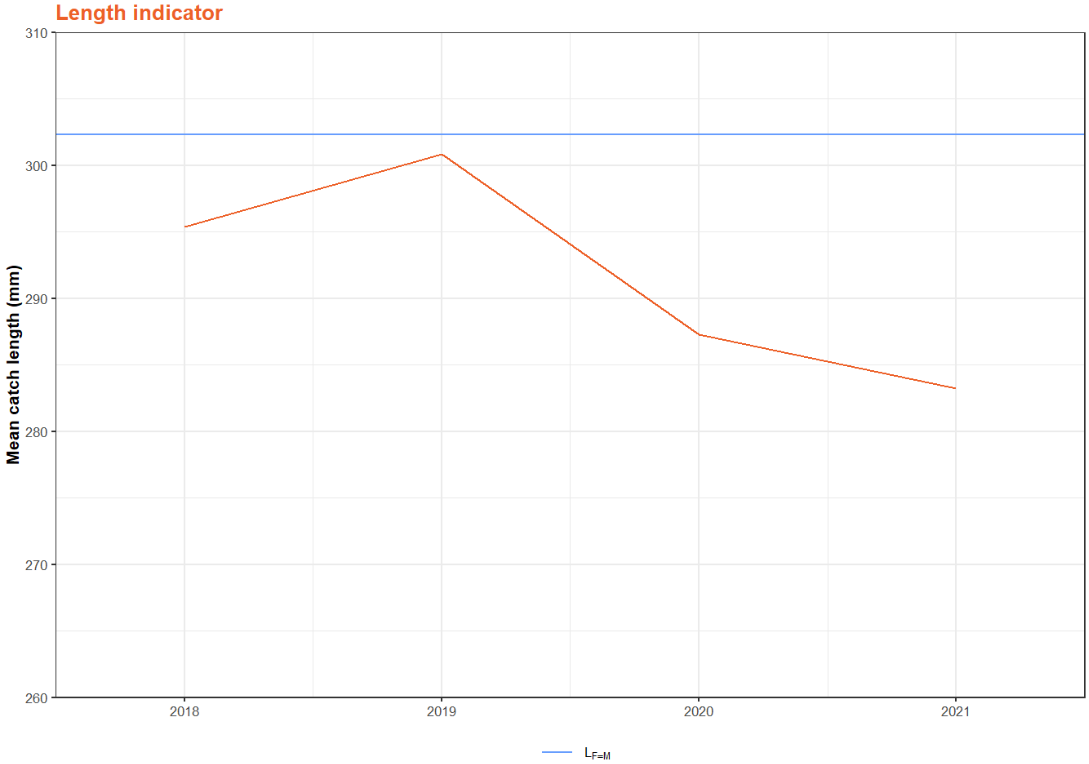


Figure 26.13. Ple 7 f&g. Position of mean catch length in respect to the length indicator L $_{F=M}$.

27 Plaice (*Pleuronectes platessa*) in divisions 7h–k (Celtic Sea South, southwest of Ireland)

Type of assessment in 2022

A trends-based assessment was conducted using a combined survey index produced using VAST biomass index of the VAST model to which an 'rfb' advice rule was applied. Stock status, $F_{MSY\ proxy}$ reference point, was estimated from LBI analysis, assuming M/K = 1.5. $L_{F=M}$ is based on L_c (length at 50% of modal abundance), which varies each year.

ICES advice applicable to 2023 and 2024

ICES advises that when the MSY approach is applied, catches should be no more than 132 tonnes in each of the years 2023 and 2024.

27.1 Impact of the COVID-19 pandemic

The sampling of plaice in 27.7h–k was effected by the implications of the COVID-19 pandemic in 2020 and 2021. Sampling levels were lower than previous years due to national restrictions on scientific sampling activities. There were insufficient samples to estimate discards based on 2021 data only, therefore a 5-year geometric mean was used (2017–2021).

Data for all scientific tuning indices were received for 2021.

27.2 General

27.2.1 Stock description and management units

The TAC specified for plaice in ICES Division 7.h–k 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 27.1. Official landings in 2021 were 46 t, a 31% undershoot of the 2021 TAC (67 t).

Plaice in 7.h–k is on the south-western margins of the species distribution. Landings of plaice are similar in ICES divisions 7h and 7j, but are considered negligible in 7k. Plaice in 7j is typically targeted by the Irish otter trawl fleet, which operate on sandy grounds off the southwest of Ireland, close to shore and this species is a small, but valuable component of the landings in a mixed fishery. Whereas, plaice in 7h is mostly targeted by the beam trawl fleet, and some otter trawl, which operate close to the boundaries of other plaice stocks (ple.27.7.fg & ple.27.7.e)(Figure 27.1).

To date no stock identification studies have been conducted on plaice in 7h–k, which is on the southwestern margins of the species distribution, which is reflected in the reported landings that show high landings in adjoining stock areas, 27.7.e and 27.7.fg (Figure 27.1). There are no relevant tagging studies completed in this area. There is evidence in other areas to suggest that plaice is a highly mobile species, and therefore it is possible that ple.27.7.h–k is an extension of larger adjoining populations, but tagging and genetic would need to be completed to determine this (ICES, 2021).

27.2.2 Landings obligation

The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters (EU, 2019) applies to bycatches of this stock. As of 2020, the EU landing obligation fully applied to plaice in divisions 7h–k. The landing obligation was phased in between 2016–2019 (Commission Delegated Regulations (EU) 2015/2438, 2016/2375, 2018/46, EU, 2015, 2016, 2018). A survivability exemption for plaice caught in ICES divisions 7h–k for vessels using beam trawls, with a maximum engine power of 221 kW, a maximum length of 24 metres, fishing within 12 nautical miles of the coast and with tow durations of no more than ninety minutes, and by vessels using beam trawls with an engine power of more than 221 kW, using a flip-up rope or benthic release panel (Commission Delegated Regulations (EU) 2020/2015). Additional survivability exemption available for plaice caught in pots, traps and creels in North-Western Waters (ICES subareas 5, 6 and 7) (Commission Delegated Regulations (EU) 2020/2015).

27.2.3 Management applicable to 2022 and 2021

TAC table 2022

Species:	Plaice *Pleuronectes platessa*		Zone: 7h, 7j and 7k (PLE/7HJK.)
Belgium	7	(1)	Precautionary TAC
France	14	(1)	Article 9 of this Regulation applies
Ireland	47	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply
Netherlands	27	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply
Union	95	(1)	
United Kingdom	19	(1)	
TAC	114	(1)	

(1) Exclusively for by-catches. No directed fisheries for plaice are permitted under this TAC.

TAC table 2021

Species:	Plaice *Pleuronectes platessa*		Zone: 7h, 7j and 7k (PLE/7HJK.)
Belgium	4	(1)	Precautionary TAC
France	8	(1)	Article 9 of this Regulation applies
Ireland	28	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply
The Netherlands	16	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply
Union	56	(1)	
United Kingdom	11	(1)	
TAC	67	(1)	

(1) Exclusively for by-catches. No directed fisheries for plaice are permitted under this TAC.

27.3 Data

27.3.1 Commercial catch data

Belgium, France, Ireland, Spain, and the United Kingdom (England) uploaded commercial catch data for 2021 to InterCatch (Figures 27.2 and 27.3). All submitted age samples are presented in Figure 27.4 and length samples in Figure 27.5. Although these samples are not used directly in the stock assessment they are used to determine a number of biological parameters which are used within the estimation of MSY proxy reference points.

Landings reported to InterCatch for this stock totalled 48 tonnes in 2021, which is a 9 tonne increase on 2020.

Discards submitted to InterCatch of plaice in divisions 7.h–k totalled 6 tonnes in 2021. As in 2020 there was again a decrease in commercial catch sampling due to COVID-19. The discard rates for this stock are highly variable over time (Figure 27.7), this variability may be driven by low and variable sample sampling numbers. Due to this high interannual variability in estimated discards, an average discard rate of 42% was calculated from 2004–2019 and applied to the landings of the same period. To ensure that recent trends in discarding were captured, discard rates were calculated using the geometric means of the submitted discards for the five most recent years. These calculated to a mean discard rate of 50% in 2020 (2016–2020) and 49% in 2021 (2017–2021) (Figure 27.8).

27.3.2 Revisions

No revisions to previous years were submitted.

27.3.3 Survey indices

Seven fisheries-independent surveys were combined to model the first biomass index for plaice in this stock area. This modelled index was produced using VAST, which is a Vector Autoregressive Spatiotemporal model in R (Thorson *et al.*, 2016). This model implements a spatial delta-generalized linear mixed model (delta-GLMM) to standardizing survey. VAST is spatially explicit model that predicts population density for all locations within a spatial domain, and then predicts derived quantities (i.e. biomass abundance) by aggregating population density across spatial domain while weighting density estimates by the area associated with each estimate.

The model was parametrised using haul level data from seven fisheries-independent surveys undertaken in the Celtic Sea (1997–2021) (Table 27.2). The coverage of these surveys varies in space and time, a full description of which can be found in Table 27.2 and Figure 27.9. The raw survey data were checked for quality (specifically, the estimated weights of the catch numbers-at-length were checked against the reported catch weights). For each valid haul, the catch weight, tow duration, tow position (midpoint), survey series and year were used as input values for the VAST model. The model was specified to have spatial autocorrelation but no temporal autocorrelation (i.e. years are independent). VAST can optionally estimate, and correct for, differences in catchability between the two survey series as there is a significant spatial overlap between the two surveys. The model first estimates the likelihood of occurrence and then the biomass using a gamma error distribution or the abundance using a lognormal error distribution. Historically none of these surveys were used to estimate abundances of plaice as individually they do not cover the full stock area, spatially/ temporally, and now of the surveys have been designed with this stock and species in mind. Vast offers a number of advantages over more traditional ways of estimating abundances. It has an ability to deal with gaps in survey coverage, and an ability to account for differences in catchability between surveys or vessels, providing an objective way to combine multiple indices even when the gear is not standardised.

The spatial domain was defined as 1000 knots, and implemented using k-means clustering to give knot positions proportional to sampling intensity (Thorson, 2019) (Figure 27.9). Residual diagnostics on the encounter probability appeared acceptable (Figure 27.10). Visualisation of the Pearson's residuals of positive catches (Figure 27.11a) and encounter probability (Figure 27.11b) show no strong patterns. These plots are the default output from the package, however in the future the presence/absence residuals should be revisited. The estimated survey biomass indices are presented in Table 27.3 and Figure 27.14, along with associated uncertainty. Visualisation of spatiotemporal variability in estimated log density of plaice in ICES divisions 7h–k (Figure 27.13), show distributional trends in areas of high abundance that mirror that of the known fishery, with high incidence of reported landings occurring in areas similar to the biomass from this VAST index, along the southwest coast of Ireland and the southwest coast of the UK. It is clear that these patches of high abundance spill over into adjoining stock area, plaice 7fg, where landings are substantially higher than the plaice in 27.7h–k.

27.3.4 Biological

A number of length-based parameters were required for the calculation of the new 'rfb' catch advice rule (ICES, 2020): mean length in observed catch ($\bar{L}_{y-1}$), the length at first capture relative to the target length ($L_{F=M}$) , asymptotic length at which growth is zero (L_∞), length at first catch (length at 50% of mode) L_c.

The calculation of the 'rfb' catch advice rule requires the calculation of *f* which is the ratio of mean length ($\bar{L}_{y-1}$) in the observed catch that is above the length of the first capture relative to the target length ($L_{F=M}$). The mean length in the observed catch was calculated by plotting the landings and discards data submitted to InterCatch over all years (2004–2021). The length of the first capture relative to the target length ($L_{F=M}$) is calculated ($L_{F=M}$ = 0.75*L_c + 0.25*L_∞). Length at first catch (length at 50% of mode)(L_c) was calculated from the landings and discards data submitted to InterCatch. L_c was calculated for each year, but was found to be highly variable due to the variable and low sample number submitted for discards (Figures 27.15 and 27.16). Therefore, a mean of the time-series, 228.9 mm, was estimated as the L_c of this stock (Figure 27.17) and used in the calculation of rfb. Similarly, the mean length in observed catch ($\bar{L}_{y-1}$) was found to be was found to be highly variable due to the variable and low sample number submitted for discards (Figures 27.15 and 27.16). Therefore, a mean of the time-series, 297.3 mm, was estimated as the $\bar{L}_{y-1}$ of this stock (Figure 27.18) and used in the calculation of rfb.

L_∞ is calculated from the von Bertalanfy growth model. Samples available through DATRAS were used to calculate these length parameters. These samples were collected by three surveys, Irish ground fish survey (IGFS, 2004–2021), Irish anglerfish and megrim survey (IAMS, 2016–2021) and the French southern Atlantic bottom trawl survey (EVOHE, 2014–2021). Although none of these surveys are designed to capture the dynamics of this stock, they do provide the samples required to produce estimates of life history parameters. Only samples from 7j (n= 1648) were used to calculate these parameters due to low sample size in 7h (n=11).

The FSA package in R (Ogle *et al.*, 2022) was used to determine the starting values Ford-Walford =(vbStarts{FSA}) and to fit a von Bertalanffy growth curve was fit to the survey data for all areas combined, by bootstrapping a nonlinear regression (nls{stats}(R Core, 2020)). Due to the uneven sample size it was not possible to determine if these growth parameters vary between ICES divisions 7j and 7h. However, we could estimate the growth parameters for the whole stock as linf = 466.83 mm (SD ± 22.85), K = 0.18 (SD± 0.03), t0 = -2.13 (SD± 0.31) (Figure 27.19). Residuals of model fitted considered acceptable (Figure 27.20).

27.4 Advice

27.4.1 Analyses of stock trends and potential status indicators

Advice is given based on trends in the VAST survey biomass index, The LBI-estimated values of the ratio *Lmean/LF=M* are used to estimate exploitation status relative to the proxy MSY reference point, as described in the stock annex.

The advice for 2023 was set using the HCR 'rfb' as outlined in the table below (ICES, 2022).

Previous catch advice Ay	110 tonnes	
Stock biomass trend		
Index A (2020, 2021)		587
Index B (2017, 2018, 2019)		457
r: Index ratio (A/B)		1.28
Fishing pressure proxy		
Mean catch length (L_{mean}=L_{2021})		29.7 cm
MSY proxy length ($L_{F=M}$)		28.9 cm
f: multiplier for relative mean length in catches (L_{mean}/$L_{F = M\ 2020}$)		1.03
Biomass safeguard		
Last index value (I2021)		150 tonnes
Index trigger value (Itrigger=Iloss×1.4)		698 tonnes
b: multiplier for index relative to trigger (I2021/Itrigger; Itrigger = Iloss*1.4 = 1.05)		1
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier to maintain the biomass above B_{lim} to with 95% probability		0.95
Uncertainty cap (+20%/-30% compared to Ay, only applied if b≥1)	Applied	1.2
Discard rate		47%
Catch advice for 2023 and 2024 (Ay × uncertainty cap)		132 tonnes
% advice change		+ 20%

These results suggest that the relative fishing mortality is below the reference F_{MSY} proxy and the relative biomass is well-above the reference B_{MSY}* 0.5 proxy. Therefore, the Precautionary Approach Buffer (PA Buffer) was not applied for the advice for this stock.

27.4.2 State of the stock

On the relative scale, the spawning biomass is estimated to have been since 2004 and has in remained high and stable in recent years (Figure 27.21). Estimated F was below F_{MSY} from 2004, and is now at the lowest point in the time-series.

27.4.3 Biological reference points

The table below summarises all known reference points for plaice in 27.7h–k and their technical basis. The LBI-estimated values of the ratio *Lmean/LF=M* are used to estimate exploitation status relative to the proxy MSY reference point.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger\ proxy}$	150	Biomass index trigger value ($I_{trigger}$), defined as $I_{trigger}$=I_{loss}×1.4, where I_{loss} is the lowest observed historical biomass index value from 2005. In estimated metric tonnes from derived from VAST.	ICES (2022a,b)
	$F_{MSY\ proxy}$	$\frac{L_{mean}}{L_{F=M}} = 1$	Relative value from LBI analysis, assuming M/K = 1.5. $L_{F=M}$ is based on L_c (length at 50% of modal abundance), which varies each year	ICES (2020)
Precautionary approach	B_{lim}	Not defined		
	B_{pa}	Not defined		
	F_{lim}	Not relevant		
	F_{pa}	Not relevant		
Management plan	SSB_{MGT}	Not relevant applicable		
	F_{MGT}	Not relevant applicable		

27.5 Recommendations for the next benchmark

This stock should be considered for the next SPiCT workshop to assess if it can be moved to a category 2 stock.

27.6 References

ICES. 2020. Tenth Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE X). ICES Scientific Reports, 2:98. 72 pp. http://doi.org/10.17895/ices.pub.5985.

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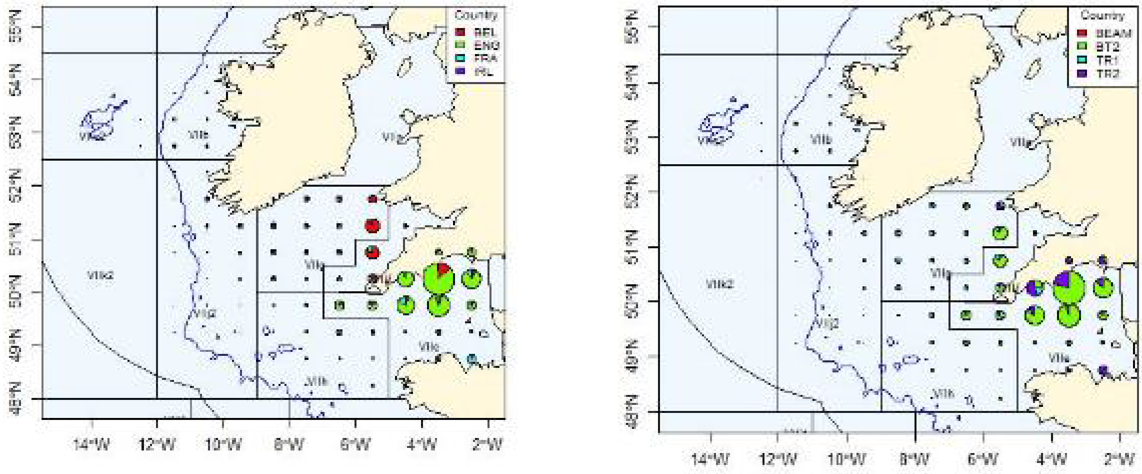

Figure 27.1 The spatial distribution of plaice landings reported to the STECF fisheries-dependant information data call in 2016 (the last data year available), disaggregated by Member State (left) and gear (right). Note beam trawlers are described as beam and BT2, and otter trawlers are described as TR1 and TR2.

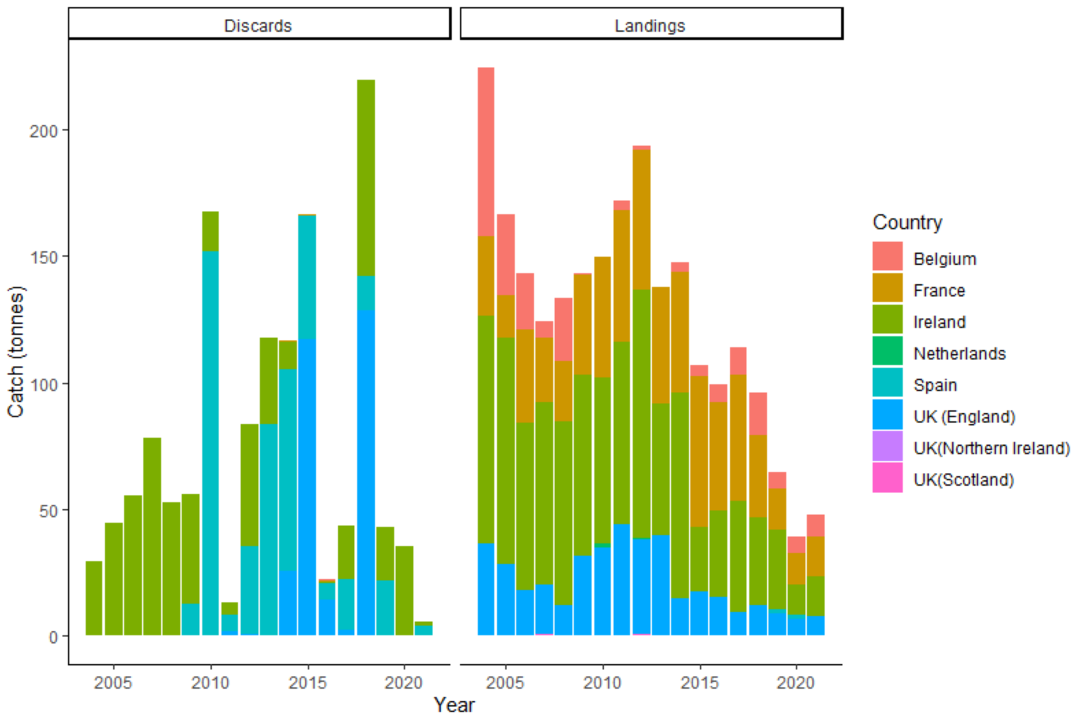

Figure 27.2. Plaice in Divisions 7.h–k. Landings and discards reported in InterCatch by country.

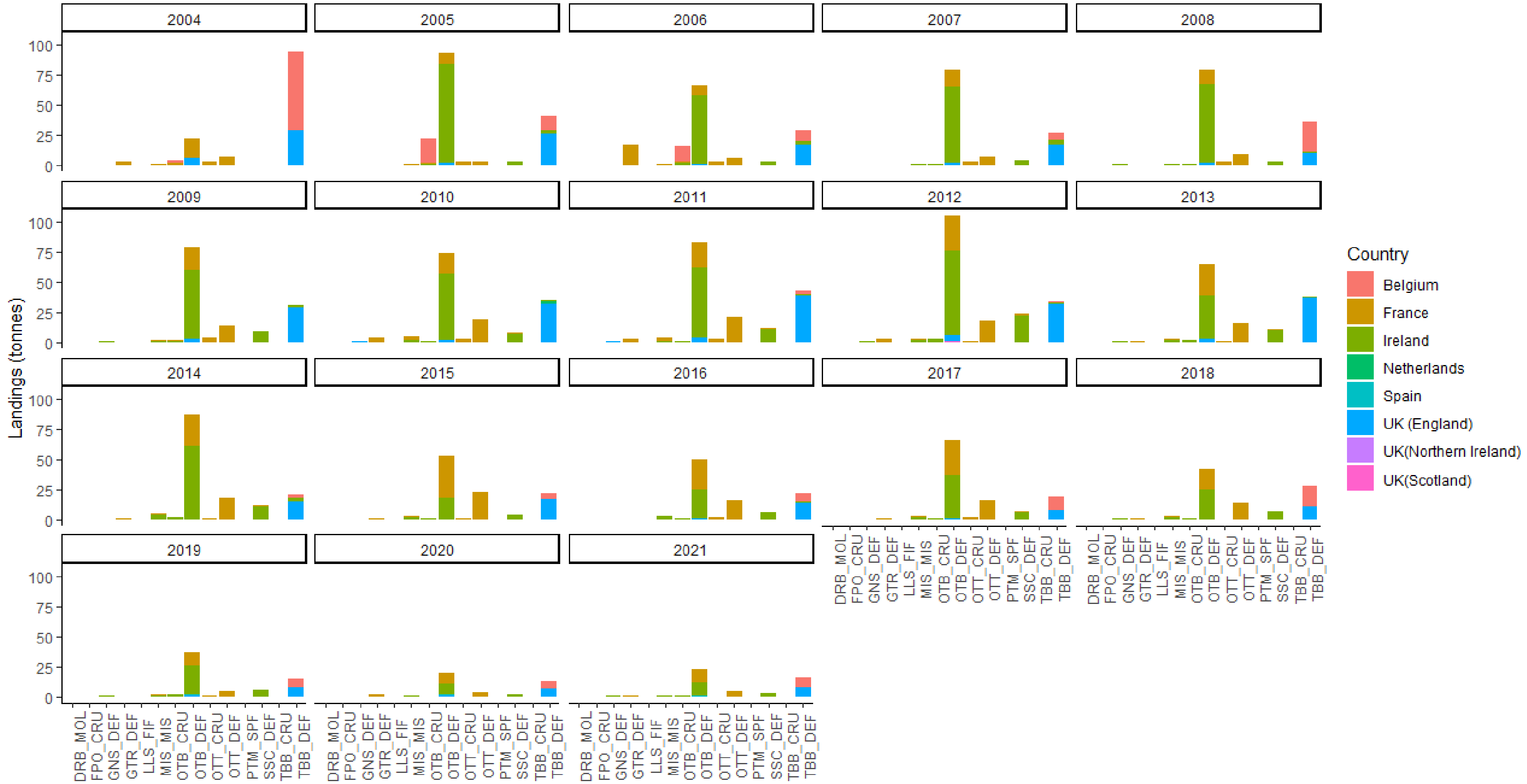

Figure 27.3. Plaice in Division 7.h–k. International landings reported in InterCatch by fleet and year.

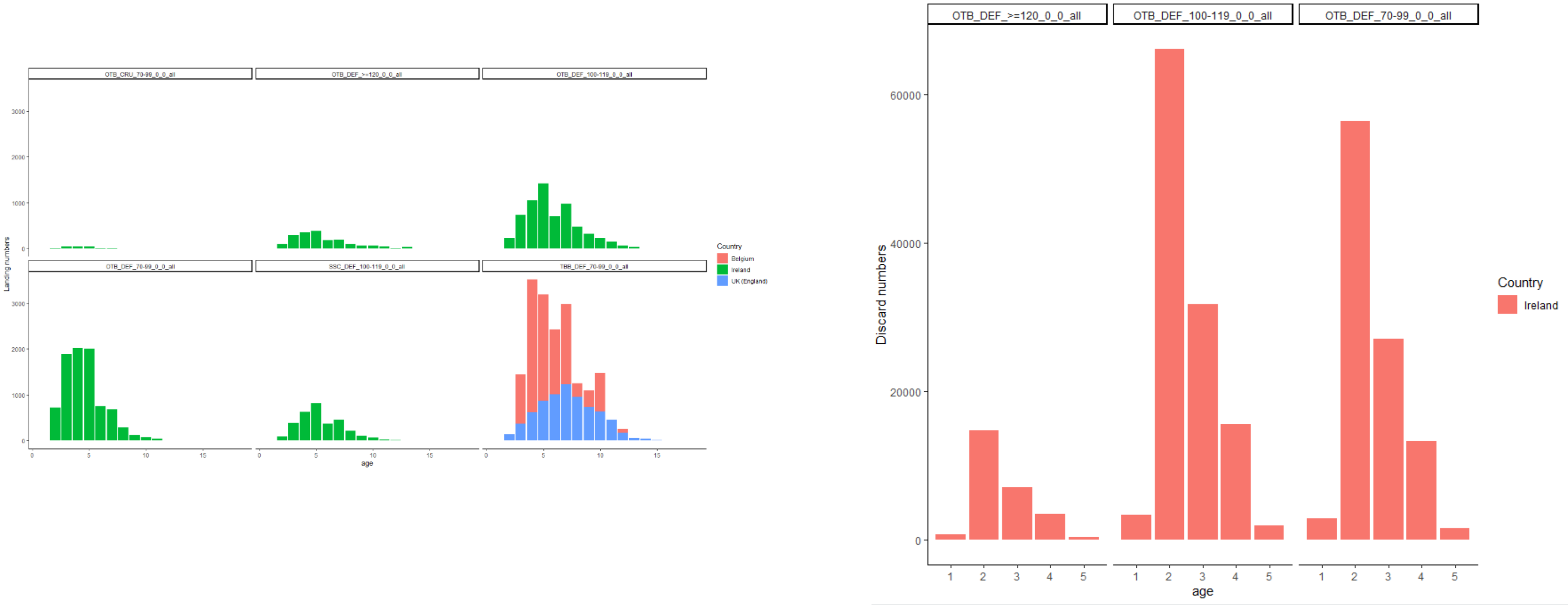

Figure 27.4. Plaice in Division 7.h–k. Unraised landings (left) and discard (right) age distributions submitted to InterCatch.

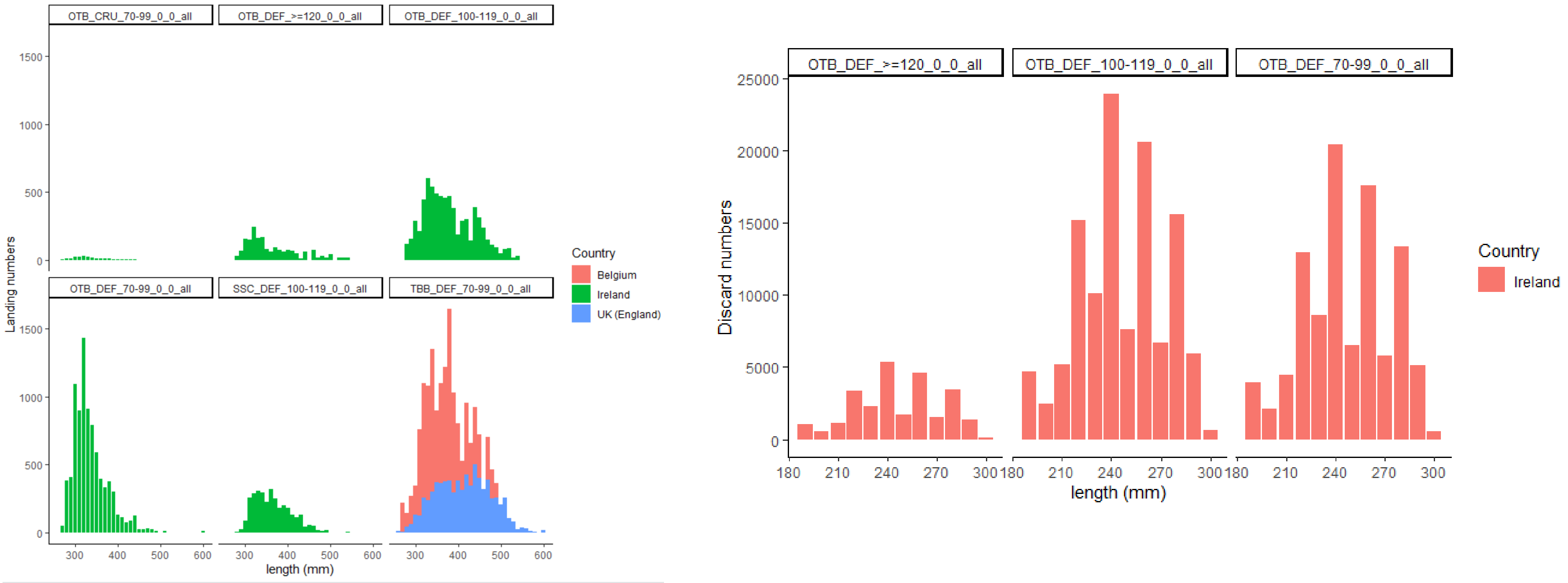

Figure 27.5. Plaice in Division 7.h–k. Unraised landings (left) and discard (right) length distributions submitted to InterCatch.

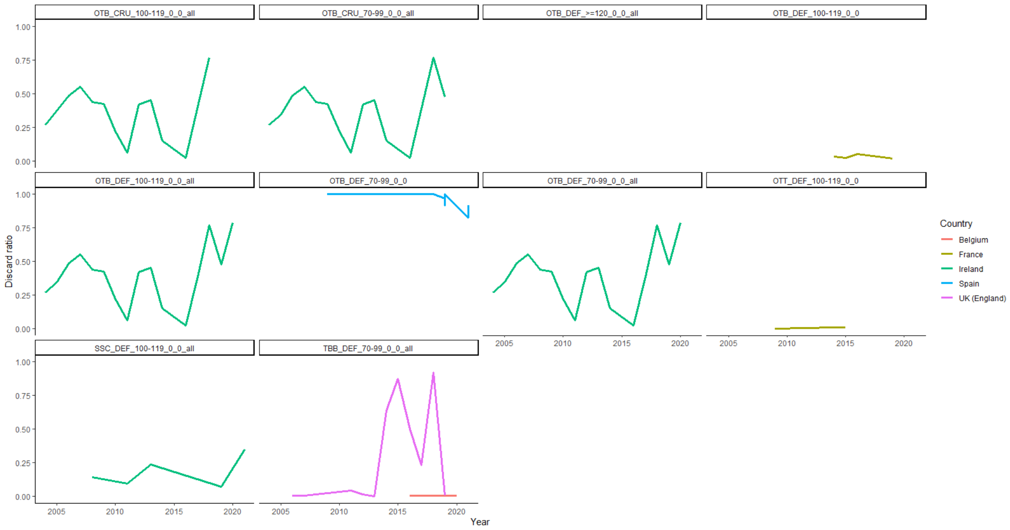

Figure 27.6. Plaice in Division 7.h–k. Raw variable discard rates.

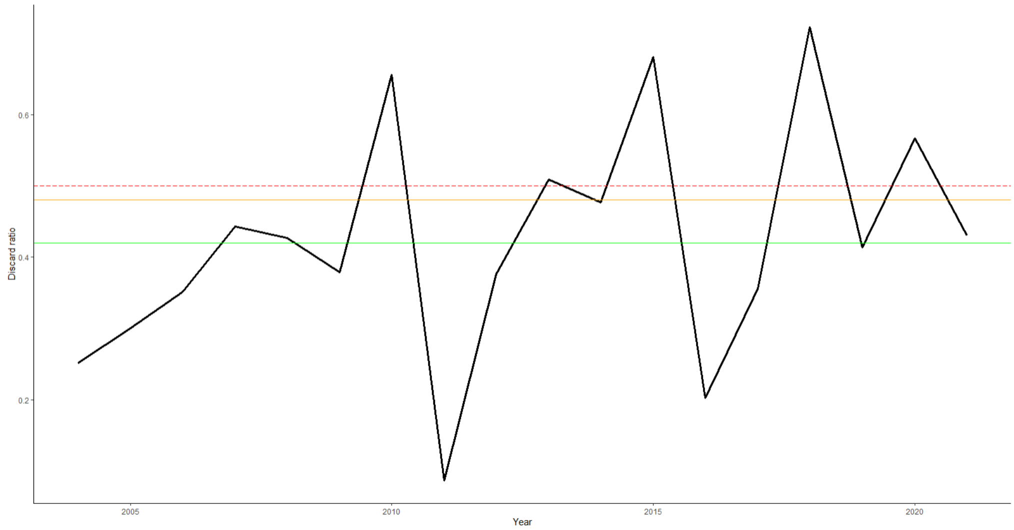

Figure 27.7. Plaice in Division 7.h-k. High inter-annual variability of discard rates supplied to InterCatch. Therefore, ICES discards are derived from estimated discard rates, 42% (green line) from 2004–2019 (mean 2004–2019), 50% (red line) in 2020 (geometric mean 2016–2020), 49% (orange line) in 2021 (geometric mean 2017–2020).

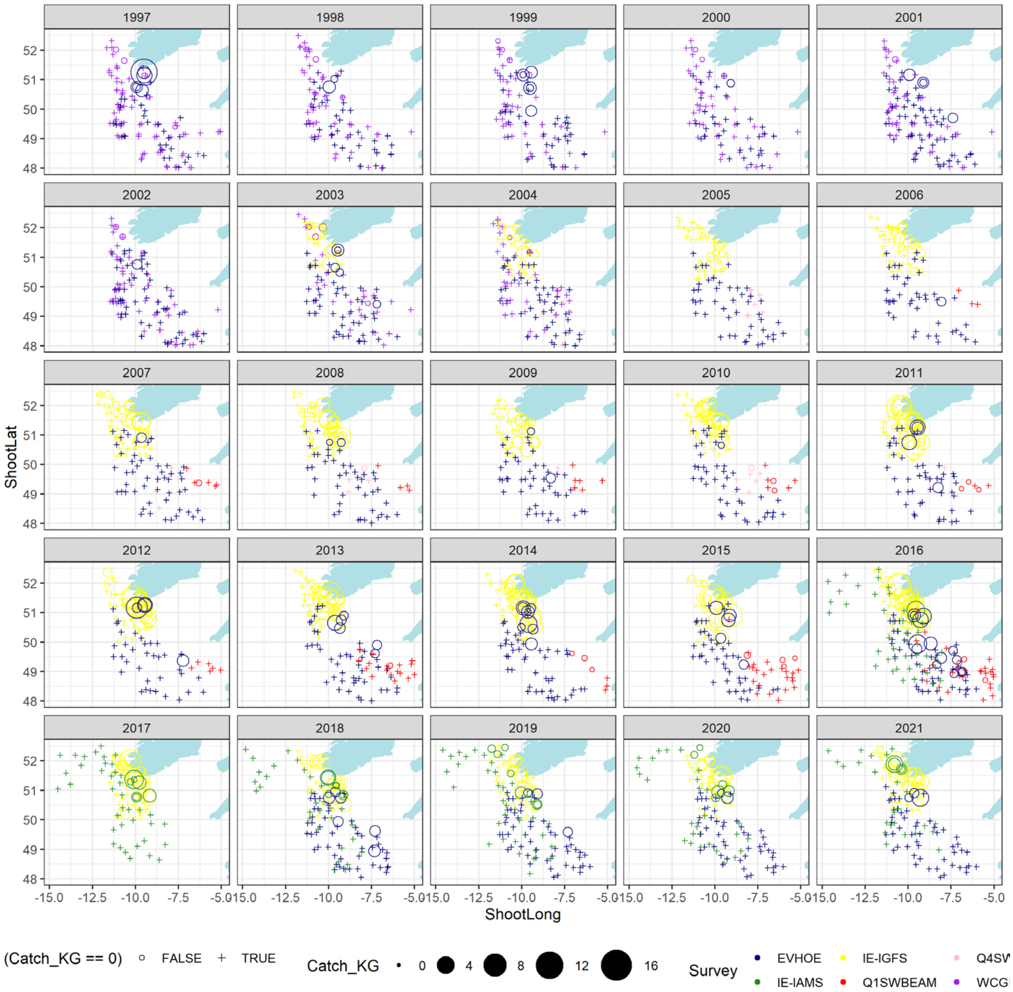

Figure 27.8. Plaice in Division 7.h–k. Survey numbers per haul by year. Each point represents haul with a positive count shown as a circle and a zero as a '+' symbol. Circle diameter is proportional to the count. Colours denote the surveys.

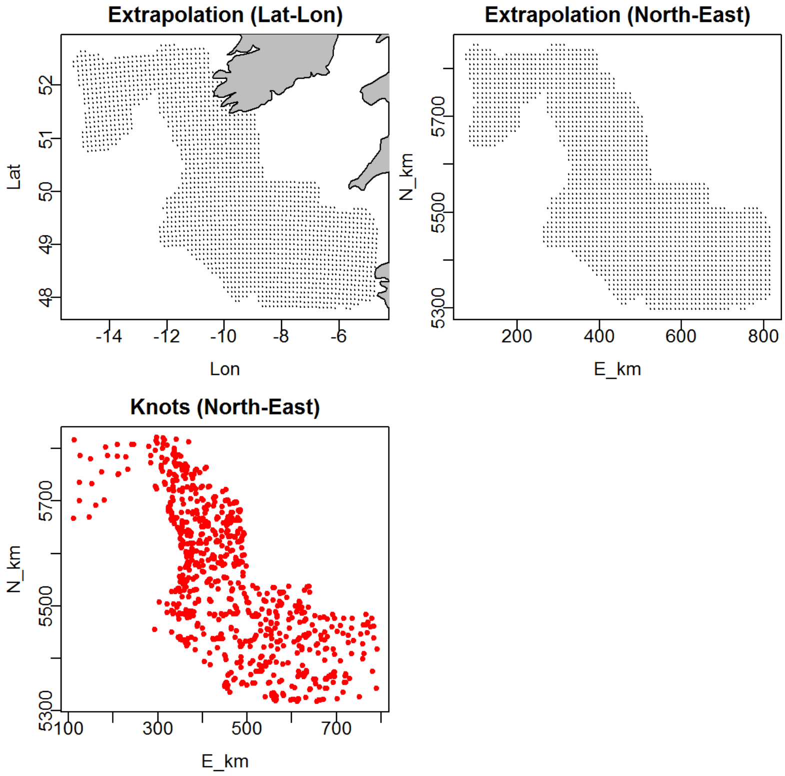

Figure 27.9. Plaice in Division 7.h–k. The spatial area defined within the model in terms of latitude and longitude (top left), kilometres (top right) and knots (bottom).

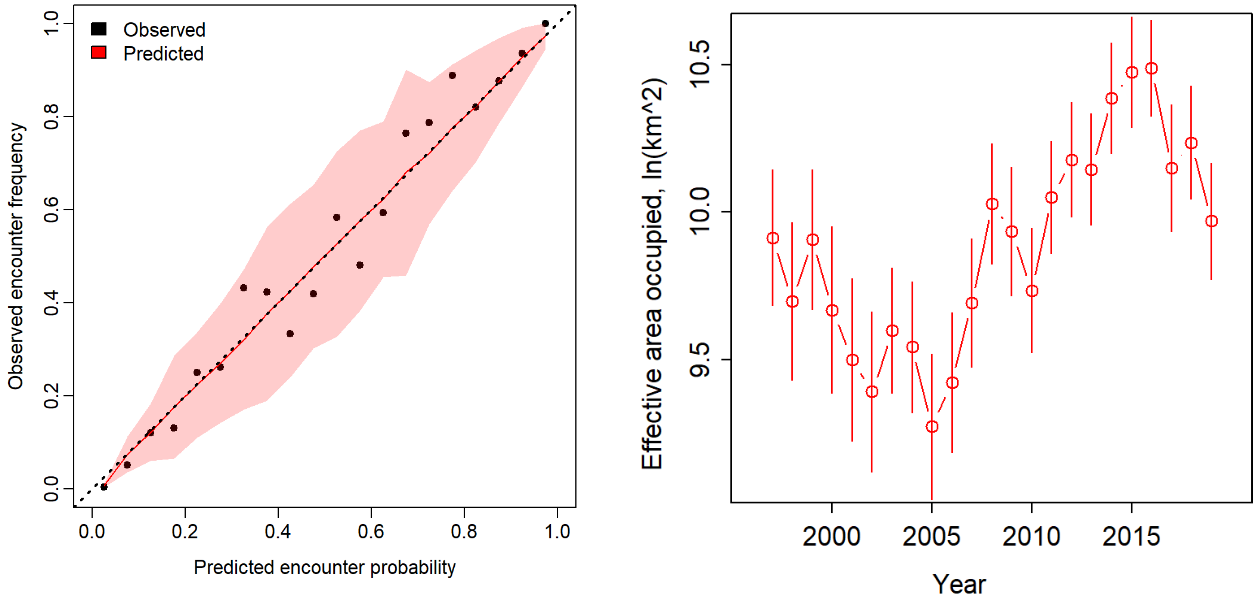

Figure 27.10. Plaice in Division 7.h–k. Residual diagnostics showing predicted encounter probability against observed encounter probability (left) and the effective area occupied (right).

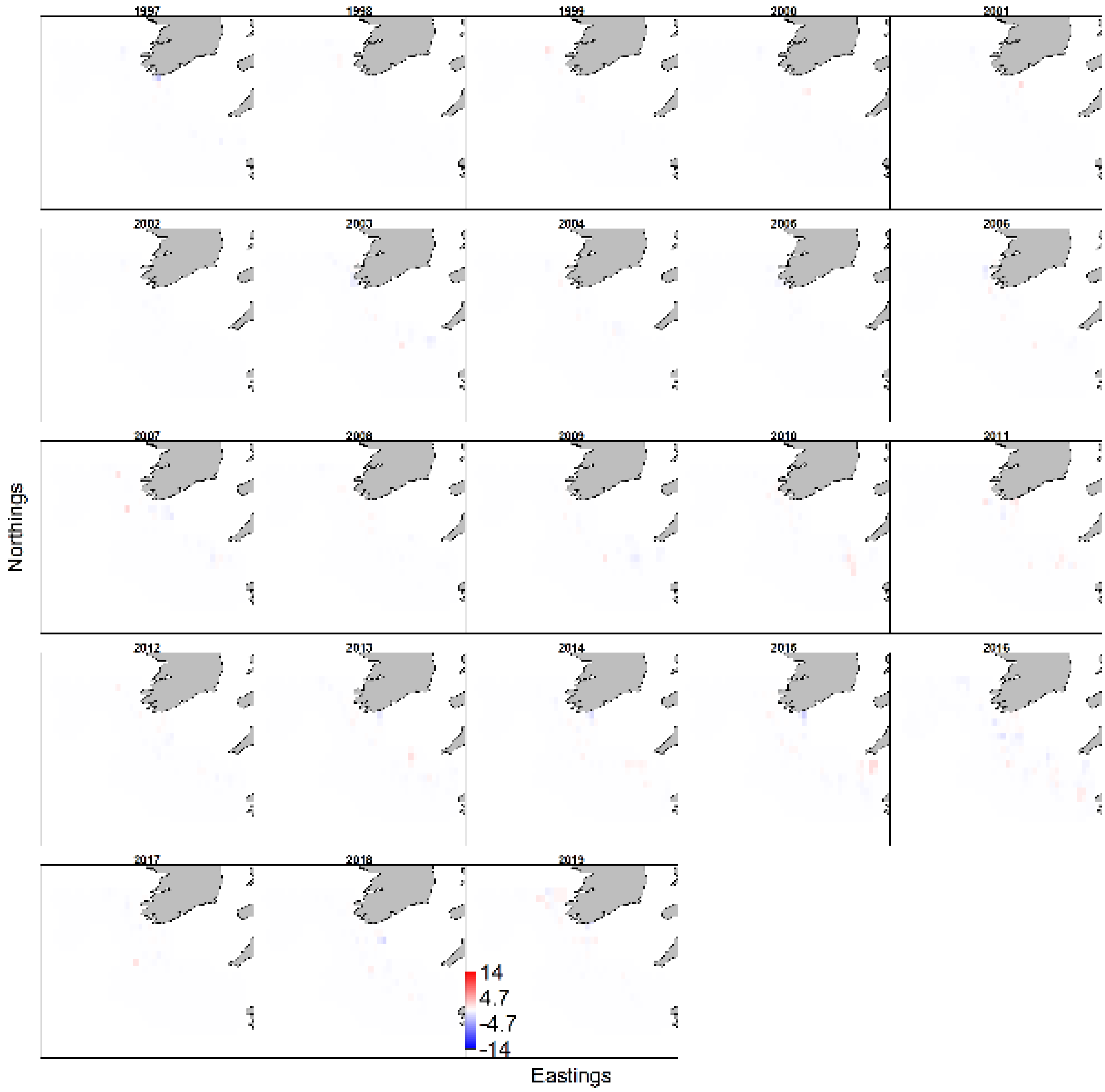

Figure 27.11(a). Plaice in Division 7.h–k. Spatiotemporal persons residuals (1) of encounter probability.

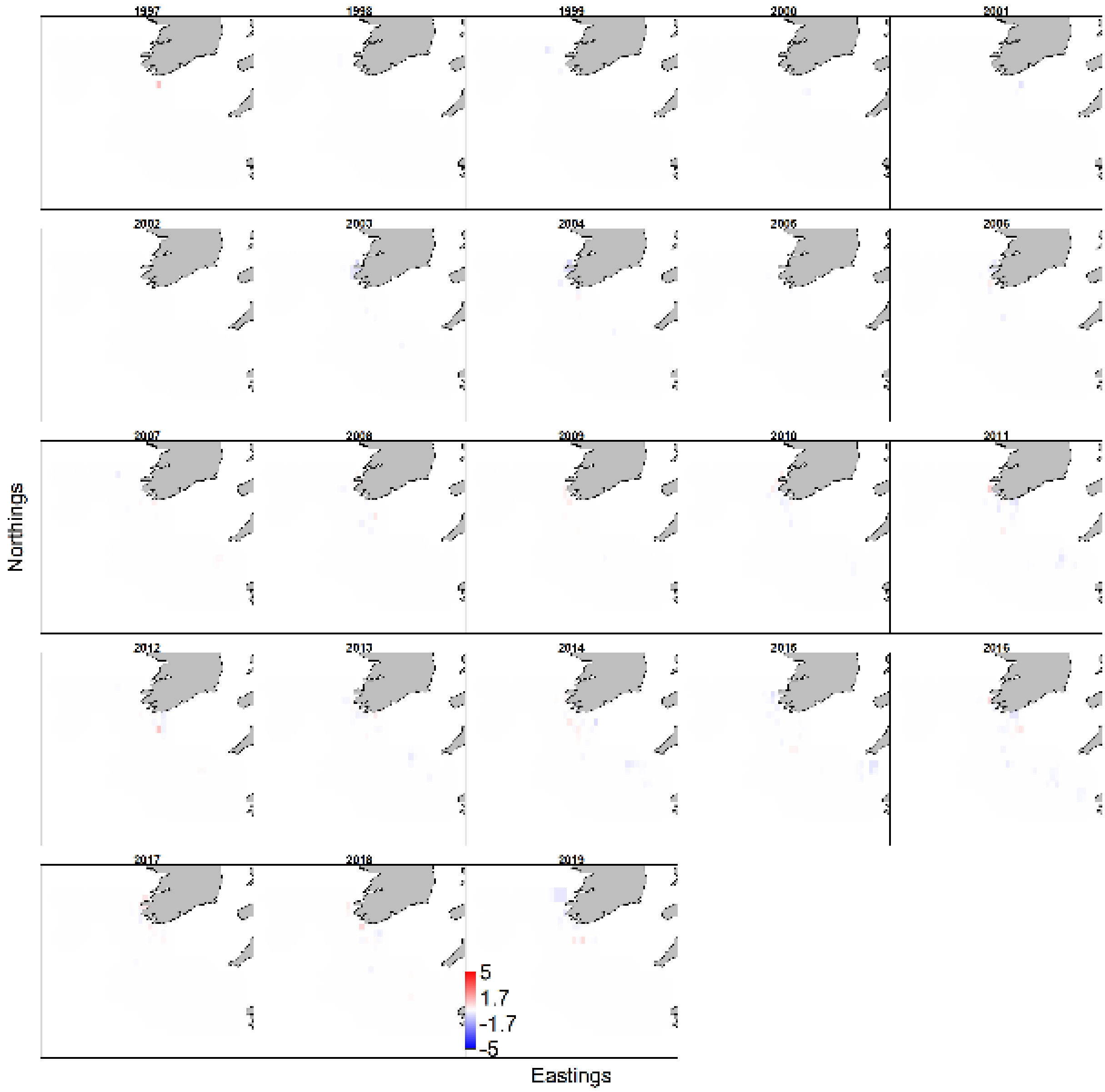

Figure 27.11(b). Plaice in Division 7.h–k. Spatiotemporal persons residuals (2) of encounter probability.

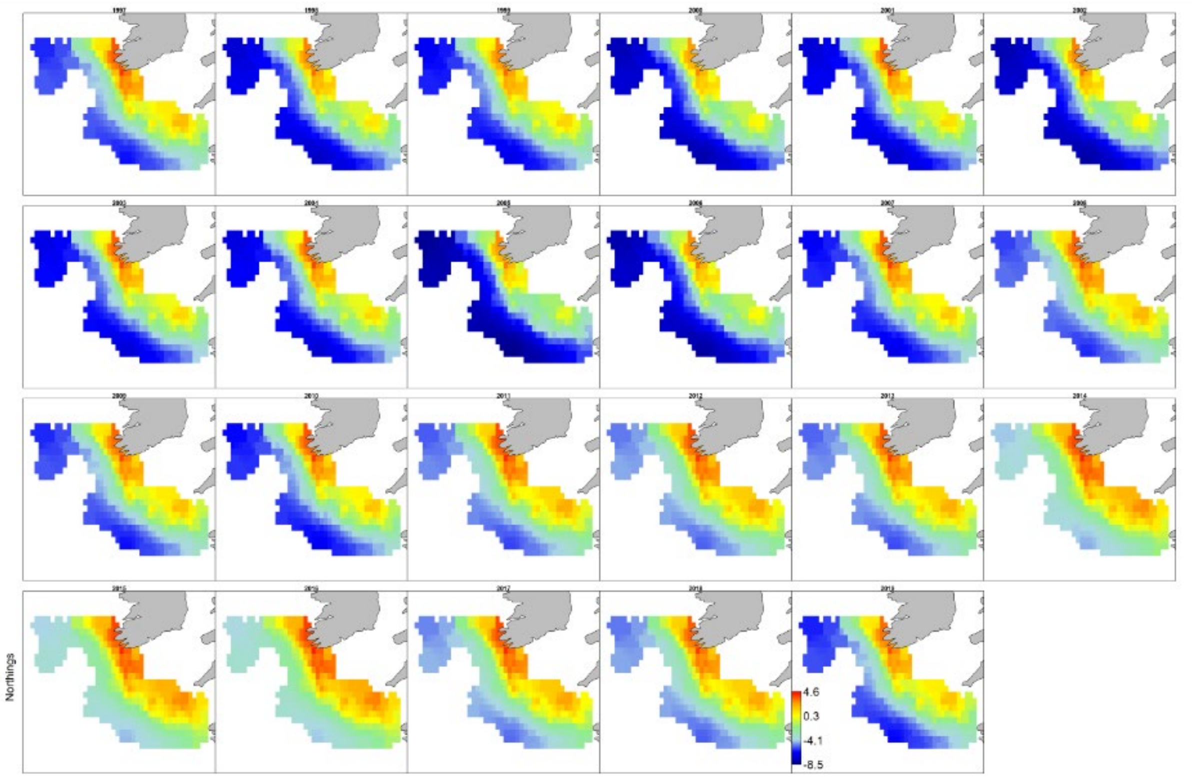

Figure 27.12. Plaice in Division 7.h–k. Spatiotemporal variability in estimated log density of plaice.

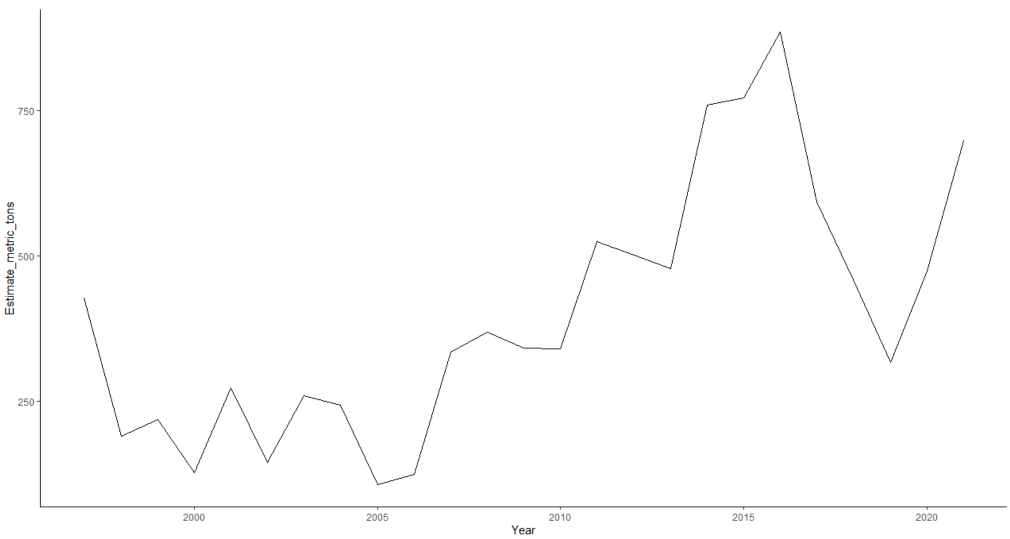

Figure 27.13. Plaice in Division 7.h–k. VAST estimated biomass in tonnes.

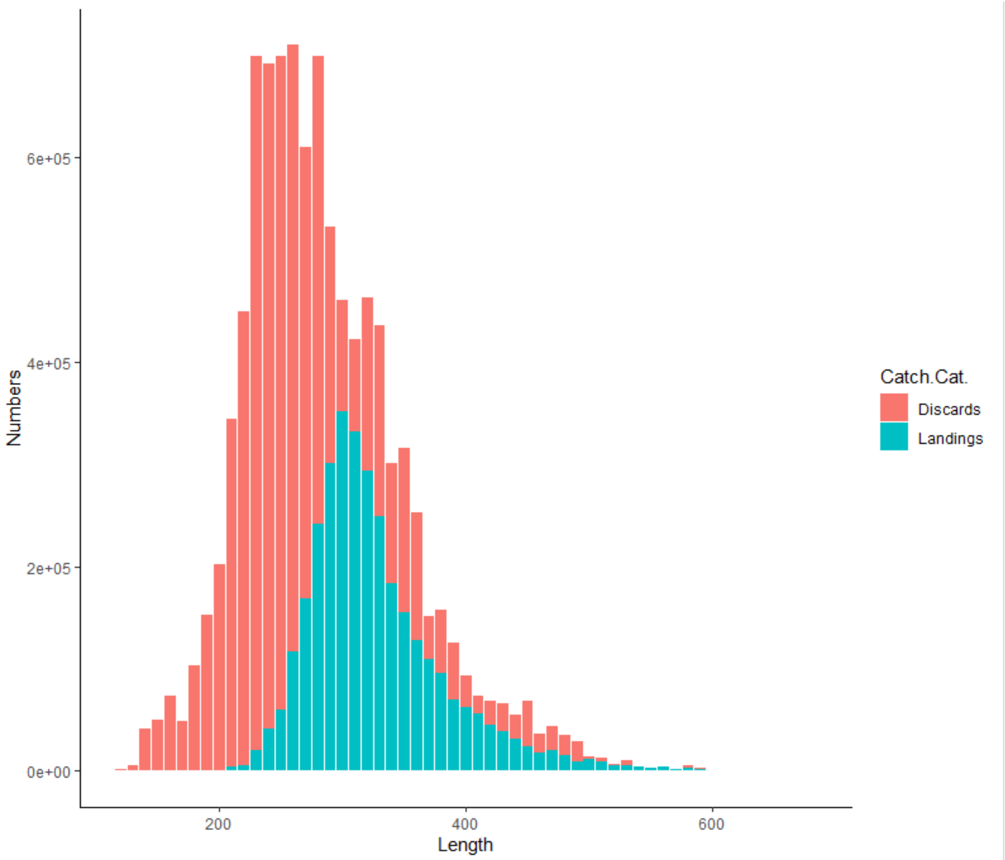

Figure 27.14. Plaice in Division 7.h–k.

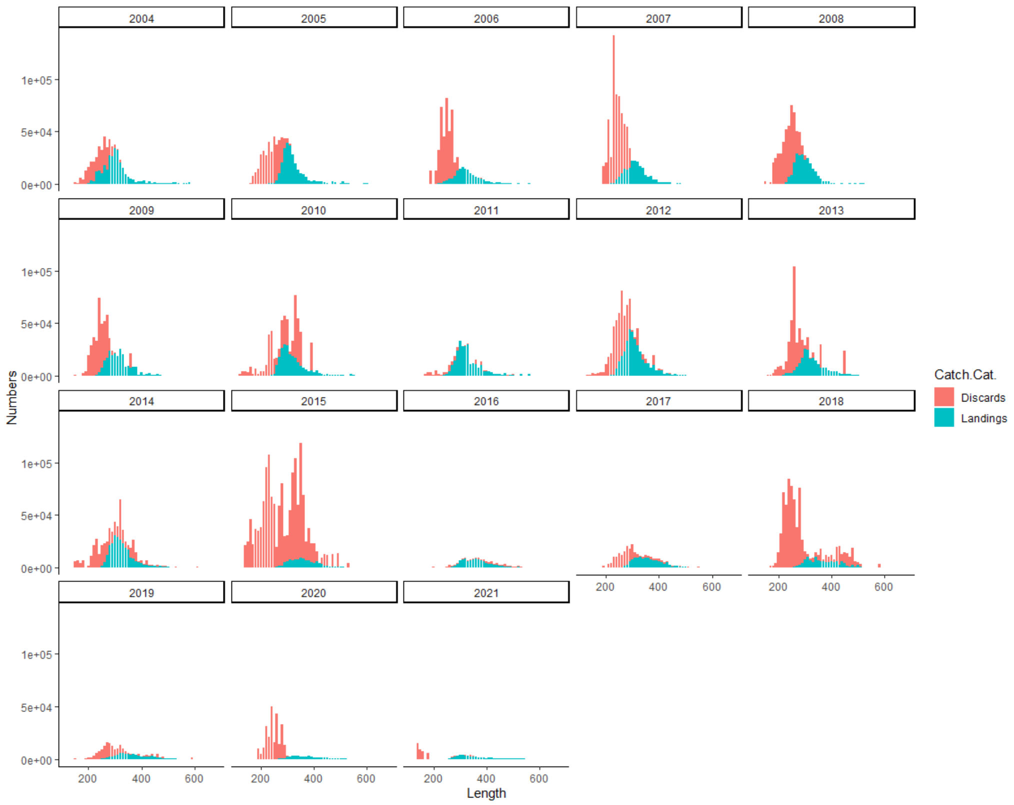

Figure 27.15. Plaice in Division 7.h–k.

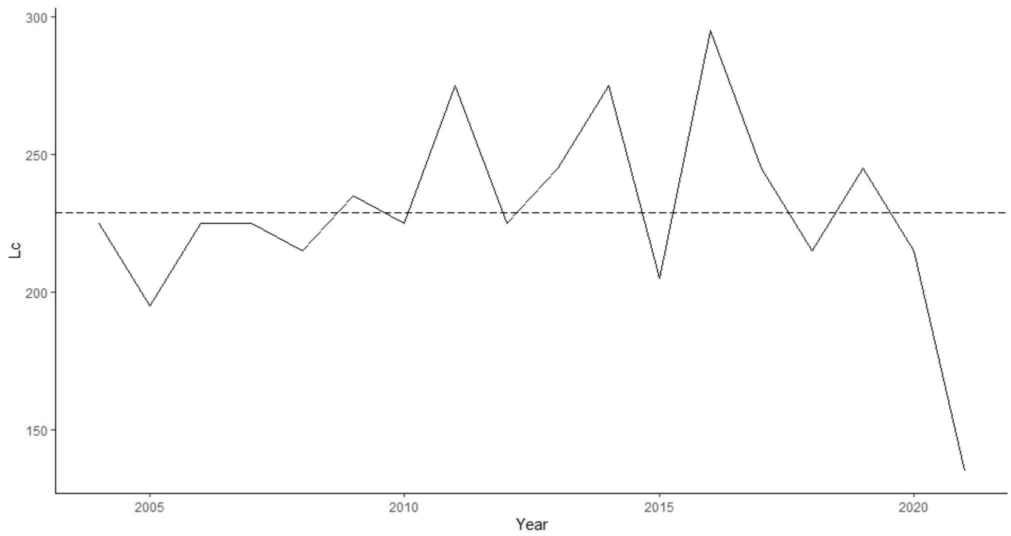

Figure 27.16. Plaice in Division 7.h–k. Lc.

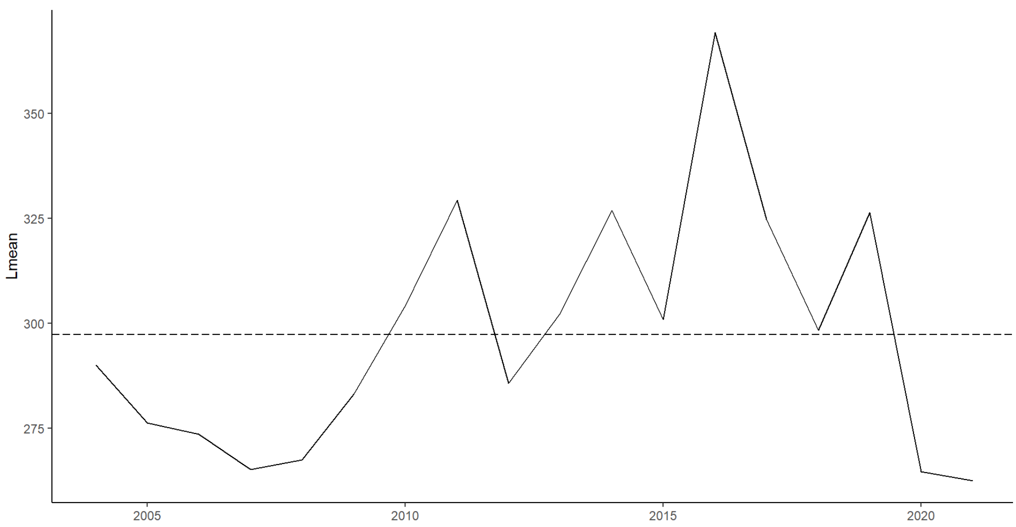

Figure 27.17. Plaice in Division 7.h–k. Lmean.

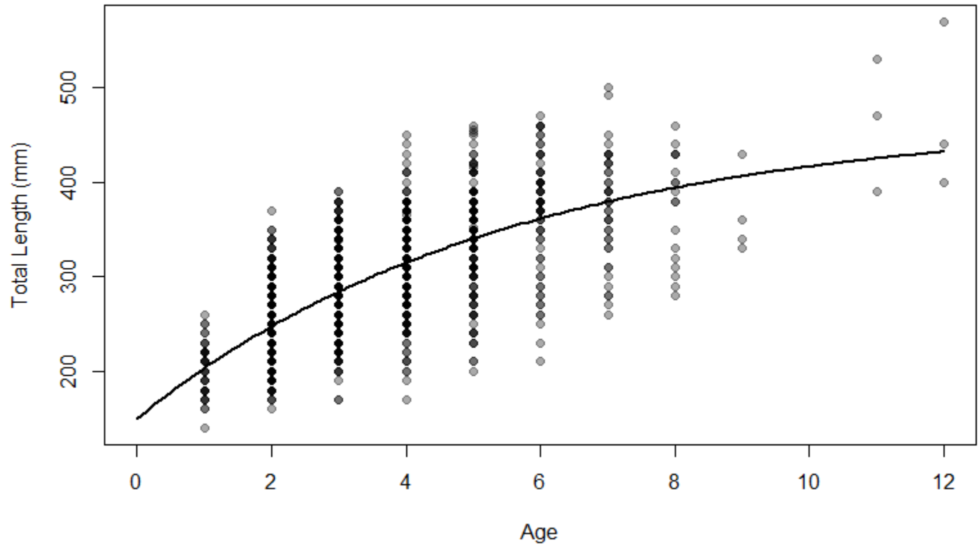

Figure 27.18. Plaice in Division 7.h–k. Length (mm) versus age (dots) with superimposed best-fit von Bertalanffy growth function (black line) of all plaice in ICES divisions 27.7h and 27.7j available in Datras.

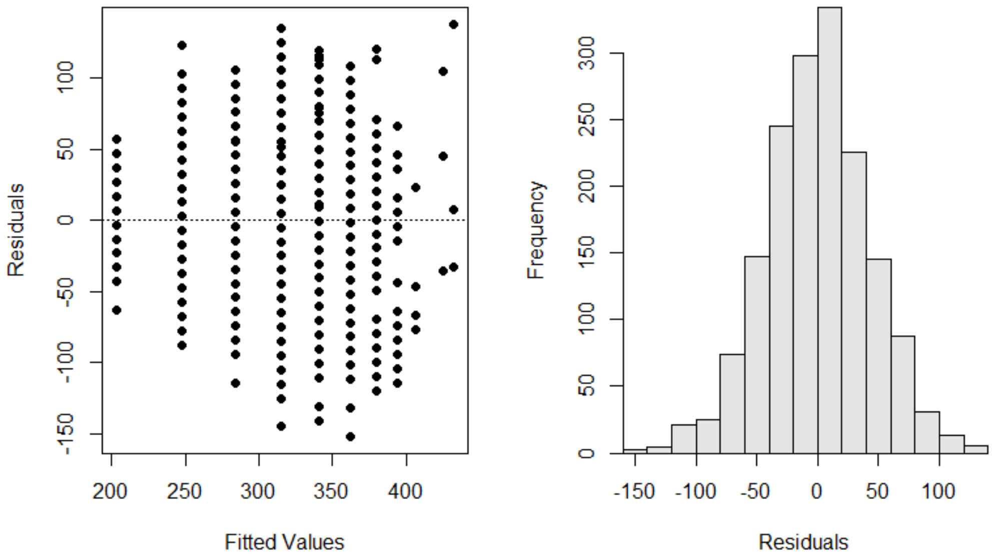

Figure 27.19. Plaice in Division 7.h–k. Residual plot (left) and histogram of residuals (right) of von Bertalanffy growth function (black line) on plaice in ICES divisions 27.7h and 27.7j available in Datras.

Table 27.1. Plaice in divisions 7.h–k. History of official landings by country and ICES estimated landings (tonnes).

Year	BEL	FRA	IRL	UK	OTH	Official landings	ICES landings
1995	0	60	321	286	0	667	
1996	0	48	305	155	52	560	
1997	0	69	344	138	0	551	
1998	0	49	286	106	13	454	
1999	45	0	299	82	1	437	
2000	4	54	200	76	7	341	
2001	27	50	160	73	3	313	
2002	69	45	155	59	2	330	
2003	20	32	127	56	6	241	
2004	67	32	91	36	6	232	224
2005	32	20	90	28	0	170	167
2006	22	36	66	18	1	143	143
2007	7	30	72	20	13	141	124
2008	25	13	73	12	1	124	133
2009	1	44	72	32	0	149	143
2010	<1	54	66	35	0	155	150
2011	4	58	72	44	0	178	172
2012	2	62	99	38	0	201	193
2013	0	49	52	40	0	141	137
2014	4	52	82	15	0	153	147
2015	0	60	25	18	0	103	107
2016	7	46	32	15	0	100	99
2017	11	53	42	10	0	116	114
2018	17	35	32	0	11	95	96
2019	6	17	c	9	2	34 c	64
2020*	7	12	12	7	1	39	39
2021*	9	14	15	8	<1	46	48

Table 27.2. Plaice in divisions 7.h–k. Surveys incorporated into VAST biomass index.

Survey	Years	Quarters	Gear	Sources	Wing spread
IGFS	2003–2021	4	Otter	DATRAS	Available at haul level
IAMS	2003–2021	1	Otter & Beam	DATRAS	Available at haul level
EVOHE	2003–2021	4	Otter	DATRAS	Available at haul level
WGCFS	1997–2004	1,2,4	Otter	CEFAS	Set to 21 m (average of other otter trawl surveys in series)
SWBEAM	2006–2021	1	Beam	DATRAS	Available at haul level
SWIBTS	2003–2011	4	Otter	CEFAS	Set to 21 m (average of other otter trawl surveys in series)

Table 27.3. Plaice in divisions 7.h–k. Table abundance index – what is the SD log and SD mt.

Year	Biomass estimate (tonnes)	SD_log	SD_mt
1997	427.38	0.35	151.27
1998	189.42	0.49	92.74
1999	218.89	0.37	80.43
2000	127.41	0.53	67.64
2001	272.77	0.48	130.76
2002	145.11	0.54	78.71
2003	259.89	0.30	78.84
2004	243.33	0.33	81.28
2005	107.38	0.41	43.79
2006	123.99	0.36	44.58
2007	334.29	0.30	101.66
2008	368.39	0.27	100.58
2009	342.01	0.31	104.69
2010	339.91	0.28	93.98
2011	524.27	0.24	128.01
2012	501.62	0.25	124.23
2013	478.33	0.24	116.64
2014	760.40	0.23	171.45
2015	771.81	0.25	192.01
2016	885.08	0.20	180.68
2017	592.94	0.27	161.56
2018	459.78	0.25	114.38
2019	317.21	0.26	83.74
2020	474.79	0.28	134.20
2021	698.41	0.25	174.04

Table 27.4. Summary table for ple-7.jk assessment in input values.

Year	Biomass index	Landings	Discards
1995		667	
1996		560	
1995		667	
1996		560	
1997	427	551	
1998	189	454	
1999	219	427	
2000	127	341	
2001	273	313	
2002	145	330	
2003	260	241	
2004	243	224	162
2005	107	167	121
2006	124	143	104
2007	334	124	90
2008	368	133	96
2009	342	143	104
2010	340	150	108
2011	524	172	124
2012	502	193	140
2013	478	137	100
2014	760	147	107
2015	772	107	77
2016	885	99	72
2017	593	114	83
2018	460	96	70
2019	317	64	47
2020	475	39	39
2021	698	48	46

28 Pollack in the Celtic Seas (ICES subareas 6 and 7)

Type of assessment in 2022

The Celtic Sea and West of Scotland (subareas 6 and 7) Pollack stock is considered a Data-Limited Stock, classified by ICES WKLIFE II (ICES, 2012) as category 4.1.2. DCAC (Depletion-Corrected Average Catch) method is recommended to assess this stock, which is performed through the NOAA toolbox.

ICES advice applicable to 2023

ICES advises that when the precautionary approach is applied, commercial catches should not exceed 3360 tonnes in 2023.

28.1 General

Stock Identity

This section is not dedicated to a 'stock', it relates to a species in a wider region where data are available. The stock structure of Pollack populations in this ecoregion is not clear. ICES does not necessarily advocate that subareas 6 and 7 constitute a management unit for Pollack, and further work is required.

Management applicable to 2022

The 2022 TAC for Pollack was set for ICES subareas 6 (and 5.a, b; international waters of 12 and 14) and 7 separately, Table 28.1.

The 2021 TAC for subarea 6 was 156 tonnes and uptake low at 41.3% and varied considerably between countries. France, which holds 48.0% of the TAC, only utilised 3.4% of their quota. The UK utilised 64.2% of the 36.5% TAC allocation, and Spain utilised none of their 1.3% TAC allocation. Ireland has 14.1% of the total TAC and had the largest uptake and exceeded their quota by 15.4% (30 tonnes as opposed to 26 tonnes).

In Subarea 7, which comprises the vast majority of landings and a TAC of 8012 tonnes, the uptake was also low at 21.3% and again varied considerably between countries. France, which holds the majority of the TAC allocation (67.0%), only utilised 9.3% of this. The UK utilised 39.6% of its 22.7% TAC allocation, Ireland utilised 86.5% of its 7.1% TAC allocation, Belgium and Spain, which hold very low TAC allocations at 2.9% and 0.2%, utilised 2.5% and 5.9% respectively.

Fishery in 2021

Landings

2087 tonnes of pollack were landed in 2021, 96.4% of which came from Subarea 7.

The nominal landings for ICES subareas 6 and 7 are shown in Tables 28.2 and 28.3 respectively.

For Subarea 6, there was an 58.3% increase in landings (76 tonnes) in 2021 compared to the landings in 2020 (48 tonnes), although this is still way below the TAC of 156 tonnes. The UK declared the highest landings (56.6%) followed by Ireland (39.5%). There was a 9% decrease in landings

(2011 tonnes) for Subarea 7 in 2021 compared to 2020 (2210 tonnes). The UK had the highest landings (40.1%) followed by France (29.5%), Ireland (29.2%), Belgium (0.3%) and Spain (0.05%).

Landings by division

In 2021, 96.4% of catches came from Subarea 7, with only 3.6% of landings derived from Subarea 6 and of those, over 99% came from division 6.a. In Subarea 7, the division with the highest proportion of landings derived from 7.e (42.7%) followed by 7.g (17.1%), 7.j (14.0%), 7.h (13.6%) and 7.f (7.9%). Landings in divisions 7.a, b, c, d and k were negligible (4.7%).

Landings by gear

The majority of Pollack landings in the Celtic Sea ecoregions were caught by gillnets and trammel nets (51.9%) followed by set lines (17.0%), bottom trawlers (16.0%), miscellaneous gears (10.9%) and beam trawlers (2.8%). When separated by subarea, the predominant gears landing pollack in Subarea 6 were bottom trawlers (57.3%) followed by nets (28.6%) and miscellaneous gears (10.2%). In Subarea 7, nets had the highest landings (52.8%) followed by lines (17.5%), bottom trawlers (14.5%), miscellaneous gears (10.9%) and beam trawlers (2.9%).

Landings by quarter

Pollack are not historically targeted throughout the entire year, and are mainly targeted during the first quarter, which coincides with spawning. The breakdown of landings per quarter shows that the highest landings were in quarter 1 (43.0%) followed by quarter 2 (23.6%), quarter 3 (18.2%) and quarter 4 (15.3%) respectively.

Discards

Discarding was negligible at less than a tonne in 2021.

Landings uncertainty

Pollack is a known recreational fishing species, however; it is unknown as to the quantities exploited by recreational fisheries. A phone study conducted in France in 2011–2013 by Levrel *et al.* (2013) estimated that 3300 tonnes are landed annually through recreational fishing, 2274 tonnes of which are retained. Radford *et al.*, 2018 further suggest that pollack landings may be similar to or above commercial landings. Work is currently being undertaken to provide recreational landing data.

28.2 Stock assessment

A DCAC (Depletion-Corrected Average Catch) method is used to estimate a yield likely to be sustainable (MacCall, 2009). Subarea 6 and 7 are run independently. For Subarea 6, six separate model runs using various parameters (Table 28.4) are conducted giving an average DCAC value plus an upper and lower 95% confidence interval and for Subarea 7, nine separate model runs using various parameters (Table 28.5) are conducted giving an average DCAC value, plus an upper and lower 95% confidence interval.

The information provided for the assessment is insufficient to evaluate the exploitation and the trends of pollack in the Celtic Seas ecoregion. Commercial catches have declined since the late 1980s, and in 2021 are at historical lows for the combined Subarea 6 and 7.

The input data and parameters used for the assessment are detailed in Tables 28.4 and 28.5.

2022 Results

The average DCAC values (Figure 28.1) show that in both subareas 6 and 7, commercial landings are below the average DCAC by 66 tonnes in Subarea 6 and 1853 tonnes in Subarea 7. This suggests that yield in Subarea 6 could be increased up to 142 tonnes and 3864 tonnes in Subarea 7.

Comparison with previous assessment

Table 28.6 compares the results with the previous year's assessment. The results are consistent with the range of DCAC values estimated when the method was previously applied.

Uncertainties in assessment and forecast

The DCAC model relies solely on commercial catch data and does not include any biological or survey data that are available for this stock. The model also cannot estimate reference points.
By construction, the DCAC method only uses long time-series of ICES landings and official landings. As the output is a smoothed value of the landings over the assessed time-series, the computations of DCAC are always similar to the previous year's results, even when recruitment or SSB fluctuate.

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 subareas 6 and 7 are not in line with the current estimates of catches and estimated sustainable yields, and therefore are not constraining.

Management plan

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including pollack in ICES subareas 6 and 7.

Recommendations

This stock began the benchmark process in 2020 (ICES, 2021), but did not proceed past the data compilation phase. This was due to difficulties in quantifying the substantial recreational catch and concerns that at present, scientific surveys were unable to provide a representative abundance index. This was due to low Pollack catches in the surveys and the inshore, reef-based population that were not adequately sampled by existing surveys. Progress was made with regards to improved age and length sampling data from the main countries involved in the fishery so there is potential to push forward with data-limited methods utilising these data.

There is potential to collaborate with ICES Working Group on Recreational Fisheries Surveys (WGRFS) to improve on the existing UK data, and to bolster ongoing work in France and Ireland to provide data on the extent of their recreational fishing of Pollack. Although the recent benchmark did not lead to an improved assessment for Pollack, progress was made in identifying the data shortcomings that exist and potential routes forward. The need for an improvement on the existing DCAC assessment remains, and there is a commitment to progressing the data and assessment options. Based on continuing work this stock is due for benchmark in late 2022.

28.3 References

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L 83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj.

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Table 28.1. 2022 TAC for Pollack in ICES subareas 6 (and 5.a, b; international waters of 12 and 14) and 7.

Species:	Pollack *Pollachius pollachius*	Zone:	6; United Kingdom and international waters of 5b; international waters of 12 and 14 (POL/56-14)
Spain	2	Precautionary TAC	
France	75		
Ireland	22		
Union	99		
United Kingdom	57		
TAC	156		

Species:	Pollack *Pollachius pollachius*		Zone:	7 (POL/07.)
Belgium	233	(1)	Precautionary TAC	
Spain	14	(1)		
France	5 372	(1)		
Ireland	572	(1)		
Union	6 191	(1)		
United Kingdom	1 821	(1)		
TAC	8 012			

(1) Special condition: of which up to 2 % may be fished in United Kingdom, Union and international waters of 8a, 8b, 8d and 8e (POL/*8ABDE).

Table 28.2. Landings of Pollack in Subarea 6 as officially reported to ICES.

Year	Bel-gium	Den-mark	France	Ger-many	Ire-land	Nether-lands	Nor-way	Portu-gal	Spain	Swe-den	UK	Total Sub-area 6
1950	1	-	-	-	-	-	-	-	-	-	295	296
1951	-	-	-	-	-	-	-	-	-	-	484	484
1952	-	-	-	-	-	1	-	-	-	-	503	504
1953	-	-	-	-	-	-	-	-	-	-	422	422
1954	-	-	-	-	-	-	-	-	-	-	452	452
1955	-	-	-	-	-	-	-	-	-	-	566	566
1956	-	-	-	-	-	-	-	-	-	-	528	528
1957	-	-	-	-	-	-	-	-	-	-	547	547
1958	.	-	-	23	-	-	-	-	-	-	710	733
1959	1	-	-	6	-	-	-	-	-	-	607	614
1960	15	-	-	-	-	-	-	-	-	-	441	456
1961	1	-	-	1	125	-	-	-	-	-	259	386
1962	2	-	-	8	197	-	-	-	-	-	235	442
1963	6	-	-	2	204	-	-	-	-	-	320	532
1964	1	-	-	1	130	-	-	-	-	-	368	500
1965	1	-	-	1	402	-	-	-	-	-	496	900
1966	2	-	-	-	200	-	-	-	-	-	428	630
1967	1	-	-	1	263	-	-	-	-	1106	413	1784
1968	5	-	-	2	214	-	148	-	-	1012	500	1881
1969	1	-	-	4	282	-	-	-	-	1224	667	2178
1970	2	-	-	1	398	-	-	-	-	756	447	1604
1971	1	-	-	5	75	-	-	-	-	750	256	1087
1972	1	-	-	1	127	-	-	-	-	779	317	1225
1973	2	-	-	-	-	-	-	-	-	-	503	505
1974	6	-	-	-	-	3	-	-	-	-	359	368
1975	< 0.5	-	-	1	-	1	4	-	-	-	393	399
1976	7	-	-	-	-	1	-	-	-	-	519	527

Year	Belgium	Denmark	France	Germany	Ireland	Netherlands	Norway	Portugal	Spain	Sweden	UK	Total Sub-area 6
1977	-	-	196	-	-	1	2	-	-	-	493	692
1978	-	-	196	-	-	-	4	-	-	-	553	753
1979	-	-	310	-	-	-	-	-	-	-	350	660
1980	-	-	36	-	-	-	-	-	-	-	233	269
1981	-	-	342	-	-	-	-	-	55	-	185	582
1982	-	< 0.5	272	-	-	-	-	-	95	-	103	470
1983	-	-	331	-	-	-	-	-	86	-	148	565
1984	-	-	212	-	-	-	-	-	222	-	194	628
1985	< 0.5	-	224	1	-	-	-	-	283	-	328	836
1986	-	-	145	-	223	-	-	-	2217	-	187	2772
1987	-	< 0.5	108	-	103	-	-	-	860	-	259	1330
1988	-	< 0.5	128	-	163	-	-	-	1925	-	221	2437
1989	-	< 0.5	111	1	103	-	-	-	-	-	179	394
1990	-	-	76	-	150	-	1	-	-	-	192	419
1991	-	-	31	-	145	-	-	-	4	-	189	369
1992	-	< 0.5	21	-	23	-	-	-	< 0.5	-	203	247
1993	-	-	39	-	12	-	-	-	-	-	273	324
1994	-	-	34	< 0.5	26	-	< 0.5	-	-	-	276	336
1995	-	-	64	3	83	-	-	-	-	-	354	504
1996	-	< 0.5	29	< 0.5	97	-	1	-	-	-	210	337
1997	-	-	14	1	69	-	2	-	-	-	162	248
1998	-	-	21	-	60	-	-	< 0.5	< 0.5	-	147	228
1999	-	-	-	-	73	-	3	-	< 0.5	-	136	212
2000	-	-	11	2	62	-	-	-	-	-	116	191
2001	-	-	8	-	108	-	-	-	-	-	101	217
2002	-	-	9	-	26	-	-	-	-	-	96	131
2003	< 0.5	-	3	-	88	-	1	-	-	-	111	203

Year	Bel-gium	Den-mark	France	Ger-many	Ire-land	Nether-lands	Nor-way	Portu-gal	Spain	Swe-den	UK	Total Sub-area 6
2004	< 0.5	-	2	-	68	-	1	-	-	-	65	136
2005	-	-	23	-	28	-	-	-	-	-	16	67
2006	-	-	3	< 0.5	31	-	< 0.5	-	4	-	5	42
2007	-	-	10	< 0.5	26	-	7	-	-	-	21	64
2008	-	-	8	-	21	-	1	-	-	-	23	54
2009	-	-	7	-	6	-	< 0.5	-	-	-	25	38
2010	-	-	6	-	34	-	< 0.5	-	-	-	39	80
2011	-	-	2	-	12	-	1	-	-	-	36	51
2012	-	-	2	-	10	-	< 0.5	-	2	-	33	48
2013	-	-	1	-	34	-	< 0.5	-	-	-	22	58
2014	-	-	1	-	25	-	< 0.5	-	-	-	18	44
2015	-	-	< 0.5	-	23	-	< 0.5	-	-	-	25	49
2016	-	-	< 0.5	-	44	-	< 0.5	-	-	-	31	76
2017	-	-	< 0.5	-	33	-	< 0.5	-	-	-	14	47
2018	-	-	< 0.5	-	22†	-	< 0.5	-	-	-	29	51†
2019	-	-	3	-	22†	-	< 0.5	-	-	-	27	51†
2020 *	-	-	< 0.5	-	13	-	-	-	-	-	32	45
2021 *	-	-	2	-	29	-	-	-	< 0.5	-	43	75

***Preliminary commercial landings.**

† Incomplete due to part of the data being unavailable under national GDPR clauses.

Table 28.3. Landings of Pollack in Subarea 7 as officially reported to ICES.

Year	Belgium	Denmark	France	Germany	Ireland	Netherlands	Norway	Spain	UK	Total Subarea 7
1950	93	-	-	-	-	-	-	-	375	468
1951	74	-	-	2	-	-	-	-	380	456
1952	80	-	-	10	-	-	-	-	336	426
1953	34	-	-	-	-	-	-	-	252	286
1954	17	-	-	4	-	-	-	-	365	386
1955	38	-	-	-	-	-	-	-	247	285
1956	67	-	-	1	-	-	-	-	155	223
1957	219	-	-	6	-	-	-	-	367	592
1958	342	-	-	17	-	-	-	-	233	592
1959	158	-	-	32	-	-	-	-	251	441
1960	317	-	-	-	-	-	-	-	267	584
1961	268	-	-	-	360	-	-	-	210	838
1962	367	-	-	1	369	-	-	-	170	907
1963	95	-	-	-	411	-	-	-	176	682
1964	299	-	-	-	342	-	-	-	194	835
1965	362	-	-	-	335	-	-	-	231	928
1966	456	-	-	-	438	-	-	-	175	1069
1967	417	-	-	-	474	-	-	-	202	1093
1968	214	-	-	-	508	-	-	-	167	889
1969	142	-	-	-	794	-	-	-	161	1097
1970	165	-	-	1	724	-	-	-	120	1010
1971	114	-	-	-	673	-	-	-	116	903
1972	142	-	-	-	1073	-	-	-	123	1338
1973	89	-	-	-	-	3	-	-	127	219
1974	299	-	-	-	-	13	-	-	223	535
1975	295	-	-	-	-	17	-	-	290	602
1976	339	-	-	-	-	4	-	-	421	764

Year	Belgium	Denmark	France	Germany	Ireland	Netherlands	Norway	Spain	UK	Total Subarea 7
1977	157	1	3569	-	-	1	-	-	465	4193
1978	186	21	5496	14	-	8	-	-	515	6240
1979	151	18	5119	76	-	1	-	-	696	6061
1980	237	7	5242	-	-	1	-	1	769	6257
1981	244	-	5814	-	-	3	-	23	780	6864
1982	154	-	4253	-	-	-	-	32	1022	5461
1983	167	-	6214	-	-	-	-	26	1045	7452
1984	207	-	3927	-	-	-	-	486	1100	5720
1985	269	-	3741	-	-	-	-	20	1022	5052
1986	241	-	4574	-	1335	-	-	17	1795	7962
1987	149	-	5213	-	848	-	-	19	2010	8239
1988	191	-	5211	-	1066	-	-	22	1740	8230
1989	145	-	3893	-	994	-	-	18	1487	6537
1990	133	-	4831	-	1066	-	-	26	1914	7970
1991	76	-	3211	-	1045	-	-	22	1962	6316
1992	62	-	2849	-	1014	-	-	19	1889	5833
1993	55	-	2325	-	1137	-	-	7	2135	5659
1994	94	-	2621	-	921	-	-	8	2391	6035
1995	88	2	2315	-	1107	-	-	4	2168	5684
1996	94	-	2684	-	1190	6	-	5	2519	6498
1997	99	-	2443	-	984	4	< 0.5	7	2540	6077
1998	92	-	2375	-	886	1	-	11	2347	5712
1999	86	-	-	-	976	-	3	19	1703	2787
2000	71	-	2422	-	1069	-	-	5	1810	5377
2001	100	-	2515	-	1274	-	-	9	1987	5885
2002	117	-	2481	-	1308	-	-	17	1999	5922
2003	113	-	2284	-	1151	-	-	12	1788	5348

Year	Bel-gium	Denmark	France	Germany	Ireland	Netherlands	Norway	Spain	UK	Total Subarea 7
2004	104	-	1914	-	1049	1	-	13	1705	4786
2005	98	-	2198	-	728	1	-	16	1684	4725
2006	78	-	2223	-	1144	1	-	50	1569	5066
2007	90	-	2003	-	1034	3	-	2	1850	4982
2008	76	-	1606	-	1058	1	-	20	1544	4305
2009	41	-	1686	-	1198	4	-	5	1614	4548
2010	35	-	1859	-	1367	2	-	6	1515	4784
2011	37	-	1801	-	1296	2	-	8	1908	5052
2012	43	-	1430	-	1520	1	< 0.5	4	1898	4896
2013	39	-	1813	-	1730	1	-	22	1936	5541
2014	84	-	2068	-	1508	1	-	27	2184	5872
2015	32	-	1176	-	1447	1	-	25	1501	4182
2016	42	-	1257	-	1536	< 0.5	-	23	1958	4817
2017	19	-	960	-	1487	< 0.5	-	23	1398	3887
2018	21	-	819	-	878†	9	-	25	1267	3018†
2019	12	-	550	-	14†	2	-	5	988	1570†
2020 *	17	-	584	-	395	2	-	3	938	1939
2021 *	7	-	584	-	419	2	-	1	802	1816

***Preliminary commercial landings.**

† Incomplete due to part of the data being unavailable under national GDPR clauses.

Table 28.4. Input parameters for the six DCAC runs carried out for Pollack in Subarea 6.

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
Sum of catch	6960	6960	6960	6960	6960	6960
CV sumC	0	0	0	0	0	0
no of years	36	36	36	36	36	36
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	lognormal	lognormal	lognormal	lognormal	lognormal	lognormal
B_{MSY}/B0	0.5	0.5	0.5	0.5	0.5	0.5
stdev B_{MSY}/B0	0.1	0.1	0.1	0.1	0.1	0.1
up lim B_{MSY}/B0	1	1	1	1	1	1
low lim B_{MSY}/B0	0	0	0	0	0	0
depletion delta Δ	0.8	0.8	0.8	0.9	0.9	0.9
stdev Δ	0.1	0.1	0.1	0.1	0.1	0.1
distr Δ	normal	normal	normal	normal	normal	normal

Table 28.5. Input parameters for the 9 DCAC runs carried out for Pollack in Subarea 7.

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9
Sum of catch	174824	174824	174824	174824	174824	174824	174824	174824	174824
CV sumC	0	0	0	0	0	0	0	0	0
no of years	36	36	36	36	36	36	36	36	36
iterations	10000	10000	10000	10000	10000	10000	10000	10000	10000
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
stdev M	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
F_{MSY}/M	0.6	0.8	1	0.6	0.8	1	0.6	0.8	1
stdev F_{MSY} to M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
distr F_{MSY} to M	lognormal	lognormal	lognormal	lognormal	lognormal	lognormal	lognormal	lognormal	lognormal
B_{MSY}/B0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
stdev B_{MSY}/B0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
up lim B_{MSY}/B0	1	1	1	1	1	1	1	1	1
low lim B_{MSY}/B0	0	0	0	0	0	0	0	0	0
depletion delta Δ	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7
stdev Δ	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
distr Δ	normal	normal	normal	normal	normal	normal	normal	normal	normal

Table 28.6. Comparison of the 2020 DCAC assessment and previous DCAC results.

	Subarea 6		Subarea 7	
	Landing (t)	Average DCAC	Landing (t)	Average DCAC
2021	76	142	2011	3864
2020	48	143	2210	3906
2019	54	146	2165	3966
2018	63	148	2895	4010
2017	44	150	3260	4042
2016	74	152	4131	4063
2015	48	155	3740	4062
2014	44	156	5359	4020
2013	57	158	4468	3953

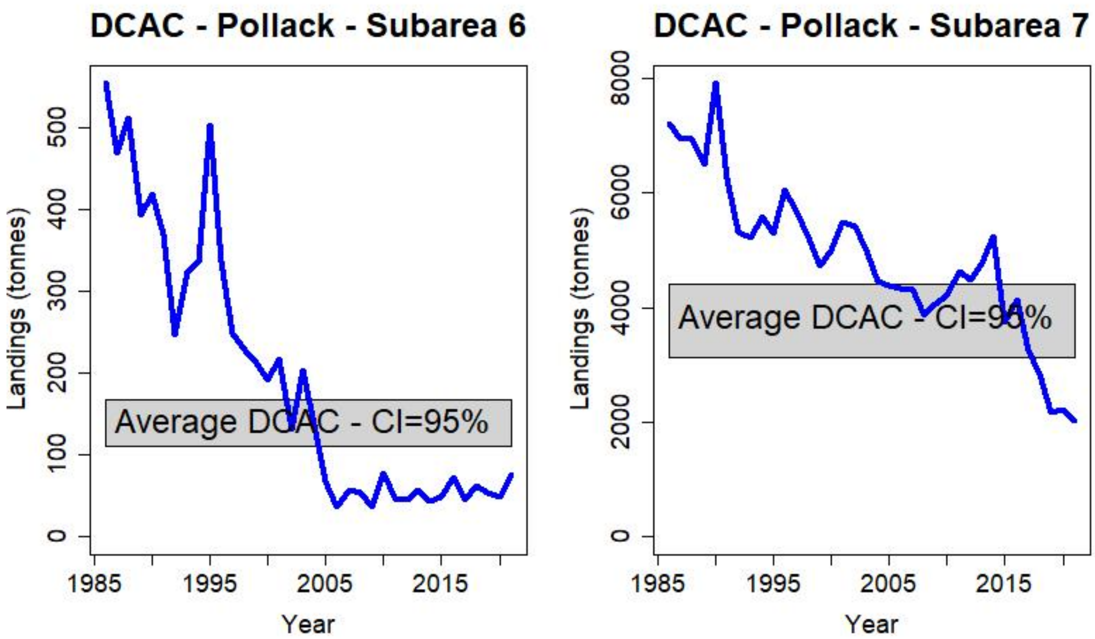


Figure 28.1. Pollack in subareas 6 and 7. The results of the depletion-corrected average catch (DCAC) assessment method as applied to commercial catch data since 1986. The grey box indicates the proxy for the maximum sustainable catch ±95% confidence intervals.

29 Seabass (*Dicentrarchus labrax*) in divisions 4.b–c, 7.a, and 7.d–h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel, and Celtic Sea)

Type of assessment

This is an update of the assessment accepted as the agreed methods to use at the benchmark workshop for the seabass: WKBASS (ICES, 2017–2018). The assessment is performed using the Stock Synthesis model implementation (SS3; Methot, 2000; 2011). The stock is treated as Category 1 with a full analytical assessment and forecast.

ICES advice applicable to 2021

The ICES advice for management of seabass fisheries in 2021 is available in the ICES Advice released in 2019, and states that "when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, total removals in 2021 that correspond to the F ranges in the plan are between 1680 tonnes and 2000 tonnes".

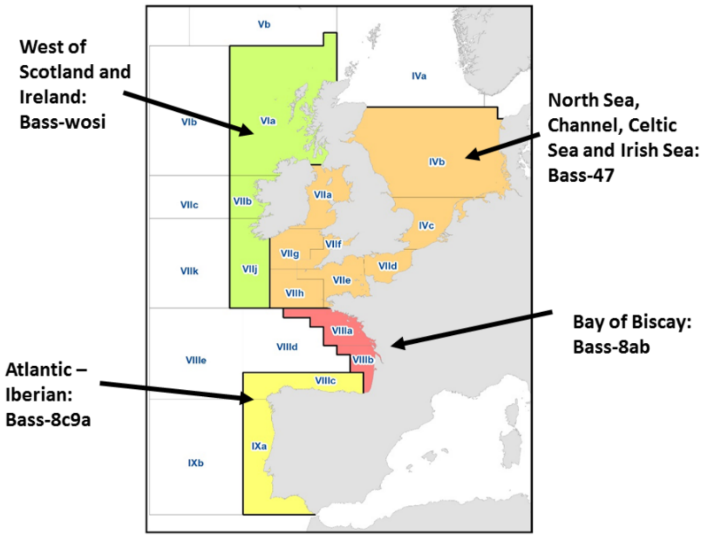
ICES advice applicable to 2022

ICES advises that when the MSY approach is applied, total removals in 2022 should be no more than 2216 tonnes. ICES notes the existence of a precautionary management plan, developed, and adopted by some of the relevant management authorities for this stock.

29.1 General

29.1.1 Stock definition and ecosystem aspects

Studies including tagging programmes and microchemistry are underway to provide information on the movement of sea bass and levels of mixing between stocks. Currently Atlantic stock identities are assumed to be as follows (ICES, 2012a,b):



In 2021, WGCSE included a session shared with WGBIE where a summary of some studies into stock identity summarized work from data storage tags, conventional tags, genetics, otolith microchemistry and larval dispersion models. The Working Groups recognized the complexity of these issues and considered that a stock identity workshop might be convened to allow relevant experts to consider these and any other relevant studies, and advise whether the existing stock boundaries remain appropriate.

29.1.2 Management

Historical management is described in the Stock Annex.

29.1.2.1 Management applicable from 2020 to 2022

In 2020, 2021 and 2022 the seabass fishery of stock bss.27.4bc7ad–h was prohibited, with derogations as shown in the simplified tables below for professional and recreational fishermen (season length, catch limits given per vessel for commercial and per fisher for recreational). See official regulations 2020, 2021, 2022 respectively for full details[1,2,3]

	Year	Demersal trawl[1]	Seines[2]	Hook and Lines[3]	Fixed Gillnets[4]
2020	January 2020 and 04/01/2020 to 12/31/2020	< 520 kg/2 months; < 5% total catch/day	< 520 kg/2 months; < 5% total catch/day	5.7 t/year	1.4 t/year
	February–March 2020	no landings	no landings	no landings	no landings
2021	January 2021 and 04/01/2021 to 07/31/2021	< 520 kg/2 months; < 5% total catch/day	< 520 kg/2 months; < 5% total catch/day		
	February–March 2021	no landings	no landings	no landings	no landings
	08/01/2021 to 12/31/2021	<380 kg/month	<380 kg/month		

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020R0123

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02021R0092-20211101

[3] https://eur-lex.europa.eu/legal-content/FR/ALL/?uri=CELEX:52022PC0054

	Year	Demersal trawl[1]	Seines[2]	Hook and Lines[3]	Fixed Gillnets[4]
		< 5% total catch/day	< 5% total catch/day		
	January 2021 and 04/01/2021 to 12/31/2021			5.7 t/year	1.4 t/year
2022	January 2022 and 04/01/2022 to 12/31/2022	< 760 kg/2 months*; < 5% total catch/day	< 760 kg/2 months*; < 5% total catch/day	5,95 t/year	1,5 t/year
	February-March 2022	no landings	no landings	no landings	no landings

***January/April; May/June; July/August; September/October; November/December.**

	Year	Recreational
2020	January–February–December 2020	0 fish/day
	01/03/2020 to 30/11/2020	2 fish/day
2021	January–February–December 2021	0 fish/day
	01/03/2021 to 30/11/2021	2 fish/day
2022	January–February–December 2022	0 fish/day
	01/03/2022 to 30/11/2022	2 fish/day

29.1.3 Fishery description

29.1.3.1 Total landings (official)

The history of the fishery is described in the Stock Annex. Table 1 and Figure 1 present official and total ICES landings. A large decrease in total landings was observed in 2014 due to poor weather conditions during winter and then from 2015 onwards due to management measures. Historically the bulk of the landings were made by the French fishery, but since implementation of management measures, landings are shared between French, UK and NL, and to a lesser extent Belgium. In 2021, 1275 tonnes were landed (official source): 613 t by UK, 385 t by France, 231 t by Netherland and 45 t by Belgium. Landings from France and the UK by gear are given in Figure 2. The COVID-19 pandemic didn’t affect total commercial catches.

29.2 Data

29.2.1 Commercial landings

Landings are used for six fleets where selectivity is modelled (Table 2): 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, where 2012 is the reference year. The source of information for the commercial fleets is the ICES database InterCatch. The time-series of recreational fisheries removals is calculated iteratively, so that fishing mortality remains constant and equal to the fishing mortality in 2012 over the period 1985–2014. After the implementation of the management in 2015, a multiplier is applied to recreational fishing mortality based on the severity of the measures (see chapter below). The landings are census data (EU logbooks and/or sales slips) from several sources:

1. Official statistics recorded in the ICES official landings database since the mid-1970s, with data from 1985 are used in this assessment.
2. French landings for 2000–2021 from a separate analysis of logbook, auction data and VMS data (SACROIS database) by Ifremer – extracted from the ICES database InterCatch.
3. Landings for Belgian vessels – extracted from the ICES database InterCatch.

4. Landings for Netherlands – extracted from the ICES database InterCatch Exception where a mistake was found in InterCatch, i.e. 2018 landings were updated for the 2020 assessment using official data.
5. UK landings by gear type recorded in official UK landings databases (historically and "InterCatch" database).

Details of the methodology used to calculate French and UK historical landings can be found in the Stock Annex.

29.2.2 Commercial length and age compositions

IBPBass2 (ICES, 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 bottom 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 to avoid over-fitting of the data. The composition data for the fleets are given in the SS3 data file. Input sample sizes for the multinomial composition data are derived from numbers of fishing trips sampled, as proxy for effective sample size. The relative sample sizes between years are maintained in any reweighting.

29.2.2.1 Sampling rates

UK (England and Wales) sampling effort for length and age compositions by gear group are given in Table 3. The UK midwater trawl fleet landings were not sampled in 1997, 2013–2017 and since 2019 due to the small number of trips targeting seabass. This has negligible impact on the assessment as this UK métier represented only 1% of total seabass landings in 2013 and landed 2 t or less each year since 2014. In addition, Stock Synthesis will impute age distributions for missing years from the selectivity curve and landings.

Sampling of seabass in France also varied between gears (Table 4). Numbers of fish sampled decreased from 2015 due to the implementation of management measures and the fact that relatively few fish are now landed. The level of sampling was very low in 2019, with some of the main métiers, including lines and nets, not sampled. Level of sampling has nevertheless increased in 2020 and 2021.

The number of trips sampled in the UK is used as input in the stock assessment, with exception of a set number being attributed to UK midwater trawl and French fleet age composition. These numbers are then iteratively adjusted using the Francis method of weighting, reducing the disproportionate effect of the different datasets used.

29.2.2.2 Length composition estimates

Figure 3 and Table 5 give fleet-raised length compositions for all French gears combined. French numbers-at-length are available from 2000 onwards. The French fleet is the combination of several types of subfleets using a variety of fishing gears: pelagic trawlers, bottom trawlers, netters, liners, Danish seiners and purse-seiners (see details in Table 4). Figure 4, Figure 5 and Figure 6 give fleet-raised length compositions per UK métier used in the assessment (UK bottom trawls and nets; Lines; Midwater trawls).

29.2.2.3 Age composition estimates

The French age composition time-series from 2000 is from the application of an annual age–length key to the annual length composition of landings (Table 6).

Fleet-raised age compositions were obtained for UK fleets from 1985 onwards by application of age–length keys developed for the areas 4.bc, 7.d, 7.e&h, and 7.a,f,g. The annual age compositions for the combined bottom trawl and nets fleet and the line fleet are given in Table 7 and Table 8, and the age compositions for the UK midwater pair trawl fleet since 1996 are given in Table 9.

29.2.3 Commercial discards

29.2.3.1 Discards and post-release mortality

Discarding of seabass below the MCRS occurs in most commercial fisheries to a variable extent. Previously, ICES advice sheets indicated overall international discard rates of only 5% by weight for the bss.27.4bc7ad–h stock. The WGCSE and WKBASS (ICES, 2017) showed that discard rates have typically been the highest in bottom otter trawls (OTB) and have increased following the introduction of additional management measures in 2015. Discards are now included in the assessment of this stock and in the absence of any data on discard survival, this has been assumed to be zero for all commercial fisheries. This has the potential to overestimate commercial fishing mortality, but the effect was initially expected to be small due to the low discard rates prior to 2015. This has changed in recent years, since the management measures have been implemented and discard rates are expected to increase in the short term as fishers adjust to take account of the changes, such as the increase in minimum conservation reference size from 36 cm to 42 cm.

Survival of fish discarded by commercial line vessels may be similar to survival of recreational angling releases (see next section), but work is needed to establish the typical gear, handling, and condition of fish to be released. Survival of seabass caught by trawls, seines, fixed or driftnets and longlines will depend on many factors including tow duration, soaking times, gear design, deep-hooking, and time on deck. There is need for studies on discard survival of seabass in different commercial fisheries.

29.2.3.2 Commercial discards data

Data sources for discards estimates and sampling design are described in the Stock Annex, with a summary of data from the UK and French on-board sampling programmes from 1985 to present given in Table 10, Table 11 and Table 12. Note that in the assessment, from 2015 onwards, discards from French observer data were replaced by logbook estimates, more realistic.

The observer estimates of annual discards by UK and French vessels from 2009 to 2014 was less than 5% of total landings. Between 2016 and 2021, the level of discarding observed in the French fleet increased compared to the previous period and varied between 10% and 22% (Table 12). This was mainly attributed to bottom trawlers where seabass is often a bycatch. French logbook data led to higher discards rate estimates of 23%, 38%, 59%, 53% 43% and 49% from 2016 to 2021. For the UK fleet a level of 9% was observed in 2016, 6% in 2018 and up to 18% in 2019, all mainly due to bottom trawlers (Table 11). In 2021, UK bottom trawlers discarded an estimated 19% of their catches. The level of sampling of the UK fleets since2017 has been low and so no raised estimate of discard length distribution was included in the assessment for these years.

French log book data from 2016 to 2021 showed that discard rates estimated from on-board sampling were much lower than those reported in logbooks. The logbook data provided estimates of discards of 155.6, 270.9, 456.4, 374.6, 313 and 404 tonnes respectively, as opposed to the on-board sampling programme estimates of 152.7, 161.7, 34.2, 79.2, 3 and 13 tonnes for 2016, 2017, 2018, 2019, 2020, 2021 respectively. The increase in discards in 2018 may be explained by more restrictive management measures, but also by the fact that French fishers have been encouraged to report their discards in logbooks because of the landings obligation.

29.2.4 Recreational catches

The approach used for recreational catches is described in detail in the Stock Annex, but is briefly summarised here including the latest relevant data.

29.2.4.1 Recreational catches point estimates

Only a single year of recreational catches was available: 1440 t in 2012. This value of 1440 t was obtained by summing international recreational activities survey estimates for France, the Netherlands and the UK. It represented total removals through adding the retained fish and releases assuming a 5% post-release mortality. A composite length–frequency distribution was generated for recreational removals from the same survey data, with a post-release mortality of 5% applied to the release component.

29.2.4.2 Recreational removals time-series reconstruction

F for the recreational fishery was assumed to be constant prior to the introduction of management measures in 2015. Limited survey data were available after the implementation of management measures at the time of the benchmark in 2017–2018, so no reliable catch estimates existed. As a result, a method was developed for estimating the impact of combinations of the MCRS, season length and bag limits on removals by recreational fishing. A multiplier was derived from 2012 catches in terms of numbers of fish for the recreational F that related to the reduction in catch due to management. This corresponded to multipliers of 0.821 in 2015, 0.282 in 2016 and 2017, 0.191 in 2018, 0.312 in 2019 and 0.464 for 2020, 2021 and 2022 (Table 13).

Since completion of the benchmark in 2018, further surveys have been conducted in the UK, France, Belgium, and the Netherlands that provide estimates of recreational catches of seabass. However, these surveys have been done in different years, using different methods, and have different associated biases. It is not obvious how best to combine the data for use in the assessment and would represent a significant departure from the current approach. Hence, this should be done as part of the next benchmark and peer-reviewed to ensure it robustness. As a result, the current approach will continue to be used until the next benchmark and recreational catches included on the issue list.

29.2.5 Biological data

All parameters for growth, weight, maturity, natural mortality and ageing error were as described in the Stock Annex.

29.2.6 Survey data used in assessment

29.2.6.1 Pre-recruit surveys in UK

An inshore trawl survey in autumn in a major bass nursery area in the Solent (7.d English coast) provides abundance indices-at-ages 2 to 4 for the stock assessment (Figure 7). Data are available from 1982, although there are intermittent years when the survey did not take place. The index calculation was updated in 2020 after a rigorous quality assessment was conducted (Table 14 and Table 15). The Stock Annex provides details of this survey (SBTS, G9863) and of some other pre-recruit survey series not considered appropriate by previous WGs and IBPBass for inclusion in the assessment.

29.2.6.2 Pre-recruit surveys in France

Similar surveys have been done by Ifremer along the coast of France since 2014 to provide insight into French seabass nurseries areas and pre-recruit dynamics. The new time-series is not available to WGCSE, but is expected to provide additional information on seabass age groups 0–3 to be considered for inclusion in the assessment. In the Channel, the survey takes place in the Seine estuary and preliminary indices are available from 2017. The survey is expected to continue until 2023 under a European Maritime and Fisheries Fund (EMFF) program (NOURDEM) and the working group will encourage its continuation after the index generated is reviewed and if it provides valuable information and supports the assessments. Indices will be tested during the next benchmark.

29.2.6.3 Channel Groundfish survey FR-CGFS

The French Channel Groundfish survey (FR-CGFS, G3425) has been carried out in October each year since 1988. It provides swept-area indices of seabass abundance in the Eastern Channel (7.d) together with length compositions. The swept-area indices are given in Table 16. Details of the survey can be found in Coppin *et al*. (2002) and sampling stations shown in Figure 8. The majority of seabass are caught in the coastal waters of England and France. The original time-series finished in 2014 as a new vessel was used for the survey from 2015. The new time-series now includes seven years of data, so may be considered for inclusion in the assessment at the next benchmark.

29.2.7 Commercial landings per unit of effort

Following the recommendation from WKBASS (ICES, 2018) the French LPUE index is now calculated by modelling the zeros and non-zeros values using a delta-GLM approach (see Stock Annex for details). Confidence interval calculated through a bootstrap estimation are presented in Table 17 and Figure 9, with the updated LPUE series used in the assessment.

29.2.8 Other relevant data

None.

29.3 Stock assessment

29.3.1 Model structure and input data / parameters for update assessment

The assessment was conducted using Stock Synthesis (Methot, 2000; 2011), using version 3.24u (Methot, 2011). The structure and input data / parameters of the SS3 model are summarized below and details are available in previous sections.

29.3.1.1 Model structure

- Temporal unit: annual based data (landings, discards, survey and commercial tuning indices, age and length frequencies).
- Spatial structure: One area.
- Sex: Both sexes combined.

29.3.1.2 Fleet definition

Six fleets defined: 1. UK bottom trawls, nets; 2. UK lines; 3. UK midwater trawls; 4. French fleets (combined); 5. Other (other countries and other UK fleets combined); 6. Recreational fisheries.

29.3.1.3 Landings and discards

Annual landings in tonnes from 1985 to final assessment year for the five fleets from ICES subdivisions 4.b and c, 7.a, d–h. Recreational catch for 2012 with the time-series from 1985 to present iteratively reconstructed conditioned on the 2012 estimated value of 1440 t.

Discards in tonnes for fleet 1 (UK bottom trawls, nets) from 2002 and fleet 4 (French) from 2009.

29.3.1.4 Abundance indices and compositional data

Channel Groundfish Survey in 7.d in autumn (France), 1988 to 2014 (FR-CGFS, G9527): total swept-area abundance index and associated length composition data (Table 16). Input CV for survey is 0.60 for 1988–1990 and 0.30 for 1991 to 2014. First three years of composition data are excluded due to sampling levels and high uncertainty in the data. For remaining years, number of stations with seabass is used as input effective sample size of compositional length data.

Cefas Solent Autumn bass survey (7.d) (SBTS, G9863): years 1986 to 2009, 2011, 2013 to present, for ages 2–4. Selection was fitted as a function of length using a double normal model, with minimum and maximum ages specified as 2 and 4 in the age selection function (Table 15).

French LPUE: as updated every year.

29.3.1.5 Fishery landings age composition data

The age bin is set from 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 bottom trawls/nets and UK lines is 1985 to present; UK midwater pair trawl is 1996 to 2018 (no samples for 1997, 2013–2014, 2016–2017, 2019–present); French is all fleets from 2000 to present.

29.3.1.6 Fishery landings length composition data

The length bin is 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 bottom trawls/nets is 1985 to present; UK lines 1985 to present; UK midwater pair trawl 1985 to 2012 (no samples for 1997, 2013–2019–present); French all fleets from 2000 to present.

29.3.1.7 Model assumptions and parameters

Table 18 summarises key model assumptions and parameters. Other parameter values and input data characteristics are defined in the SS3 control file BassIVVII.ctl, the start.SS file, the forecast file Forecast.SS and the data file BassIVVII.dat.

29.3.1.8 Incorporation of recreational fishery catch estimates

2012 catch input and F multipliers on all other years to iteratively estimate the full time-series of recreational catches; calculations for the final assessment run are given in Table 21.

29.3.1.9 Final update assessment: diagnostics

The likelihood components (log L * Lambda) for the update SS3 assessment are given below:

Likelihood components	Likelihood
TOTAL	710.35
Catch	8.26e–013
Equilibrium catch	0.0259
Survey	-41.21

Likelihood components	Likelihood
Discards	26.24
Length compositions	398.4
Age compositions	302.79
Recruitment	24.06
Forecast Recruitment	0.032851
Parameter soft bounds	0.01808

A range of model outputs and diagnostics are given in Figures 13–33.

Good correspondence was found between the observed and fitted length and age compositions for each fleet (Figures 16–28). However, the fit to the French length compositions was poorer in 2014–2019 and the fit to French age composition was variable throughout the time-series. 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 look good (Figure 19 and Figure 25).

The survey abundance indices both fisheries-independent and fishery-dependent are fitted reasonably well (Figure 26, Figure 27 and Figure 28).The UK Solent autumn survey is characterised by a large variability with outliers present in the model fit (Figure 26). 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 predict recruitment deviations back to around the 1974 year class due to the strong year classes captured in the data in the early years (Figure 29) 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 29) although this perception is affected by the imposition of a steepness value of 0.999 for the fitted Beverton–Holt stock–recruit curve. Sensitivities to differing values for this parameter carried out during the benchmark workshops found that likelihoods progressively worsened as the steepness value was reduced.

29.3.2 Analytical retrospective analyses

Retrospective analysis with a five-year peel was carried out for the calculation of the Mohn's rho. This analysis shows that there is some evidence of a retrospective pattern, see table below and Figure 30, for recruitment, SSB and fishing mortality. However, the retrospective bias is within the tolerance threshold accepted by ICES (-15 to +20) for SSB and fishing mortality, there has been no tolerance threshold set for recruitment.

	Mohn's rho

Spawn–stock biomass	0.162
Fishing mortality (ages 4–15)	-0.126
Recruitment (age 0)	0.236

The model is sensitive to the recent change in selectivity due to management measures where a block change in the selectivity and retention parameter estimates where introduced for data proceeding 2015.

29.3.3 Final update assessment: long-term trends

The time-series of estimates of numbers-at-age, combined recreational and commercial $F_{(4–15)}$, are given in Table 19 and Table 20, and a summary of SSB, recruitment, F and commercial and recreational catch are given in Table 21 and Figure 31. These series are based on the final SS3 update run with 2021 set as the final year.

A sharp increase in F between 2011 and 2013 is generated because the assessment model interprets that landings were maintained despite a rapid decline in biomass. This may be a plausible scenario where aggregations or predictable migration routes of seabass can be targeted, and it is possible for fisheries to maintain landings as total stock size declines, and hence inflict an increasing fishing mortality rate. The F has since decreased in-line with sharp reduction in catches due to the discontinuation of the French midwater trawl and the implementation of additional management measures. In 2021 F has not changed compared to 2020, reflecting the latest management measures. SSB increased slightly which may have resulted from the management measures in place since 2015, and some above average recruitment events since 2013 as described below.

WGCSE has concluded 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 was well above F_{MSY} prior to 2015. Recruitment has been declining since the mid-2000s, and has been poor since 2008, however the recruitment estimated for 2013, 2014, 2016, 2018 and 2019 is above the long-term geometric mean of 15 652. Uncertainties in the assessment are explored in a subsequent section.

29.3.4 Comparison with previous assessments

With the addition of the 2021 data and the updated French LPUE, the time-series of recreational catch was updated to remain consistent with the assumption of a constant F for the period 1985 to 2014 and an F multiplier reduction for 2015 to present (Figure 32).

With these changes included in the update assessment, the perception of the stock has remained largely unchanged. The spawning–stock biomass, fishing mortality and recruitment estimated in 2021 when compared with the recent assessment (Figure 33) are very close, well within the 95% confidence intervals.

29.3.5 The state of the stock

The marked increase in biomass in the 1990s was driven by the very strong 1989 year class and a number of subsequent strong year classes. The biomass prior to this was declining during a period of poor recruitment, and the recent decline in biomass also coincided 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 since 2008. These periods of poor recruitment have a major impact on biomass, which is exacerbated by any increase in F. Total biomass changes more quickly than SSB, due to the time taken for fish to reach maturity. An increasing trend in biomass was estimated since 2018, which may have resulted from the management measures in place to restrict catches since 2015 and the occurrence of a number of just above average recruitment events since 2013.

The period of increasing SSB in the 1990s and early 2000s also coincided with expansion of the stock in the North Sea. The enhanced productivity and geographic range of the stock at this time also coincided with a period of elevated sea temperatures (see WGCSE and Stock Annex for UK inshore sea temperature trends in relation to seabass recruitment).

The assumption of a constant recreational fishing mortality over time implies that recreational harvests were a much larger fraction of total fishery removals in the 1980s compared with the 2000s onwards (Figure 10). It is likely that in the 1970s or earlier, seabass was primarily the target of recreational fishing.

29.4 Biological reference points

The fishing pressure and biomass PA and MSY reference points defined by WKBASS (2018) were updated during WGCSE 2019 due to the inclusion of additional 2018 data and a new LPUE series which changed the perception of the stock. The details of the calculations of the new reference points are given in the Stock Annex with reference points given below.

In 2021, ICES revised the basis F_{pa} for all stocks to use $F_{P.05}$, as a result the value is now 0.203. All other reference points were unchanged.

Reference points	Value
Precautionary Approach	
B_{lim}	10313
B_{pa}	14439
F_{lim}	0.254
F_{pa}	0.203
MSY Approach	
F_{MSY}	0.1713
$F_{MSY\ lower}$	0.142
$F_{MSY\ upper}$	0.1713
MSY $B_{trigger}$	14439

29.5 Short-term predictions

Inputs for a short-term forecast are given in Table 22, and their derivation is explained below.

29.5.1 Recruiting year-class strength

Recruitment estimates for seabass were below average from 2008 to 2012 (Table 21). Since recruitment is at a low level since 2008 the working group agreed to only include 2010 to 2019 (10 years) for the geometric mean recruitment for the forecast (10 104thousand), this was also identified and advised by the ADG in 2019. This is summarised in the text table below:

Year class	SS3 (age 0)	GM 2010–2019
2019	12 587thousand	
2020		10 104thousand
2021		10 104thousand
2022		10 104thousand

29.5.2 Numbers of fish in 2022

These were derived from the update Stock Synthesis run with final year set at 2021. The numbers for ages 0–2 in 2022 were adjusted using the ratio of LTGM to SS3 values for 2020–2022 age 0 as explained above and in Stock Annex.

29.5.3 F-at-age vectors

Status quo F-at-age for the commercial fishery was taken as the average F-at-age as estimated from the last three years derived from the update Stock Synthesis run with final year set at 2021. This approach was taken to allow for the change in selectivity associated with the implementation of new management measures (Table 13).

The recreational F vector was estimated in a similar way using the average of the last three years, however the final F_{bar} was scaled using F multipliers on the 2012 F in Table 13 taking into account the management measures in place. For the intermediate year (2022), this was a nine-month open season with a two bag limit and a MCRS of 42 cm. Additional years' Fs were scaled to keep the F of the recreational fleet proportional to the F of the commercial fleet as in the intermediate year 2021.

29.5.4 Weights-at-age

Mean weights-at-age in the stock were taken from the Stock Synthesis output. The commercial fishery weights for 2021 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 80.26 cm.

29.5.5 Maturity ogive

The proportion mature at-age is the length-based ogive applied to the length-at-age distributions around the input VB growth curve, calculated within Stock Synthesis.

29.5.6 Detailed short-term forecast output at *status quo* F

A detailed short-term forecast is given in Table 22 assuming that F in 2022 and 2023is the average of 2019–2021 from the assessment for the commercial fleet, and for the recreation fleet the partial F used is that described in Section 29.5.3.

Fishing in 2021 at the same fishing mortality as in 2018–2020 for the commercial fleet, and with the current two bag limit for nine months for the recreational fleet, an SSB of 12 153 t is predicted in 2022, increasing from 11 619 t in 2021. With the same fishing effort in 2022 the SSB would go up to 12 371 t. There is uncertainty in the forecast, as the actual rate of decline in population abundance in recent years is likely to be more uncertain than indicated by the SS3 model confidence limits. Also, the effect of the final package of technical and other management measures for seabass in 2015 to present are not fully known at this stage, and information will be needed on their implementation and effectiveness before their impact on fishing mortality can be ascertained. The assumption of constant recreational F is also untested.

29.5.7 Management options

WGCSE provides management options in which F multipliers are applied proportionally to commercial and recreational F-at-age (Table 23). In reality, fisheries managers 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 a number of different scenarios and include F of 0.153 calculated by reducing F_{MSY} by the stock size relative to MSY $B_{trigger}$ for combined commercial and recreational fishing. This would provide combined commercial and recreational catches of 2554 tonnes. This would be an increase of 15.3% compared to the advice for 2022. The allocation between commercial and recreational fisheries depends on the balance of controls applied on recreational and commercial fishing in 2021 and 2022.

With zero F in 2023, SSB is expected to increase from 12 835t in 2023 to 14 753 t in 2024. Therefore, it is now possible to achieve B_{pa} or MSY $B_{trigger}$ (both 14 439 tonnes) in this time period.

29.6 Uncertainties and bias in assessment and forecast

29.6.1 Landings and discards data

Historical landings of small-scale national fisheries not supplying EU logbooks or sales slips are known to be inaccurate. IBPBass ran the Stock Synthesis model with and without additional UK landings for nets and lines estimated from a separate Cefas logbook scheme, and found this had relatively little impact on stock trends or fishing mortality, but rescaled the biomass and recruitment due to the additional catch. However, if the extent of non-reporting is changing over time, for example to develop track record in the possible event of a future TAC, then bias will be introduced in the assessment trends.

Discard rates are low in most fisheries other than trawls. Estimates of discards are available only from the early 2000s, but do not cover all fisheries, are imprecise, and are only included for some fleets in the assessment. The overall discard rate by weight is thought to be less than 5% before the implementation of management measures, increasing in recent years. Nonetheless, a time-series of discards at-length or -age is needed for all fleets if the impact of technical measures to improve selectivity is to be evaluated as part of any future bass management.

29.6.2 Fishery composition data

The ability to fit selectivity patterns for defined groups of fishery métiers, and to detect changes in selectivity, depends 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. In France, sampling effort has also been very low in recent years and now appears to only cover trawls when a large portion of the fleet is composed of other nets and lines. Currently, there are no composition data supplied by Netherlands and Belgium.

ICES has developed extensive advice on establishing statistically-sound sampling designs for estimating fishery length and age compositions and discard quantities (see reports of ICES Workshops on Practical Implementation of Statistically Sound Catch Sampling Programmes (WKPICS1–3, available on ICES website). Stratified random sampling of fishing vessels or harbours may lead to low sample sizes for species such as seabass for which large fractions of the total catches may be taken in relatively small numbers of fishing trips. The cost-benefit of expanding the sampling in vessel or harbour strata where most seabass landings are recorded, without compromising statistical sampling design, should be investigated. The next benchmark should evaluate if sampling is currently sufficient to support continued application of Stock Synthesis fitting selection parameters to fishery composition data.

29.6.3 Recreational fishery harvests

Current assessments accommodate an estimate of recreational fishery landings in the assessment and forecasts based on landings from 2012 (ICES, 2016; 2018). This a crude approach based on surveys for only a year or two in France, UK, and the Netherlands, and leads to an assumption of constant recreational fishing mortality over time. Recreational catches have been observed to vary significantly over time in other fisheries, so this assumption of constant mortality is unlikely to be true.

Since completion of the benchmark in 2018, further surveys have been done of recreational catches, but it is not obvious how best to combine the data for use in the assessment and would represent a significant departure from the current approach. Hence, this should be done as part of the next benchmark and peer-reviewed to ensure its robustness. At this stage, it will also be necessary to review the assumptions made related to changes in recreational fishing mortality and selectivity over time, and consider splitting recreational catches by country and/or fate of fish.

Release rates are expected to increase due to bag limits and increases in MCRS that are in place or planned. Current studies of post-release mortality are limited, and more studies are needed to develop a better understanding of the fate of released fish given the high incidence of catch-and-release practices in sea angling for seabass.

29.6.4 Surveys

The Channel Groundfish Survey included in the assessment provides data on a wider range of sizes and ages than the Cefas Solent survey, though with a steeply domed size selection pattern. From 2015 onwards, Ifremer no longer used the scientific vessel “Gwen Drez” which was replaced by the larger vessel “Thalassa”. A calibration exercise was carried out in 2014 to assess the effect of this change to a larger vessel. WGCSE noted a concern that coverage of the coastal waters of 7.d could be altered by the use of this new vessel (the size of the vessel may prevent fishing as close to the coast as was possible with the previous vessel). The results of the calibration exercise were evaluated and it was found that the series could not be extended beyond 2014 and that a new series would need to be created from 2015 onward. This new dataseries is still to be considered for inclusion in the assessment.

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. There are several studies that have demonstrated spatial and temporal variation in abundance of seabass in estuaries in the UK, France, and Ireland. It would be useful to review and, if possible, include additional time-series at the next benchmark and consider a developing a broader survey of nursery habitats for all species. For information, such a survey is conducted in France from 2017 onwards in the Seine estuary through the project Nourdem (and also in the Bay of Biscay in the Loire estuary from 2016 and in the Gironde estuary from 2019). In 2022, a time-series of six years will be available, also a juvenile seabass index should be tested in the model. The trawl used was developed for catching seabass. An average of 5500 bass are caught during the survey, allowing a calculation of robust index.

29.6.5 Commercial LPUE indices

The reliance of the assessment on the Solent and Channel trawl surveys is a potential source of bias because they cover only a part of the stock range, and the selectivity is heavily skewed towards young bass. This is of principle concern in establishing the current rate of decline in spawning–stock biomass and associated trends in fishing mortality. In the absence of relative abundance indices for older bass from surveys or commercial fishing vessels covering the range of the stock, it is difficult for the model to fit the recent stock trends and fishing mortality. Statistical modelling of French LPUE data by vessel and rectangle by Laurec and Drogou (WGCSE 2015, Annex 3, WD 07) is used in the assessment.

Analyses of UK commercial fishery LPUE, based on averaging across ICES rectangles where the bulk of seabass catches have been recorded, was presented to IBPNEW in 2012 (ICES, 2012a). There were divergent trends between fleets where seabass are typically a bycatch, and mainly under 10 m vessels where increased targeting has probably been occurring using lines and nets. Future development of UK LPUE indices together with equivalent French data would require careful evaluation of potential for LPUE of each fleet to track abundance. Further analyses on the validity of the French LPUE as an index of abundance should also be considered, especially in light of the current restrictions of fishing activities.

29.6.6 Stock structure and migrations

The assessment treats all seabass in 4.b,c and 7.a,d–h as a single biological stock, but there can be extensive migrations. For example, migrations are expected to occur between the south of the area and the Bay of Biscay (which is treated separately in the WGBIE group), or between the North Sea and the Channel, there is also strong site fidelity (Pawson *et al*., 2008) resulting in a high proportion of tagged fish being recaptured at the same coastal location, even in subsequent years after migrations to offshore spawning sites. Immature seabass may remain close inshore, and exploitation of young fish in coastal waters (<6 nautical miles offshore) may be predominantly by inshore fleets of that country. Mature fish originating from coastal waters of the UK, France or Netherlands or other countries may become increasingly vulnerable to offshore pelagic pair trawlers fishing mainly on mature fish during December to April. These spatial, ontogenetic patterns may lead to complex responses of length and age compositions to previous fishery catches of each country and fleet. This could potentially be addressed using spatial structuring in Stock Synthesis, but the data demands would increase substantially. Both the UK (England) and France have studies underway to improve knowledge of seabass movement and mixing.

29.6.7 Biological parameters

The maturity ogive used in the assessment was derived from sampling from the 1980s onwards. There has been no coordinated sampling across the full range of the stock in recent years to determine if the current ogive is still valid. Sporadic recent sampling has suggested that seabass may be spawning at sizes smaller than recorded historically (see Stock Annex). This would alter the F_{MSY} and could also be associated with changes in growth parameters. Mean length-at-age in UK samples remained more or less constant over several decades of sampling, but this analysis needs updating. Changes in growth, or inappropriate growth parameters, will lead to bias in fitting length-selectivity parameters to the French fishery and survey data.

29.6.8 Intermediate year fishing mortality and catch levels for forecasts

Measures introduced by the UK government and EU commission to reduce fishing mortality toward F_{MSY} have the potential to affect the short-term forecast assumptions for this stock. Table 22 and Table 23 provide a detailed short-term *status quo* forecast and a range of management options from the forecast run.

29.7 Recommendations

29.7.1 Management considerations

Seabass in this stock are characterised by slow growth, late maturity and low natural mortality of adults, which imply the need for comparatively low rates of fishing mortality to avoid depletion of spawning potential in each year class. Productivity of the stock is affected by extended periods of enhanced or reduced recruitment, which appear to be related to changes in sea temperature. Warm conditions facilitate northward penetration of seabass in the North Sea and Northeast Atlantic and enhance the growth and survival of young fish in estuarine and other coastal nursery habitats. A period of above-average sea temperatures and enhanced recruitment between 1989 and the mid-2000s generated a large increase in biomass and a geographic expansion. Increased abundance and a lack of a TAC or other means to control fishing outside of nursery areas stimulated a growth of fisheries and markets for seabass. Many small-scale artisanal fisheries, especially line fishing and some forms of netting, have developed a high seasonal dependency on seabass, and there is also a significant recreational fishing mortality in inshore waters. The behaviour of seabass, forming predictable aggregations for spawning and moving close inshore to feed at other times of year, increase their vulnerability to exploitation by offshore and inshore fisheries. Increased targeting of seabass has resulted in a progressive increase in fishing mortality above values considered appropriate to achieve F_{MSY}. The combination of increasing fishing mortality and environmental conditions causing poor recruitment since 2008 appears responsible for a continuous decline in biomass since 2010. Catches appear to be declining in fisheries where seabass is mainly a bycatch, but some other fisheries such as netting in the UK appear to be expanding and may be exploiting known seasonal migration routes and local aggregations of fish despite a more widespread contraction of the population.

Careful management of fishing pressure on seabass is needed to prevent SSB declining to such an extent that the stock's ability to produce strong recruitment in more favourable environmental conditions is impaired. Since 2013, the European Commission developed 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 an increase the MCRS to 42 cm. Further measures to restrict catches without resorting to a TAC have been implemented. Any management measures applied to commercial and recreational fisheries should take into account the need for collection of data to demonstrate the effectiveness of the measures, and the ability to enforce the measures adequately.

ICES advice in 2004 recommended that "implementation of 'input' controls, preferably through technical measures aimed at protecting juvenile fish, in conjunction with entry limitations into the offshore fishery in particular should be promoted", and that "any consideration of catch limitation (output control) would need to take into account that seabass are a bycatch in mixed fisheries to a various extent, depending on gear and country; this incites discarding and should be avoided". This form of advice has re-occurred in subsequent ICES advice for seabass.

WGCSE notes that protection of juvenile fish through technical measures is good to improve the fishery selectivity and increase the number of seabass that are able to spawn at least once, but this is probably not enough to ensure a sufficient decrease in F. Protection of juveniles already exists to an extent already through designation of 37 UK seabass nursery areas where certain types of fishing on seabass is prevented annually or seasonally. However, catching and discarding of seabass by trawlers fishing close to nursery areas remains an issue. Data available to WGCSE indicate that discarding is mainly by otter trawlers using 80–90 mm mesh in or near areas where juvenile bass are most abundant, for example in UK coastal waters of the eastern Channel. Improvements to fishery selectivity to successfully achieve a large reduction in fishing mortality on pre-spawning fish without increasing discarding would require changes to gear designs, which could have a strong spatial management component.

Entry limitation can prevent an increase in effort but will not decrease F to the extent needed, unless existing licences are withdrawn. The occurrence of seabass as a small bycatch in many fisheries raises the problem of this becoming a "choke species" if vessel catch limits are introduced and seabass fall under the landings obligation.

ICES also previously advised that "Management of seabass fisheries needs to take into account the distinctive characteristics and economic value of the different fisheries. Seabass is of high social and economic value to the large inshore artisanal fleets and to sea angling and other recreational fishing that contribute substantially to local economies". Data from France indicated that the first sale value of the high-volume and lower quality catches of seabass caught by pelagic trawlers targeting offshore spawning fish during December to March had been up to three times lower per kg than for smaller volume sales of higher-quality fish from métiers fishing inshore (Drogou *et al*., 2011). However, there is at present insufficient information to accurately evaluate the total economic value and impact of seabass fisheries beyond just the first sale value and covering direct incomes from sales and direct as well as indirect and induced costs, employment and added value generated downstream. The interrelationship between markets for wild caught and farmed seabass also needs to be evaluated. A number of studies on the economic value of recreational sea fisheries have been conducted in recent and these demonstrate high levels of spend into national economies years (e.g. Armstrong *et al*., 2013; Roberts *et al*., 2017; Hyder *et al*., 2018a). Marine recreational fisheries in Europe has been shown to have a total economic impact of 10.5 billion and support almost 100,000 jobs in Europe (Hyder *et al*., 2017; 2018a), but this cannot be easily split between individual species.

No bio-economic scenarios are available at present to appreciate the effect of management measures for seabass, based on economic considerations, and work is urgently needed in this area. The importance of seabass to recreational fisheries, artisanal and other inshore commercial fisheries and large-scale offshore fisheries in different regions means that resource sharing is an important management consideration that has implications for the type of scientific evidence needed. A number of studies have shown that recreational catches of bss.27.4bc7ad–h represent around one quarter of the total catch (Armstrong *et al*., 2013; Hyder *et al*., 2018b; Radford *et al*., 2018).

The effects of targeting of offshore spawning aggregations of seabass in the English Channel and Celtic Sea are poorly understood, particularly how the fishing effort is distributed in relation to mixing of fish from different nursery grounds or summer feeding grounds in the UK, France and other countries, given the strong site fidelity of seabass.

The current stock structure assumptions are pragmatic and need further evaluation. The seabass population in coastal waters of the Republic of Ireland is currently considered as a separate stock, although it extends into at least one of the ICES divisions defining the 4.bc and 7.a,d–h stock. Further studies are needed to determine if the seabass in Irish coastal waters are indeed functionally separate, or if they also mix with the other stock during spawning time and contribute to commercial catches on the offshore spawning grounds. Moreover, the Bay of Biscay is also currently considered as a separate stock although tagging programme indicates some exchange with the area 4 and 7 stock studied assessed by WGCSE.

As bass is, at present, a non-TAC species, there is potential for continued displacement of fishing effort from other species with limiting quotas. The fisheries on seabass have grown in the 1990s and 2000s due to good recruitment, and new markets have been established, competing with farmed bass. Fishing mortality gradually increased over time and was above F_{MSY} for many years. With the stock in decline measures were introduced to prevent the risk of stock collapse. Currently the likelihood of collapse remains high unless strong year classes are produced again and the management measures in place are continued and remain flexible to improving the fishery selection pattern, and limit total fishing mortality across all ages of seabass.

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Table 1. Bss.27.4bc7ad–h: Annual landings from 4b&c and 7a,d–h (official landings per country and total ICES estimates).

Year	Belgium	Denmark	Germany	France	UK	Netherlands	Channel Is.	Total	Total ICES
1985	0	0	0	620	105	0	18	743	994
1986	0	0	0	841	124	0	15	980	1319
1987	0	0	0	1226	123	0	14	1363	1980
1988	0	18	0	714	173	8	12	925	1239
1989	0	2	0	675	192	2	48	919	1161
1990	0	0	0	609	189	0	25	824	1063
1991	0	0	0	726	239	0	16	982	1227
1992	0	0	0	721	148	0	36	906	1186
1993	0	1	0	718	230	0	45	994	1255
1994	0	1	0	593	535	0	49	1178	1371
1995	0	1	0	801	708	0	69	1579	1835
1996	0	1	0	1703	563	8	56	2331	3022
1997	0	1	0	1429	561	1	74	2066	2620
1998	0	2	0	1363	488	48	79	1980	2390
1999	0	1	0	na	685	32	108	826	2670
2000	0	5	0	1522	407	60	130	2124	2407
2001	0	2	0	1619	458	77	80	2236	2500
2002	0	1	0	1580	627	96	73	2377	2622
2003	154	1	0	1903	586	163	84	2891	3459
2004	159	1	0	1883	617	191	159	3010	3731
2005	206	1	0	1937	512	327	220	3203	4430
2006	211	2	0	2116	736	308	23	3396	4377
2007	178	1	0	2075	873	376	18	3521	4064
2008	187	0	0	1506	934	380	20	3027	4107
2009	174	0	0	2904	801	395	15	4288	3889
2010	216	4	0	3441	879	399	14	4952	4562
2011	152	2	0	2688	928	395	17	4183	3858
2012	154	3	0	2492	946	376	12	3982	3987
2013	146	4	2	2868	841	370	12	4243	4137
2014	148	1	1	1322	1080	253	11	2816	2682
2015	40	0	0	1113	701	218	9	2081	2066
2016	23	0	1	545	551	156	24	1300	1295
2017	22	0	0	423	438	132	12	1027	984
2018	18	0	0	297	432	172	11	931	948
2019	19	0	0	309	411	209	22	970	972
2020*	24	0	0	387	521	218	0	1150	1042
2021*	45	0	0	385	613	231	1	1275	1126

Source: Official Landings Statistics. 2020 and 2021 provisional data; Total ICES, from InterCatch database.

Table 2. Bss.27.4bc7ad–h: Landings for the country / fleet components included separately in the assessment model.

Year	Fleet 1: UK Trawls, nets	Fleet 2: UK Lines	Fleet 3: UK pelagic trawlers	Fleet 4: France combined gears	Fleet 5: Other countries and gears	Fleet 6: RecFish
1985	70	30	1	870	23	1820
1986	84	33	2	1180	19	1639
1987	96	18	0	1840	25	1493
1988	129	30	8	1028	44	1384
1989	141	29	7	917	67	1279
1990	128	18	22	849	47	1150
1991	152	60	14	971	29	1056
1992	105	23	8	1001	49	1080
1993	146	62	1	979	68	1258
1994	354	154	0	786	76	1509
1995	424	169	4	1057	181	1689
1996	308	128	87	2395	104	1696
1997	335	119	71	1984	111	1605
1998	241	121	85	1773	170	1548
1999	274	148	220	1843	185	1548
2000	236	53	52	1805	261	1601
2001	263	58	97	1883	199	1685
2002	361	75	110	1825	251	1782
2003	353	65	127	2471	443	1863
2004	380	72	131	2604	544	1908
2005	353	59	68	3161	789	1905
2006	359	119	11	3259	629	1874
2007	413	166	37	2771	677	1871
2008	514	163	17	2750	663	1878
2009	486	147	9	2649	598	1852
2010	452	183	42	3236	649	1751
2011	462	143	98	2526	629	1605
2012	564	185	49	2610	579	1440
2013	530	191	39	2871	506	1222
2014	751	236	1	1303	391	1008
2015	440	199	0	1110	317	690
2016	305	210	2	547	231	209
2017	125	147	0	442	270	206
2018	160	267	0	313	208	150
2019	134	259	1	329	249	274
2020	190	306	0	409	137	453
2021	228	361	0	413	124	489

Table 3. Bss.27.4bc7ad–h: Sampling of commercial fishery landings of otter (A.), pelagic midwater trawls (A.), lines (B.) and nets (B.) for length and age in the UK (England and Wales). Nsamp is the number of landings (trips) sampled; Nfish is the number of fish measured.

A.	UK Otter trawl					UK Pelagic/midwater				
Year	Age Nsamp	Nfish	Length Nsamp	Nfish	Landings (t)	Age Nsamp	Nfish	Length Nsamp	Nfish	Landings (t)
1985	45	235	15	225	27	3	44	2	43	1
1986	18	216	28	2591	24					2
1987	41	421	54	1181	41	4	42	1	589	0.02
1988	23	257	23	1298	65	2	64	2	1684	8
1989	63	531	44	1595	80	4	126	4	1451	7
1990	63	883	48	773	67	8	19			22
1991	92	983	32	731	39	12	125	1	1490	14
1992	69	699	17	398	41	2	50	2	220	8
1993	118	1219	38	836	80	9	39			1
1994	182	1927	113	3925	125			1	127	0.3
1995	28	529	66	1995	162			1	19	4
1996	49	660	39	1041	122	1	41	3	392	87
1997	59	1660	52	2445	140	1	49			71
1998	28	676	39	1442	133	20	95	4	167	85
1999	24	379	46	1216	138	12	382	9	770	220
2000	92	759	42	1814	133	23	847	14	2463	52
2001	45	851	49	2152	141	3	58	5	691	97
2002	54	523	47	1454	161			4	545	110
2003	48	512	45	1418	207	15	459	4	744	127
2004	33	361	31	1295	173	8	161	5	522	131
2005	35	498	31	2432	181	3	149	2	299	68
2006	15	252	17	810	160	1	43	1	100	11
2007	44	385	21	903	173	1	20	3	355	37
2008	37	580	32	2151	196	6	409	8	1283	17
2009	24	1184	13	807	175	8	317	6	625	9
2010	25	360	28	1312	150	7	153	3	376	42
2011	25	577	49	1903	137	3	103	4	463	98
2012	18	182	41	751	157			1	199	49
2013	15	289	23	859	125					39
2014	14	164	22	523	104					1
2015	28	377	39	1277	100	1	4	1	4	1
2016	19	256	90	527	52					2
2017	38	510	128	915	51	0	0	0	0	0
2018	43	263	43	492	28	1	15	1	33	0
2019	30	105	89	686	15	0	0	0	0	1
2020	47	90	47	251	27	0	0	0	0	0
2021	51	151	51	376	36	0	0	0	0	0

A.	UK Otter trawl					UK Pelagic/midwater				
	Age		Length			Age		Length		
Year	Nsamp	Nfish	Nsamp	Nfish	Landings (t)	Nsamp	Nfish	Nsamp	Nfish	Landings (t)
B.	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
2017	28	303	171	2225	158	0	0	41	727	74
2018	103	1478	123	2166	267	55	694	55	1763	132
2019	99	1815	103	3083	259	57	783	92	1929	120
2020	95	943	95	2425	306	61	572	61	1872	163

A.	UK Otter trawl					UK Pelagic/midwater				
	Age		Length			Age		Length		
Year	Nsamp	Nfish	Nsamp	Nfish	Landings (t)	Nsamp	Nfish	Nsamp	Nfish	Landings (t)
2021	136	1362	136	3412	242	42	399	42	1424	154

Table 4. Bss.27.4bc7a d-h: Sampling of commercial fishery seabass landings for length and age in France for lines, nets (A), Danish seines and other gears (B), and pelagic trawls and bottom trawls (C) (2017 real sampling excluding simulated). Nsamp is the number of landings (trips) sampled; Nfish is the number of fish measured.

A.	FR_lines					FR_nets				
	Age		Length		Landings	Age		Length		Landings
Year	Nsamp	Nfish	Nsamp	Nfish		Nsamp	Nfish	Nsamp	Nfish	
2000	NA	NA	53	1613	305	NA	NA	2	72	108
2001	NA	NA	101	2659	375	NA	NA	1	5	110
2002	NA	NA	79	2076	349	NA	NA	0	0	128
2003	NA	NA	78	1732	438	NA	NA	1	4	152
2004	NA	NA	78	1748	381	NA	NA	6	84	150
2005	NA	NA	34	949	439	NA	NA	4	110	148
2006	NA	NA	73	1719	554	NA	NA	11	291	140
2007	NA	NA	69	2235	560	NA	NA	28	641	158
2008	NA	NA	41	1280	425	NA	NA	25	496	128
2009	12	211	33	1339	251			25	159	94
2010	4	169	10	334	278			49	615	160
2011	39	443	17	540	359			156	278	129
2012	37	385	10	681	295			60	408	142
2013	6	174	16	309	291	3	130	26	512	126
2014			10	299	285			29	218	163
2015	23	70	16	326	210			35	242	109
2016			2	84	156	5	67	32	293	64
2017			9	219	166			18	151	35
2018			4	208	151	9	45	9	45	74
2019			0	0	139			0	0	70
2020			27	703	164			13	193	78
2021			34	759	162			38	662	75

B.	FR_danish seine					FR_other gears				
	Age		Length		Landings	Age		Length		Landings
Year	Nsamp	Nfish	Nsamp	Nfish		Nsamp	Nfish	Nsamp	Nfish	
2000	NA	NA	0	0	0	NA	NA	0	0	20
2001	NA	NA	0	0	0	NA	NA	0	0	27
2002	NA	NA	0	0	0	NA	NA	0	0	22
2003	NA	NA	0	0	0	NA	NA	0	0	23
2004	NA	NA	0	0	0	NA	NA	0	0	17
2005	NA	NA	0	0	0	NA	NA	0	0	17
2006	NA	NA	0	0	0	NA	NA	0	0	35
2007	NA	NA	0	0	0	NA	NA	0	0	24
2008	NA	NA	0	0	0	NA	NA	0	0	40
2009			0	0	27			0	0	127
2010			0	0	61			2	2	90
2011			2	6	43			36	292	62
2012	16	153	6	370	112			7	154	91
2013			2	28	18			1	1	82
2014			12	23	9			1	1	25
2015	10	36	0	12	26			0	0	16
2016			28	78	20			0	0	20
2017			14	42	22			0	0	40
2018			0	0	9			0	0	16
2019			0	0	21			0	0	22
2020			2	77	11			0	0	20
2021			2	33	16			0	0	17

C.	FR_pelagic trawl					FR_bottom trawl				
	Age		Length		Landings	Age		Length		Landings
Year	Nsamp	Nfish	Nsamp	Nfish		Nsamp	Nfish	Nsamp	Nfish	
2000	NA	NA	2	629	681	NA	NA	2	196	692
2001	NA	NA	0	0	659	NA	NA	0	0	713
2002	NA	NA	3	680	415	NA	NA	4	710	911
2003	NA	NA	4	753	773	NA	NA	8	998	1087
2004	NA	NA	6	938	820	NA	NA	12	887	1236
2005	NA	NA	11	1239	1319	NA	NA	14	689	1239
2006	NA	NA	16	2597	1420	NA	NA	11	1240	1110
2007	NA	NA	8	1800	841	NA	NA	11	588	1187
2008	NA	NA	8	1065	1012	NA	NA	18	1927	1145
2009	13	299	55	899	1098	20	164	93	1468	1052
2010	14	741	28	1299	1828	37	201	64	626	819
2011	38	1591	30	2309	1142	61	525	151	1955	791
2012	33	1587	9	1649	1143	51	478	87	1204	824
2013	17	737	10	1253	1516	34	344	73	2060	737
2014	11	202	23	455	242	50	326	137	2139	571
2015			12	158	107	57	203	76	1628	642
2016			6	48	17	103	407	183	1396	271
2017			0	0	6	37	120	126	495	33
2018			0	0	1	23	265	31	163	63
2019			0	0	1	13	73	22	104	76
2020			0	0	2			30	572	133
2021			2	33	3			61	1789	140

Table 5. Bss.27.4bc7a d-h: Numbers-at-length in French commercial all-gears fishery landings (input to assessment at lengths 14–94 cm with <20 and >88 size classes empty).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
l20	0	0	0	0	0	0	0	0	0	0	717	0	0	0	0	0	0	0	0	0	0	0
l22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
l24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
l26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0
l28	0	0	0	3455	0	0	0	0	0	292	0	0	1219	0	0	291	0	0	0	0	0	0
l30	0	0	1015	13054	14	0	15689	0	0	473	0	0	0	146	0	346	71	0	0	0	0	0
l32	0	0	0	58717	13057	9903	32459	181	8250	2239	9811	1976	1583	0	3076	2678	1481	0	0	0	0	80
l34	9931	17962	12469	105655	78811	29872	179130	4715	28986	10714	28290	13885	6518	1504	3620	5102	1440	137	0	0	0	0
l36	34932	19809	38249	125326	127801	97890	285704	39335	229758	124925	169311	57121	85760	29667	33532	44175	2814	2646	0	0	194	90
l38	85866	68920	46427	180475	124051	128022	217657	102714	263071	211881	177571	87842	172510	88507	68262	75546	4340	2523	91	0	1030	763
l40	126730	76594	62503	119495	227214	231750	178250	146272	266408	225545	182105	128838	140273	149070	74871	93273	7417	3572	814	0	6255	7417
l42	102836	98008	82461	145456	282390	266905	196868	145122	237160	193030	283064	187586	147895	146130	82684	115713	24816	9257	2444	2034	16127	24659
l44	80478	109595	91064	104545	243107	344681	289998	164011	270810	222613	251956	201447	162333	123170	51365	122460	20422	14861	2954	2198	17867	22303
l46	93344	106857	86723	130023	188494	270532	285451	130859	228996	238849	230227	199487	180752	140677	61292	95208	22427	9603	4379	1948	12708	20722
l48	80934	77694	62163	115806	126685	239265	263272	100043	142650	155222	188149	194697	158490	127136	39844	59668	20653	7367	2606	635	9921	13639
l50	55399	57055	55905	91915	72581	169478	200874	99210	112385	159658	186310	145447	130759	116842	38109	51436	15619	6801	3549	1246	5488	11644
l52	52948	51658	46180	93878	82331	115269	119836	75929	74336	114530	109212	124239	107214	99156	29929	37860	10415	4599	2861	345	3890	7315
l54	42094	36737	35998	48742	50633	62106	99509	74405	66260	84649	120550	92526	90638	103818	39911	21406	16034	3586	2702	456	2456	5362
l56	26460	35839	26001	60839	60284	67741	99674	55147	48853	96257	71590	72471	78934	89197	32298	20681	9753	1012	2538	415	1515	4242
l58	27357	22762	19019	31614	31334	61132	54522	46087	39689	51578	62211	46869	54869	59004	30016	13591	12328	2519	3581	0	1226	3181
l60	23581	25834	14210	33688	19126	43591	45908	28056	29840	36547	31544	31690	35387	65851	21467	11946	7678	913	2008	0	1064	1996
l62	14295	18773	11129	30691	23996	35774	23763	23057	28335	57472	19076	19998	33085	64579	16797	11776	7506	1120	1669	373	636	1617
l64	18044	13532	16771	18823	14799	25788	20607	18091	14420	24016	62005	17624	17714	53482	16261	9356	4348	1369	1641	0	641	1199
l66	10773	11068	11011	13230	10650	12456	14969	8715	12694	21415	26388	14720	15170	37744	8387	6653	2634	510	778	124	333	695
l68	9903	9120	5447	7960	8569	13360	13976	8793	9039	27466	9340	7906	9374	23884	5579	2485	4465	315	463	124	378	882
l70	5709	11771	4795	5374	4880	8908	9653	4835	6821	20198	8541	6114	8114	32512	8995	1163	1353	345	255	0	133	468
l72	5721	5733	4559	5617	2974	8053	4521	2707	4714	12083	29128	2082	4147	14996	3027	660	956	408	47	0	62	141
l74	2345	5345	1825	3275	2675	9811	3424	1962	1623	7551	1884	1163	2313	9001	642	628	219	652	0	0	0	121

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
I76	2595	2782	1260	1356	2567	5020	2883	1010	1257	979	2114	1096	1540	2640	773	431	0	92	0	0	0	76
I78	2102	1691	357	297	548	2378	731	399	534	1765	182	476	1134	2073	0	9	127	718	0	0	0	5
I80	888	583	155	783	425	1365	201	158	261	264	5525	148	282	176	198	16	0	0	0	0	0	0
I82	1021	296	109	112	149	107	261	37	8	1004	6097	104	451	1566	0	278	0	92	0	0	0	3
I84	548	204	0	148	295	0	30	59	0	0	863	0	29	0	0	0	0	0	0	0	0	0
I86	123	0	0	0	0	0	0	0	0	0	0	0	27	1115	0	0	301	0	0	0	0	0
I88	0	61	0	0	149	0	0	0	0	0	1207	0	0	0	0	0	0	0	0	0	0	0

Table 6. Bss.27.4bc7ad–h: Numbers-at-age in French commercial fishery landings, 2000–2021, all gears combined (with <2 year old age classes empty).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
a2	0	0	0	2611	3	0	3138	0	1208	878	0	0	0	0	0	0	0	0	0	0	0	10
a3	0	2651	8114	10800	4	24195	74600	5307	79917	17293	6830	0	0	0	0	0	0	98	0	0	34	1505
a4	9440	55640	73892	364427	80483	77794	131099	73224	175402	92501	64071	3481	265	0	2300	10607	1850	1065	735	2251	7217	13637
a5	222655	47734	125531	241694	627951	253455	564668	135809	545960	77583	74708	109582	17233	6417	4138	28960	20182	1605	5490	2392	17734	30515
a6	273687	298773	90294	318445	438799	735235	361515	460583	401231	49868	135505	152702	216615	16487	36582	39482	18999	6568	1582	2391	37642	23147
a7	139562	211740	236147	96562	297961	352182	841651	124606	456312	17981	112579	142896	266517	133787	54484	30417	18589	4507	1571	112	3170	34777
a8	79413	90962	86108	254050	65297	443765	146484	139879	143871	17887	117368	121070	240104	88986	43902	60049	20496	6102	776	1682	4038	11829
a9	47258	44742	31151	114829	131612	39104	253945	79978	147881	0	57320	264916	222113	109206	41316	27137	14682	3870	2704	454	6130	9287
a10	43924	21074	23025	57883	77533	161572	13655	69214	40719	28366	22351	105282	172833	143048	4541	17343	14879	2085	70	231	4343	0
a11	49293	39908	17823	26223	25416	69617	132370	33191	57341	1248	10523	58721	82759	103915	1742	5353	10075	1160	0	386	211	2465
a12	20207	36007	14760	19879	14848	26314	84910	65868	17882	0	10414	24328	35102	47660	202	3804	0	727	306	0	1403	0
a13	10767	17787	15912	14232	14254	17996	22068	68599	35092	0	7096	18672	21967	18471	178	2650	1423	649	0	0	0	976
a14	4925	4394	9752	18088	13528	19238	6648	11131	12669	0	7652	4666	8640	16817	121	4485	131	351	0	0	0	471
a15	4927	6838	3743	6600	7628	17974	6999	9034	5518	0	213	3149	2570	1275	0	0	81	455	0	0	0	0
a16	10901	8034	1553	4028	5270	22718	16069	5486	6091	0	2322	410	1374	4149	0	0	0	0	0	0	0	0

Table 7. Bss.27.4bc7ad–h: Numbers-at-age in the UK (England and Wales) bottom trawl, nets (with <2 year old age classes empty).

UK OTB NET	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15	a16+
1985	65	11844	30828	6121	9692	1240	3914	9713	2454	2581	1320	343	841	286	892
1986	0	15673	20303	18759	3453	7662	704	3197	10503	1833	1403	2889	1222	1688	3595
1987	0	439	30263	58458	13753	2095	2437	656	726	5731	2565	1889	761	817	2796
1988	0	1930	20862	54472	41710	12803	1721	2315	780	451	5503	2024	1312	801	2589
1989	33394	5411	1223	7659	43911	26891	9002	3076	2901	1878	2896	8914	1499	1286	3436
1990	0	3035	2503	3770	16047	31459	21020	5042	2186	1463	846	1100	4837	353	2703
1991	1533	6933	36938	2381	1283	6576	18064	16248	7033	589	2617	2321	480	6659	3674
1992	0	15982	55550	33557	1183	796	1956	4750	4762	1230	451	433	139	497	3202
1993	0	657	81429	65981	21858	1351	627	1796	4803	3920	1500	710	735	475	2347
1994	2	1328	30970	369416	41472	16079	1130	294	2282	5842	4387	1596	650	646	3717
1995	0	5599	37064	81529	334815	17932	6931	702	415	1046	3440	3215	1846	2699	2680
1996	191	11473	43831	31632	64618	173733	8235	3622	216	315	454	1881	1688	534	1784
1997	0	2490	8501	64000	45238	39229	145407	8105	4456	632	640	294	2689	1712	2235
1998	0	1103	44997	49461	69489	25366	15136	41057	2671	860	96	96	385	623	811
1999	241	82	80414	146338	43841	28582	9612	6192	18072	1112	729	40	270	97	830
2000	0	9528	2584	151515	72747	11772	11046	4992	4636	8323	818	184	14	55	643
2001	614	11085	92408	29064	105169	25329	7388	8742	5811	8136	7522	804	768	69	759
2002	338	11495	43605	240476	16779	67647	16021	7450	8022	2682	3842	10166	645	193	568
2003	0	5698	75254	70415	154267	8719	38901	14072	4789	3196	2260	1599	3937	937	756
2004	0	4406	38270	214112	76652	95133	2733	12227	4039	1583	994	802	263	1029	221
2005	0	18910	135210	89202	124422	33796	30175	3112	7357	1390	1123	363	173	650	842
2006	0	20497	141335	144890	54069	56281	17344	24148	2207	3475	2277	859	210	188	1433
2007	0	955	33606	169272	96625	44423	34061	12877	14366	11530	4527	1621	11	254	428
2008	0	9338	110875	296983	139083	47617	19838	17332	8660	6128	852	793	988	317	824
2009	0	2659	73056	169969	172602	64997	19002	14443	9064	8631	3610	2235	1302	0	249
2010	0	319	77100	155258	118179	78410	28938	11821	6979	6043	2645	2083	2273	534	1663
2011	0	845	28630	124625	92582	71094	54338	31775	10438	11227	6347	2933	2203	675	1692
2012	0	1620	14135	166965	219883	61319	39609	31669	15268	9427	4092	3864	2546	538	930

UK OTB NET	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15	a16+
2013	0	0	45016	60547	182858	117821	33448	30222	22727	17473	11825	2908	2687	2429	2133
2014	0	6622	31923	107001	58412	114826	78809	38859	27037	30548	19853	5152	1776	1857	1487
2015	0	50	3716	20172	45807	36830	63272	35025	17302	12685	10431	2917	7265	7308	966
2016	0	0	1591	7863	13991	31088	24925	40386	24807	10618	8218	4788	1960	2098	1528
2017	0	0	39	454	2176	1179	881	928	852	713	107	257	41	144	236
2018	0	130	4361	18582	26874	18792	9488	6826	4615	6186	5377	1562	1164	960	766
2019	0	105	2168	26492	29521	14508	9155	4501	4944	4192	4556	2635	1331	803	2067
2020	0	1058	4481	16161	85080	29885	12476	5890	3316	3182	2712	2768	2351	1456	1772
2021	0	270	2643	9490	20563	70224	23930	11483	5748	3157	2275	4297	2012	421	716

Table 8. Bss.27.4bc7ad–h: Numbers-at-age in the UK (England and Wales) lines (with <2 year old age classes empty).

	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15	a16+
1985	0	9225	11491	3441	5902	891	1113	5133	1176	694	913	46	122	134	936
1986	0	577	8939	3343	933	2354	358	758	5428	960	871	953	573	645	1307
1987	0	108	1052	3719	2132	581	477	432	523	1578	845	211	167	179	1187
1988	0	33	1751	13389	5067	2398	551	1014	209	456	1863	895	715	523	977
1989	22	0	538	8171	36046	1842	371	104	208	58	215	1040	115	87	334
1990	0	305	82	185	1284	3456	2407	897	357	369	193	242	1261	81	828
1991	0	131	8420	471	177	792	4927	4024	1842	89	1229	1685	367	4831	2887
1992	0	1195	5473	5267	294	269	518	1193	1633	563	130	195	169	143	1411
1993	16	526	11652	11776	7569	590	289	931	3941	3344	1367	663	703	643	3789
1994	0	71	4059	119784	18540	9393	943	173	1754	5414	5570	1205	639	274	2790
1995	0	486	6943	21979	97509	7380	5313	480	699	831	5684	3696	1936	840	4733
1996	0	210	8804	12487	15338	57127	4566	4979	127	510	364	2521	1573	1300	2346
1997	59	454	3102	15613	11415	8287	50819	2853	1635	557	354	243	2195	1065	1570
1998	0	3676	8366	10920	22630	10485	6452	28231	2949	1091	138	196	793	1381	1254
1999	479	255	25158	37306	13589	13697	5288	5001	20522	1669	2038	247	777	315	3314
2000	0	421	294	19380	12402	2696	3285	1476	1248	4697	330	258	16	88	559
2001	54	471	7385	1392	17864	7702	2027	3239	1685	1761	3774	440	301	27	420
2002	30	729	2609	14173	2686	17358	7757	2621	5179	1463	1766	3687	322	101	180
2003	0	80	7166	7917	25014	2167	10164	3262	1473	982	796	681	1704	186	166
2004	0	279	1697	13884	8601	17310	2398	6365	3626	1181	1189	1172	406	2243	143
2005	0	621	2669	5059	14699	5529	6985	589	5697	1845	236	1307	33	189	606
2006	0	44	16121	35990	13714	22306	5794	12717	1644	3135	1258	305	358	1016	734
2007	0	22	6611	31578	28396	14511	17834	8499	10951	5163	3121	5119	85	344	485
2008	0	199	5010	27319	42071	21561	12265	12566	5458	4960	1372	1032	3431	198	992
2009	0	315	8415	19843	33661	25695	12017	9320	5021	5371	4748	811	1075	0	0
2010	0	814	7029	45515	54766	39716	15835	5147	2395	2910	706	522	359	81	277
2011	0	8	5209	11538	24667	19293	16668	13032	4947	6066	2695	1941	2187	522	657
2012	0	91	1695	18362	28593	23507	22946	17909	10199	7725	2994	2672	2158	596	820
2013	0	0	1187	6979	35135	32251	18057	14762	10333	10543	6106	3730	2886	1957	1938
2014	0	980	4985	26081	20743	39548	28357	15323	12440	12413	8018	4889	1976	1673	1322
2015	0	6	1834	5941	23369	22221	31442	19014	10344	8210	7036	2504	3136	744	798
2016	0	0	742	7020	11858	20142	15479	25838	13362	7406	5904	4674	2548	3894	2567
2017	0	0	1734	4007	5766	2324	2362	1036	4159	993	356	469	202	475	330
2018	0	454	6992	23652	41538	31173	17352	16753	11214	14117	9044	4650	3791	2220	3945
2019	0	85	3010	36477	41315	26099	16791	9320	10364	11061	9434	5936	3248	2068	4291
2020	0	431	3437	11667	90256	53606	27720	13526	7890	7117	5823	5194	3678	2127	3185
2021	0	206	5501	21294	39528	93379	41709	26913	12827	6814	10191	4230	3570	3866	5300

Table 9. Bss.27.4bc7ad–h: Numbers-at-age in the UK (England and Wales) midwater pair trawl fleet (no samples for 1997, 2013–2017, 2019–present) (with <3 year old age classes empty).

	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16+
1996	0	289	796	3892	71666	5583	1648	21	334	154	622	485	199	559
1998	0	245	5979	11845	8553	8135	25138	2517	345	93	53	119	893	569
1999	0	2983	18409	15106	27147	13818	18060	43097	4389	1686	324	387	308	2689
2000	15	60	2476	7587	3270	4497	1459	2830	7077	634	174	39	96	420
2001	0	179	899	19777	20290	7042	5268	3124	2845	9666	857	636	123	261
2002	3	37	2380	1578	24087	9693	6297	5978	450	5664	9215	0	0	530
2003	0	2689	10619	39257	7971	40551	10293	3162	3254	618	169	4043	77	281
2004	7	1254	12502	14372	48109	3199	20694	8010	353	1797	1141	91	968	18
2005	0	114	2103	15321	14397	17408	1907	5182	0	1831	99	0	40	599
2006	0	227	567	608	4076	1423	3085	254	176	111	0	0	0	53
2007	0	385	2517	7038	5387	6833	2795	1900	631	807	12	37	19	121
2008	45	445	1540	3279	1787	1412	1557	755	960	30	183	490	0	40
2009	0	90	635	2175	2596	843	784	168	298	173	11	169	0	0
2010	9	36	1741	5546	8261	6678	4755	403	3786	152	294	313	551	50
2011	0	255	4397	10231	13640	15909	13642	4424	4233	2773	1688	1003	264	423
2012	0	391	4461	10776	10016	8757	5789	2741	1134	290	433	143	127	226
2015	0	7	23	85	103	137	30	6	3	0	0	0	0	0
2018	0	0	2	9	5	1	1	0	0	0	0	0	0	0

Table 10. Bss.27.4bc7ad–h: Numbers of trips sampled for discards by Cefas (UK): 2002–2021, by gear group and area.

Division & fleet	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
(a) bottom otter trawls																				
4	16	34	56	37	41	85	58	49	46	42	54	30	53	45	12	0	1	3		
7.afg	8	15	23	8	11	43	50	28	22	22	22	12	14	16	2	0	0	5		
7.d	1	2	4	3	1	2	1	6	7	9	4	5	7	3	13	1	1	7		11
7.eh	9	24	37	31	49	90	87	38	29	32	29	45	73	68	29	0	10	18	4	9
Total	34	75	120	79	102	220	196	121	104	105	109	92	147	132	56	1	12	33	4	20
(b) Fixed/driftnets																				
4	0	0	2	1	11	31	15	20	15	11	13	18	10	7	0	0	0	0		
7.afg	3	7	5	3	7	8	9	10	7	16	22	16	25	12	3	0	0	0		
7.d	0	0	1	0	0	17	6	4	1	7	10	42	25	17	10	0	0	16		
7.eh	1	5	9	2	3	16	10	14	19	17	25	24	24	15	0	0	0	0		
Total	4	12	17	6	21	72	40	48	42	51	70	100	84	51	13	0	0	16		
(c) Lines																				
4	0	1	0	0	0	1	2	0	0	0	0	0	1	1	0	0	0	0		
7.afg	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0		
7.d	0	0	0	0	0	0	0	0	0	0	0	0	1	0	33	2	0	0		
7.eh	0	0	1	0	0	0	0	0	0	0	1	0	8	5	4	0	0	0		
Total	0	1	1	0	0	1	2	0	0	0	2	1	10	6	37	2	0	0		
(d) Midwater trawls																				
4	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
7.afg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
7.d	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
7.eh	0	1	1	1	2	1	0	0	0	0	0	2	1	0	0	0	0	0		
Total	1	1	1	3	2	1	0	0	0	0	0	2		0	0	0	0	0		
(e) Other gears																				
4	8	5	10	1	2	1	1	7	6	8	4	10		0	6	0	0	0		

Division & fleet	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
7.afg	4	11	8	4	9	1	2	3	3	1	4	8		0	5	0	0	0		
7.d	0	1	5	2	3	1	1	2	4	1	2	3	1	2	0	0	0	0		
7.eh	10	17	27	16	24	32	18	13	17	27	22	21	14	15	1	0	0	0		
Total	22	34	50	23	38	35	22	25	30	37	32	42	15	17	12	0	0	0		

Table 11. Bss.27.4bc7ad–h: Estimated annual numbers and weight of seabass retained and discarded by UK using fixed or driftnets, otter trawl, beam trawl and lines fleets in areas 4, 7.d, 7.eh and 7.afg, based on at-sea sampling, and raised from landings in sampled strata to landings in all strata. Numbers of sampled trips (Ntrip) are shown.

	Otter trawl				Nets				Beam trawl				Lines				Total OTB, nets, lines and BTS		
	discards	retained	rate (%)	Nti-rip	discards	retained	rate %	Nti-rip	discards	retained	rate %	Nti-rip	discards	retained	rate (%)	Nti-rip	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
2017*	0	35	1	1	-	74	-	0	-	16	-	0	11	147	7	2		272	-
2018*	11	13	46	5	-	132	-	0	15	13	54	7	-	267	-	0	26	425	6
2019*	83	15	85	3	6	120	5		0.1	12	1		0	258	0		89	410	18
2020*	12	27	44	1	0	163	0	3	13	15	87	0	0	306	0	0	25	522	5
2021*	8	33	19	20	0	195	0	0	0	13	0	0	0	361	0	20	8	607	1

***Not used in assessment (lack of information. High probability of underestimation considering management measures).**

Table 12. Bss.27.4bc7ad–h: Number of fishing trips sampled for retained and discarded weight of seabass on French vessels using different gear types: 2009–2020. (Data are clearly underestimated from 2015 and are not used in assessment).

Pelagic trawl FR	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	0	773	0.00%	NA		
2004	0	820	0.00%	NA		
2005	0	1319	0.00%	NA		
2006	0	1420	0.00%	NA		
2007	0	841	0.00%	NA	12	2
2008	2	1012	0.20%	3.93	21	4
2009	21.2	1098	1.89%	0.05		
2010	7.4	1828	0.40%	0.71	35	106
2011	7.2	1142	0.63%	0.12	9	46
2012	0.9	1143	0.08%	2.38	7	29
2013	0.3	1516	0.02%	2		
2014	0	242	0.00%	NA		
2015	11.7	107	9.86%	0.03	32	5
2016*	0.5	17.43081	2.79%	NA	19	2
2017*		6		NA	0	0
2018*	0.2	1	17%		28	1
2019*		1				
2020*	-	2	-	-	0	0
2021*	0	3				
bottom trawlFR	**discards (t)**	**Landings (t)**	**discard rates**	**cv indicator**	**Nb trip sampled**	**Nb fish sampled**
2003	73.8	1087	6.36%	0.35	18	26
2004		1236	NA	NA	24	3
2005	43.9	1239	3.42%	0.9		
2006	42.9	1110	3.72%	1.07	24	36
2007	9.6	1187	0.80%	0.73		
2008	40.7	1145	3.43%	0.94	57	63
2009		1052	NA	NA	143	102
2010	76.6	819	8.55%	0.32	137	5
2011	27.2	791	3.32%	0.46	122	57
2012	24.5	824	2.89%	0.23	151	118
2013	26.3	737	3.45%	0.37	139	145
2014		571	NA	NA	133	29
2015	35.4	642	5.23%	0.49	189	356
2016*	126.9	271	31.86%	NA	512	90
2017*	156	178	47%	NA	61	141
2018*	32	72	31%		217	71
2019*	76	76	50%		9	31
2020*	3	133	2%	-	4	4

2021*	11	140				
netsFR	**discards (t)**	**Landings (t)**	**discard rates**	**cv indicator**	**Nb trip sampled**	**Nb fish sampled**
2003	31.7	152	17.26%	1.2		
2004	77.6	150	34.09%	0.1		
2005	0	148	0.00%	NA		
2006	125.5	140	47.27%	0.34		
2007	2.2	158	1.37%	0.61	32	2
2008	0.5	128	0.39%	0.79		
2009	6.4	94	6.37%	0.41	196	3
2010	6.1	160	3.67%	0.29	108	5
2011	9	129	6.52%	0.35		
2012	11.8	142	7.67%	0.55	269	9
2013	21.6	126	14.63%	0.18	173	2
2014	21.7	163	11.75%	0.11	118	3
2015	14.7	109	11.88%	0.2	217	8
2016*	19.4	64	23.25%	NA	258	209
2017*	0.7	34	2%	NA	0	0
2018*	2	74	3%		101	17
2019*	3	70	4%			
2020*	-	78	-	-	12	0
2021*	-	75	-	-		
linesFR	**discards (t)**	**Landings (t)**	**discard rates**	**cv indicator**	**Nb trip sampled**	**Nb fish sampled**
2003	0	438	0.00%	NA		
2004	0	381	0.00%	NA		
2005	0	439	0.00%	NA		
2006	0	554	0.00%	NA		
2007	0	560	0.00%	NA		
2008	100.3	425	19.09%	0.35		
2009	5.6	251	2.18%	0.71	17	21
2010	3.9	278	1.38%	1.24		
2011	13.1	359	3.52%	0.35		
2012	15.8	295	5.08%	0.26		
2013	14.2	291	4.65%	0.45		
2014	15.8	285	5.25%	0.4		
2015	7.4	210	3.40%	0.32	28	21
2016*		156		NA		
2017*		166		NA	0	0
2018*		151			0	0
2019*		139				
2020*	-	164	-	-	0	0
2021*	2	162				

OtherFR	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	0	23	0.00%	NA		
2004	6.6	17	27.97%	NA		
2005	0	17	0.00%	NA		
2006	0	35	0.00%	NA		
2007	0	24	0.00%	NA		
2008	0	40	NA	NA		
2009	0	127	NA	NA		
2010	0	90	0.00%	NA		
2011	44.8	62	41.95%	5.97		
2012	1.1	91	1.19%	0.25	6	9
2013	0	82	0.00%	NA		
2014	0	25	0.00%	NA	130	96
2015	11	11	50.00%	0.58		
2016*	5.9	19.82406	22.94%	NA	64	9
2017*	5	58	8%	NA	0	0
2018*		15			0	0
2019*		43				
2020*	-	20	-	-	-	-
2021*	-	33	-	-	-	-

FR_ALL	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	105.5	2473	4%		18	26
2004	84.2	2604	3%		24	3
2005	43.9	3162	1%		0	0
2006	168.4	3259	5%		24	36
2007	11.8	2770	0%		44	4
2008	143.5	2750	5%		78	67
2009^	33.2	2622	1%		356	126
2010^	94	3175	3%		280	116
2011^	101.3	2483	4%	7.25	131	103
2012^	54.1	2495	2%	3.67	433	165
2013^	62.4	2752	2%		312	147
2014^	37.5	1286	3%		381	128
2015^	80.2	1079	7%	1.62	466	390
2016*	152.7	529	22%		853	310
2017*	161.7	442	27%		61	141
2018*	34.2	313	10%			
2019*	79.2	329	19%		9	31
2016**	155.6	*529*	23%			
2017**	270.9	*442*	38%			
2018**	456.4	*313*	59%			

2019**	374.6	*329*	53%	
2020**	313	*409*	43%	
2021**	404	*413*	49%	

^ included in the assessment (source on-board sampling programme).

*** not included in the assessment (source on-board sampling programme).**

**** included in the assessment (source logbook data).**

Table 13. Bss.27.4bc7ad–h: Values of expected recreational F reductions associated with management measures applied to bss.27.4bc7ad–h since 2015. Frec multiplier represents the recreational F relative to 2012. Note that the emergency measures were implemented part way through 2015, so the reduction was applied for half the year.

Year	Management scenario			Frec Multiplier
	MCRS	Bag limit	Open season	
Pre-2015	36 cm	none	All year	1.000
2015 Jan–Jun	36 cm	none	All year	0.821
2015 Jul–Dec	42 cm	three fish		
2016 & 2017	42 cm	one fish	6 months	0.282
2018	42 cm	one fish	3 months	0.191
2019	42 cm	one fish	7 months	0.312
2020	42 cm	two fish	9 months	0.464
2021	42 cm	two fish	9 months	0.464
2021	42 cm	two fish	9 months	0.464

Table 14. Bss.27.4bc7ad–h: Time-series of Cefas Solent autumn survey of juvenile seabass. Indices were revised in 2020 and updated in the assessment. A change in trawl design took place in 1993, and calibration factors are applied.

Year	Solent Index prior to 2020 revision	2021 Solent Index
1986	5.84	5.84
1987	2.6	2.6
1989	7.05	7.05
1990	3.98	3.98
1991	3.32	3.32
1992	19.7	19.7
1993	14.63	14.63
1994	5.46	6.69
1995	10.24	10.53
1996	6.06	6.35
1997	38.2	40.4
1998	7.34	7.22
1999	20.91	19.02
2000	17.46	17.8
2001	39.91	42.69
2002	11.7	13.95
2003	13.55	14.18
2005	21.93	23.46
2006	19.73	19.76
2007	5.5	5.5
2008	25.52	25.52
2009	19.83	19.83
2011	4.05	4.05
2013	1.52	1.56
2014	1.4	1.45
2015	7.44	7.45
2016	6.03	6.2
2017	3.54	3.54
2018	2.66	2.66
2019		1.95
2020		4.92
2021		3.59

Table 15. Bss.27.4bc7ad–h: Numbers-at-age in Solent survey 1986–present: updated time-series of Cefas Solent autumn survey of juvenile seabass.

	Age 2	Age 3	Age 4
1986	0.27	4.26	1.31
1987	0.05	0.28	2.27
1989	6.68	0.37	0.00
1990	2.81	1.15	0.02
1991	3.08	0.21	0.03
1992	0.95	18.59	0.16
1993	6.65	3.59	4.39
1994	3.67	2.69	0.34
1995	4.19	5.88	0.46
1996	5.86	0.38	0.12
1997	33.78	6.54	0.08
1998	1.23	5.41	0.58
1999	17.62	0.59	0.82
2000	5.91	11.86	0.03
2001	36.70	4.21	1.77
2002	7.07	6.56	0.31
2003	8.51	5.07	0.60
2005	14.21	8.37	0.88
2006	9.53	9.21	1.02
2007	3.42	1.78	0.30
2008	18.52	6.66	0.34
2009	13.19	6.31	0.32
2011	2.25	1.39	0.41
2013	1.38	0.08	0.10
2014	0.76	0.67	0.02
2015	6.95	0.44	0.05
2016	3.86	2.24	0.11
2017	0.86	2.56	0.12
2018	2.17	0.32	0.18
2019	0.57	1.36	0.02
2020	3.85	0.87	0.20
2021	1.94	1.60	0.05

Table 16. Bss.27.4bc7ad–h: Seabass indices of abundance 2000–2014 (swept area) from the Channel Groundfish Survey. The relative standard error CV is the log-transformed value used in SS3 (sqrt(loge (1+CV^2)).

year	Total hauls	No. hauls with seabass	Percentage of hauls with seabass	Mean no. seabass per positive haul	Swept-area abundance index	CV
1988	68	6	9	2	245776	0.15
1989	61	3	5	1	77716	0.58
1990	75	8	11	8	1129914	0.12
1991	79	19	24	9	4250636	0.03
1992	60	23	38	13	2617986	0.11
1993	65	21	32	8	2299919	0.10
1994	86	19	22	5	1097828	0.11
1995	166	17	10	5	1021741	0.09
1996	134	26	19	3	1224238	0.13
1997	169	31	18	6	1817599	0.12
1998	82	38	46	8	2531043	0.08
1999	102	37	36	8	1642271	0.12
2000	100	36	36	9	2570994	0.08
2001	109	39	36	9	3150674	0.14
2002	100	44	44	12	3872427	0.11
2003	94	41	44	20	8739056	0.11
2004	94	44	47	8	3598436	0.10
2005	105	40	38	7	3005315	0.08
2006	110	36	33	14	5518000	0.12
2007	103	33	32	8	3661314	0.14
2008	105	40	38	10	6468839	0.15
2009	102	26	26	7	2564694	0.09
2010	101	30	30	4	1804538	0.10
2011	108	27	25	4	1513742	0.12
2012	96	25	26	5	2034552	0.11
2013	96	19	20	4	995987	0.13
2014	98	20	20	3	669931	0.13

Table 17. Bss.27.4bc7ad–h: Commercial lpue index for French fleet updated for the 2022 assessment.

Year	Index	+- SE
2001	0.915	0.140
2002	0.961	0.105
2003	0.944	0.109
2004	0.927	0.091
2005	1.016	0.072
2006	1.019	0.089
2007	1.106	0.080
2008	1.083	0.084
2009	1.000	0.045
2010	0.924	0.048
2011	0.813	0.050
2012	0.747	0.045
2013	0.740	0.069
2014	0.617	0.047
2015	0.626	0.056
2016	0.516	0.044
2017	0.484	0.051
2018	0.506	0.070
2019	0.683	0.099
2020	0.745	0.124
2021	0.925	0.149

Table 18. Bss.27.4bc7ad–h: Key model assumptions and parameters from the WGCSE 2021 update assessment.

Characteristic	Settings
Starting year	1985
Ending year	Assessment year-1 (2021)
Equilibrium commercial catch for starting year	0.82* landings in 1985 by fleet.
Equilibrium recreational catch for starting year	Constant F estimated using 2012 survey results 1985–2014; 2015–present Frec multiplier on F 2012 survey results
Number of areas	1
Number of seasons	1
Number of fishing fleets	6
Number of surveys	2: CGFS; Solent autumn survey.
Number of commercial tunning fleets	1
Individual growth	von Bertalanffy, parameters fixed, combined sex
Number of active parameters	114
Population characteristics	
Maximum age	30
Genders	1
Population length bins	4–100, 2 cm bins
Ages for summary total biomass	0–30
Data characteristics	
Data length bins (for length structured fleets)	6–94, 2 cm bins
Data age bins (for age structured fleets)	0–16+
Minimum age for growth model	2
Maximum age for growth model	30
Maturity	Logistic 2-parameter – females; L50 = 40.65 cm
Fishery characteristics	
Fishery timing	-1 (whole year)
Fishing mortality method	Hybrid
Maximum F	2.9
Fleet 1: UK Trawl/nets selectivity	Double normal, length-based
Fleet 2: UK Line selectivity	Asymptotic, length-based
Fleet 3: UK Midwater trawl selectivity	Asymptotic, length-based
Fleet 4: Combined French fleet selectivity	Asymptotic 1985–2014, Double normal 2015–present, length-based
Fleet 5: Other fleets/gears selectivity	Mirrors French fleet
Fleet 6: Rrecreational fishery	Double normal, length-based
Blocks: Selectivity and Retention	Fleets 1, 2, 4, 5 and 6 2015 to present
Survey characteristics	
Solent autumn survey timing (yr)	0.83

Characteristic	Settings
CGFS survey timing (yr)	0.75
French LPUE timing (yr)	-1
Catchabilities (all surveys)	Analytical solution
Survey selectivities: Solent autumn:	Double normal, length-based constrained by Min-Max age selectivity, age-based
Survey selectivities: CGFS	Double normal, length-based
Tunning fleet: French LPUE	Mirrors French fleet
Fixed biological characteristics	
Natural mortality	0.24
Beverton–Holt steepness	0.999
Recruitment variability (σR)	0.9
Weight–length coefficient	0.00001296
Weight–length exponent	2.969
Maturity inflection (L50%)	40.649 cm
Maturity slope	-0.33349
Length-at-age Amin	19.6 cm at Amin=2
Length-at-Amax	80.26 cm
von Bertalanffy k	0.09699
von Bertalanffy Linf	84.55 cm
von Bertalanffy t0	-0.730 yr
Std. Deviation length-at-age (cm)	SD = 0.1166 * age + 3.5609
Age error matrix	CV 12% at-age
Other model settings	
First year for main recruitment deviations	1955
Last year for recruit deviations	2018
Last year no bias adjustment	1973.5
First year full bias adjustment	1981.7
Last year full bias adjustment	2018.9
First year recent year no bias adjustment	2019.7
Maximum bias adjustment	0.915

Table 19. Bss.27.4bc7ad–h: Final seabass update assessment: model estimated stock numbers-at-age (thousands of fish).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1985	855	1199	21985	8048	4913	1601	1458	1220	1678	4133	1443	913	683	522	382	266	589
1986	2490	672	942	17188	6221	3725	1185	1054	866	1179	2887	1005	635	475	363	266	594
1987	21289	1959	528	735	13246	4689	2730	845	736	597	806	1967	683	431	322	246	584
1988	17384	16747	1537	411	563	9866	3373	1898	572	488	392	525	1276	443	279	209	538
1989	90994	13675	13149	1199	316	423	7195	2391	1317	391	332	265	354	860	298	188	504
1990	7431	71578	10737	10261	923	237	308	5094	1657	900	265	224	178	239	580	201	467
1991	15313	5846	56198	8378	7891	692	173	218	3522	1130	609	179	151	120	160	390	450
1992	22686	12046	4588	43797	6422	5879	498	120	148	2352	747	401	117	99	79	105	552
1993	8674	17845	9453	3574	33570	4789	4236	347	82	99	1552	490	262	77	65	51	430
1994	33431	6823	14006	7368	2743	25082	3460	2964	237	55	66	1027	324	173	51	43	318
1995	49741	26298	5358	10932	5666	2054	18173	2434	2043	161	37	44	692	218	116	34	244
1996	3124	39127	20645	4178	8386	4223	1477	12663	1658	1372	107	25	29	458	145	77	185
1997	57526	2457	30678	16037	3180	6162	2968	994	8237	1053	859	67	15	18	283	89	162
1998	17317	45252	1927	23854	12226	2343	4352	2013	654	5303	669	542	42	10	11	178	158
1999	56771	13622	35495	1499	18212	9038	1662	2967	1331	423	3388	425	343	26	6	7	212
2000	24547	44658	10683	27599	1143	13428	6375	1122	1934	847	266	2113	264	213	16	4	137
2001	27708	19309	35025	8308	21063	845	9540	4356	743	1254	542	169	1337	167	134	10	89
2002	43508	21796	15145	27242	6342	15576	600	6515	2883	481	802	344	107	845	105	85	63
2003	44224	34225	17097	11782	20797	4688	11058	410	4315	1871	309	511	219	68	536	67	94
2004	34018	34788	26828	13272	8951	15239	3282	7401	265	2715	1158	189	312	133	41	326	98

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2005	22668	26760	27266	20817	10073	6546	10636	2187	4751	165	1670	706	115	189	81	25	257
2006	24147	17831	20958	21107	15717	7297	4504	6951	1370	2885	98	982	413	67	110	47	164
2007	27697	18995	13965	16221	15929	11372	5009	2937	4344	830	1713	58	573	240	39	64	123
2008	14458	21787	14883	10822	12274	11575	7855	3295	1857	2671	501	1024	34	340	142	23	111
2009	12729	11373	17072	11534	8186	8910	7985	5163	2084	1143	1615	300	610	20	202	85	80
2010	2456	10013	8913	13237	8735	5956	6171	5278	3288	1293	697	977	181	366	12	121	99
2011	10188	1932	7840	6894	9967	6286	4051	3974	3252	1963	756	403	561	103	210	7	126
2012	4378	8014	1513	6073	5206	7212	4311	2639	2484	1975	1171	446	237	329	61	123	78
2013	15034	3444	6276	1170	4565	3729	4867	2752	1613	1472	1148	673	255	135	188	35	115
2014	28374	11826	2695	4839	874	3224	2460	3012	1619	915	816	628	366	138	73	102	82
2015	6095	22320	9269	2087	3636	622	2155	1561	1844	969	541	480	369	215	82	43	109
2016	25790	4795	17547	7254	1598	2634	416	1353	949	1111	584	327	291	225	132	50	95
2017	6281	20287	3771	13770	5624	1199	1879	284	901	628	735	387	218	194	151	89	98
2018	19116	4941	15955	2959	10683	4235	866	1311	195	615	429	503	265	149	134	104	129
2019	12589	15037	3886	12530	2306	8146	3115	614	912	135	425	297	349	185	104	93	163
2020	21771	9903	11826	3051	9754	1756	5997	2219	430	634	94	296	207	244	129	73	180
2021	21754	17125	7787	9280	2373	7421	1290	4252	1542	297	438	65	205	144	169	90	177
2022	21755	17112	13467	6111	7222	1808	5466	917	2960	1067	205	303	45	142	100	118	186

Table 20. Bss.27.4bc7ad–h: Final seabass update assessment: model estimated fishing mortality-at-age.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1985	0.000	0.001	0.006	0.017	0.037	0.061	0.085	0.102	0.113	0.119	0.122	0.123	0.124	0.124	0.124	0.124	0.123
1986	0.000	0.002	0.007	0.021	0.043	0.071	0.098	0.119	0.132	0.140	0.144	0.146	0.147	0.147	0.147	0.147	0.146
1987	0.000	0.003	0.010	0.027	0.055	0.089	0.123	0.151	0.170	0.182	0.189	0.192	0.194	0.195	0.195	0.195	0.194
1988	0.000	0.002	0.008	0.022	0.046	0.076	0.104	0.125	0.139	0.147	0.152	0.154	0.154	0.154	0.154	0.154	0.152
1989	0.000	0.002	0.008	0.022	0.047	0.077	0.105	0.127	0.141	0.148	0.153	0.154	0.155	0.155	0.155	0.154	0.152
1990	0.000	0.002	0.008	0.023	0.047	0.078	0.107	0.129	0.143	0.151	0.155	0.157	0.157	0.157	0.157	0.156	0.154
1991	0.000	0.002	0.009	0.026	0.054	0.090	0.123	0.148	0.164	0.173	0.178	0.180	0.181	0.181	0.180	0.180	0.177
1992	0.000	0.002	0.010	0.026	0.053	0.088	0.121	0.147	0.165	0.175	0.181	0.184	0.185	0.186	0.186	0.185	0.184
1993	0.000	0.002	0.009	0.025	0.051	0.085	0.117	0.142	0.158	0.168	0.173	0.176	0.177	0.177	0.177	0.177	0.175
1994	0.000	0.002	0.008	0.023	0.049	0.082	0.111	0.132	0.145	0.151	0.154	0.155	0.155	0.155	0.154	0.153	0.150
1995	0.000	0.002	0.009	0.025	0.054	0.090	0.121	0.144	0.158	0.166	0.170	0.171	0.171	0.171	0.170	0.169	0.166
1996	0.000	0.003	0.013	0.033	0.068	0.113	0.156	0.190	0.214	0.228	0.237	0.241	0.242	0.243	0.243	0.242	0.240
1997	0.000	0.003	0.012	0.031	0.065	0.108	0.148	0.179	0.200	0.213	0.220	0.223	0.224	0.224	0.224	0.223	0.220
1998	0.000	0.003	0.011	0.030	0.062	0.103	0.143	0.174	0.195	0.208	0.215	0.218	0.220	0.220	0.220	0.219	0.217
1999	0.000	0.003	0.012	0.031	0.065	0.109	0.154	0.188	0.211	0.225	0.232	0.236	0.237	0.237	0.237	0.237	0.234
2000	0.000	0.003	0.011	0.030	0.062	0.102	0.141	0.172	0.193	0.206	0.214	0.218	0.219	0.220	0.219	0.219	0.217
2001	0.000	0.003	0.011	0.030	0.062	0.102	0.141	0.173	0.194	0.207	0.214	0.218	0.219	0.220	0.220	0.219	0.217
2002	0.000	0.003	0.011	0.030	0.062	0.103	0.142	0.172	0.193	0.205	0.211	0.214	0.216	0.216	0.215	0.215	0.212

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2003	0.000	0.003	0.013	0.035	0.071	0.116	0.162	0.198	0.223	0.239	0.248	0.253	0.255	0.255	0.255	0.255	0.252
2004	0.000	0.004	0.014	0.036	0.073	0.120	0.166	0.203	0.229	0.246	0.255	0.260	0.262	0.262	0.262	0.262	0.259
2005	0.000	0.004	0.016	0.041	0.082	0.134	0.185	0.228	0.259	0.279	0.291	0.297	0.300	0.301	0.301	0.301	0.298
2006	0.000	0.004	0.016	0.041	0.084	0.136	0.188	0.230	0.261	0.281	0.293	0.299	0.302	0.303	0.303	0.303	0.300
2007	0.000	0.004	0.015	0.039	0.079	0.130	0.179	0.219	0.247	0.265	0.275	0.280	0.282	0.283	0.283	0.282	0.279
2008	0.000	0.004	0.015	0.039	0.080	0.131	0.180	0.218	0.245	0.263	0.273	0.277	0.279	0.280	0.279	0.278	0.275
2009	0.000	0.004	0.014	0.038	0.078	0.127	0.174	0.211	0.237	0.254	0.263	0.268	0.270	0.270	0.270	0.269	0.265
2010	0.000	0.005	0.017	0.044	0.089	0.145	0.200	0.244	0.276	0.297	0.309	0.315	0.317	0.318	0.318	0.317	0.314
2011	0.000	0.004	0.015	0.041	0.084	0.137	0.189	0.230	0.258	0.277	0.287	0.292	0.294	0.294	0.293	0.293	0.288
2012	0.000	0.004	0.017	0.045	0.094	0.153	0.209	0.253	0.283	0.302	0.313	0.318	0.320	0.320	0.319	0.318	0.312
2013	0.000	0.005	0.020	0.053	0.108	0.176	0.240	0.291	0.327	0.351	0.364	0.370	0.372	0.372	0.372	0.370	0.364
2014	0.000	0.004	0.015	0.046	0.100	0.163	0.215	0.251	0.273	0.285	0.290	0.291	0.290	0.287	0.284	0.281	0.269
2015	0.000	0.001	0.005	0.027	0.083	0.161	0.226	0.258	0.267	0.267	0.264	0.260	0.256	0.251	0.247	0.243	0.224
2016	0.000	0.000	0.002	0.014	0.047	0.098	0.144	0.167	0.173	0.172	0.170	0.167	0.163	0.160	0.156	0.153	0.139
2017	0.000	0.000	0.002	0.014	0.044	0.086	0.120	0.136	0.141	0.141	0.140	0.138	0.136	0.134	0.132	0.130	0.121
2018	0.000	0.000	0.002	0.010	0.031	0.067	0.104	0.123	0.129	0.129	0.128	0.126	0.124	0.122	0.120	0.118	0.109
2019	0.000	0.000	0.002	0.010	0.032	0.066	0.099	0.117	0.123	0.123	0.122	0.121	0.119	0.118	0.116	0.115	0.108
2020	0.000	0.000	0.002	0.011	0.033	0.068	0.104	0.124	0.130	0.131	0.130	0.128	0.127	0.125	0.123	0.122	0.115
2021	0.000	0.000	0.002	0.011	0.032	0.066	0.102	0.122	0.129	0.130	0.129	0.127	0.125	0.124	0.122	0.120	0.113

Table 21. Bss.27.4bc7ad–h: Final seabass update assessment: stock summary table.

Year	Low	Recruitment (Age 0, thousands)	High	Low	SSB (Tonnes)	High	Low	F(4–15)	High	$F_{commercial}$	$F_{recreational}$	Commercial landings	Commercial discards*	Recreational removals
1985	74	855	1635	17572	23629	29686	0.076	0.105	0.133	0.037	0.068	994		1820
1986	442	2490	4538	15315	20735	26155	0.09	0.123	0.157	0.056	0.068	1318		1638.5
1987	15045	21289	27534	13658	18496	23333	0.117	0.161	0.2	0.093	0.068	1979		1493
1988	9976	17384	24793	12431	16800	21168	0.095	0.13	0.165	0.062	0.068	1239		1384
1989	76439	90994	105549	12061	16146	20231	0.096	0.131	0.166	0.063	0.067	1161		1279
1990	2289	7431	12574	10912	14789	18665	0.095	0.133	0.17	0.066	0.068	1064		1150
1991	9230	15313	21397	9323	12945	16566	0.108	0.153	0.197	0.085	0.068	1226		1056
1992	15613	22686	29758	8027	11350	14673	0.111	0.155	0.199	0.087	0.068	1186		1080
1993	4094	8674	13254	8663	11735	14807	0.111	0.148	0.185	0.08	0.068	1256		1258
1994	23880	33431	42982	11432	14377	17322	0.105	0.133	0.161	0.066	0.067	1370		1509
1995	38898	49741	60583	15017	18087	21156	0.118	0.146	0.175	0.079	0.067	1835		1689
1996	455	3124	5793	16747	20021	23296	0.161	0.2	0.24	0.133	0.068	3022		1696
1997	45330	57526	69722	15828	19147	22467	0.15	0.188	0.23	0.120	0.068	2620		1605
1998	8068	17317	26565	14607	17868	21128	0.145	0.183	0.22	0.115	0.068	2390		1548
1999	43395	56771	70148	14047	17205	20362	0.156	0.197	0.24	0.129	0.068	2670		1548
2000	15298	24547	33797	14165	17255	20346	0.144	0.182	0.22	0.114	0.068	2407		1601
2001	15645	27708	39770	15049	18200	21351	0.145	0.182	0.22	0.114	0.068	2500		1685
2002	28707	43508	58309	15800	19024	22247	0.143	0.18	0.22	0.112	0.068	2622	17	1782
2003	31439	44224	57010	16902	20213	23524	0.168	0.21	0.25	0.143	0.068	3459	16	1863
2004	23245	34018	44791	17568	20953	24337	0.172	0.22	0.26	0.149	0.068	3731	59	1908
2005	14857	22668	30479	18014	21470	24925	0.194	0.25	0.3	0.178	0.068	4430	96	1905
2006	16681	24147	31614	17485	20993	24501	0.195	0.25	0.3	0.180	0.068	4377	53	1874
2007	18925	27697	36469	17050	20524	23998	0.185	0.23	0.28	0.165	0.068	4064	50	1871

Year	Low	Recruitment (Age 0, thousands)	High	Low	SSB (Tonnes)	High	Low	F(4–15)	High	$F_{commercial}$	$F_{recreational}$	Commercial landings	Commercial discards*	Recreational removals
2008	7871	14458	21046	17419	20797	24175	0.184	0.23	0.28	0.164	0.068	4107	8	1878
2009	8033	12729	17424	17793	21070	24347	0.18	0.22	0.27	0.156	0.068	3889	151.2	1852
2010	339	2456	4572	17643	20805	23967	0.21	0.26	0.31	0.194	0.068	4562	147.9	1751
2011	6762	10188	13613	16213	19192	22171	0.196	0.24	0.29	0.176	0.068	3858	22	1605
2012	2163	4378	6593	14932	17702	20471	0.21	0.27	0.32	0.199	0.068	3987	156.6	1440
2013	9443	15034	20624	13144	15749	18355	0.24	0.31	0.38	0.24	0.068	4137	53.4	1222
2014	18802	28374	37947	10524	13040	15557	0.191	0.25	0.31	0.184	0.067	2682	24.7	1008
2015	2030	6095	10161	8483	10967	13451	0.172	0.23	0.29	0.177	0.055	2066	39.5	689.5
2016	13317	25790	38263	6603	9058	11514	0.104	0.147	0.191	0.128	0.019	1295	198.6	209
2017	1860	6281	10702	5810	8254	10699	0.085	0.123	0.161	0.104	0.0189	984	271.102	206
2018	5906	19116	32326	5706	8231	10756	0.074	0.11	0.145	0.097	0.0131	948	482.4	150
2019	2009	12589	23169	6251	9033	11816	0.072	0.106	0.14	0.085	0.021	972	463.9	274
2020		10105**		7130	10369	13609	0.075	0.112	0.15	0.081	0.032	1042	325	453
2021		10105**		7754	11491	15227	0.072	0.111	0.149	0.079	0.032	1126	411.8	489
2022		10105**		8128	12384	16640								

*** Incomplete for some fleets 2002–2008.**

****Geometric mean recruitment 2010–2019.**

Table 22. Bss.27.4bc7ad–h: Inputs for short-term forecast. Fishing mortality is the estimates for 2022. Numbers-at-ages 0–2 in 2022 are adjusted by replacing Stock Synthesis values for 0-group in 2020–2021 (years with no recruit deviations estimated) with the long-term GM, adjusted for natural mortality.

age	Stock numbers 2022	weight in stock	Proportion mature (female)	H.Cons retained mean F	H.Cons Discarded mean F	H.Cons retained mean weights	H.Cons discarded mean weights	H.Cons proportion retained	Recreational F	Recreational removals mean weight	M
0	10105	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.24
1	7949	0.024	0.000	0.000	0.000	0.117	0.117	0.188	0.000	0.079	0.24
2	6251	0.096	0.000	0.000	0.001	0.236	0.237	0.190	0.002	0.191	0.24
3	6111	0.210	0.000	0.001	0.005	0.385	0.385	0.209	0.005	0.342	0.24
4	7222	0.369	0.093	0.007	0.014	0.588	0.562	0.338	0.012	0.531	0.24
5	1808	0.571	0.297	0.030	0.019	0.812	0.753	0.634	0.020	0.751	0.24
6	5466	0.808	0.578	0.066	0.012	1.014	0.967	0.853	0.027	0.993	0.24
7	917	1.073	0.797	0.088	0.005	1.243	1.221	0.949	0.031	1.252	0.24
8	2960	1.358	0.914	0.095	0.002	1.512	1.505	0.984	0.034	1.528	0.24
9	1067	1.658	0.965	0.096	0.000	1.804	1.806	0.995	0.035	1.821	0.24
10	205	1.965	0.985	0.095	0.000	2.106	2.113	0.998	0.035	2.124	0.24
11	303	2.276	0.993	0.093	0.000	2.410	2.420	0.999	0.035	2.432	0.24
12	45	2.584	0.997	0.091	0.000	2.709	2.722	0.999	0.035	2.737	0.24
13	142	2.888	0.998	0.090	0.000	3.002	3.018	1.000	0.035	3.037	0.24
14	100	3.183	0.999	0.088	0.000	3.286	3.305	1.000	0.036	3.327	0.24
15	118	3.468	0.999	0.086	0.000	3.559	3.579	1.000	0.036	3.607	0.24
16	186	4.184	1.000	0.085	0.000	4.216	4.063	1.000	0.036	3.874	0.24

Age 0,1,2 over-written as follows:

2022 yc	**2022 age 0 replaced by 20010–2019 LTGM (10104);**
2021 yc	**2022 age 1 from SS3 survivor estimate at-age 1, 2022 * LTGM / SS3 estimate of age 0 in 2021;**
2020 yc	**2022 age 2 from SS3 survivor estimate at-age 2, 2022 * LTGM / SS3 estimate of age 0 in 2020.**

Table 23. Bss.27.4bc7ad–h: Management options table. F-Multipliers for 2023 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 (see advice sheet for footnotes).

Basis	Total removals* (2023)	Projected landings (2023)	Projected discards (2023)	Recreational removals (2023)	F_{total} (2023)	$F_{projected\ landings}$ (2023)	$F_{projected\ discards}$ (2023)	F recreational removals (2023)	SSB (2024)	% SSB change**	% advice change***
ICES advice basis											
MSY approach: $F_{MSY} \times SSB_{2023}$/MSY $B_{trigger}$	2542	1653	194	695	0.153	0.105	0.0059	0.042	12631	-2.1	14.7
EU MAP^: $F_{MSY} \times SSB_{2023}$/MSY $B_{trigger}$	2542	1653	194	695	0.153	0.105	0.0059	0.042	12631	-2.1	14.7
EU MAP^: $F_{MSY\ upper} \times SSB_{2023}$/MSY $B_{trigger}$	2542	1653	194	695	0.153	0.105	0.0059	0.042	12631	-2.1	14.7
EU MAP^: $F_{MSY\ lower} \times SSB_{2023}$/MSY $B_{trigger}$	2133	1388	162	583	0.127	0.087	0.0049	0.035	12964	0.50	-3.7
$F = F_{MSY}$	2821	1834	216	771	0.171	0.117	0.0066	0.047	12405	-3.8	27
F = 0	0	0	0	0	0	0	0	0	14716	14.1	-100
F_{pa}	3294	2140	253	901	0.20	0.139	0.0079	0.056	12021	-6.8	49
F_{lim}	4096	2612	313	1101	0.25	0.174	0.0098	0.070	11430	-11.4	85
$SSB_{2024} = B_{lim}$	5422	3509	429	1484	0.36	0.24	0.0139	0.099	10313	-20	145
$SSB_{2024} = B_{pa}$	336	219	25	92	0.0190	0.0130	0.000	0.005	14439	11.9	-85
SSB_{2024} = MSY $B_{trigger}$	336	219	25	92	0.0190	0.0130	0.000	0.005	14439	11.9	-85
$F = F_{2022}$	1906	1241	144	521	0.113	0.077	0.0044	0.031	13149	1.94	-14.0
$SSB_{2024} = SSB_{2023}$	2213	1440	168	605	0.132	0.090	0.0051	0.036	12899	0.00	-0.135

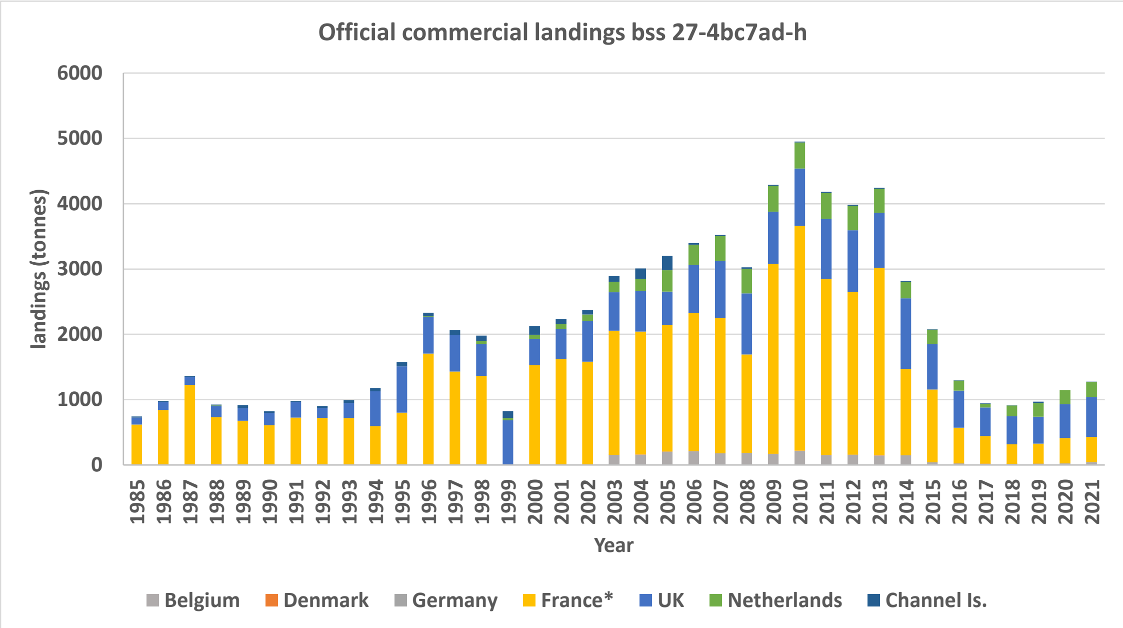


Figure 1. Bss.27.4bc7ad–h: Trends in official sea bass landings by country.

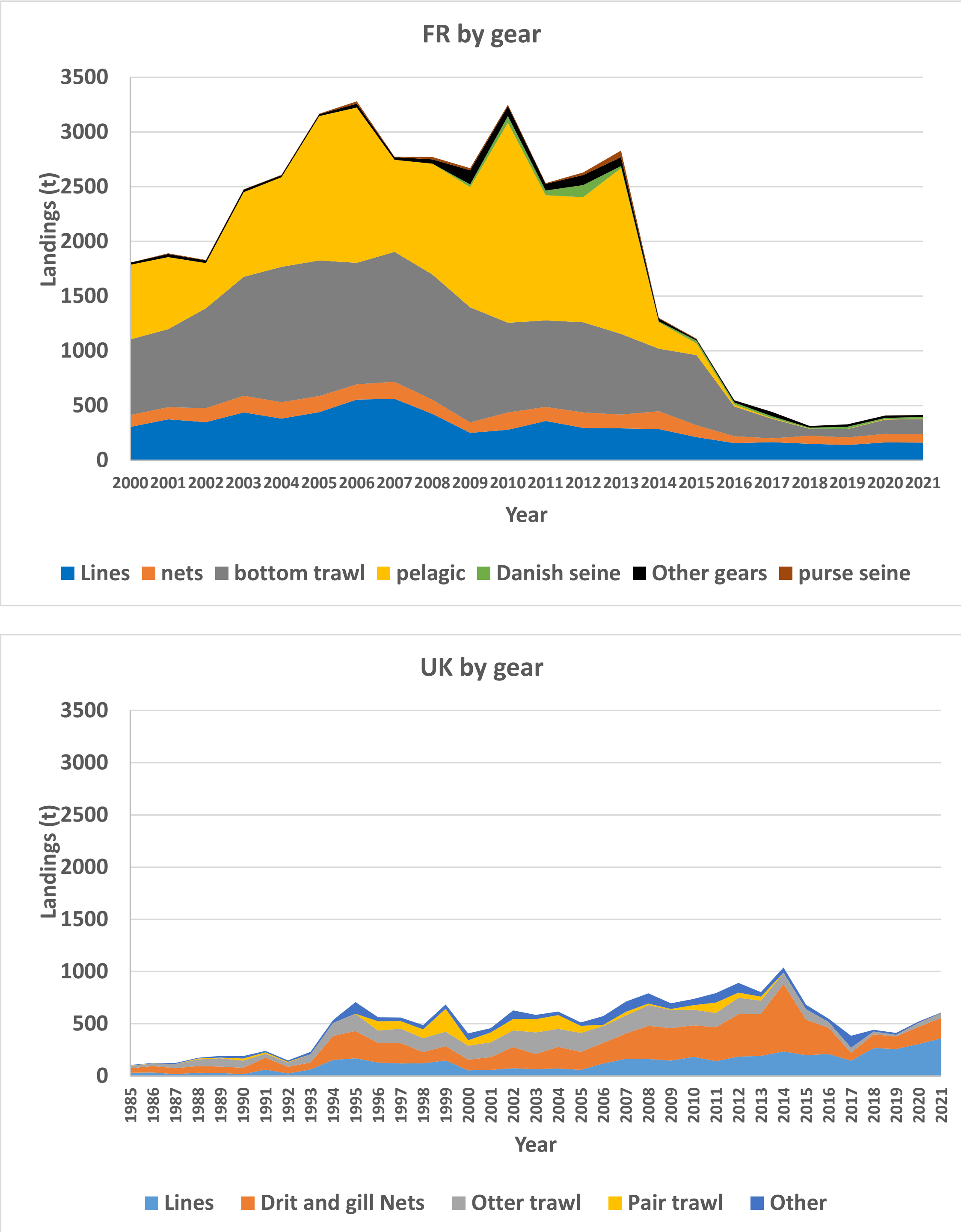


Figure 2. Bss.27.4bc7ad–h: Trends in ICES estimates of seabass landings by gear (France –top- and UK –bottom).

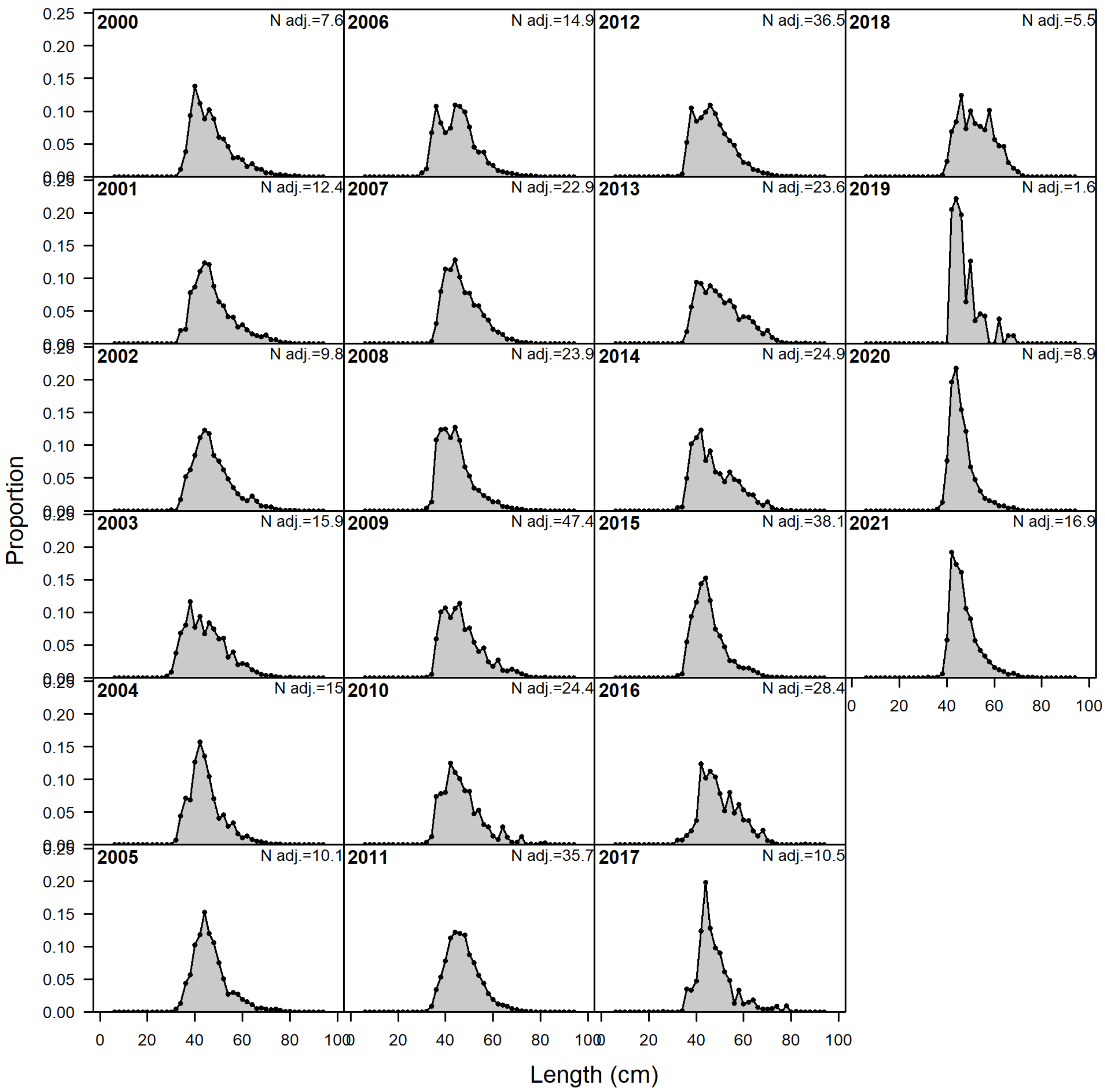


Figure 3. Bss.27.4bc7ad–h: Length composition for the combined French fleet from 2000 onwards.

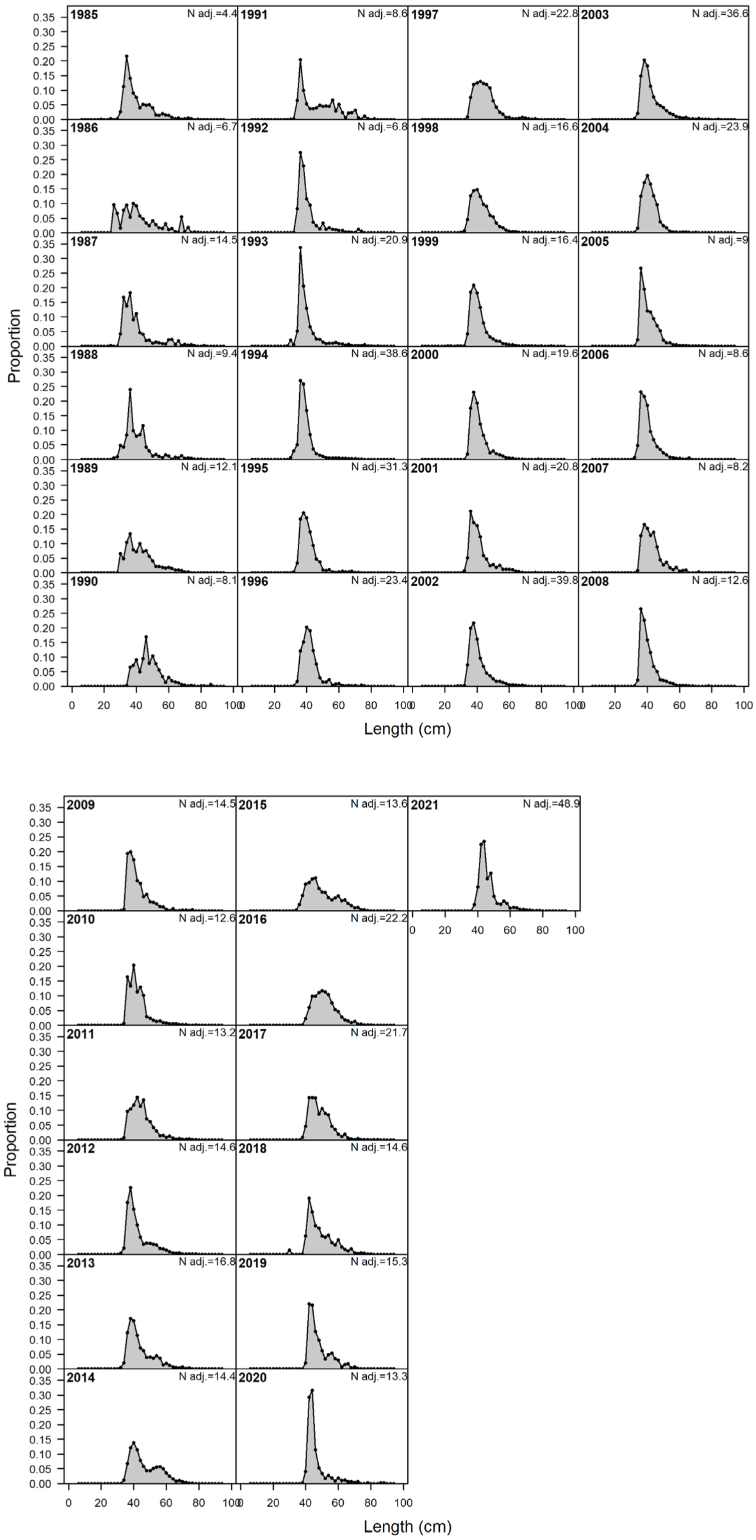


Figure 4. Bss.27.4bc7ad–h: Length composition of UK bottom trawls and nets fleet landings from 1985 onwards

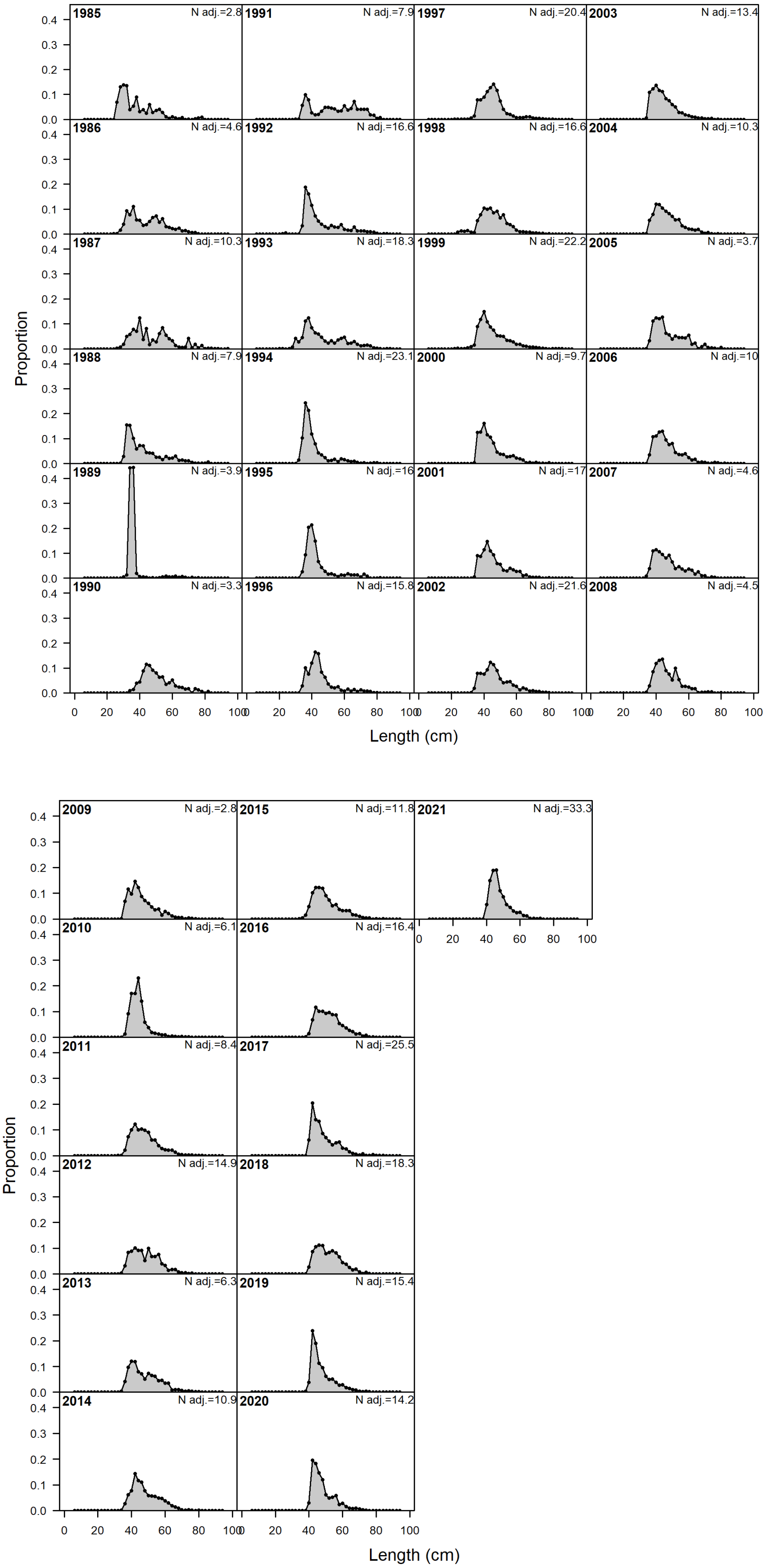


Figure 5. Bss.27.4bc7ad–h: Length composition of UK Lines fleet landings from 1985 onwards.

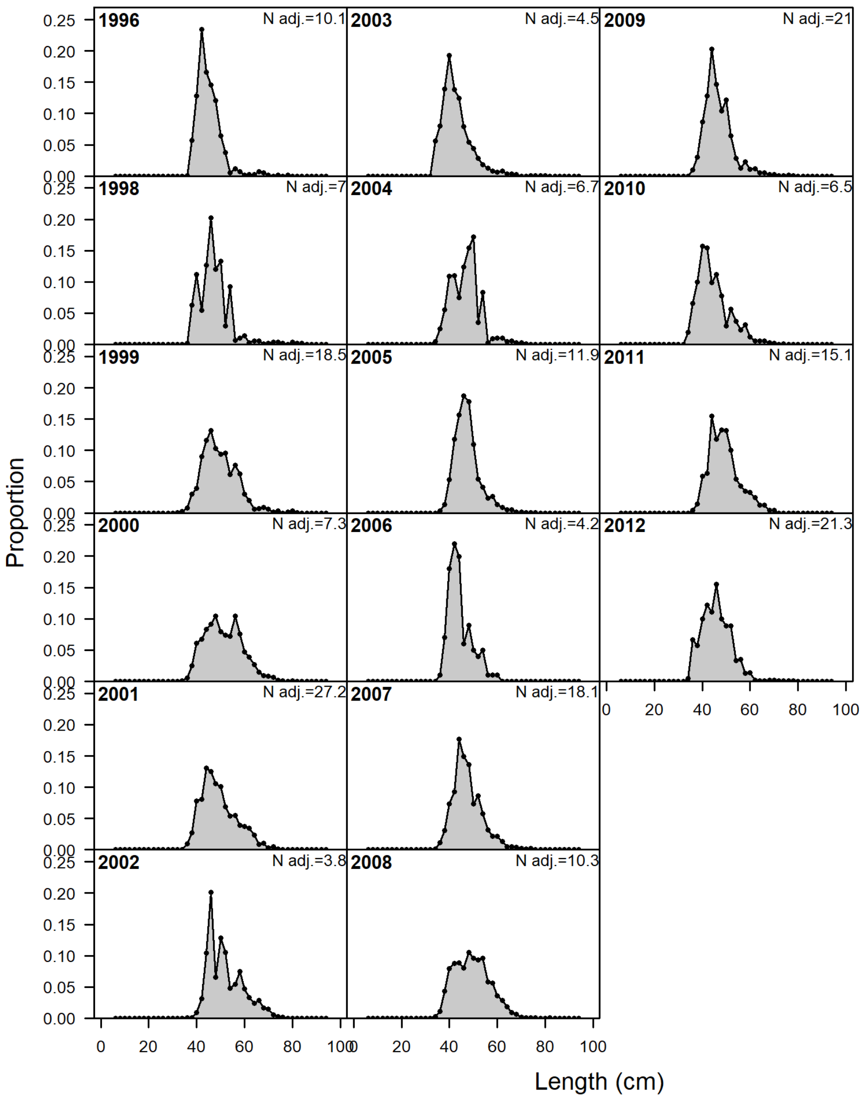


Figure 6. Bss.27.4bc7ad–h: Available length composition of UK Midwater pair trawl fleet landings.

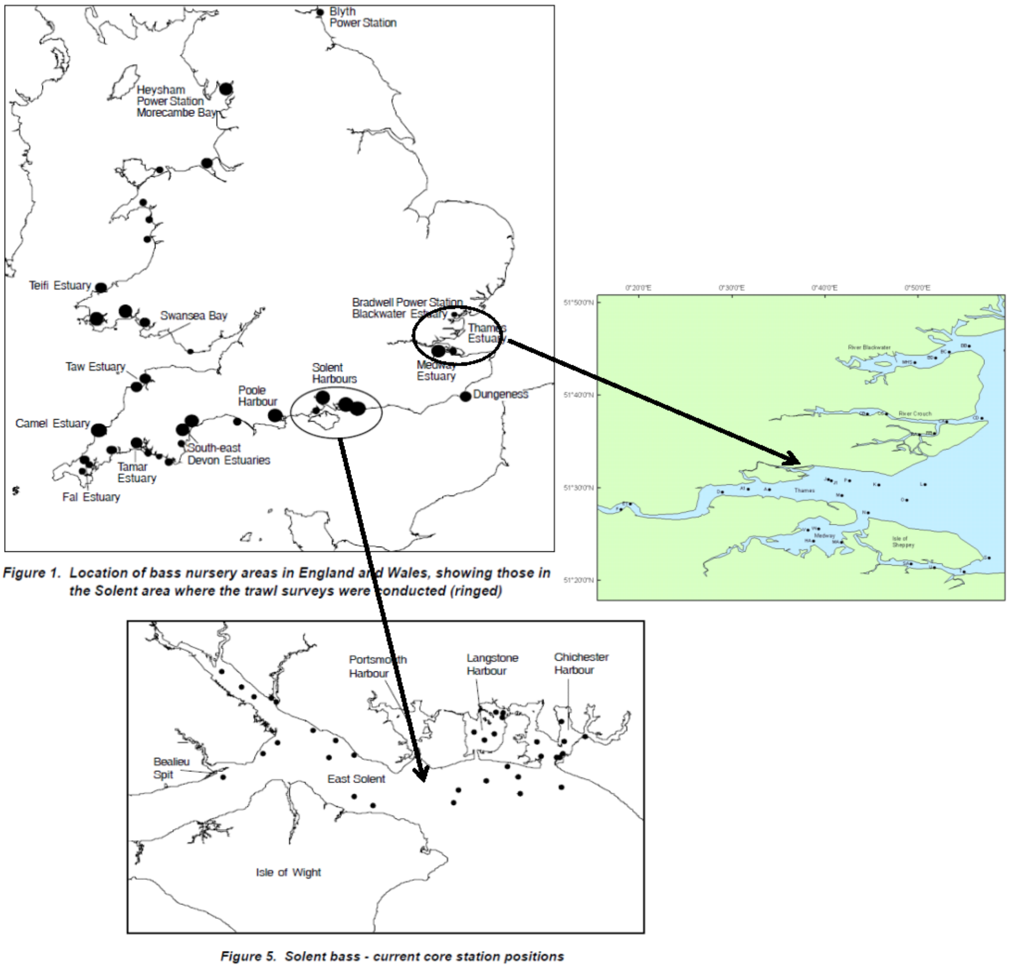


Figure 7. Bss.27.4bc7ad–h: Location of Cefas Solent and Thames juvenile seabass surveys.

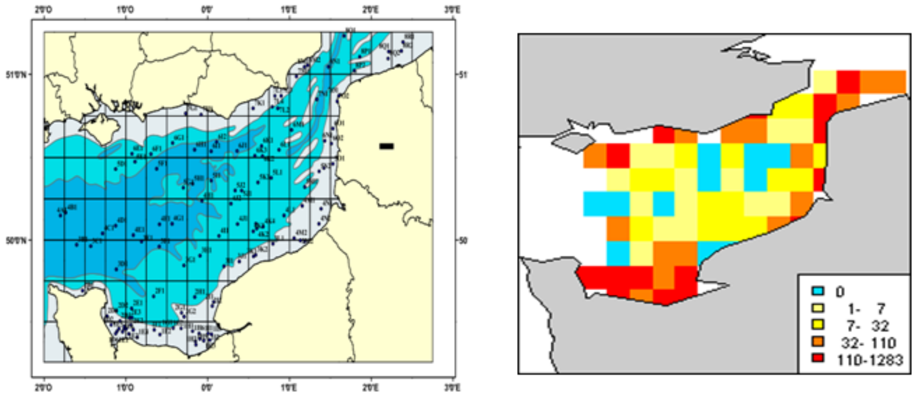


Figure 8. Bss.27.4bc7ad–h: Left: stations fished during the Channel Groundfish Survey carried out annually by France. Right: distribution of total catches of seabass over the survey series.

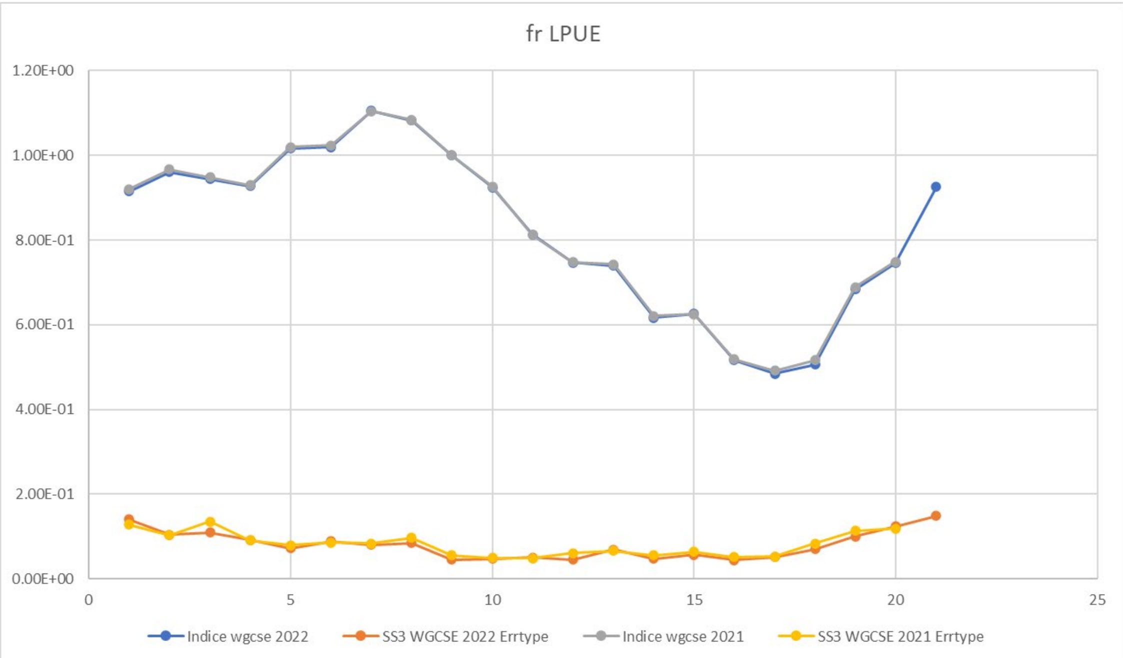
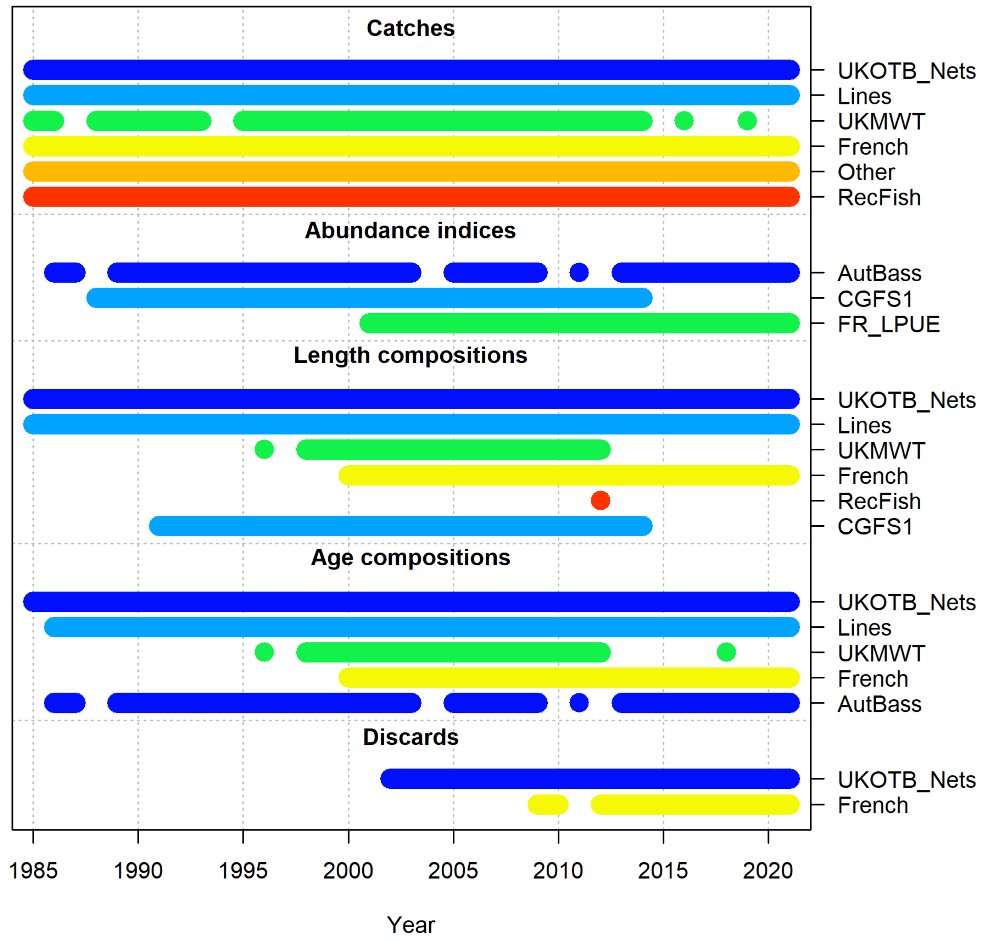


Figure 9. Bss.27.4bc7ad–h: Comparison of French commercial LPUE index for European seabass in ICES divisions 4bc and 7a,d–h between last year's assessment and the updated 2022 LPUE.



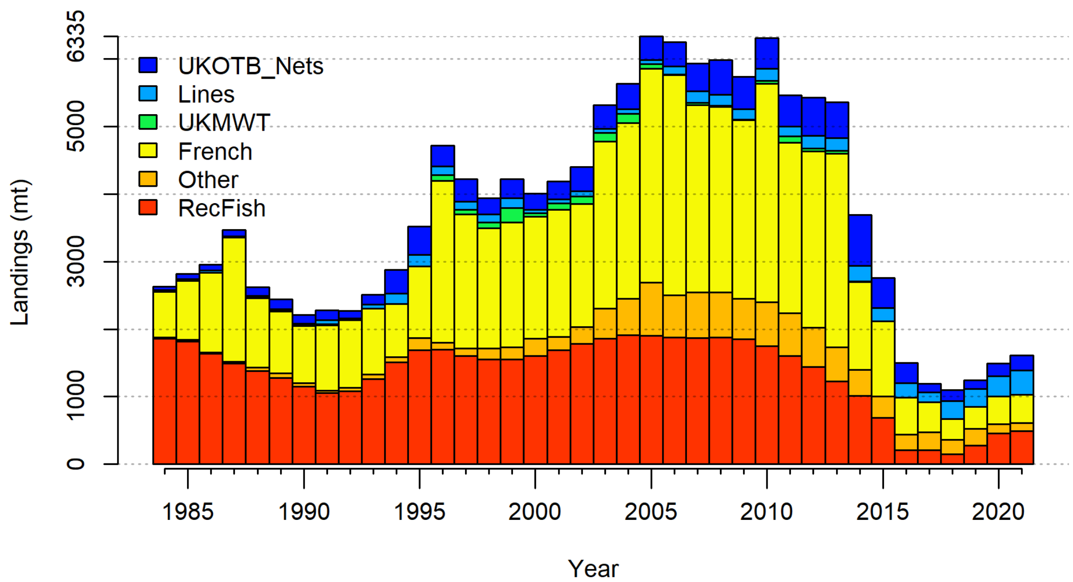


Figure 10. Bss.27.4bc7ad–h: Top: Datasets used in the updated assessment. Bottom: Landings series for the six fleets.

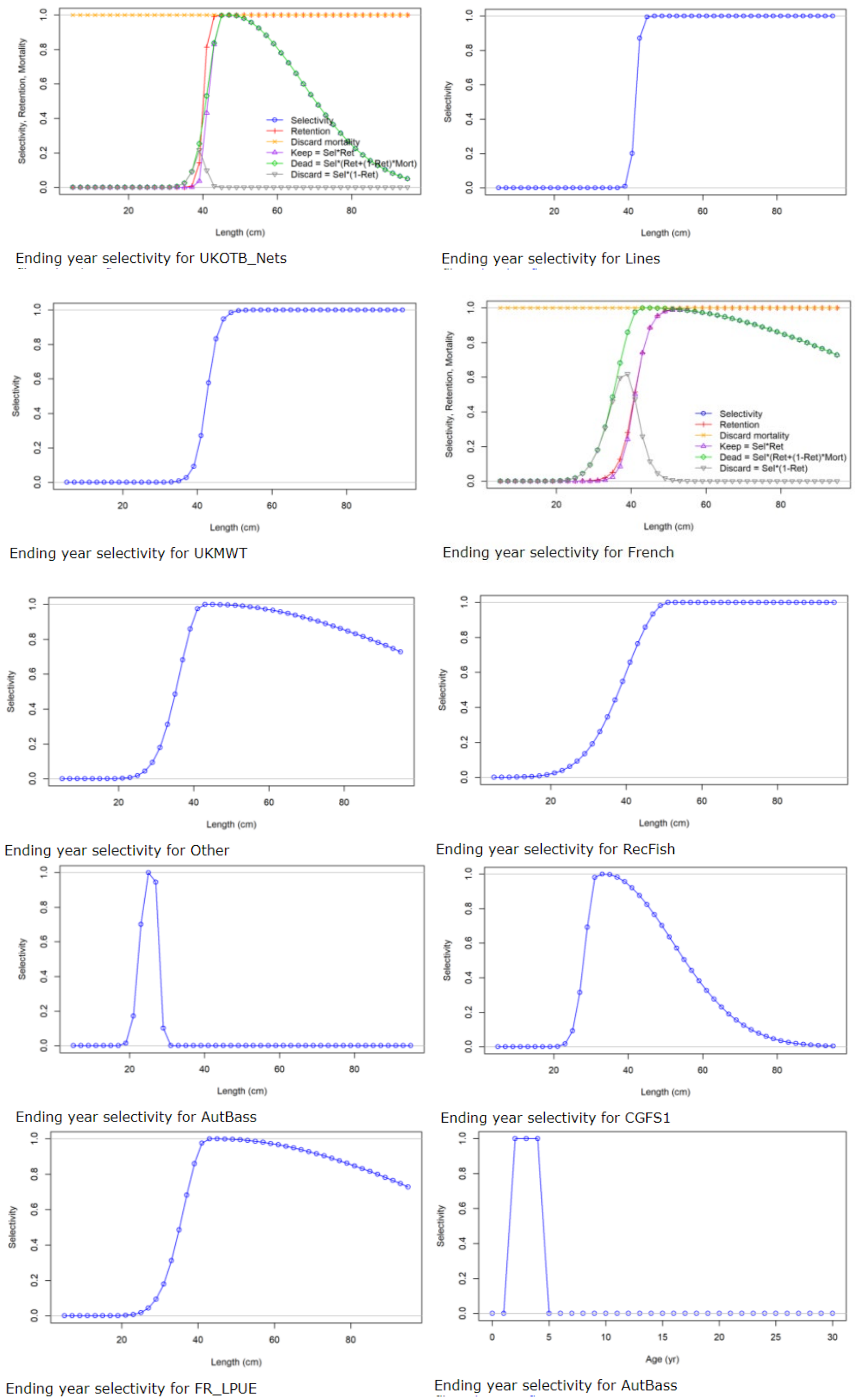
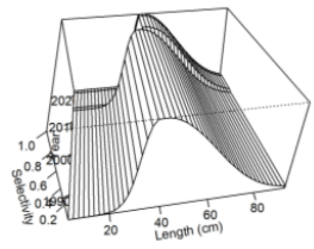
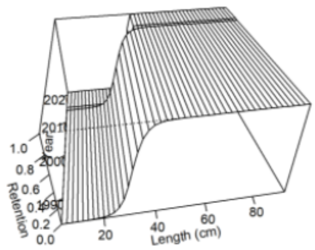


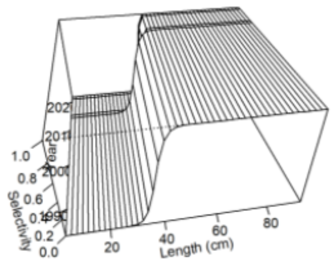
Figure 11. Bss.27.4bc7ad–h: Final seabass update assessment: Fitted length-based and age-based selectivity curves.



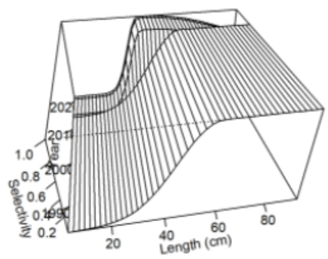
Surface plot of Time-varying selectivity for UKOTB_Nets



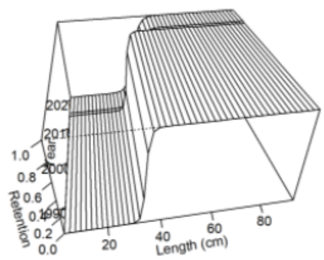
Surface plot of Time-varying retention for UKOTB_Nets



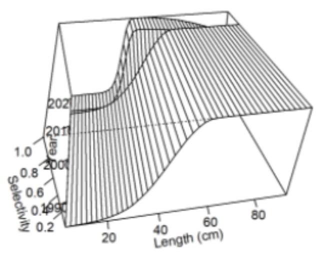
Surface plot of Time-varying selectivity for Lines



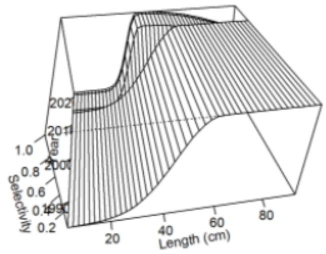
Surface plot of Time-varying selectivity for French



Surface plot of Time-varying retention for French

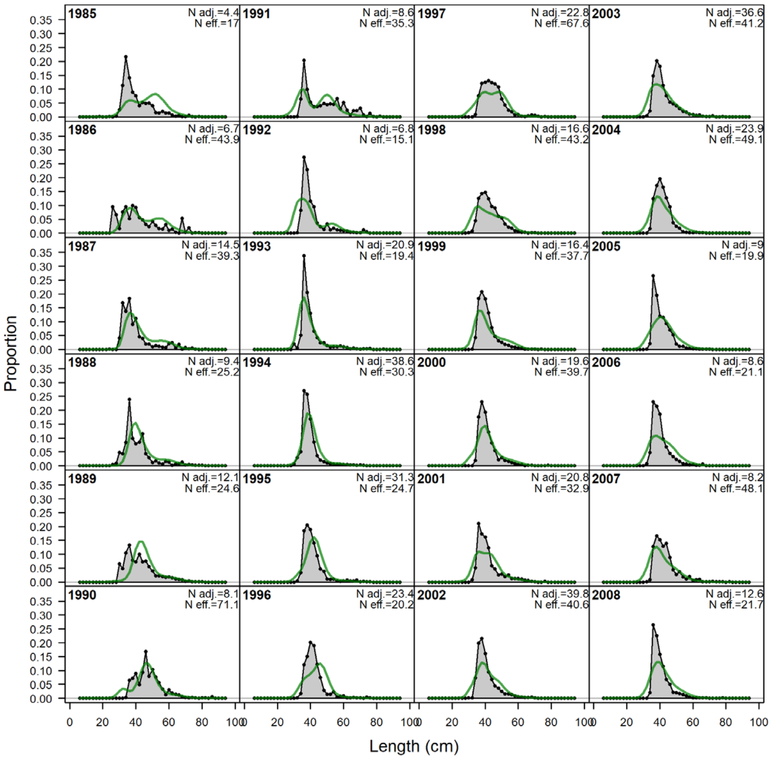


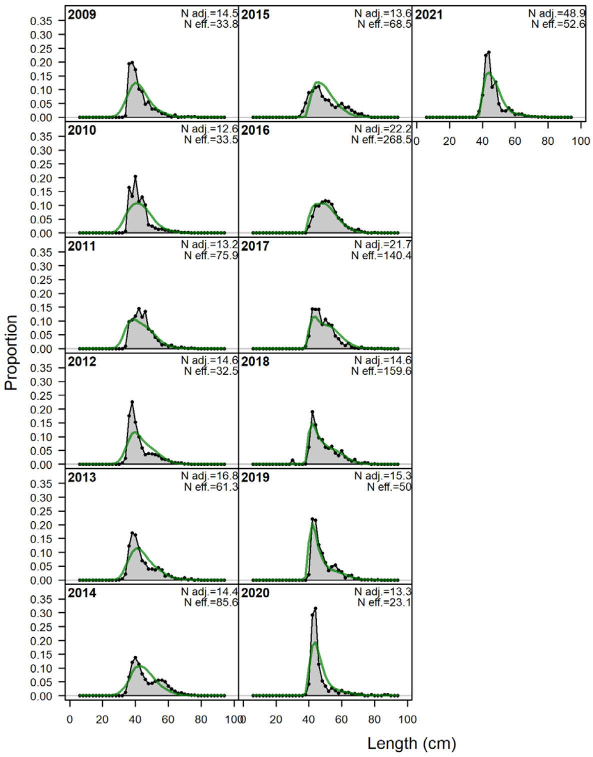
Surface plot of Time-varying selectivity for FR_LPUE

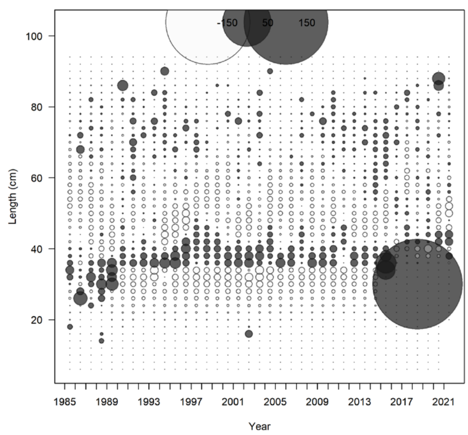


Surface plot of Time-varying selectivity for Other

Figure 12. Bss.27.4bc7ad–h: Final seabass update assessment: Fitted time-series of length-based and age-based selectivity and retention curves for fleets with blocks.


1985 N adj.=4.4 N eff.=17
1986 N adj.=6.7 N eff.=43.9
1987 N adj.=14.5 N eff.=39.3
1988 N adj.=9.4 N eff.=25.2
1989 N adj.=12.1 N eff.=24.6
1990 N adj.=8.1 N eff.=71.1
1991 N adj.=8.6 N eff.=35.3
1992 N adj.=6.8 N eff.=15.1
1993 N adj.=20.9 N eff.=19.4
1994 N adj.=38.6 N eff.=30.3
1995 N adj.=31.3 N eff.=24.7
1996 N adj.=23.4 N eff.=20.2
1997 N adj.=22.8 N eff.=67.6
1998 N adj.=16.6 N eff.=43.2
1999 N adj.=16.4 N eff.=37.7
2000 N adj.=19.6 N eff.=39.7
2001 N adj.=20.8 N eff.=32.9
2002 N adj.=39.8 N eff.=40.6
2003 N adj.=36.6 N eff.=41.2
2004 N adj.=23.9 N eff.=49.1
2005 N adj.=9 N eff.=19.9
2006 N adj.=8.6 N eff.=21.1
2007 N adj.=8.2 N eff.=48.1
2008 N adj.=12.6 N eff.=21.7
Proportion
Length (cm)


2009 N adj.=14.5 N eff.=33.8
2010 N adj.=12.6 N eff.=33.5
2011 N adj.=13.2 N eff.=75.9
2012 N adj.=14.6 N eff.=32.5
2013 N adj.=16.8 N eff.=61.3
2014 N adj.=14.4 N eff.=85.6
2015 N adj.=13.6 N eff.=68.5
2016 N adj.=22.2 N eff.=268.5
2017 N adj.=21.7 N eff.=140.4
2018 N adj.=14.6 N eff.=159.6
2019 N adj.=15.3 N eff.=50
2020 N adj.=13.3 N eff.=23.1
2021 N adj.=48.9 N eff.=52.6
Proportion
Length (cm)


-150
50
150
Length (cm)
Year

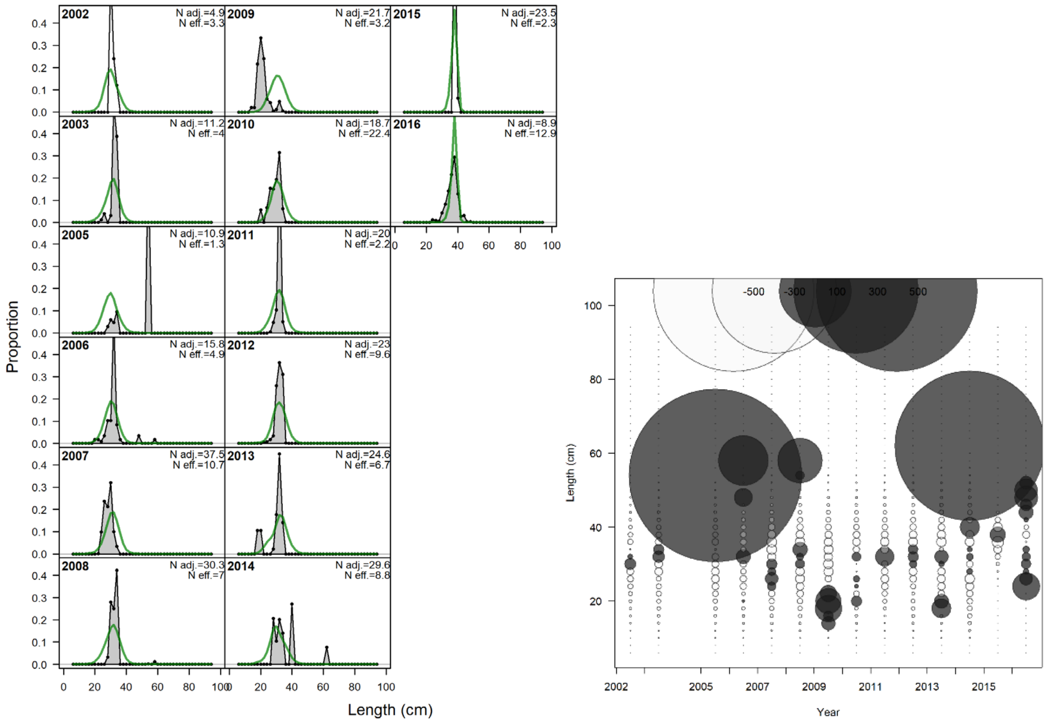


Figure 13. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of UK trawl and net fishery-length composition data for the retained (top 3) and discarded (bottom 2) catch components.

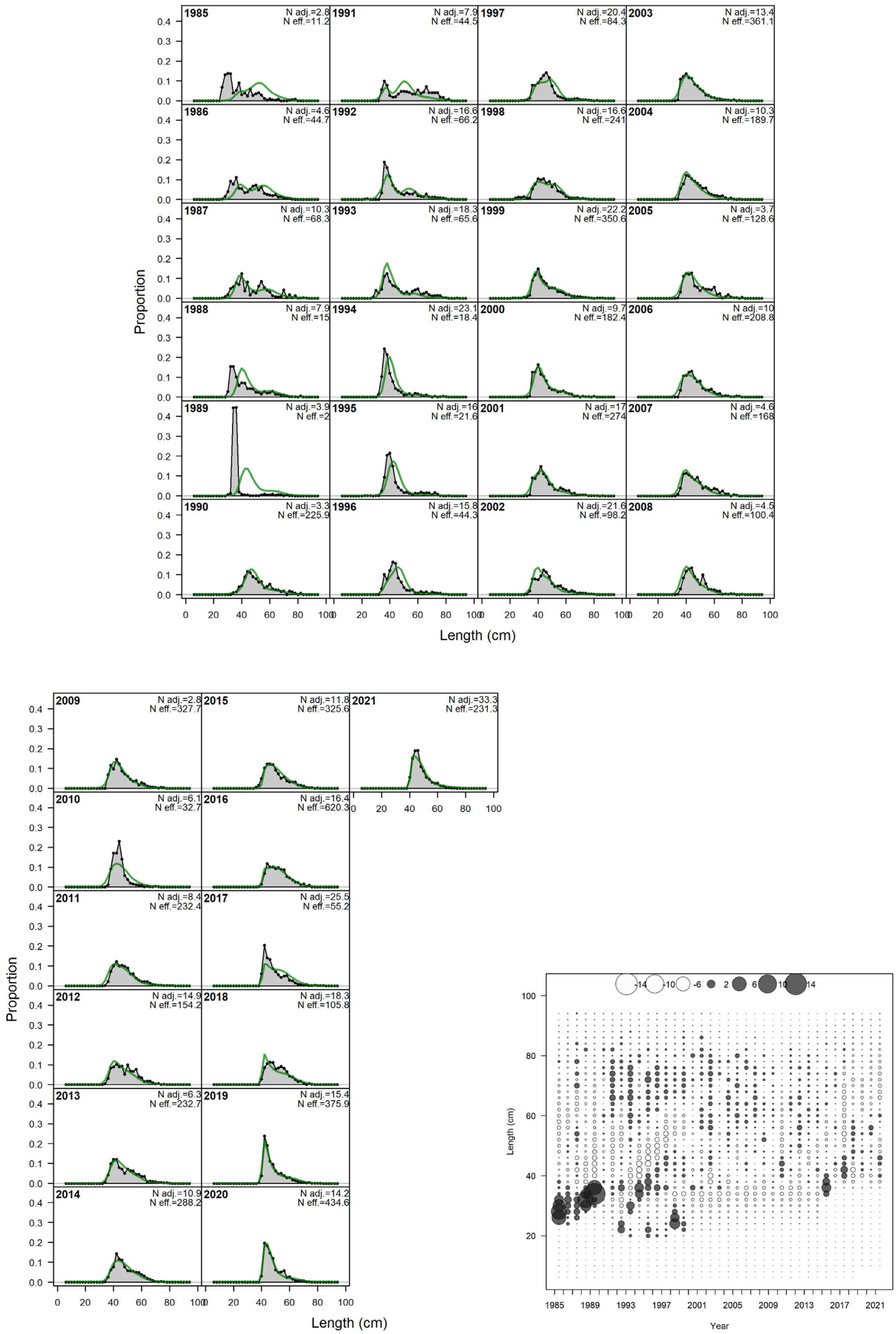


Figure 14. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of UK lines length-composition data for the retained catch components.

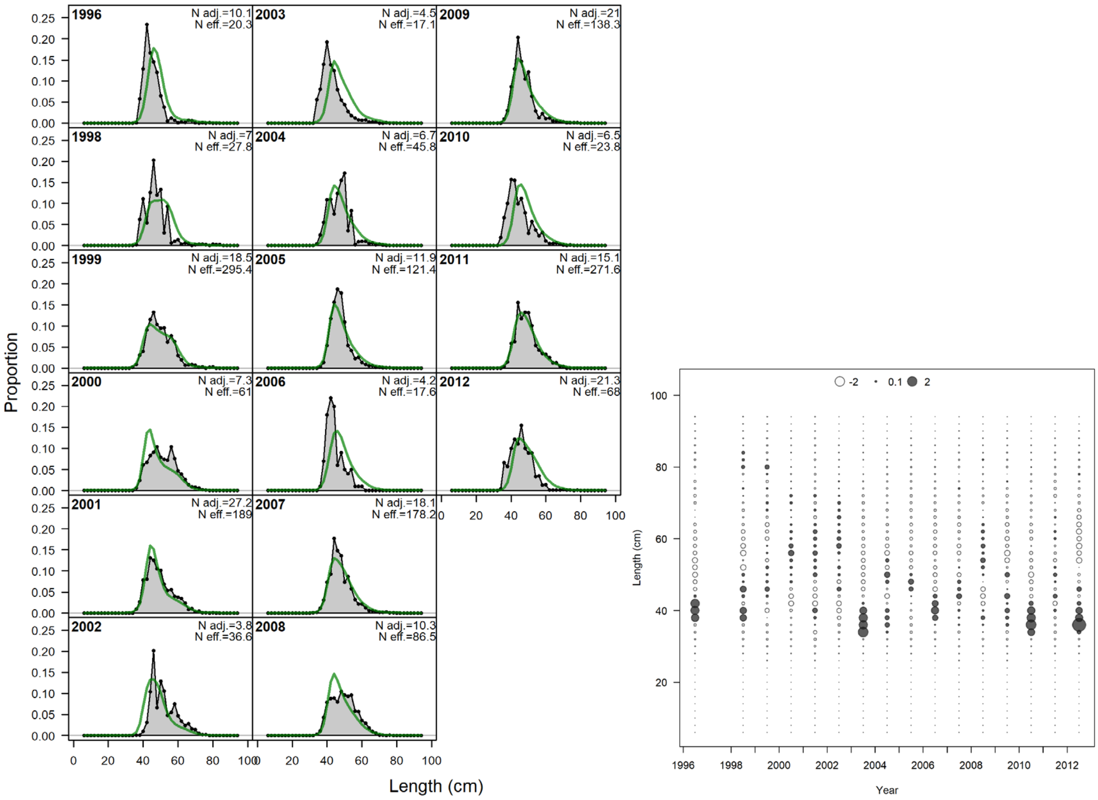


Figure 15. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of UK midwater trawl fishery length-composition data for the retained catch components.

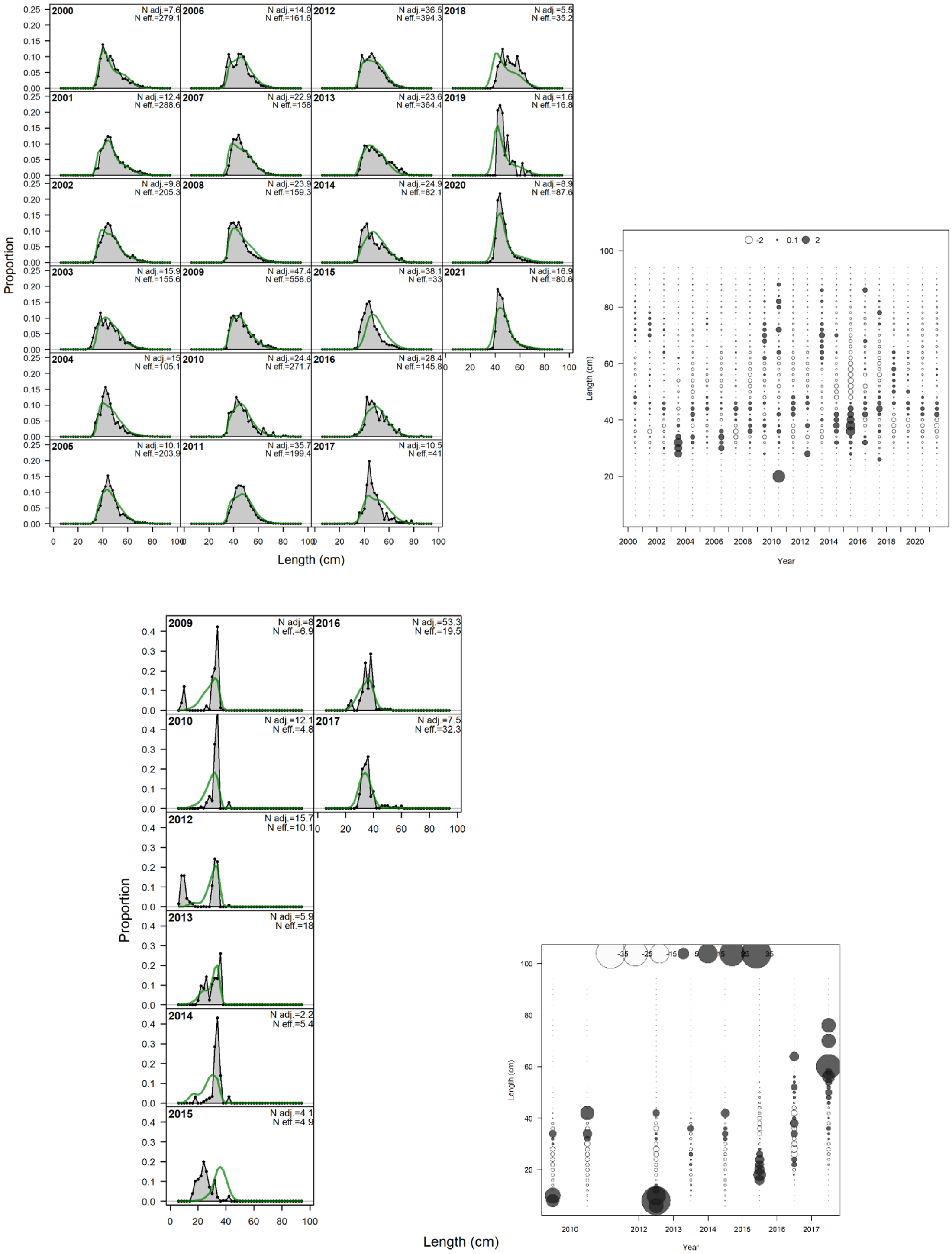


Figure 16. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of French fishery length-composition data for the retained (top row) and discarded (bottom row) catch components.

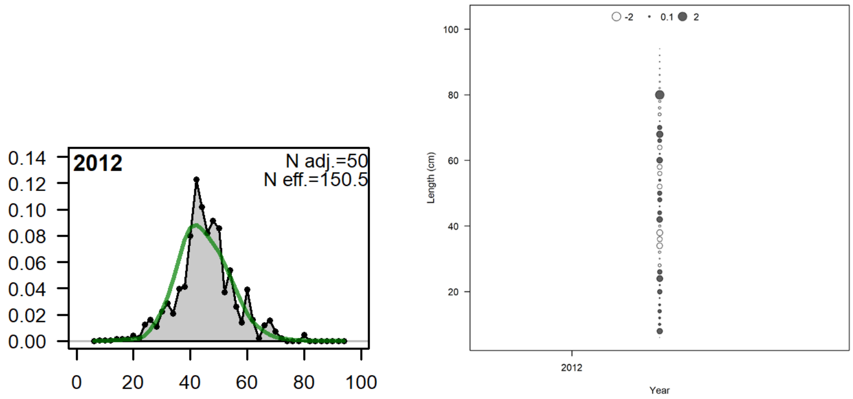


Figure 17. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of recreational length-compositions data.

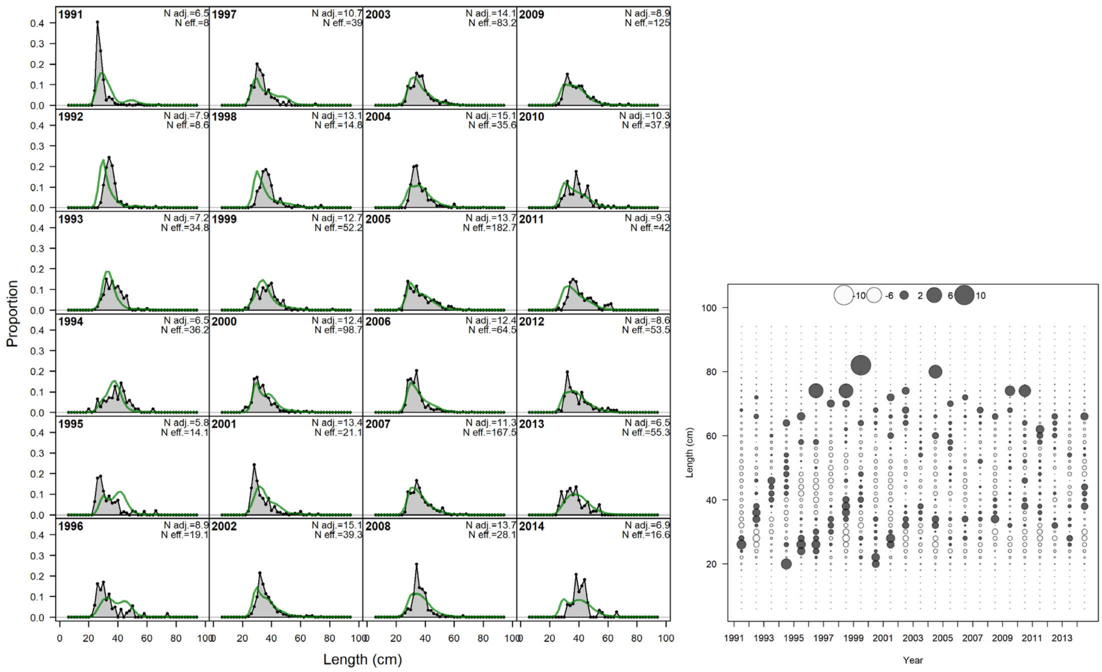


Figure 18. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of Channel groundfish survey length-compositions.

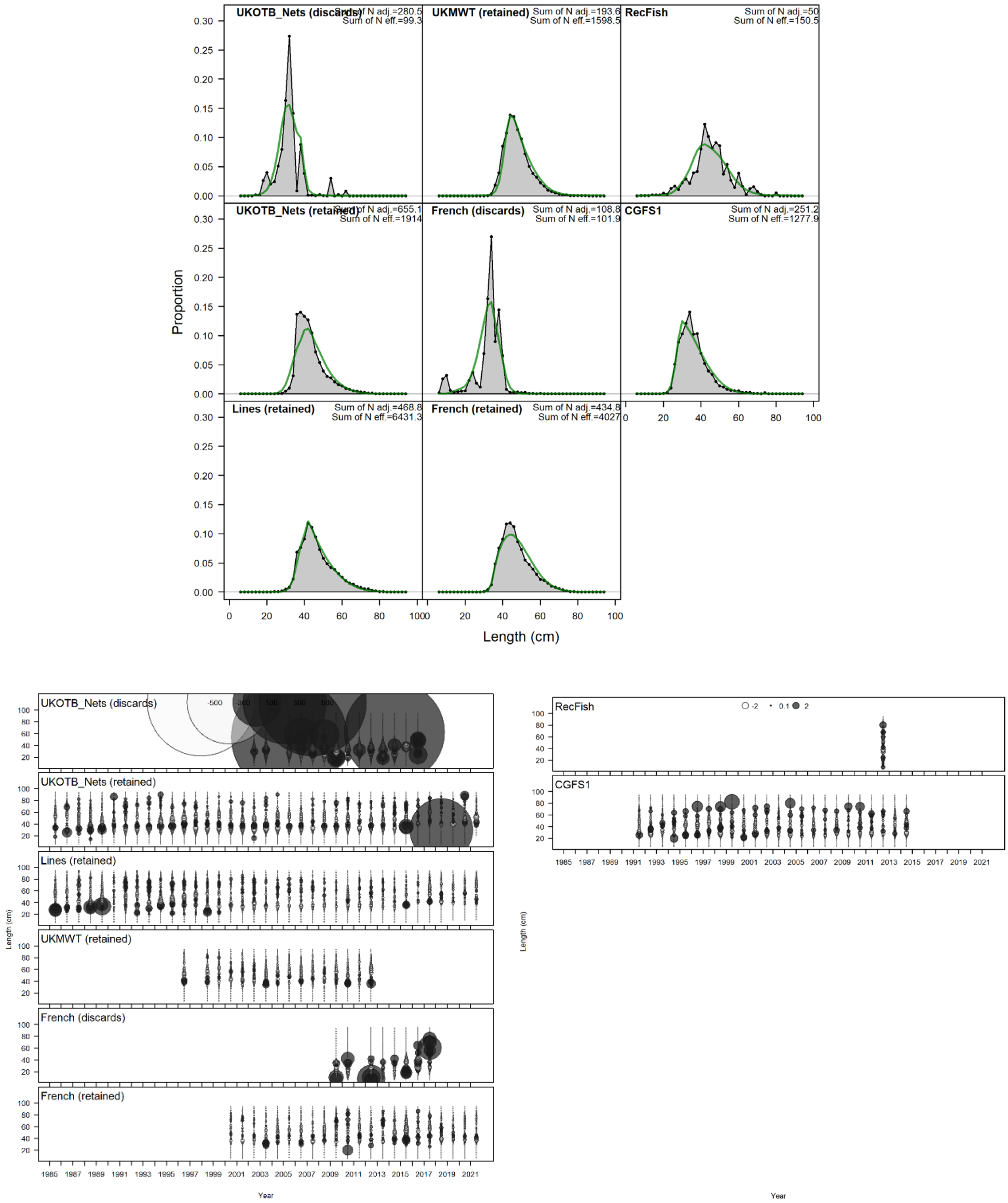


Figure 19. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of the commercial fisheries and Channel groundfish survey length compositions, aggregated across time for the retained and discarded catch components.

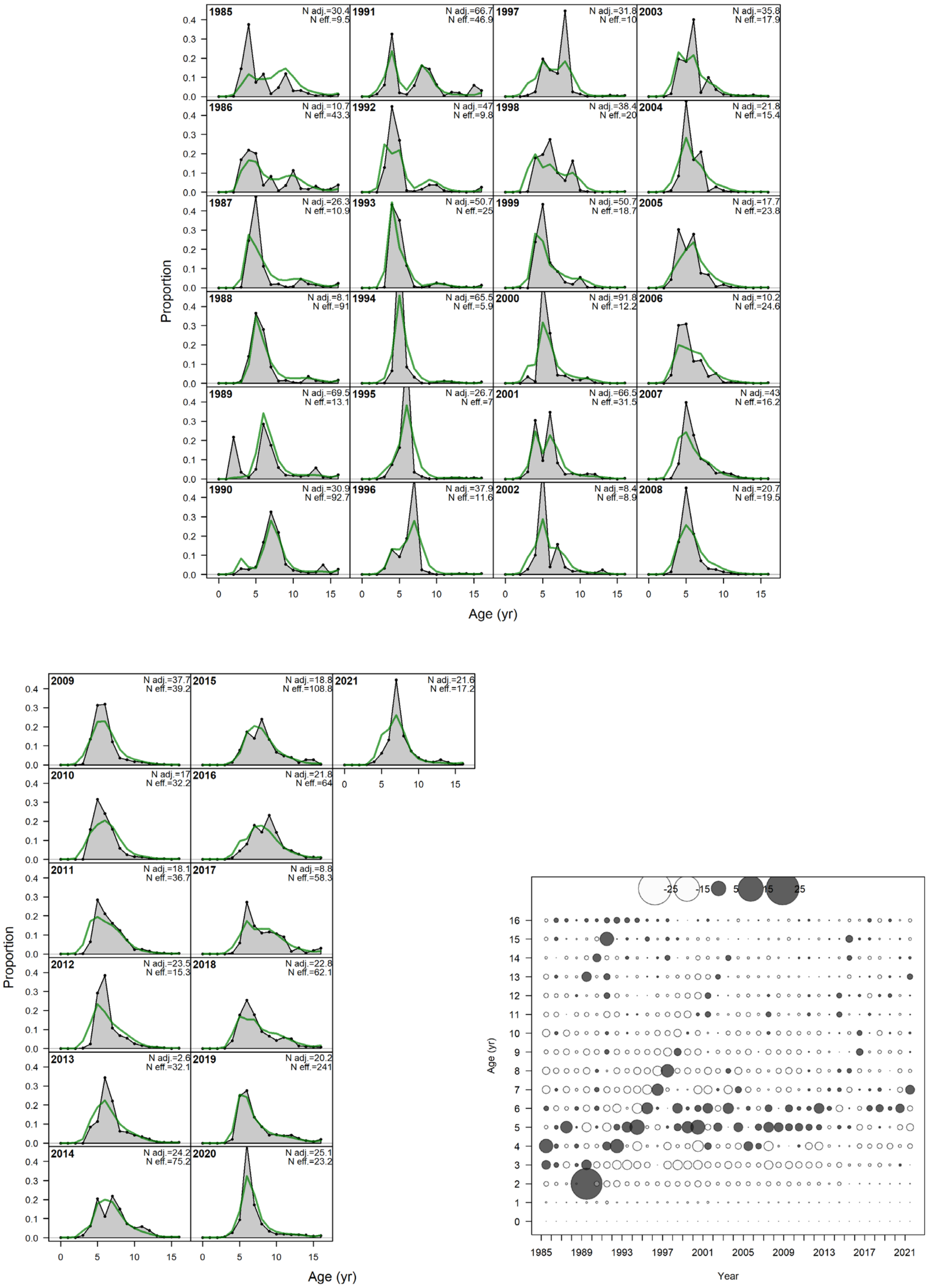


Figure 20. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of age composition data for the combined UK otter trawl and nets fleets.

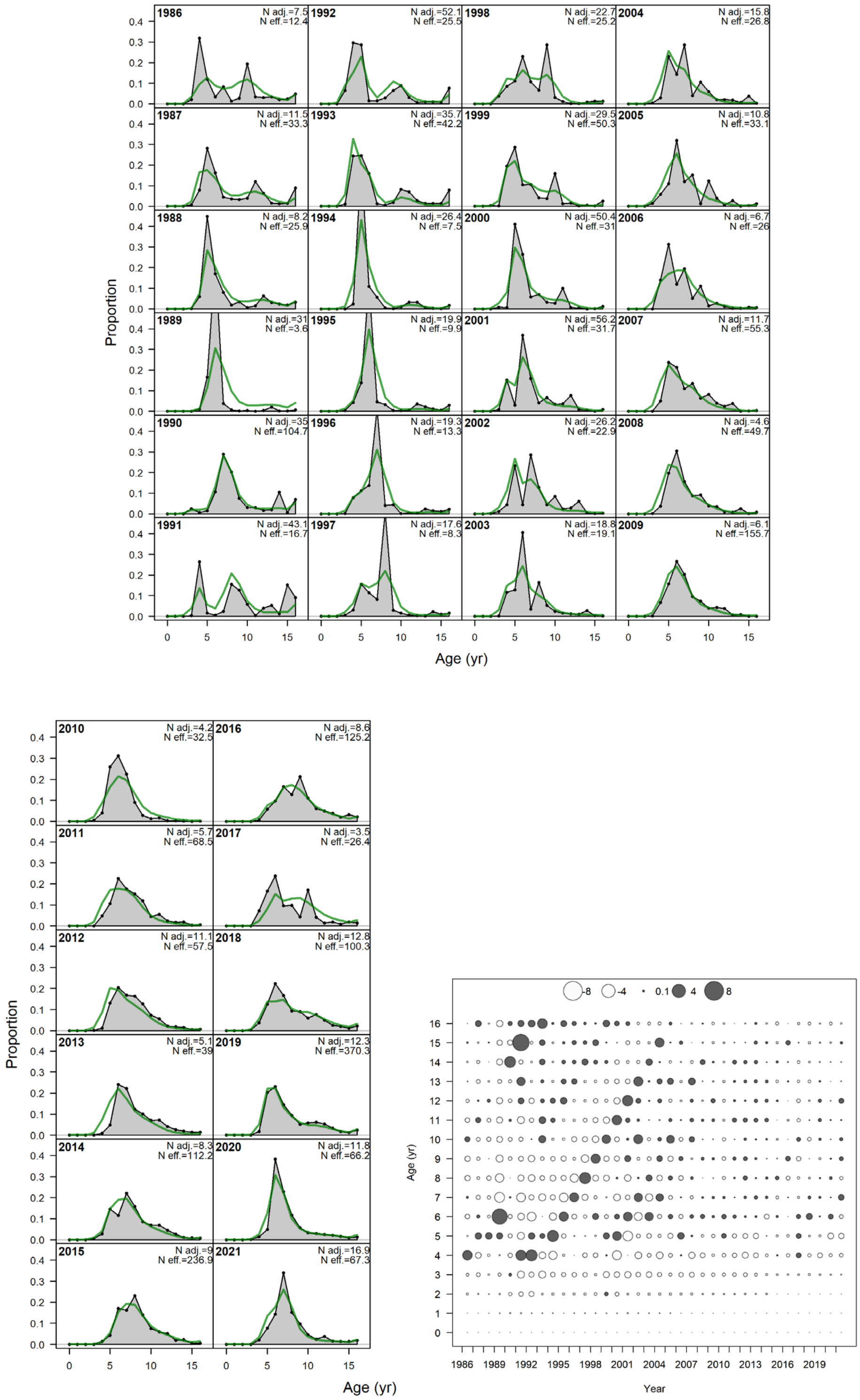


Figure 21. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of age composition data for the combined UK lines fleet.

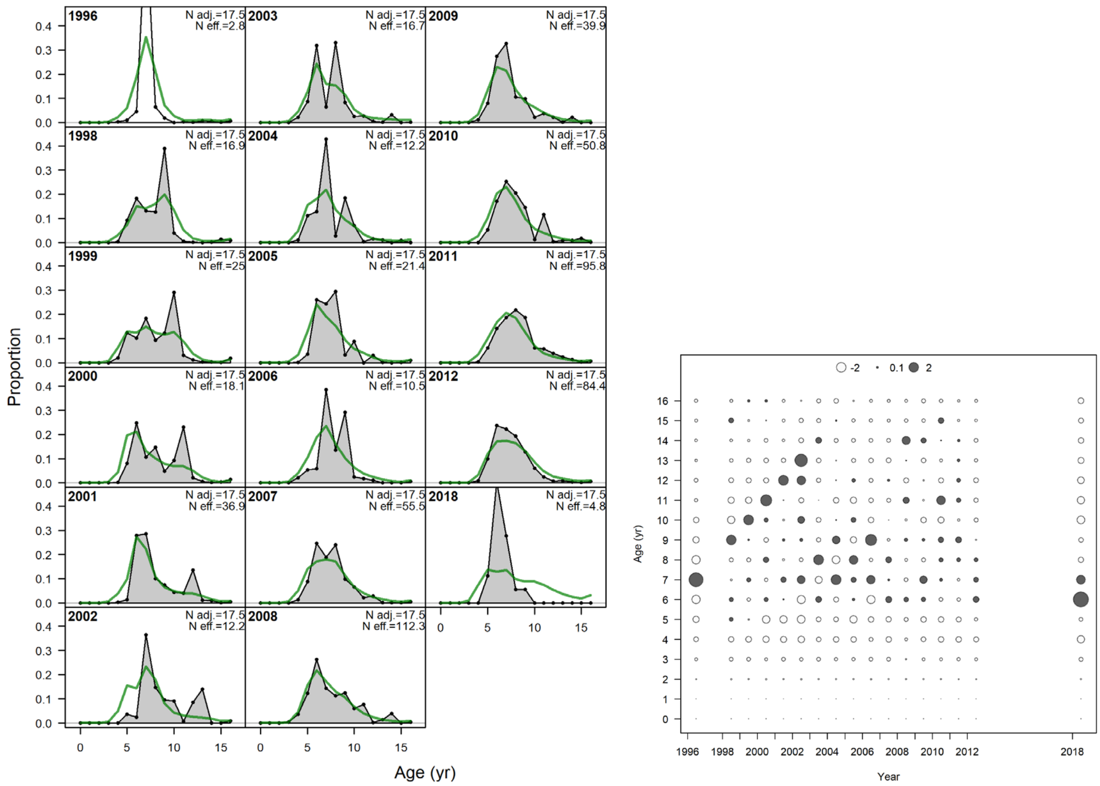


Figure 22. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of age composition data for the UK mid-water trawl fleet.

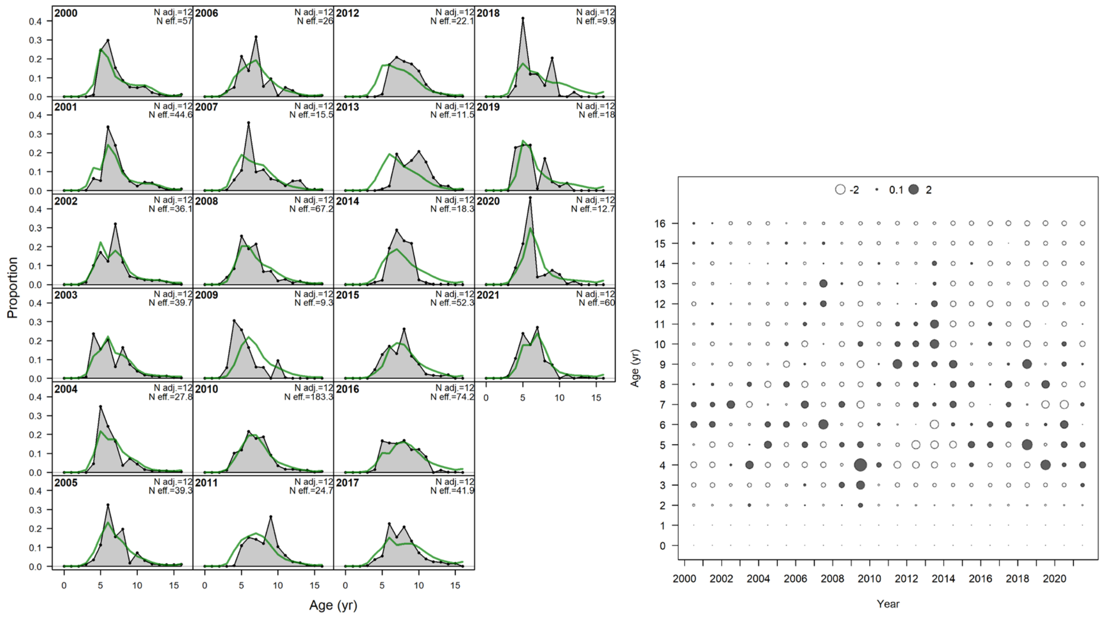


Figure 23. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of age composition data for the combined French fleets.

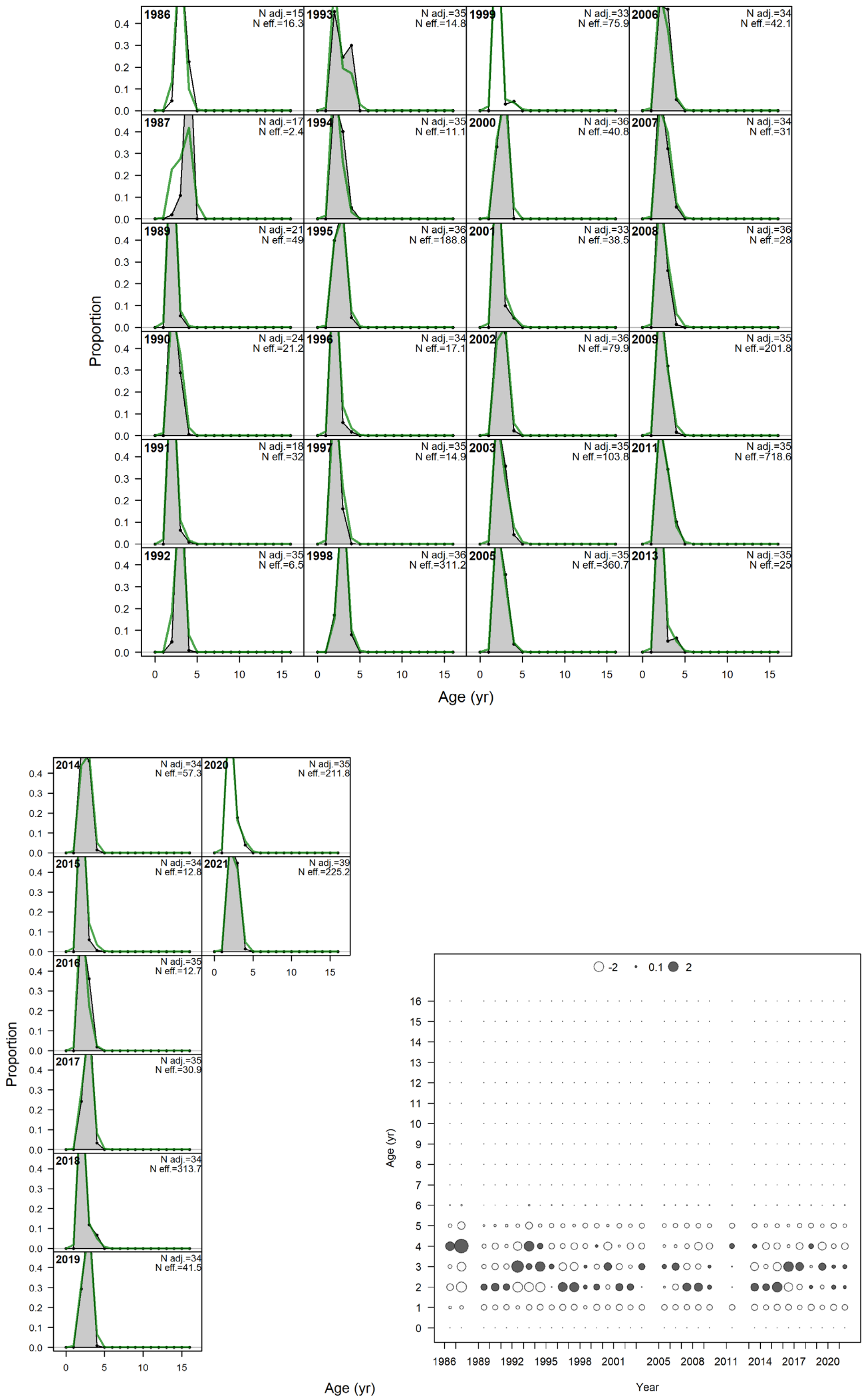
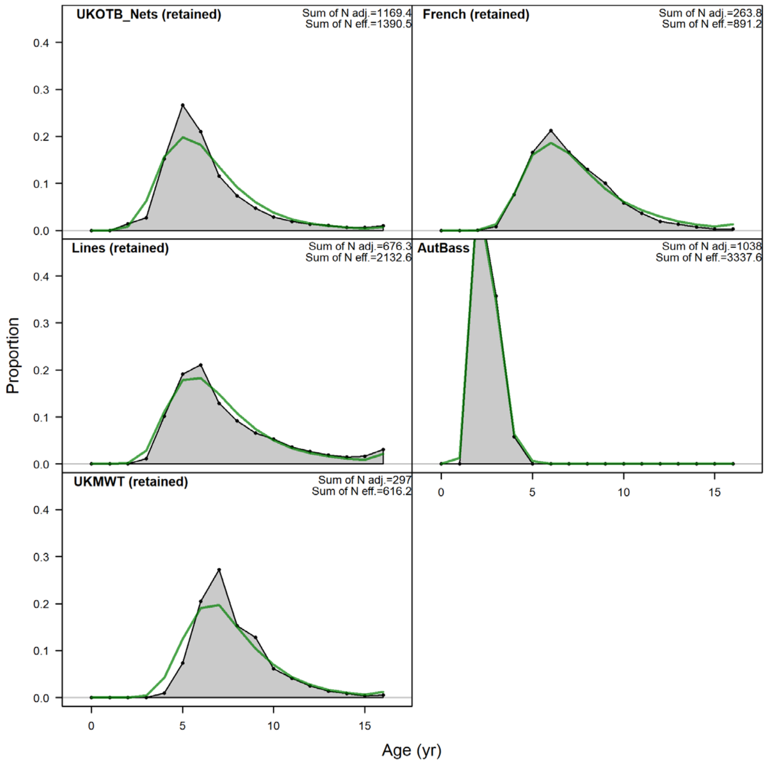


Figure 24. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of age composition data for the Solent Autumn bass survey.



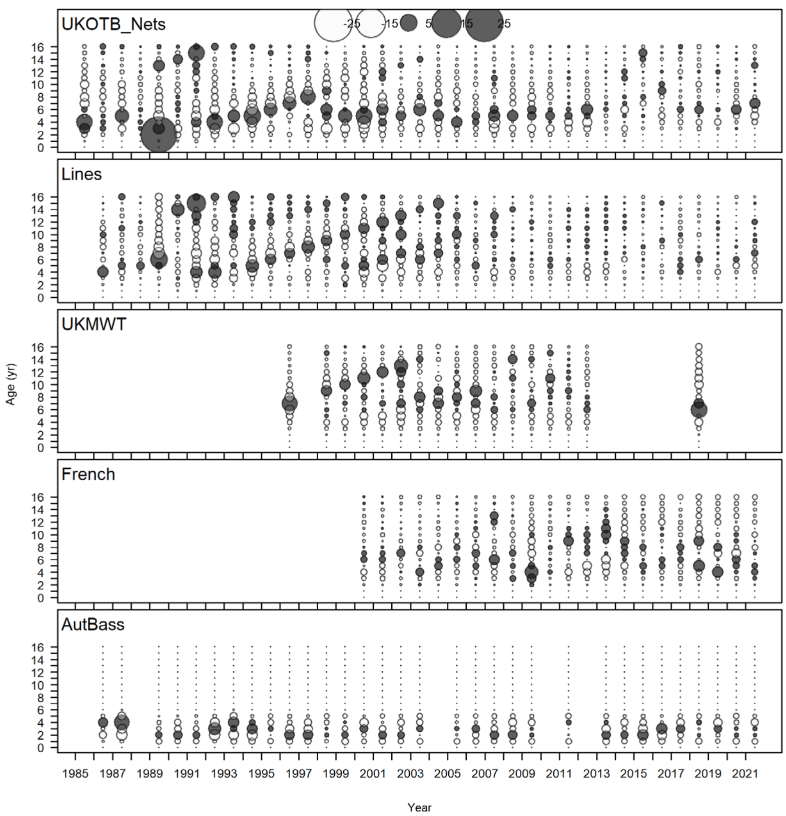


Figure 25. Bss.27.4bc7ad–h: Final seabass update assessment: Fit and residuals of UK fleets age compositions, aggregated across time.

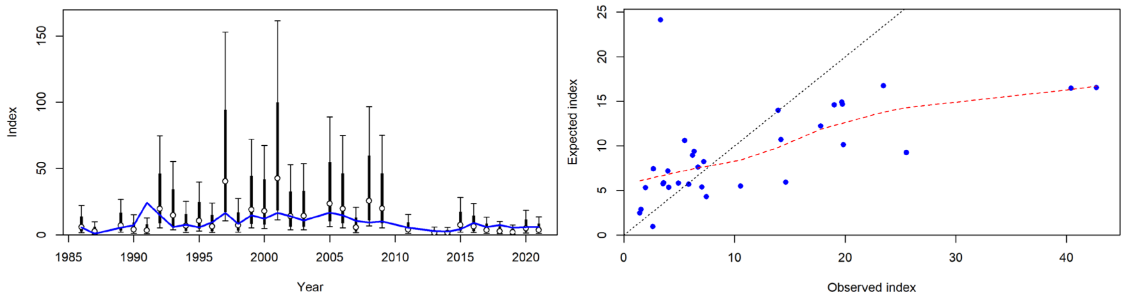


Figure 26. Bss.27.4bc7ad–h: Final seabass update assessment: Fit to Solent Autumn bass survey total abundance index, accounting for age and length-based selectivity.

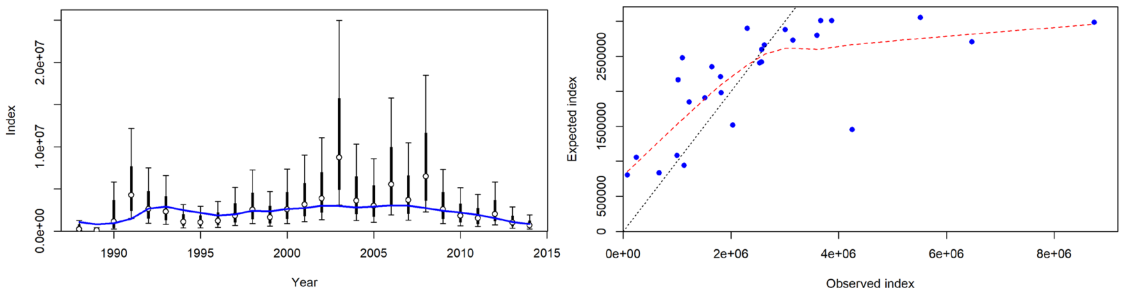


Figure 27. Bss.27.4bc7ad–h: Final seabass update assessment: Fit to Channel groundfish survey total abundance index, accounting for length-based selectivity.

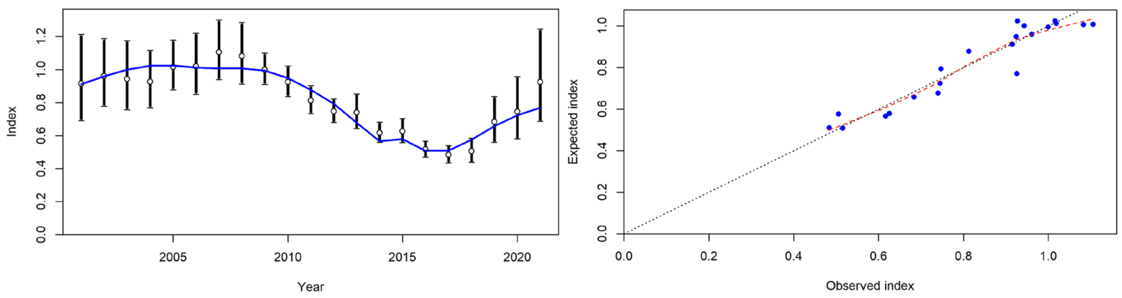


Figure 28. Bss.27.4bc7ad–h: Final seabass update assessment: Fit to the French landings per unit of effort commercial index, accounting for length-based selectivity.

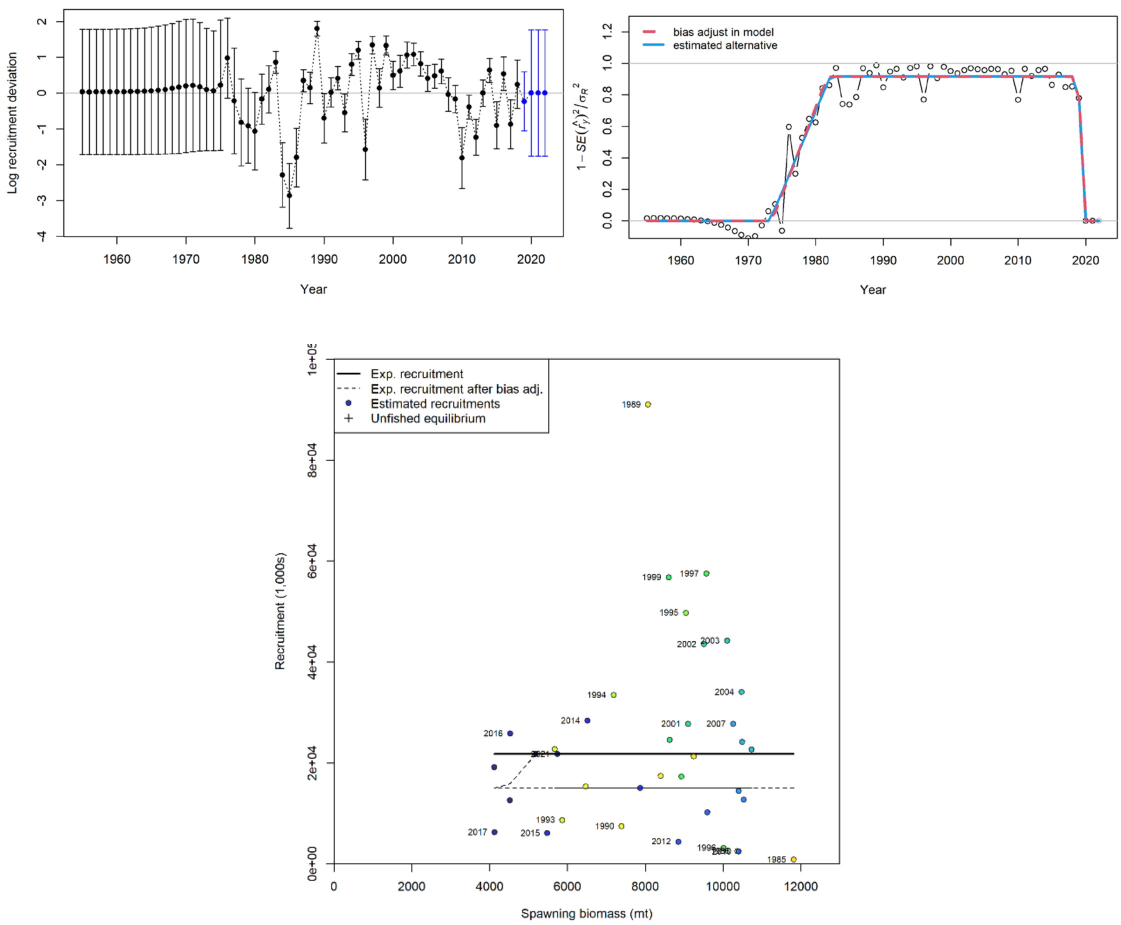


Figure 29. Bss.27.4bc7ad–h: Final seabass update assessment: Top: time-series of log-recruit deviations (deviations for 1965–1984 precede the period of input catch data). Below: stock–recruit scatter (model is fitted assuming Beverton–Holt stock–recruit model and steepness = 0.999).

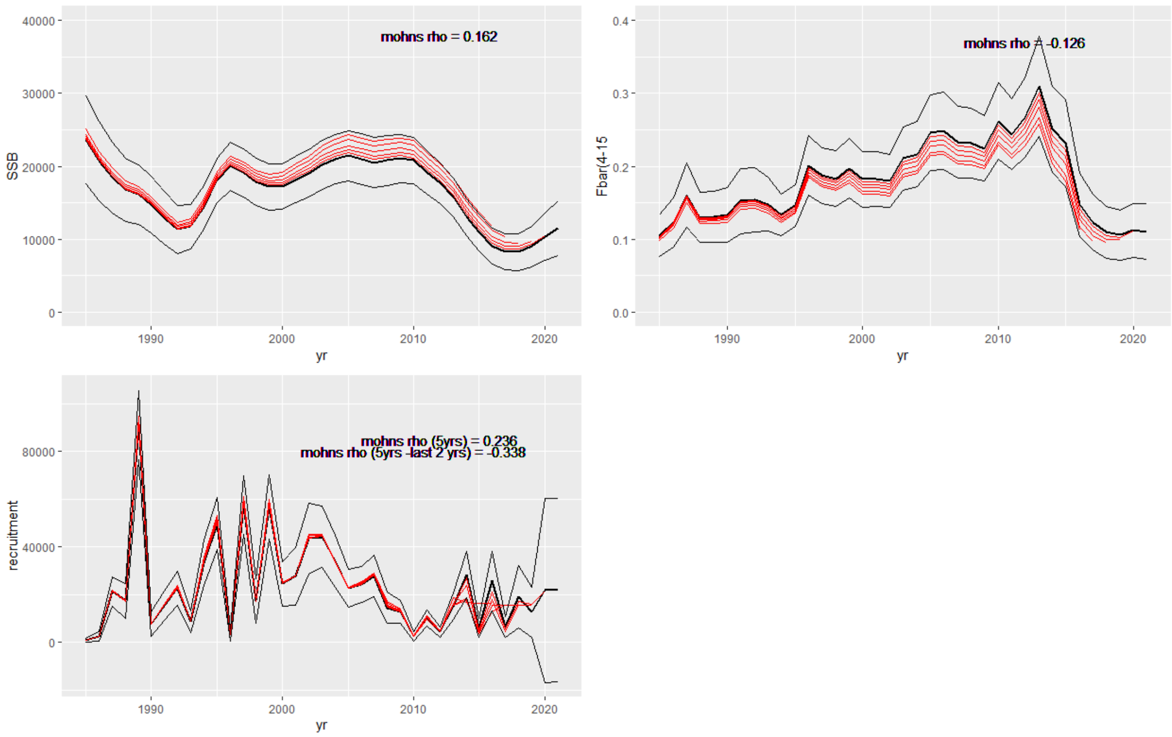


Figure 30. Bss.27.4bc7ad–h: Retrospective analysis of stock trends from final update assessment, based on Stock Synthesis run final year set to 2021 and peeling back five years (for the final run, terminal F is for 2020 and SSB and total biomass terminate in 2021).

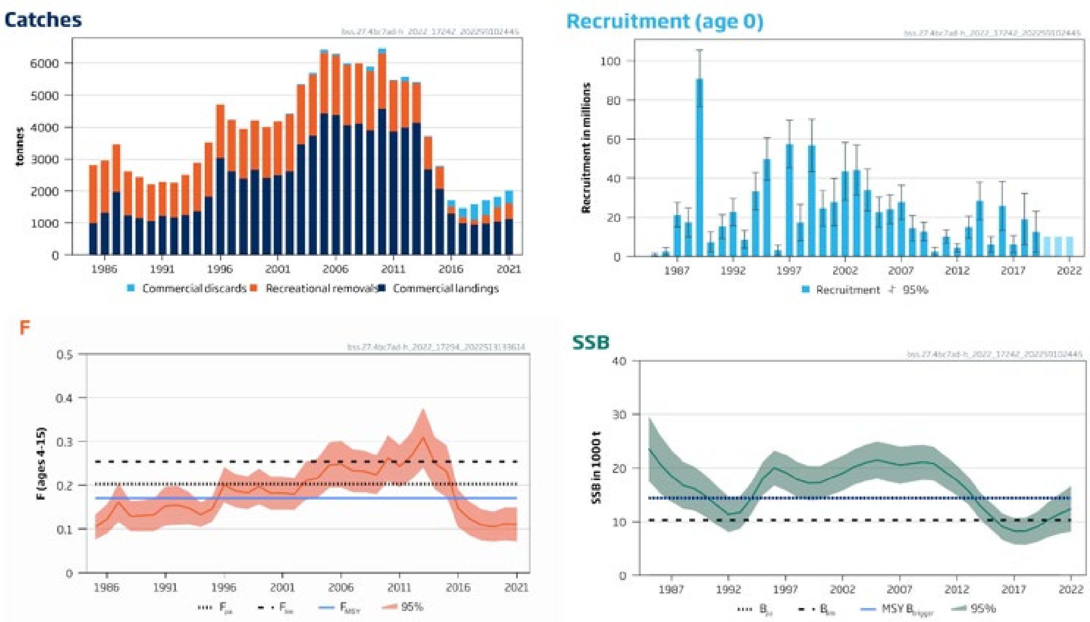


Figure 31. Bss.27.4bc7ad–h: Stock trends from final update assessment, based on Stock Synthesis run final year set at 2021 to give 2022 numbers and biomass and 2021 F. Recruitment in 2020–2022 is the geometric mean 2010–2019. Recruitment, F and SSB are shown with 95% confidence intervals.

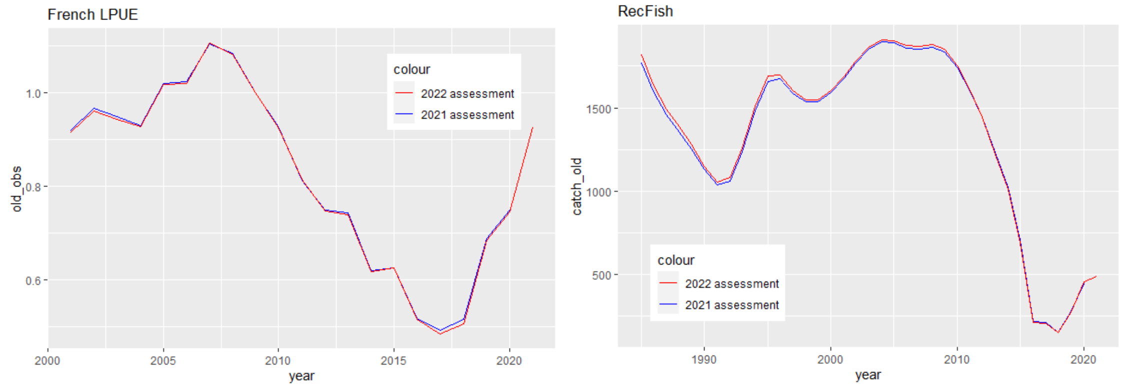


Figure 32. Bss.27.4bc7ad–h: Comparison between LPUE and recreational catch time-series from this year's final update assessment and the 2021 WGCSE assessment.

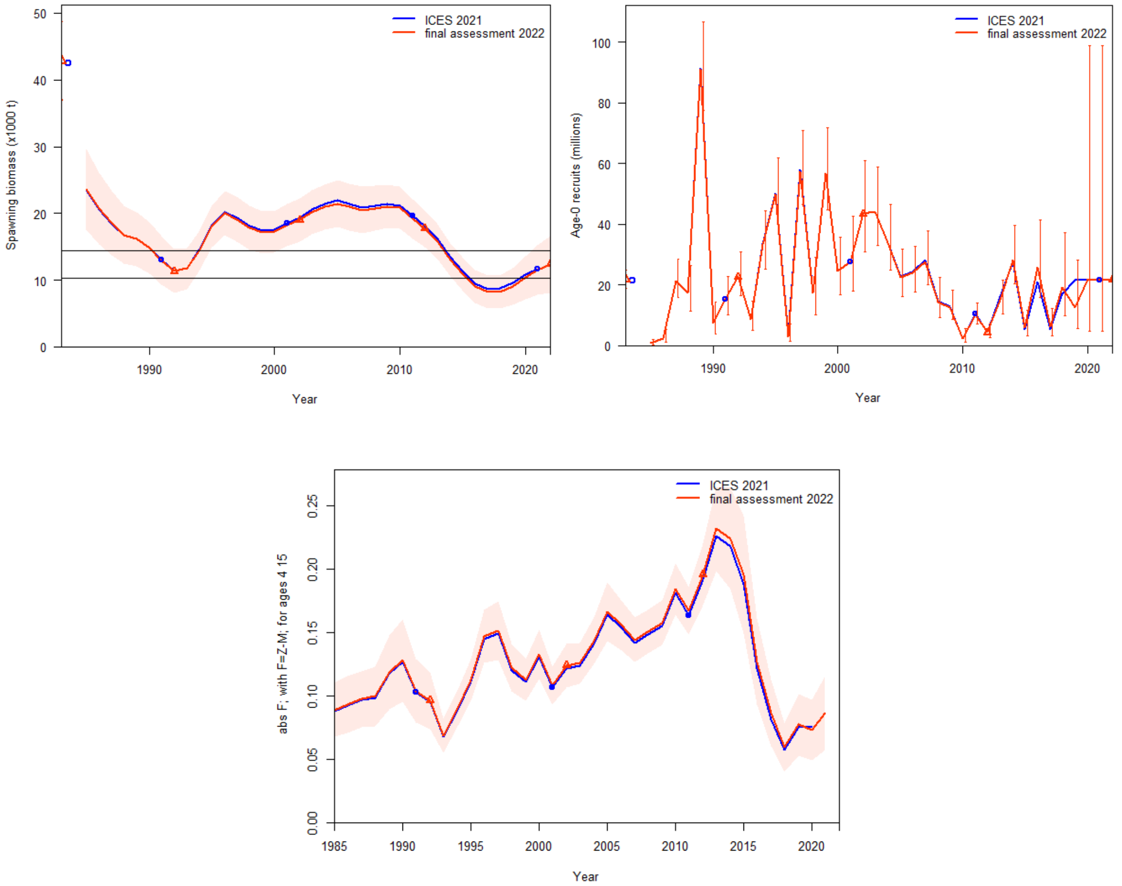


Figure 33. Bss.27.4bc7ad–h: Comparison between stock trends from this year's final update assessment and last year WGCSE assessment.

30 Sole (*Solea solea*) in divisions 7.b and 7.c (West of Ireland)

Type of assessment in 2022

No assessment was performed.

30.1 General

30.1.1 Stock identity

Sole in 7.b are mainly caught by Irish vessels on sandy grounds in coastal areas. Sole catches in 7.c are negligible. In 7.b there are two distinct areas where sole are caught: an area around Galway Bay and an area in the north of 7.b, which extends into 6.a (the Stags and Broadhaven Ground). The landings and LPUE of sole in 7.bc appear to have been more or less stable since the start of the logbooks' time-series in 1995. It is not known how much exchange there is between sole on the Aran Grounds and those on the Stags and Broadhaven Ground.

30.1.2 Data

The time-series of official landings is presented in Table 30.1 and Figure 30.1.

The time-series of otter-trawl landings effort and LPUE since 1995 are shown in Figure 30.2. Landings and effort have gradually declined since the late 1990s and early 2000s, giving rise to relatively stable LPUE over the time-series, with fluctuations.

30.1.3 Historical stock development

No analytical assessment was performed.

Table 30.1. Landings of Sole in 7.bc as officially reported to ICES.

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1908	0	0	1	37	0	38	**1965**	0	95	5	24	0	124		
1909	0	0	0	32	0	32	**1966**	0	0	1	11	0	12		
1910	0	0	0	28	0	28	**1967**	0	78	0	11	0	89		
1911	0	0	1	22	0	23	**1968**	0	121	0	8	0	129		
1912	0	0	1	22	0	23	**1969**	0	86	1	9	0	96		
1913	0	0	1	25	0	26	**1970**	0	3	0	8	0	11		
1914	0	0	1	43	0	44	**1971**	0	0	2	5	0	7		
1915	0	0	1	12	0	13	**1972**	0	4	0	13	0	17		
1916	0	0	0	14	0	14	**1973**	0	0	0	12	0	12		
1917	0	0	0	6	0	6	**1974**	0	25	0	12	0	37		
1918	0	0	0	7	0	7	**1975**	0	7	0	19	0	26		
1919	0	0	0	6	0	6	**1976**	0	6	0	44	0	50		
1920	0	0	9	5	0	14	**1977**	0	3	0	14	0	17		
1921	0	0	10	9	0	19	**1978**	0	3	0	16	0	19		
1922	0	0	4	9	0	13	**1979**	0	6	0	13	0	19		
1923	0	0	2	10	0	12	**1980**	0	9	0	24	0	33		
1924	0	0	15	64	0	79	**1981**	0	6	0	47	0	53		
1925	0	0	11	18	0	29	**1982**	0	5	1	55	0	61		
1926	0	7	10	18	0	35	**1983**	0	9	0	40	0	49		
1927	0	47	11	19	0	77	**1984**	0	3	0	17	0	20		
1928	0	49	8	16	0	73	**1985**	0	6	0	44	0	50		
1929	0	74	11	18	0	103	**1986**	0	8	0	29	0	37		
1930	0	52	5	22	0	79	**1987**	0	2	0	39	0	41		
1931	0	82	9	29	0	120	**1988**	0	2	1	34	0	37		
1932	0	122	10	27	0	159	**1989**	0	0	0	38	0	38		
1933	0	411	10	10	0	431	**1990**	0	0	0	41	0	41		
1934	0	217	10	13	0	240	**1991**	0	5	0	46	0	51		
1935	0	40	7	11	0	58	**1992**	0	2	0	43	0	45		
1936	0	43	20	9	0	72	**1993**	0	1	0	59	0	60	0	60
1937	0	32	25	14	0	71	**1994**	0	1	0	60	0	61	9	70
1938	0	44	21	7	0	72	**1995**	0	2	0	59	0	61	-2	59
1939	0	0	0	13	0	13	**1996**	0	2	0	52	0	54	3	57
1940	0	0	0	19	0	19	**1997**	0	3	1	51	0	55	0	55
1941	0	0	0	14	0	14	**1998**	0	0	0	49	0	49	17	66
1942	0	0	0	8	0	8	**1999**	0	0	0	68	0	68	4	72
1943	0	0	0	11	0	11	**2000**	0	12	0	65	0	77	-9	68
1944	0	0	0	16	0	16	**2001**	0	7	0	53	0	60	0	60
1945	0	0	0	20	0	20	**2002**	0	14	0	50	0	64	-3	61
1946	0	0	12	10	0	22	**2003**	0	19	0	50	0	69	-5	64

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1947	15	0	6	8	0	29	**2004**	0	18	0	49	0	67	2	69
1948	0	0	11	14	0	25	**2005**	0	7	0	38	0	45	-1	44
1949	0	41	12	12	0	65	**2006**	0	12	0	31	0	43	1	43
1950	0	24	9	6	0	39	**2007**	0	7	0	34	0	41	1	42
1951	0	27	7	6	0	40	**2008**	0	6	0	31	0	37	2	40
1952	0	40	2	6	0	48	**2009**	0	5	0	46	0	51	0	51
1953	0	99	2	4	0	105	**2010**	0	8	0	35	0	43	0	43
1954	0	116	1	7	0	124	**2011**	0	5	0	22	0	27	5	22
1955	0	66	1	9	0	76	**2012**	0	7	0	38	0	45	2	43
1956	0	161	1	6	0	168	**2013**	0	3	0	30	0	33	0	33
1957	0	94	1	4	0	99	**2014**	0	3	0	24	0	26	1	26
1958	0	163	2	6	0	171	**2015**	0	12	9	31	0	52	0	52
1959	0	327	1	8	0	336	**2016**	0	6	0	36	0	42	0	42
1960	0	80	1	9	0	90	**2017**	0	5	0	22	0	27	0	27
1961	0	110	1	12	0	123	**2018**	0	5	0	22	0	27	0	27
1962	0	100	0	8	0	108	**2019**	0	3	0	15	<1	18	0	18
1963	0	172	0	19	0	191	**2020**	0	2	0	13	1	16	0	16
1964	0	159	1	24	0	184	**2021**	0	2	0	14	0	17	0	17

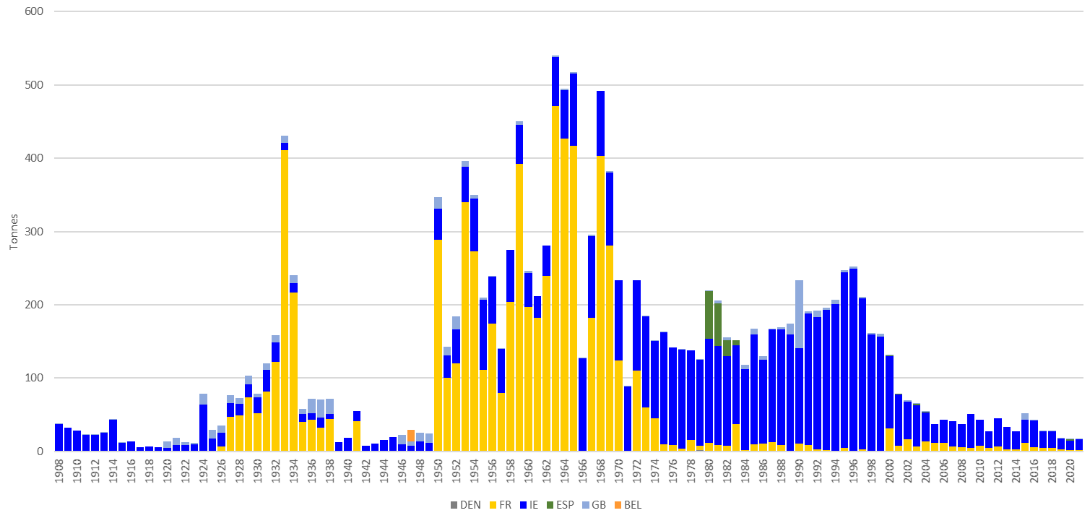


Figure 30.1. Landings of Sole in 7.bc as officially reported to ICES (1908–2021).

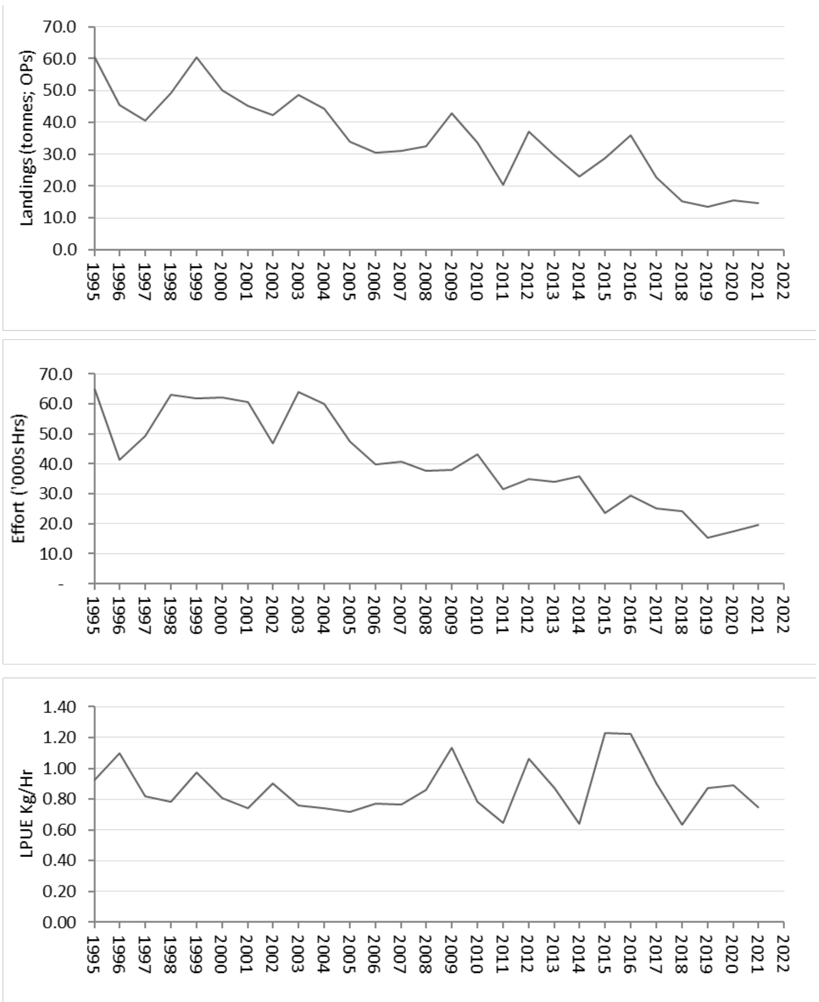


Figure 30.2. Sole in 7.b Irish otter trawl landings (top) effort (middle) and landings per unit of effort (LPUE; bottom) since 1995.

31 Sole (*Solea solea*) in Division 7.a (Irish Sea)

Type of assessment in 2022

This assessment is an update assessment.

ICES advice applicable to 2022

ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 787 tonnes.

Comments made by the audit of last year's assessment

No major deficiencies for the sole assessment in the Irish Sea were reported.

31.1 General

Stock description and management units

The sole fisheries in the Irish Sea are managed by TAC (see text tables below) and technical measures, with the assessment area corresponding to the stock area. Technical measures in force are minimum mesh sizes and minimum landing size (24 cm). In addition, beam trawlers, fishing with mesh sizes equal to or greater than 80 mm, are obliged to have 180 mm mesh sizes in the entire upper half of the anterior part of their net. More details can be found in Council Regulation (EC) N°254/2002 and the Stock Annex.

Since 2000, a spawning closure for cod has been in force. The first year of the regulation the closure covered the western and eastern Irish Sea. Since then, closure has been mainly in the western part whereas the sole fishery takes place mainly in the eastern part of the Irish Sea (Liverpool Bay and Cardigan Bay). No direct impact on the sole stock is expected from this closure.

For 2009, Council Regulation (EC) N°43/2009 allocates different amounts of kW*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The area's are Kattegat, part of 3.a not covered by Skaggerak and Kattegat, ICES zone IV, EC waters of ICES zone 2.a, ICES zone 7.d, ICES zone 7.a, ICES zone 6.a and EC waters of ICES zone 5.b. The grouping of fishing gear concerned are: bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≥100 mm) – TR2 (≥70 and <100 mm) – TR3 (≥16 and <32 mm); beam trawl of mesh size: BT1 (≥120 mm) – BT2 (≥80 and <120 mm); gillnets excluding trammelnets: GN1; trammelnets: GT1 and longlines: LL1.

For 2010–2016, Council Regulation (EC) N°53/2010, Council Regulation (EC) N°57/2011, Council Regulation (EC) N°43/2012, Council Regulation (EC) N°40/2013, Council Regulation (EC) N°43/2014, Council Regulation (EC) N°2015/104 and Council Regulation (EC) N°2016/72 were updates of the Council Regulation (EC) N°43/2009 with new allocations, based on the same effort groups of vessels and areas as stipulated in Council Regulation (EC) N°43/2009.

Since the 1st of April 2015 all Belgian beam trawl vessels with mesh size of 80–119 mm fishing in ICES Division 7.a are obliged by national decree to use the 'Flemish Panel' to increase selectivity. This means the last tapered netting section of a beam trawl anterior is directly attached to the codend, the upper and lower netting sections are constructed of at least 120 mm mesh (as measured between the knots) and the stretched length is at least 3 m.

Management applicable to 2021 and 2022

The TAC and the national quotas by country for 2021

Species:	Common sole *Solea solea*	Zone:	7a (SOL/07A.)
Belgium	356	Analytical TAC	
France	5	Article 3 of Regulation (EC) No 847/96 shall not apply	
Ireland	104	Article 4 of Regulation (EC) No 847/96 shall not apply	
The Netherlands	113		
Union	578		
United Kingdom	176		
TAC	768		

The TAC and the national quotas by country for 2022

Species:	Common sole *Solea solea*	Zone:	7a (SOL/07A.)
Belgium	364	Analytical TAC	
France	5	Article 3 of Regulation (EC) No 847/96 shall not apply	
Ireland	105	Article 4 of Regulation (EC) No 847/96 shall not apply	
Netherlands	116		
Union	590		
United Kingdom	181		
TAC	787		

Fishery in 2021

A full description of the fishery is provided in the Stock Annex, Section A2.

An overview of the landings data provided and used by the Working Group (WG) is shown in Table 31.1. The landings reached a level of 2808 t in the mid-1980s due to good recruitments in 1982–1984, but then subsequently dropped to a lowest of 818 t in 2000. After a small increase to 1090 t in the beginning of the 2000s, the landings have fallen to under 350 t in 2008–2012. From 2013 to 2018 the landings continued to decrease as they dropped to under 150 t. In 2017, the record low value of 34 t was recorded. From 2016 to 2018, there has been no targeted fisheries for sole in ICES Division 7.a. Afterwards the landings increased again to about 400 t in 2019 and 2020 and 629 t in 2021.

In 2021, the WG estimated landings are 629 t, of which Belgium landed 75% (473 t), Ireland 13% (81 t), 9% (56 t) by the UK (England and Wales) and the remainder by Northern Ireland, Scotland, Isle of Man and France. This corresponds to an international uptake of 82% of the agreed TAC in 2021 (768 t) and last year's forecast.

The WG estimate of the 2020 landings was not revised.

In 2021, 87% of the landings were taken by beam trawls, 12% by otter trawls and <1% by other gears.

31.2 Data

Landings

Age compositions for 2021 were available from the countries that take the major part of the international landings (97%) (Belgium, UK (E&W) and Ireland). The raw age data were combined for the three countries without weighting. The combined ALK was applied to the raised length distribution of the national catches to obtain a combined age distribution. This distribution was applied to the landings from Northern Ireland, Scotland, Isle of Man and France to obtain the landings numbers-at-age for 2021 (Table 31.2, Figure 31.1). The standardised landings proportion-at-age is presented in Figure 31.2. Annual length distributions of the three major countries involved are given in Table 31.3. Because of the substantial reduction of the TAC in 2014–2018, sampling levels in this period were also substantially reduced.

Landings weights-at-age for 2021 were taken from the combined age–weight key (Table 31.4).

Stock weights-at-age for 2000–2021 were derived from the mean catch weights by cohort interpolation to the first of January (Rivard weight calculator) (Table 31.5).

Further details on raising methods are given in the stock annex.

As last year, the combined age data (calculated outside InterCatch) as well as the landings from Northern Ireland, Scotland, Isle of Man and France were uploaded to InterCatch. It should be noted that the international age distribution is uploaded as "BE" as no international country code is available in InterCatch at present.

Discards

The available discard information (Table 31.6 and Figure 31.3) suggests that discarding is not a major problem in the Irish Sea sole fishery. However, discards have increased recently from 3.5% (average 2016–2018) to 12% (average 2019–2021). Belgian beam trawl length distributions of retained and discarded catches of sole for 2021 (Figure 31.3) indicate that predominantly 2 and 3-year old fish are discarded. In 2020 and 2021, no observer information from the UK and Irish fleet was available.

As an attempt, estimating an overall discard rate for the stock, individual discard estimates for 2019–2021 from the main métiers and countries (Belgium, Ireland and UK) were averaged to obtain an overall discard rate (Table 31.6b). In 2020 and 2021, only discard information from the Belgian beam trawl fleet was provided. The percent of the métiers with discard information covering the total international landings is 90%, 74% and 75% for 2019, 2020 and 2021 respectively. Assuming that discard rates do not change from the average of the last three years (2019–2021) and a fixed proportion of discards survive, a discard rate of around 12% (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

The UK (E&W) September beam-trawl survey (UK(E&W)-BTS-Q3) was unable to cover the 7.a Division in 2020 due to the Covid-19 disruption. Therefore, the 2020 information is missing from the LPUE series (1988–2019,2021) (Table 31.7b and Figure 31.4). The UK (E&W) March beam-trawl survey (UK(E&W)-BTS-Q1) provides information from 1993 to 1998. From 2006 until 2010 the two UK beam trawl surveys have been used as tuning indices in the Irish Sea sole assessments (Table 31.8). Following the outcome of WKFLAT 2011, the March survey (UK(E&W)-BTS-Q1) was omitted from the following assessments.

The LPUE from the UK(E&W)-BTS-Q3 has fluctuated since the beginning of the time-series (1988) between 90 and 200 kg/100 Km fished. Since 2000, it has dropped gradually to the lowest value in 2012 (26.47 kg/100 Km fished). Thereafter, it gradually increased to 118.66 kg/100 Km fished in 2019. For 2021 a lower value of 63.6 kg/100 Km fished was noted.

The UK(E&W)-BTS-Q3 survey was unable to cover the 7.a Division in 2020 due to Covid-19. The assessment was performed without tuning data for 2020.

Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

Commercial LPUE

Trends in LPUE and effort are given in Table 31.7 and Figures 31.5 and 31.6.

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 (2013–2021) and the UK (E&W) otter trawlers (2014–2021) are based on days fished instead of hours fished. In 2013, the UK administration switched to the EU electronic logbook system. Therefore, a lot of the reported effort is missing and the 2013 value cannot be used as an absolute number. Details of the 2013 UK beam trawl were unavailable due to reduced numbers of trips reporting this gear specific effort information via the newly introduced e-logbook system. The otter trawl fleet effort reporting was unaffected by this as these vessels were not reporting their landings via this method in 2013. However, from 2014 onwards, both the UK beam trawl and otter trawl effort values (hours fished) are unavailable because of the reporting issues.

Effort from both Belgian and UK commercial beam trawl fleets increased from the early seventies until the beginning of the nineties. Since then UK beam trawl effort has shown a continuing declining trend. Inspection of an alternate effort indicator (days fished) suggests that the declining trend continues in the period 2013–2018, followed by a slight increase in 2019. In 2020 and 2021, effort continues to increase to a similar level as observed in 2007. In contrast, the Belgian beam trawl effort has shown a more fluctuating pattern. After the decline in the early nineties, it reached its highest level in 2002 and decreased again afterwards. For the period 2008–2012, it remained stable at a very low level but in 2013 it continued to decrease and in 2016, it dropped to the lowest level in the time-series. In 2017–2018, there’s a slight increase. In the period 2019–2021, effort further increased to the level recorded in 2012. The substantial decrease of the Belgian and UK commercial beam trawl effort in the period 2013–2018, is in line with the substantial reductions of the TAC. From 2019 onwards, a sole-directed fisheries is again allowed and a higher TAC is set. This is clearly reflected in the higher activity of the Belgian beam trawlers from 2019 onwards.

The effort of the Irish beam trawlers shows a slow decline since 2004 and reached the lowest level in the time-series in 2013. Since 2014, the Irish beam trawl effort has increased, followed by a decrease in 2020 and 2021. In 2008, all beam trawl fleets showed a substantial reduction in effort compared to 2007.

The effort from the UK otter trawlers remained stable until the beginning of the nineties. Since then the UK otter trawl effort has continuously declined and is at the lowest level in 2013. As, in 2015 and 2016 all otter trawl vessels active in the Irish Sea were under 12 m, no effort (days fished) was recorded. Since 2017, the otter trawl effort (days fished) fluctuates at a low level. The Irish otter trawlers have shown a striking reduction in effort since 2000, followed by a slight increase in the period 2010–2012. In 2017, the Irish otter trawl effort fell back to the lowest observed level in the time-series. It remains at this lower level, except for the slightly higher value observed in 2019.

LPUE for both UK and Belgian beam trawlers was at a high level in the late seventies and early eighties but since early 2000s, LPUE for these fleets has fluctuated at a lower level. In the period 2007–2009 there has been a small increase in the UK beam trawl LPUE. However, in 2012 the LPUE has dropped to a remarkable low level in the time-series (4.3 kg/hour fished). An update for 2013–2017 was not available. However, the alternate LPUE indicator (kg/days fished) suggests that the UK beam trawl LPUE increased in 2015. For 2016–2018 no catches of sole and/or no effort were recorded therefore the LPUE is zero. After a slight increase in 2019, the LPUE further increased in 2020–2021 to a similar level as observed in 2009. 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 (13.2 kg/hour fished) and in 2017 it dropped to the lowest level in the time-series (3.8 kg/hour fished). In 2018, there's a slight increase to 5.4 kg/hour fished, followed by a substantial increase to 32.3 kg/hour fished in 2019 and 30.8 kg/hour fished in 2020. In 2021 the LPUE further increased to the highest level of the time-series (46.17 kg/hour). The Irish beam trawl LPUE shows a gradually diminishing trend over the whole time-series. After the slight increase in 2013, it fell back to a record low level in 2016-2018. Since 2019 there's a slight increasing trend.

The UK otter trawl LPUE remained stable until the beginning of the 2000s but is at the record low level in 2012. The alternative LPUE indicator (kg/days fished) suggests that the declining trend continues after 2012. After the record low level in 2017 (5.6 kg/days fished), the LPUE gradually increases to 192.7 kg/days fished) in 2021. In 2012–2016, the LPUE of Irish otter trawlers is fluctuating at a lower level. In 2017–2021 a higher value was recorded.

In 2020 during which the COVID-19 disruptions took place, a shift between the UK beam and otter trawl fleet was noted, as the activity of the beam trawlers substantially increased whereas that of the otter trawlers was substantially reduced. Further, no substantial changes in effort or LPUE compared to 2019 were recorded.

Historical Stock Development

In 2010, the Irish Sea sole assessment was based on XSA with two survey tuning indices (UK(E&W)-BTS-Q3 and UK(E&W)-BTS-Q1 (Table 31.8). 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. In 2020 and 2021, the assessment was performed without tuning data for 2020, as the UK(E&W)-BTS-Q3 could not take place in Division 7.a due to the Covid-19 disruptions.

31.3 Stock assessment

Data screening

The age range for the analysis was 2–8+.

The screening of the tuning indices (UK(E&W)-BTS-Q3) showed good cohort tracking (Figure 31.7) and consistency between ages for year-class strength (Figure 31.8).

Final Update Assessment

The model settings for the final assessment are summarized below

Assmnt Year	:2010	:2011-2021
Assmnt Model	: XSA	:XSA
Fleets	:	:
Bel Beam Trwl	: omitted	:omitted
UK Trawl	: omitted	:omitted
UK Sept BTS	:1988-2009 [2-7]	:1988- assessment year-1 * [2-7]
UK Mar BTS	:1993-1999 [2-7]	:omitted
Time Ser. Wts	: linear 20 yrs	:no taper weighting
Power Model	: none	:none
Q plateau	: 7	:4
Shk se	:1.5	:1.5
Shk age-yr	: 5 yrs 3 ages	: 5 yrs 3 ages
Pop Shk se	: 0.3	: 0.3
Prior Wting	: none	: none
Plusgroup	: 8	: 8
Fbar	: 4-7	: 4-7

***2020 not available due to COVID-19 and therefore not included in the assessment.**

The final XSA output is given in Table 31.9 (diagnostics), Table 31.10 (fishing mortalities) and Table 31.11 (stock numbers). Log catchability residuals for the final assessment are given in Figure 31.9. A summary of the XSA results is given in Table 31.12 and trends in yield, fishing mortality, recruitment and spawning–stock biomass are shown in Figure 31.10. Retrospective patterns for the final run are shown in Figure 31.11.

The UK(E&W)-BTS-Q3 survey was unable to cover Division 7.a in 2020 due to COVID-19. Last year's and this year's assessment were performed without tuning data for 2020. Last year, the recruitment estimate for 2020 was considered uncertain and was replaced by the geometric mean of recruitment (GM, 2015–2019). With the addition of the 2021 catch data and the 2021 UK(E&W)-BTS-Q3 tuning information, the 2020 recruitment (7051 thousand fish) is estimated to be higher than the geometric mean of recruitment (2931 thousand fish, GM, 2015–2019). Both the age 3 catch numbers in 2021 (Figure 31.1) and the age 3 UK(E&W)-BTS-Q3 index of 2021 indicate that 2018 is a strong year class.

Adding the 2021 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 and 2021. 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. For 2021 all negative residuals (lower estimates from the UK(E&W)-BTS-Q3 fleet compared to the VPA estimates) were noted.

The survivor estimates and fishing mortality estimates are almost entirely determined by the UK(E&W)-BTS-Q3 survey as it gets a high weighting (>96%) at all ages.

A Mohn's rho analysis was conducted based on the XSA stock assessment results, i.e. the last data year (2021) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 4–7)	recruitment
Mohn's rho value	0.086	-0.081	-0.085

The Mohn's rho values for this assessment are low and are well within the ICES WKFORBIAS thresholds (+0.20, -0.15), i.e. the current assessment indicates sufficient consistency for advice purposes. There is a slight tendency to overestimate the SSB and to underestimate the fishing mortality.

Comparison with previous assessments

A comparison of the estimates of this year's assessment with last year's is given in Figure 31.12. Trends in fishing mortality, SSB and recruitment are very similar.

The geometric mean of recruitment (2931 thousand fish, GM, 2015–2019) that replaced the 2020 XSA recruitment estimate in last year's assessment, was revised upwards by 141% (7051 thousand fish) in this year's assessment. The 2019 and 2018 recruitments were revised downwards by 14% and 16% respectively in this year's assessment. In last year's assessment, F and SSB for 2020 were estimated to be 0.131 and 3493 t respectively; this year's estimates for 2020 are 0.149 and 3298 t, an upward revision of 14% for F and a downward revision of 6% for SSB.

State of the stock

Estimated trends of Irish Sea sole landings, SSB, fishing mortality and recruitment are presented in Table 31.12 and Figure 31.12. Since the late eighties the landings of Irish Sea sole have been declining to the lowest level of the time-series (34 t) in 2017. SSB has been at a higher level until the late eighties. Since then SSB has been fluctuating between B_{pa} and B_{lim} and since 2004 it dropped below B_{lim}. After the record low value in 2014 (866 t), SSB gradually increased but remains below just below $MSYB_{trigger}$ in 2021 (3385 t). High fishing mortalities were observed during the late eighties until the mid-nineties. Thereafter fishing mortality declined to a level fluctuating just above F_{lim}. From 2013 onwards, fishing mortality has dropped under the level of F_{pa}/F_{MSY}. In 2018, the lowest level of the time-series was recorded (0.015). The decline in F is supported by a substantial reduction of the TAC in this period. As the TAC increased and the sole targeted fisheries was again permitted, F increased to 0.156 in 2019 and 0.149 in 2020. In 2021 F increased to above F_{pa}/F_{MSY}. Since 2001 recruitment has been well below the mean (5418 thousand fish) and the 2011 recruitment (year class 2009) is estimated to be the lowest in the time-series (633 thousand fish). The 2016 recruitment (3931 thousand fish, year class 2014) is estimated to be six times higher than the record low recruitment in 2011. Thereafter, higher and lower recruitments alternate. The 2018 year class (7051 thousand 2 year old fish) is estimated to be highest recorded in the last 20 years, followed by the weaker 2019 year class (1405 thousand 2 year old fish).

31.4 Short-term projections

Estimating year-class abundance

The 2011–2014 recruitments have been the lowest in the time-series. Higher recruitment was observed from 2015 onwards. However, the 2019 year class ((2021 recruitment) is now estimated at 1405 thousand fish at age 2 (Table 31.12), which is 52% lower than the short term GM (2015–2019) (2931 thousand fish) used in last year's forecast.

The age 2 estimates are almost solely coming from the UK(E&W)-BTS-Q3. From 2010 to 2014, the UK(E&W)-BTS-Q3 abundance index for age 2 fluctuated around the level of the lowest abundance in 2011 (0.29). In 2016 (2.97) and 2018 (2.18) again higher age 2 abundance indices were noted. The 2021 UK(E&W)-BTS-Q3 abundance index for age 2 (0.74) is around the same level of 2017 (0.8).

Forecast assumptions

Figure 31.13 shows three different targets for the intermediate year: F_last ($F = F_{2021}$ or status quo), F_average ($F = F_{average\ 2019\text{-}2021}$), and TAC. F estimates decreased slightly in 2020 compared to 2019 but increased in 2021.

The F in 2021 (0.259) is higher than in previous years (F_{2020}=0.149, F_{2019}=0.156) and the assumed 2022 landings using a status quo fishing mortality scaled to 2021 (815 t) are higher than the 2022 TAC (787 t). Landings and catch (discards calculated based on an overall discard rate) have been below the international TAC for 2021 (Figure 31.14), whereas in previous years catch and/or landings were closer to the TAC. This could possibly be allocated to the Brexit and the fact that the 2021 TAC was available at a later stage during the year. As this was a temporary issue, it seemed reasonable that the landings in 2022 would be in line with the ICES advice/TAC. Therefore, the working group agreed to use a landings constraint (696 t) for the intermediate year (2022) like previously assumed for this stock.

As input for the forecast fishing mortality was calculated as the mean of 2019–2021, scaled to 2021 (0.259). Catch and stock weights-at-age were also averages for the years 2019–2021. Population numbers at the start of 2022 for ages 3 and older, were taken from the XSA output. The Stock Annex recommends using a short-term geometric mean (assessment year minus 10 up to assessment year minus 2) for the recruitment in the short-term forecast.

The forecast was conducted with FLR's FLash R package using the output from the landings only XSA assessment. The resulting yield was obtained by adding discards to the landing with an average discard rate of the last three historical years (2019–2021, 0.12%).

The input for the short-term catch predictions and sensitivity analysis is given in Table 31.13.

MSY forecast

As the SSB in 2023 (3299 t) is assumed to be below $MSYB_{trigger}$, the F_{MSY} target (0.2) is rescaled to 0.189 (F_{MSY} × SSB2023/$MSYB_{trigger}$).

Table 31.15 and Figure 31.15 show a detailed output of the forecast targeting F = F_{MSY} × SSB2023/$MSYB_{trigger}$ for 2023–2024 and Figure 31.16 shows the year classes contributing to the forecast yield and SSB. The assumed short-term GM recruitments accounts for about 10% of the landings in 2023 and about 21% of the 2024 SSB.

Implementing the MSY approach with F = F_{MSY} × SSB2023/MSY$B_{trigger}$ = 0.189, leads to a total yield of 605 t in 2023, and an SSB of 31291 t in 2024.

The advice is a reduction of 23% compared to the advice for 2022. This decline is because of (1) a projected decline in the SSB caused by low recruitment in 2021 and (2) a downward revision of stock size caused by lower 2021 survey indices for age 4+ and lower mean stock weights-at-age.

Additional options

A management options table is provided in Table 31.14

31.5 Biological reference points

The most recent reference points for this stock were developed by WKMSYREF4 in 2015 (ICES, 2016). These reference points are presented in the following table. Please note that ICES changed the basis for F_{pa} to $F_{p.05}$ in 2021, and the updated F_{pa} value is shown here.

Reference points	ACFM 2007 onwards	2016 onwards	2021 onwards
F_{MSY}	0.16 (PLOTMSY, WG2010)	0.20 (Eqsim, WKMSYREF 4)	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})	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)	0.22 ($F_{p.05}$; F that leads to SSB ≥ B_{lim} with 95% probability)
B_{lim}	2200 t (B_{loss} estimated in 2007)	2500 t (lowest value with above average recruitment)	2500 t (lowest value with above average recruitment)
B_{PA}	3100 t (B_{pa}~B_{lim}*1.4)	3500 t (B_{lim} *1.4)	3500 t (B_{lim} *1.4)
$B_{trigger}$	B_{PA}	3500 t	3500 t

31.6 Management plans

No management plan is currently in place for Irish Sea sole.

31.7 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 recent years, sampling levels were also significantly reduced. In 2019 the TAC increased again and additionally a scientific sole quota is reserved for Belgian vessels fishing in ICES Division 7.a to assure a qualitative sampling. Due to Covid-19, only discard information from the Belgian beam trawl fleet was provided for 2020 and 2021.

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 2015–2020, 84%–97% of the TAC has been taken. 629 t sole were landed and 61 t were discarded in 2021, a total catch of 690 t, while the agreed TAC was 787 t.

Discards

The absence of discard data in the assessment is considered to have a minor effect on the quality of the assessment as the average discarding by weight has been low in the past (3–8%). However, higher discard rates were recorded in 2019 (14%) and 2020 (12%). The most recent discard information indicates a decrease in 2021 (9%). It might be recommended to include discards in the next benchmark assessment.

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. In 2019–2021 higher effort values were recorded as the TAC increased and sole directed fisheries were again allowed.

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. The UK(E&W)-BTS-Q3 survey data for 2020 were not available due to COVID-19.

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.

31.8 Recommendations for next Benchmark

The assessment diagnostics indicate a good correlation between the catch data and the survey tuning series. 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 analysed 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.

A future benchmark might look into including discard estimates in the assessment and estimating historical discards. An alternative assessment model such as a state–space stock assessment model (SAM) would be beneficial and allows to propagate the main uncertainties into the forecasts properly.

31.9 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 31.17).

Recruitment at age 2 has been well below average since 2001. In 2016 and 2018, recruitment is estimated to be six times higher than the record low levels in 2011–2014. SSB has increased since 2014 and is between B_{lim} and MSY $B_{trigger}$ in 2019, 2020 and 2021. SSB in 2021 was 3385 and slightly below MSY $B_{trigger}$ (3500 t). Over the last couple of years fishing mortality has decreased to close to zero. In 2019, fishing mortality started to increase and is above F_{MSY} in 2021.

Sole is caught in a mixed-fishery with other flatfish as well as gadoids. Information from observer trips indicates that discarding of sole is relatively low.

31.10 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.

31.11 References

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ICES. 2016b. 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 31.1. Sol.27.7a - Nominal landings (tonnes) as officially reported by ICES, and working group estimates of the landings. Last year's landings are preliminary.

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

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
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	-	71	-	-	2	576	-7	569	960
2007	306	1	115	-	70	-	-	4	492	0	492	820
2008	216	1	66	-	37	-	-	-	320	12	332	669
2009	257	-	47	-	20	1	-	1	325	0	325	502
2010	217	-	47	-	12	-	-	-	277	0	277	402
2011	250	<1	49	-	31	-	-	-	330	0	330	390
2012	222	<1	51	-	23	-	-	-	297	1	298	300
2013	96	<1	40	-	12	-	-	-	148	0	148	140
2014	43	-	43	-	10	-	-	-	96	3	99	95
2015	36	<1	32	-	7	-	-	-	75	1	76	90
2016	14	-	15	-	6	-	-	-	35	0	35	40
2017	14	<1	14	-	4	2	-	-	34	0	34	40
2018	14	-	16	-	6	<1	-	-	36	0	36	40
2019	329	<1	55	-	15	<1	-	-	400	0	400	414
2020	284	<1	48	-	65	<1	-	-	398	6	404	457
2021	477	<1	81	-	74	<1	-	-	633	-4	629	768

[1] **1989 onwards: N. Ireland included with England & Wales.**

Table 31.2. Sol.27.7a - Landings numbers-at-age (in thousands).

year/age	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1970	29	895	1009	467	1457	289	228	803	265	729	91	74	14	333	6683
1971	113	434	2096	1130	232	878	141	106	327	376	265	298	54	320	6769
1972	31	673	730	1538	537	172	522	97	46	279	142	152	98	164	5182
1973	368	363	2195	557	815	267	112	329	74	104	150	135	87	152	5708
1974	25	891	576	1713	383	422	232	58	226	44	55	103	110	143	4981
1975	262	733	2386	539	842	157	227	158	91	139	24	24	110	233	5924
1976	29	375	1331	2329	247	544	134	151	80	16	98	28	9	223	5594
1977	221	416	1292	774	1066	150	218	89	64	46	7	63	49	112	4565
1978	65	958	649	1009	442	638	98	204	29	69	33	16	48	90	4347
1979	108	1027	3432	829	637	326	285	65	76	20	65	6	1	102	6978
1980	187	940	1969	3057	521	512	361	352	45	107	53	26	14	187	8333
1981	70	580	1668	1480	1640	114	184	86	258	22	130	26	22	137	6418
1982	8	346	1241	1298	711	641	91	113	23	81	46	10	2	31	4643
1983	37	165	998	758	757	416	334	69	74	35	83	23	36	55	3839
1984	651	786	380	610	343	424	178	251	23	30	19	36	3	17	3750
1985	154	1600	1085	343	334	164	259	188	127	45	22	6	37	55	4418
1986	141	3334	3465	960	235	277	210	187	125	157	27	46	22	74	9260
1987	189	3347	4104	3184	844	307	224	139	153	87	87	17	17	84	12783
1988	32	444	4747	2100	1309	203	83	76	45	93	70	62	7	80	9350
1989	179	771	775	3979	1178	552	121	23	28	8	41	4	8	22	7689
1990	564	1185	986	598	2320	592	333	38	17	18	13	11	5	31	6713
1991	1316	1269	841	300	226	1172	255	125	27	4	6	14	5	23	5583
1992	363	2431	917	556	190	156	523	217	156	23	3	1	0	6	5541
1993	83	543	1965	559	251	199	147	257	114	93	19	12	10	34	4285
1994	122	1343	1070	1579	394	133	98	141	171	37	55	4	8	10	5166
1995	132	920	1444	737	1010	179	62	48	61	80	32	40	9	18	4771
1996	60	469	1188	741	430	509	142	49	28	37	35	23	14	19	3745
1997	790	714	475	711	409	258	295	85	58	34	13	26	5	15	3889
1998	167	1728	466	256	315	191	126	150	51	45	18	17	6	10	3546
1999	301	1069	1259	297	115	136	82	37	45	22	10	5	8	23	3410
2000	178	906	907	600	150	55	70	53	24	45	21	6	13	26	3053
2001	240	1438	822	717	511	80	65	67	58	28	20	8	6	20	4080
2002	148	930	1623	740	575	254	79	30	48	24	12	13	4	6	4486
2003	437	825	966	795	302	217	205	29	14	24	15	13	18	26	3888
2004	299	862	342	368	304	139	57	54	14	12	10	9	4	20	2495
2005	536	1052	626	271	314	279	141	75	77	13	7	18	15	22	3445
2006	112	670	649	203	113	151	133	86	59	41	14	5	9	31	2276
2007	171	356	348	243	86	41	63	68	53	25	34	10	5	40	1541

year/age 2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
2008	99	353	190	195	156	56	31	45	42	35	8	24	5	20	1258
2009	92	414	333	146	132	127	14	18	37	26	25	12	13	17	1405
2010	22	336	233	177	65	72	69	19	8	14	12	16	4	16	1063
2011	17	225	401	176	97	54	50	31	9	5	6	5	4	12	1091
2012	17	148	311	274	116	52	26	32	29	3	4	5	5	11	1034
2013	23	99	75	106	78	34	32	10	12	11	6	2	3	6	497
2014	12	49	59	37	38	51	17	11	8	5	5	2	2	6	303
2015	15	36	37	30	17	21	35	11	7	5	4	4	1	7	231
2016	1	18	22	14	10	7	8	11	3	4	1	2	2	2	103
2017	2	41	19	15	5	6	2	3	4	1	1	1	0	1	102
2018	4	22	46	14	9	3	2	1	2	2	1	1	0	1	107
2019	48	553	279	300	89	64	20	14	11	13	9	8	3	4	1416
2020	96	282	425	176	192	79	44	26	9	8	10	13	7	13	1379
2021	18	602	410	437	202	292	69	52	23	18	12	13	11	27	2187

Table 31.3. Sol.27.7a - Annual length distributions by country (2021).

	UK (England & Wales)	Belgium	Ireland
Length (cm)	All gears	All gears	All gears
20			
21			
22	108	3019	1529
23	825	20247	2096
24	3401	79907	3240
25	12612	151048	6908
26	17031	165088	16261
27	32812	169098	20873
28	33145	181956	24563
29	26937	159203	19963
30	25258	148319	17501
31	18910	138444	18691
32	14228	104292	18538
33	9796	84566	19499
34	6167	72039	11585
35	4340	68338	13161
36	2189	45535	8943
37	890	30065	9752
38	441	20305	5631
39	624	10692	4769
40	420	6678	4924
41	203	4592	1687
42	36	3837	2739
43	72	2302	973
44	0	1747	1768
45	36	1642	172
46	0	0	172
47	0	180	57
48	0	177	229
49	0	213	0
50	0	83	57
51			
Total	210 481	1 673 612	236 281

Table 31.4. Sol.27.7a - Landing weights-at-age (kg).

year/age	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1970	0.13	0.153	0.178	0.204	0.232	0.26	0.29	0.321	0.353	0.387	0.422	0.458	0.495	0.533
1971	0.152	0.178	0.204	0.23	0.257	0.284	0.312	0.34	0.369	0.398	0.427	0.457	0.487	0.517
1972	0.126	0.164	0.201	0.237	0.272	0.306	0.338	0.369	0.4	0.428	0.456	0.483	0.508	0.533
1973	0.151	0.178	0.204	0.23	0.256	0.283	0.309	0.335	0.361	0.387	0.413	0.439	0.464	0.49
1974	0.138	0.174	0.209	0.241	0.272	0.301	0.328	0.353	0.377	0.399	0.419	0.437	0.453	0.468
1975	0.13	0.172	0.21	0.244	0.275	0.303	0.327	0.347	0.364	0.378	0.387	0.394	0.396	0.396
1976	0.12	0.161	0.2	0.239	0.276	0.313	0.348	0.383	0.416	0.449	0.48	0.511	0.541	0.569
1977	0.085	0.146	0.202	0.251	0.293	0.33	0.36	0.384	0.401	0.413	0.418	0.417	0.409	0.395
1978	0.093	0.147	0.197	0.243	0.286	0.326	0.361	0.394	0.422	0.447	0.468	0.486	0.5	0.511
1979	0.134	0.165	0.199	0.234	0.271	0.311	0.352	0.395	0.441	0.488	0.537	0.589	0.642	0.697
1980	0.146	0.169	0.193	0.219	0.247	0.275	0.305	0.337	0.37	0.404	0.439	0.476	0.515	0.555
1981	0.162	0.183	0.207	0.234	0.264	0.296	0.331	0.369	0.41	0.454	0.5	0.55	0.602	0.657
1982	0.112	0.171	0.225	0.275	0.321	0.362	0.399	0.432	0.461	0.485	0.505	0.52	0.531	0.538
1983	0.189	0.212	0.238	0.266	0.298	0.332	0.369	0.41	0.453	0.499	0.548	0.599	0.654	0.712
1984	0.191	0.225	0.257	0.288	0.318	0.347	0.374	0.4	0.425	0.449	0.472	0.493	0.513	0.532
1985	0.144	0.189	0.231	0.272	0.31	0.346	0.38	0.412	0.441	0.469	0.494	0.517	0.538	0.557
1986	0.122	0.164	0.203	0.241	0.277	0.311	0.344	0.375	0.404	0.432	0.458	0.482	0.505	0.525
1987	0.135	0.164	0.196	0.231	0.268	0.308	0.35	0.395	0.442	0.492	0.545	0.6	0.658	0.719
1988	0.111	0.147	0.183	0.218	0.252	0.286	0.319	0.352	0.384	0.415	0.446	0.476	0.505	0.534
1989	0.125	0.163	0.201	0.237	0.271	0.304	0.336	0.366	0.395	0.422	0.448	0.473	0.496	0.517
1990	0.135	0.162	0.192	0.227	0.265	0.307	0.354	0.404	0.458	0.516	0.578	0.644	0.714	0.788
1991	0.133	0.172	0.208	0.241	0.272	0.3	0.326	0.349	0.369	0.386	0.401	0.413	0.423	0.43
1992	0.149	0.177	0.207	0.239	0.274	0.31	0.349	0.39	0.433	0.478	0.525	0.574	0.625	0.679
1993	0.102	0.156	0.205	0.248	0.285	0.318	0.345	0.366	0.382	0.392	0.397	0.397	0.391	0.38
1994	0.175	0.198	0.227	0.261	0.301	0.346	0.397	0.453	0.515	0.582	0.654	0.732	0.816	0.905
1995	0.129	0.182	0.232	0.277	0.318	0.356	0.389	0.419	0.444	0.466	0.484	0.497	0.507	0.513
1996	0.156	0.193	0.228	0.263	0.296	0.327	0.358	0.387	0.414	0.44	0.465	0.488	0.51	0.531
1997	0.154	0.197	0.237	0.275	0.311	0.345	0.376	0.406	0.433	0.458	0.481	0.501	0.519	0.536
1998	0.187	0.209	0.234	0.263	0.295	0.331	0.369	0.411	0.457	0.506	0.558	0.614	0.672	0.735
1999	0.179	0.217	0.252	0.285	0.314	0.341	0.365	0.387	0.406	0.422	0.436	0.446	0.454	0.46
2000	0.14	0.189	0.25	0.311	0.368	0.428	0.384	0.456	0.613	0.533	0.412	0.517	0.631	0.784
2001	0.175	0.18	0.271	0.293	0.326	0.42	0.465	0.382	0.415	0.459	0.378	0.532	0.381	0.615
2002	0.162	0.172	0.211	0.283	0.328	0.333	0.417	0.277	0.309	0.29	0.338	0.602	0.459	0.691
2003	0.16	0.187	0.247	0.294	0.342	0.326	0.35	0.594	0.505	0.576	0.23	0.48	0.632	0.455
2004	0.17	0.219	0.289	0.338	0.371	0.383	0.383	0.459	0.504	0.551	0.416	0.365	0.489	0.506
2005	0.16	0.203	0.256	0.286	0.312	0.326	0.334	0.34	0.331	0.337	0.388	0.364	0.335	0.572
2006	0.179	0.194	0.224	0.297	0.293	0.318	0.302	0.315	0.337	0.39	0.391	0.768	0.395	0.517
2007	0.172	0.224	0.296	0.36	0.38	0.429	0.415	0.467	0.461	0.428	0.513	0.54	0.642	0.588

year/age	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
2008	0.148	0.189	0.248	0.279	0.291	0.386	0.397	0.373	0.368	0.35	0.451	0.34	0.588	0.54
2009	0.141	0.195	0.229	0.279	0.277	0.261	0.34	0.289	0.281	0.229	0.251	0.312	0.242	0.315
2010	0.166	0.193	0.266	0.285	0.321	0.308	0.314	0.353	0.365	0.366	0.386	0.356	0.238	0.33
2011	0.215	0.213	0.276	0.362	0.413	0.368	0.383	0.318	0.521	0.287	0.46	0.297	0.368	0.292
2012	0.187	0.22	0.26	0.311	0.331	0.368	0.374	0.302	0.298	0.509	0.47	0.342	0.36	0.321
2013	0.17	0.213	0.278	0.32	0.347	0.353	0.332	0.403	0.403	0.329	0.308	0.302	0.331	0.418
2014	0.17	0.196	0.269	0.328	0.369	0.397	0.402	0.452	0.444	0.49	0.416	0.524	0.607	0.427
2015	0.18	0.221	0.309	0.342	0.381	0.4	0.391	0.381	0.383	0.349	0.412	0.345	0.382	0.381
2016	0.187	0.223	0.269	0.356	0.332	0.414	0.426	0.377	0.444	0.42	0.739	0.45	0.662	0.433
2017	0.177	0.239	0.323	0.386	0.495	0.493	0.503	0.472	0.44	0.588	0.331	0.373	0.457	0.465
2018	0.186	0.24	0.31	0.389	0.476	0.485	0.567	0.716	0.334	0.524	0.278	0.34	0.493	0.522
2019	0.186	0.22	0.278	0.324	0.392	0.366	0.419	0.54	0.441	0.427	0.487	0.343	0.265	0.455
2020	0.169	0.219	0.273	0.335	0.378	0.371	0.347	0.358	0.448	0.308	0.452	0.422	0.564	0.339
2021	0.186	0.227	0.255	0.324	0.322	0.334	0.316	0.336	0.375	0.419	0.366	0.474	0.426	0.345

Table 31.5. Sol.27.7a - Stock weights-at-age (kg).

year/age	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1970	0.13	0.153	0.178	0.204	0.232	0.26	0.29	0.321	0.353	0.387	0.422	0.458	0.495	0.533
1971	0.152	0.178	0.204	0.23	0.257	0.284	0.312	0.34	0.369	0.398	0.427	0.457	0.487	0.517
1972	0.126	0.164	0.201	0.237	0.272	0.306	0.338	0.369	0.4	0.428	0.456	0.483	0.508	0.533
1973	0.151	0.178	0.204	0.23	0.256	0.283	0.309	0.335	0.361	0.387	0.413	0.439	0.464	0.49
1974	0.138	0.174	0.209	0.241	0.272	0.301	0.328	0.353	0.377	0.399	0.419	0.437	0.453	0.468
1975	0.13	0.172	0.21	0.244	0.275	0.303	0.327	0.347	0.364	0.378	0.387	0.394	0.396	0.396
1976	0.12	0.161	0.2	0.239	0.276	0.313	0.348	0.383	0.416	0.449	0.48	0.511	0.541	0.569
1977	0.085	0.146	0.202	0.251	0.293	0.33	0.36	0.384	0.401	0.413	0.418	0.417	0.409	0.395
1978	0.093	0.147	0.197	0.243	0.286	0.326	0.361	0.394	0.422	0.447	0.468	0.486	0.5	0.511
1979	0.134	0.165	0.199	0.234	0.271	0.311	0.352	0.395	0.441	0.488	0.537	0.589	0.642	0.697
1980	0.146	0.169	0.193	0.219	0.247	0.275	0.305	0.337	0.37	0.404	0.439	0.476	0.515	0.555
1981	0.162	0.183	0.207	0.234	0.264	0.296	0.331	0.369	0.41	0.454	0.5	0.55	0.602	0.657
1982	0.112	0.171	0.225	0.275	0.321	0.362	0.399	0.432	0.461	0.485	0.505	0.52	0.531	0.538
1983	0.189	0.212	0.238	0.266	0.298	0.332	0.369	0.41	0.453	0.499	0.548	0.599	0.654	0.712
1984	0.191	0.225	0.257	0.288	0.318	0.347	0.374	0.4	0.425	0.449	0.472	0.493	0.513	0.532
1985	0.144	0.189	0.231	0.272	0.31	0.346	0.38	0.412	0.441	0.469	0.494	0.517	0.538	0.557
1986	0.122	0.164	0.203	0.241	0.277	0.311	0.344	0.375	0.404	0.432	0.458	0.482	0.505	0.525
1987	0.135	0.164	0.196	0.231	0.268	0.308	0.35	0.395	0.442	0.492	0.545	0.6	0.658	0.719
1988	0.111	0.147	0.183	0.218	0.252	0.286	0.319	0.352	0.384	0.415	0.446	0.476	0.505	0.534
1989	0.125	0.163	0.201	0.237	0.271	0.304	0.336	0.366	0.395	0.422	0.448	0.473	0.496	0.517
1990	0.135	0.162	0.192	0.227	0.265	0.307	0.354	0.404	0.458	0.516	0.578	0.644	0.714	0.788
1991	0.133	0.172	0.208	0.241	0.272	0.3	0.326	0.349	0.369	0.386	0.401	0.413	0.423	0.43
1992	0.149	0.177	0.207	0.239	0.274	0.31	0.349	0.39	0.433	0.478	0.525	0.574	0.625	0.679
1993	0.102	0.156	0.205	0.248	0.285	0.318	0.345	0.366	0.382	0.392	0.397	0.397	0.391	0.38
1994	0.175	0.198	0.227	0.261	0.301	0.346	0.397	0.453	0.515	0.582	0.654	0.732	0.816	0.905
1995	0.129	0.182	0.232	0.277	0.318	0.356	0.389	0.419	0.444	0.466	0.484	0.497	0.507	0.513
1996	0.156	0.193	0.228	0.263	0.296	0.327	0.358	0.387	0.414	0.44	0.465	0.488	0.51	0.531
1997	0.154	0.197	0.237	0.275	0.311	0.345	0.376	0.406	0.433	0.458	0.481	0.501	0.519	0.536
1998	0.187	0.209	0.234	0.263	0.295	0.331	0.369	0.411	0.457	0.506	0.558	0.614	0.672	0.735
1999	0.179	0.217	0.252	0.285	0.314	0.341	0.365	0.387	0.406	0.422	0.436	0.446	0.454	0.46
2000	0.124	0.158	0.23	0.303	0.345	0.41	0.385	0.478	0.707	0.633	0.362	0.602	0.571	0.784
2001	0.151	0.159	0.226	0.271	0.318	0.393	0.446	0.383	0.435	0.531	0.449	0.468	0.444	0.615
2002	0.145	0.174	0.195	0.277	0.31	0.33	0.419	0.359	0.344	0.347	0.394	0.477	0.495	0.691
2003	0.144	0.174	0.207	0.249	0.311	0.327	0.341	0.498	0.374	0.422	0.258	0.403	0.617	0.455
2004	0.15	0.187	0.232	0.289	0.331	0.362	0.353	0.401	0.547	0.528	0.49	0.29	0.484	0.506
2005	0.144	0.186	0.237	0.288	0.325	0.348	0.358	0.361	0.39	0.412	0.462	0.389	0.35	0.572
2006	0.152	0.177	0.213	0.276	0.289	0.315	0.314	0.324	0.339	0.36	0.363	0.546	0.38	0.518
2007	0.156	0.2	0.24	0.284	0.336	0.354	0.363	0.376	0.381	0.38	0.447	0.459	0.702	0.588

year/age	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
2008	0.134	0.181	0.236	0.288	0.324	0.383	0.413	0.393	0.415	0.402	0.439	0.417	0.564	0.54
2009	0.129	0.17	0.208	0.263	0.278	0.276	0.363	0.339	0.323	0.29	0.296	0.375	0.287	0.315
2010	0.158	0.165	0.228	0.256	0.3	0.292	0.286	0.347	0.325	0.321	0.297	0.299	0.272	0.331
2011	0.167	0.188	0.231	0.31	0.343	0.344	0.343	0.316	0.429	0.324	0.41	0.339	0.362	0.292
2012	0.156	0.218	0.235	0.293	0.346	0.39	0.371	0.34	0.308	0.515	0.368	0.397	0.327	0.321
2013	0.149	0.2	0.248	0.288	0.329	0.342	0.35	0.388	0.349	0.313	0.396	0.377	0.337	0.418
2014	0.111	0.183	0.24	0.302	0.343	0.371	0.377	0.388	0.423	0.444	0.37	0.402	0.428	0.427
2015	0.153	0.194	0.246	0.303	0.353	0.384	0.394	0.392	0.416	0.394	0.449	0.379	0.447	0.381
2016	0.127	0.2	0.244	0.332	0.337	0.397	0.413	0.384	0.412	0.401	0.508	0.431	0.478	0.433
2017	0.152	0.212	0.268	0.322	0.42	0.405	0.456	0.448	0.407	0.511	0.373	0.525	0.454	0.465
2018	0.149	0.206	0.273	0.354	0.428	0.49	0.529	0.6	0.397	0.481	0.405	0.335	0.429	0.522
2019	0.155	0.202	0.259	0.317	0.39	0.417	0.451	0.553	0.562	0.378	0.505	0.309	0.3	0.455
2020	0.119	0.202	0.245	0.305	0.35	0.381	0.356	0.387	0.492	0.369	0.439	0.453	0.44	0.339
2021	0.127	0.196	0.236	0.297	0.329	0.356	0.343	0.341	0.367	0.433	0.336	0.463	0.424	0.345

Table 31.6a. Sol.27.7a - Discard rates for the main fleets operational in the Irish Sea (Belgian, UK and Irish beam trawl, UK and Irish otter trawl, UK and Irish *Nephrops* trawl).

	BEL	UK						IRL		
Gear	TBB	TBB	OTB	TWIN OTB	NEPH OTB	TWIN NEPH	Other	TBB	NEPH OTB	OTB DEF
Landings (t)	716	284	61	4	25	6	Na	427	/	/
Discard ratio	0.05	0.08	0.05	0.01	0.08	0.02	Na	0.02	/	/
years	2007–2009	2002, 2005–2007	2002–2009	2003,2004,2007	2003, 2006–2009	2002,2003,2008	Na	2003–2009	/	/
Landings (t) 2010	210.917	1.721	1.071	0.014	3.329	0.501	0.741	38.283	5.327	3.632
Discard ratio 2010	0.04	Na	0.00	Na	0.05	Na	Na	0.05	0.16*	0.39*
Landings (t) 2011	239.483	13.662	2.866	0.05	5.201	0.414	0.821	32.514	10.116	5.581
Discard ratio 2011	0.04	Na	0.02	Na	0.00	Na	Na	0.003	0.16*	0.00

*** It should be noted that the 16% discard rate for 2010–2011 of the Irish *Nephrops* fleet and the 39% discard rate for 2010 of the Irish otter trawl fleet only accounts for respectively 1.9%, 3.1% and 1.3% of the total international landings.**

Table 31.6b. 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
	2017	11.047	2.154	0	0.436
	2018	13.2	1.085	0	0.5
	2019	324.835	4.06	0	51.157
	2020	293.321	1.628	0	40.999
	2021	455.637	16.929	0	44.347
UK (England)	2012	7.278	5.459	1.229	0
	2013	0.168	5.108	1.258	0
	2014	0.149	3.579	1.582	1.404
	2015	0.164	3.505	0.491	0
	2016	0.110	2.700	0.641	0.029
	2017	0.06	1.449	1.004	0
	2018	0.099	2.259	0.877	0
	2019	0.940	5.663	0.784	–
	2020	46.350	3.482	3.992	–
	2021	43.674	10.075	1.829	–
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
	2017	7.214	6.493	0.961	0.205
	2018	9.079	7.041	0.376	0.474
	2019	28.562	26.588	0.879	4.149
	2020	28.820	18.773	0.087	–
	2021	50.067	31.366	0.006	–
		total L	L corresponding with discard info	% coverage of L	total D	rate

Country	Year	Landings (L) (t)			Discards (D) (t)	
BE		TBB	OTB	other		
	2012	286.44	227.01	0.79	17.22	0.071
	2013	142.74	107.35	0.75	8.54	0.074
	2014	91.93	45.74	0.50	4.09	0.082
	2015	71.88	42.89	0.60	3.74	0.080
	2016	32.61	21.08	0.65	0.64	0.029
	2017	30.38	18.99	0.63	0.64	0.033
	2018	34.02	22.50	0.66	0.97	0.041
	2019	392.31	351.42	0.90	55.31	0.136
	2020	396.45	293.32	0.74	41.00	0.123
	2021	609.58	455.64	0.75	44.35	0.089
	average 19–21					0.116

Table 31.7a. Sol.27.7a - Effort series.

	Belgium	UK(E&W)				Ireland	
	beam[1]	beam [2]	beam[3]	otter[2]	otter[3]	otter[4]	beam[4]
Year	Whole year	Whole year	Whole year	Whole year	Whole year	Whole Year	Whole Year
1972	-	-	-	128.4	-	-	-
1973	-	-	-	147.6	-	-	-
1974	-	-	-	115.2	-	-	-
1975	28.4	-	-	130.7	-	-	-
1976	24.9	-	-	122.3	-	-	-
1977	22.1	-	-	101.9	-	-	-
1978	17.5	0.9	-	89.1	-	-	-
1979	20.4	1.7	-	89.9	-	-	-
1980	32.0	4.3	-	107.0	-	-	-
1981	36.5	6.4	-	107.1	-	-	-
1982	26.5	5.5	-	127.2	-	-	-
1983	28.7	2.8	0.0	88.1	1716.5	-	-
1984	17.5	4.1	263.0	103.1	7932.1	-	-
1985	27.0	7.4	428.1	102.9	6930.8	-	-
1986	44.5	17.0	1122.9	90.3	6693.2	-	-
1987	51.6	22.0	1178.5	130.6	9008.9	-	-
1988	38.2	18.6	1019.2	132.0	8292.4	-	-
1989	42.2	25.3	1344.5	139.5	16161.4	-	-
1990	42.4	31.0	1473.1	117.1	7724.5	-	-
1991	17.1	25.8	1211.3	107.3	7081.1	-	-
1992	25.1	23.4	908.1	96.8	6671.8	-	-
1993	23.9	21.5	826.9	78.9	6013.1	-	-
1994	32.5	20.1	1451.6	43.0	3060.0	-	-
1995	28.6	20.9	1429.4	43.1	3357.0	80.3	8.6
1996	23.2	13.3	894.3	42.2	3085.1	64.8	6.3
1997	30.7	10.8	784.4	39.9	2903.3	92.2	9.9
1998	24.7	10.4	696.0	36.9	2620.6	93.5	11.6
1999	22.7	11.0	778.9	22.9	1803.5	110.3	14.7
2000	26.0	6.3	410.7	27.0	2034.9	82.7	11.4
2001	36.8	12.5	767.4	32.8	2352.9	77.5	13.1
2002	47.0	8.0	535.1	24.8	1774.0	77.9	17.7
2003	44.3	14.0	863.7	23.9	1728.3	73.9	18.7
2004	32.3	7.4	419.9	23.5	1727.0	72.5	14.2
2005	37.5	11.4	627.8	16.7	1313.6	68.3	14.7
2006	24.8	4.6	280.1	5.2	478.5	66.2	12.2
2007	19.5	3.2	193.5	4.4	397.2	74.1	14.2

	Belgium	UK(E&W)				Ireland	
	beam[1]	beam [2]	beam[3]	otter[2]	otter[3]	otter[4]	beam[4]
2008	10.3	1.3	98.0	2.7	320.4	58.8	9.5
2009	11.7	0.5	24.9	1.5	157.7	42.8	7.6
2010	11.3	0.2	10.2	1.4	151.0	45.8	9.4
2011	12.4	1.6	91.2	0.7	72.7	54.5	8.1
2012	10.9	0.9	60.7	0.4	85.0	58.3	7.2
2013	7.0	0.0	1.3	0.3	31.9	42.6	5.0
2014	3.9	-	0.4	-	16.1	47.7	6.0
2015	3.5	-	0.9	-	0.0	39.8	8.3
2016	1.8	-	3.9	-	0.0	33.4	7.9
2017	3.0	-	0.0	-	160.7	12.1	7.5
2018	2.5	-	0.0	-	238.1	13.6	9.6
2019	10.1	-	7.0	-	247.2	17.2	13.3
2020	9.5	-	199.0	-	72.6	13.3	10.4
2021	9.9	-	222.6	-	193.6	13.2	8.9

[1]000' hours fishing.

[2]000'hours fished (GRT corrected >40 vessels).

[3] days fished.

[4] 000'hours.

*** Provisional.**

Table 31.7b. Sol.27.7a – LPUE.

	Belgium	UK(E&W)				UK		Ireland	
	beam[1]	beam[3]	beam[2]	otter[3]	otter[2]	beam survey[4]		otter[1]	beam[1]
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	21.39	-	-	1.39	-	-	-	-	-
1976	23.13	-	-	0.94	-	-	-	-	-
1977	19.79	-	-	0.80	-	-	-	-	-
1978	18.10	34.32	-	1.04	-	-	-	-	-
1979	33.41	32.01	-	1.43	-	-	-	-	-
1980	28.18	31.70	-	1.01	-	-	-	-	-
1981	22.16	21.32	-	0.75	-	-	-	-	-
1982	22.01	29.94	-	0.53	-	-	-	-	-
1983	13.88	37.31	0.0	0.57	150.2	-	-	-	-
1984	22.47	16.24	2851.4	0.71	119.3	-	-	-	-
1985	20.58	17.34	2956.3	0.56	135.7	-	-	-	-
1986	19.12	19.23	3925.7	0.84	174.9	-	-	-	-
1987	17.73	14.82	3726.9	0.77	144.9	-	-	-	-
1988	21.29	11.81	2673.3	0.46	80.3	161.92	-	-	-
1989	21.93	9.17	1750.6	0.70	138.9	150.07	-	-	-
1990	17.52	9.52	2300.9	0.61	119.7	196.90	-	-	-
1991	18.70	10.43	2420.9	1.12	177.4	175.76	-	-	-
1992	19.21	9.50	2763.0	1.02	126.0	162.64	-	-	-
1993	19.97	7.60	1879.8	0.54	69.1	100.16	104.7	-	-
1994	19.06	11.76	1479.9	0.74	88.1	110.71	91.9		-
1995	18.12	14.96	1721.1	0.95	142.3	92.04	79.3	0.38	12.69
1996	17.72	9.44	1471.7	0.53	47.7	89.48	-	0.25	14.94
1997	16.62	10.49	961.8	0.73	103.2	155.79	63.3	0.23	8.53
1998	18.96	8.42	907.8	0.48	50.5	144.97	89.3	0.38	7.77
1999	19.47	9.94	1124.9	0.60	64.8	116.02	-	0.29	9.22
2000	15.52	12.90	1604.7	0.44	34.6	130.70	-	0.29	8.49
2001	15.02	11.72	1537.4	0.15	23.4	96.87	-	0.38	7.86
2002	14.95	16.73	1484.3	1.48	98.8	76.73	-	0.32	4.67
2003	15.41	13.20	1351.6	0.15	340.4	88.55	-	0.34	4.20
2004	16.25	13.86	941.7	0.17	27.6	98.92	-	0.14	4.31
2005	17.52	9.14	1199.9	0.19	21.3	48.91	-	0.16	4.70

	Belgium	UK(E&W)				UK		Ireland	
	beam[1]	beam[3]	beam[2]	otter[3]	otter[2]	beam survey[4]		otter[1]	beam[1]
2006	16.32	7.83	826.1	0.52	34.8	52.63	-	0.16	6.00
2007	14.32	16.38	1629.9	0.42	21.4	53.05	-	0.37	6.37
2008	19.85	15.25	887.4	0.30	16.4	50.67	-	0.20	6.08
2009	19.96	18.88	1201.2	0.22	13.6	45.75	-	0.28	4.53
2010	18.68	13.90	262.3	0.46	17.8	27.80	-	0.19	4.09
2011	19.34	4.45	322.5	0.18	13.7	36.97	-	0.30	4.13
2012	19.61	4.27	99.9	0.08	4.4	26.47	-	0.14	5.41
2013	13.23	-	27.7	0.10	16.3	31.65	-	0.22	6.27
2014	9.16	-	0.0	-	13.0	41.14	-	0.14	5.40
2015	9.24	-	146.1	-	34.2	58.88	-	0.18	3.14
2016	6.81	-	0.0	-	21.3	69.35	-	0.18	1.17
2017	3.81	-	0.0	-	5.6	64.24	-	0.36	1.23
2018	5.36	-	0.0	-	12.6	78.51	-	0.28	1.49
2019	32.26	-	124.8	-	48.5	118.66	-	0.63	2.23
2020	30.81	-	1305.4	-	97.2	-	-	0.67	2.92
2021*	46.17	-	1079.7	-	192.7	63.60	-	0.72	5.79

All LPUE values in Kg/hr.

[1] Kg/hr.

[2] Kg/day.

[3] Kg/000'hr fished (GRT corrected >40' vessels).

[4] Kg/100 km fished.

Table 31.8. Sol.27.7a - Tuning series (values in bold are used in the assessment).

BE-CBT	**Belgium Commercial Beam trawl (Effort = Corrected formula)**										
1975	2005										
1	1	0	1								
4	14										
12.3	1045	275	393	69	105	94	61	72	11	15	64
11.8	568	1066	80	263	64	58	35	5	56	5	5
10.7	434	307	509	76	93	45	23	20	2	35	32
9.9	169	304	155	258	41	90	12	29	12	7	17
11.2	1455	510	323	193	162	37	36	9	41	0	0
16.7	958	1644	296	268	247	210	30	64	31	14	7
22.6	909	721	998	62	92	44	161	13	92	10	8
19.5	451	608	378	394	52	64	11	29	24	5	0
20.5	259	310	394	238	216	44	38	28	49	3	26
12	107	204	143	188	91	121	2	1	4	14	0
19.6	606	171	186	99	150	125	83	27	13	4	23
38	1531	468	138	135	90	104	69	69	20	8	21
43.2	1527	881	297	167	69	39	54	59	40	13	9
30.5	2027	1012	480	21	33	37	34	42	35	0	7
34	376	2423	751	250	59	15	9	2	14	0	1
36.1	307	223	1263	276	142	13	9	11	11	8	5
13.8	253	78	60	588	115	40	16	1	1	11	3
23.9	298	330	68	40	203	93	36	12	0	0	0
24.5	862	253	149	89	79	160	66	77	0	0	0
31	680	786	164	103	39	117	58	19	15	0	7
26.2	729	366	410	52	27	6	28	15	6	11	3
21.6	537	334	241	219	53	13	11	14	9	7	2
28.5	270	376	180	162	134	28	27	15	9	8	1
23.3	248	146	142	89	73	62	20	20	9	10	3
21.7	693	199	65	50	37	21	17	9	6	4	6
18.6	685	220	107	31	15	33	13	7	9	0.6	8

30.5	600	284	248	39	35	44	33	1	3	0.2	4
38.6	1138	814	349	109	30	9	2	1	1	1	0
24.45	724	436	196	84	20	7	2	1	0	2	1
25.58	313	197	159	47	12	11	6	3	0	0	0
32.15	505	342	156	71	87	9	7	1	13	2	1
UK(E&W)-BTS-Q3		September beam trawl survey									
1988	2021										
1	1	0.75	0.85								
1	9										
100.062	118	196	180	410	76	40	4	0	4		
129.71	218	304	180	74	284	56	32	8	6		
128.969	1712	534	122	42	88	194	40	20	6		
123.78	148	1286	122	26	16	14	55	19	7		
129.525	220	309	657	142	34	22	7	75	17		
131.192	83	330	143	211	40	17	7	16	36		
124.892	60	408	203	73	132	49	11	13	6		
126.004	246	154	253	110	30	67	12	5	5		
126.004	886	126	32	76	46	23	31	8	2		
126.004	1158	577	72	24	55	27	16	30	7		
126.004	539	716	292	18	6	24	23	5	18		
126.004	385	293	255	203	29	8	26	5	6		
126.004	354	464	147	219	91	13	2	13	6		
126.004	91	284	192	65	96	63	6	3	12		
126.004	205	61	121	126	42	79	49	2	1		
126.004	242	210	51	97	81	40	43	26	1		
126.004	406	240	119	27	77	45	41	17	19		
122.298	53	165	69	25	13	35	25	4	6		
126.004	107	110	90	45	36	9	16	15	10		
126.004	125	93	49	57	41	11	4	6	12		
122.298	126	126	60	21	43	23	6	2	9		

126.004	60	150	68	40	19	30	12	7	1
126.004	26	60	74	37	17	5	9	9	3
122.298	88	35	62	68	35	12	4	13	6
122.298	22	49	16	46	25	12	11	2	6
126.004	75	57	36	21	33	18	21	9	1
126.004	172	43	22	35	14	26	21	14	6
126.004	421	150	41	20	23	5	15	29	8
122.298	129	363	91	29	20	24	8	8	9
126.004	237	101	177	56	24	15	9	7	7
126.004	268	275	75	144	38	21	9	6	9
126.004	1018	224	167	68	132	37	11	4	3
-	-	-	-	-	-	-	-	-	-
126.004	93	93	282	65	38	22	50	2	0

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

UK(E&W)-C0T		**UK Commercial Otter trawl**											
1991	2013												
1	1	0	1										
2	14												
107.3	265	155	63	29	19	71	20	11	2	0	1	1	1
96.8	16	224	69	22	16	10	36	10	10	1	0	0	0
78.9	9	27	77	19	3	7	4	5	1	2	0	0	0

43	4	66	34	50	20	3	4	4	7	1	2	0	0
43.1	17	50	34	15	24	7	1	2	0	2	1	1	0
42.2	2	5	18	12	7	12	4	1	1	1	1	1	1
39.9	14	15	7	14	9	3	7	3	1	1	0	1	0
36.9	5	24	5	3	5	3	2	2	1	1	0	0	0
22.8	5	15	12	2	0	2	1	1	1	1	0	0	0
27	2	12	9	8	1	0	1	1	0	0	0	0	0
32.9	3	10	6	8	5	0	0	0	0	0	0	0	0
24.8	0	8	16	3	5	3	1	0	1	0	0	0	0
23.9	1	2	6	4	2	1	2	0	0	0	0	0	0
23.5	3	5	3	4	3	2	1	1	0	0	0	0	0
16.7	2	4	2	1	2	2	1	1	1	0	0	0	0
5.2	1	2	4	1	1	1	1	1	1	1	0	0	0
4.4	1	1	2	2	0	0	1	1	1	0	0	0	0
2.7	0	1	1	1	1	0	0	0	0	0	0	0	0
1.54	0	0	0.2	0.3	0.1	0.2	0.2	0	0	0.1	0	0	0
1.42	0	0.1	0.2	0.3	0.1	0.1	0.2	0.1	0	0.1	0.1	0.1	0
0.686	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0
0.241	0	0	0	0	0	0	0	0	0	0	0	0	0
0.272	0	0	0	0	0	0	0	0	0	0	0	0	0
IR-COT	Irish Commercial Otter trawl												
1995	2005												
1	1	0	1										
2	10												
70682	6.8	17.7	25.5	9.2	25.8	3.6	0.8	1.5	1.9	1995			
58166	0	5.7	12.9	12.7	4.7	4.7	2.2	0.2	0	1996			
75029	27.8	10.2	4.1	9.2	6.4	3.5	3.9	1	0.2	1997			
81073	5.5	40.7	14.7	6.6	12.3	5.4	2.7	4.1	1	1998			
93221	26.6	36.8	30.9	5.1	3.8	5.3	2.4	0.5	1.2	1999			
64320	1.6	13.2	13.4	11	3.4	1.1	1	0.4	0	2000			

77541	0.2	6.1	18.6	18.6	10.8	2.1	4.1	1.3	0.3	2001
39996	20.3	20	30.2	16.4	8.2	2.9	2.4	1.4	0.5	2002
73854	0.9	35.9	21.7	9.8	3.3	0.5	0.8	0.2	0.2	2003
72507	9	15.1	4.1	3.2	1.9	1.6	0.3	0.2	0.1	2004
##										
31142	4	1.7	1.6	1.6	0.6	0.1	0	0	0	2005
##										

Please note the 2005 data are based only on Q3 and Q4 data and have not been raised to annual effort.

It should not be included as part of this time-series.

Table 31.9. Sol.27.7a – Diagnostics.

```
FLR XSA Diagnostics 2022-04-22 10:58:04

CPUE data from indices

Catch data for 52 years. 1970 to 2021. Ages 2 to 8.

            fleet first age last age first year last year alpha beta
1 UK (E&W)-BTS-Q3         2        7       1988      2021  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   2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
   year
age  2012  2013  2014  2015  2016  2017  2018  2019  2020  2021
  2 0.021 0.039 0.016 0.009 0.000 0.001 0.001 0.017 0.014 0.014
  3 0.328 0.145 0.098 0.057 0.012 0.012 0.015 0.197 0.120 0.106
  4 0.361 0.245 0.109 0.090 0.039 0.015 0.015 0.233 0.205 0.228
  5 0.369 0.179 0.165 0.067 0.039 0.032 0.012 0.118 0.201 0.299
  6 0.252 0.151 0.081 0.096 0.025 0.017 0.021 0.089 0.093 0.333
  7 0.228 0.098 0.126 0.053 0.046 0.018 0.011 0.185 0.096 0.179
  8 0.228 0.098 0.126 0.053 0.046 0.018 0.011 0.185 0.096 0.179
```

XSA population number (Thousand)

year \ age	2	3	4	5	6	7	8
2012	872	557	1078	935	547	269	593
2013	639	773	363	680	585	384	926
2014	775	556	605	257	514	455	499
2015	1714	690	457	491	197	429	1510
2016	3931	1537	590	378	416	162	763
2017	1755	3556	1374	513	329	367	795
2018	3596	1586	3178	1224	450	293	975
2019	2964	3250	1414	2832	1095	399	510
2020	7051	2636	2414	1014	2277	906	1489
2021	1405	6289	2116	1780	751	1878	1445

Estimated population abundance at 1st Jan 2022

year \ age	2	3	4	5	6	7	8
2022	0	1254	5118	1525	1195	487	1422

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	2004	2005
2	0.035	0.018	0.403	0.501	-0.059	-0.282	0.154	0.168	-0.288	0.090	0.439	-0.156	-0.007	-0.050	-0.910	0.130	0.032	-0.006
3	0.574	0.357	-0.135	-0.302	0.463	-0.283	-0.054	0.285	-0.687	-0.084	0.103	0.002	-0.215	-0.232	-0.235	-0.185	0.410	-0.374
4	-0.008	0.054	-0.254	-0.938	0.438	-0.112	-0.300	0.038	-0.258	-0.178	-0.779	0.313	0.316	-0.495	0.058	0.226	-0.113	-0.227
5	-0.396	-0.030	0.956	-0.623	-0.028	-0.321	0.020	-0.591	-0.229	0.026	-0.767	0.329	-0.122	-0.142	-0.392	0.198	0.439	-0.075
6	-0.240	-0.241	0.295	-0.205	0.166	-0.073	0.538	-0.021	-0.179	-0.159	-0.280	0.351	0.151	-0.094	0.078	0.005	0.040	0.175
7	-0.122	0.087	0.195	-0.185	-0.191	-0.068	0.198	-0.330	-0.142	0.288	0.211	0.194	-0.110	-0.008	-0.009	-0.226	0.360	-0.019

age \ year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	0.268	-0.240	0.011	-0.003	-0.596	-0.166	-0.156	0.290	-0.202	0.248	0.324	-0.178	0.107	0.108	NA	-0.028
3	0.142	0.240	0.020	0.042	-0.117	0.039	-0.256	0.050	-0.151	0.223	0.214	0.011	-0.039	0.191	NA	-0.019
4	-0.102	0.258	0.037	0.200	-0.076	0.375	0.298	0.481	0.370	0.077	0.182	-0.054	0.052	0.285	NA	-0.167
5	0.713	0.261	0.390	0.466	-0.192	0.262	-0.163	0.252	0.356	0.126	0.256	0.097	-0.329	0.162	NA	-0.474
6	0.246	-0.030	0.125	0.369	-0.383	-0.104	-0.453	-0.226	0.214	-0.464	0.331	0.060	0.086	-0.182	NA	-0.130
7	-0.198	-0.021	-0.197	-0.077	-0.517	0.004	0.151	0.305	0.159	-0.177	0.192	-0.560	-0.339	-0.308	NA	-0.349

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	-7.4328	-7.7576	-7.8903	-7.8903	-7.8903	-7.8903
S.E_Logq	0.2924	0.2924	0.2924	0.2924	0.2924	0.2924

```
 Terminal year survivor and F summaries:

 Age 2 Year class =2019

source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.961      1220  2019
fshk                0.039      2493  2019

 Age 3 Year class =2018

source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.957      5024  2018
fshk                0.043      7762  2018

 Age 4 Year class =2017

source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.943      1290  2017
fshk                0.057      3653  2017

 Age 5 Year class =2016

source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.915       744  2016
fshk                0.085      4961  2016

 Age 6 Year class =2015

source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.947       428  2015
fshk                0.053      3828  2015

 Age 7 Year class =2014

source
                scaledWts survivors yrcls
UK (E&W)-BTS-Q3     0.954      1003  2014
fshk                0.046       835  2014
```

Table 31.10. Sol.27.7a - Fishing mortality.

year/age	2	3	4	5	6	7	8+	F_{bar}(4–7)
1970	0.008	0.12	0.296	0.444	0.429	0.391	0.391	0.39
1971	0.012	0.148	0.399	0.554	0.367	0.441	0.441	0.44
1972	0.01	0.081	0.352	0.506	0.493	0.452	0.452	0.451
1973	0.03	0.144	0.362	0.439	0.487	0.431	0.431	0.43
1974	0.004	0.085	0.316	0.472	0.544	0.445	0.445	0.444
1975	0.042	0.157	0.303	0.485	0.397	0.396	0.396	0.395
1976	0.008	0.07	0.419	0.482	0.379	0.428	0.428	0.427
1977	0.015	0.135	0.326	0.407	0.375	0.37	0.37	0.37
1978	0.008	0.074	0.287	0.404	0.382	0.358	0.358	0.358
1979	0.013	0.143	0.364	0.632	0.426	0.476	0.476	0.475
1980	0.04	0.134	0.393	0.567	0.949	0.639	0.639	0.637
1981	0.017	0.149	0.329	0.511	0.603	0.483	0.483	0.481
1982	0.003	0.095	0.477	0.408	0.437	0.442	0.442	0.441
1983	0.007	0.081	0.384	0.532	0.392	0.438	0.438	0.436
1984	0.045	0.181	0.243	0.38	0.433	0.353	0.353	0.352
1985	0.01	0.134	0.361	0.321	0.328	0.337	0.337	0.337
1986	0.006	0.276	0.422	0.553	0.338	0.439	0.439	0.438
1987	0.059	0.181	0.566	0.763	1.26	0.868	0.868	0.864
1988	0.01	0.172	0.371	0.563	0.734	1.112	1.112	0.695
1989	0.044	0.3	0.451	0.539	0.633	0.704	0.704	0.582
1990	0.113	0.4	0.682	0.666	0.616	0.676	0.676	0.66
1991	0.116	0.353	0.487	0.399	0.503	0.645	0.645	0.508
1992	0.08	0.289	0.413	0.613	0.42	0.69	0.69	0.534
1993	0.014	0.149	0.355	0.422	0.548	0.925	0.925	0.563
1994	0.025	0.296	0.43	0.476	0.527	0.559	0.559	0.498
1995	0.072	0.235	0.527	0.526	0.563	0.428	0.428	0.511
1996	0.026	0.346	0.475	0.5	0.591	0.547	0.547	0.528
1997	0.105	0.418	0.62	0.515	0.503	0.765	0.765	0.601
1998	0.026	0.311	0.468	0.716	0.4	0.412	0.412	0.499
1999	0.062	0.206	0.348	0.546	0.734	0.268	0.268	0.474
2000	0.027	0.241	0.241	0.247	0.519	0.847	0.847	0.464
2001	0.057	0.284	0.319	0.273	0.307	0.513	0.513	0.353
2002	0.069	0.29	0.527	0.469	0.325	0.22	0.22	0.385
2003	0.163	0.582	0.489	0.471	0.315	0.175	0.175	0.363
2004	0.091	0.488	0.449	0.308	0.294	0.208	0.208	0.315
2005	0.212	0.459	0.703	0.686	0.416	0.425	0.425	0.557
2006	0.093	0.396	0.506	0.456	0.603	0.32	0.32	0.471
2007	0.101	0.422	0.326	0.318	0.314	0.404	0.404	0.341
2008	0.055	0.279	0.372	0.274	0.311	0.308	0.308	0.316

year/age	2	3	4	5	6	7	8+	F_{bar}(4–7)
2009	0.044	0.302	0.409	0.48	0.268	0.396	0.396	0.388
2010	0.015	0.199	0.248	0.352	0.362	0.205	0.205	0.292
2011	0.029	0.181	0.342	0.267	0.295	0.511	0.511	0.354
2012	0.021	0.328	0.361	0.369	0.252	0.228	0.228	0.303
2013	0.039	0.145	0.245	0.179	0.151	0.098	0.098	0.168
2014	0.016	0.098	0.109	0.165	0.081	0.126	0.126	0.12
2015	0.009	0.057	0.09	0.067	0.096	0.053	0.053	0.076
2016	0	0.012	0.039	0.039	0.025	0.046	0.046	0.037
2017	0.001	0.012	0.015	0.032	0.017	0.018	0.018	0.02
2018	0.001	0.015	0.015	0.012	0.021	0.011	0.011	0.015
2019	0.017	0.197	0.233	0.118	0.089	0.185	0.185	0.156
2020	0.014	0.12	0.205	0.201	0.093	0.096	0.096	0.149
2021	0.014	0.106	0.228	0.299	0.333	0.179	0.179	0.259

Table 31.11. Sol.27.7a - Stock numbers-at-age (start of year, in thousands).

year/age	2	3	4	5	6	7	8+	Total
1970	3695	8349	4145	1368	4389	939	8212	31097
1971	10177	3316	6703	2791	794	2585	5534	31900
1972	3186	9101	2588	4071	1451	498	4321	25214
1973	13133	2853	7595	1647	2221	802	3418	31667
1974	5870	11533	2236	4784	960	1234	2829	29446
1975	6679	5288	9588	1475	2699	504	3220	29455
1976	3857	5795	4087	6406	822	1642	2221	24830
1977	15772	3462	4887	2432	3581	509	2192	32835
1978	9040	14060	2737	3193	1464	2227	2042	34763
1979	8847	8118	11811	1859	1930	905	1713	35184
1980	5070	7902	6369	7423	894	1140	2536	31334
1981	4496	4410	6257	3889	3808	313	2365	25538
1982	2460	4002	3438	4074	2111	1886	1163	19134
1983	5556	2218	3292	1930	2452	1234	2094	18775
1984	15457	4992	1850	2029	1026	1498	1962	28815
1985	16223	13367	3769	1313	1256	602	2703	39234
1986	23690	14533	10573	2378	862	819	2497	55353
1987	3454	21302	9978	6271	1238	556	1453	44253
1988	3490	2946	16091	5125	2645	318	800	31415
1989	4366	3128	2244	10043	2640	1149	527	24096
1990	5547	3780	2097	1293	5303	1268	992	20279
1991	12650	4482	2293	959	601	2592	1008	24585
1992	4943	10195	2848	1275	582	329	1945	22117
1993	6174	4128	6912	1705	625	346	1185	21075
1994	5230	5508	3219	4385	1011	327	1282	20962
1995	2004	4616	3706	1895	2466	540	1051	16278
1996	2493	1687	3302	1980	1014	1270	862	12609
1997	8338	2199	1081	1858	1087	508	1039	16108
1998	6849	6793	1310	526	1004	595	1312	18389
1999	5230	6038	4503	742	233	609	1036	18391
2000	6943	4446	4446	2877	389	101	470	19672
2001	4543	6114	3161	3160	2032	209	709	19927
2002	2328	3882	4164	2078	2177	1353	1153	17135
2003	3052	1966	2628	2224	1176	1423	2252	14721
2004	3632	2346	994	1459	1256	776	1007	11470
2005	2945	3002	1303	574	970	847	1113	10754
2006	1318	2155	1716	584	262	579	1450	8063
2007	1863	1086	1313	936	335	130	938	6600

year/age	2	3	4	5	6	7	8+	Total
2008	1949	1523	644	857	616	221	827	6638
2009	2263	1670	1043	402	590	408	519	6895
2010	1602	1961	1117	627	225	408	894	6834
2011	633	1428	1454	789	399	142	319	5164
2012	872	557	1078	935	547	269	593	4850
2013	639	773	363	680	585	384	926	4350
2014	775	556	605	257	514	455	499	3662
2015	1714	690	457	491	197	429	1510	5489
2016	3931	1537	590	378	416	162	763	7776
2017	1755	3556	1374	513	329	367	795	8688
2018	3596	1586	3178	1224	450	293	975	11302
2019	2964	3250	1414	2832	1095	399	510	12463
2020	7051	2636	2414	1014	2277	906	1489	17787
2021	1405	6289	2116	1780	751	1878	1445	15664

Table 31.12. Sol.27.7a – Summary.

year	recruits	tsb	ssb	landings	Y/ssb	fbar4-7
1970	3695	7132	6436	1785	0.280	0.390
1971	10177	7406	6222	1882	0.300	0.440
1972	3186	5727	5011	1450	0.290	0.451
1973	13133	6553	5123	1428	0.280	0.430
1974	5870	6189	5068	1307	0.260	0.444
1975	6679	6229	5359	1441	0.270	0.395
1976	3857	5501	4889	1463	0.300	0.427
1977	15772	5509	4490	1147	0.260	0.370
1978	9040	6244	5092	1106	0.220	0.358
1979	8847	6887	5684	1614	0.280	0.475
1980	5070	6429	5513	1941	0.350	0.637
1981	4496	5908	5165	1667	0.320	0.481
1982	2460	4745	4330	1338	0.310	0.441
1983	5556	4916	4095	1169	0.290	0.436
1984	15457	6783	4601	1058	0.230	0.352
1985	16223	7849	5635	1146	0.200	0.337
1986	23690	9503	6944	1995	0.290	0.438
1987	3454	8538	7148	2808	0.390	0.864
1988	3490	5975	5498	1999	0.360	0.695
1989	4366	5156	4609	1833	0.400	0.582
1990	5547	4262	3603	1583	0.440	0.660
1991	12650	4450	3165	1212	0.380	0.508
1992	4943	4434	3430	1259	0.370	0.534
1993	6174	3840	3212	1023	0.320	0.563
1994	5230	4951	4023	1374	0.340	0.498
1995	2004	3934	3493	1266	0.360	0.511
1996	2493	3057	2689	1002	0.370	0.528
1997	8338	3420	2480	1003	0.400	0.601
1998	6849	4216	2998	911	0.300	0.499
1999	5230	4287	3288	863	0.260	0.474
2000	6943	3883	3097	818	0.260	0.464
2001	4543	4276	3531	1053	0.300	0.353
2002	2328	3980	3539	1090	0.310	0.385
2003	3052	3573	3174	1014	0.320	0.363
2004	3632	2754	2274	709	0.310	0.315
2005	2945	2493	2055	855	0.420	0.557
2006	1318	1872	1623	569	0.350	0.471
2007	1863	1640	1383	492	0.360	0.341

year	recruits	tsb	ssb	landings	Y/ssb	fbar4-7
2008	1949	1571	1320	332	0.250	0.316
2009	2263	1341	1069	325	0.300	0.388
2010	1602	1451	1190	277	0.230	0.292
2011	633	1249	1091	330	0.300	0.354
2012	872	1283	1150	298	0.260	0.303
2013	639	1191	1081	148	0.140	0.168
2014	775	955	866	99	0.110	0.120
2015	1714	1492	1284	76	0.060	0.076
2016	3931	1594	1189	35	0.030	0.037
2017	1755	2193	1794	34	0.020	0.020
2018	3596	2955	2494	36	0.010	0.015
2019	2964	3207	2703	400	0.150	0.156
2020	7051	3997	3298	404	0.120	0.149
2021	1405	3879	3385	629	0.190	0.259

Table 31.13. Sole in 7.a - Input for catch forecast and F_{MSY} analysis.

Input:	**F 2022: TAC constraint for 2022 (projected landings 2022: 696 t)**
	F 2023–2024: mean 19–21 scaled to 2021
	Catch and stock weights are mean 19–21
	Recruits age 2 in 2022–2024 GM(12–20)

2022								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	1937	0.1	0.38	0	0	0.134	0.0174	0.18
3	1254	0.1	0.71	0	0	0.2	0.1627	0.222
4	5118	0.1	0.97	0	0	0.247	0.2559	0.269
5	1525	0.1	0.98	0	0	0.306	0.2377	0.328
6	1195	0.1	1	0	0	0.356	0.198	0.364
7	487	0.1	1	0	0	0.385	0.1768	0.357
+gp	2515	0.1	1	0	0	0.404	0.1768	0.392
FBAR 4–7							0.2171	

2023								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	1937	0.1	0.38	0	0	0.134	0.0208	0.18
3	1723	0.1	0.71	0	0	0.2	0.1944	0.222
4	964	0.1	0.97	0	0	0.247	0.3058	0.269
5	3585	0.1	0.98	0	0	0.306	0.2841	0.328
6	1088	0.1	1	0	0	0.356	0.2367	0.364
7	887	0.1	1	0	0	0.385	0.2113	0.357
+gp	2276	0.1	1	0	0	0.404	0.2113	0.392
FBAR 4–7							0.2595	

2023								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	1937	0.1	0.38	0	0	0.134	0.0208	0.18
3	1723	0.1	0.71	0	0	0.2	0.1944	0.222
4	964	0.1	0.97	0	0	0.247	0.3058	0.269
5	3585	0.1	0.98	0	0	0.306	0.2841	0.328
6	1088	0.1	1	0	0	0.356	0.2367	0.364
7	887	0.1	1	0	0	0.385	0.2113	0.357
+gp	2276	0.1	1	0	0	0.404	0.2113	0.392
FBAR 4–7							0.2595	

Table 31.14. Sol.27.7a - Management option table.

F 2022: TAC constraint for 2022 (projected landings 2022: 696 t)
F 2023–2024: mean 19–21 scaled to 2021
Catch and stock weights are mean 19–21
Recruits age 2 in 2022–2024 GM(12–20)
F_{bar} age range: 4–7

2022				
SSB	F_{Mult}	F_{bar}	Landings	
3588	0.8	0.217	696	
2023				2024
SSB	F_{Mult}	F_{bar}	Landings	SSB
3299	0.0	0.000	0	3674
3299	0.1	0.026	79	3593
3299	0.2	0.052	157	3514
3299	0.3	0.078	232	3437
3299	0.4	0.104	306	3361
3299	0.5	0.130	378	3288
3299	0.6	0.156	448	3217
3299	0.7	0.182	517	3147
3299	0.8	0.208	584	3079
3299	0.9	0.234	649	3012
3299	1.0	0.259	712	2948
3299	1.1	0.285	775	2885
3299	1.2	0.311	835	2823
3299	1.3	0.337	895	2763
3299	1.4	0.363	952	2704
3299	1.5	0.389	1009	2647
3299	1.6	0.415	1064	2591
3299	1.7	0.441	1118	2537
3299	1.8	0.467	1170	2483
3299	1.9	0.493	1222	2432
3299	2.0	0.519	1272	2381

Input units are thousands and kg - output in tonnes.

Basis	**Catch_ 2023**	**Landings_ 2023**	**Discards_ 2023**	**Fbar_ 2023**	**SSB_ 2024**	**SSB_ change**	**TAC_ change**	**Advice_ change**
F_{MSY}_rescal	605	535	70	0	3129	-5.2	-23	-23
F_{MSY} _lower_rescal	492	435	57	0.151	3230	-2.1	-37	-37
F_0	0	0	0	0	3674	11.4	-100	-100
F_{pa}	695	615	81	0.22	3047	-7.6	-11.6	-11.6
F_{lim}	888	786	103	0.29	2874	-12.9	12.9	12.9
B_{lim}	1305	1154	151	0.46	2500	-24	66	66
B_{pa}	192	170	22	0.056	3500	6.1	-76	-76
F_{int}	687	608	80	0.22	3054	-7.4	-12.7	-12.7
$B_{intplus1}$	415	367	48	0.126	3299	0	-47	-47
F_{MSY} _lower	520	460	60	0.16	3205	-2.9	-34	-34
F_{MSY}	638	564	74	0.2	3099	-6.1	-18.9	-18.9
F_{MSY} _upper	752	665	87	0.24	2996	-9.2	-4.5	-4.5

Table 31.15. Sol.27.7a - Detailed output of the short-term forecast (MSY approach: F = F_{MSY} × SSB_{2023}/MSY $B_{trigger}$). Input units are thousands and kg - output in tonnes.

Year:	2022						
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
2	0.01736	32	6	1937	259	736	98
3	0.16266	179	40	1254	251	890	178
4	0.25588	1102	296	5118	1262	4964	1225
5	0.23766	308	101	1525	467	1494	458
6	0.19804	205	74	1195	426	1195	426
7	0.17678	75	27	487	187	487	187
8	0.17678	388	152	2515	1017	2515	1017
Total		2289	696	14030	3869	12282	3588
F_{bar}4–7	0.21709						

Year:	2023						
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
2	0.01508	28	5	1937	259	736	98
3	0.14125	216	48	1723	345	1223	245
4	0.22219	183	49	964	238	935	231
5	0.20638	637	209	3585	1098	3514	1076
6	0.17197	164	60	1088	388	1088	388
7	0.15351	120	43	887	341	887	341
8	0.15351	309	121	2276	920	2276	920
Total		1657	535	12460	3588	10659	3299
F_{bar}4–7	0.18851						

Year:	2024						
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
2	0.01508	28	5	1937	259	736	98
3	0.14125	217	48	1727	345	1226	245
4	0.22219	257	69	1353	334	1313	324
5	0.20638	124	41	699	214	685	210
6	0.17197	397	145	2639	940	2639	940
7	0.15351	112	40	829	319	829	319
8	0.15351	333	130	2455	992	2455	992
Total		1468	478	11638	3404	9882	3129
F_{bar}4–7	0.18851						

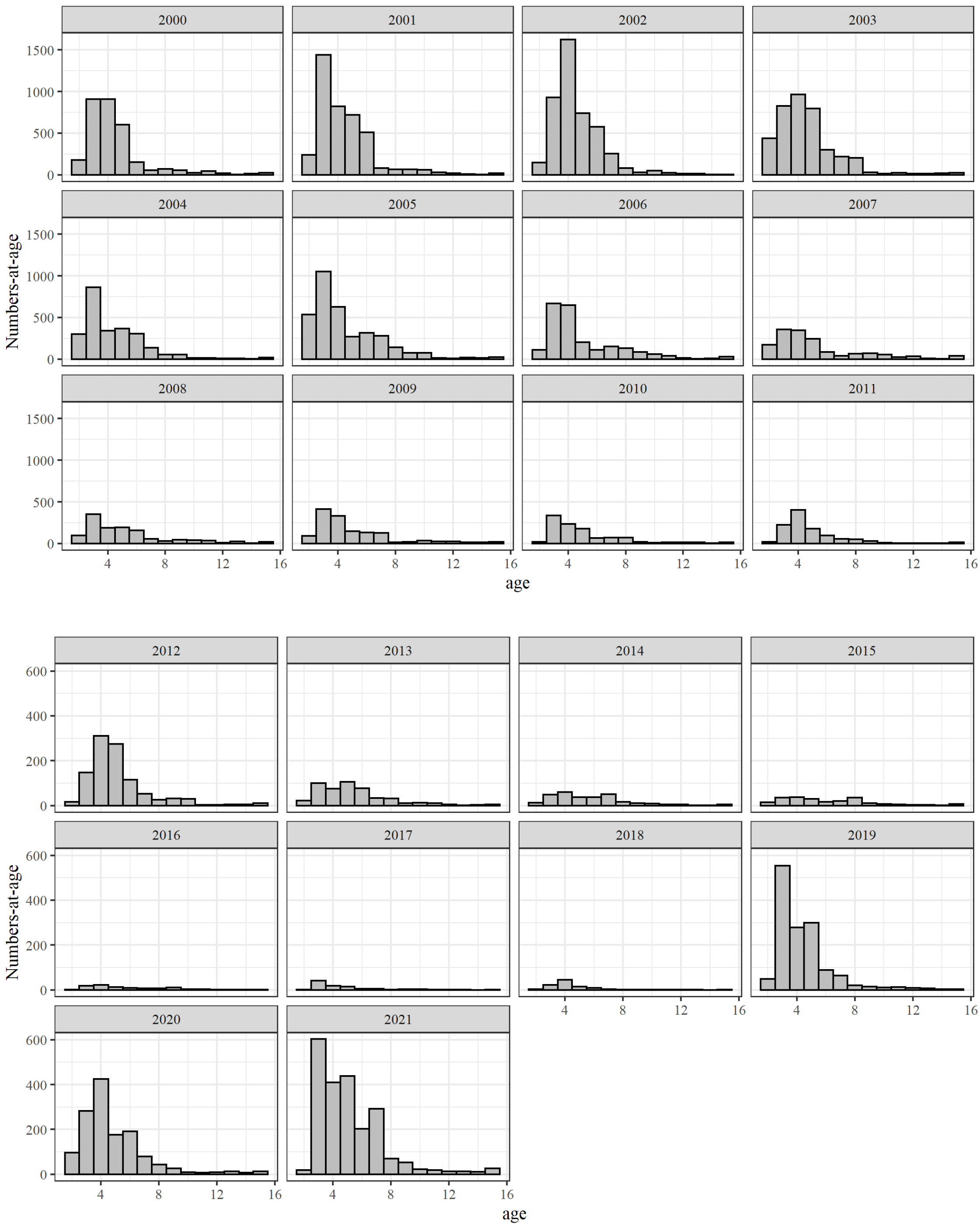

Figure 31.1a. Sol.27.7a - Age composition of landings.

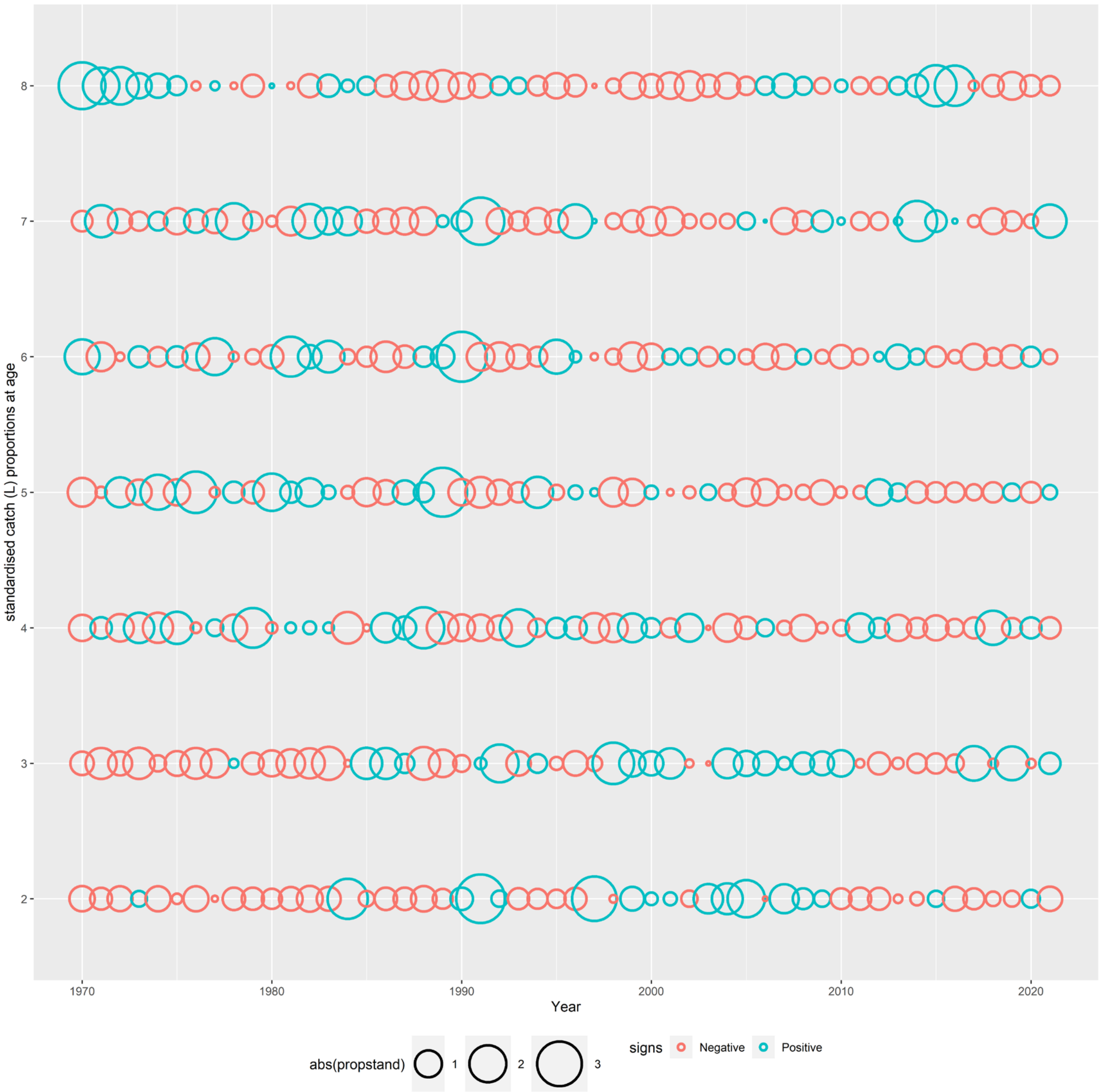

Figure 31.2. Sol.27.7a - Standardized landings proportion.

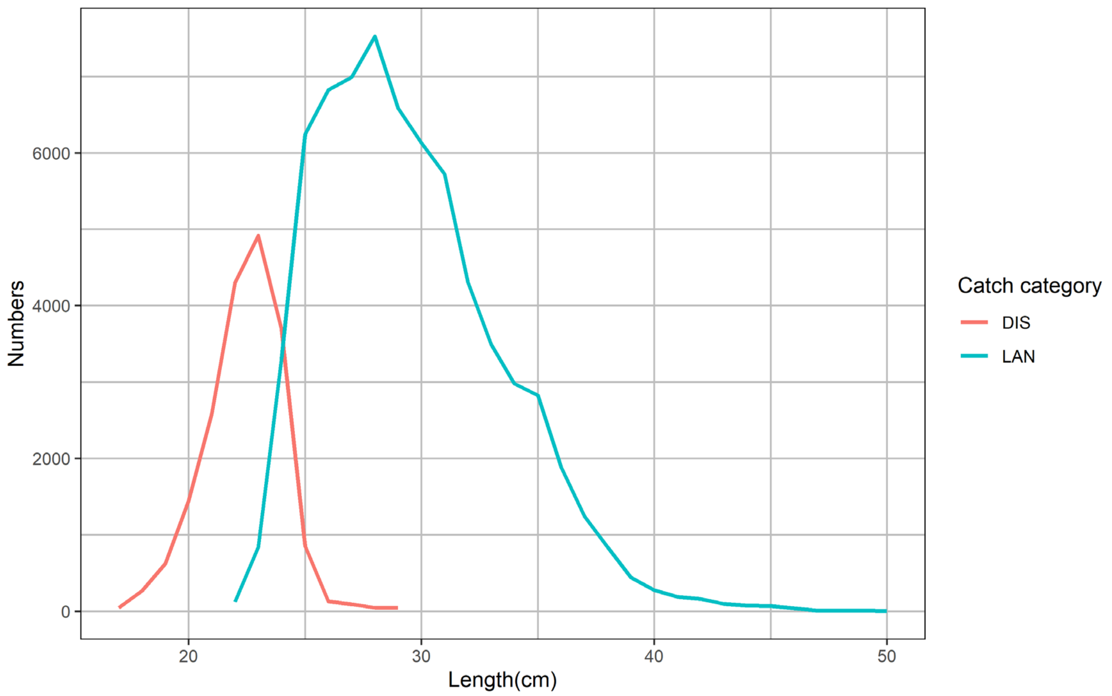

Figure 31.3.- Sol.27.7a - BE Length distributions of discarded and retained fish from discard sampling studies (Beam trawl).

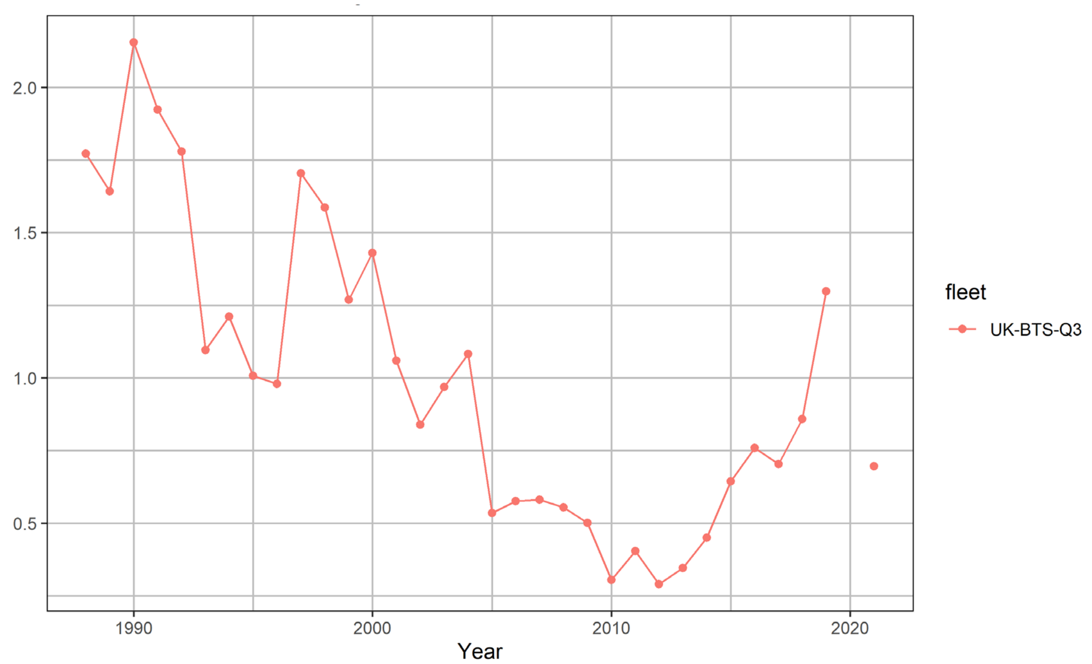

Figure 31.4. Figure 31.4 Sole in 7.a - Mean standardised LPUE (kg/100 Km fished) for the UK (E&W) September beam-trawl survey (UK(E&W)-BTS-Q3).

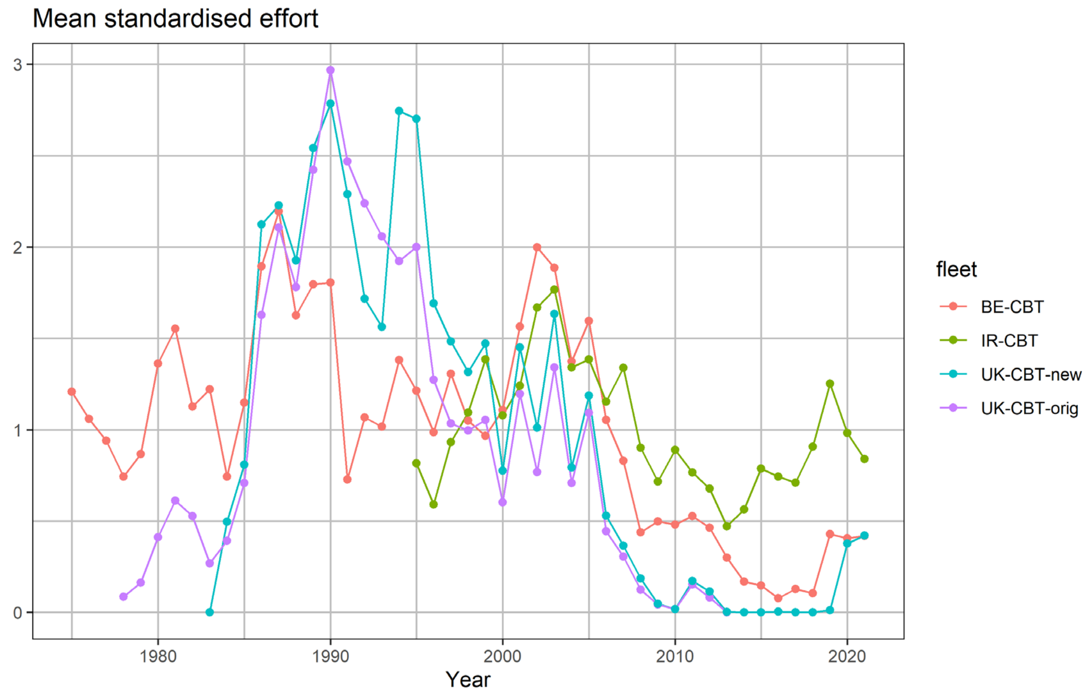

Figure 31.5b. Sole in 7.a - Mean standardised effort and LPUE for the commercial otter trawl fleets.

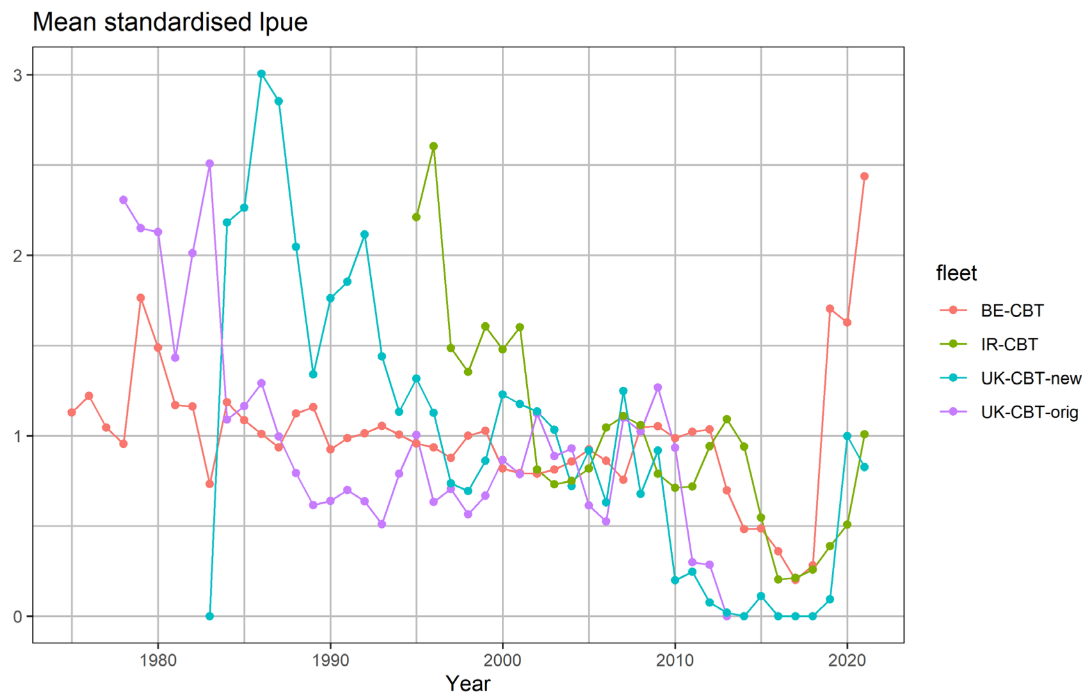

Figure 31.5. Sole in 7.a - Mean standardised effort and LPUE for the commercial beam trawl fleets.

LPUE: BE-CBT and IR-CBT: Kg/hr; UK-CBT-new: Kg/day; UK-CBT-orig: Kg/000'hr fished (GRT corrected >40' vessels).

EFFORT: BE-CBT: 000' hours fishing; IR-CBT: 000'hours; UK-CBT-new: days fished; UK-CBT-orig: 000'hours fished (GRT corrected >40' vessels).

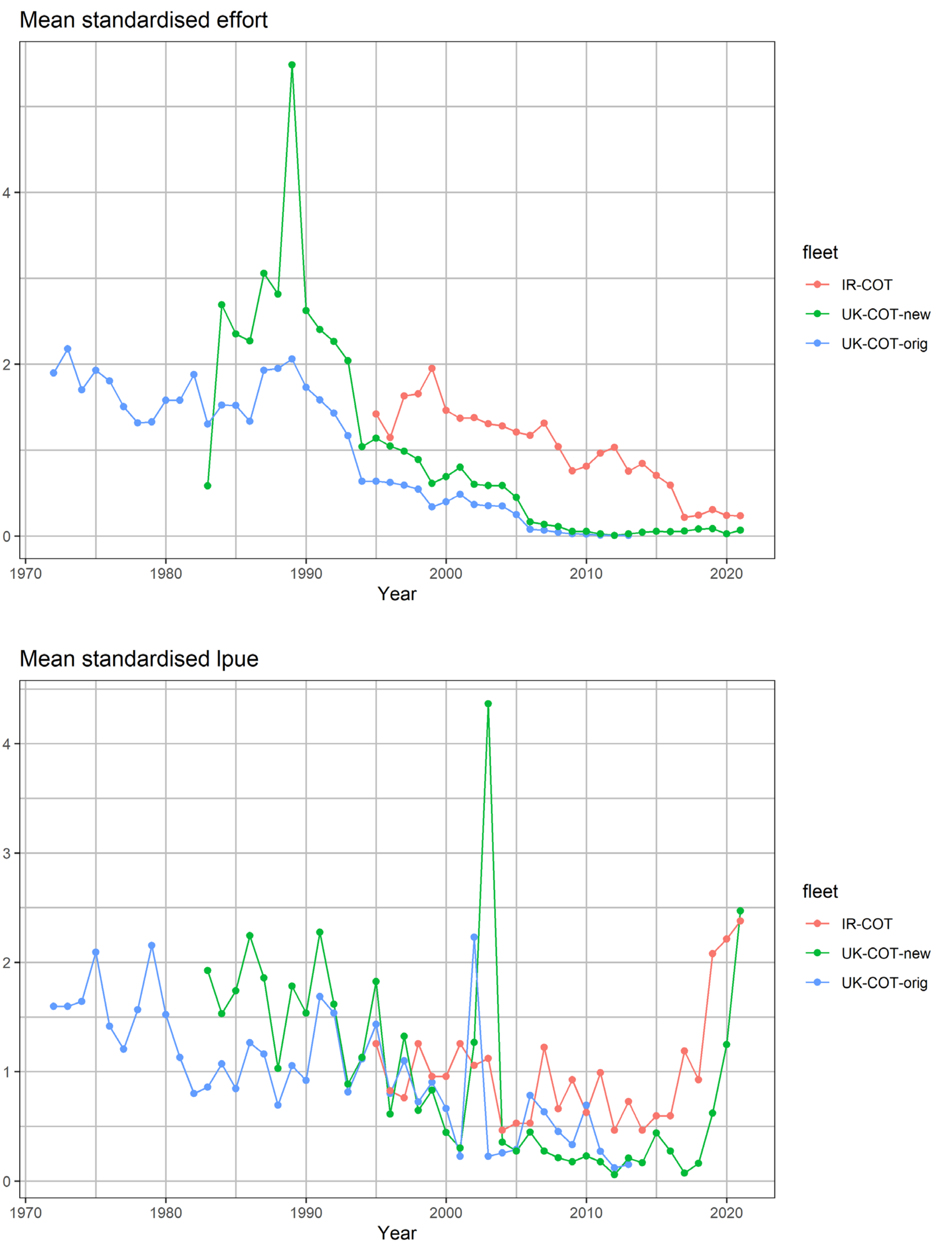

Figure 31.6. Sole in 7.a - Mean standardised effort and LPUE for the commercial otter trawl fleets.

LPUE: IR-COT: Kg/hr; UK-COT-new: Kg/day; UK-COT-orig: Kg/000'hr fished (GRT corrected >40' vessels).

EFFORT: IR-CBT: 000'hours; UK-CBT-new: days fished; UK-CBT-orig: 000'hours fished (GRT corrected >40' vessels).

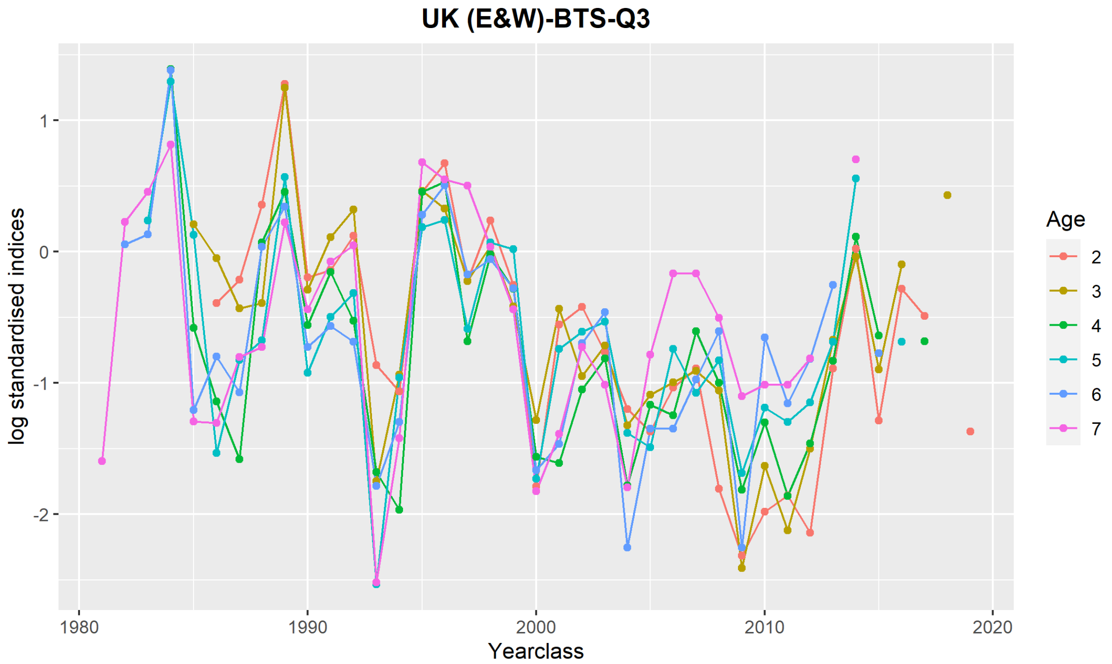

Figure 31.7. Sol.27.7.a - Mean-standardised indices.

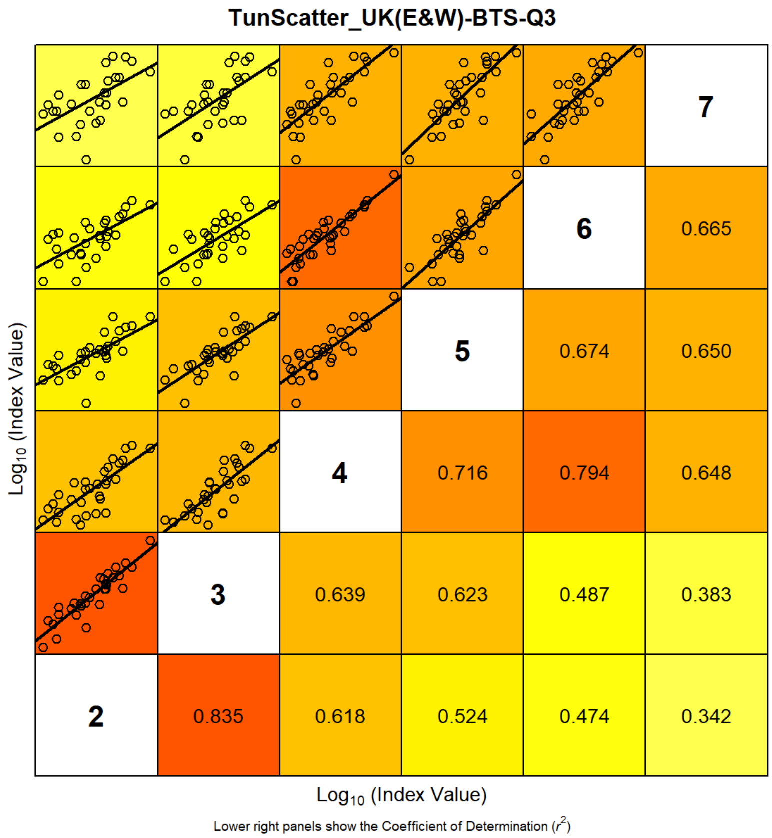

Figure 31.8. Sol.27.7a - Consistency plot UK(E&W)-BTS-Q3 survey.

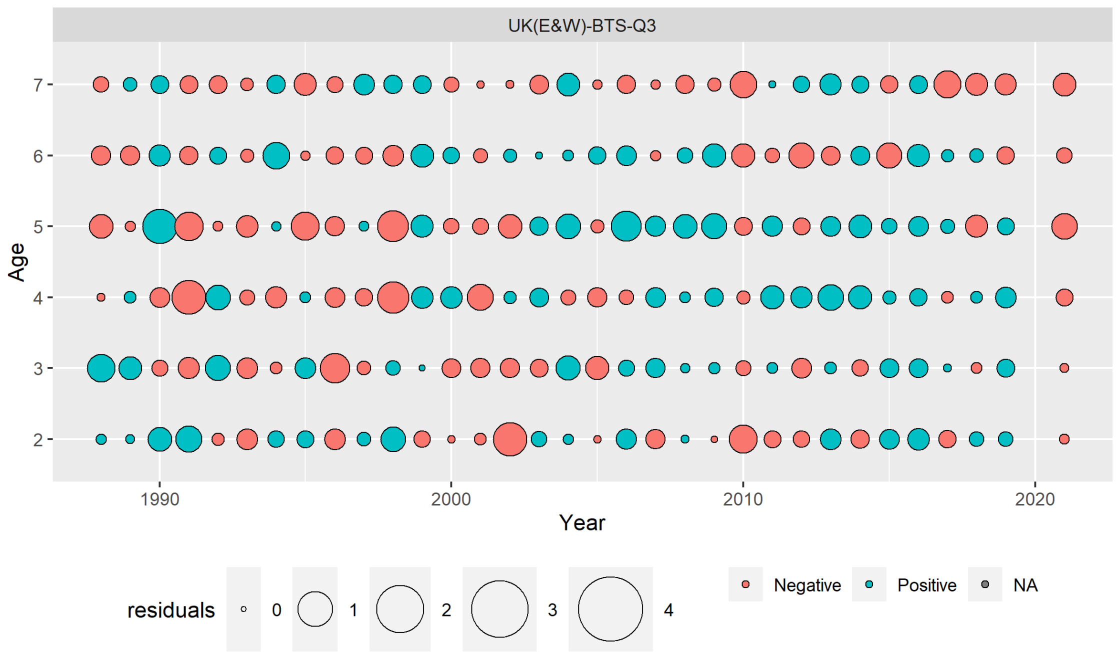

Figure 31.9. Sol.27.7a - Log catchability residual plot - Final XSA.

Figure 31.10. Sol.27.7a - Summary plots.

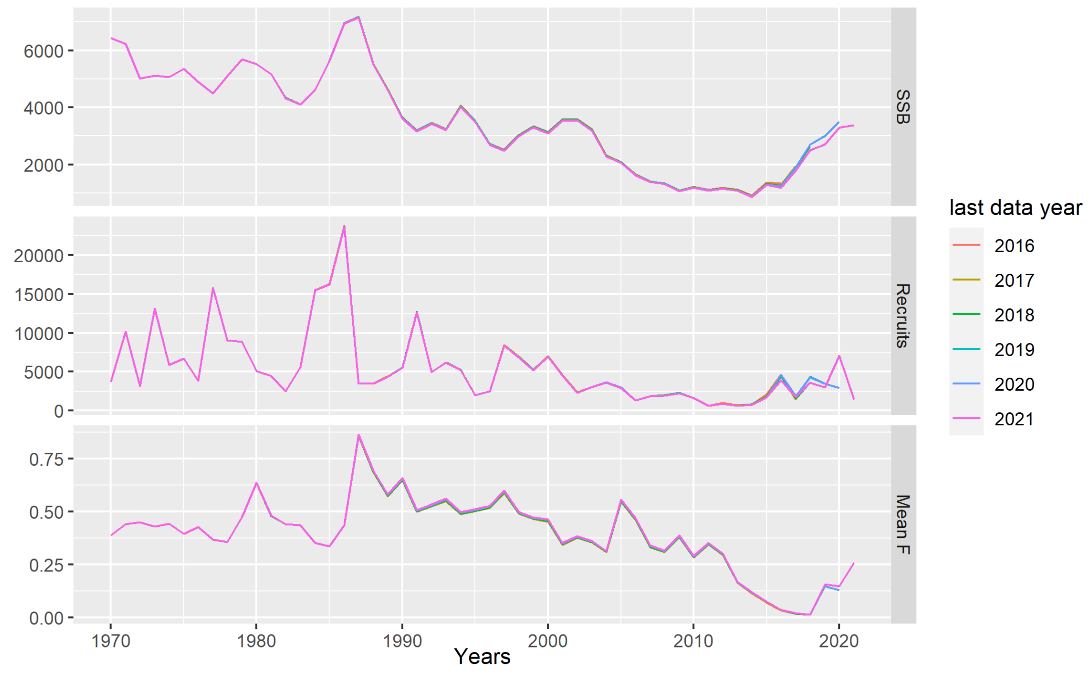

Figure 31.11. Sol.27.7a - Retrospective XSA analysis (shrinkage SE=1.5).

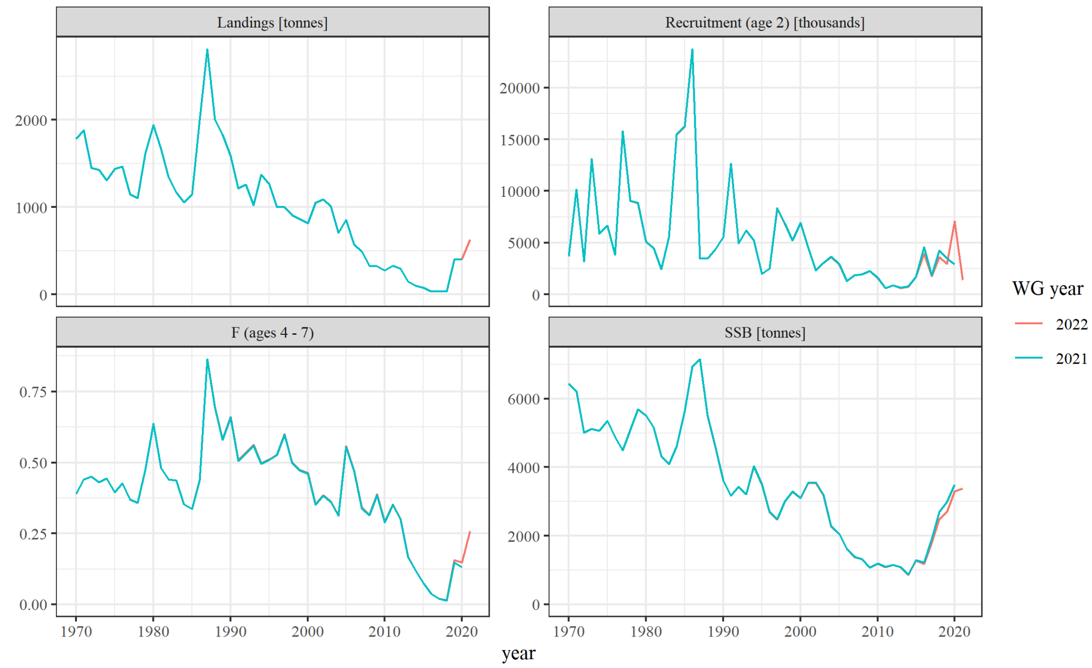

Figure 31.12. - Sol.27.7a - comparison with last year's assessment.

Figure 31.13. Sol.27.7a - Options for the intermediate year in the short-term forecast.

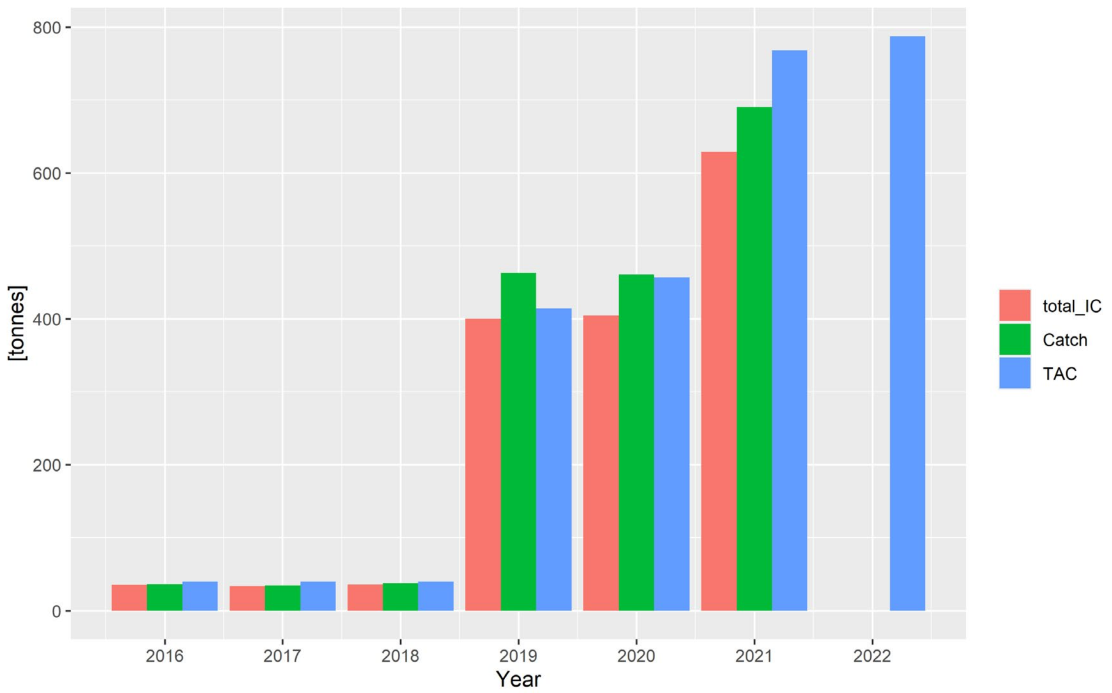

Figure 31.14. Sol.27.7a - Comparison of international TAC, catch and landings.

Figure 31.15. Sol.27.7a - Output for the short-term forecast under the MSY approach (MSY approach: F = F_{MSY} × SSB_{2023}/MSY $B_{trigger}$ = 0.189).

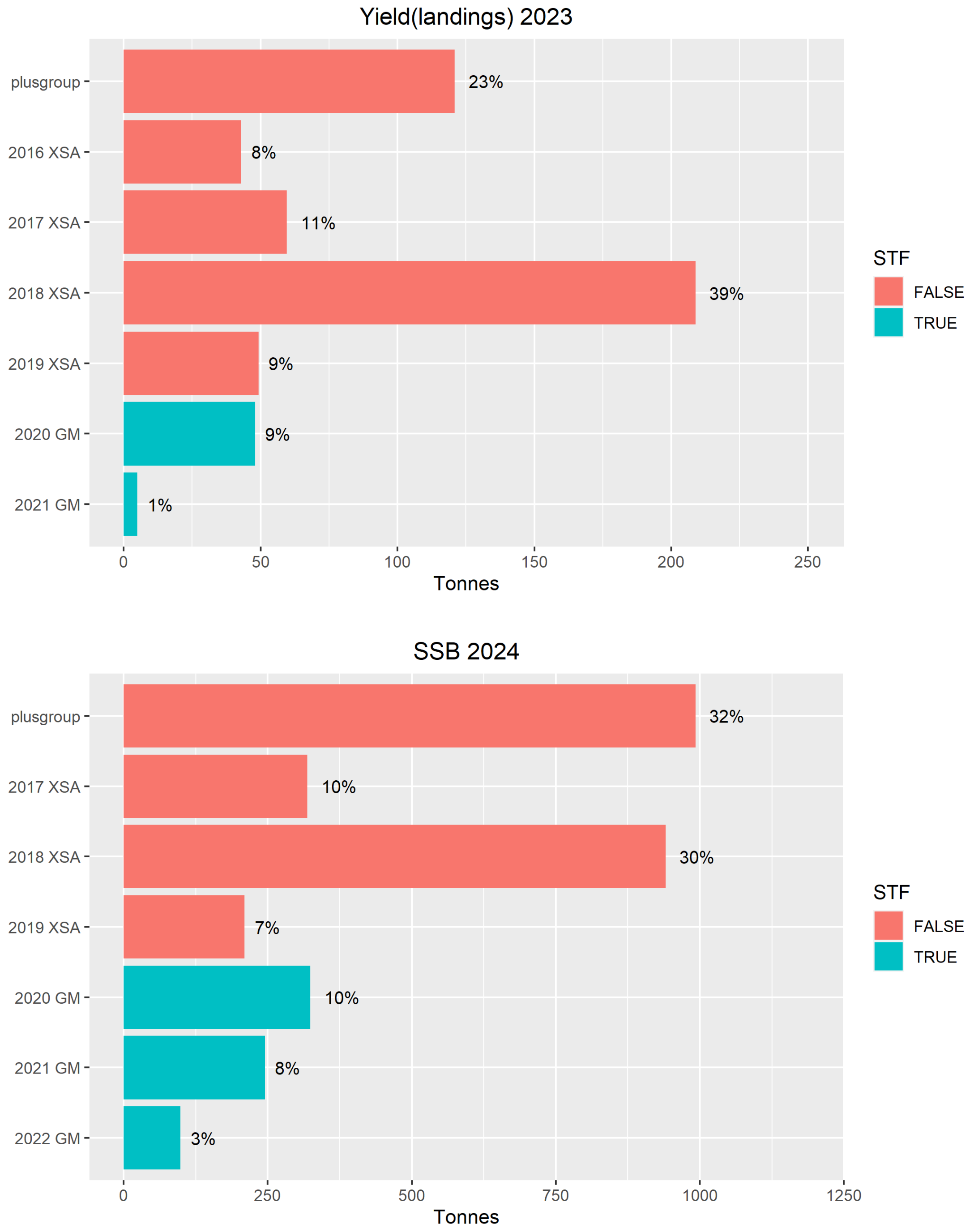

Figure 31.16. Sol.27.7a - Year-class sources and contributions for the short-term forecast (MSY approach: F = F_{MSY} × SSB_{2023}/MSY $B_{trigger}$ = 0.189).

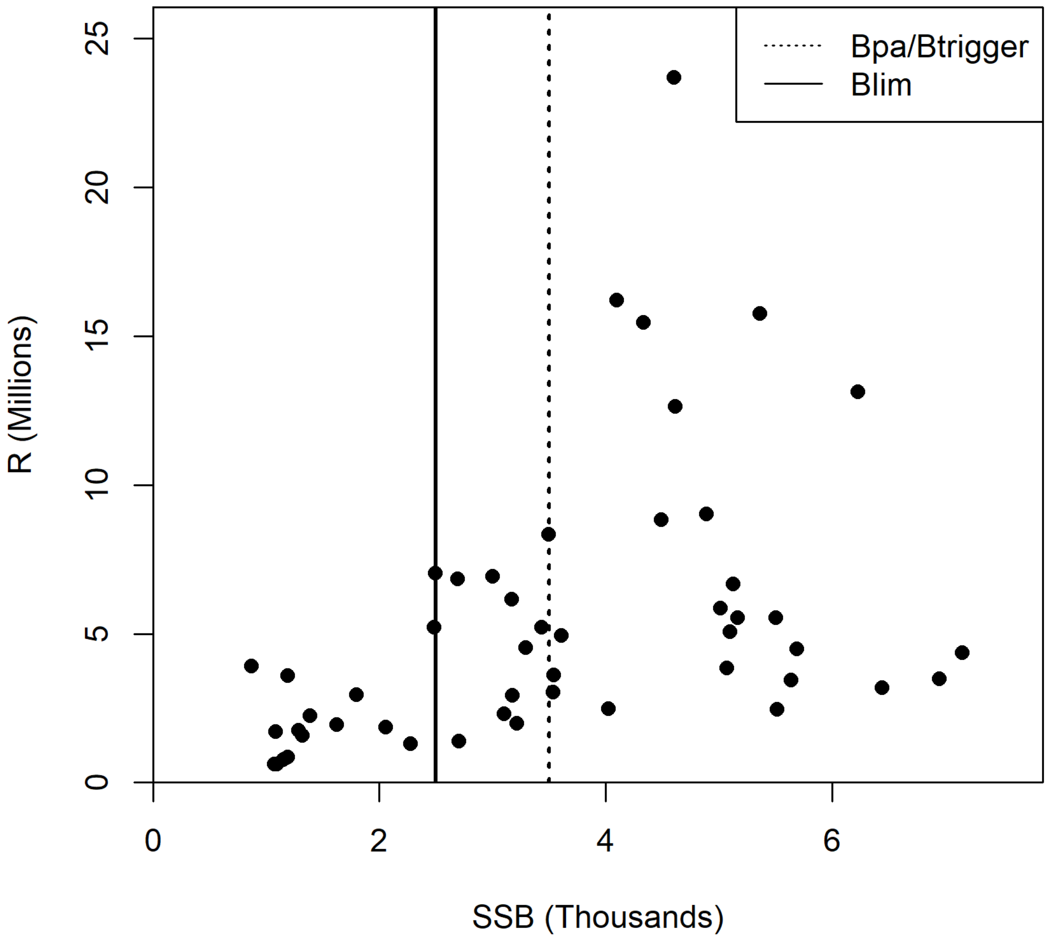

Figure 31.17. Sol.27.7a – Stock–recruitment plot.

32 Sole (*Solea solea*) in Division 7.e (western English Channel)

Type of assessment in 2021

Last year's assessment report is available at:

https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2021/WGCSE_publication%20with%20multiple%20files/WGCSE2021_32%20Sole%207e.pdf

ICES advice applicable to 2022

Last year's advice is available at https://doi.org/10.17895/ices.advice.7862 and stated:

ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 1810 tonnes.

32.1 Impact of the COVID-19 pandemic

The sole in Division 7.e stock, its fishery, and data sampling were largely unaffected by the implications of the COVID-19 pandemic in 2021.

32.2 ICES Transparent Assessment Framework

The Division 7.e sole stock is included in the ICES Transparent Assessment Framework (TAF, https://taf.ices.dk, https://github.com/ices-taf). All WGCSE assessments since 2018 are available from the ICES TAF GitHub page (https://github.com/ices-taf/2018_sol.27.7e, https://github.com/ices-taf/2019_sol.27.7e, https://github.com/ices-taf/2020_sol.27.7e_assessment; please note, access to these repositories is so far restricted to ICES and members of WGCSE). The current WGCSE 2022 assessment is available from https://github.com/ices-taf/2022_sol.27.7e_assessment.

All changes since last year's assessment can be accessed with the following link: https://github.com/ices-taf/2022_sol.27.7e_assessment/compare/8331f09...main.

The TAF repository includes all input data, R scripts for processing data, preparing and running the stock assessment and forecast, and scripts for creating all figures and tables presented in this report. This repository also contains documentation on how to reproduce the WGCSE assessment for sole.

32.3 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 32.1.

Official landings in 2021 were 1395 t, a 28% undershoot of the 2021 TAC (1925 t).

The TAC and the national quotas by country for 2021

Species	**Sole** *Solea solea*	**Zone:**	**7e** (Sol/07E.)
Belgium	63		Analytical TAC
France	671		
Union	733		
United Kingdom	1 175		
TAC	1 925		

(Source: Council Regulation (EU) 2021/1239, EU, 2021).

The TAC and the national quotas by country for 2022

Species	**Sole** *Solea solea*	**Zone:**	**7e** (Sol/07E.)
Belgium	59		Analytical TAC
France	631		
Union	690		
United Kingdom	1 111		
TAC	1 810		

(Source: Council Regulation (EU) 2022/515, EU, 2022).

Maximum number of days a vessel may be present within the area by category of regulated gear per year for 2022

Regulated gear	Maximum number of days	
Beam trawls of mesh size ≥ 80 mm	BE	176
	FR	188
Static nets with mesh size ≤ 220 mm	BE	176
	FR	191

(Source: Council Regulation (EU) 2022/515, ANNEX III, EU, 2022).

Landing obligation

As of 2020, the EU landing obligation fully applied to sole in Division 7.e. However, a de minimis exemption allows up to 3% of total annual catches to be discarded for trammel and gillnets and beam trawls with mesh size 80–119 mm with a Flemish panel (Commission Delegated Regulation (EU) 2020/2015, EU, 2020).

A landing obligation also applies in UK waters and includes a *de minimis* exemption for sole for trammel and gillnets (MMO, 2020a) and beam trawls with a Flemish panel (MMO, 2020b).

However, the UK landing obligation specifies the de minimis exemption as a "small percentage of the total catch" without specifying a value.

The EU landing obligation was phased in between 2016–2019 (Commission Delegated Regulations (EU) 2015/2438, 2016/2375, 2018/46, EU, 2015, 2016, 2018). During the phasing in, the landing obligation applied to all catches of sole in 7.e with trammel and gillnets (gear codes GNS, GN, GND, GNC, GTN, GTR, GEN) and all beam trawls. However, a *de minimis* exemption applied, allowing up to 3% discards of annual catches for all trammel and gillnets and for beam trawls with a mesh size of 80–199 mm with increased selectivity. In 2016, the first year of the application, the landing obligation applied only to vessels for which the total landings consisted of more than 10% sole during two reference years (2013 and 2014, Commission Delegated Regulation (EU) 2015/2438, EU, 2015). This threshold was tightened for 2017, and the landing obligation applied to vessels landing more than 5% in the reference years 2014 and 2015 (Commission Delegated Regulation (EU) 2016/2375, EU, 2016). Subsequently, this restriction was lifted altogether, and for 2018 (Commission Delegated Regulation (EU) 2018/46, EU, 2018), the landing obligation applied to all vessels using trammel and gillnets and beam trawls, as described above.

Given the low discards observed in the fishery, the landing obligation is unlikely to impact this stock or the advice significantly.

32.4 Data

InterCatch

International catch data are collated using the ICES InterCatch platform. For 2021, data for Belgium, France, Ireland, the Netherlands and the United Kingdom (England, Scotland and the Channel Island Guernsey) were uploaded into InterCatch (Figures 32.1 and 32.2). All submitted age samples are presented in Figure 32.8 and length samples in Figure 32.9. The raising procedure is described in the Stock Annex.

Landings

Landings of sole in Division 7.e were below 500 t at the beginning of the time-series in the 1970s. Subsequently, landings increased and stayed around 1500 t in the 1980s and have been around 1000 t in the 1990s and 2000s (Table 32.1). The landings dropped in the late 2000s below 750 t and increased since 2015 to 1392 t in 2021.

The UK, France and Belgium provided age-structured landings samples in InterCatch (Figure 32.8).

Total international landings numbers-at-age (Table 32.2 and Figure 32.5) and landings and stock weights-at-age (Tables 32.3 and 32.4 and Figure 32.6), as used in the assessment, were derived following the procedures outlined in the Stock Annex.

The fleets for which age distributions were submitted accounted for 85.1%of the 2021 total international landings, based on the InterCatch level (year, country, fleet, and quarter), up from 84.8% for 2020 and 77.8% for 2019.

Discards

Discards for this stock are very low and not included in the assessment.

For 2021, discards estimates were provided by Belgium, France, Ireland (0 discards), and the UK for some fleets in InterCatch based on discard sampling. Discard age samples were only provided for the French OTB_DEF_70-99 Q2 and UK TBB_DEF_70-99 Q4.

Discards data are only available from InterCatch for the years 2012–2021. In general, the discard rates are low (Figure 32.3). A higher discard rate was observed in 2015, attributed to high discards from the multirig otter trawl (mesh size 90–99 mm) fleet. The three-year average (2019–2021) discard rate is 0.44%. This reduction in the discard rate might be linked to introducing the landing obligation in 2016.

The discard rate by fleet and country is shown in Figure 32.4 (shown are only discards submitted to InterCatch).

No discard information is included in the assessment, given that it is currently not possible to provide discard estimates for the entire time-series. Nevertheless, excluding discard estimates from the assessment is unlikely to have any major impact on the perception of stock status given the minor scale of the problem.

Revisions

No revisions to previous years were submitted.

Biological data

Natural mortality was assumed to be constant over all ages and years at 0.1. The maturity ogive from divisions 7.f and 7.g was used following the procedures outlined in the Stock Annex and adopted in previous assessments.

In agreement with the Stock Annex, stock and catch weights-at-age were derived by fitting a second-degree polynomial model to the raw landings weights-at-age extracted from InterCatch (Figure 32.7). For 2021 data, the youngest age for which data (catch numbers and weights) were provided was age 1.

Survey indices

Abundance estimates derived from the surveys as used in the assessment are given in Table 32.6 and shown in Figures 32.10, 32.11, 32.12 and 32.13, and internal consistencies in Figures 32.14, 32.15 and 32.16. In general, cohort tracking and internal consistency are better in the commercial tuning fleets and less pronounced in the scientific surveys.

The UK-FSP survey

The UK Western Channel sole and plaice survey (previously called Fisheries Science Partnership survey; UK-FSP, quarter 3, ICES survey code B4381, Burt *et al*., 2022) conducted another survey of sole and plaice abundance in the Western English Channel in 2021. The survey uses two 4 m beam trawls with 80 mm nominal codend mesh and focuses on the area around the English coast. 83 out of 90 tows were completed in 2021. 339 sole otoliths were collected for ageing in 2021.

Catch rates are reported standardised as numbers per hour per meter of beam length. The results indicate that sole continues to be widespread in the area (Figure 32.17) and that many cohorts contribute to the stock. The total CPUE increased since 2016 but dropped slightly in 2020 and 2021. The index is mainly driven by ages 3, 4, and 5. The internal consistency in the survey is good for ages 3+. Some year and cohort effects are visible.

The Q1SWBeam survey

The second survey used for sole is the Quarter 1 South West Beam trawl (Q1SWBeam, also called Q1SWECOS, ICES survey code B2732), which started in 2006. This survey deploys two 4 m beam trawls and uses a fully random stratified approach. In contrast to the FPS survey, the Q1SWBeam covers the entire western English Channel and, if conditions permit, adjacent areas. In 2021, 78 out of 81 tows were completed in the western English Channel. The landings per unit of effort (LPUE) numbers-at-age as well as aggregated over all ages are variable without particular trends or patterns, and internal consistency is mediocre.

Sole are caught in the entire western English Channel with higher numbers along the English coast.

In 2020, this survey was delayed due to disruptions of the COVID pandemic but returned to its normal schedule in 2021.

Commercial fleets effort and lpue

Two commercial tuning series from the UK are used (commercial beam trawl UK-CBT and commercial otter trawl UK-COT).

Effort for under 24 m UK beam trawlers in days fished steadily increased from 1992, and reached the highest levels on record in 2012 and stayed around this level until the end of the time-series (Figure 32.10). Currently, the effort is well above the long-term average. In contrast, the effort for over 24 m UK beam trawlers increased from 1992 to 2004 and then decreased to below the average of the time-series, reaching a minimum in 2013. Since then, the effort increased again slightly and is currently around the long-term average. When the effort of all UK beam trawl vessels is combined, the effort stayed almost constant since the early 2000s.

UK otter trawl (UK-COT) effort has been in continual decline since the early 1970s and was at the lowest levels on record in 2015. For 2016, this fleet reported zero effort and landings. This could be explained by a shift in the size of fishing vessels to smaller vessels. Since 2017, a new database is being used for recording, but the data are not consistent with historical data and are therefore not used in the stock assessment.

Age-disaggregated commercial abundance indices for the UK-CBT-late (UK-CBT values from 2003 onwards) and UK-COT fleets as used in the assessment are given in Tables 32.5 and 32.6 and plotted in Figures 32.10–32.13.

32.5 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, apart from one additional data year.

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).

Data screening

Data screening procedures identified no major anomalies in the catch numbers-at-age, weights or tuning information used in the 2022 assessment.

The landings numbers-at-age 3 were exceptionally high in 2017 but returned to usual levels in 2018 (Figure 32.5). This anomaly was evident in age samples from the UK and France and various fleets (see WGCSE 2018 report), i.e. does not seem to be a sampling issue. Another strong cohort appeared in the landings-at-age 3 in 2019, and is tracking well as age 4 in 2020 and age 5 in 2021, and was also visible in the two survey indices and the commercial beam trawl LPUE in 2021.

Tuning information consisted of four fleets: two UK commercial time-series (UK-CBT-late and UK-COT) and two UK standardised research surveys (UK-FSP and Q1SWBeam).

The UK commercial otter trawl fleet (UK-COT) reported zero effort in 2016. Therefore, there is no LPUE value for this fleet for 2016. Consequently, this tuning index only influences the assessment up to and including 2015.

Details of the derivation of the tuning fleets are presented in the Stock Annex. The tuning information available for this assessment is shown in Table 32.6.

Final update assessment

The working group fitted the XSA model developed by WKFLAT 2012 (ICES, 2012) using the updated assessment settings agreed at IBPWCFlat2 (ICES, 2015).

The XSA assessment settings used at the last three working groups are shown in the table below, and more historical settings have been included in the Stock Annex.

	WGCSE 2020	WGCSE 2021	WGCSE 2021
Assessment age range	2–12+	2–12+	2–12+
F_{bar} age range	F(3–9)	F(3–9)	F(3–9)
Assessment method	XSA	XSA	XSA
Tuning Fleets:			
Q1SWBeam	2006–2019 Ages 2–11 (non-offset)	2006–2020 Ages 2–11 (non-offset)	2006–2021 Ages 2–11 (non-offset)
UK-FSP	20014–2019 Ages 2–11	20014–2020 Ages 2–11	20014–2021 Ages 2–11
UK combined beam (late)	2003–2019 Ages 3–11	2003–2020 Ages 3–11	2003–2021 Ages 3–11
UK otter trawl	1988–2016 Ages 3–11	1988–2016 Ages 3–11	1988–2016 Ages 3–11
Time taper	Yes	Yes	Yes
Power model	Tricubic	Tricubic	Tricubic
Taper range	15 years	15 years	15 years
P shrinkage	No	No	No
Q plateau age	7	7	7
F shrinkage S.E	0.5	0.5	0.5
Number of years	3	3	3
Number of ages	5	5	5
Fleet S.E.	0.4	0.4	0.4

Figure 32.18 shows the results from the final XSA model fit, Figure 32.19 the model residuals, Figure 32.20 a comparison of the current assessment with last years' assessments, Figure 32.21 XSA survivor weightings for the last two years and Figure 32.22 a five-year retrospective.

The survey residuals show relatively large values in earlier years. This is an expected feature of the XSA assessment, which includes a taper range of 15 years. This means that older survey observations are down-weighted and any observations 15 years or older are not used in the assessment.

A Mohn's rho analysis was conducted based on the XSA stock assessment results, i.e. the last data year (2021) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 3–9)	recruitment
Mohn's rho value	-0.091	0.157	0.026

The Mohn's rho values for this assessment are well within the ICES WKFORBIAS thresholds (+0.20, -0.15), i.e. the current assessment indicates sufficient consistency for advice purposes. The retrospective has been increasing slightly in recent years; however, this does not cause concerns because the SSB is usually underestimated while the fishing mortality is overestimated, i.e. the retrospective pattern is likely only to increase precaution of the assessment and advice.

XSA diagnostic of the final assessment are presented in Table 32.7, stock numbers-at-age in Table 32.8, fishing mortalities-at-age in Table 32.9 and an assessment summary in Table 32.10.

Consistency of the stock assessment

The comparison of historical stock assessment results (historical retro, Figure 32.20) and the analytical retrospective analysis (Figure 32.22) show slightly different retrospective patterns. It is worth noting that the historical comparison (Figure 32.22) shows the assessment results (including short-term forecast assumptions for the intermediate year) from conducting the stock assessment in the corresponding years. These values are stored in an ICES database and not updated afterwards. On the other hand, the analytical retrospective analysis (Figure 32.22) is conducted with the most recent version of the input data, and its retrospective runs are also based on these most recent (possibly updated or revised) data and only removing data years from the end.

The differences between the historical and analytical retro can be explained through revisions of historical input data over the years, namely:

- Q1SWBeam: The scientific Q1SWBeam survey was revised prior to WGCSE 2020 because of a quality control process of the survey data and data processing. This is described in the WGCSE 2020 report. This has led to some changes in historical data, which means all historical assessment results prior to 2020 are based on slightly different historical Q1SWBeam data compared to the assessment afterwards.
- FSP: The FSP survey index values used in the assessment are a product of a model fitting to the raw data. This means that the entire time-series is updated every year, including historical values.

Furthermore, the terminal year of the historical retro includes assumptions for the intermediate year. In the following year's assessment, the observed perception of the fishery can be different from that assumed in the previous year.

State of the stock

Stock trends are shown in Table 32.10 and plotted in Figure 32.19. The stock is in a desirable state, both in terms 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 is currently well above MSY $B_{trigger}$.

The base level of recruitment has remained relatively stable throughout the time-series, fluctuating without a major temporal trend at around 4 million recruits. Recruitment variability has decreased since 1991. In recent years, recruitment has been variable again, with very high recruitment estimates in 2018 and 2020 but a very low estimate in 2021.

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. Since then, F has remained below this level but has been increasing again and was just below F_{MSY} in 2021.

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 relatively high proportion of the catches and including some individuals aged 33–38 in recent years.

32.6 Short-term projections

Forecast assumptions

Figure 32.23 shows three different targets for the intermediate year: status quo ($F = F_{2021}$), average ($F = F_{average\ 2019–2021}$), and TAC. F estimates decreased slightly in 2020 compared to 2019 but increased in 2021.

Landings have been below the international TAC and the advised catch in previous years (Figure 32.24). The catch advice for 2022 (1810 t) is substantially higher than recent landings, and reaching this level would mean an increase in landings of 30% compared to 2021. However, this appears unlikely given the recent trend in landings, fleet capacity and legal limitations on fishing effort.

F_{2021} (0.287) is higher than in previous years (F_{2020}=0.239, F_{2019}=0.257), and landings have been increasing continuously since 2015, likely because of an increase in recent TACs. Therefore, the working group decided to use the most recent F (F_{2021}=0.287) for the intermediate year (2022). Using a three-year average F would have resulted in a decrease in F, which is considered unlikely considering the recent trends in landings and F.

Weights-at-age were calculated as the average of the last three historical years, as in previous years.

The Stock Annex recommends using a long-term geometric mean of the full time-series (1969 to terminal assessment year) for the recruitment in the short-term forecast. However, the Stock Annex also specifies that a short-term geometric mean should be used if distinct periods of successive low or high recruitment are evident over the final three years. In the previous year (WGCSE 2021), such a shorter period was used. However, this year (WGCSE 2022), WGCSE reverted to using the full time-series (the standard practice of the Stock Annex) because recruitment has been highly variably in the recent past with very high (2018, 2020) but also very low (2021) recruitment estimates.

The forecast was conducted with FLR's FLash R package using the output from the landings only XSA assessment. The resulting yield was obtained by adding discards to the landing with an average discard rate of the last three historical years (2019–2021, 0.44%).

The input data for the short-term forecast are shown in Table 32.11.

MSY forecast

Table 32.12 shows a detailed output of the forecast targeting F_{MSY} for 2023–2024, and Table 32.13 the year classes contributing to the forecast yield and SSB.

Figure 32.25 shows the forecast results for F_{MSY}, and Figure 32.26 the forecast, including F_{MSY} ranges.

Implementing the MSY approach with F_{MSY}=0.29 leads to a total yield of 1394 t in 2023, and an SSB of 4541 t in 2024.

The advice is a reduction of 23% compared to the advice for 2022. This decline is because of a projected decline in the SSB, caused by (1) low recruitment in 2021 and (2) previously strong cohorts which had increased the SSB are now disappearing because they have been fished down in recent years with the increasing fishing mortality and due to natural mortality reducing the cohorts. This trend is illustrated in Figures 32.27 (biomass) and 32.27 (numbers). The recent increases in SSB have been supported by strong year classes of relatively old and heavier fish, which are disappearing and causing a reduction in the SSB in the short-term forecast (Figure 32.27). This effect is more pronounced in terms of the numbers of fish, which are already declining in 2021 and this trend continues into the short-term forecast (Figure 32.28).

Additional options

A management options table is provided in Table 32.14, and Table 32.15 shows additional options.

32.7 Biological reference points

The most recent reference points for this stock were developed by WKMSYREF4 in 2015 (ICES, 2016). These reference points are presented in the following table. Please note that ICES changed the basis for F_{pa} to $F_{p.05}$ in 2021, and the updated F_{pa} value is shown here.

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 (2016, 2017)
	F_{MSY}	0.29	The peak of the median landings yield curve.	ICES (2016, 2017)
	F_{MSY} lower	0.16	Minimum F which produces at least 95% of maximum yield.	ICES (2016, 2017)
	F_{MSY} upper	0.34	Maximum F which produces at least 95% of maximum yield.	ICES (2016, 2017)
Precautionary approach	B_{lim}	2000 t	Rounded B_{pa}/1.4.	ICES (2016, 2017)
	B_{pa}	2900 t	Rounded B_{loss} (1999 year class). Lowest SSB with high recruitment.	ICES (2016, 2017)
	F_{lim}	0.44	Segmented regression simulation of recruitment with B_{lim} as the breakpoint and no error.	ICES (2016, 2017)
	F_{pa}	0.39	Fp.05; the F that leads to SSB ≥ Blim with 95% probability.	ICES (2016, 2017)
Previous management plan	SSB_{MGT}	Not defined		
	F_{MGT}	0.27		EU (2007)

32.8 Management plan

The European Commission implemented a management plan for the recovery of the stock early in 2007 (Council Regulation (EC) No 509/2007). The management plan has not been formally evaluated, but the working group concluded that: The long-term management target (F_{MGT} = 0.27) is precautionary in the sense that it ensures that there is a less than 5% chance of SSB declining below previously observed levels, as well as maintaining yield within 10% of MSY (*WGCSE note: long-term yield at F_{MAX}*) (working group, 2005; working group, 2006).

This management plan has not been used in recent years, and the ICES advice has been based on the MSY approach, targeting F_{MSY}.

The management plan (Council Regulation (EC) No 509/2007) is no longer in force since 2019 and has been repealed by an EU multiannual plan for stocks fished in the Western Waters and adjacent waters (Regulation (EU) 2019/472, EU, 2019) which aims at targeting MSY.

32.9 Uncertainties in assessment and forecast

The methodology provided is as robust as possible and does not currently appear to suffer from a serious retrospective pattern.

Discarding

Discarding is considered negligible in the sole fishery, averaging only 0.44% of the total international catch weight in 2021. Nevertheless, a time-series of available discards information raised to the fleet level should be developed to effectively deal with potential future discard issues and improve estimates of total mortality. The EU landing obligation was implemented during 2016–2019 with a discard plan and seemed to have reduced the already low discards even more. The landings advice has been topped up with the available discard information to give catch advice. Developing a time-series of discard information appears to be less urgent than in the past.

Surveys

The assessment methodology includes two survey indices. The UK-Q1SWBeam survey added to the assessment in 2012 covers the entire management area, providing fishery-independent tuning information for the entire age range used in the assessment. Therefore, the assessment relies much less on the commercial tuning information and is less susceptible to localised exploitation by the fishery. 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 sector operating in this fishery (UK) are included in the assessment. France submitted no age samples for the 2019 season. Due to reprocessing of age data submitted by France in 2018, age samples from several strata were retracted. French age data between 2009 and 2014 were insufficient at older ages to raise the length compositions, and therefore UK age data were used to cover the larger fish.

There are very limited discard age samples, but this does not impose a problem on the assessment or forecast due to very low discarding.

Consistency

The assessment for this stock was last benchmarked in 2012, and an inter-benchmark was held in 2015. The 2022 assessment is consistent with the previous assessments conducted in recent years. Temporal trends in SSB and F estimates were virtually identical.

32.10 Recommendation for the next benchmark

There is no requirement to benchmark this stock in the short term.

The XSA assessment uses a taper range of 15 years for the tuning indices, effectively down-weighting older tuning data and removing data older than 15 years altogether. As tuning time-series become longer, potentially important information might get lost in the process. Therefore, a re-evaluation of assessment parametrisation should be considered.

LPUE estimates for the UK-CBT and UK-COT fleets should be closely monitored to avoid the recurrence of inaccuracies in commercial tuning information observed at the 2014 and 2015 working groups. A rescaling observed in the 2018 and 2019 assessments can be explained by underlying data. Consequently, the next benchmark should evaluate the temporal stability of the retrospective patterns and determine whether the assessment settings need to be revised.

The UK-COT effort has been in continuous decline and reported no activity in 2016 and subsequently, due to a new database system, cannot be replicated anymore. Consequently, a benchmark could investigate the removal of commercial tuning information altogether from the assessment.

As the time-series on discards increases, a future benchmark might look into including discard estimates in the assessment and estimating historical discards. Discards are very low and, due to the implementation of the landing obligation in 2016, unlikely to become a problem in the future.

32.11 Management considerations

France provided discard estimates for the first time at the 2016 working group. Discard estimates from France are higher than from the other countries.

Plaice is taken as bycatch in this fishery, and therefore management advice for sole must also consider the advice for plaice. Anglerfish, cuttlefish, and lemon sole are also important bycatches in this fishery.

32.12 Ecosystem considerations and changes in the environment

See Stock Annex.

32.13 Regulations and their effects

Management of this stock is mainly by TAC. In 2005, effort restrictions were implemented for beam trawlers and entangling gears targeting sole in this fishery to enforce the TAC and improve data quality. The effort restrictions were included in the 2007 management plan (EU, 2007) and are continued in the EU multiannual plan (EU, 2019). The effort restrictions limit the number of days at sea for vessels in 7.e using beam trawls (≥80 mm mesh size) and static nets (≤120 mm mesh size). The limits for effort are set annually in the EU council with the TAC and apply only for vessels which catch more than 300 kg of sole annually.

Mesh restrictions for towed gears are set to 80 mm codends, which correspond well with the minimum landing size of sole at 24 cm (25 cm for Belgian vessels since December 2017).

32.14 References

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32.15 Tables

Table 32.1. Sole in Division 7.e. History of official landings and ICES estimates. All weights are in tonnes.

Year	Belgium	France	Netherlands	Ireland	UK and Channel Islands	Official total	ICES landings	ICES discards
1974		323				323	427	
1975	3	271			217	491	491	
1976	4	352			260	616	616	
1977	3	331			272	606	606	
1978	4	384			453	841	861	
1979	1	515			665	1181	1181	
1980	45	447		13	764	1269	1269	
1981	16	415	1		788	1220	1215	
1982	98	321			1028	1447	1446	
1983	47	405	3		1043	1498	1498	
1984	48	421			901	1370	1370	
1985	58	130			911	1099	1409	
1986	62	467			840	1369	1419	
1987	48	432			632	1112	1280	
1988	67	98			784	949	1444	
1989	69	112	6		613	800	1390	
1990	41	81			636	758	1315	
1991	35	325			477	837	852	
1992	41	267			468	776	895	
1993	59	236			498	793	904	
1994	33	257			546	836	800	
1995	21	294			565	880	856	
1996	8	297			428	733	833	
1997	13	348		1	496	858	949	
1998	40	343			389	772	880	
1999	13				396	409	957	

Year	Belgium	France	Netherlands	Ireland	UK and Channel Islands	Official total	ICES landings	ICES discards
2000	4	241			413	658	914	
2001	19	224			407	650	1069	
2002	33	198			309	540	1106	
2003	1	363		1	255	620	1078	
2004	7	302			185	494	1075	
2005	26	406			527	959	1039	
2006	32	357			575	964	1022	
2007	34	384			536	953	1015	
2008	28	312		< 1	474	815	908	
2009	17	386			382	785	701	
2010	17	375			369	761	698	
2011	22	424			431	877	801	
2012	39	325		< 1	506	871	872	2
2013	30	319			540	889	883	1
2014	25	351		< 1	510	886	885	10
2015	42	245		< 1	490	777	774	54
2016	46	245			624	915	913	10
2017	56	198		< 1	746	1000	1007	4
2018	68	217	< 1	< 1	801	1086	1075	3
2019	47	208	< 1	< 1	925	1182	1185	4
2020*	58	194	< 1		966	1218	1219	< 1
2021*	104	243	< 1	< 1	1048	1395	1392	13

*** Preliminary.**

Table 32.2. Sole in Division 7.e. Landings numbers-at-age (thousands).

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12+	TOTAL
1969	89	322	80	148	210	21	50	26	20	9	63	1037
1970	53	232	322	90	83	112	13	35	52	22	113	1127
1971	51	200	246	198	65	80	156	10	35	54	113	1207
1972	146	412	167	115	112	14	25	134	38	54	106	1323
1973	71	396	433	89	99	120	17	52	30	4	136	1446
1974	45	349	220	178	71	80	43	32	24	55	106	1202
1975	82	567	170	199	115	28	53	26	22	24	171	1456
1976	167	419	472	161	135	92	46	58	51	14	213	1830
1977	426	318	384	206	102	70	74	10	24	32	159	1804
1978	250	1123	347	214	189	103	72	77	38	27	203	2644
1979	227	803	811	250	229	174	103	90	104	28	290	3108
1980	175	559	497	630	126	183	140	65	56	130	342	2902
1981	245	806	651	467	389	179	126	76	58	55	211	3262
1982	128	1451	916	553	352	240	136	113	81	61	294	4324
1983	91	753	1573	583	351	267	294	119	73	37	262	4401
1984	333	663	826	758	325	204	129	152	54	28	255	3727
1985	287	1700	756	469	585	179	97	103	85	29	125	4414
1986	246	1618	971	421	321	336	84	75	90	74	127	4363
1987	487	808	1090	427	204	224	229	47	50	41	162	3770
1988	443	1438	596	728	374	153	162	109	39	50	171	4262
1989	390	871	1233	497	509	225	110	107	113	48	214	4316
1990	341	902	581	553	244	264	143	103	75	85	235	3525
1991	450	415	482	289	220	93	111	68	37	31	145	2341
1992	316	1434	417	297	115	112	61	74	26	23	90	2964
1993	209	704	1107	350	219	151	78	60	56	31	79	3045
1994	97	657	558	558	112	106	49	57	44	50	99	2388
1995	95	308	629	427	411	131	101	61	33	18	142	2356
1996	365	445	364	298	235	257	68	61	49	37	143	2321
1997	216	831	724	325	180	194	173	44	20	40	88	2835

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12+	TOTAL
1998	265	606	536	336	209	151	80	127	35	34	162	2543
1999	280	915	500	398	255	114	103	54	107	25	123	2874
2000	307	599	751	367	229	107	53	68	51	88	91	2710
2001	145	1401	531	497	268	178	100	55	43	42	159	3419
2002	332	1251	843	387	322	129	105	94	33	18	85	3599
2003	598	835	953	645	130	74	50	58	63	14	61	3482
2004	398	1080	448	445	526	164	116	61	54	35	85	3412
2005	258	468	834	449	366	293	113	80	45	24	96	3027
2006	500	786	472	606	250	224	185	85	56	31	87	3282
2007	201	852	755	293	362	179	130	110	55	27	99	3062
2008	281	752	678	376	163	184	105	71	67	39	89	2805
2009	166	540	385	333	202	66	74	37	50	35	65	1955
2010	68	348	394	329	204	127	49	71	20	34	78	1723
2011	91	499	476	405	233	156	80	39	34	28	93	2136
2012	31	227	525	400	355	231	137	67	44	39	124	2180
2013	120	324	483	595	280	214	147	98	48	23	110	2441
2014	198	320	466	426	410	168	112	79	61	27	97	2364
2015	177	329	395	336	261	206	115	78	45	30	82	2054
2016	92	420	469	276	249	242	189	67	50	33	107	2194
2017	123	1188	334	307	277	130	94	41	36	129	78	2737
2018	80	446	410	272	339	156	242	99	82	221	154	2501
2019	115	874	659	633	381	198	168	123	70	86	157	3463
2020	169	558	1194	613	444	254	137	83	72	33	159	3716
2021	115	841	693	1182	576	329	173	122	80	48	178	4338

Table 32.3. 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	0.500	0.444	0.514	0.530	0.596
1971	0.151	0.222	0.296	0.367	0.350	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	0.460	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	0.210	0.293	0.351	0.395	0.427	0.487	0.580	0.638	0.525	0.663
1976	0.170	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	0.400	0.503	0.464	0.518	0.485	0.553	0.683
1978	0.178	0.239	0.300	0.387	0.435	0.374	0.482	0.485	0.484	0.535	0.665
1979	0.189	0.239	0.330	0.427	0.464	0.472	0.481	0.570	0.527	0.574	0.732
1980	0.189	0.254	0.343	0.389	0.525	0.560	0.609	0.646	0.655	0.600	0.783
1981	0.174	0.225	0.321	0.381	0.477	0.514	0.533	0.598	0.619	0.708	0.660
1982	0.214	0.209	0.278	0.347	0.426	0.498	0.510	0.523	0.526	0.564	0.663
1983	0.187	0.250	0.271	0.306	0.388	0.417	0.473	0.530	0.608	0.551	0.665
1984	0.210	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	0.360	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	0.310	0.370	0.425	0.474	0.518	0.557	0.590	0.618	0.665
1988	0.170	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	0.510	0.551	0.590	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	0.520	0.561	0.597	0.627	0.683
1993	0.146	0.209	0.268	0.324	0.376	0.425	0.470	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	0.300	0.354	0.406	0.455	0.503	0.548	0.592	0.633	0.734

year\age	2	3	4	5	6	7	8	9	10	11	12+
1998	0.191	0.247	0.300	0.350	0.397	0.441	0.482	0.520	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	0.310	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	0.290	0.342	0.391	0.439	0.485	0.529	0.570	0.610	0.706
2003	0.173	0.241	0.306	0.367	0.425	0.479	0.530	0.577	0.620	0.660	0.746
2004	0.176	0.230	0.282	0.334	0.385	0.435	0.485	0.534	0.582	0.629	0.757
2005	0.180	0.236	0.290	0.343	0.394	0.444	0.493	0.540	0.586	0.630	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	0.350	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	0.540	0.579	0.612	0.639	0.703
2010	0.169	0.258	0.339	0.412	0.476	0.532	0.580	0.619	0.650	0.673	0.699
2011	0.200	0.261	0.319	0.375	0.428	0.480	0.528	0.575	0.618	0.660	0.749
2012	0.162	0.240	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	0.740
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	0.250	0.313	0.370	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	0.720
2017	0.225	0.279	0.331	0.382	0.432	0.479	0.525	0.568	0.610	0.651	0.763
2018	0.205	0.264	0.321	0.374	0.425	0.473	0.518	0.560	0.600	0.636	0.768
2019	0.180	0.233	0.284	0.333	0.379	0.423	0.464	0.503	0.540	0.574	0.682
2020	0.188	0.235	0.280	0.323	0.365	0.406	0.445	0.483	0.519	0.553	0.642
2021	0.157	0.213	0.265	0.313	0.358	0.399	0.435	0.468	0.498	0.523	0.592

Table 32.4. 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	0.200	0.270	0.330	0.380	0.425	0.460	0.490	0.520	0.550	0.609
1970	0.120	0.195	0.255	0.305	0.355	0.395	0.430	0.465	0.490	0.510	0.541
1971	0.090	0.170	0.240	0.295	0.345	0.390	0.420	0.445	0.470	0.490	0.544
1972	0.130	0.200	0.265	0.325	0.380	0.420	0.460	0.490	0.520	0.540	0.558
1973	0.105	0.170	0.235	0.290	0.340	0.390	0.435	0.475	0.510	0.540	0.585
1974	0.125	0.200	0.265	0.320	0.370	0.410	0.455	0.490	0.515	0.530	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	0.380	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	0.330	0.380	0.425	0.463	0.498	0.526	0.555	0.630
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	0.360	0.436	0.513	0.575	0.620	0.650	0.674	0.714
1981	0.119	0.197	0.276	0.358	0.427	0.490	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	0.120	0.195	0.250	0.307	0.365	0.420	0.475	0.520	0.570	0.615	0.709
1984	0.108	0.192	0.268	0.339	0.400	0.453	0.501	0.545	0.577	0.607	0.696
1985	0.150	0.204	0.258	0.311	0.364	0.416	0.468	0.520	0.571	0.621	0.790
1986	0.140	0.206	0.268	0.326	0.381	0.432	0.480	0.524	0.564	0.601	0.691
1987	0.137	0.210	0.278	0.341	0.398	0.450	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	0.300	0.350	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	0.290	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	0.580	0.613	0.677
1993	0.114	0.178	0.239	0.296	0.350	0.401	0.448	0.492	0.532	0.570	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	0.500	0.536	0.568	0.641
1996	0.189	0.238	0.285	0.331	0.376	0.420	0.463	0.504	0.544	0.583	0.677
1997	0.156	0.215	0.272	0.327	0.380	0.431	0.480	0.526	0.570	0.612	0.717

year\age	2	3	4	5	6	7	8	9	10	11	12+
1998	0.162	0.220	0.274	0.325	0.374	0.419	0.462	0.501	0.537	0.571	0.650
1999	0.183	0.233	0.280	0.326	0.369	0.410	0.448	0.485	0.519	0.551	0.624
2000	0.172	0.230	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	0.420	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	0.550	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	0.360	0.410	0.460	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	0.400	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	0.360	0.404	0.447	0.489	0.529	0.569	0.640
2009	0.136	0.215	0.287	0.354	0.415	0.469	0.518	0.560	0.596	0.626	0.698
2010	0.121	0.215	0.300	0.376	0.445	0.505	0.557	0.600	0.636	0.663	0.696
2011	0.169	0.231	0.290	0.347	0.402	0.454	0.504	0.552	0.597	0.639	0.738
2012	0.120	0.202	0.276	0.343	0.402	0.453	0.497	0.532	0.561	0.581	0.664
2013	0.144	0.200	0.256	0.310	0.363	0.414	0.464	0.513	0.560	0.606	0.729
2014	0.157	0.223	0.284	0.340	0.391	0.438	0.480	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	0.590	0.617	0.714
2017	0.197	0.252	0.305	0.357	0.407	0.455	0.501	0.546	0.588	0.630	0.749
2018	0.174	0.235	0.293	0.348	0.400	0.450	0.496	0.540	0.580	0.618	0.760
2019	0.152	0.207	0.259	0.309	0.356	0.401	0.444	0.484	0.522	0.557	0.672
2020	0.165	0.212	0.257	0.302	0.344	0.386	0.426	0.464	0.501	0.536	0.632
2021	0.128	0.186	0.240	0.290	0.336	0.379	0.417	0.452	0.483	0.511	0.586

Table 32.5. Sole in Division 7.e. Landings, effort and mean standardised lpue for the UK commercial fleets.

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
UK-CBT<24 m	1988	2527	293	115.97	1.93
	1989	1956	162	83.06	1.38
	1990	1958	179	91.51	1.52
	1991	1458	134	92.22	1.53
	1992	1342	142	106.22	1.76
	1993	1432	154	107.71	1.79
	1994	2241	161	71.97	1.19
	1995	2017	134	66.28	1.1
	1996	1999	106	52.99	0.88
	1997	1991	132	66.3	1.1
	1998	2357	99	42.12	0.7
	1999	2518	115	45.7	0.76
	2000	2913	134	45.85	0.76
	2001	3746	148	39.57	0.66
	2002	3482	110	31.55	0.52
	2003	3785	93	24.44	0.41
	2004	3512	64	18.12	0.3
	2005	3305	191	57.72	0.96
	2006	3277	224	68.27	1.13
	2007	4027	225	55.77	0.93
	2008	4629	213	45.94	0.76
	2009	4040	185	45.85	0.76
	2010	4727	201	42.42	0.7
	2011	5913	258	43.65	0.72
	2012	7188	314	43.65	0.72
	2013	6322	329	52.02	0.86
	2014	5870	308	52.54	0.87
	2015	6260	310	49.54	0.82

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	2016	6114	355	58.1	0.96
	2017	6578	402	61.08	1.01
	2018	6366	386	60.66	1.01
	2019	6067	397	65.49	1.09
	2020	5643	393	69.61	1.16
	2021	5354	399	74.5	1.24
UK-CBT>24 m	1988	2971	391	131.77	2.74
	1989	3938	340	86.37	1.79
	1990	3518	314	89.12	1.85
	1991	2412	206	85.47	1.78
	1992	1993	197	98.63	2.05
	1993	2678	194	72.54	1.51
	1994	4574	236	51.5	1.07
	1995	4917	257	52.3	1.09
	1996	5592	178	31.84	0.66
	1997	5377	199	37.1	0.77
	1998	4945	164	33.19	0.69
	1999	4512	141	31.32	0.65
	2000	5237	151	28.84	0.6
	2001	5874	142	24.11	0.5
	2002	5957	104	17.51	0.36
	2003	6810	94	13.78	0.29
	2004	7100	69	9.66	0.2
	2005	6684	236	35.27	0.73
	2006	6595	236	35.79	0.74
	2007	5594	196	35.1	0.73
	2008	4924	154	31.36	0.65
	2009	3523	115	32.66	0.68
	2010	3064	94	30.64	0.64

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	2011	2790	92	32.95	0.68
	2012	2609	86	33.01	0.69
	2013	2444	93	38.13	0.79
	2014	2900	104	35.95	0.75
	2015	3039	101	33.12	0.69
	2016	4064	166	40.79	0.85
	2017	4556	207	45.41	0.94
	2018	4116	231	56.17	1.17
	2019	4329	313	72.36	1.5
	2020	4335	321	74.07	1.54
	2021	4505	354	78.56	1.63
UK-CBT	1988	5497	684	124.51	2.34
	1989	5894	503	85.27	1.6
	1990	5476	493	89.97	1.69
	1991	3870	341	88.02	1.65
	1992	3334	339	101.69	1.91
	1993	4111	349	84.79	1.59
	1994	6814	397	58.23	1.09
	1995	6935	391	56.37	1.06
	1996	7591	284	37.41	0.7
	1997	7368	331	44.99	0.84
	1998	7302	263	36.07	0.68
	1999	7031	256	36.47	0.68
	2000	8150	285	34.92	0.66
	2001	9620	290	30.13	0.57
	2002	9439	214	22.69	0.43
	2003	10596	186	17.59	0.33
	2004	10612	132	12.46	0.23
	2005	9990	427	42.7	0.8

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	2006	9873	460	46.57	0.87
	2007	9621	421	43.75	0.82
	2008	9552	367	38.42	0.72
	2009	7563	300	39.7	0.75
	2010	7791	294	37.79	0.71
	2011	8703	350	40.22	0.75
	2012	9797	400	40.82	0.77
	2013	8767	422	48.15	0.9
	2014	8769	413	47.05	0.88
	2015	9298	411	44.17	0.83
	2016	10178	521	51.19	0.96
	2017	11114	606	54.57	1.02
	2018	10482	617	58.9	1.11
	2019	10396	711	68.35	1.28
	2020	9978	714	71.55	1.34
	2021	9859	753	76.35	1.43
UK-COT	1988	4265	29	6.77	1.43
	1989	4607	28	6.18	1.31
	1990	4423	26	5.97	1.27
	1991	4004	14	3.39	0.72
	1992	4108	12	3.02	0.64
	1993	3761	15	3.95	0.84
	1994	3423	18	5.27	1.12
	1995	3294	13	3.99	0.84
	1996	2589	12	4.83	1.02
	1997	3011	15	4.96	1.05
	1998	2699	11	4.22	0.89
	1999	2486	13	5.16	1.09
	2000	2681	11	4.11	0.87

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	2001	2732	13	4.9	1.04
	2002	2448	9	3.66	0.78
	2003	2273	8	3.31	0.7
	2004	2334	6	2.46	0.52
	2005	1762	12	6.86	1.45
	2006	1699	8	4.57	0.97
	2007	1917	9	4.9	1.04
	2008	1750	7	4.26	0.9
	2009	1847	10	5.36	1.14
	2010	2213	10	4.53	0.96
	2011	1930	8	4.08	0.86
	2012	2068	12	5.96	1.26
	2013	1587	8	4.96	1.05
	2014	1440	8	5.56	1.18
	2015	978	5	4.98	1.06
	2016	0	0	NA	NA
UK-COT new	2016	2020	14	7.08	0.71
	2017	2398	15	6.1	0.61
	2018	1986	17	8.42	0.84
	2019	1548	14	9.33	0.93
	2020	1076	15	14.23	1.43
	2021	1353	20	14.75	1.48

Table 32.6. Sole in Division 7.e. Tuning data file. Not all tuning time-series, years and ages shown here were used in the assessment.

```
sol.27.7e WGCSE 2022
104
UK-CBT-late
2003 2021
1 1 0 1
3 14
  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
  10.17804    263.46     217.34     158.93     161.88     118.88     102.14      49.07
45.22       21.3      23.14      13.03       5.69
  11.11408    454.27     353.27     177.37     142.06     120.28      81.72      72.95
42.23      28.03      16.59      11.97       9.63
  10.48248    217.63     454.82     260.75     116.59      118.4      76.79      51.54
49.36      33.91      24.42      21.84      10.92
  10.39628    618.98     411.51     357.08     217.83      105.4      69.38         57
36.74      40.95      22.94      13.23      10.34
   9.97809    366.92     668.85      351.1      232.9     155.35      85.53      44.65
28.78      13.68      12.36       13.5      10.39
   9.85862    489.94     449.21      574.6     243.75     181.18      96.72      47.65
40.73      26.66      25.03      24.62      14.92
```

UK-COT
1988 2016
1 1 0 1
3 11

4264.71	30.97	15.73	19.29	8.63	2.55	2.55
	1.83	0.35	0.76			
4607.04	15.09	18.34	9.22	11.75	4.72	2.42
	2.36	2.01	1.4			
4422.52	18.3	12.56	9.21	6.09	5.53	2.08
	1.83	1.12	0.9			
4004.37	10.04	7.03	4.12	2.46	0.96	1.44
	0.42	0.41	0.23			
4107.71	26.24	6	3.6	1.19	1.14	0.48
	0.65	0.17	0.09			
3761	12.45	17.56	5.38	3.44	2.49	1.26
	1	0.92	0.56			
3423.03	12.42	11.46	12.35	2.5	2.6	1.23
	1.35	1.03	1.18			
3294.06	5.25	9.75	6.34	6.17	1.89	1.49
	0.91	0.52	0.25			
2589.38	9.47	6.54	4.37	3.15	3.54	0.95
	0.76	0.68	0.45			
3010.66	15.16	8.81	4.78	2.83	2.9	2.53
	0.63	0.28	0.43			
2698.6	8.74	7.58	4.25	2.49	1.53	0.93
	1.47	0.31	0.44			
2486.17	11.56	5.84	4.91	2.89	1.45	1.46
	0.74	1.49	0.39			
2680.63	6.67	8.41	4.03	2.64	1.24	0.59
	0.81	0.62	0.99			
2731.54	18.02	5.27	4.96	2.69	2.01	1.12
	0.7	0.51	0.5			
2448.37	9.88	6.12	2.39	2.67	1.27	0.82
	0.33	0.2	0.25			
2272.9	4.61	5.87	4.8	1.04	0.85	0.49
	0.54	0.27	0.13			
2334.16	6.05	2.58	2.23	3.25	0.46	0.57
	0.3	0.24	0.18			
1762.36	6.44	9.56	3.53	4.13	3.44	0.74
	0.9	0.58	0.45			
1699.49	6.93	3.27	4.13	1.36	1.63	1.75
	0.6	0.31	0.2			
1916.84	9.32	5.44	2.3	2.32	1.19	1.41
	1.13	0.36	0.21			
1750.36	5.61	4.85	2.08	1.15	1.18	0.75
	0.75	0.7	0.32			
1847.2	7.97	5.47	3.92	2.17	0.64	0.83
	0.39	0.52	0.45			
2212.85	2.71	5.85	4.74	3.15	1.63	0.81
	0.74	0.3	0.6			
1930.5	6.51	3.32	3.89	2.46	1.64	0.58
	0.31	0.37	0.19			

2068.16	4.24	9.16	3.97	4.06	2.3	1.76
	0.82	0.49	0.46			
1586.58	2.01	4.55	5.64	2.66	1.74	1.49
	0.89	0.56	0.26			
1440.22	2.13	3.57	2.99	3.56	1.8	1.29
	0.9	0.68	0.34			
977.63	1.62	1.98	1.86	1.59	1.35	0.7
	0.5	0.42	0.25			
0	0	0	0	0	0	0
	0	0	0			
Q1SWBeam-nonoffset						
2006 2021						
1 1 0.1 0.25						
1 27						
1	0	20.9617	24.3417	10.5008	29.9494	15.518
	15.7871	13.7063	12.2623	9.09681	8.07492	
	1.29966	3.32659	0.71346	1.24661	4.26735	
	1.11282	0.66165	0	0	0	0
	0	0	0	0	0	
1	0.2503	17.4443	46.7889	15.0922	2.073	7.4772
	2.9714	3.2638	8.2173	6.17255	2.70645	0
	1.92946	1.46792	0.60148	0	1.04005	
	0.31768	0	0	0	0.50834	0
	0	0.12415	0	0		
1	0	11.9694	38.5327	44.2588	16.8101	
	17.9839	5.8217	8.2188	15.3684	6.56008	
	4.07772	3.63512	3.3578	2.4216	0.75185	0.2483
	0.2483	0	5.56781	0	0	0
	0	0	0	0	0	
1	0	5.235	33.4672	22.5017	25.8667	
	12.4215	1.7615	3.6862	0.3434	7.53917	
	7.88458	1.66924	1.35582	0.26643	0.10484	0
	0.10668	2.23934	3.64113	0	0	0
	0	0	0.10455	1.76165	1.76165	
1	0	23.8814	25.2679	44.1021	28.7077	
	18.1813	16.9984	1.0967	2.19	1.87814	
	3.87783	1.63973	1.19362	1.11282	0.70528	0
	0.65966	0	0	0	1.11282	0
	0	0	0	0	0	
1	0	15.6093	31.6425	19.472	13.4385	6.9196
	3.0124	4.3092	2.6587	0.38676	2.81983	
	1.21893	0.7916	0	0.30255	0.11824	0
	0	0.17878	0	0	0.11824	0
	0	0	0	0		
1	0	2.4032	35.864	28.1768	11.668	8.48
	10.0964	7.2705	5.3933	0	0.20648	
	4.31641	0.67921	0	0.09932	0.65966	0
	0.09932	0	0	0	0	0
	0	0	0	0		
1	0	4.3218	17.2513	32.7718	26.2459	
	15.6648	12.9839	10.3966	9.301	7.65213	
	1.25131	7.2166	0	4.88124	1.36061	0

	0	0	0	0	0	
	7.49313	1.20296	0	0	0	0
1	1.2565	6.1443	38.1218	37.1957	10.5263	20.342
	13.5544	26.5539	6.0348	2.87995	3.19119	
	1.29615	1.32124	2.31644	1.6562	2.0409	
	0.66062	0	0	2.0409	0.24598	0
	0	0	0	0	0	
1	0.9895	7.8397	16.9527	10.4441	12.6618	
	15.7945	22.0161	12.8365	11.1984	4.78045	
	4.96361	2.26539	7.19622	1.99517	0	
	4.59811	0.50271	1.08277	0.13153	0.38463	
	3.34157	0	0	0	0	0
	0					
1	0.12515	17.0147	37.47	16.1717	17.0353	
	12.0928	11.7792	15.8913	3.3377	3.79163	
	5.62407	3.36633	1.86454	0.12415	0	
	0.50124	0	0	0	1.67202	0
	0.45985	0	0	0	0	0
1	1.38477	8.3704	21.7183	25.912	13.405	
	10.9208	8.4759	3.8099	2.7153	2.4744	0.5697
	8.26016	0.86427	3.74239	0.16748	0.40391	0
	0	0.33721	0.52773	0.19391	0	0
	0	0	0	0		
1	0	13.509	25.4432	38.4368	31.8088	
	12.9337	17.061	10.5022	8.6894	9.04688	
	2.42789	6.10779	5.71409	7.21492	1.67776	0
	0	0	0	0.73992	0	0
	0	0	0	0	0	
1	0	23.4314	61.6211	29.4074	31.5671	
	17.6249	5.5207	3.9496	3.5844	2.57041	
	6.82601	0.1729	4.50089	1.29713	3.98425	0
	0	0.39571	0	0.45154	0	0
	0.83462	0	0	0	0	
1	0.34121	21.5071	36.9707	39.7765	19.9786	
	14.7538	11.4951	5.0737	5.4513	4.28901	
	8.38046	0.94747	0.80528	0	0.18163	0
	0	0	0	0	0	0.2699
	0	0	0	0	0	
1	0.18772	6.7674	67.4654	39.6929	62.266	
	19.2075	16.213	25.5911	2.4385	6.22532	
	4.13235	0.28577	0.43425	3.3362	0	0
	0	0	0	0	0.14986	0
	0.15319	0	0	0	0	

```
FSP-UK
2003 2021
1 1 0.7 0.75
1 27
1            0.0005996525 0.1640287001 0.3331577428 0.3421042854 0.3077896855
             0.0276877607 0.0434349878 0.001199431  0.0606079973 0.0452031639
             0.0762864358 0.0041900979 0.0044704097 0.0017318557 0.000259465
             0.0014588961 0            0            0.0001297325 0.0001297325 0
             0.000259465  0.0001297325 0            0.0001297325 0            0
1            0.0001356596 0.1531649719 0.5482140297 0.3113148035 0.2625606101
             0.1242854207 0.0562310285 0.0854244108 0.0348852879 0.0161248214
             0.0169492456 0.0101294248 0.0064762205 0.0060502419 0.0044275753
             0.0012155768 0.0011866052 0.0006639293 0.0034808758 0.0014061443
             0.0004170558 0.0013951526 0.0022790494 0.0007329086 0.0008245222 0
             0
1            0            0.1033295175 0.19641048   0.2419913717 0.1091266279
             0.1568026119 0.145326301  0.036140277  0.0293963588 0.0143508007
             0.0153718894 0.0071929565 0.0067527739 0.0018681385 0.009940521
             0.00740716   0.0023788354 0.002716705  0.0021409311 0.0017422746
             0.0005904058 0.0033955813 0.0006752624 0            0
             0.0002352598 0
1            0.0039650485 0.1530093905 0.338159914  0.1553922995 0.2150083739
             0.0964601581 0.1165659253 0.1314649338 0.0263190435 0.0257133886
             0.0180415374 0.0143487238 0.0090641849 0.0018065091 0.0041883778
             0.0038052388 0.0035466212 0.0026256712 0.0019710043 0.0012706678
             0.0005645573 0.0007581292 0.0005729774 0.0012706678 3.38845e-05
             3.38845e-05  0
1            0.0010962171 0.1222741336 0.4498553047 0.2031795541 0.0752568916
             0.0913421932 0.0585642238 0.0482046412 0.0990784093 0.0183456175
             0.0234301884 0.0051412317 0.0112336251 0.0042618881 0.0040821708
             0.0039301402 0            0.0003138761 0.0004997104 0.0009808918
             0.0008212451 0.0011351212 0.001694755  0.0009721986 0            0
             0
1            2.26161e-05  0.2195262683 0.3064700266 0.2655864135 0.2476267164
             0.0431112703 0.0375114545 0.0146047595 0.0569714222 0.0329368056
             0.0020584201 0.0103801271 0.0052184252 0.0003427702 0.0019322174
             0.001240166  0.0002593175 0.0023037596 0.0017552985 0.0001146081
             0.0019529181 0.0014618085 4.20676e-05  0.0001036959 0.0016033953
             1.03851e-05  0
1            0            0.0871756844 0.2996241409 0.3111598691 0.1612888821
             0.0607181418 0.0399573377 0.0280004615 0.0151930886 0.0179131136
             0.047375509  0.0070657871 0.0029069767 0.0028085641 0.0034248136 0
             0.0023009922 0            0            0            0.0014487729 0
             0            0            0            0            0
1            0            0.1198634134 0.196874246  0.2457977047 0.1811689438
             0.1272699744 0.0356769991 0.020992322  0.0271910269 0.0175688686
             0.0235333828 0.0111317663 0.0040175529 0.0028670567 0.0098378335
             0.0061571312 0            0            0.0017165606 0
             0.0014381202 0.001962611  0.0014381202 0            0            0
             0
1            0            0.06241178   0.4007807363 0.0936432403 0.1661392336
             0.084172186  0.0489667592 0.0045383432 0.0133242011 0.0072883556
             0.010725752  0.0124001688 0.0133052176 0.0012450574 0.0037505906
```

	7.88011e-05	0.0047453587	4.72807e-05	0.0012292972	1.57602e-05	
	3.15204e-05	6.30409e-05	3.15204e-05	1.57602e-05	1.57602e-05	
	0.0034488814	0				
1	0	0.0462429317	0.3661074051	0.3751123378	0.171327639	
	0.1173729434	0.0335259216	0.0444066234	0.0275603154	0.0030803347	
	0.006453779	0.0001320431	0.0090582307	0.0102501203	0.0064423865	
	0.006337584	0.0019806469	0	6.60216e-05	6.60216e-05	
	0.0012992471	0.0001320431	6.60216e-05	0	6.60216e-05	0
	0					
1	0	0.0497881333	0.3584337435	0.4301705234	0.3611324055	
	0.1699642895	0.0915132656	0.0522974874	0.0372679269	0.0063585644	0
	0.0155682804	0.0169229843	0.0150488511	0	0.0065329235	
	0.0065015519	0	0	0	0.0005752481	0
	0	0	0	0	0	
1	0	0.0992979309	0.3132769061	0.404824384	0.3187756661	
	0.2144234295	0.1202334108	0.0707920098	0.0346720214	0.0427286271	
	0.0019981129	0.0122453312	0.0035399024	0.0091491166	0.0040710437	
	0.0080827697	0.0039462729	0.0059770088	9.99056e-05	0.0015076265	
	9.99056e-05	0	0	9.99056e-05	0	0
	0					
1	0.0048896085	0.1093931233	0.2409909098	0.342222128	0.1843469436	
	0.1273706237	0.1082327865	0.0763853928	0.0576452317	0.0237495021	
	0.0250038238	0.00933254	0.0036693854	0.0111649666	0.0028229153	
	0.0031227752	0.0034365469	0.0047588703	0.0011504961	0	0
	0	0	0	0.0014642678	0	0
1	0	0.106692296	0.462891223	0.1532642147	0.1442259017	
	0.1230641606	0.0781141924	0.102312786	0.0301074486	0.0478016471	
	0.014684173	0.0168037935	0.0050194129	0.0033997592	0.0021956008	
	0.0063508475	0.0048557028	0.003975375	0.0011243485	0.0027226531	0
	0.0017564806	0	0	0	0	0
1	0	0.12886873	0.4887237516	0.3304347223	0.0960669305	
	0.0858467213	0.0726999591	0.0391128558	0.0589537549	0.0200598221	
	0.0122974024	0.0180049259	0.0119845876	0.0039815527	0.0027961056	0
	0.0024247625	0.005117608	0.0059944095	0.0011243485	0	0
	0	0	0	0	0	
1	0	0.1586709782	0.2933003672	0.4153420564	0.2476762135	
	0.0907601391	0.0694807344	0.0922203076	0.0271016214	0.0610983845	
	0.0369478639	0.0380261073	0.0120135944	0.0073046846	0.0019174935	0
	0	0.0011504961	0.0014381202	0.0026932068	0.0024055828	0
	0	0	0.0011504961	0	0	
1	0	0.2112724882	0.9077480144	0.1994578656	0.1528107317	
	0.0897784456	0.0471313352	0.0455976848	0.0374275951	0.0276157117	
	0.0403826099	0.0079840292	0.0096721581	0.0032406206	0.0017564806	0
	0.0017564806	0.0028808291	0.0064020338	0	0.0045777045	0
	0.00148414	0	0	0	0	
1	0.001278329	0.3004545955	0.3368668308	0.4213025839	0.1902005191	
	0.1366906837	0.0642090392	0.0396030017	0.0304254687	0.0543559787	
	0.0184056185	0.042564176	0.0141117117	0.003992626	0.0064497077	
	0.0041487154	0.0024780937	0.0012243989	0.0001231713	2.46343e-05	
	0.002276511	0.005323707	4.92685e-05	2.46343e-05	2.46343e-05	
	2.46343e-05	0				
1	0	0.0457153066	0.3479819938	0.2646579215	0.3520245785	
	0.0947774833	0.0712985299	0.0333363482	0.0224343434	0.0129740757	

	0.0234239362	0	0.0232988167	0.0018886193	0.0018886193	
	0.0064010685	0.0081597965	0.0029903139	0	0	
	0.0019875965	0.0018886193	0	0	0	0
	0					

UK-CBT-early
1988 2002
1 1 0 1
3 11

5.50	660.36	337.83	439.11	199.29	63.46	62.34
	58.95	13.18	21.70	13.33	27.52	6.95
5.89	334.92	420.18	206.01	239.87	86.59	36.69
	36.30	34.02	21.23	13.23	14.64	8.91
5.48	330.59	249.78	187.83	120.79	118.15	45.22
	34.04	22.00	18.96	10.14	16.62	8.71
3.87	169.69	178.00	138.03	89.94	39.06	50.15
	27.73	13.14	9.08	16.74	3.98	7.26
3.33	569.33	159.31	112.20	42.39	44.18	21.30
	30.70	7.94	5.60	5.48	5.88	5.21
4.11	276.52	436.07	135.24	82.61	58.75	29.82
	23.11	22.81	11.35	3.31	8.58	5.80
6.81	347.00	282.99	271.57	54.29	49.16	24.17
	27.27	20.69	23.17	11.03	8.54	4.49
6.93	139.39	287.26	193.06	187.53	57.49	45.54
	26.86	14.72	8.08	17.93	7.45	5.17
7.59	146.04	118.70	100.89	81.14	87.63	23.24
	21.23	16.83	12.69	13.77	12.60	5.11
7.37	300.18	244.82	114.67	60.06	66.02	58.33
	14.54	6.74	13.71	5.51	6.41	4.75
7.30	188.05	166.31	103.86	61.72	44.52	23.65
	35.65	9.80	9.76	8.10	8.57	3.78
7.03	264.75	137.13	101.88	64.10	27.00	25.49
	13.29	26.52	5.87	9.91	2.81	2.98
8.15	194.23	235.47	112.00	69.45	33.41	16.90
	19.70	14.88	26.19	2.84	4.35	1.86
9.62	400.24	142.06	135.26	69.22	46.01	25.81
	13.47	11.17	10.68	12.43	4.64	3.50
9.44	280.20	169.83	62.21	62.54	27.88	19.67
	8.64	3.97	4.69	2.63	4.92	2.28

UK-WEC-BTS
1988 2013
1 1 0.75 0.8
1 9

128.20	2.00	39.00	129.00	52.00	75.00	22.00
	0.00	12.00	3.00			
165.70	5.00	56.00	120.00	107.00	34.00	40.00
	17.00	5.00	7.00			
175.70	23.00	52.00	76.00	31.00	24.00	7.00
	15.00	3.00	6.00			
171.70	11.00	231.00	79.00	51.00	23.00	21.00
	5.00	17.00	4.00			
196.60	5.00	140.00	316.00	44.00	36.00	12.00
	7.00	5.00	11.00			
189.20	5.00	54.00	115.00	105.00	14.00	10.00
	9.00	3.00	3.00			
205.90	6.00	47.00	106.00	62.00	44.00	5.00
	5.00	2.00	3.00			
187.20	14.00	37.00	44.00	42.00	26.00	31.00
	4.00	5.00	5.00			
184.40	28.00	112.00	67.00	25.00	32.00	20.00
	17.00	3.00	2.00			
184.70	11.00	130.00	126.00	43.00	14.00	16.00
	13.00	14.00	5.00			
185.50	11.00	141.00	114.00	76.00	22.00	10.00
	14.00	6.00	8.00			
187.90	11.00	97.00	128.00	47.00	23.00	8.00
	4.00	4.00	4.00			
180.40	12.00	136.00	70.00	52.00	23.00	16.00
	5.00	3.00	5.00			
178.00	9.00	197.00	162.00	52.00	31.00	12.00
	12.00	4.00	1.00			
180.00	6.00	37.00	113.00	48.00	27.00	6.00
	3.00	2.00	0.00			
170.70	23.00	124.00	78.00	56.00	28.00	6.00
	1.00	1.00	2.00			
164.90	16.00	110.00	120.00	24.00	15.00	10.00
	16.00	9.00	4.00			
186.60	8.00	110.00	39.00	53.00	12.00	12.00
	6.00	2.00	4.00			
184.70	5.00	120.00	95.00	26.00	37.00	10.00
	7.00	9.00	0.00			
181.00	7.00	188.00	135.00	50.00	11.00	23.00
	3.00	3.00	1.00			
174.70	10.00	85.00	158.00	77.00	40.00	2.00
	14.00	3.00	6.00			
172.00	11.00	104.00	126.00	96.00	49.00	13.00
	13.00	12.00	1.00			
179.90	20.00	175.00	154.00	84.00	59.00	31.00
	20.00	7.00	12.00			
176.20	9.00	156.00	231.00	62.00	39.00	25.00
	24.00	8.00	2.00			

179.70	3.00	47.00	162.00	125.00	40.00	27.00
	13.00	3.00	6.00			
181.60	4.00	36.00	100.00	106.00	80.00	21.00
	9.00	6.00	3.00			

Table 32.7. Sole in Division 7.e. Detailed XSA survivor diagnostics.

FLR XSA Diagnostics 2022-05-13 17:48:39

CPUE data from indices

Catch data for 53 years 1969 to 2021. Ages 2 to 12.

	fleet	first age	last age	first year	last year	alpha	beta
1	UK-CBT-late	3	11	2003	2021	<NA>	<NA>
2	UK-COT	3	11	1988	2015	<NA>	<NA>
3	Q1SWBeam-nonoffset	2	11	2006	2021	<NA>	<NA>
4	FSP-UK	2	11	2004	2021	<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 > 6

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 = 1

Minimum standard error for population
estimates derived from each fleet = 0.4

prior weighting not applied

Regression weights

age \ year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
all	0.482	0.61	0.725	0.82	0.893	0.944	0.976	0.993	0.999	1

Fishing mortalities

age \ year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	0.009	0.039	0.062	0.046	0.017	0.027	0.009	0.019	0.020	0.045
3	0.081	0.113	0.125	0.125	0.131	0.276	0.115	0.119	0.109	0.117
4	0.175	0.222	0.212	0.201	0.235	0.131	0.129	0.221	0.212	0.173
5	0.247	0.273	0.278	0.209	0.189	0.213	0.135	0.269	0.294	0.299
6	0.291	0.244	0.273	0.244	0.211	0.261	0.342	0.253	0.273	0.438
7	0.305	0.255	0.203	0.191	0.333	0.145	0.207	0.306	0.239	0.297
8	0.256	0.289	0.184	0.186	0.241	0.187	0.388	0.318	0.319	0.227
9	0.263	0.261	0.221	0.170	0.140	0.068	0.271	0.309	0.229	0.462
10	0.359	0.273	0.231	0.168	0.140	0.094	0.167	0.279	0.267	0.322
11	0.392	0.284	0.216	0.153	0.163	0.559	1.108	0.237	0.184	0.257
12	0.392	0.284	0.216	0.153	0.163	0.559	1.108	0.237	0.184	0.257

XSA population number (Thousand)

year \ age	2	3	4	5	6	7	8	9	10	11	12
2012	3540	3054	3449	1924	1478	923	638	306	153	125	401
2013	3282	3174	2547	2621	1360	1000	615	447	213	96	467
2014	3464	2856	2564	1845	1805	964	701	417	312	147	524
2015	4160	2946	2279	1876	1265	1243	712	528	303	224	610
2016	5817	3596	2353	1687	1378	896	929	535	403	231	750
2017	4908	5176	2854	1683	1264	1010	581	661	421	317	190
2018	9132	4324	3554	2265	1231	880	790	436	559	347	240
2019	6378	8188	3488	2825	1790	791	648	485	301	428	781
2020	9050	5662	6577	2529	1954	1258	527	426	322	206	992
2021	2745	8028	4592	4815	1706	1346	896	347	307	223	824

Estimated population abundance at 1st Jan 2022

year \ age	2	3	4	5	6	7	8	9	10	11	12
2022	0	2374	6464	3497	3232	996	905	646	198	201	156

Fleet: UK-CBT-late

Log catchability residuals.

year

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	-0.274	-0.487	0.571	0.763	0.884	0.541	0.244	-0.597	0.128	-0.293
4	-0.577	-1.221	0.218	0.284	0.280	0.236	0.039	-0.160	-0.417	-0.096
5	-0.812	-1.417	-0.087	0.311	0.102	-0.081	0.106	0.043	-0.060	-0.398
6	-1.696	-0.973	0.065	-0.084	-0.028	0.075	0.169	-0.069	-0.065	-0.135
7	-1.319	-2.014	0.117	0.155	-0.020	0.040	-0.276	-0.039	-0.089	-0.108
8	-1.393	-1.175	-0.689	0.357	0.032	0.266	-0.164	-0.036	-0.192	-0.086
9	-0.722	-1.379	0.130	0.031	0.072	-0.055	-0.227	-0.026	-0.306	-0.123
10	-1.249	-1.062	0.197	0.199	-0.411	0.119	-0.400	-0.427	0.136	0.079
11	-1.345	-1.219	0.370	0.155	0.108	-0.027	-0.340	-0.083	0.088	0.113

year

age	2013	2014	2015	2016	2017	2018	2019	2020	2021
3	-0.665	-0.244	-0.130	0.237	0.399	-0.175	0.242	0.124	0.080
4	0.102	-0.096	-0.164	-0.071	0.084	0.175	0.146	0.034	-0.012
5	0.148	-0.032	0.019	-0.198	-0.162	-0.053	0.112	0.259	0.122
6	-0.029	0.104	-0.005	-0.021	-0.129	-0.204	0.013	0.042	0.313
7	-0.083	-0.001	-0.160	0.158	-0.126	0.083	0.128	0.062	0.187
8	0.164	-0.085	-0.184	-0.073	0.059	-0.157	-0.084	0.372	-0.066
9	-0.022	0.021	-0.250	-0.303	-0.240	-0.016	0.005	-0.108	0.284
10	0.137	-0.041	-0.063	-0.101	-0.323	-0.357	0.028	-0.248	0.185
11	0.108	0.054	-0.203	-0.288	-0.234	0.159	-0.235	-0.585	0.050

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	-5.0580	-4.4680	-4.3435	-4.2893	-4.2893	-4.2893	-4.2893	-4.2893	-4.2893
S.E_Logq	0.4448	0.3599	0.4029	0.4531	0.5525	0.4597	0.3624	0.4080	0.4496

Fleet: UK-COT

Log catchability residuals.

year

age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	1.117	0.757	1.029	0.755	0.721	0.679	0.912	0.357	0.798	1.129
4	0.647	0.463	0.461	0.007	-0.036	0.202	0.456	0.537	0.525	0.336
5	0.537	0.417	0.303	-0.259	-0.418	0.272	0.201	0.192	0.310	0.352
6	0.358	0.316	0.476	-0.554	-1.335	-0.099	-0.111	-0.234	0.027	-0.007
7	-0.345	0.173	0.084	-0.824	-0.977	-0.192	0.096	0.020	-0.202	0.230
8	-0.154	-0.096	-0.105	-0.780	-1.196	-0.463	-0.495	-0.051	-0.012	-0.366
9	-0.536	0.147	0.112	-1.141	-1.299	0.012	0.022	-0.496	-0.080	-0.209
10	-1.262	-0.142	-0.072	-0.854	-1.728	-0.571	0.606	-0.596	-0.235	-0.915
11	-0.372	0.422	-0.437	-1.111	-2.082	-0.130	0.087	-0.333	-0.185	-0.508

year

age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	0.796	0.894	0.465	0.838	0.517	0.251	0.170	1.150	0.856	0.937
4	0.344	0.243	0.322	-0.035	-0.359	-0.091	-0.573	0.729	0.306	0.326
5	0.026	0.285	0.090	0.132	-0.432	-0.278	-0.786	0.313	0.288	0.181
6	0.169	-0.003	-0.110	0.015	0.019	-0.968	-0.385	0.388	-0.252	0.001
7	-0.090	0.192	-0.557	0.042	-0.156	-0.636	-1.491	0.418	-0.068	-0.011
8	-0.383	0.428	-0.377	-0.350	-0.276	-0.683	-0.714	-0.351	0.218	0.075
9	-0.485	-0.199	0.288	0.189	-1.054	-0.186	-0.867	0.490	-0.123	0.081
10	-0.435	-0.055	-0.091	0.381	-0.471	-0.702	-0.549	0.487	-0.027	-0.335
11	-0.040	0.281	-0.161	0.118	0.324	-0.416	-0.656	0.865	-0.097	-0.033

year

age	2008	2009	2010	2011	2012	2013	2014	2015
3	0.609	0.812	-0.394	0.341	0.171	-0.333	-0.067	0.015
4	0.162	0.246	-0.021	-0.406	0.250	0.141	-0.016	-0.106
5	-0.195	0.146	0.091	-0.131	-0.105	0.215	0.030	-0.106
6	-0.091	0.073	-0.066	-0.243	0.069	-0.027	0.091	0.015
7	-0.064	-0.357	-0.028	-0.277	-0.022	-0.139	0.003	-0.157
8	0.145	-0.054	-0.001	-0.587	0.057	0.207	-0.021	-0.259
9	-0.109	-0.127	0.028	-0.516	0.032	-0.002	0.156	-0.304
10	0.083	-0.208	-0.265	-0.146	0.257	0.283	0.173	0.078
11	0.069	-0.072	0.062	-0.234	0.410	0.312	0.227	-0.147

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	-14.2957	-13.6814	-13.5450	-13.4117	-13.4117	-13.4117	-13.4117	-13.4117	-13.4117
S.E_Logq	0.4270	0.3152	0.2995	0.3768	0.4016	0.3552	0.4393	0.5235	0.5434

Fleet: Q1SWBeam-nonoffset

Log catchability residuals.

age \ year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0.790	0.754	0.313	-0.413	0.849	0.764	-1.130	-0.463	-0.161	-0.103
3	0.015	0.575	0.472	0.265	0.054	-0.002	0.466	-0.299	0.602	-0.240
4	-0.205	-0.222	0.740	0.123	0.649	-0.137	-0.046	0.416	0.535	-0.620
5	0.622	-1.435	0.304	0.526	0.571	-0.352	-0.423	0.084	-0.478	-0.322
6	0.640	-0.275	1.153	0.384	0.457	-0.580	-0.519	0.170	0.153	0.251
7	0.672	-0.536	0.014	-0.755	1.071	-1.038	0.129	0.292	0.362	0.591
8	0.743	-0.485	1.009	0.016	-0.928	0.046	0.161	0.561	1.350	0.608
9	1.365	0.661	1.440	-1.675	-0.154	0.261	0.599	0.764	0.394	0.767
10	1.787	1.098	0.834	1.050	0.347	-1.477	0.000	1.314	-0.052	0.473
11	2.061	1.105	1.106	1.380	0.699	1.056	-1.745	0.296	0.802	0.809

age \ year	2016	2017	2018	2019	2020	2021
2	0.331	-0.206	-0.352	0.560	0.124	0.165
3	0.355	-0.529	-0.219	0.028	-0.116	0.137
4	-0.208	0.052	0.227	-0.006	-0.340	0.010
5	0.077	-0.156	0.398	0.192	-0.150	0.344
6	-0.108	-0.114	0.095	0.015	-0.247	0.181
7	0.317	-0.163	0.684	-0.320	-0.062	0.224
8	0.565	-0.403	0.338	-0.453	0.004	1.075
9	-0.462	-0.892	0.723	-0.262	0.272	-0.285
10	-0.051	-0.529	0.497	-0.123	0.320	0.750
11	0.902	-1.634	-0.178	0.495	1.421	0.648

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	-6.1455	-4.8787	-4.7133	-4.6222	-4.5738	-4.5738	-4.5738	-4.5738	-4.5738	-4.5738
S.E_Logq	0.5609	0.3354	0.3737	0.5259	0.4358	0.5615	0.6352	0.8140	0.7844	1.0169

Fleet: FSP-UK

Log catchability residuals.

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	0.961	0.173	0.459	0.346	0.876	0.040	0.084	-0.221	-0.554	-0.383	0.270
3	0.537	0.132	0.280	0.469	0.171	0.031	-0.349	0.086	0.312	0.276	0.255
4	0.578	0.063	0.239	0.149	0.252	0.393	-0.002	-0.912	0.177	0.652	0.577
5	0.485	-0.003	0.467	0.001	0.815	0.120	0.168	-0.077	0.033	0.488	0.718
6	0.011	0.486	0.439	0.247	-0.015	-0.106	0.284	-0.192	0.039	0.459	0.429
7	0.040	0.622	0.622	0.451	-0.141	0.248	-0.278	-0.363	-0.732	0.155	0.427
8	1.039	-0.018	0.959	0.136	-0.412	-0.057	-0.096	-2.010	-0.118	0.106	0.202
9	0.618	0.446	0.076	1.088	0.644	0.014	0.316	-0.237	0.146	0.066	0.034
10	0.431	0.152	0.842	0.133	0.370	-0.195	0.449	-0.643	-1.281	-0.951	0.542
11	0.633	0.855	0.834	1.228	-1.616	1.055	0.381	0.349	-0.316	0.000	-1.776

age \ year	2015	2016	2017	2018	2019	2020	2021
2	0.172	-0.210	0.157	-0.269	0.383	0.386	-0.285
3	-0.039	0.419	0.214	-0.233	0.261	-0.368	-0.680
4	0.519	-0.292	0.208	0.216	-0.432	-0.325	-0.459
5	0.104	-0.050	-0.436	0.157	-0.450	-0.102	-0.127
6	0.243	0.099	-0.138	0.002	-0.448	-0.101	-0.211
7	0.059	0.163	-0.164	-0.028	-0.237	-0.440	-0.361
8	0.264	0.330	-0.201	0.495	-0.061	0.004	-0.765
9	0.270	-0.415	-0.006	-0.220	0.025	-0.112	-0.041
10	-0.061	0.331	-0.614	0.270	0.175	0.777	-0.568
11	0.281	-0.278	-0.483	0.926	0.173	0.079	0.295

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	-10.6122	-9.2096	-9.1044	-9.1078	-9.1971	-9.1971	-9.1971	-9.1971	-9.1971	-9.1971
S.E_Logq	0.4107	0.3227	0.4243	0.3499	0.2688	0.3795	0.6578	0.3652	0.5981	0.8250

Terminal year survivor and F summaries:

,Age 2 Year class =2019

source

	scaledwts	survivors	yrcls
Q1SWBeam-nonoffset	0.362	2801	2019
FSP-UK	0.546	1785	2019

```
fshk                    0.091      6778  2019

 ,Age 3 Year class =2018

source
                   scaledwts survivors yrcls
UK-CBT-late             0.314      7000  2018
Q1SWBeam-nonoffset      0.314      7417  2018
FSP-UK                  0.314      3276  2018
fshk                    0.057      6589  2018

 ,Age 4 Year class =2017

source
                   scaledwts survivors yrcls
UK-CBT-late             0.347      3455  2017
Q1SWBeam-nonoffset      0.347      3531  2017
FSP-UK                  0.239      2209  2017
fshk                    0.066      3188  2017

 ,Age 5 Year class =2016

source
                   scaledwts survivors yrcls
UK-CBT-late             0.311      3651  2016
Q1SWBeam-nonoffset      0.311      4558  2016
FSP-UK                  0.311      2847  2016
fshk                    0.067      4285  2016

 ,Age 6 Year class =2015

source
                   scaledwts survivors yrcls
UK-CBT-late             0.308      1361  2015
Q1SWBeam-nonoffset      0.308      1194  2015
FSP-UK                  0.308       807  2015
fshk                    0.076      1628  2015

 ,Age 7 Year class =2014

source
                   scaledwts survivors yrcls
UK-CBT-late             0.351      1092  2014
Q1SWBeam-nonoffset      0.222      1132  2014
FSP-UK                  0.351       631  2014
fshk                    0.076      1095  2014

 ,Age 8 Year class =2013

source
                   scaledwts survivors yrcls
UK-CBT-late             0.507       605  2013
Q1SWBeam-nonoffset      0.150      1894  2013
FSP-UK                  0.241       301  2013
fshk                    0.102       402  2013

 ,Age 9 Year class =2012

source
                   scaledwts survivors yrcls
UK-CBT-late             0.382       263  2012
Q1SWBeam-nonoffset      0.139       149  2012
FSP-UK                  0.382       190  2012
fshk                    0.097       374  2012

 ,Age 10 Year class =2011

source
                   scaledwts survivors yrcls
UK-CBT-late             0.523       242  2011
Q1SWBeam-nonoffset      0.171       426  2011
FSP-UK                  0.191       114  2011
fshk                    0.116       284  2011

 ,Age 11 Year class =2010

source
                   scaledwts survivors yrcls
UK-CBT-late             0.622       164  2010
Q1SWBeam-nonoffset      0.079       298  2010
FSP-UK                  0.170       210  2010
fshk                    0.129       109  2010
```

Table 32.8. 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	2606	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	547	456	827	144	1493	18901
1980	4702	3755	2834	2787	970	751	497	397	327	650	1702	19372
1981	8130	4088	2866	2091	1923	758	506	316	298	243	934	22154
1982	4679	7124	2932	1974	1448	1370	516	337	214	214	1035	21844
1983	3866	4113	5065	1782	1260	976	1011	337	198	117	828	19554
1984	5968	3412	3005	3087	1058	806	629	635	192	110	982	19884
1985	6982	5083	2456	1934	2073	648	535	446	430	123	532	21242
1986	3765	6044	2982	1504	1303	1319	417	392	306	309	529	18870
1987	5847	3173	3930	1774	961	874	874	297	283	191	754	18959
1988	3878	4827	2102	2519	1199	675	578	573	224	208	713	17497
1989	3735	3088	3000	1335	1587	729	465	369	415	166	743	15632
1990	2817	3009	1965	1542	736	952	445	316	232	268	739	13022
1991	7161	2225	1864	1225	870	434	610	267	189	139	656	15639
1992	3902	6051	1618	1228	833	578	304	446	177	136	528	15801
1993	3350	3230	4111	1068	829	645	416	217	334	136	344	14679
1994	2378	2832	2253	2667	633	541	440	302	140	249	487	12921
1995	3452	2059	1938	1508	1882	466	389	351	218	84	646	12994
1996	3940	3033	1570	1155	958	1312	297	256	259	166	649	13597
1997	3331	3218	2322	1074	762	644	943	204	174	188	412	13271

year\age	2	3	4	5	6	7	8	9	10	11	12+	total
1998	4398	2808	2121	1412	662	518	398	689	143	138	648	13936
1999	3585	3727	1965	1409	958	400	325	284	502	97	478	13730
2000	6522	2977	2503	1302	896	624	253	197	206	352	366	16198
2001	5423	5610	2124	1550	829	593	462	179	114	138	515	17538
2002	3815	4769	3743	1417	930	496	367	323	110	62	286	16319
2003	5381	3136	3125	2586	914	535	326	232	203	68	303	16809
2004	2870	4300	2043	1921	1726	703	413	248	155	124	298	14801
2005	3994	2218	2863	1423	1315	1062	480	264	166	89	351	14225
2006	4612	3369	1562	1797	860	842	682	327	162	108	301	14622
2007	3934	3698	2300	964	1050	540	549	441	215	94	348	14133
2008	4209	3369	2536	1363	594	605	318	373	295	141	319	14123
2009	3788	3541	2333	1650	876	383	373	188	270	203	374	13978
2010	4864	3269	2690	1744	1176	600	283	267	135	197	457	15683
2011	3471	4337	2627	2059	1265	870	422	210	174	103	338	15876
2012	3540	3054	3449	1924	1478	923	638	306	153	125	401	15991
2013	3282	3174	2547	2621	1360	1000	615	447	213	96	467	15823
2014	3464	2856	2564	1845	1805	964	701	417	312	147	524	15599
2015	4160	2946	2279	1876	1265	1243	712	528	303	224	610	16148
2016	5817	3596	2353	1687	1378	896	929	535	403	231	750	18577
2017	4908	5176	2854	1683	1264	1010	581	661	421	317	190	19065
2018	9132	4324	3554	2265	1231	880	790	436	559	347	240	23758
2019	6378	8188	3488	2825	1790	791	648	485	301	428	781	26103
2020	9050	5662	6577	2529	1954	1258	527	426	322	206	992	29504
2021	2745	8028	4592	4815	1706	1346	896	347	307	223	824	25829

Table 32.9. Sole in Division 7.e. Estimated fishing mortality-at-age.

year\age	2	3	4	5	6	7	8	9	10	11	12+	F_{bar} (3–9)
1969	0.051	0.153	0.144	0.176	0.157	0.151	0.108	0.048	0.084	0.110	0.110	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	0.200	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	0.120	0.059	0.059	0.219	0.690	0.230	0.230	0.138
1973	0.034	0.212	0.185	0.163	0.163	0.162	0.081	0.152	0.063	0.124	0.124	0.160
1974	0.015	0.205	0.156	0.097	0.170	0.171	0.072	0.199	0.089	0.140	0.140	0.153
1975	0.029	0.243	0.130	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	0.180
1977	0.071	0.152	0.230	0.178	0.128	0.108	0.069	0.048	0.114	0.093	0.093	0.130
1978	0.058	0.240	0.221	0.174	0.220	0.165	0.140	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	0.040	0.170	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	0.270	0.270	0.270
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	0.340	0.365	0.462	0.489	0.402	0.402	0.363
1984	0.061	0.229	0.341	0.298	0.390	0.309	0.244	0.290	0.350	0.317	0.317	0.300
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	0.330	0.419	0.348	0.300	0.312	0.238	0.226	0.370	0.290	0.290	0.310
1987	0.092	0.312	0.345	0.292	0.253	0.314	0.322	0.182	0.205	0.256	0.256	0.288
1988	0.128	0.376	0.354	0.362	0.398	0.273	0.349	0.224	0.201	0.289	0.289	0.333
1989	0.116	0.352	0.565	0.496	0.411	0.393	0.286	0.363	0.337	0.359	0.359	0.409
1990	0.136	0.379	0.373	0.473	0.428	0.346	0.410	0.417	0.413	0.404	0.404	0.404
1991	0.068	0.218	0.318	0.285	0.309	0.256	0.212	0.311	0.230	0.264	0.264	0.273
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	0.260	0.333	0.423	0.326	0.283	0.221	0.341	0.194	0.274	0.274	0.312
1994	0.044	0.279	0.302	0.248	0.206	0.230	0.126	0.223	0.405	0.238	0.238	0.231
1995	0.029	0.171	0.418	0.353	0.261	0.349	0.317	0.202	0.171	0.261	0.261	0.296
1996	0.102	0.167	0.279	0.316	0.298	0.231	0.275	0.288	0.221	0.263	0.263	0.265

year\age	2	3	4	5	6	7	8	9	10	11	12+	F_{bar} (3–9)
1997	0.071	0.317	0.397	0.383	0.285	0.382	0.214	0.254	0.132	0.254	0.254	0.319
1998	0.065	0.257	0.309	0.288	0.403	0.366	0.237	0.216	0.295	0.304	0.304	0.297
1999	0.086	0.298	0.311	0.352	0.329	0.357	0.403	0.223	0.255	0.314	0.314	0.325
2000	0.051	0.238	0.379	0.352	0.313	0.200	0.247	0.449	0.302	0.303	0.303	0.311
2001	0.029	0.304	0.305	0.411	0.414	0.378	0.259	0.391	0.507	0.391	0.391	0.352
2002	0.096	0.323	0.270	0.338	0.453	0.319	0.358	0.364	0.375	0.375	0.375	0.346
2003	0.124	0.328	0.387	0.304	0.162	0.158	0.175	0.304	0.396	0.240	0.240	0.260
2004	0.157	0.307	0.262	0.279	0.386	0.282	0.350	0.298	0.459	0.356	0.356	0.309
2005	0.070	0.251	0.366	0.404	0.346	0.343	0.285	0.384	0.332	0.339	0.339	0.340
2006	0.121	0.281	0.382	0.438	0.366	0.327	0.335	0.320	0.447	0.360	0.360	0.350
2007	0.055	0.277	0.423	0.384	0.450	0.428	0.286	0.304	0.317	0.353	0.353	0.365
2008	0.073	0.268	0.330	0.342	0.340	0.385	0.425	0.224	0.275	0.347	0.347	0.330
2009	0.047	0.175	0.191	0.239	0.278	0.200	0.235	0.233	0.216	0.202	0.202	0.222
2010	0.015	0.119	0.167	0.221	0.202	0.252	0.201	0.327	0.173	0.198	0.198	0.213
2011	0.028	0.129	0.211	0.231	0.215	0.210	0.222	0.218	0.232	0.340	0.340	0.205
2012	0.009	0.081	0.175	0.247	0.291	0.305	0.256	0.263	0.359	0.392	0.392	0.231
2013	0.039	0.113	0.222	0.273	0.244	0.255	0.289	0.261	0.273	0.284	0.284	0.237
2014	0.062	0.125	0.212	0.278	0.273	0.203	0.184	0.221	0.231	0.216	0.216	0.214
2015	0.046	0.125	0.201	0.209	0.244	0.191	0.186	0.170	0.168	0.153	0.153	0.189
2016	0.017	0.131	0.235	0.189	0.211	0.333	0.241	0.140	0.140	0.163	0.163	0.211
2017	0.027	0.276	0.131	0.213	0.261	0.145	0.187	0.068	0.094	0.559	0.559	0.183
2018	0.009	0.115	0.129	0.135	0.342	0.207	0.388	0.271	0.167	1.108	1.108	0.227
2019	0.019	0.119	0.221	0.269	0.253	0.306	0.318	0.309	0.279	0.237	0.237	0.257
2020	0.020	0.109	0.212	0.294	0.273	0.239	0.319	0.229	0.267	0.184	0.184	0.239
2021	0.045	0.117	0.173	0.299	0.438	0.297	0.227	0.462	0.322	0.257	0.257	0.287

Table 32.10. Sole in Division 7.e. Assessment summary.

Year	Recruitment Age 2 [thousands]	TSB [tonnes]	SSB [tonnes]	Landings [tonnes]	Yield/SSB	F_{bar} (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	0.160
1974	3107	3512	2896	427	0.15	0.153
1975	2967	4428	3670	491	0.13	0.131
1976	2791	4102	3403	616	0.18	0.180
1977	6556	5339	4098	606	0.15	0.130
1978	4657	5428	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	0.270
1982	4679	5916	4575	1446	0.32	0.321
1983	3866	5377	4374	1498	0.34	0.363
1984	5968	5462	4430	1370	0.31	0.300
1985	6982	5568	4009	1409	0.35	0.329
1986	3765	5257	4013	1419	0.35	0.310
1987	5847	5310	4111	1280	0.31	0.288
1988	3878	5119	4043	1444	0.36	0.333
1989	3735	4318	3442	1390	0.4	0.409
1990	2817	4222	3287	1315	0.4	0.404
1991	7161	4219	2991	852	0.28	0.273
1992	3902	4100	2937	895	0.3	0.244
1993	3350	3579	2810	904	0.32	0.312
1994	2378	3785	3053	800	0.26	0.231
1995	3452	3875	3067	856	0.28	0.296
1996	3940	4152	3054	833	0.27	0.265

Year	Recruitment Age 2 [thousands]	TSB [tonnes]	SSB [tonnes]	Landings [tonnes]	Yield/SSB	F_{bar} (Ages 3–9)
1997	3331	3831	2920	949	0.32	0.319
1998	4398	3941	2910	880	0.3	0.297
1999	3585	3947	2830	957	0.34	0.325
2000	6522	4301	2865	914	0.32	0.311
2001	5423	4507	2894	1069	0.37	0.352
2002	3815	4183	3009	1106	0.37	0.346
2003	5381	4398	3287	1078	0.33	0.260
2004	2870	4021	3099	1075	0.35	0.309
2005	3994	3963	3087	1039	0.34	0.340
2006	4612	3688	2717	1023	0.38	0.350
2007	3934	3779	2751	1015	0.37	0.365
2008	4209	3801	2679	908	0.34	0.330
2009	3788	3920	2967	701	0.24	0.222
2010	4864	4433	3430	698	0.2	0.213
2011	3471	4716	3555	801	0.23	0.205
2012	3540	4570	3738	872	0.23	0.231
2013	3282	4513	3662	883	0.24	0.237
2014	3464	4843	3925	885	0.23	0.214
2015	4160	4955	3988	774	0.19	0.189
2016	5817	6005	4523	913	0.2	0.211
2017	4908	5958	4293	1007	0.23	0.183
2018	9132	6671	4605	1075	0.23	0.227
2019	6378	6838	4946	1185	0.24	0.257
2020	9050	7626	5464	1219	0.22	0.239
2021	2745	6702	5418	1392	0.26	0.287

Table 32.11. Sole in Division 7.e. Input data for the short-term forecast.

Age	N2022	N2023	N2024	M	Mat	PF	PM	SWt	Sel	CWt
2	4077	4077	4077	0.1	0.14	0	0	0.148	0.031	0.175
3	2374	3577	3576	0.1	0.45	0	0	0.202	0.127	0.227
4	6464	1893	2848	0.1	0.88	0	0	0.252	0.222	0.277
5	3497	4683	1368	0.1	0.98	0	0	0.3	0.316	0.323
6	3232	2306	3080	0.1	1	0	0	0.345	0.354	0.368
7	996	2053	1460	0.1	1	0	0	0.389	0.309	0.41
8	905	661	1360	0.1	1	0	0	0.429	0.317	0.448
9	646	597	435	0.1	1	0	0	0.467	0.367	0.485
10	198	405	373	0.1	1	0	0	0.502	0.319	0.519
11	201	130	266	0.1	1	0	0	0.535	0.249	0.55
12	733	659	556	0.1	1	0	0	0.63	0.249	0.639

Table 32.12. Sole in Division 7.e. Single option output of the short-term forecast (targeting F_{MSY}).

Age	F	Catch.No	Yield	Stock.No	Biomass	SSNo	SSB
Year = 2022, F_{bar} = 0.287							
2	0.031	118	21	4077	605	571	85
3	0.127	269	61	2374	479	1068	215
4	0.222	1228	340	6464	1629	5688	1433
5	0.316	904	292	3497	1050	3427	1029
6	0.354	919	338	3232	1116	3232	1116
7	0.309	253	103	996	387	996	387
8	0.317	235	105	905	388	905	388
9	0.367	190	92	646	302	646	302
10	0.319	51	27	198	99	198	99
11	0.249	42	23	201	108	201	108
12	0.249	154	98	733	462	733	462
Total	NA	4363	1500	23323	6624	17665	5624
Year = 2023, F_{bar} = 0.290							
2	0.031	119	21	4077	605	571	85
3	0.128	409	93	3577	721	1610	325
4	0.224	363	100	1893	477	1665	420
5	0.319	1220	394	4683	1406	4589	1378
6	0.357	661	243	2306	797	2306	797
7	0.312	525	215	2053	798	2053	798
8	0.32	173	77	661	284	661	284
9	0.371	176	86	597	279	597	279
10	0.322	106	55	405	203	405	203
11	0.251	27	15	130	70	130	70
12	0.251	139	89	659	415	659	415
Total	NA	3918	1388	21042	6054	15247	5052

Age	F	Catch.No	Yield	Stock.No	Biomass	SSNo	SSB
Year = 2024, F_{bar} = 0.290							
2	0.031	119	21	4077	605	571	85
3	0.128	409	93	3576	721	1609	325
4	0.224	546	151	2848	718	2507	632
5	0.319	357	115	1368	411	1341	403
6	0.357	883	324	3080	1064	3080	1064
7	0.312	373	153	1460	568	1460	568
8	0.32	355	159	1360	583	1360	583
9	0.371	129	62	435	203	435	203
10	0.322	98	51	373	187	373	187
11	0.251	56	31	266	142	266	142
12	0.251	118	75	556	350	556	350
Total	NA	3441	1235	19400	5552	13558	4541

Units are thousands (for numbers) and tonnes (for weights).

Table 32.13. Sole in Division 7.e. Year-class sources and contributions for the short-term forecast (in percent).

cohort	Yield 2022	Yield 2023	SSB 2022	SSB 2023	SSB 2024
2010	6.5	NA	8.2	NA	NA
2011	1.5	6.4	1.9	8.2	NA
2012	1.8	1.1	1.8	1.4	7.7
2013	6.1	4	5.4	4	3.1
2014	7	6.2	6.9	5.5	4.1
2015	6.9	5.6	6.9	5.6	4.5
2016	22.5	15.5	19.8	15.8	12.8
2017	19.5	17.5	18.3	15.8	12.5
2018	22.6	28.4	25.5	27.3	23.4
2019	4.1	7.2	3.8	8.3	8.9
2020	1.4	6.7	1.5	6.4	13.9
2021		1.5		1.7	7.1
2022					1.9

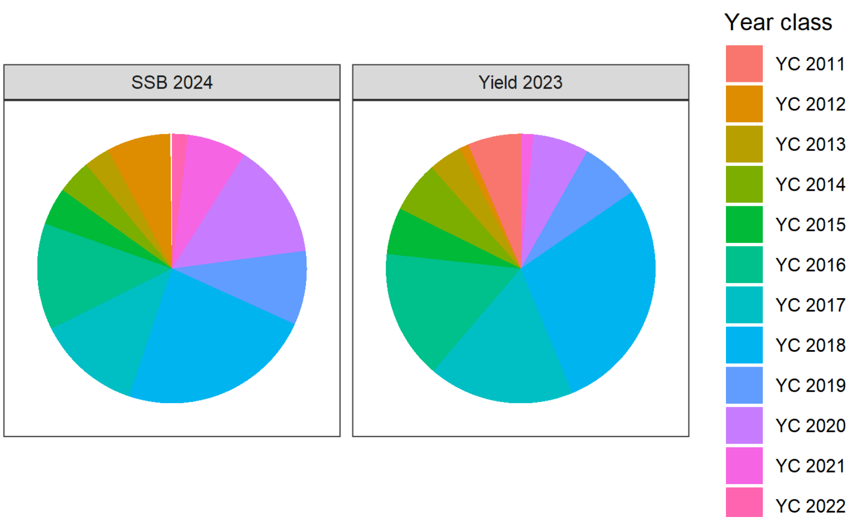


Table 32.14. Sole in Division 7.e. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2023)	Projected landings (2023)	Projected discards (2023)	$F_{projected\ landings}$ (2023)	SSB (2024)	% SSB change **	% TAC change***	% advice change^
ICES advice basis								
MSY approach: F_{MSY}	1394	1388	6	0.29	4541	-10.1	-23	-23
Other options								
EU MAP^^: F_{MSY}	1394	1388	6	0.29	4541	-10.1	-23	-23
F = MAP^^ $F_{MSY\ lower}$	820	816	4	0.160	5103	1.01	-55	-55
F = MAP^^ $F_{MSY\ upper}$	1596	1589	7	0.34	4344	-14.0	-11.8	-11.8
F = 0	0	0	0	0	5909	17.0	-100	-100
F_{pa}	1788	1781	8	0.39	4156	-17.7	-1.19	-1.19
F_{lim}	1971	1962	9	0.44	3979	-21	8.9	8.9
$SSB_{2024} = B_{lim}$	4036	4018	18	1.29	2000	-60	123	123
Rollover TAC	1810	1802	8	0.40	4135	-18.1	0	0
$SSB_{2024} = B_{pa}$ = MSY $B_{trigger}$	3088	3074	14	0.81	2900	-43	71	71
$SSB_{2024} = SSB_{2023}$	872	868	4	0.171	5052	0	-52	-52

*** Total catch derived from the projected landings and the assumed discard rate.**

**** SSB 2024 relative to SSB 2023.**

***** Total catch in 2023 relative to TAC 2022 (1810 tonnes).**

^ Advice value for 2023 relative to the advice value for 2022 (1810 tonnes).

^^ EU multiannual plan (MAP) for the Western Waters (EU, 2019).

Table 32.15. Sole in Division 7.e. Annual catch scenarios (more options and more digits provided, sorted by fishing mortality in intermediate year). All weights are in tonnes.

Basis	Total catch* (2023)	Projected landings (2023)	Projected discards (2023)	$F_{projected\ landings}$ (2023)	SSB (2024)	% SSB change **	% TAC change***	% advice change^
F0	0	0	0	0	5908.694	16.95698	-100	-100
$F_{MSY\ lower}$	819.5634341	815.9695	3.593925	0.16	5103.206	1.013098	-54.7203	-23.2619
F=0.17	866.5067574	862.707	3.799779	0.17	5057.182	0.102106	-52.1267	-52.1267
SSB_{stable}	871.769138	867.9463	3.822856	0.171127	5052.024	0	-51.836	-51.836
F_{sq}0.6	877.973809	874.1237	3.850064	0.172458	5045.942	-0.12039	-51.4932	-51.4932
F=0.18	912.9784847	908.9749	4.003566	0.18	5011.634	-0.79947	-49.5592	-49.5592
F=0.19	958.9836515	954.7783	4.205306	0.19	4966.557	-1.69173	-47.0175	-47.0175
F=0.2	1004.527238	1000.122	4.405022	0.2	4921.945	-2.57478	-44.5013	-44.5013
F=0.21	1049.614169	1045.011	4.602736	0.21	4877.794	-3.44872	-42.0103	-42.0103
F=0.22	1094.249317	1089.451	4.798469	0.22	4834.098	-4.31364	-39.5442	-39.5442
F_{sq}0.8	1138.192266	1133.201	4.991166	0.229944	4791.092	-5.16489	-37.1164	-37.1164
F=0.23	1138.437498	1133.445	4.992242	0.23	4790.852	-5.16964	-37.1029	-37.1029
F=0.24	1182.183479	1176.999	5.184075	0.24	4748.053	-6.01682	-34.686	-34.686
F=0.25	1225.491972	1220.118	5.37399	0.25	4705.694	-6.85527	-32.2933	-32.2933
F=0.26	1268.367637	1262.806	5.562007	0.26	4663.771	-7.68509	-29.9244	-29.9244
MP2	1310.815085	1305.067	5.748147	0.27	4622.28	-8.50638	-27.5793	-27.5793
MP	1310.815085	1305.067	5.748147	0.27	4622.28	-8.50638	-27.5793	-27.5793
F=0.27	1310.815085	1305.067	5.748147	0.27	4622.28	-8.50638	-27.5793	-27.5793
F=0.28	1352.838875	1346.906	5.932428	0.28	4581.215	-9.31921	-25.2575	-25.2575

Basis	Total catch* (2023)	Projected landings (2023)	Projected discards (2023)	$F_{projected\ landings}$ (2023)	SSB (2024)	% SSB change **	% TAC change***	% advice change^
F_{sq}	1383.792056	1377.724	6.068163	0.28743	4550.977	-9.91775	-23.5474	-23.5474
F_{MSY}	1394.443516	1388.329	6.114872	0.29	4540.573	-10.1237	-22.9589	-22.9589
F=0.3	1435.633468	1429.338	6.295496	0.3	4500.348	-10.9199	-20.6832	-20.6832
F=0.31	1476.413142	1469.939	6.474322	0.31	4460.537	-11.7079	-18.4302	-18.4302
F=0.32	1516.786901	1510.136	6.651368	0.32	4421.134	-12.4879	-16.1996	-16.1996
TAC085	1538.5	1531.753	6.746584	0.32542	4399.948	-12.9072	-15	-15
F=0.33	1556.75906	1549.932	6.826653	0.33	4382.135	-13.2598	-13.9912	-13.9912
$F_{MSY\ upper}$	1596.333886	1589.334	7.000195	0.34	4343.537	-14.0238	-11.8048	-22.8451
Fpa	1788.39415	1780.552	7.842412	0.39	4156.394	-17.7281	-1.19369	-1.19369
TAC	1810	1802.063	7.937157	0.395784	4135.36	-18.1445	-1.11E-14	-1.11E-14
F_{lim}	1971.134969	1962.491	8.643761	0.44	3978.624	-21.2469	8.902484	8.902484
TAC115	2081.5	2072.372	9.127731	0.471443	3871.409	-23.3691	15	15
B_{pa}	3087.903683	3074.363	13.54098	0.814384	2900	-42.5973	70.60241	70.60241
$B_{trigger}$	3087.903683	3074.363	13.54098	0.814384	2900	-42.5973	70.60241	70.60241
B_{lim}	4036.128381	4018.429	17.69911	1.29102	2000	-60.4119	122.9905	122.9905

*** Total catch derived from the projected landings and the assumed discard rate.**

**** SSB 2024 relative to SSB 2023.**

***** Total catch in 2023 relative to TAC 2022 (1810 tonnes).**

^ Advice value for 2023 relative to the advice value for 2022 (1810 tonnes).

32.16 Figures

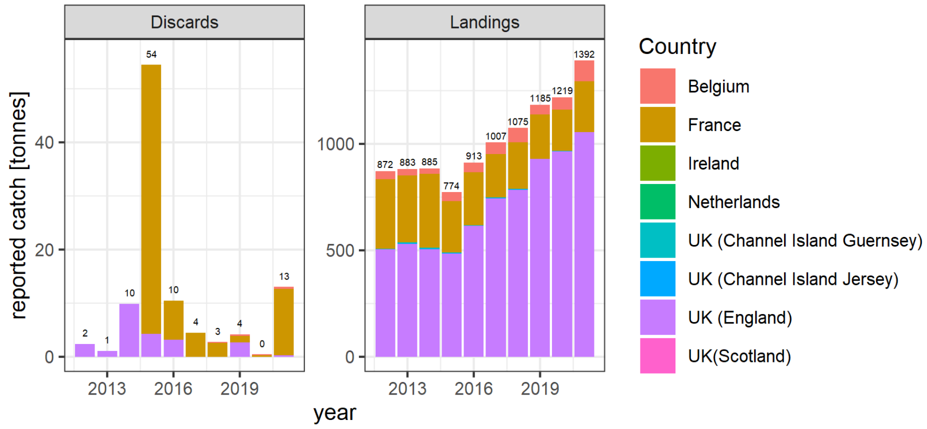


Figure 32.1. Sole in Division 7.e. Landings and discards reported in InterCatch by country.

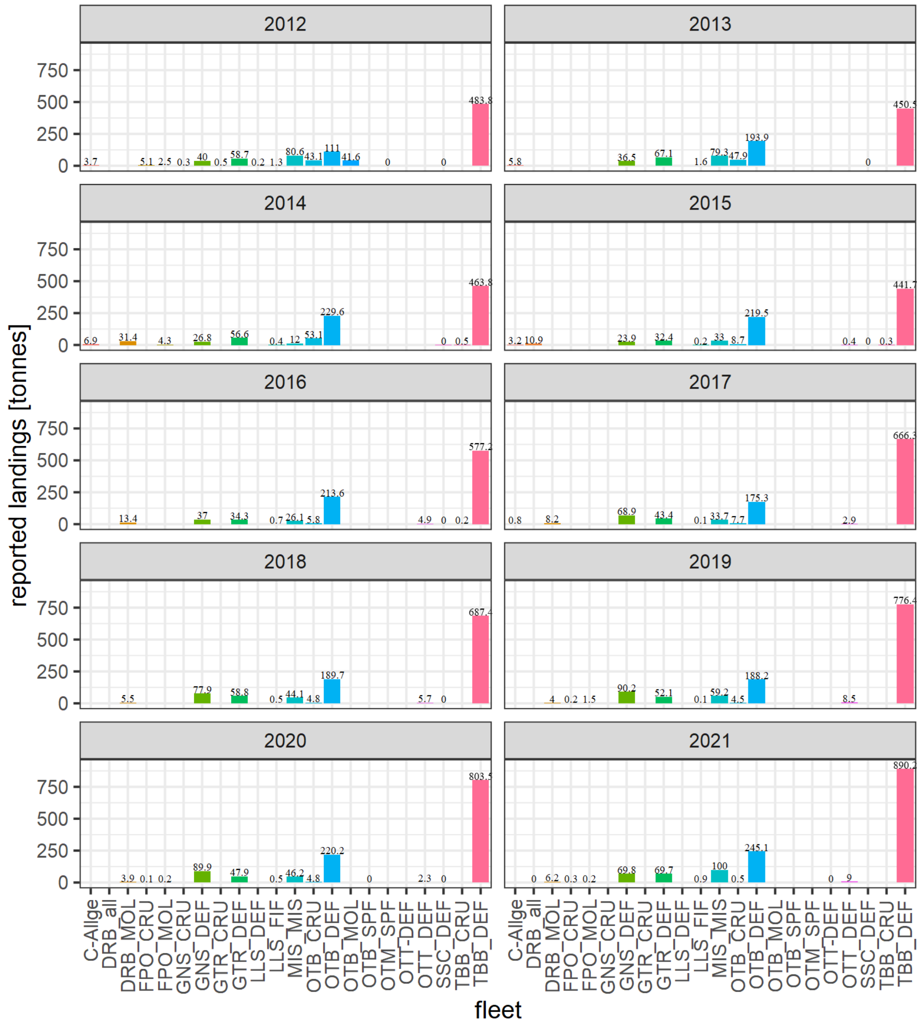


Figure 32.2. Sole in Division 7.e. International landings reported in InterCatch by fleet and year.

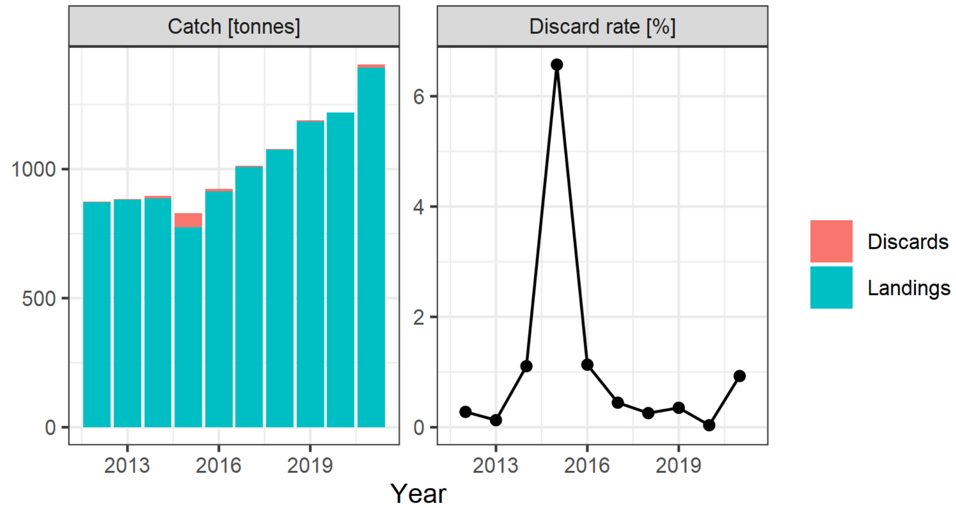


Figure 32.3. Sole in Division 7.e. Discard rates for discards reported in InterCatch.

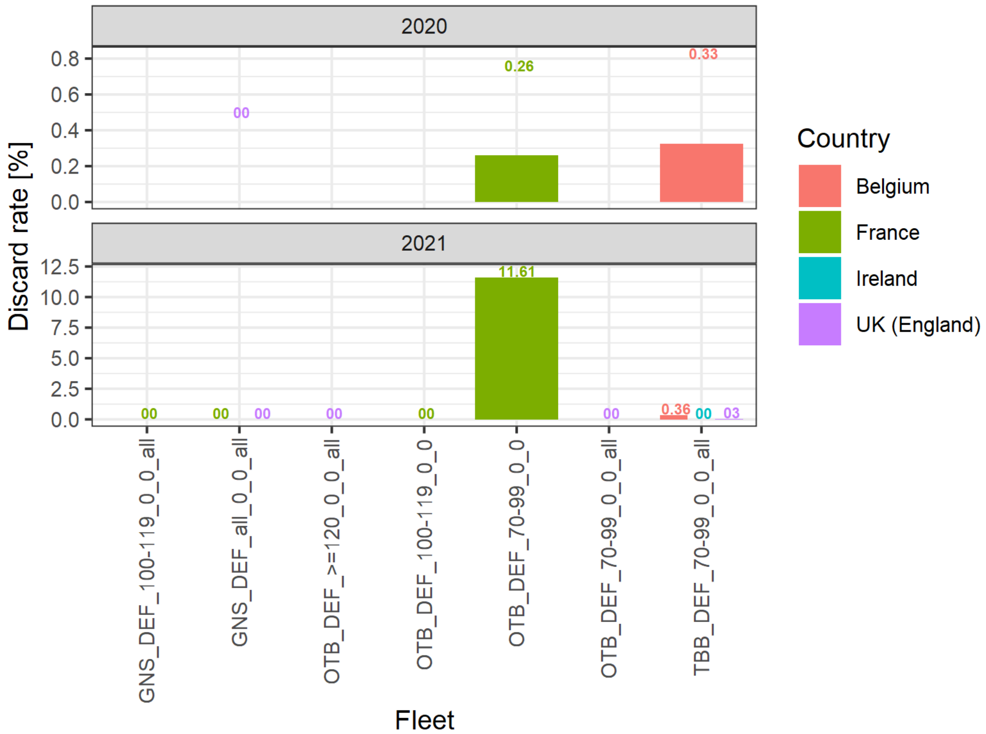


Figure 32.4. Sole in Division 7.e. Annual reported discard rates in InterCatch by fleet and country.

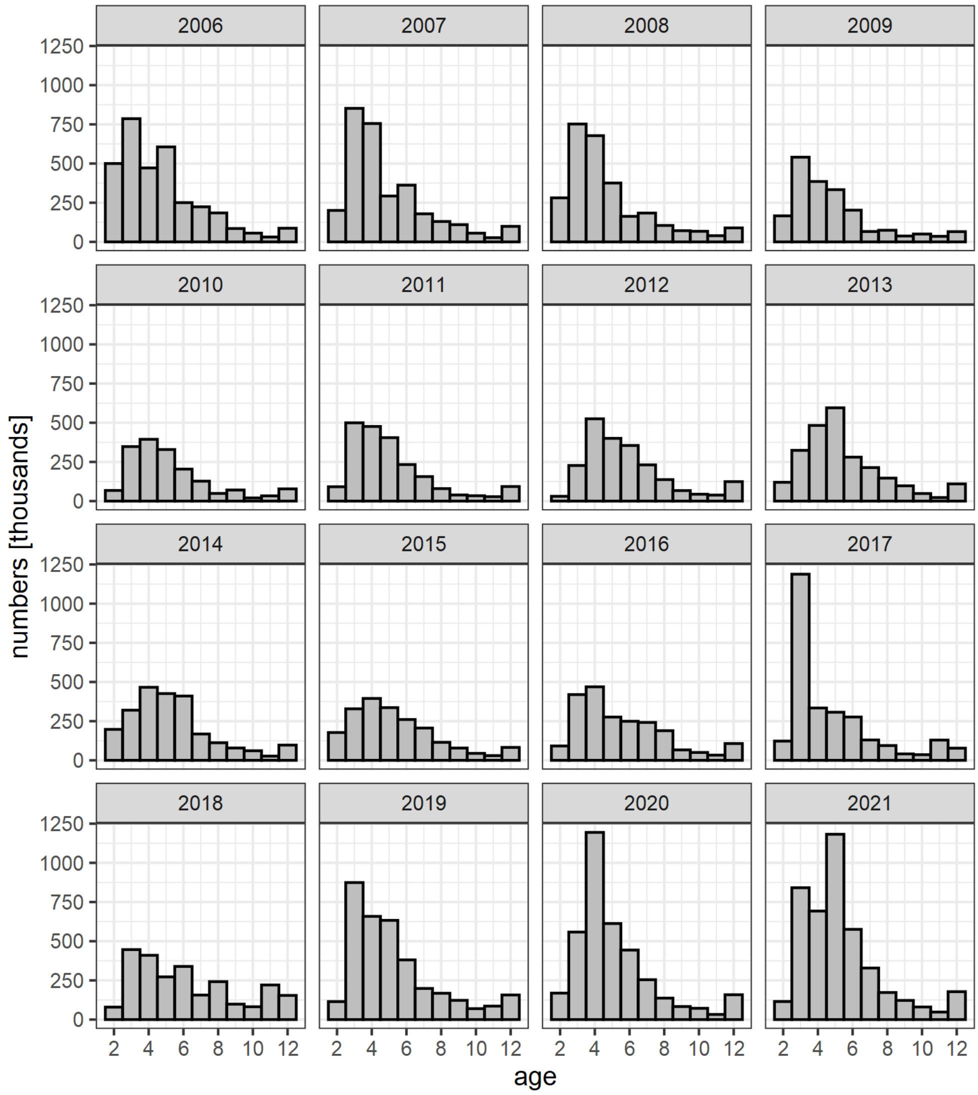


Figure 32.5. Sole in Division 7.e. International landings numbers-at-age (last 16 years).

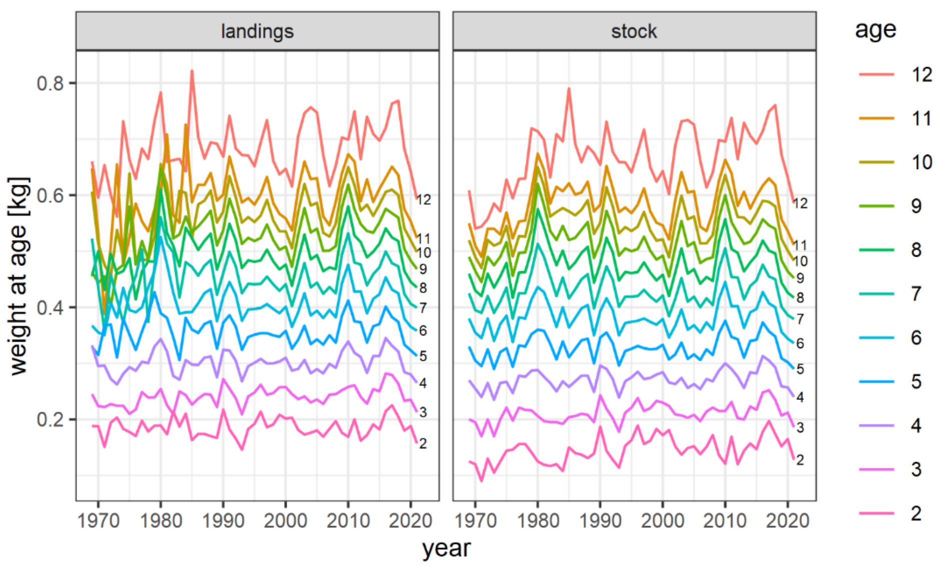


Figure 32.6. Sole in Division 7.e. Catch (landings) and stock weights-at-age.

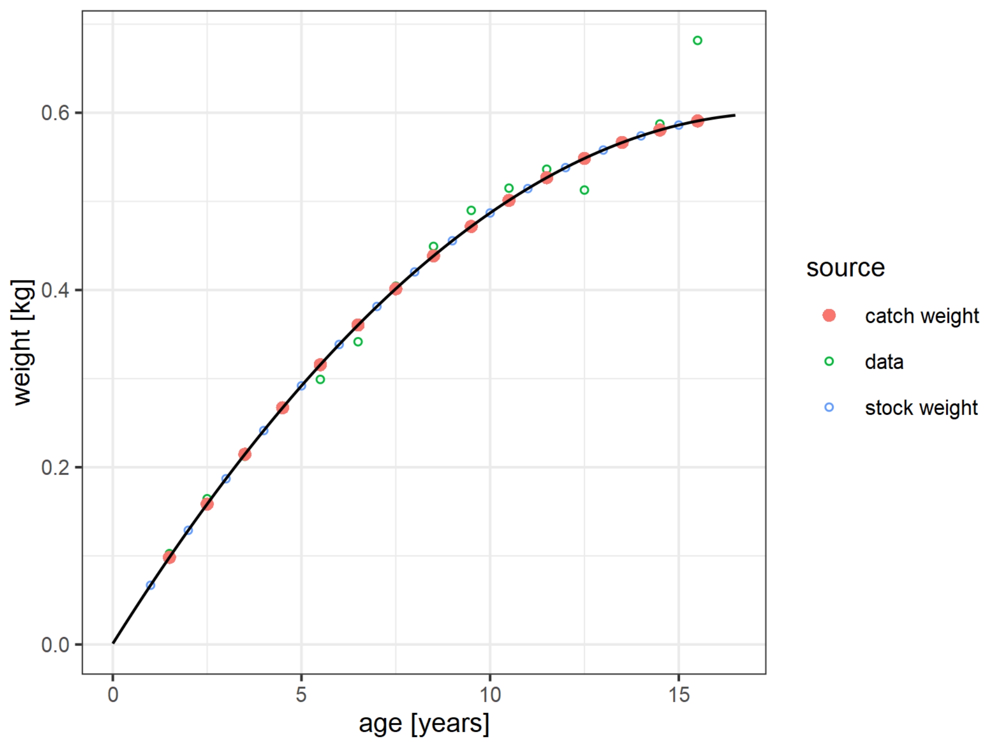


Figure 32.7. Sole in Division 7.e. Generation of stock and catch weights from landings weights-at-age.

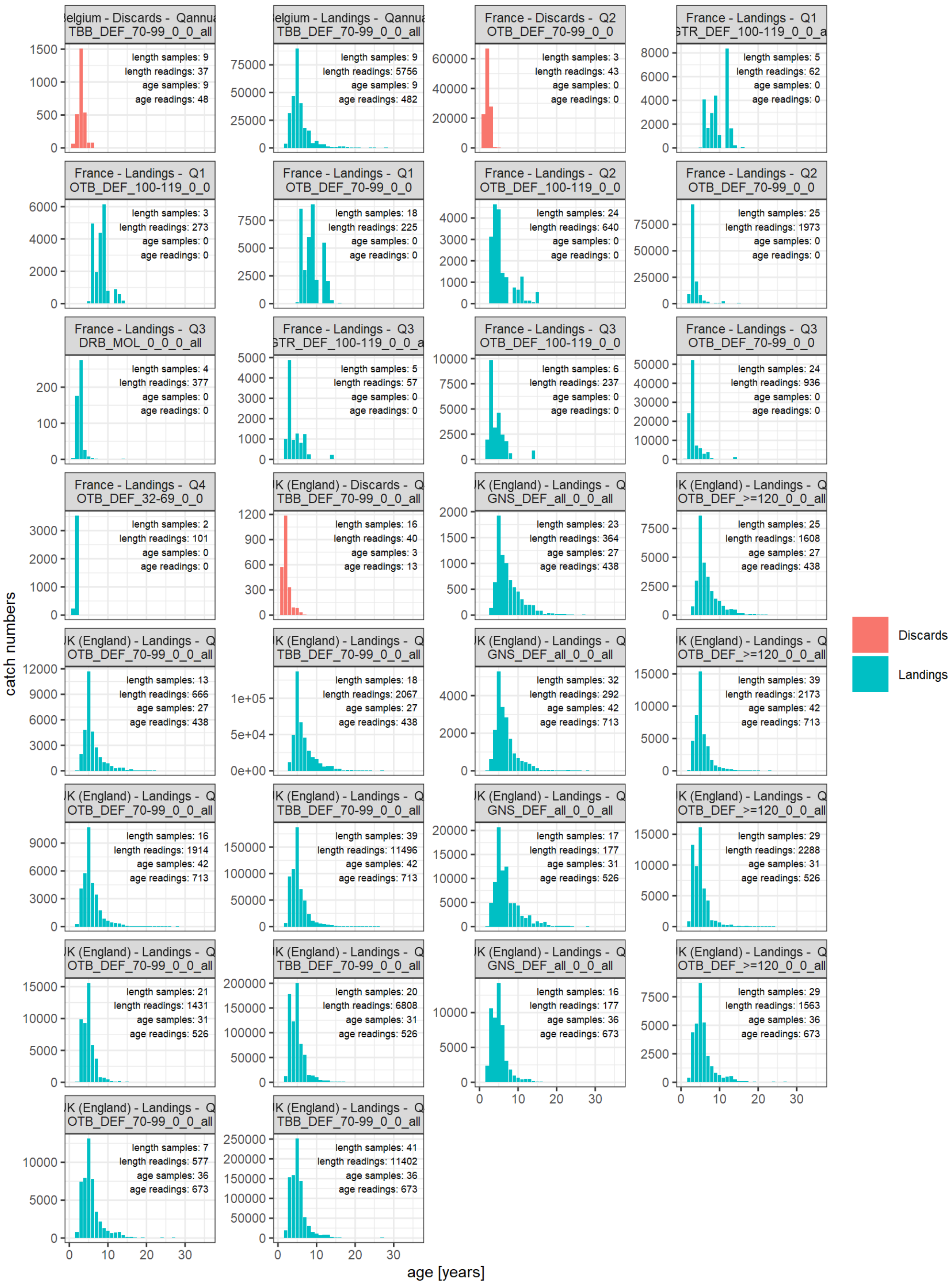


Figure 32.8. Sole in Division 7.e. Landings age distributions submitted to InterCatch. Numbers are raised to fleet level.

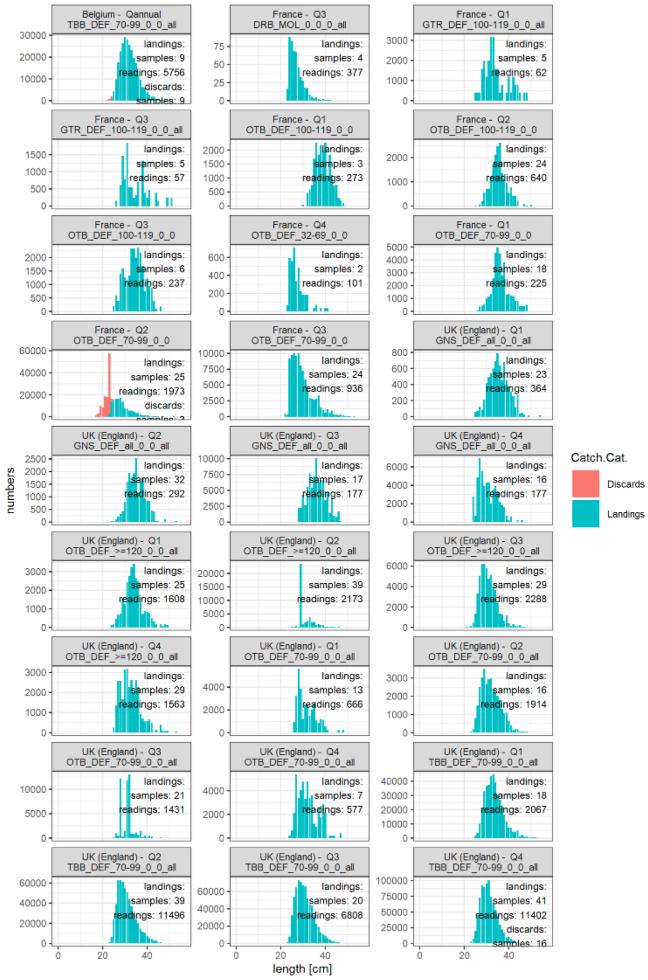


Figure 32.9. Sole in Division 7.e. Length distributions submitted to InterCatch. Numbers are raised to fleet level.

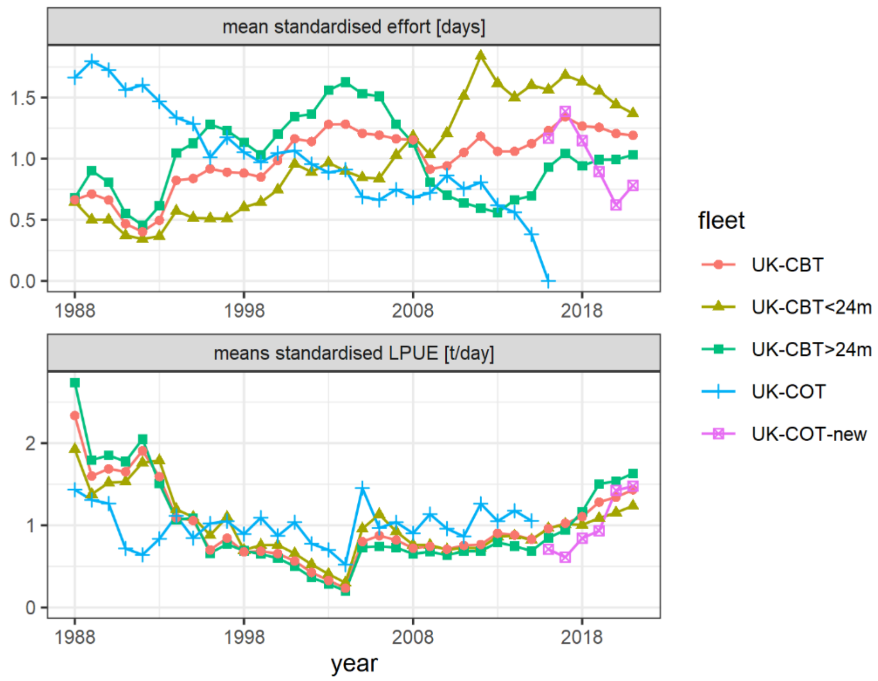


Figure 32.10. Sole in Division 7.e. Means standardised lpue and effort for the UK commercial fleets.

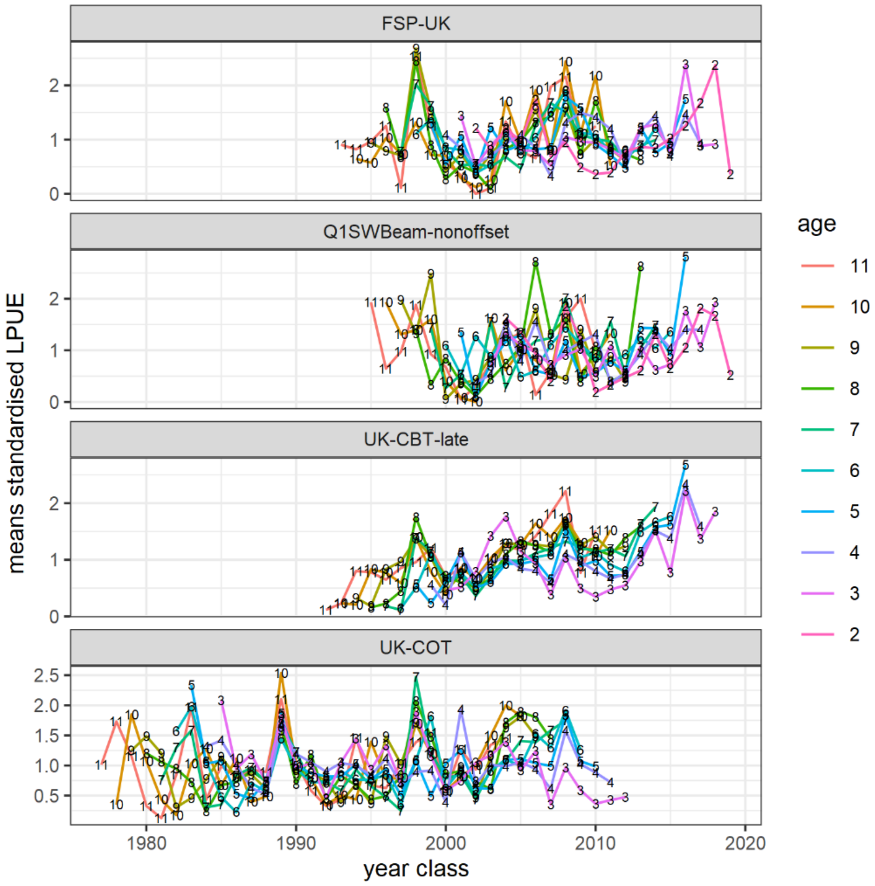


Figure 32.11. Sole in Division 7.e. Means standardised lpue/cpue by year class. Note, the cohorts differ on the x-axes due to the differences in the length and age ranges of the tuning series.

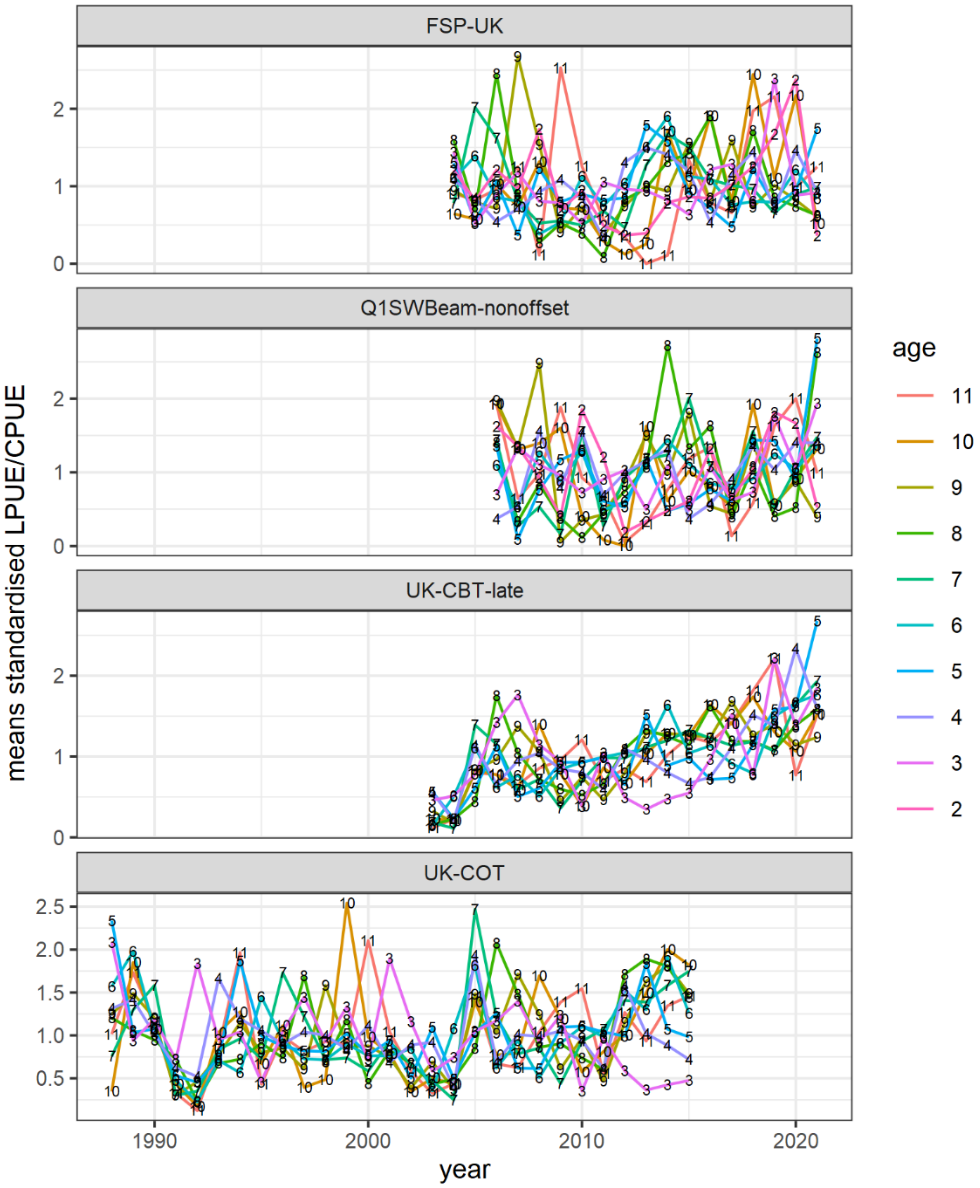


Figure 32.12. Sole in Division 7.e. Means standardised lpue/cpue by year. Note, the lines differ on the x-axes due to the differences in the length and age ranges of the tuning series.

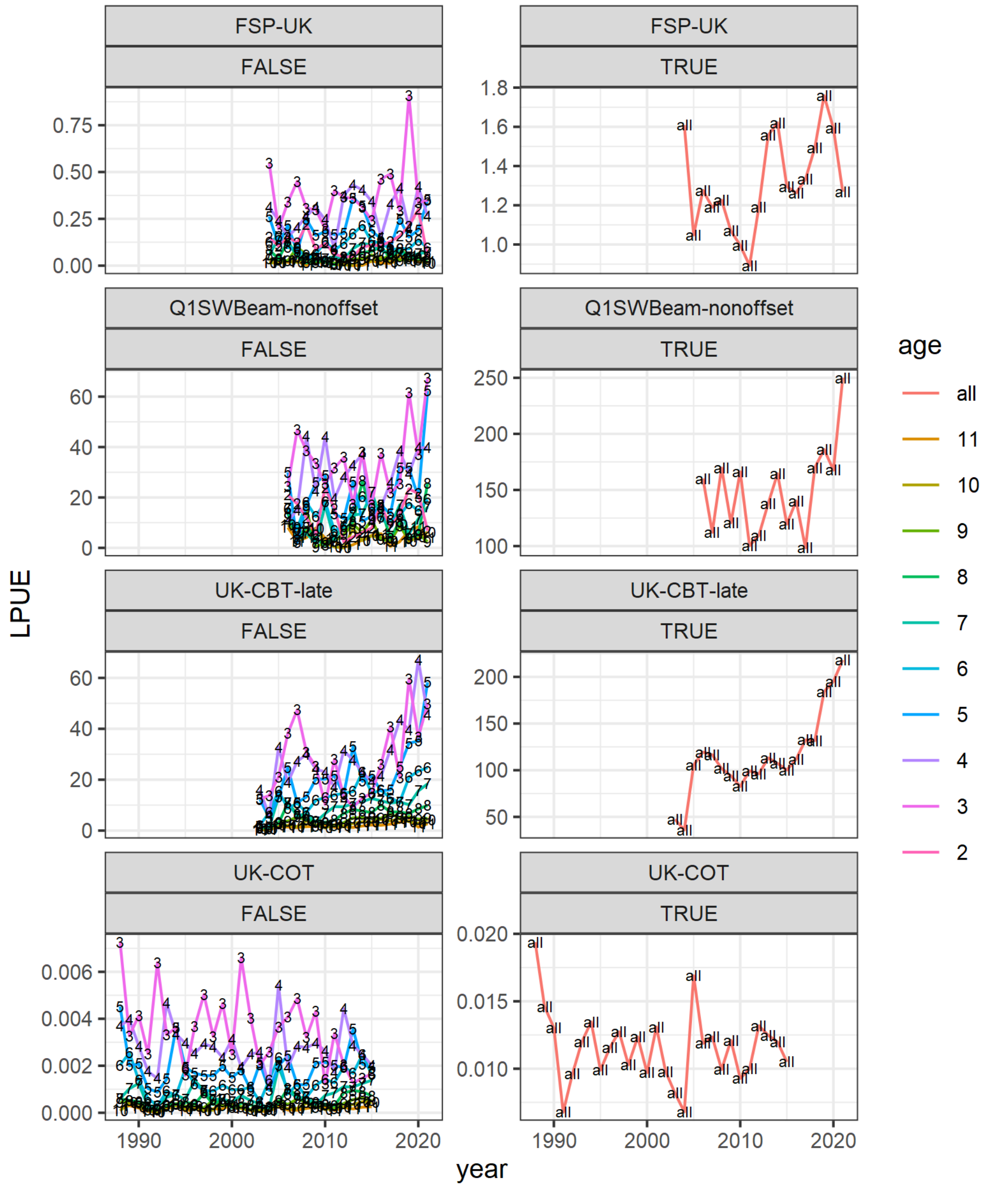


Figure 32.13. Sole in Division 7.e. Survey indices (raw values) for all commercial and scientific surveys. The plots on the left show the index values at-age, on the right are the values aggregated over all ages.

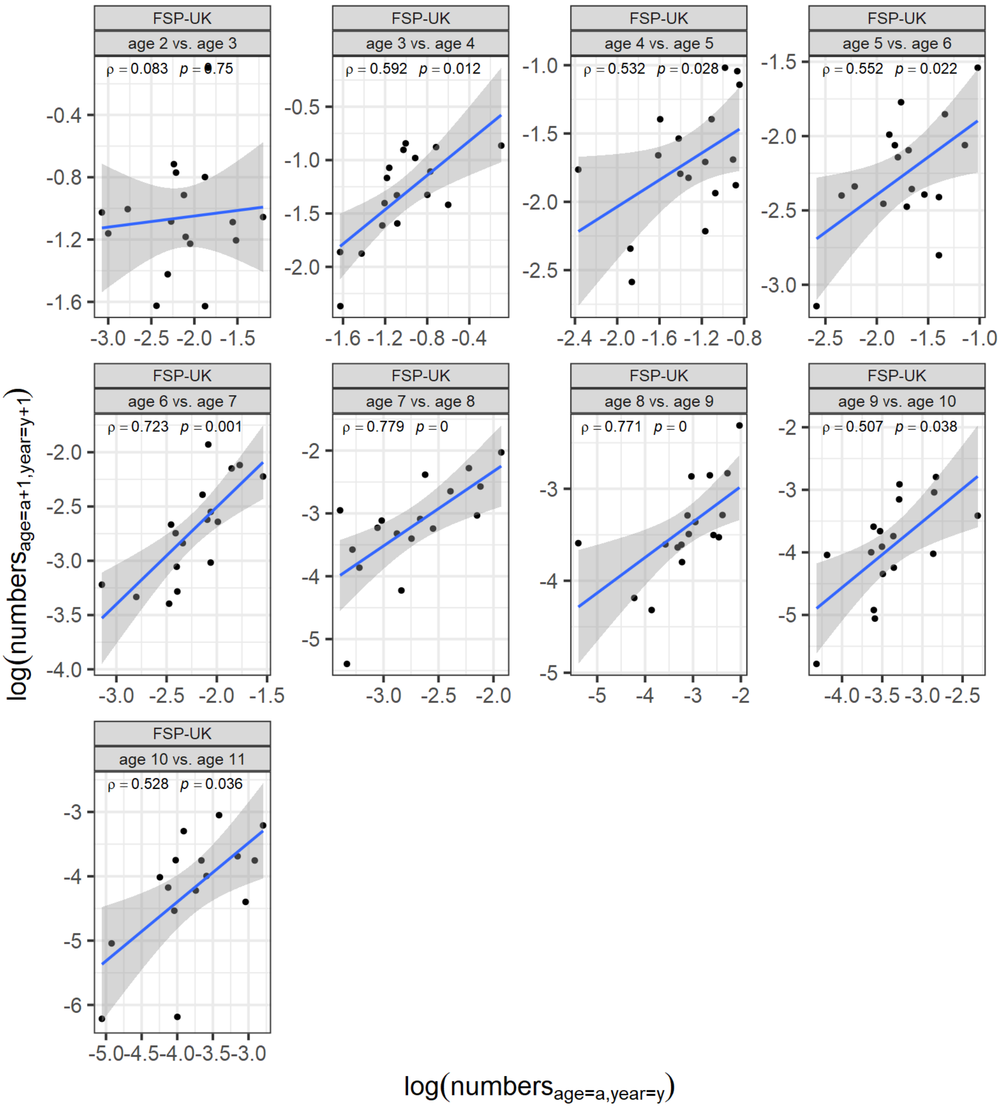


Figure 32.14. Sole in Division 7.e. Internal consistencies in the scientific surveys. Shown is the correlation between numbers-at-age and the numbers of the same cohort one year later, including Pearson correlation coefficient *ρ* and the *p*-value.

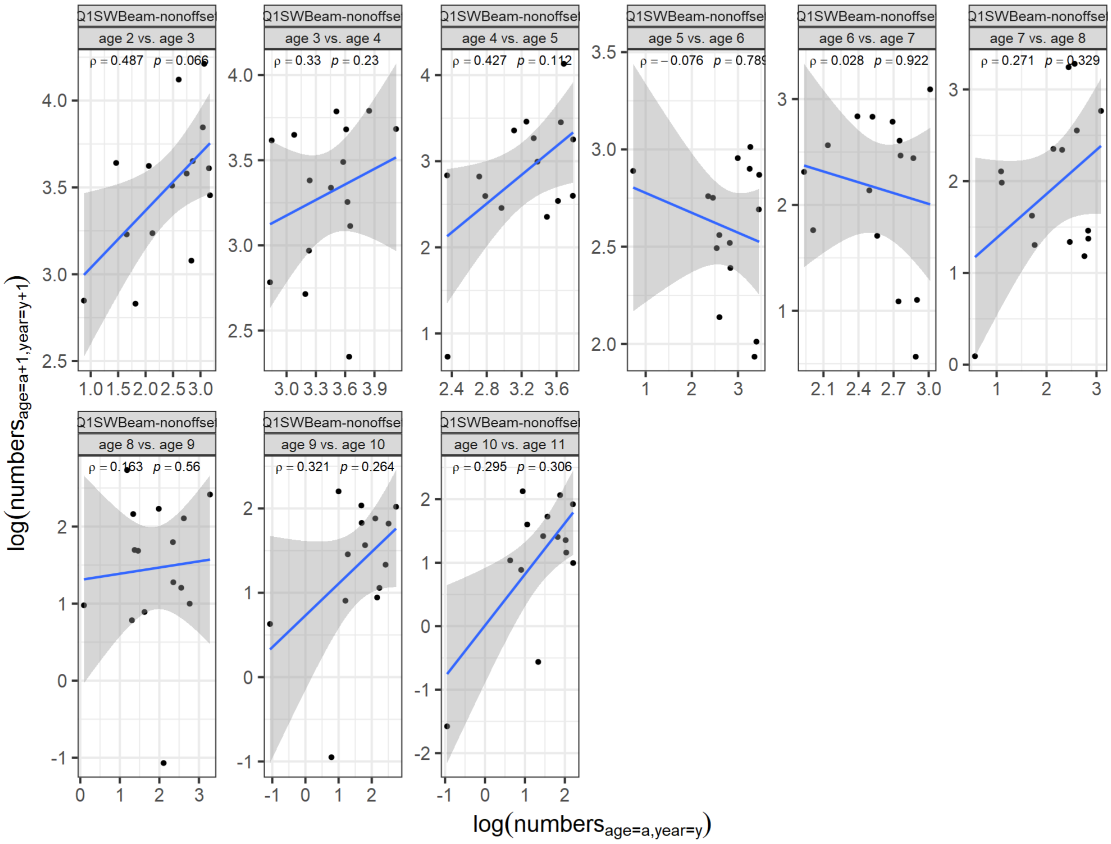


Figure 32.15. Sole in Division 7.e. Internal consistencies in the scientific surveys. Shown is the correlation between numbers-at-age and the numbers of the same cohort one year later, including Pearson correlation coefficient ρ and the p-value.

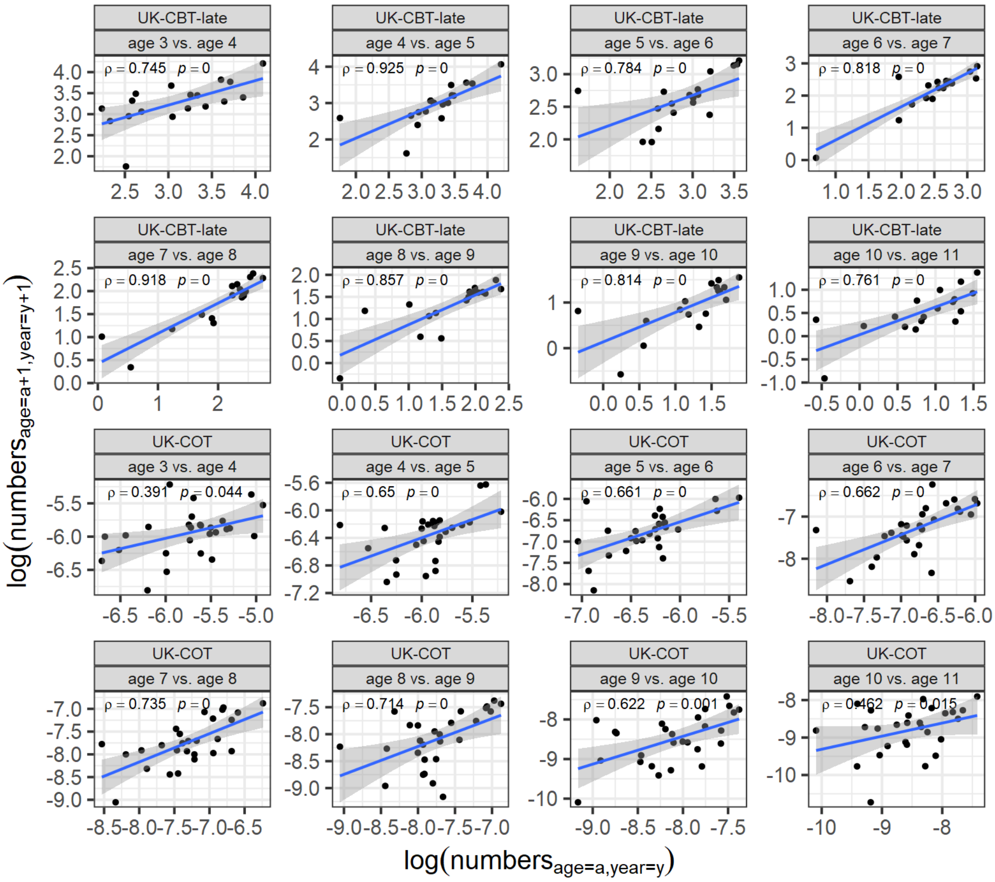


Figure 32.16. Sole in Division 7.e. Internal consistencies in the commercial surveys. Shown is the correlation between numbers-at-age and the numbers of the same cohort one year later, including Pearson correlation coefficient *ρ* and the *p*-value.

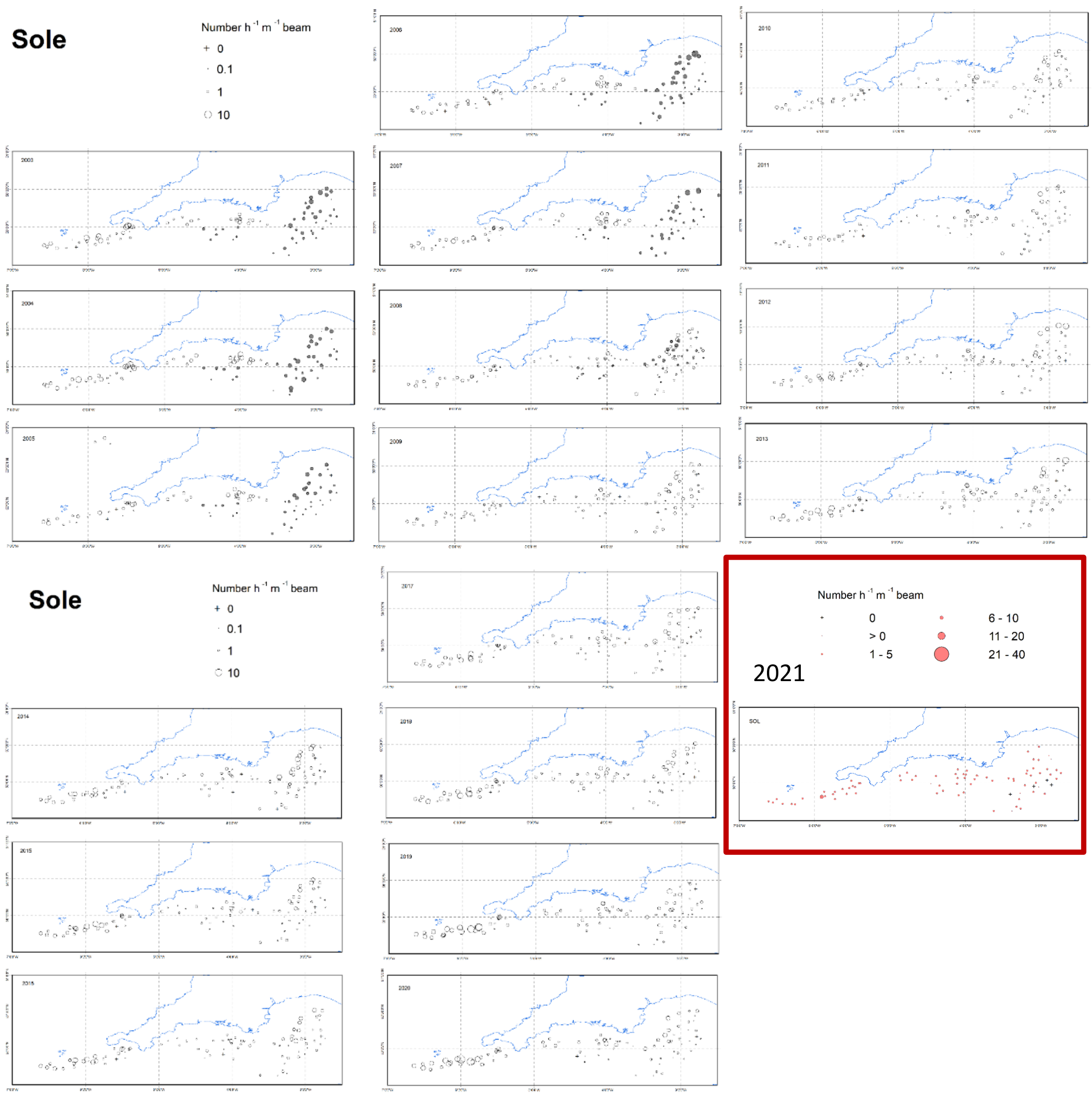


Figure 32.17. Sole in Division 7.e. Sole catch rates during FSP "Western Channel Sole and Plaice" surveys, 2003–2021 (number h^{-1} m beam^{-1}). Open circles: FV Nellie and FV Carhelmar tows; filled circles: FV Lady T Emiel tows. Please note that 2021 numbers are not to scale. Source: Burt *et al*. (2021, 2022).

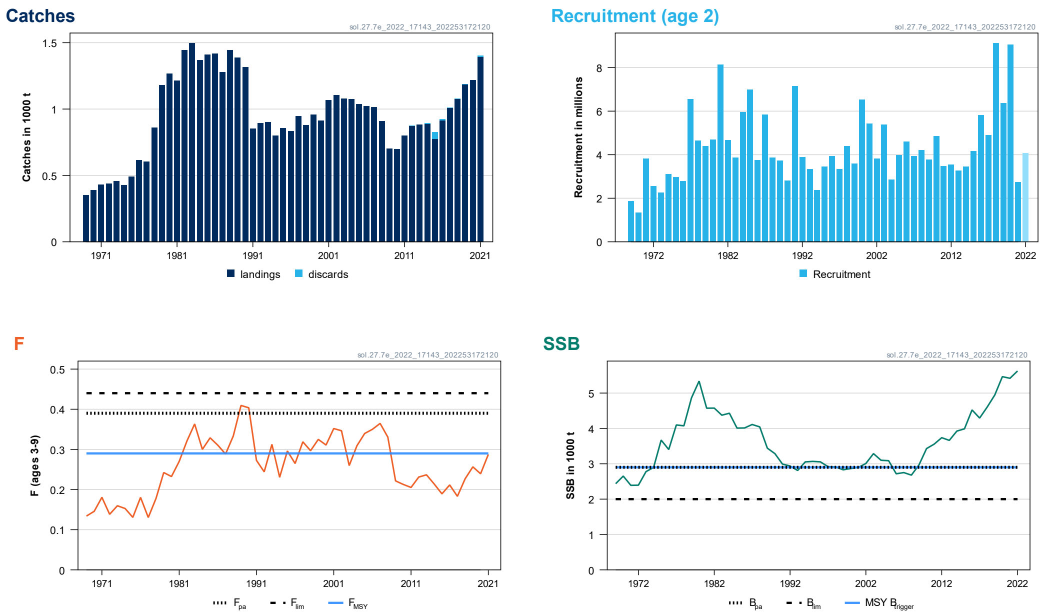


Figure 32.18. Sole in Division 7.e. Results of the final XSA run. Summary of the stock assessment. ICES estimated catches, recruitment (age 2), fishing mortality (F), and spawning–stock biomass (SSB). The assumed recruitment value for 2022 is shaded in a lighter colour. Discard estimates are only available since 2012.

Figure 32.19. Sole in Division 7.e. XSA fleet log catchability residuals for. Note that the application of time-series weighting set as a tricubic taper with a range of 15 years excludes log catchability residuals prior to 2004.

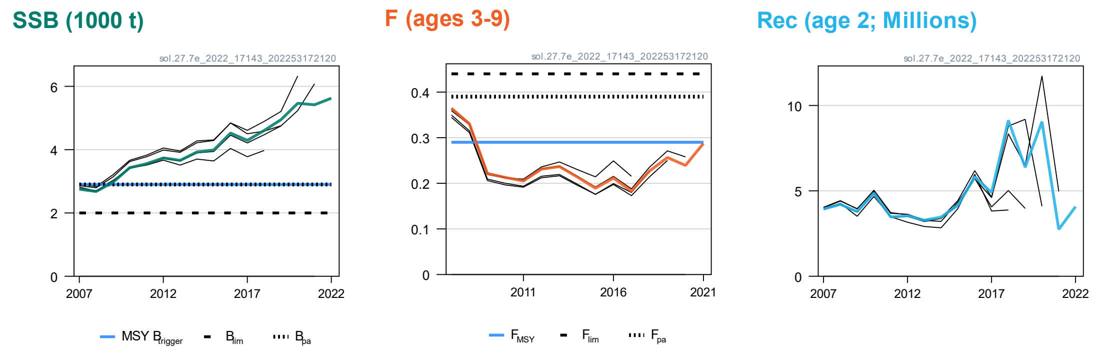


Figure 32.20. Sole in Division 7.e. Comparison of the current XSA assessment with the final assessment runs from the last years.

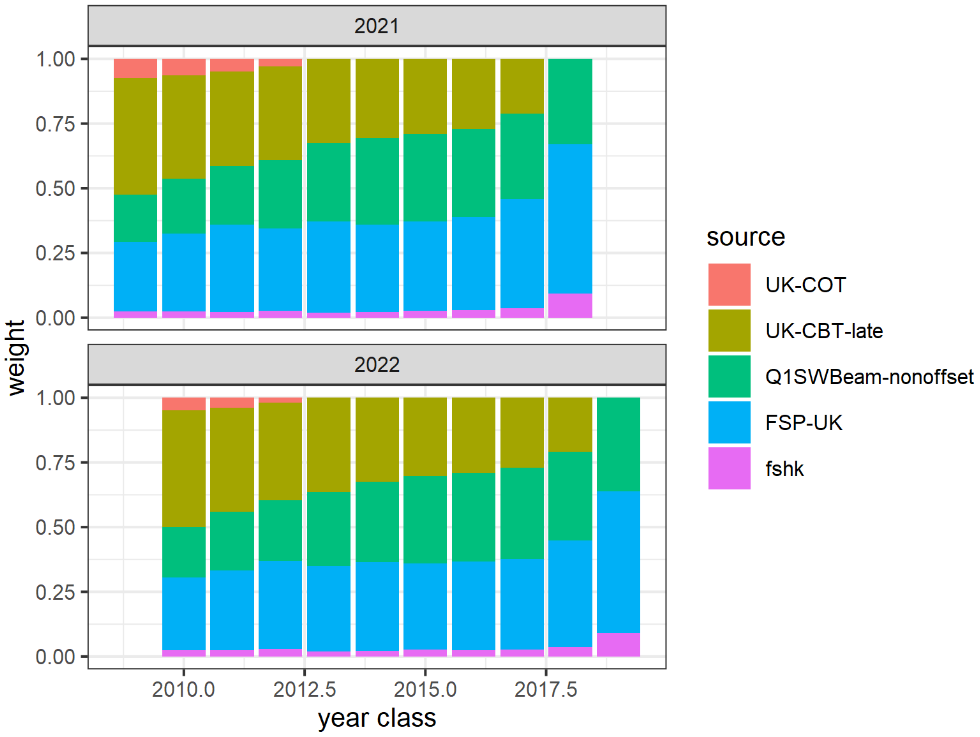


Figure 32.21. Sole in Division 7.e. Scaled weights for the current XSA assessment and the previous XSA assessment conducted at last year's WGCSE.

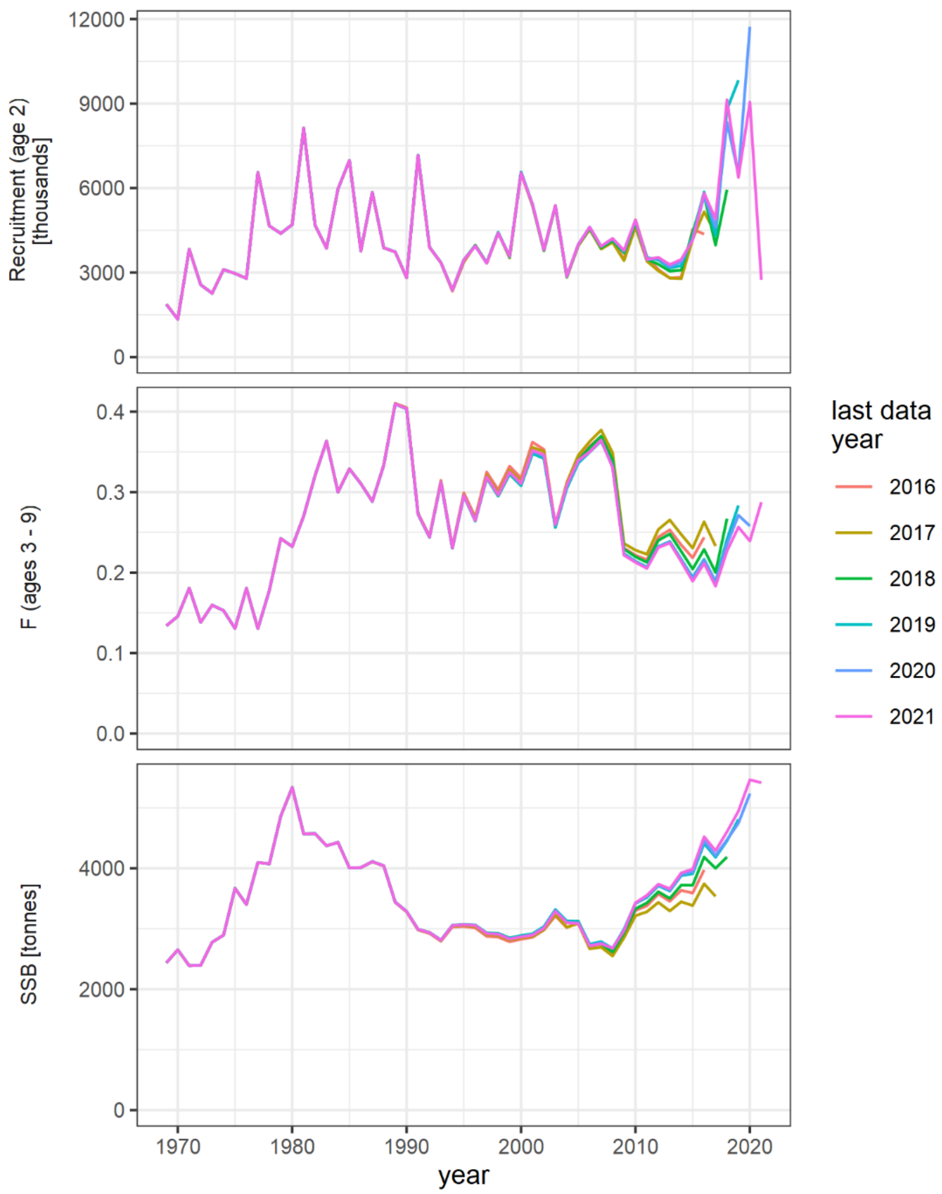


Figure 32.22. Sole in Division 7.e. Five-year retrospective of stock status and fishing mortality estimates.

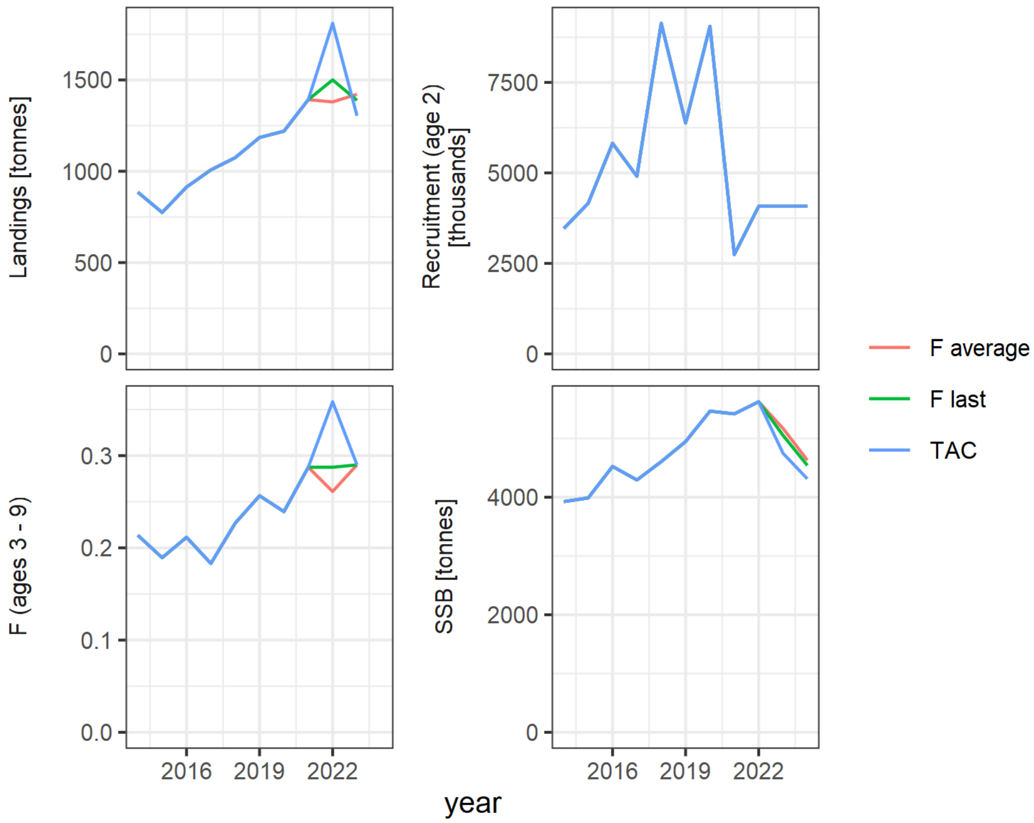


Figure 32.23. Sole in Division 7.e. Options for the intermediate year in the short-term forecast.

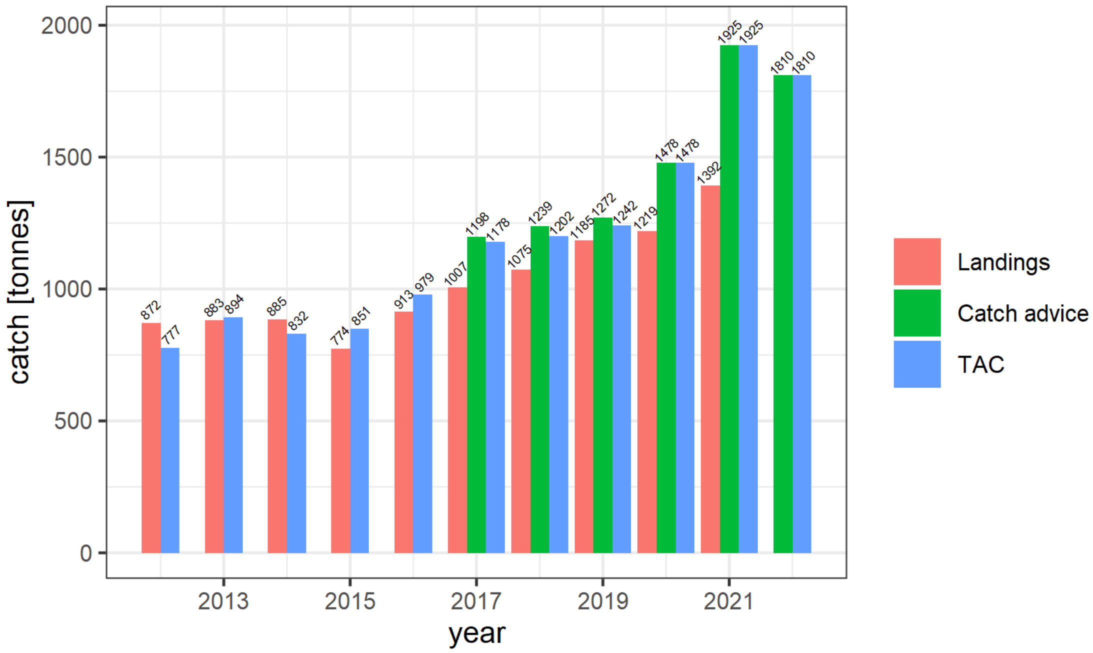


Figure 32.24. Sole in Division 7.e. Comparison of international TAC, catch advice and realised landings.

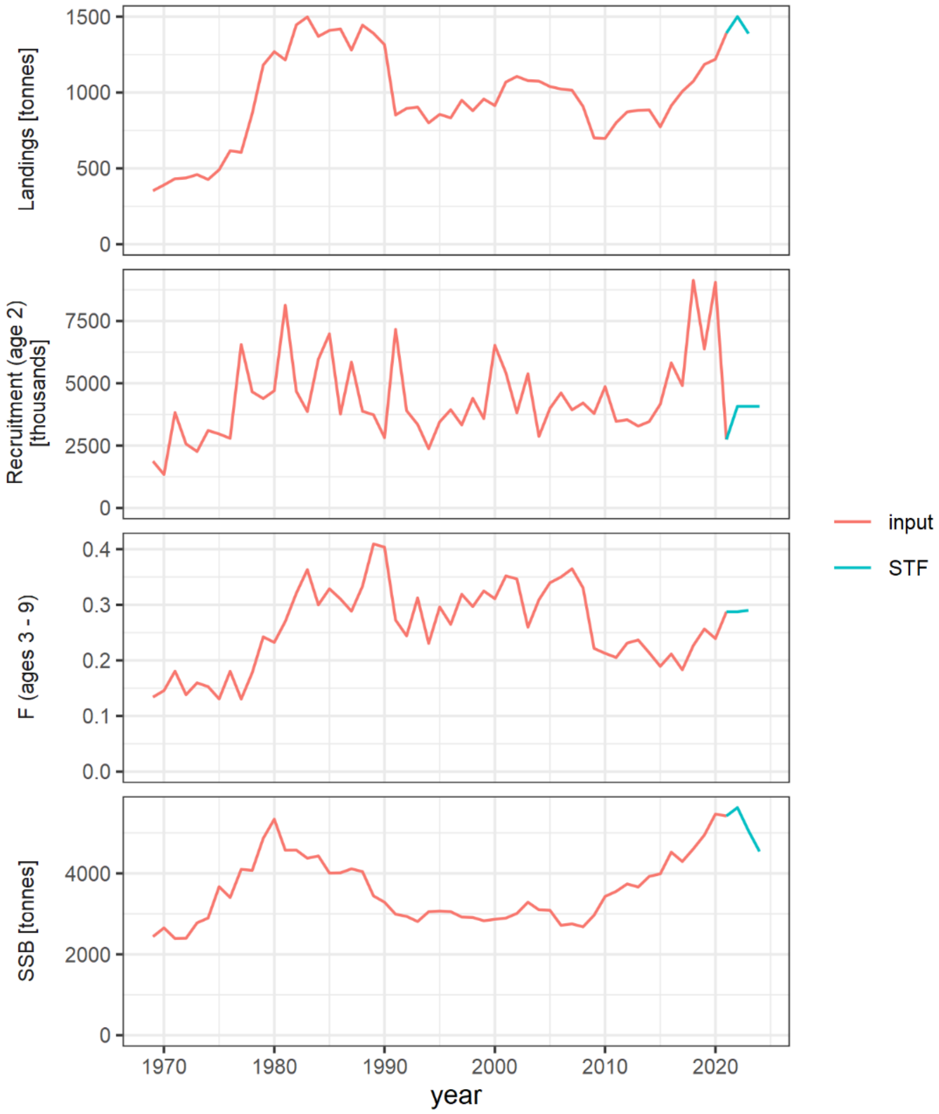


Figure 32.25. Sole in Division 7.e. Output for the short-term forecast under the MSY approach.

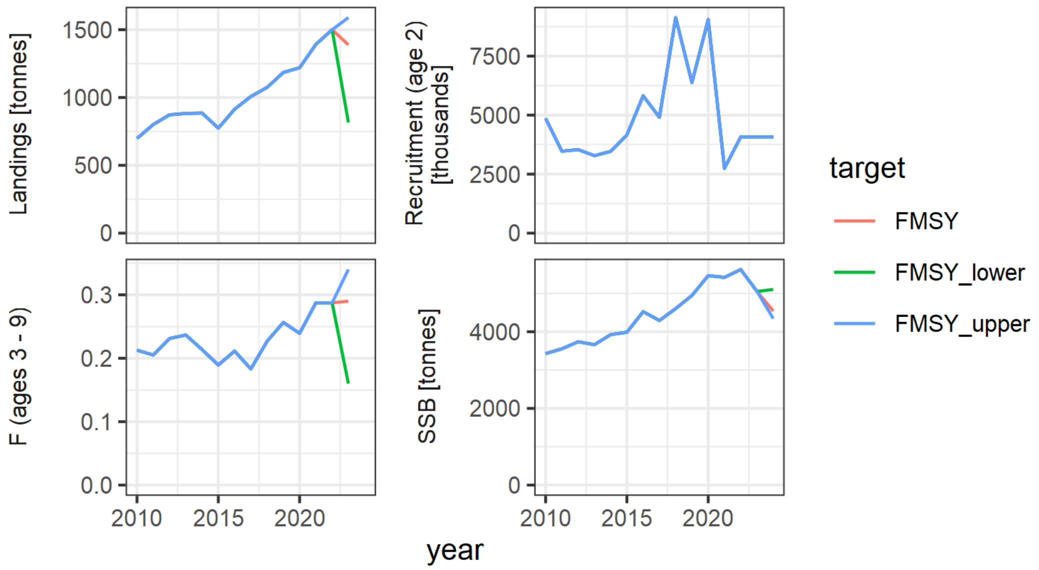


Figure 32.26. Sole in Division 7.e. Output of the short-term forecast of the MSY approach, including F_{MSY} ranges.

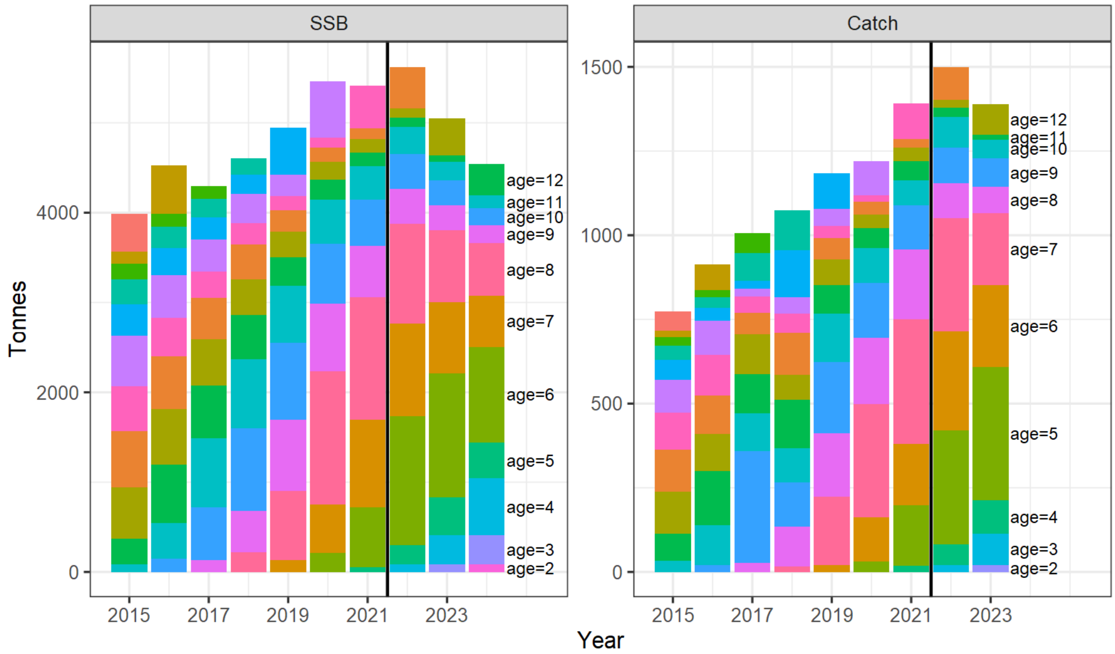


Figure 32.27. Sole in Division 7.e. Age class contributions (biomass) to the SSB and catch. Age 12 is the plus group. The vertical black line indicates where the short-term forecast starts.

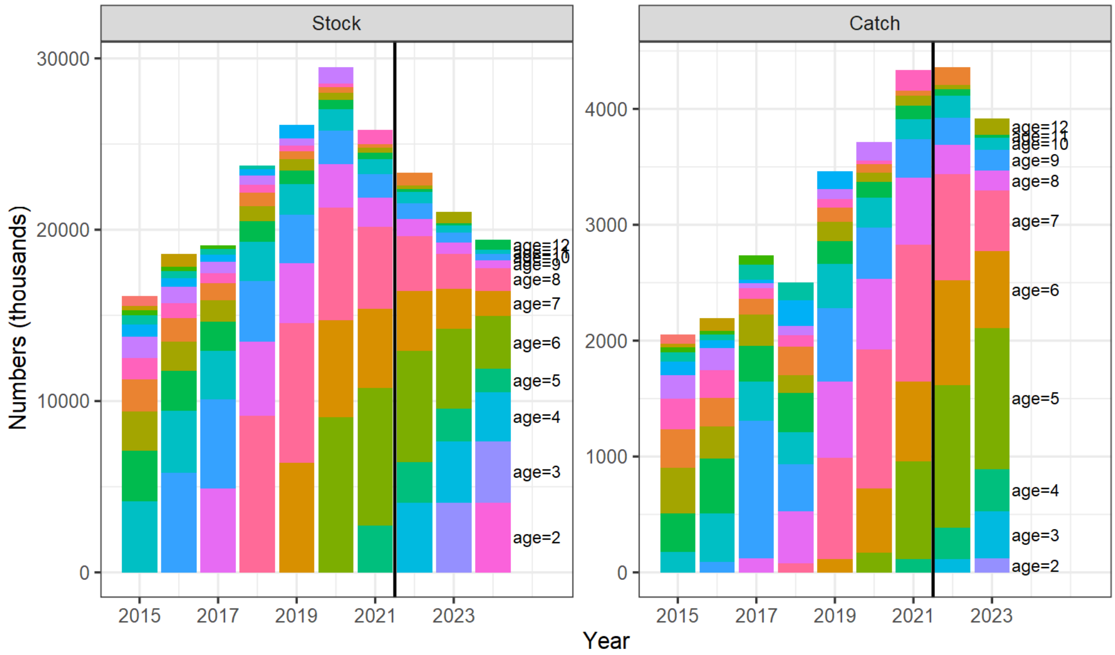


Figure 32.28. Sole in Division 7.e. Age class contributions (numbers) to the stock and catch. Age 12 is the plus group. The vertical black line indicates where the short-term forecast starts.

33 Sole (*Solea solea*) in Division 7.f and 7.g (Bristol Channel, Celtic Sea)

Type of assessment in 2022

This assessment is an update assessment.

ICES advice applicable to 2022

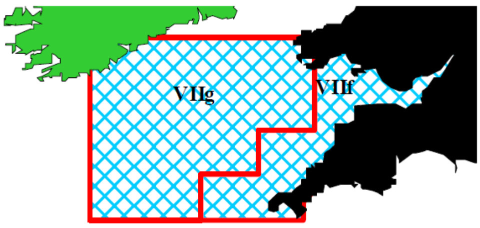
ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 1337[1] tonnes.

Comments made by the audit of last year's assessment

No major deficiencies for the sole assessment in the Celtic sea were reported.

33.1 General

Stock description and management units.



The sole fisheries in the Celtic Sea are managed by TAC and technical measures. 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.

The agreed TACs in 2021 and 2022 are presented in the text tables below. Technical measures in force for this stock are minimum mesh sizes and minimum conservation reference sizes (MCRS, 25 cm for Belgian vessels from March 11th 2017 onwards, except vessels with engine power <221 kW and/or volume <70 GT). National regulations also restricted areas for certain types of vessels.

Three rectangles in the Celtic Sea (30E4, 31E4 and 32E3, referred to as the "Trevose Box") were closed during the first quarter of 2005, and in February–March each year from 2006 onwards. A derogation has permitted beam trawlers to fish there in March 2005. The effects of this closure have been discussed in previous WGSSDS meetings and ACFM 2007, and evaluated at WKCELT 2014

[1] Value corrected. The assessment and advice were revised due to the discovery of an error in the setting of the catch numbers for age 1 and 2 for 1971–2003 in the SAM model. Values and figures have been updated in this sheet.

Management applicable to 2021 and 2022

The TAC and the national quotas by country for 2021.

Species:	Common sole *Solea solea*		Zone:	7f and 7g (SOL/7FG.)
Belgium		830	Analytical TAC	
France		83	Article 8(2) of this Regulation applies	
Ireland		42		
Union		955		
United Kingdom		433		
TAC		1 413		

The TAC and the national quotas by country for 2022.

Species:	Common sole *Solea solea*		Zone:	7f and 7g (SOL/7FG.)
Belgium		781	Analytical TAC	
France		78	Article 8(2) of this Regulation applies	
Ireland		39		
Union		898		
United Kingdom		415		
TAC		1 337		

Fishery in 2021

An overview of the landings and discard data provided and used by the Working Group (WG) is shown in Table 33.1 and Figure 33.1. The landings have fluctuated over the time-series with higher amounts of around 1500–1600 t in 1986, 2003 and 2020. The available discard data indicate that discarding of sole has increased in 2018 and 2019 (to 141 and 145t respectively) due to the strong 2016 year class. Afterwards discards decreased again to 106 t in 2020.

In 2021, the WG estimated landings are 1336 t, of which Belgium landed 62.1% (830 t), UK (England and Wales) 29.6% (395 t), France 4.5% (60 t), Ireland 3.6% (48 t) and the remainder by Northern Ireland and Spain. Discards were estimated to be at 62 t. This catch figure (1398 t) corresponds to an international uptake of 99% of the agreed TAC in 2021 (1413 t).

The WG estimate of the 2020 landings and discards was not revised.

In 2021, 87% of the landings and discards were taken by beam trawls, 13% by otter trawls and <1% by other gears.

33.2 Data

Age-compositions and weights-at-age

InterCatch was used for estimation of both landings and discards numbers and age compositions, as input for the assessment. Belgium, Ireland, France, UK, Spain and Northern Ireland have provided data this year under the ICES InterCatch format on a métier basis. Quarterly/yearly data for 2021 were available for landing numbers and weight-at-age, for most of the Belgian, Irish and UK fleets. These comprise 90% of the international landings. Discard weights were available for 60% of the landings. The age coverage for the sampled discards is 100%.

If discards were not included for a particular year-quarter-country-métier combination, they are assumed to be unknown (non-zero) and therefore raised (InterCatch). The weighting factor for raising the discards was 'Landings CATON' (landings catch). Discard raising was performed on a gear level regardless of season or country. The following groups were distinguished based on gear:

- TBB
- OTB including OTB, OTT, SSC, SDN
- GTR including GTR and GNS

The remaining gears were combined in a REST group (including MIS, FPO, DRB, LHM, LLS).

The GNS/GTR, TBB and OTB/OTT/SSC/SDN groups contribute respectively 0%, 69% and 0.006% to the landings of sole in 27.7.fg.

Raising within a gear group was performed when the proportion of landings for which discard weights are available was equal or larger than 50% compared to the total landings of that group. For the 2021 data, this was only the case for the TBB gear group. When the threshold was not reached for a gear group, it was pooled with the REST group to raise discards based on all available information.

To allocate age compositions, landings and discards were handled separately; samples from landings were used only for landings and *vice versa*. When age distributions (both landings and discards) had to be borrowed from other strata, allocations were performed on a gear level. The same gear groups (TBB, OTB, GTR and REST) as used for discard raising were applied. In 2021, the proportion of landings covered for age composition is respectively 27%, 100% and 22% for the GNS/GTR, TBB and OTB/OTT/SSC/SDN group. The proportion of landings for which discard age coverage is available is respectively 0%, 69%, and 0% for the GNS/GTR, TBB and OTB/OTT/SSC/SDN group. When the threshold of 50% was reached for the proportion of landings or discards covered by age, allocation of age occurred with all available information within that gear group. For the 2021 landings and discard data, this threshold was only reached for the TBB group. When the threshold was not reached, unsampled data were pooled in the REST group and ages were allocated using all sampled data. The weighting factor was '*Mean Weight weighted by numbers-at-age*'.

Figure. 33.2 shows the available landings and discards data by country, gear and year.

Raised discard data from InterCatch were available from 2004 onwards. To estimate discard mean weight-at-age and numbers-at-age prior to 2004, a constant ratio of discards to landings by age was applied using data from 2004–2018 (WKFlatNSCS 2020).

Further details on raising methods are given in the stock annex.

Catch numbers-at-age are given in Table 33.2 and weights-at-age in the catch are given in Table 33.3. Age compositions are plotted in Figures 33.3ab. The standardised catch proportion-at-age is presented in Figure 33.4.

Length-compositions

Annual length compositions for 2021 are given by fleet in Table 33.4 Length distributions of the total Belgian and UK(E&W) landings for the last 21 years are plotted in Figure 33.5. Belgian vessels generally land a greater proportion of small fish compared to the UK(England and Wales).

The length distributions for 2021 of retained and discarded catches of sole by the Belgium beam trawl fleet are presented in Figure 33.6 from The Belgian beam trawl fleet mainly discarded fish of 23 and 24 cm. According to the Belgian age–length samples, these fish were mainly age 3 or 4.

Biological

The stock weights (Table 33.5) were obtained using the Rivard weight calculator (http://nft.nefsc.noaa.gov./), that conducts a cohort interpolation of the catch weights. The resulting stock weight for age 1 was very variable, and it was decided during the benchmark to set the stock weight of age 1 to the lowest estimated stock weight for age 2 for 1971–2019.

A new maturity ogive was estimated during the WKFlatNSCS (ICES, 2020) using only survey data of the UK(E&W)-Q1SWECOS. Maturity data are available for 2013–2019. The new maturity ogive is calculated with a length-based model with sex-specific ALK. This new ogive indicates that >60% of the 2 and 3 year old individuals are mature, while this was not the case in the maturity ogive used until the WGCSE 2019. The maturity at-age 1 was manually set to 0 as no mature sole at age 1 were encountered at the UK(E&W)-Q1SWECOS survey.

Updated maturity at-age based on data from the UK(E&W)-Q1SWECOS survey.

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Maturity	0.0	0.67	0.91	0.98	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Natural mortality was assumed to be 0.1 for all ages and years

Surveys

The WGCSE 2022 Celtic Sea sole stock assessment used one scientific survey index: UK(E&W)-BTS-Q3 (1988–2021), from age 1 to 5. It is the only index providing information on the recruiting age (age 1). Standardised abundance indices for the UK beam trawl survey (UK(E&W)-BTS-Q3)) are shown in Table 33.6 and Figure 33.7. 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 33.8).

After the peak in 2000 (228.46 kg/100 Km fished, Figure 33.9 and Table 33.8), the LPUE from the UK(E&W)-BTS-Q3 dropped gradually to the lowest value in 2006 (68.967 kg/100 Km fished). Thereafter, it fluctuated between 80 kg/100 Km fished and 120 kg/100 Km fished until 2017. In 2018, it increased again to 206.44 kg/100 Km fished and for 2020 and 2021 a lower value of about 112 kg/100 Km fished was noted.

Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

Commercial LPUE

Available estimates of effort and LPUE are presented in Tables 33.7–33.8 and Figure 33.10.

Commercial LPUE and effort data were available for Belgian beam trawlers, UK(E&W) beam and otter trawlers and Irish seiners, otter and beam trawlers. It should be noted that in 2013, the UK administration switched to the EU electronic logbook system. Therefore, effort and LPUE reporting is now based on days fished.

Belgian beam trawl effort was at highest levels in 2003–2005. During these years, effort shifted from the Eastern English Channel (Division 7.d) to the Celtic Sea (divisions 7.fg) because of days-at-sea limitations in the former area. In 2006, these restrictions had been lifted and effort decreased substantially to about half of the values observed in the early 2000s. The sharp effort reduction in 2008 may be a combined result of the unrestricted effort regime in Division 7.d and the high fuel prices. The increase in 2012–2013 is due to the good opportunities of sole catches in the Celtic Sea taken by the mobile Belgian fleet. Afterwards, effort decreased again to lower levels during 2014–2019. Together with the substantial increase of the TAC in 2020, the effort also increased in 2020. A slightly lower effort was noted in 2021.

The effort from the UK(E&W) beam trawl fleet has declined sharply since the early 2000s to a record low in 2011 (area 7f and area 7g east) and 2008 (area 7g west), and fluctuated between this lower value and the time-series mean afterwards. For area 7g a just above average value was noted for 2021. The effort from the UK(E&W) otter trawlers has shown a gradually declining trend over time.

LPUE of the Belgian beam trawlers peaked in 2002. After a sharp decline to its record low in 2004, LPUE has been increasing gradually to around 20–21 kg/hour in 2014–2015. In 2017, a decrease to 15.72 kg/hour was recorded. Afterwards it increased again and was at the highest level of the time-series in 2020 (25.74 kg/hour). A slightly lower value of 22.04 kg/hour was recorded in 2021.

At the end of the 1990s and the beginning of the 2000s, the LPUE of the UK beam trawlers was stable at lower levels compared to the period before. Afterwards, the LPUE fluctuated and gradually increased to a value around the time-series mean in 2020/2021.

The LPUE of the UK otter trawlers is relatively stable at a lower level, but increased the last three years in area 7f and 7g west.

Irish effort and LPUE data are also presented. The main target species in the Irish fisheries are megrim, anglerfish, etc. The vessels usually operate on fishing grounds in the Western Celtic Sea with lower sole densities and therefore the LPUE values are low.

Tuning series

All available tuning data are given in Table 33.9, with the data used in the assessment highlighted in bold.

The age-structured UK(E&W)-BTS-Q3 scientific survey tuning series is the only scientific survey used for tuning.

During the WGCSE 2019, two age-structured commercial tuning series (UK(E&W)-CBT and BE-CBT) were used in the assessment. The UK(E&W)-CBT tuning-series used in the WGCSE 2019 assessment was limited to 2012 and earlier, because of effort reporting issues. As the hours fished became an optional field in the logbooks and not consistently filled, this field is inappropriate to use as a metric for effort.

During the WKFlatNSCS (ICES, 2020) an updated UK(E&W)-CBT tuning series was introduced in the assessment. The new UK(E&W)-CBT series from 1987–2021 was generated using a random effects model. Activity days was used as an effort measure, since it is mandatory to record.

The Belgian commercial beam trawl tuning fleet consists of two parts (1971–1996 and 2006–2021, BE_CBT and BE_CBT3). During the IBPBrisol (ICES, 2019b), the BE_CBT3 was constructed focusing on the landings and effort data of pure trips from the large fleet segment of the Belgian beam trawl fleet fishing in divisions 7.f and 7.g. Several models were tested and a GLMM including a categorical year effect, a log-linear relationship between the engine power of a beam trawler and the landing rate, a categorical temporal effect 'month' and a categorical spatial effect 'ICES statistical rectangle' were retained. The exponent of the estimated coefficients of the year effect were used as landing rate for the tuning series. More information is provided in the stock annex and the WKFlatNSCS report (ICES, 2020).

During the Benchmark, these commercial tuning series were used as commercial biomass tuning series. These time-series of the commercial tuning series were split in order to better account for changes in catchability due to e.g. technological creep (see figure below). Figure 33.11 shows the evolution through time of the commercial biomass tuning series. The Belgian BE_CBT_2006–2021 and the UK(E&W)-CBT_2006–2021 tuning series show a relatively similar increasing trend during the last years.

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.

33.3 Stock assessment

Historical stock development

The method used to assess Celtic Sea sole was XSA until the WGCSE 2019. During the WKFlatNSCS (ICES, 2020), the assessment was transferred to a state–space stock assessment model (SAM). This was done by using the *stock assessment* package, which enables to interface a performant SAM implementation (https://github.com/fishfollower/SAM/) in *Template Model Builder* (TMB)[2] from the R statistical software.

The main feature of SAM is that it includes both process models on survival, recruitment and fishing mortality, describing the internal states of the system, and observation models for catch and tuning data. Additionally, tuning data can be introduced in different ways, e.g. as SSB (spawning–stock biomass), TSB (total stock biomass) or landings indices, while the random effects formulation of the process models resulting from the hierarchical nature of the state–space modelling framework, can easily be used to handle missing observations as is the case with catch information on age 1. Finally, SAM allows to specify different model configurations, and parametrization of both process and observation models.

[2] TMB offers a modelling framework for fast estimation of hierarchical models written in C code through the Laplace approximation. In addition, increased performance of nonlinear optimization procedures is achieved through the use of AUTODIFF (automatic differentiation), and performant C libraries for linear algebra (Eigen and CholMod).

During the benchmark, it was decided to transfer the age-structured commercial tuning series into biomass indices. These time-series of the commercial tuning series were split, in order to better account for changes in catchability due to e.g. technological creep. The age-structured UK(E&W)-BTS-Q3 survey tuning series was also included. The model was further optimized in terms of parameter configuration for the process and observation models (see table below).

The F_{bar} calculates the mean fishing mortality for the set age range and should represent a significant part of the catch. The F_{bar} in the WGCSE 2019 assessment was set at age 4–8. However, as age 3 represents a large proportion of the catch (Figure 33.3), during the WKFlatNSCS it was decided to expand the F_{bar} to ages 3–8. The F_{bar} with ages 3–8 represents an average 77% of the catch, with a minimum of 48% and a maximum of 97%.

The SAM model input and configuration are shown in the table below and in Table 33.10.

DATA & SETTINGS	
tuning indices	
UK(E&W)-BTS survey (1988-(assessment year-1))	Age (1-5)
BE-CBT_1971-1983	Biomass
BE-CBT_1984-1996	Biomass
BE-CBT3_2006-(assessment year-1)	Biomass
UK(E&W)-CBT_1984-2005	Biomass
UK(E&W)-CBT_2006-(assessment year-1)	Biomass
catch numbers-at-age	Catch numbers for age 1 and 2 set to NA prior 2004
maturity ogive	Age1 = 0; Age2 = 0.67; Age3 = .91; Age4 = .98; Age5 = .99; Age6 = .99; Age6+ = 1
natural mortality	0.1 for all ages and years
prop. M < spawning	0 for all years
prop. F < spawning	0 for all years
Plus group	10
Fbar	3-8
MODEL CONFIGURATION	
stock-recruitment	plain random walk on logN(1)
correlation F-at-age	AR(1)
F parameters-at-age	6 = 0, 1, 2, 3, 3, 3, 4, 4, 5, 5
q parameters (-at-age)	
UK(E&W)-BTS survey (1988-(assessment year-1))	4 = 0, 1, 2, 3, 3, -1, -1, -1, -1, -1
BE-CBT_1971-1983	1
BE-CBT_1984-1996	1
BE-CBT3_2006-(assessment year-1)	1
UK(E&W)-CBT_1984-2005	1
UK(E&W)-CBT_2006-(assessment year-1)	1
σ² F parameters-at-age	1 = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
σ² N parameters-at-age	2 = 0, 1, 1, 1, 1, 1, 1, 1, 1, 1
σ² obs pars (-at-age)	
catch numbers-at-age	2 = 0, 0, 1, 1, 1, 1, 1, 1, 1, 1
UK(E&W)-BTS survey (1988-(assessment year-1))	3 = 2, 3, 3, 4, 4, -1, -1, -1, -1, -1
BE-CBT_1971-1983	1
BE-CBT_1984-1996	1
BE-CBT3_2006-(assessment year-1)	1
UK(E&W)-CBT_1984-2005	1
UK(E&W)-CBT_2006-(assessment year-1)	1
ρ observations at-age	
catch numbers-at-age	“AR(1)” (single ρ for all ages)
UK(E&W)-BTS survey (1988-(assessment year-1))	“ID”
BE-CBT_1971-1983	-
BE-CBT_1984-1996	-
BE-CBT3_2006-(assessment year-1)	-
UK(E&W)-CBT_1984-2005	-
UK(E&W)-CBT_2006-(assessment year-1)	-

This year's assessment

The SAM model fitting diagnostics and survey catchabilities are shown in Table 33.11, the fishing mortalities in Table 31.12, the stock numbers in Table 31.13 and the assessment summary in Table 33.14 and Figure 33.12.

In general, the estimated catches from the SAM model corroborate the observed catches. Mainly at the start of the time-series, some observed catches do not fall within the confidence bounds of the estimated catches. The SAM catch estimate for 2020 is also considerably lower than the ICES catch estimate.

Spawning–stock biomass (SSB) has been above MSY $B_{trigger}$ since 2009 and shows an increasing trend over the last years, with the 2019, 2020 and 2021 estimates at the same high level. Fishing mortality was below F_{MSY} in 2017–2019, but increased again and was at F_{MSY} in 2020 and 2021. Recruitment has been variable without an overall trend. The 2017 recruitment is estimated to be among the highest in the time-series. Recruitment estimates have been above average since 2015.

The one-step ahead residuals for the final SAM assessment are shown in Figure 33.13. There may be some indications of a trend in the UK beam trawl fleet (UK(E&W)-CBT_2006–2021) with predominantly negative residuals in the last years, in contrast to the positive residuals of the BE_CBT_2006–2021 during the last years.

Retrospective patterns for the final run are shown in Figure 33.14. Retrospective analysis does not indicate major problems; the retrospective patterns are within the confidence bounds. A Mohn's rho analysis was conducted based on the SAM stock assessment results, i.e. the last data year (2021) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The Mohn's rho values for this assessment are low and well within the bounds of -15 % to 20% suggested by ICES, i.e. the current assessment indicates sufficient consistency for advice purposes.

The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (AGES 3-8)	RECRUITMENT
Mohn's rho value	-0.071	0.1	0.055

Comparison with previous assessments

The 2021 assessment was revised in October 2021 due to the discovery of an error in the setting of the catch numbers for age 1 and 2 for 1971–2003 in the SAM model. The comparison was done with the updated values.

A comparison of the estimates of this year's assessment with last year's is given in Figure 33.15. Trends in fishing mortality, SSB and recruitment are very similar. The 2018 recruitment was revised upwards by 7.4% in this year's assessment, whereas the 2019 and 2020 recruitments were revised downwards by 7.7% and 5% respectively in this year's assessment. In last year's assessment, F and SSB for 2020 were estimated to be 0.269 and 5811 t respectively; this year's estimates for 2020 are 0.251 and 5945 t, a downward revision of 6.9% for F and an upward revision of 2.3% for SSB.

State of the stock

Trends in catch, SSB, F_{bar}(3–8) and recruitment are presented in Table 33.14 and Figure 33.12.

In the beginning of the time-series, fishing mortality fluctuated around F_{MSY} (0.251). During the eighties and nineties fishing mortality increased for this stock to levels well above F_{MSY} (0.51 in 1997). In the following decades, fishing mortality decreased. Fishing mortality has been just below F_{MSY} in 2017–2019 but slightly increased again and is at F_{MSY} in 2020 and 2021.

Recruitment has fluctuated around 5 million recruits with occasional strong year classes. The 1998 year class is estimated to be among the strongest in the time-series (13 679 thousand fish). Recruitment has been above average (5842 thousand fish) since 2015, and the recruitment of 2017 is estimated to be the highest of the time-series (14 305 thousand fish).

SSB has declined almost continuously from the highest value of 6636 t in 1971 to the lowest observed in the time-series in 1997 (2191 t). The exceptional year class of 1998 has increased SSB to above the long-term average (3947 t) in 2022. With the exemption of 2007 and 2008 SSB has been above MSY $B_{trigger}$ (3057 t) since 2001. SSB increased during the last years, as a result of the decreasing fishing mortality and good recruitment. SSB in 2019-2021 (around 5900 thousand fish) is at its highest level since 1973.

33.4 Short-term projections

Estimating year-class abundance

Higher recruitment was observed from 2015 onwards. However, the 2020 year class ((2021 recruitment) is now estimated at 8071 thousand fish at age 1 (Table 33.13), which is 60% higher than the median resampled recruitment from the years 1971–2018 (5055 thousand fish), used in last year's forecast.

The age 1 estimates are almost solely coming from the UK(E&W)-BTS-Q3. In 1999 (24.6), 2008 (10.4) and 2017 (10.5) above average UK(E&W)-BTS-Q3 abundance indices for age 1 were noted. Those high abundance indices align with the high recruitment in those years. The 2021 UK(E&W)-BTS-Q3 abundance index for age 1 (9.0) is around the same level of 2000 (9.2).

Forecast assumptions

The F in 2021 (0.25) is slightly higher than the mean F over the last three years ($F_{average\ 2019–2021}$ = 0.246) and using this F to project the stock into 2022, would result in slightly higher landings (1357 t) than the 2022 TAC (1337 t). As recent landings have been close to the TAC (Figure 33.16), the working group decided to use a TAC constraint for the intermediate year (2022). Assuming a TAC constraint for 2022 of 1337 t, implies a fishing mortality in 2022 of 0.246. This results in an SSB of 6120 t in 2023.

As input for the forecast fishing mortality was calculated as the mean of 2019–2021, scaled to 2021 (0.25). Catch and stock weights-at-age were also averages for the years 2019–2021. Population numbers at the start of 2022 for ages 3 and older, were taken from the SAM output. The long-term median resampled recruitment (1971–2019) as estimated by a stochastic projection (SAM, 5111 thousand fish) was assumed for recruitment in 2022 and subsequent years.

There are no known specific environmental drivers known for this stock.

MSY forecast

Table 33.15 and Figure 33.17 show the output of the forecast targeting F = F_{MSY} for 2023–2024 and Figure 33.18 the year classes contributing to the forecast yield and SSB. The assumed long-term median resampled recruitment (1971–2019) accounts for about 4.5% of the landings in 2023 and about 16.4% of the 2024 SSB.

Implementing the MSY approach with F = F_{MSY} = 0.251 leads to a total yield of 1338 t in 2023, and an SSB of 5903 t in 2024.

The advice for 2023 is comparable to the advice for 2022 (0.075% advice change).

Additional options

A management options table is provided in Table 33.15.

33.5 Biological reference points

Current biological reference points calculated during the WGCSE 2020 are given in the text table below:

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	3057	Tonnes; B_{pa}
	F_{MSY}	0.251	EQsim analysis based on the recruitment period 1971–2018
Precautionary approach	B_{lim}	2184	Tonnes; B_{loss} estimated in 2020, corresponding to SSB in 1997
	B_{pa}	3057	Tonnes; B_{lim} × 1.4
	F_{lim}	0.543	EQsim analysis, based on the recruitment period 1971–2018
	F_{pa}	0.402	$Fp_{.05}$; F that leads to SSB ≥ B_{lim} with 95% probability.
Management plan	MAP MSY $B_{trigger}$	3057	Tonnes; MSY $B_{trigger}$
	MAP B_{pa}	3057	Tonnes; B_{pa}
	MAP B_{lim}	2184	Tonnes; B_{lim}
	MAP F_{MSY}	0. 251	F_{MSY}
	MAP range F_{lower}	0.136–0.251	Consistent with ranges provided by ICES (2020), resulting in no more than 5% reduction in long-term yield compared with MSY
	MAP range F_{upper}	0.251–0.462	Consistent with ranges provided by ICES (2020), resulting in no more than 5% reduction in long-term yield compared with MSY

*** EU multiannual plan (MAP) for the Western Waters (EU, 2019).**

33.6 Management plans

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

33.7 Uncertainties and bias in assessment and forecast

Sampling

The major fleets fishing for 7.f and 7.g sole are sampled (approximately 90% of the total landings). Sampling is considered to be at a reasonable level.

Discards

Discard estimates used to be low, but are increasing. Discards are included in the assessment since the WGCSE 2020.

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. During the WKFlatNSCS (ICES, 2020) a further correction for 2004–2007 landings data was done.

Surveys

The UK(E&W)-BTS-Q3 survey, which is solely responsible for the recruiting estimates, has been able to track year-class strength at-ages greater than 0 rather well in the past. However, the estimates of strong year classes have sometimes been revised downward in previous assessments and may cause bias in the forecast.

33.8 Recommendations for next Benchmark

Sole in 7.f and 7.g have been benchmarked in February 2020. The remaining issues are listed below.

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?
Natural mortality Alternate rates of natural mortality. Natural mortality is assumed constant over ages and years at 0.1. When new information is available, this should be investigated.	*estimates of natural mortality	*estimates of natural mortality
Effect of changing exploitation patterns Effect of changing exploitation patterns related to the Trevose Box closure. ICES rectangles 30E4, 31E4 and 32E3 form the Trevose Box which is closed for fishing from February 1st until March 31st. This management measure is in place since 2006 and aims to protect spawning fish, cod and other demersal stocks such as sole in particular (ICES special request, 2007). This measure has a significant effect on the behaviour of the fleets. During the first week after re-opening of the Trevose box, catch rates of the Belgian beam trawl fleet are estimated to be twice as high with respect to the situation before the closure of the Trevose Box (prior to 2006) (Sys *et al*., 2017). Those temporal and spatial effects were accounted for in the new modelled Belgian commercial tuning index (ICES, 2019b). However, this change in exploitation pattern may also have an effect on the mortality of mature females or exhibit hyperstability, in which catch per unit effort (CPUE) remains elevated as stock abundance declines.	* Check for hyperstability * Check mortality of mature females	
Scientific survey information 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). The new UK-Q1SWECOS tuning series was considered during the WKFlatNSCS 2020, but not retained. Criteria such as length of the time-series, amount of spatial coverage and consistent statistical sampling design were considered for including/excluding the new UK-Q1SWECOS tuning series. However, we recommend that those survey data will be uploaded into DATRAS and that the survey design will be reviewed by the WGBEAM (The Working Group on Beam Trawl Surveys), to assure quality control of the data. The time-series was too short for any strong conclusions now but the inclusion of those survey indices should be reconsidered during the next benchmark.	*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 Trends and reasons for the decreasing catch and stock weights for the older ages	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

33.9 Management considerations

The stock–recruitment relationship is not well-defined, there is no real evidence of reduced recruitment at low levels of SSB for this (Figure 33.19). Following the recent strong year classes, SSB is now at its highest level since 1973.

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).

33.10 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.

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.27.7fg - Official Nominal landings and landings and discard data used by the Working Group (t).

Year	Belgium		Denmark	France	Ireland	UK(E.&W, NI)	UK(Scotland)	Spain	Other	Total-Official	Unallocated	Used by WG	TAC	Discards**
1986	1039	*	2	146	188	611	-	-	3	1989	-389	1600		80
1987	701	*	-	117	9	437	-	-	-	1264	-42	1222	1600	56
1988	705	*	-	110	72	317	-	-	-	1204	-58	1146	1100	61
1989	684	*	-	87	18	203	-	-	-	992	0	992	1000	70
1990	716	*	-	130	40	353	0	-	-	1239	-50	1189	1200	57
1991	982	*	-	80	32	402	0	-	-	1496	-389	1107	1200	126
1992	543	*	-	141	45	325	6	-	-	1060	-79	981	1200	77
1993	575	*	-	108	51	285	11	-	-	1030	-102	928	1100	56
1994	619	*	-	90	37	264	8	-	-	1018	-9	1009	1100	52
1995	763	*	-	88	20	294	-	-	-	1165	-8	1157	1100	50
1996	695	*	-	102	19	265	0	-	-	1081	-86	995	1000	47
1997	660	*	-	99	28	251	0	-	-	1038	-111	927	900	46
1998	675	*	-	98	42	198	-	-	-	1013	-138	875	850	43
1999	604		-	61	51	231	0	-	-	947	65	1012	960	89
2000	694		-	74	29	243	-	-	-	1040	51	1091	1160	158
2001	720		-	77	35	288	-	-	-	1120	48	1168	1020	101
2002	703		-	65	32	318	+	-	-	1118	227	1345	1070	58
2003	715		-	124	26	342	+	-	-	1207	340	1547	1240	54

Year	Belgium	Denmark	France	Ireland	UK(E.&W, NI)	UK(Scotland)	Spain	Other	Total-Official	Unallocated	Used by WG	TAC	Discards**
2004	735	-	79	33	283	-	-	-	1130	261	1391	1050	140
2005	645	-	101	34	217	-	-	-	997	266	1263	1000	23
2006	576	-	75	38	232	-	-	-	921	137	1058	950	41
2007	582	-	85	32	245	-	-	-	943	109	1052	890	36
2008	466	-	68	28	218	-	-	-	781	9	790	964	8
2009	513	-	73	26	195	-	-	-	806	-34	772	993	30
2010	620	-	44	27	180	-	-	-	871	-4	867	993	56
2011	775	-	54	30	168	-	-	-	1027	0	1027	1241	28
2012	843	-	48	33	175	-	-	-	1099	2	1101	1060	32
2013	789	-	49	42	205	-	-	-	1085	8	1093	1100	26
2014	703	-	58	28	252	-	-	-	1042	-1	1041	1001	27
2015	674	-	24	27	105	-	-	-	830	1	831	851	17
2016	563	-	72	21	174	-	-	-	830	2	832	779	31
2017	551	-	49	28	149	-	-	-	777	1	778	845	65
2018	607	-	44	27	171	-	-	-	850	0	850	920	141
2019	800	-	42	33	193	-	<1	-	1068	0	1068	1009	145
2020 ^	1121	-	44	51	291	-	<1	-	1507	17	1524	1652	106
2021 ^	859	-	61	48	395	-	2	-	1365	-29	1336	1337	62

^Landings are preliminary.

*** including 7.g–k.**

**** Discards estimated by ICES.**

Table 33.2. Sol.27.7fg - Catch numbers-at-age (in thousands).

year/age	1	2	3	4	5	6	7	8	9	10+	Total
1971	0	610	303	1377	638	439	541	770	379	1231	6288
1972	0	855	1014	322	684	334	214	234	317	739	4713
1973	0	575	2116	768	311	357	120	111	117	649	5124
1974	0	245	492	886	420	212	241	98	110	547	3251
1975	0	188	323	345	652	308	111	103	68	375	2473
1976	0	493	937	575	624	567	263	132	199	469	4259
1977	0	496	492	358	277	248	407	121	28	368	2795
1978	0	502	833	348	157	161	100	200	72	175	2548
1979	0	519	630	767	212	156	198	125	154	170	2931
1980	0	1038	1092	899	596	183	62	97	101	355	4423
1981	0	951	759	813	407	382	151	121	95	383	4062
1982	0	540	934	317	477	284	208	93	112	328	3293
1983	0	1023	1212	748	290	354	227	194	52	322	4422
1984	0	1062	951	622	553	187	279	107	47	276	4084
1985	0	310	1656	786	577	300	101	141	74	241	4186
1986	0	781	1457	1204	537	363	194	88	104	330	5058
1987	0	503	1076	818	589	277	206	101	61	180	3811
1988	0	831	522	902	450	393	128	79	68	270	3643
1989	0	757	1308	617	634	240	189	83	24	102	3954
1990	0	438	1117	1207	407	459	139	116	50	130	4063
1991	0	2304	776	676	507	153	157	56	46	163	4838
1992	0	684	1911	661	418	257	61	60	28	89	4169
1993	0	559	970	1133	339	189	162	64	84	99	3599
1994	0	466	888	759	882	287	150	66	42	146	3686
1995	0	204	1299	1127	429	490	134	113	66	109	3971
1996	0	280	1163	928	433	232	193	58	43	106	3436
1997	0	387	1000	615	408	256	128	127	45	106	3072
1998	0	311	1048	743	303	173	109	51	52	87	2877
1999	0	961	1931	856	288	145	81	31	23	44	4360
2000	0	2720	1664	701	246	61	56	43	19	51	5561
2001	0	1111	2155	883	445	245	65	39	26	81	5050
2002	0	46	1647	2261	674	253	96	55	36	51	5119
2003	0	209	871	1294	2111	453	250	90	29	84	5391
2004	5	393	1846	941	1086	742	132	100	54	100	5399
2005	12	418	1096	1028	592	499	336	72	55	89	4197
2006	8	485	1151	844	706	250	229	169	60	106	4008
2007	19	697	979	721	435	382	149	142	155	93	3772
2008	10	180	515	499	387	212	209	85	109	150	2356
2009	30	549	511	588	435	259	164	121	51	203	2911
2010	26	506	1510	657	380	257	140	103	80	119	3778
2011	18	170	1103	1389	394	308	187	118	56	168	3911
2012	29	361	318	1039	1339	370	222	130	84	219	4111
2013	13	545	998	523	826	652	222	104	61	160	4104
2014	14	173	684	735	308	388	381	122	99	243	3147
2015	0	193	837	924	433	145	201	114	69	113	3029
2016	66	727	458	635	663	303	111	132	94	70	3259
2017	47	432	1157	493	421	353	147	55	59	101	3265
2018	4	989	840	1105	275	293	186	95	56	122	3965
2019	53	373	2240	729	874	306	162	115	105	118	5075
2020	0	242	777	2775	1161	789	304	160	106	189	6503
2021	0	128	688	1077	1944	942	361	126	63	171	5500

Table 33.3. Sol.27.7fg - Catch weights-at-age (kg).

year/age	1	2	3	4	5	6	7	8	9	10+
1971	0.039	0.11	0.168	0.224	0.273	0.316	0.353	0.384	0.408	0.441
1972	0.106	0.136	0.185	0.227	0.265	0.303	0.34	0.377	0.413	0.539
1973	0.081	0.134	0.2	0.259	0.311	0.361	0.408	0.452	0.493	0.602
1974	0.063	0.13	0.202	0.27	0.329	0.385	0.436	0.483	0.524	0.624
1975	0.046	0.127	0.208	0.286	0.355	0.416	0.473	0.523	0.565	0.671
1976	0.114	0.149	0.214	0.268	0.316	0.363	0.409	0.453	0.496	0.665
1977	0.098	0.15	0.229	0.297	0.355	0.408	0.46	0.506	0.548	0.668
1978	0.068	0.141	0.228	0.308	0.377	0.44	0.498	0.55	0.596	0.72
1979	0.023	0.127	0.226	0.32	0.4	0.47	0.531	0.58	0.621	0.664
1980	0.048	0.134	0.228	0.315	0.391	0.459	0.523	0.578	0.625	0.72
1981	0.078	0.141	0.22	0.292	0.355	0.413	0.469	0.519	0.564	0.665
1982	0.061	0.142	0.236	0.323	0.396	0.461	0.521	0.571	0.616	0.704
1983	0.085	0.153	0.247	0.329	0.397	0.458	0.513	0.56	0.602	0.679
1984	0.019	0.126	0.229	0.329	0.414	0.492	0.561	0.621	0.673	0.771
1985	0.089	0.151	0.239	0.316	0.382	0.443	0.499	0.551	0.596	0.703
1986	0.046	0.134	0.23	0.32	0.399	0.47	0.536	0.593	0.643	0.748
1987	0.048	0.136	0.23	0.319	0.395	0.465	0.528	0.583	0.632	0.74
1988	0.074	0.143	0.229	0.308	0.377	0.441	0.502	0.556	0.606	0.738
1989	0.013	0.112	0.196	0.28	0.355	0.423	0.487	0.542	0.592	0.691
1990	0.049	0.128	0.21	0.291	0.362	0.429	0.494	0.552	0.609	0.747
1991	0.054	0.138	0.232	0.319	0.392	0.458	0.516	0.564	0.608	0.674
1992	0.073	0.136	0.212	0.281	0.342	0.397	0.451	0.499	0.543	0.64
1993	0.057	0.128	0.204	0.275	0.338	0.396	0.45	0.5	0.544	0.645
1994	0.081	0.139	0.212	0.276	0.331	0.38	0.425	0.465	0.5	0.563
1995	0.068	0.136	0.216	0.288	0.351	0.408	0.462	0.51	0.552	0.643
1996	0.027	0.122	0.21	0.296	0.371	0.438	0.5	0.551	0.598	0.677
1997	0.074	0.142	0.228	0.306	0.375	0.439	0.5	0.554	0.605	0.707
1998	0.079	0.147	0.237	0.319	0.392	0.461	0.527	0.589	0.647	0.781
1999	0.015	0.121	0.217	0.314	0.399	0.476	0.548	0.613	0.67	0.765
2000	0.078	0.148	0.24	0.321	0.389	0.45	0.506	0.553	0.594	0.665
2001	0.066	0.137	0.22	0.296	0.362	0.424	0.482	0.533	0.579	0.677
2002	0.054	0.126	0.2	0.271	0.336	0.398	0.457	0.512	0.564	0.704
2003	0.123	0.151	0.214	0.266	0.313	0.361	0.408	0.454	0.501	0.639
2004	0.099	0.152	0.194	0.274	0.347	0.371	0.459	0.522	0.524	0.631
2005	0.109	0.155	0.203	0.267	0.346	0.439	0.473	0.595	0.624	0.707
2006	0.142	0.144	0.186	0.272	0.33	0.401	0.412	0.411	0.465	0.574
2007	0.161	0.157	0.221	0.284	0.335	0.372	0.414	0.488	0.511	0.589
2008	0.149	0.163	0.21	0.281	0.361	0.359	0.449	0.62	0.625	0.59
2009	0.105	0.157	0.188	0.242	0.294	0.348	0.378	0.476	0.485	0.546
2010	0.11	0.144	0.179	0.234	0.312	0.358	0.387	0.414	0.524	0.616
2011	0.123	0.155	0.185	0.233	0.277	0.361	0.431	0.465	0.483	0.688
2012	0.102	0.142	0.206	0.243	0.271	0.312	0.35	0.38	0.417	0.543
2013	0.092	0.158	0.195	0.249	0.29	0.329	0.361	0.463	0.492	0.587
2014	0.138	0.15	0.199	0.268	0.347	0.394	0.427	0.496	0.523	0.702
2015	0.135	0.132	0.193	0.248	0.311	0.367	0.438	0.502	0.463	0.589
2016	0.109	0.165	0.203	0.251	0.285	0.342	0.416	0.429	0.47	0.621
2017	0.093	0.151	0.2	0.255	0.315	0.33	0.382	0.444	0.513	0.549
2018	0.082	0.175	0.187	0.251	0.294	0.327	0.385	0.436	0.425	0.575
2019	0.099	0.12	0.17	0.24	0.307	0.327	0.419	0.451	0.445	0.614
2020	0.155	0.114	0.176	0.205	0.257	0.331	0.363	0.415	0.504	0.556
2021	0.12	0.127	0.17	0.212	0.252	0.26	0.35	0.412	0.493	0.537

Table 33.4. - Sol.27.7fg - Annual landings length distributions by fleet.

	UK (England & Wales)	Belgium	Ireland
Length (cm)	Beam trawl		
17			
18			
19			
20			
21		192	
22	9	2619	
23	3849	18609	
24	10514	111613	16
25	29791	365739	844
26	50277	460218	1297
27	69733	449261	1785
28	85621	415013	3713
29	114396	326791	4268
30	111213	287587	4865
31	126187	195077	3576
32	93874	150824	5044
33	81263	117136	4258
34	59104	92599	3066
35	82402	71869	2801
36	51647	54728	2585
37	36187	35589	1718
38	25149	27470	1210
39	19331	20718	1192
40	13171	17462	1035
41	9421	6205	1048
42	5379	5207	273
43	7088	2847	228
44	2612	3102	434
45	1911	2544	233
46	539	1781	254
47	1442	356	
48	423	652	
49	137	241	
50	91	195	
51	11		
52			
53	11		
54			
55			
56			
57			
58			
59			
60			
Total	1 092 783	3 244 244	45 743

Table 33.5. Sol.27.7fg - Stock weights-at-age (kg).

year/age	1	2	3	4	5	6	7	8	9	10+
1971	0.041	0.085	0.145	0.205	0.26	0.304	0.341	0.37	0.39	0.416
1972	0.041	0.073	0.143	0.196	0.244	0.288	0.328	0.365	0.398	0.511
1973	0.041	0.119	0.165	0.219	0.266	0.31	0.352	0.392	0.431	0.56
1974	0.041	0.103	0.165	0.232	0.292	0.346	0.397	0.444	0.487	0.599
1975	0.041	0.089	0.165	0.241	0.31	0.37	0.426	0.477	0.523	0.649
1976	0.041	0.083	0.165	0.237	0.301	0.359	0.413	0.463	0.509	0.669
1977	0.041	0.131	0.185	0.252	0.308	0.359	0.409	0.455	0.498	0.643
1978	0.041	0.118	0.185	0.266	0.335	0.395	0.451	0.503	0.549	0.695
1979	0.041	0.093	0.179	0.27	0.351	0.421	0.483	0.538	0.585	0.654
1980	0.041	0.056	0.17	0.267	0.354	0.429	0.496	0.554	0.602	0.7
1981	0.041	0.082	0.172	0.258	0.334	0.402	0.464	0.521	0.571	0.674
1982	0.041	0.105	0.182	0.267	0.34	0.404	0.464	0.517	0.565	0.682
1983	0.041	0.097	0.187	0.279	0.358	0.426	0.486	0.54	0.586	0.676
1984	0.041	0.104	0.187	0.285	0.369	0.442	0.507	0.564	0.614	0.733
1985	0.041	0.054	0.174	0.269	0.354	0.428	0.496	0.556	0.608	0.716
1986	0.041	0.109	0.186	0.276	0.355	0.424	0.487	0.544	0.596	0.715
1987	0.041	0.079	0.176	0.271	0.355	0.43	0.498	0.559	0.612	0.737
1988	0.041	0.083	0.176	0.266	0.347	0.417	0.483	0.542	0.594	0.729
1989	0.041	0.091	0.167	0.253	0.331	0.4	0.463	0.521	0.574	0.686
1990	0.041	0.041	0.154	0.239	0.319	0.39	0.457	0.519	0.575	0.721
1991	0.041	0.082	0.173	0.259	0.338	0.407	0.47	0.528	0.58	0.673
1992	0.041	0.086	0.171	0.256	0.33	0.395	0.454	0.507	0.554	0.648
1993	0.041	0.097	0.167	0.242	0.308	0.368	0.423	0.475	0.521	0.631
1994	0.041	0.089	0.165	0.237	0.302	0.358	0.41	0.458	0.5	0.578
1995	0.041	0.105	0.173	0.247	0.311	0.368	0.419	0.466	0.507	0.602
1996	0.041	0.091	0.169	0.253	0.327	0.392	0.452	0.504	0.552	0.647
1997	0.041	0.062	0.167	0.254	0.333	0.404	0.468	0.526	0.577	0.681
1998	0.041	0.104	0.184	0.27	0.346	0.416	0.481	0.542	0.599	0.732
1999	0.041	0.098	0.179	0.273	0.357	0.432	0.502	0.569	0.628	0.739
2000	0.041	0.047	0.17	0.264	0.35	0.423	0.491	0.55	0.603	0.695
2001	0.041	0.103	0.181	0.267	0.341	0.406	0.466	0.519	0.566	0.664
2002	0.041	0.091	0.165	0.244	0.315	0.38	0.44	0.497	0.548	0.688
2003	0.041	0.09	0.164	0.231	0.292	0.348	0.403	0.456	0.507	0.645
2004	0.041	0.137	0.172	0.242	0.304	0.341	0.407	0.462	0.488	0.623
2005	0.041	0.124	0.175	0.228	0.308	0.391	0.419	0.523	0.571	0.668
2006	0.041	0.125	0.17	0.235	0.297	0.373	0.425	0.441	0.526	0.605
2007	0.041	0.149	0.178	0.23	0.302	0.35	0.408	0.448	0.458	0.573
2008	0.041	0.162	0.181	0.249	0.32	0.347	0.409	0.507	0.552	0.569
2009	0.041	0.153	0.175	0.226	0.287	0.355	0.368	0.462	0.548	0.572
2010	0.041	0.123	0.168	0.21	0.275	0.325	0.367	0.396	0.499	0.567
2011	0.041	0.13	0.163	0.204	0.254	0.336	0.393	0.424	0.447	0.651
2012	0.041	0.132	0.179	0.212	0.251	0.294	0.356	0.405	0.44	0.574
2013	0.041	0.127	0.167	0.227	0.266	0.299	0.336	0.403	0.432	0.554
2014	0.041	0.118	0.177	0.229	0.294	0.338	0.375	0.423	0.492	0.668
2015	0.041	0.135	0.171	0.222	0.288	0.357	0.415	0.463	0.479	0.596
2016	0.041	0.149	0.164	0.221	0.266	0.326	0.391	0.434	0.486	0.599
2017	0.041	0.128	0.182	0.227	0.281	0.306	0.361	0.43	0.469	0.544
2018	0.041	0.128	0.168	0.224	0.274	0.321	0.356	0.408	0.434	0.558
2019	0.041	0.099	0.172	0.212	0.277	0.31	0.37	0.417	0.44	0.571
2020	0.041	0.106	0.145	0.187	0.249	0.319	0.344	0.417	0.477	0.555
2021	0.041	0.14	0.139	0.193	0.227	0.259	0.34	0.387	0.452	0.544

Table 33.6. Sol.27.7fg - Indices of abundance (No/100km) for UK(E&W)-BTS-Q3.

year/age	0	1	2	3	4	5	6	7	8	9
1988	30	81	326	49	19	5	0	0	0	0
1989	144	222	331	176	20	15	7	4	2	2
1990	30	385	313	50	16	4	7	3	0	0
1991	32	241	517	67	17	15	4	0	2	2
1992	4	394	260	139	30	18	10	1	2	1
1993	3	169	320	43	19	1	2	2	1	1
1994	1	333	387	99	14	7	7	0	0	2
1995	27	124	222	52	11	6	12	1	1	1
1996	3	150	212	54	23	6	3	3	1	3
1997	32	433	180	18	11	12	4	3	5	0
1998	91	770	411	50	10	8	4	2	1	4
1999	24	2464	250	32	13	6	3	4	1	0
2000	13	916	1356	31	22	5	0	2	1	1
2001	22	379	600	259	19	8	5	2	0	2
2002	8	663	239	127	102	12	6	2	3	0
2003	12	392	530	46	25	47	8	3	3	0
2004	56	749	378	86	13	19	37	3	3	0
2005	37	343	225	32	13	6	4	14	1	2
2006	11	273	201	40	13	7	0	2	10	0
2007	91	358	108	43	13	7	6	3	3	11
2008	5	1039	105	13	15	6	8	3	3	4
2009	1	509	318	24	7	8	3	3	3	2
2010	18	85	471	121	17	2	4	8	3	2
2011	18	502	52	138	69	7	2	6	3	0
2012	13	542	231	8	53	24	1	1	1	3
2013	9	279	518	43	13	24	15	1	5	1
2014	34	244	257	76	13	5	23	8	1	1
2015	28	746	48	44	31	7	3	13	6	0
2016	26	573	359	12	27	13	7	3	5	8
2017	6	1046	174	67	13	16	17	4	3	11
2018	27	434	906	279	45	17	9	15	11	4
2019	2	708	325	164	23	29	3	6	7	4
2020	3	331	238	74	67	24	17	2	6	7
2021	57	896	154	45	37	33	12	12	0	3
Mean	26.98	522.73	338.88	76.51	25.05	12.65	7.41	4.08	2.86	2.38

Table 33.7. Sol.27.7fg- Effort.

	England & Wales						Belgium		Ireland		
Year	Otter trawl[1]	Beam trawl[1]	Otter trawl[2]	Beam trawl[2]	Otter trawl[3]	Beam trawl[3]	Beam trawl[4]	Beam trawl[6]	Otter trawl[5]	Scottish seine[6]	Beam trawl[6]
1971							11.06	-	-	-	-
1972							8.44	-	-	-	-
1973							17.39	-	-	-	-
1974							18.83	-	-	-	-
1975							16.38	-	-	-	-
1976							28.07	-	-	-	-
1977							24.11	-	-	-	-
1978							18.09	-	-	-	-
1979							18.90	-	-	-	-
1980							29.02	-	-	-	-
1981							35.39	-	-	-	-
1982							28.77	-	-	-	-
1983	620	195	82	149	0	8	34.95	-	-	-	-
1984	1723	901	316	298	0	129	33.48	-	-	-	-
1985	1493	1101	206	285	23	92	40.49	-	-	-	-
1986	1125	973	334	180	35	29	52.46	-	-	-	-
1987	1211	1681	364	187	26	26	37.26	-	-	-	-
1988	838	1102	351	77	20	36	42.92	-	-	-	-
1989	966	861	327	125	15	7	53.58	-	-	-	-
1990	1229	1256	435	165	24	194	40.27	-	-	-	-
1991	1066	1667	306	483	45	104	18.05	-	-	-	-
1992	898	1420	303	633	435	90	25.47	-	-	-	-
1993	836	1669	251	694	30	135	31.27	-	-	-	-
1994	623	2219	225	610	19	116	38.35	-	-	-	-
1995	580	2303	196	694	30	128	47.81	-	63.33	6.43	20.69
1996	593	2391	341	560	105	220	47.63	53.27	59.97	9.73	26.70
1997	577	2661	370	770	122	146	51.98	57.36	65.00	16.07	28.06
1998	517	2846	385	591	94	159	52.11	57.79	72.25	14.88	35.21
1999	395	3058	176	1461	235	312	55.03	55.11	51.48	8.01	40.83
2000	284	3133	187	1007	160	200	56.05	51.34	60.56	9.86	36.83
2001	309	3172	187	1155	179	91	52.06	54.90	69.37	16.33	39.50
2002	416	2652	123	463	170	60	43.24	49.60	77.20	20.88	31.49
2003	696	2669	51	772	124	158	42.81	62.73	86.78	20.07	49.22
2004	641	2503	198	923	125	178	-	78.73	97.12	18.42	54.89
2005	876	1968	21	618	154	116	-	64.50	124.67	14.64	49.56
2006	924	1330	23	630	233	70	-	49.61	118.04	14.78	60.47
2007	798	1407	31	518	219	12	-	45.91	135.36	15.81	55.81
2008	711	1202	109	290	229	5	-	28.72	125.41	11.65	37.20
2009	656	1105	244	266	296	48	-	30.65	137.11	8.18	37.94
2010	565	1162	84	327	469	78	-	32.46	140.79	9.68	40.22
2011	525	868	8	180	353	111	-	38.77	120.33	11.01	35.33
2012	543	1408	138	275	487	102	-	46.25	127.68	14.14	40.33
2013	280	1611	72	265	37	77	-	45.23	118.20	13.15	38.48
2014	156	959	10	131	0	24	-	31.30	127.34	12.46	37.84
2015	79	726	3	245	0	56	-	31.79	132.69	9.28	37.79
2016	0	915	0	396	0	34	-	32.34	148.17	10.44	39.55
2017	93	986	95	514	193	74	-	33.35	136.05	9.75	35.21
2018	127	1071	71	440	210	15	-	31.48	105.81	9.69	37.42
2019	169	981	34	255	277	8	-	32.03	103.89	14.26	34.08
2020	100	1012	10	346	40	99	-	41.70	89.91	13.59	29.14
2021	155	1260	22	540	28	102	-	36.18	33.04	11.85	31.57

[1]Division 7.f only -days fished (Corrected).

[2] 7.g EAST - days fished (corrected).

[3] 7.g WEST - days fished (corrected).

[4] Fishing hours (x 10^3) corrected for fishing power using P = 0.000204 BHP^1.23.

[5] Division 7.g only - Fishing hours (x10^3).

[6] Fishing hours (x10^3).

Table 33.8. Sol.27.7fg – LPUE.

	UK							Belgium		Ireland		
Year	BT Survey[1] Div VIIfg	Otter trawl[2] Div VIIf	Beam trawl[2] Div VIIf	Otter trawl[2] Div VIIgEast	Beam trawl[2] Div VIIgEast	Otter trawl[2] Div VIIgWest	Beam trawl[2] Div VIIgWest	Beam trawl[3] Div VIIfg	Beam trawl[4] Div VIIfg	Otter trawl[4] Div VIIg	Scottish sein[4] Div VIIg	Beam trawl[4] Div VIIg
1971	-	-	-	-	-	-	-	47.92	-	-	-	-
1972	-	-	-	-	-	-	-	37.06	-	-	-	-
1973	-	-	-	-	-	-	-	39.47	-	-	-	-
1974	-	-	-	-	-	-	-	37.81	-	-	-	-
1975	-	-	-	-	-	-	-	31.41	-	-	-	-
1976	-	-	-	-	-	-	-	30.50	-	-	-	-
1977	-	-	-	-	-	-	-	27.90	-	-	-	-
1978	-	-	-	-	-	-	-	23.35	-	-	-	-
1979	-	-	-	-	-	-	-	33.19	-	-	-	-
1980	-	-	-	-	-	-	-	29.73	-	-	-	-
1981	-	-	-	-	-	-	-	24.03	-	-	-	-
1982	-	-	-	-	-	-	-	25.93	-	-	-	-
1983	-	30.54	201.80	35.75	250.70	0.00	39.68	22.18	-	-	-	-
1984	-	19.53	204.65	28.04	130.61	0.00	63.21	20.78	-	-	-	-
1985	-	26.58	240.45	37.31	235.62	33.78	188.28	17.94	-	-	-	-
1986	-	25.55	247.74	21.27	190.11	10.22	184.94	17.83	-	-	-	-
1987	-	19.85	179.34	36.02	225.56	0.47	113.56	17.32	-	-	-	-
1988	79.52	11.13	110.35	8.88	304.43	1.82	230.65	15.29	-	-	-	-
1989	150.02	17.36	130.42	18.75	247.17	10.28	707.10	11.33	-	-	-	-
1990	93.61	13.41	148.47	18.08	269.40	8.12	106.57	15.64	-	-	-	-
1991	122.06	12.26	119.52	16.20	117.12	15.23	169.61	24.24	-	-	-	-
1992	121.41	17.90	105.84	20.99	119.32	20.62	127.52	18.57	-	-	-	-
1993	76.37	8.85	118.08	4.27	119.85	9.83	358.96	15.21	-	-	-	-
1994	109.74	13.00	70.00	3.50	74.32	5.72	116.30	13.94	-	-	-	-
1995	69.91	13.76	73.20	12.75	63.20	15.20	41.46	13.62	-	0.40	0.62	0.81
1996	71.71	9.69	65.05	6.95	43.84	0.68	12.41	11.27	11.45	0.73	0.05	0.88
1997	81.67	12.55	53.81	6.42	43.77	0.44	16.05	9.96	9.68	0.42	0.23	1.16
1998	137.11	8.24	44.86	4.85	27.16	0.04	47.84	10.12	9.64	0.48	0.11	1.11
1999	168.46	13.25	52.36	8.18	26.19	0.01	14.01	11.26	12.14	0.17	0.09	0.50
2000	228.46	7.01	53.85	23.26	36.94	0.09	14.9	11.90	13.77	0.19	0.05	0.26
2001	158.08	17.1	62.39	27.5	33.01	0.11	22.69	13.25	13.60	0.31	0.55	0.18
2002	121.89	11.61	79.47	47.01	54.15	0.11	43.04	18.71	17.80	0.43	0.29	0.14
2003	123.91	8.03	80.85	0.00	45.42	0.70	52.96	19.48	11.40	0.12	0.03	0.19
2004	152.03	8.84	76.09	2.70	37.88	0.05	91.33	-	9.17	0.19	0.02	0.20
2005	76.28	10.67	70.02	3.07	41.36	0.20	80.99	-	9.78	0.14	0.00	0.29
2006	68.96	16.40	81.57	6.23	45.13	0.10	20.93	-	10.63	0.11	0.05	0.26
2007	80.95	10.75	92.17	15.04	43.57	0.05	39.00	-	11.53	0.13	0.02	0.20
2008	115.96	11.94	94.85	10.67	41.48	0.00	19.96	-	14.35	0.12	0.02	0.29
2009	90.64	13.13	69.37	6.88	50.65	0.00	9.81	-	14.01	0.10	0.00	0.28
2010	109.55	13.59	79.90	8.63	53.69	0.00	44.89	-	16.68	0.13	0.01	0.20
2011	99.47	20.78	109.20	4.47	98.38	0.00	50.73	-	17.90	0.19	0.01	0.20
2012	101.45	24.10	80.16	5.17	53.43	0.00	42.43	-	17.01	0.15	0.01	0.48
2013	119.38	27.81	82.82	4.62	44.52	0.07	39.60	-	16.54	0.14	0.01	0.65
2014	86.75	6.19	107.25	11.56	42.11	0	18.57	-	21.30	0.12	-	0.34
2015	85.45	51.13	103.07	5.62	57.39	0	42.64	-	20.14	0.11	-	0.31
2016	113.55	0.00	113.16	0	33.65	0	34.17	-	16.25	0.10	0.01	0.20
2017	111.38	31.29	100.03	18.09	35.05	0.22	58.81	-	15.72	0.18	0.05	0.22
2018	206.44	36.37	119.89	4.86	47.74	0.15	52.26	-	18.09	0.18	-	0.27
2019	150.04	46.55	129.79	11.12	61.33	0.12	23.35	-	23.08	0.25	0.00	0.26
2020	111.72	51.82	168.07	5.58	117.30	0	92.58	-	25.74	0.31	0.02	0.93
2021*	112.38	89.52	156.87	6.41	78.38	9.80	136.10	-	22.04	0.27	0.02	0.54

[1] Kg/100 km.

[2] Kg/day.

[3] Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23.

[4] Kg/hour. ***Provisional.**

Table 33.9. Sol.27.7fg - Tuning series.

BE-CBT_1971_1983	**Belgium Beam trawl (Biomass tuning index)**		
1971	1983		
1	1	0	0
1	-1		
1	45.319		
1	33.193		
1	35.906		
1	35.915		
1	29.286		
1	27.369		
1	25.677		
1	23.971		
1	32.663		
1	28.343		
1	23.326		
1	26.083		
1	20.742		
BE-CBT_1984_1996	**Belgium Beam trawl (Biomass tuning index)**		
1984	1996		
1	1	0	0
1	-1		
1	19.788		
1	20.556		
1	19.824		
1	18.996		
1	15.129		
1	12.805		
1	16.620		
1	23.442		
1	20.455		

1	16.472		
1	15.722		
1	15.199		
1	12.243		
BE-CBT3-2006-2021	**Belgium Beam trawl (Biomass tuning index)**		
2006	2021		
1	1	0	0
1	-1		
1	2.109		
1	1.916		
1	1.844		
1	1.677		
1	2.046		
1	2.383		
1	2.371		
1	2.047		
1	2.567		
1	2.418		
1	2.299		
1	2.501		
1	2.996		
1	3.650		
1	3.753		
1	4.566		

UK(E&W)-CBT_1984_2005	UK(E+W) Beam trawl (Biomass tuning index)		
1984	2005		
1	1	0	0
1	-1		
1	144.81		
1	127.06		
1	139.65		
1	103.20		
1	88.73		
1	69.98		
1	89.25		
1	67.02		
1	52.94		
1	42.69		
1	44.13		
1	46.17		
1	40.14		
1	53.85		
1	74.17		
1	80.67		
1	56.27		
1	51.17		
1	61.30		
1	71.98		
1	79.08		
1	83.60		

UK(E&W)-CBT_2006_2021	**UK(E+W) Beam trawl (Biomass tuning index)**	
2006	2021	
1	1	0
1	-1	
1	131.32	
1	218.97	
1	241.55	
1	208.66	
1	233	
1	281.56	
1	248.56	
1	211.97	
1	295.78	
1	235.16	
1	201.64	
1	205.73	
1	254.71	
1	233.35	
1	292.91	
1	357.47	

UK(E&W)-BTS-Q3	**UK(E+W) 7.f Corystes (automated indices since 1995). Ages used in the assessment are in bold**									
1988	2021									
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

UK(E&W)-BTS-Q3	**UK(E+W) 7.f Corystes (automated indices since 1995). Ages used in the assessment are in bold**									
118.592	40	**289**	**305**	**90**	**16**	**6**	27	9	1	1
118.592	33	**885**	**57**	**52**	**37**	**8**	4	16	7	0
118.592	31	**680**	**426**	**14**	**32**	**15**	8	4	6	9
118.592	7	**1240**	**206**	**80**	**15**	**19**	20	5	4	13
118.592	32	**515**	**1074**	**331**	**53**	**20**	11	18	13	5
118.592	2	**840**	**386**	**195**	**27**	**34**	4	7	8	5
118.592	3	**393**	**282**	**88**	**80**	**28**	20	2	7	8
118.592	68	**1062**	**183**	**53**	**44**	**39**	14	14	0	3

Table 33.10. Sol.27.7fg – Configuration.

```
$minAge
[1] 1

$maxAge
[1] 10

$maxAgePlusGroup
[1] 1 0 0 0 0 0 0

$keyLogFsta
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]    0    1    2    3    3    3    4    4    5     5
[2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[4,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[5,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[6,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[7,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1

$corFlag
[1] 2

$keyLogFpar
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[2,]    0    1    2    3    3   -1   -1   -1   -1    -1
[3,]    4   -1   -1   -1   -1   -1   -1   -1   -1    -1
[4,]    5   -1   -1   -1   -1   -1   -1   -1   -1    -1
[5,]    6   -1   -1   -1   -1   -1   -1   -1   -1    -1
[6,]    7   -1   -1   -1   -1   -1   -1   -1   -1    -1
[7,]    8   -1   -1   -1   -1   -1   -1   -1   -1    -1

$keyQpow
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[4,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[5,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[6,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[7,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1

$keyVarF
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]    0    0    0    0    0    0    0    0    0     0
[2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[4,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[5,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[6,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[7,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1

$keyVarLogN
 [1] 0 1 1 1 1 1 1 1 1 1
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```
$keyVarObs
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[1,]    0    0    1    1    1    1    1    1    1     1
[2,]    2    3    3    4    4   -1   -1   -1   -1    -1
[3,]    5   -1   -1   -1   -1   -1   -1   -1   -1    -1
[4,]    6   -1   -1   -1   -1   -1   -1   -1   -1    -1
[5,]    7   -1   -1   -1   -1   -1   -1   -1   -1    -1
[6,]    8   -1   -1   -1   -1   -1   -1   -1   -1    -1
[7,]    9   -1   -1   -1   -1   -1   -1   -1   -1    -1

$obsCorStruct
[1] AR ID ID ID ID ID ID
Levels: ID AR US

$keyCorObs
     1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10
[1,]   0   0   0   0   0   0   0   0    0
[2,]  NA  NA  NA  NA  -1  -1  -1  -1   -1
[3,]  -1  -1  -1  -1  -1  -1  -1  -1   -1
[4,]  -1  -1  -1  -1  -1  -1  -1  -1   -1
[5,]  -1  -1  -1  -1  -1  -1  -1  -1   -1
[6,]  -1  -1  -1  -1  -1  -1  -1  -1   -1
[7,]  -1  -1  -1  -1  -1  -1  -1  -1   -1

$stockRecruitmentModelCode
[1] 0

$noScaledYears
[1] 0

$keyScaledYears
numeric(0)

$keyParScaledYA
<0 x 0 matrix>

$fbarRange
[1] 3 8

$keyBiomassTreat
[1] -1 -1  0  0  0  0  0

$obsLikelihoodFlag
[1] LN LN LN LN LN LN LN
Levels: LN ALN

$fixVarToWeight
[1] 0

$fracMixF
[1] 0

$fracMixN
[1] 0

$fracMixObs
[1] 0 0 0 0 0 0 0
```

```
$constRecBreaks
numeric(0)

$predVarObsLink
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[2,]   -1   -1   -1   -1   -1   NA   NA   NA   NA    NA
[3,]   NA   NA   NA   NA   NA   NA   NA   NA   NA    NA
[4,]   NA   NA   NA   NA   NA   NA   NA   NA   NA    NA
[5,]   NA   NA   NA   NA   NA   NA   NA   NA   NA    NA
[6,]   NA   NA   NA   NA   NA   NA   NA   NA   NA    NA
[7,]   NA   NA   NA   NA   NA   NA   NA   NA   NA    NA

$hockeyStickCurve
[1] 20

$stockWeightModel
[1] 0

$keyStockWeightMean
 [1] NA NA NA NA NA NA NA NA NA NA

$keyStockWeightObsVar
 [1] NA NA NA NA NA NA NA NA NA NA

$catchWeightModel
[1] 0

$keyCatchWeightMean
 [1] NA NA NA NA NA NA NA NA NA NA

$keyCatchWeightObsVar
 [1] NA NA NA NA NA NA NA NA NA NA

$matureModel
[1] 0

$keyMatureMean
 [1] NA NA NA NA NA NA NA NA NA NA

$mortalityModel
[1] 0

$keyMortalityMean
 [1] NA NA NA NA NA NA NA NA NA NA

$keyMortalityObsVar
 [1] NA NA NA NA NA NA NA NA NA NA

$keyXtraSd
     [,1] [,2] [,3] [,4]
```

Table 33.11. Sol.27.7fg – Diagnostics.

#Model_table#

	log(L)	#par	AIC
M1	-249.3667	24	546.7334

#Tuning_table#

Name	Type	Years	Ages	LogQ_age1	sd_age1	LogQ_age2	sd_age2	LogQ_age3	sd_age3
UK-BTS-Q3	age-based	1988-2021	1-5	-7.196	0.100	-7.4	0.1	-8.614	0.099
BE-CBT_71-83	biomass	1971-1983	-1	-5.115	0.064	NA	NA	NA	NA
BE-CBT_84-96	biomass	1984-1996	-1	-5.244	0.055	NA	NA	NA	NA
BE-CBT_06-21	biomass	2006-2021	-1	-7.360	0.054	NA	NA	NA	NA
UK-CBT_84-05	biomass	1984-2005	-1	-3.825	0.076	NA	NA	NA	NA
UK-CBT_06-21	biomass	2006-2021	-1	-2.804	0.074	NA	NA	NA	NA

Name	Type	Years	Ages	LogQ_age4	sd_age4	LogQ_age5	sd_age5
UK-BTS-Q3	age-based	1988-2021	1-5	-9.239	0.066	-9.239	0.066
BE-CBT_71-83	biomass	1971-1983	-1	NA	NA	NA	NA
BE-CBT_84-96	biomass	1984-1996	-1	NA	NA	NA	NA
BE-CBT_06-21	biomass	2006-2021	-1	NA	NA	NA	NA
UK-CBT_84-05	biomass	1984-2005	-1	NA	NA	NA	NA
UK-CBT_06-21	biomass	2006-2021	-1	NA	NA	NA	NA

Table 33.12. Sol.27.7fg - Fishing mortality.

year/age	1	2	3	4	5	6	7	8	9	10+	Fbar(3-8)
1971	0.003	0.086	0.281	0.33	0.33	0.33	0.293	0.293	0.273	0.273	0.31
1972	0.003	0.08	0.261	0.304	0.304	0.304	0.268	0.268	0.249	0.249	0.285
1973	0.003	0.076	0.246	0.282	0.282	0.282	0.248	0.248	0.231	0.231	0.265
1974	0.003	0.072	0.233	0.267	0.267	0.267	0.236	0.236	0.22	0.22	0.251
1975	0.003	0.07	0.228	0.26	0.26	0.26	0.23	0.23	0.213	0.213	0.244
1976	0.003	0.081	0.264	0.299	0.299	0.299	0.264	0.264	0.243	0.243	0.282
1977	0.003	0.074	0.24	0.271	0.271	0.271	0.238	0.238	0.218	0.218	0.255
1978	0.003	0.068	0.219	0.247	0.247	0.247	0.215	0.215	0.196	0.196	0.231
1979	0.003	0.072	0.233	0.263	0.263	0.263	0.228	0.228	0.207	0.207	0.247
1980	0.003	0.082	0.265	0.3	0.3	0.3	0.259	0.259	0.233	0.233	0.281
1981	0.003	0.092	0.299	0.339	0.339	0.339	0.293	0.293	0.262	0.262	0.317
1982	0.004	0.096	0.314	0.358	0.358	0.358	0.311	0.311	0.276	0.276	0.335
1983	0.004	0.101	0.33	0.378	0.378	0.378	0.329	0.329	0.289	0.289	0.354
1984	0.004	0.101	0.332	0.385	0.385	0.385	0.332	0.332	0.291	0.291	0.358
1985	0.004	0.108	0.355	0.417	0.417	0.417	0.357	0.357	0.313	0.313	0.386
1986	0.004	0.117	0.385	0.46	0.46	0.46	0.393	0.393	0.345	0.345	0.425
1987	0.004	0.114	0.375	0.455	0.455	0.455	0.389	0.389	0.341	0.341	0.42
1988	0.004	0.11	0.363	0.447	0.447	0.447	0.38	0.38	0.334	0.334	0.411
1989	0.004	0.105	0.344	0.424	0.424	0.424	0.358	0.358	0.313	0.313	0.389
1990	0.004	0.11	0.361	0.447	0.447	0.447	0.375	0.375	0.329	0.329	0.408
1991	0.004	0.106	0.348	0.432	0.432	0.432	0.36	0.36	0.32	0.32	0.394
1992	0.004	0.104	0.342	0.423	0.423	0.423	0.35	0.35	0.314	0.314	0.385
1993	0.004	0.111	0.366	0.455	0.455	0.455	0.378	0.378	0.339	0.339	0.414
1994	0.005	0.12	0.395	0.495	0.495	0.495	0.41	0.41	0.37	0.37	0.45
1995	0.005	0.132	0.435	0.546	0.546	0.546	0.451	0.451	0.406	0.406	0.496
1996	0.005	0.133	0.44	0.551	0.551	0.551	0.455	0.455	0.41	0.41	0.501
1997	0.005	0.136	0.449	0.561	0.561	0.561	0.465	0.465	0.42	0.42	0.51
1998	0.005	0.128	0.421	0.526	0.526	0.526	0.436	0.436	0.395	0.395	0.479
1999	0.004	0.115	0.374	0.465	0.465	0.465	0.383	0.383	0.348	0.348	0.422
2000	0.004	0.1	0.324	0.403	0.403	0.403	0.334	0.334	0.306	0.306	0.367
2001	0.004	0.097	0.315	0.396	0.396	0.396	0.329	0.329	0.305	0.305	0.36
2002	0.004	0.099	0.319	0.406	0.406	0.406	0.338	0.338	0.315	0.315	0.369
2003	0.004	0.106	0.345	0.445	0.445	0.445	0.372	0.372	0.349	0.349	0.404
2004	0.004	0.109	0.355	0.46	0.46	0.46	0.387	0.387	0.367	0.367	0.418
2005	0.004	0.105	0.34	0.445	0.445	0.445	0.377	0.377	0.362	0.362	0.405
2006	0.004	0.1	0.321	0.424	0.424	0.424	0.364	0.364	0.354	0.354	0.387
2007	0.004	0.094	0.299	0.4	0.4	0.4	0.349	0.349	0.341	0.341	0.366
2008	0.003	0.086	0.271	0.367	0.367	0.367	0.326	0.326	0.321	0.321	0.337
2009	0.003	0.081	0.254	0.351	0.351	0.351	0.315	0.315	0.312	0.312	0.323
2010	0.003	0.077	0.242	0.338	0.338	0.338	0.306	0.306	0.303	0.303	0.311
2011	0.003	0.078	0.243	0.344	0.344	0.344	0.315	0.315	0.314	0.314	0.317
2012	0.003	0.082	0.256	0.368	0.368	0.368	0.34	0.34	0.341	0.341	0.34
2013	0.003	0.082	0.256	0.372	0.372	0.372	0.345	0.345	0.349	0.349	0.344
2014	0.003	0.081	0.253	0.37	0.37	0.37	0.344	0.344	0.352	0.352	0.342
2015	0.003	0.074	0.229	0.334	0.334	0.334	0.31	0.31	0.318	0.318	0.309
2016	0.003	0.067	0.206	0.301	0.301	0.301	0.277	0.277	0.284	0.284	0.277
2017	0.002	0.06	0.185	0.271	0.271	0.271	0.248	0.248	0.255	0.255	0.249
2018	0.002	0.056	0.172	0.253	0.253	0.253	0.232	0.232	0.239	0.239	0.232
2019	0.002	0.057	0.175	0.258	0.258	0.258	0.236	0.236	0.243	0.243	0.237
2020	0.002	0.06	0.185	0.274	0.274	0.274	0.251	0.251	0.256	0.256	0.251
2021	0.002	0.06	0.184	0.274	0.274	0.274	0.249	0.249	0.254	0.254	0.25

Table 33.13. Sol.27.7fg - Stock numbers-at-age (start of year, in thousands).

year/age	1	2	3	4	5	6	7	8	9	10+	Total
1971	8764	5281	1833	4682	2034	1514	1804	2652	1462	4827	34853
1972	4526	8318	4355	1400	2805	1265	999	1153	1722	4009	30552
1973	3408	3965	7335	2940	1085	1744	786	711	766	3815	26556
1974	3476	3003	3228	5032	2012	794	1144	545	529	3073	22835
1975	3507	3139	2460	2325	3445	1407	548	773	405	2408	20418
1976	5278	3068	2653	1840	1748	2390	979	368	602	1976	20903
1977	4852	4946	2482	1664	1325	1135	1755	673	220	1800	20851
1978	5208	4325	4327	1718	1041	1001	776	1278	480	1324	21478
1979	3715	4851	3648	3300	1157	729	781	608	961	1301	21050
1980	4903	3196	4162	2669	2173	809	507	556	465	1694	21136
1981	5055	4508	2540	2917	1687	1364	525	418	387	1561	20961
1982	5038	4570	3815	1550	1937	1094	832	334	326	1382	20877
1983	6467	4453	3750	2476	977	1242	701	522	213	1254	22056
1984	5698	6002	3622	2374	1592	611	837	456	298	1103	22591
1985	5600	5093	5059	2308	1530	950	399	536	302	989	22765
1986	3947	5178	4094	3169	1376	902	555	275	337	904	20736
1987	5677	3365	4274	2404	1799	778	499	325	186	785	20092
1988	4605	5347	2567	2837	1277	1043	453	267	204	674	19274
1989	4856	4327	4518	1660	1732	700	591	295	148	566	19394
1990	7394	4334	3659	2982	968	1069	404	356	189	504	21859
1991	4950	7192	3420	2366	1717	548	618	242	207	492	21751
1992	5045	4387	6100	2112	1382	953	321	379	151	442	21272
1993	4728	4550	3482	3748	1170	769	533	210	261	383	19833
1994	4313	4407	3643	2134	2128	674	461	296	136	428	18620
1995	3781	3868	3592	2263	1120	1155	362	279	184	350	16953
1996	4383	3447	3038	2139	1131	593	586	204	157	331	16009
1997	6338	4005	2757	1702	1091	586	314	323	120	297	17532
1998	7907	5773	3221	1588	869	541	295	176	177	251	20798
1999	13679	6834	4553	1964	772	463	296	155	107	246	29069
2000	9156	12696	5333	2637	1111	390	272	180	94	238	32105
2001	5702	8160	10410	3245	1520	687	248	179	112	243	30505
2002	7121	4880	6588	7204	1890	925	405	169	126	237	29544
2003	5429	6579	3820	4281	4494	1030	589	267	107	267	26863
2004	4806	4826	5398	2450	2638	2387	544	360	171	264	23844
2005	4283	4348	3782	3218	1440	1493	1296	322	219	288	20690
2006	3544	3895	3542	2324	1907	814	870	770	205	328	18199
2007	3924	3174	3214	2259	1356	1167	487	547	513	338	16978
2008	7507	3362	2574	2096	1369	821	729	302	368	558	19684
2009	6791	7111	2692	1811	1335	847	540	470	192	634	22423
2010	3110	6354	6602	2040	1197	873	552	362	321	552	21963
2011	5364	2554	5578	5161	1382	867	578	387	234	637	22741
2012	6362	4885	2017	3977	3424	959	587	380	257	623	23472
2013	5111	5780	4044	1535	2435	1986	637	379	240	584	22729
2014	3987	4719	4791	2843	1021	1456	1186	406	250	550	21209
2015	7926	3311	3989	3503	1748	653	904	670	268	467	23438
2016	8365	7404	2693	2757	2269	1130	447	565	440	429	26499
2017	14305	7059	6505	2075	1821	1455	760	320	362	564	35225
2018	6861	14068	5896	5100	1522	1244	934	548	241	617	37031
2019	7032	6159	12982	4469	3671	1212	825	625	432	599	38006
2020	6104	6079	5391	10338	3714	2536	925	570	442	764	36864
2021	8071	5392	5079	4396	7427	2946	1730	661	379	873	36952

Table 33.14. Sol.27.7fg - Summary ('Catch' refers to model estimate).

year	R low	R value	R high	TSB low	TSB value	TSB high	SSB low	SSB value	SSB high	Catch low	Catch value	Catch high	Fbar low	Fbar value	Fbar high
1971	5929	8764	12954	6180	7196	8379	5642	6636	7805	1376	1699	2099	0.248	0.31	0.387
1972	3178	4526	6445	5356	6220	7224	4926	5762	6741	1185	1401	1658	0.234	0.285	0.346
1973	2392	3408	4855	5456	6316	7312	5062	5891	6855	1194	1409	1662	0.218	0.265	0.321
1974	2439	3476	4953	5013	5809	6731	4709	5484	6387	1049	1241	1470	0.206	0.251	0.306
1975	2452	3507	5015	4621	5355	6205	4338	5055	5891	957	1133	1342	0.2	0.244	0.299
1976	3726	5278	7475	4266	4933	5705	3925	4571	5323	912	1092	1307	0.23	0.282	0.345
1977	3432	4852	6859	4202	4831	5554	3770	4361	5045	825	970	1140	0.21	0.255	0.309
1978	3660	5208	7409	4266	4902	5632	3833	4431	5123	766	919	1102	0.187	0.231	0.287
1979	2589	3715	5331	4343	4978	5705	3986	4593	5292	863	1025	1217	0.202	0.247	0.301
1980	3470	4903	6928	4319	4943	5657	3990	4594	5288	1001	1181	1394	0.234	0.281	0.336
1981	3577	5055	7143	4051	4612	5251	3681	4217	4832	957	1133	1341	0.266	0.317	0.378
1982	3561	5038	7127	4049	4581	5182	3633	4134	4704	1039	1226	1447	0.281	0.335	0.398
1983	4556	6467	9178	4047	4564	5147	3589	4070	4616	1061	1254	1481	0.299	0.354	0.419
1984	4010	5698	8097	4214	4741	5334	3737	4219	4762	1086	1280	1509	0.303	0.358	0.423
1985	3941	5600	7957	3857	4341	4886	3468	3920	4431	1141	1351	1601	0.328	0.386	0.455
1986	2778	3947	5608	3992	4500	5073	3591	4058	4585	1217	1452	1733	0.359	0.425	0.504
1987	4043	5677	7971	3552	3998	4499	3173	3587	4055	1110	1315	1559	0.356	0.42	0.495
1988	3312	4605	6404	3288	3693	4147	2919	3293	3715	974	1155	1370	0.349	0.411	0.484
1989	3494	4856	6748	3146	3522	3942	2765	3108	3493	841	998	1185	0.33	0.389	0.459
1990	5296	7394	10324	2971	3324	3719	2570	2890	3250	934	1106	1309	0.345	0.408	0.484
1991	3583	4950	6837	3248	3669	4145	2826	3198	3619	947	1132	1353	0.333	0.394	0.466
1992	3671	5045	6933	3280	3708	4193	2877	3264	3703	891	1079	1307	0.323	0.385	0.46
1993	3429	4728	6518	3090	3469	3895	2709	3053	3439	906	1082	1291	0.351	0.414	0.488
1994	3137	4313	5931	2859	3200	3581	2512	2820	3167	914	1085	1288	0.385	0.45	0.526
1995	2731	3781	5236	2774	3100	3465	2443	2736	3065	963	1145	1362	0.423	0.496	0.582
1996	3166	4383	6068	2524	2818	3146	2207	2472	2768	883	1043	1231	0.428	0.501	0.585
1997	4588	6338	8754	2312	2589	2900	1948	2191	2465	831	988	1175	0.432	0.51	0.602
1998	5663	7907	11041	2652	2998	3391	2131	2409	2723	807	963	1151	0.405	0.479	0.566
1999	9744	13679	19202	3117	3543	4028	2352	2672	3037	779	938	1130	0.357	0.422	0.5
2000	6648	9156	12610	3157	3583	4065	2558	2909	3309	885	1091	1345	0.304	0.367	0.443
2001	4109	5702	7914	4405	5055	5801	3780	4349	5003	1121	1368	1670	0.302	0.36	0.43
2002	5166	7121	9816	4402	5022	5728	3871	4441	5094	1221	1477	1787	0.312	0.369	0.436
2003	3954	5429	7453	4136	4686	5309	3668	4176	4753	1243	1498	1805	0.343	0.404	0.475
2004	3525	4806	6553	4113	4631	5214	3636	4104	4632	1215	1452	1735	0.354	0.418	0.493
2005	3160	4283	5804	3720	4167	4667	3318	3729	4191	1104	1308	1550	0.343	0.405	0.477
2006	2607	3544	4818	3283	3666	4093	2936	3286	3678	873	1026	1206	0.328	0.387	0.456
2007	2886	3924	5336	3051	3415	3823	2700	3028	3397	819	960	1125	0.309	0.366	0.433
2008	5411	7507	10415	3129	3534	3992	2645	2987	3373	731	856	1001	0.283	0.337	0.402
2009	4982	6791	9256	3321	3814	4381	2724	3119	3572	623	734	865	0.271	0.323	0.384
2010	2236	3110	4326	3428	3878	4388	2982	3378	3827	716	844	994	0.261	0.311	0.37
2011	3953	5364	7280	3614	4066	4574	3211	3627	4098	867	1022	1204	0.267	0.317	0.377
2012	4690	6362	8630	3629	4085	4599	3139	3551	4017	849	1007	1195	0.284	0.34	0.406
2013	3759	5111	6950	3559	4002	4500	3078	3470	3912	848	999	1178	0.285	0.344	0.414
2014	2898	3987	5486	3639	4119	4661	3236	3674	4171	931	1100	1298	0.28	0.342	0.417
2015	5799	7926	10833	3584	4060	4599	3070	3503	3998	781	921	1086	0.252	0.309	0.377
2016	6197	8365	11292	3837	4360	4953	3152	3591	4092	688	813	959	0.225	0.277	0.34
2017	10348	14305	19774	4385	4990	5677	3489	3979	4539	699	826	976	0.201	0.249	0.308
2018	4956	6861	9498	5285	6036	6894	4415	5040	5754	804	960	1148	0.186	0.232	0.29
2019	4886	7032	10120	5759	6569	7494	5107	5846	6692	996	1182	1402	0.19	0.237	0.296
2020	3542	6104	10519	5653	6534	7552	5126	5945	6894	1122	1350	1624	0.197	0.251	0.321
2021	3880	8071	16786	5437	6579	7961	4879	5894	7119	1080	1317	1606	0.188	0.25	0.333

Table 33.15. Sol.27.7fg – Short-term forecast.

Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 3–8}$ (2022)	0.25	Based on a catch of 1337 t for 2022.
SSB_{2023}	6120	Short-term forecast fishing at F=0.25; in tonnes.
Rage $_1$ (2022–2023)	5111	Median recruitment, resampled from the years 1971–2019; in thousands.
Catch (2022)	1337	TAC for 2022; in tonnes.
Projected landings (2022)	1258	Assuming average landings ratio by age 2019–2021; in tonnes.
Projected discards (2022)	79	Assuming average discard ratio by age 2019–2021; in tonnes.

Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2023)	Projected landings * (2023)	Projected discards ** (2023)	F_{total} (2023)	$F_{projected\ landings}$ (2023)	$F_{projected\ discards}$ (2023)	SSB (2024)	% SSB change ***	% TAC change ^	% Advice change ^^
ICES advice basis										
MSY approach= F_{MSY}	1338	1258	80	0.251	0.23	0.0180	5903	-3.5	0.075	0.075
Other scenarios										
F=EU MAP ^^^: F_{MSY}	1338	1258	80	0.251	0.23	0.0180	5903	-3.5	0.075	0.075
F=EU MAP ^^^ $F_{MSY\ lower}$	765	720	45	0.136	0.126	0.0097	6504	6.3	-43	-43
F=EU MAP ^^^ $F_{MSY\ upper}$	2232	2097	135	0.462	0.43	0.033	4963	-18.9	67	67
F = 0	0	0	0	0	0	0	7307	19.4	-100	-100
F_{pa}	1996	1877	119	0.402	0.37	0.029	5212	-14.8	49	49
F_{lim}	2531	2377	154	0.543	0.50	0.039	4647	-24	89	89
$SSB_{2024} = B_{lim}$	4919	4572	347	1.59	1.48	0.114	2184	-64	268	268
$SSB_{2024} = B_{pa}$ = MSY $B_{trigger}$	4063	3797	266	1.10	1.02	0.078	3057	-50	204	204
F = F_{2022}	1312	1234	78	0.25	0.23	0.0175	5930	-3.1	-1.87	-1.87
$SSB_{2024} = SSB_{2023}$	1130	1064	66	0.21	0.193	0.0148	6120	0	-15.5	-15.5

*** Marketable landings, assuming recent discard rate.**

**** Including BMS landings (EU stocks), assuming recent discard rate.**

***** SSB 2024 relative to SSB 2023.**

^ Total catch in 2023 relative to TAC 2022 (1337 tonnes).

^^ Advice value for 2023 relative to the advice value for 2022 (1337 tonnes).

^^^ EU multiannual plan (MAP) for the Western Waters and adjacent waters (EU, 2019).

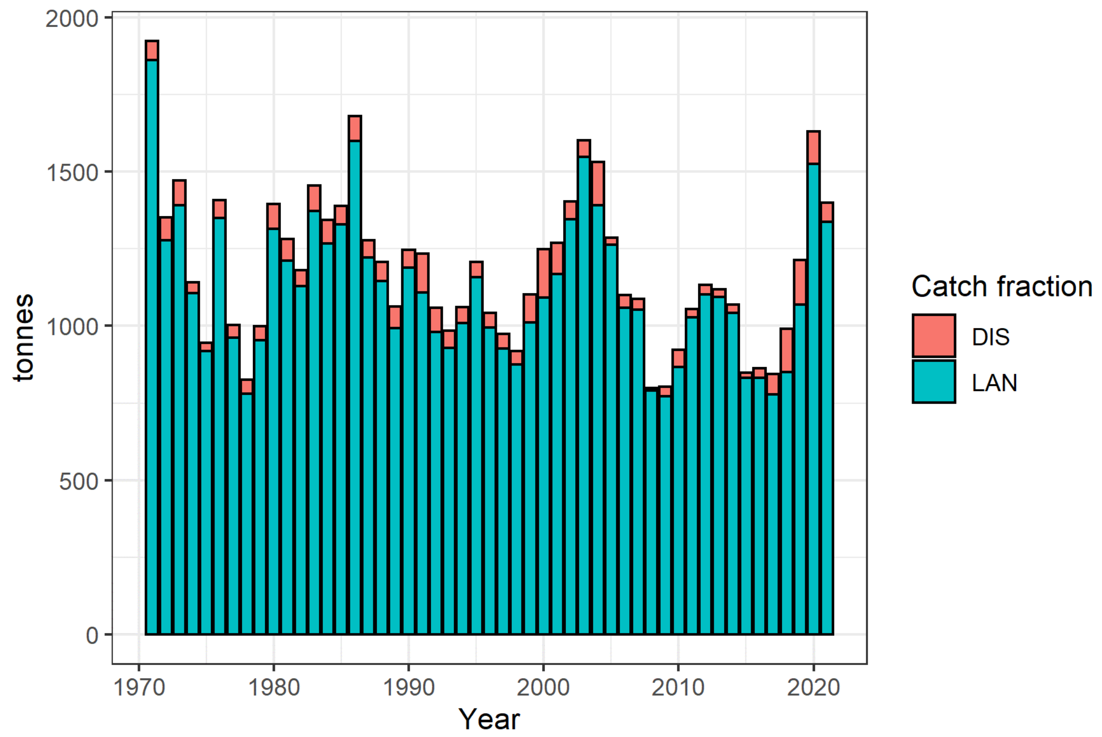

Figure 33.1. Sol.27.7fg - Landings and discards estimates by weight, as used by the WG.

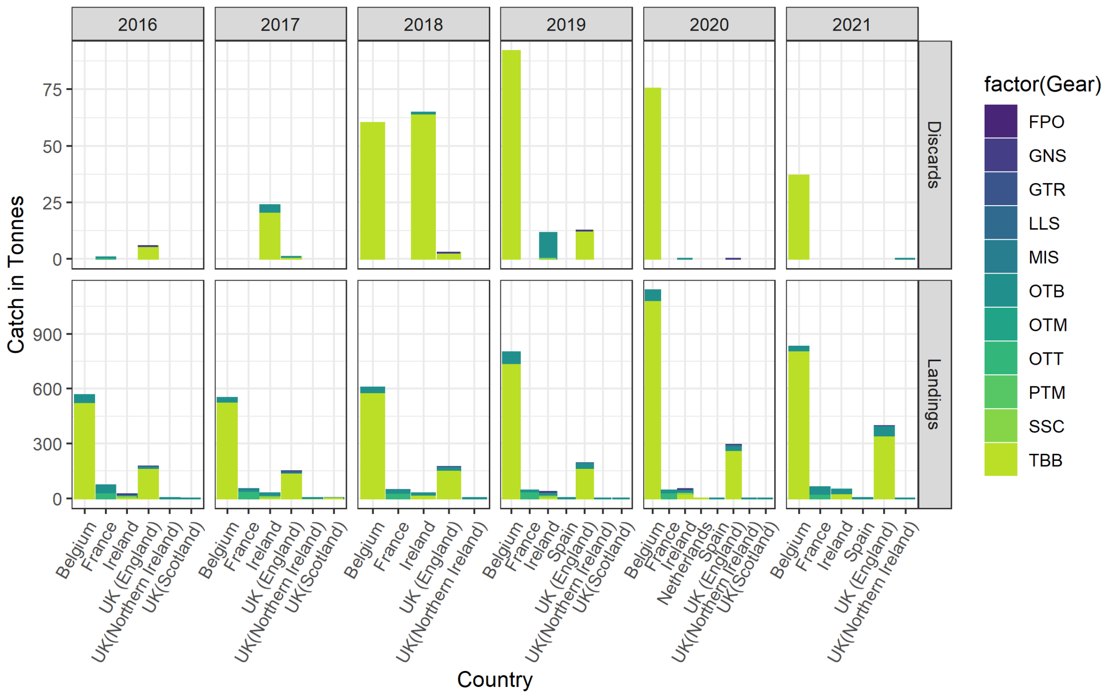

Figure 33.2. Sol.27.7fg - InterCatch landings and discard data by year, country and gear.

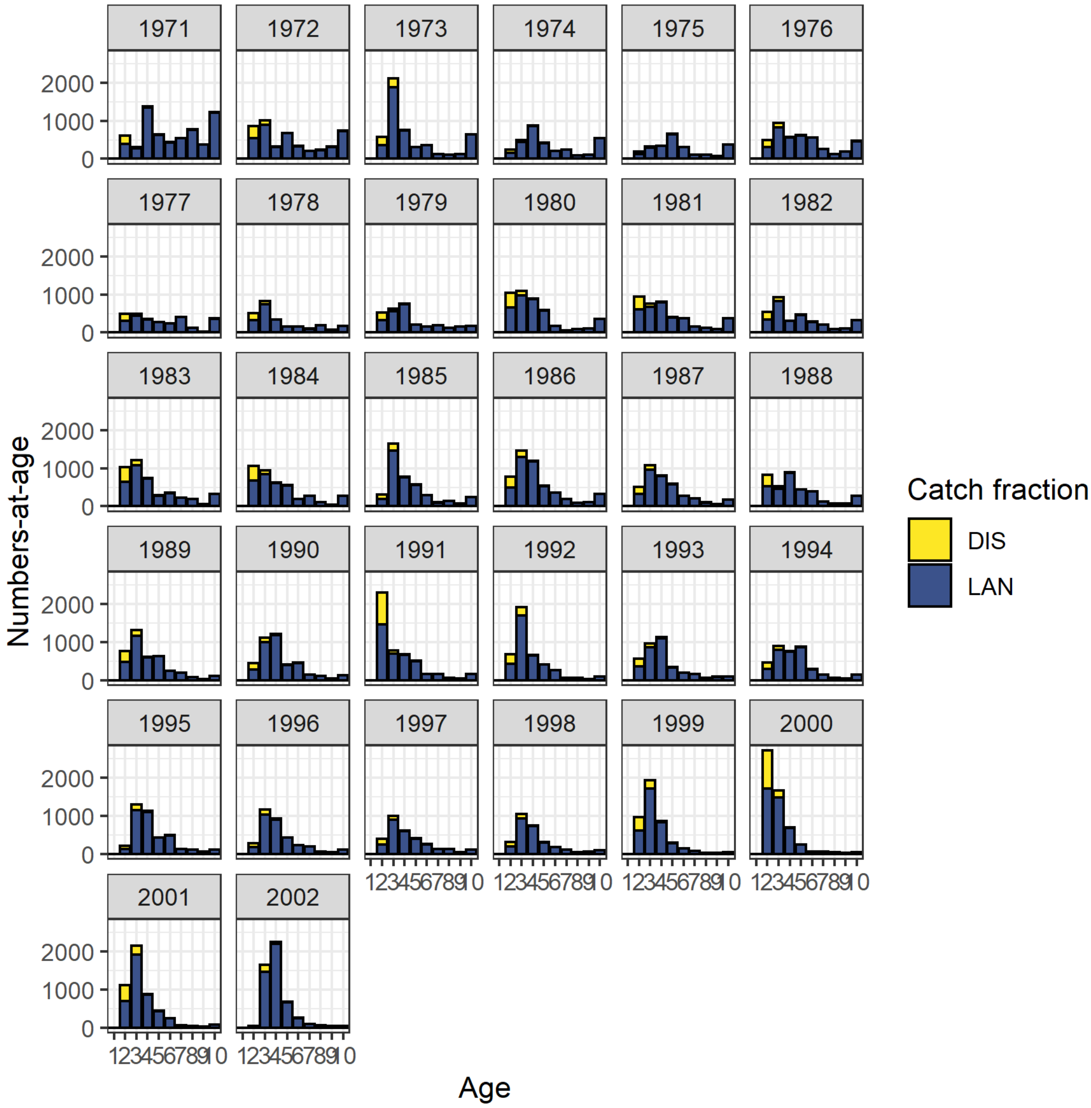

Figure 33.3a. Sol.27.7fg - Age composition of the catch.

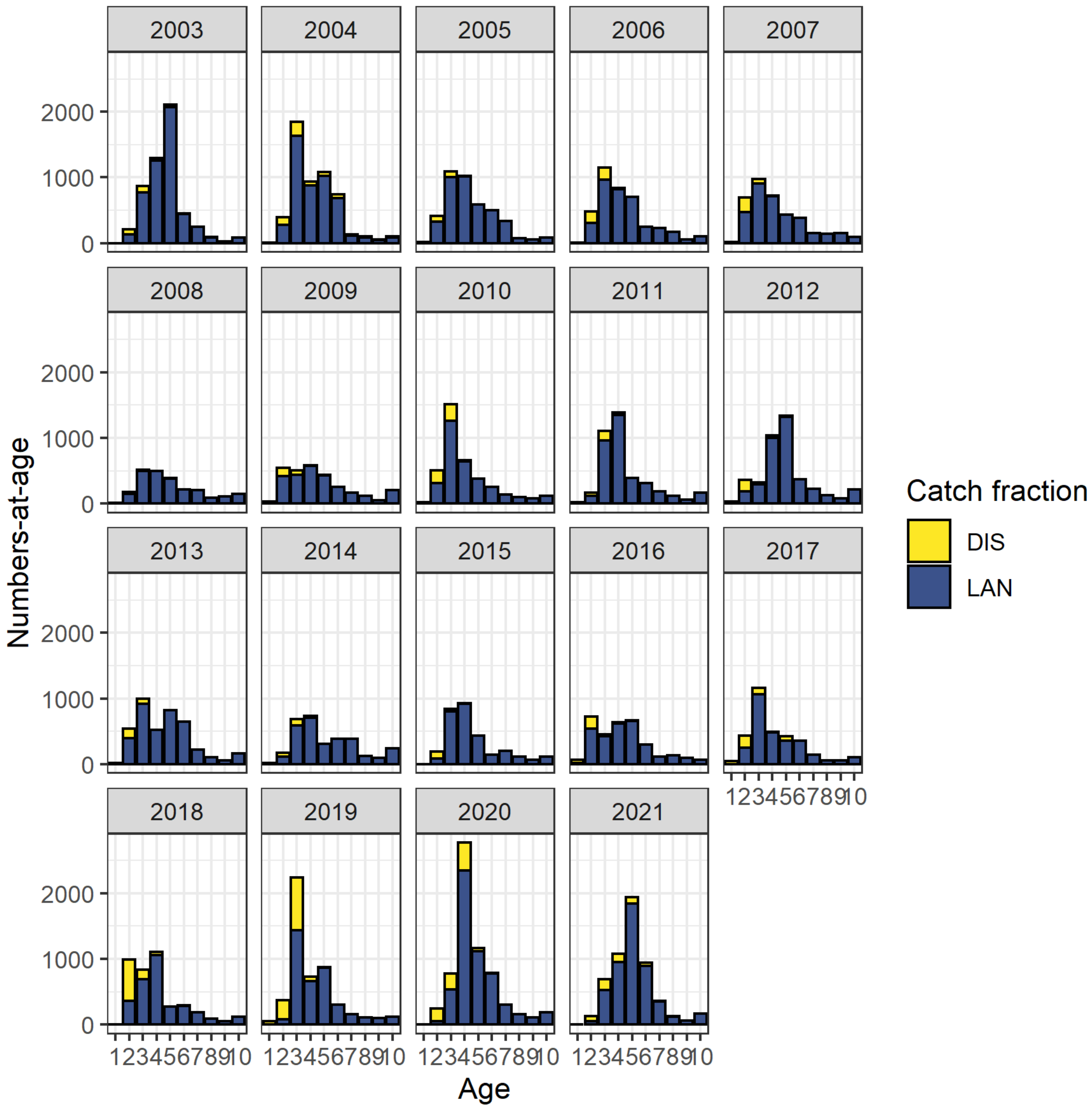

Figure 33.3b. Sol.27.7fg - Age composition of the catch.

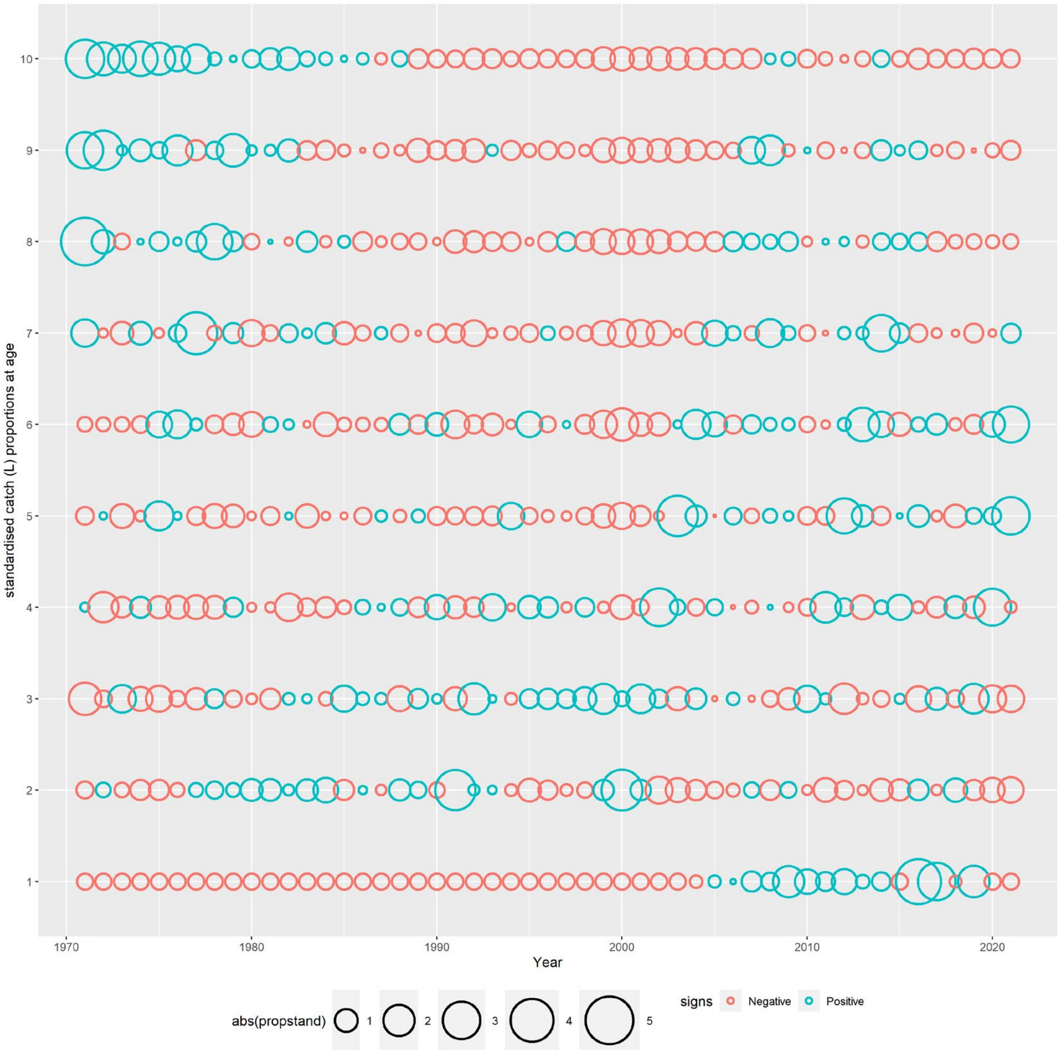

Figure 33.4. Sol.27.7fg - Standardized catch proportion.

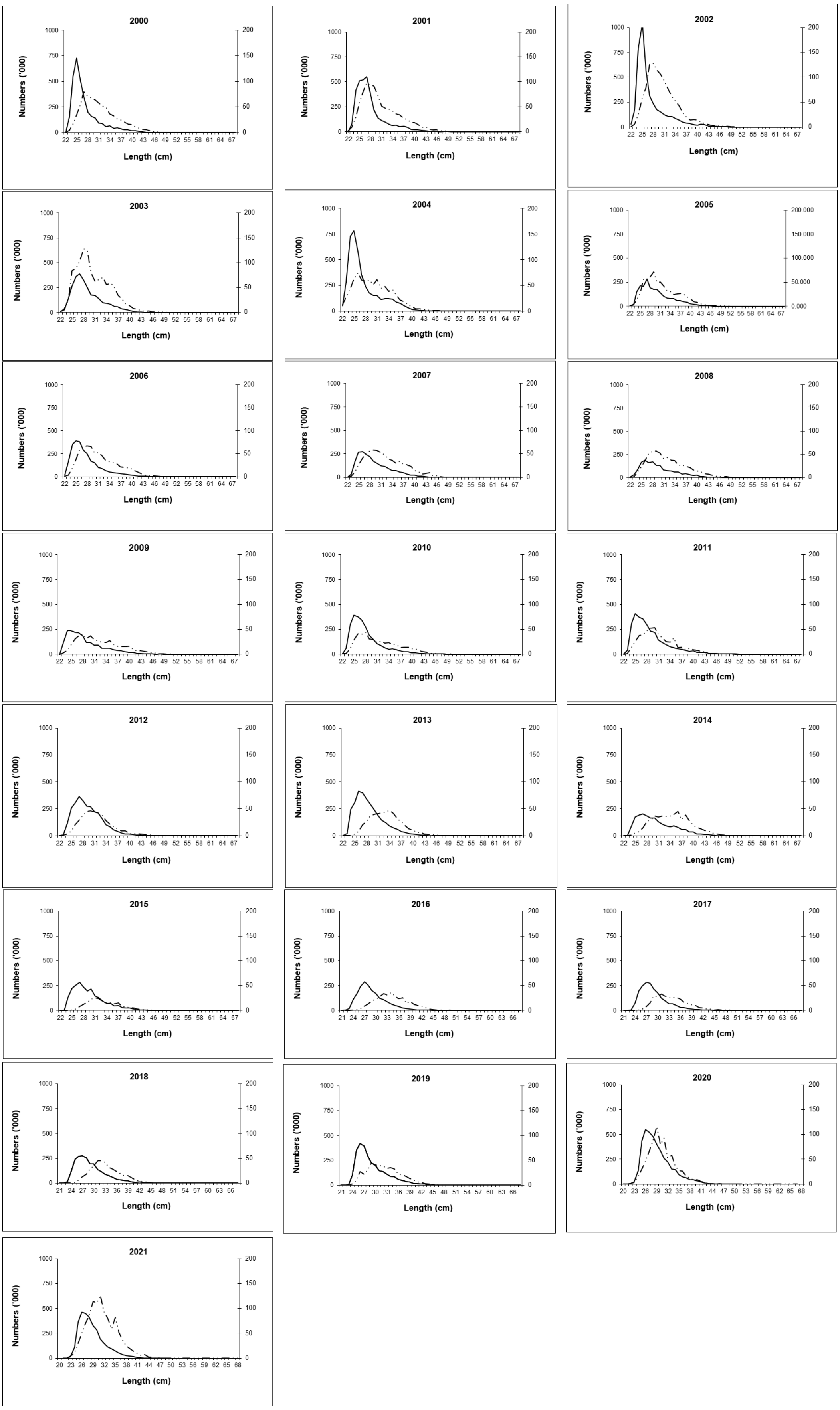

Figure 33.5. Sol.27.7fg - Dotted lines give the length distributions of UK (England and Wales) landings; solid lines of Belgian landings.

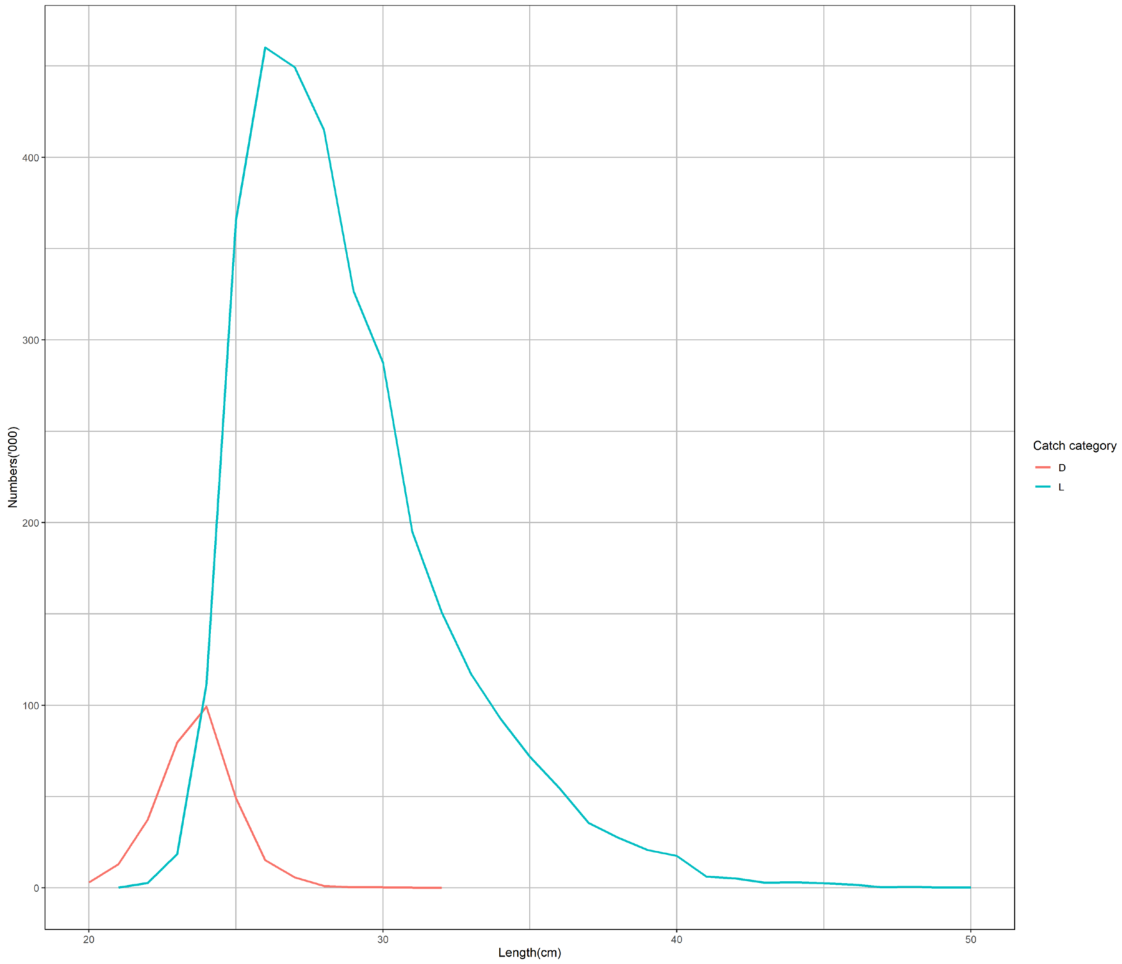

Figure 33.6. Sol.27.7fg - Belgian length distributions of discarded and retained fish from discard sampling studies.

Figure 33.7a. Sol.27.7.fg - Mean-standardised indices.

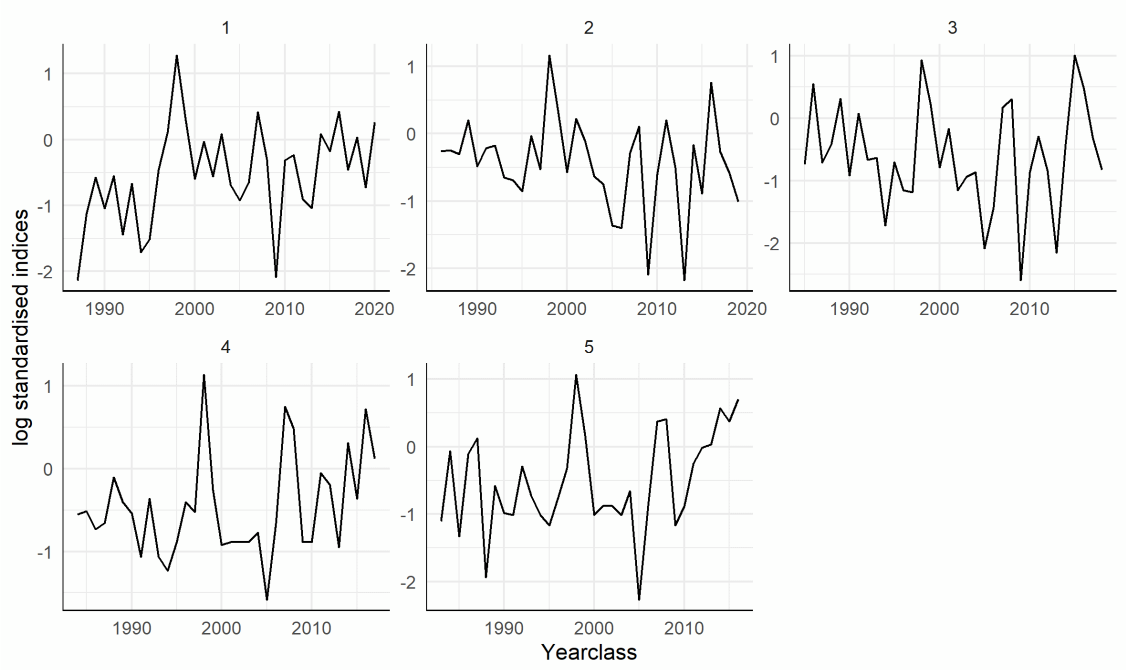

Figure 33.7b. Sol.27.7.fg - Mean-standardised indices.

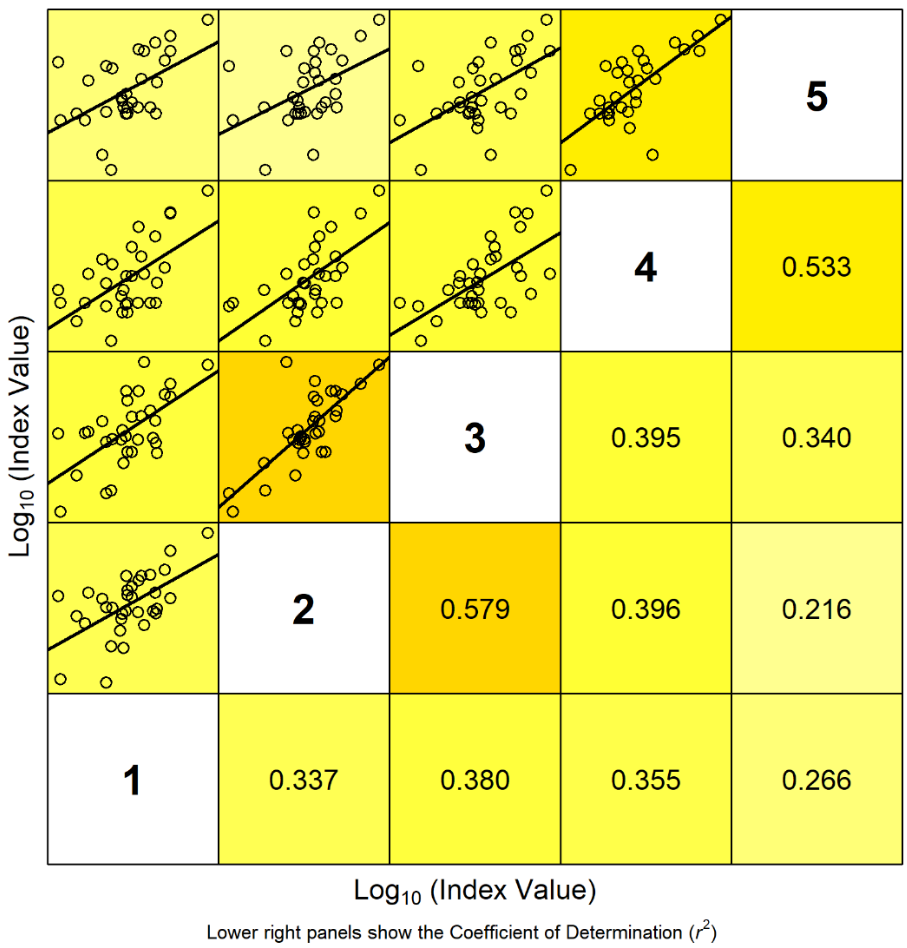

Figure 33.8. Sol.27.7fg - Consistency plot UK(E&W)-BTS-Q3 survey.

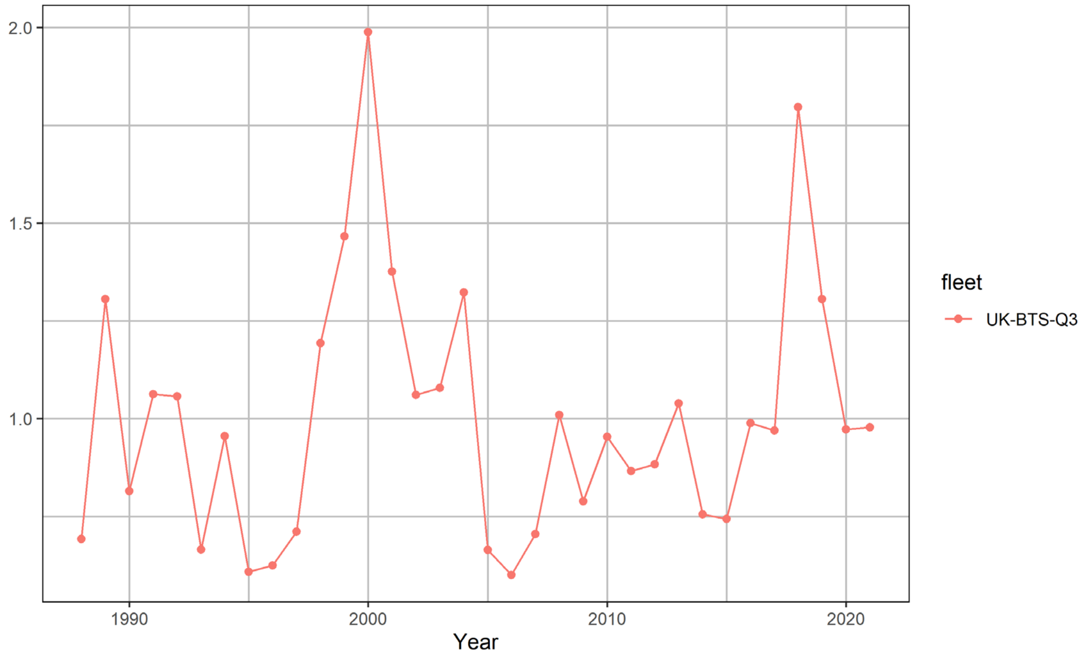

Figure 33.9. Sol.27.7fg – Mean standardized LPUE UK(E&W)-BTS-Q3 survey (kg/100 km fished).

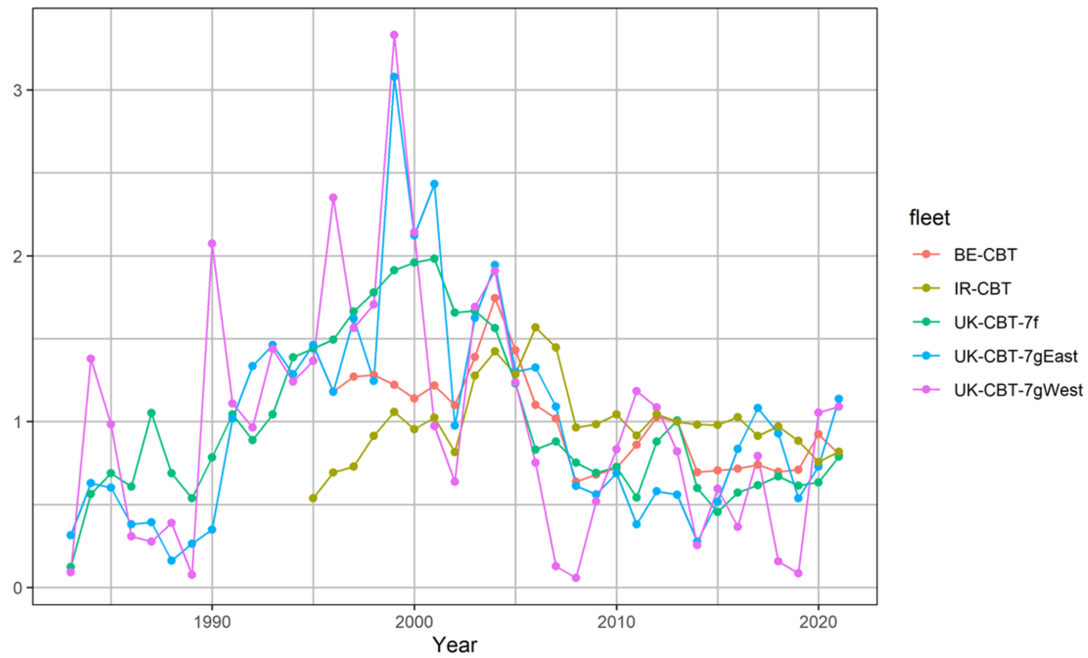

Figure 33.10a. Sol.27.7fg - Mean standardised Effort (fishing hours (BE-CBT and IR-CBT), days fished (UK-CBT)).

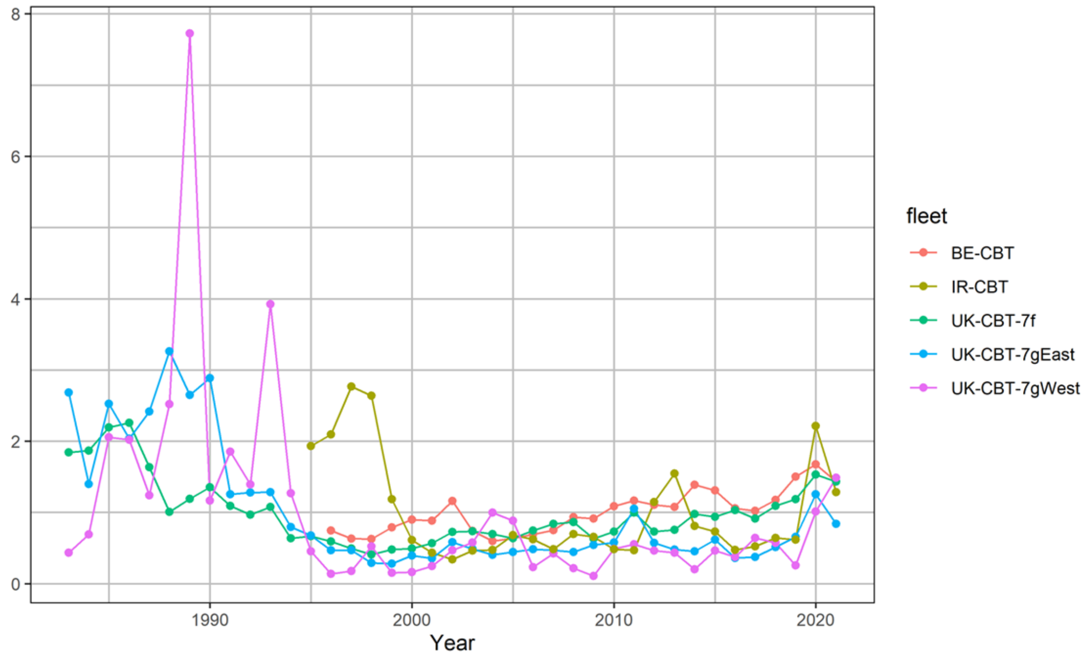

Figure 33.10b. Sol.27.7fg - Mean standardised LPUE (kg/hour (BE-CBT and IR-CBT), kg/day (UK-CBT)).

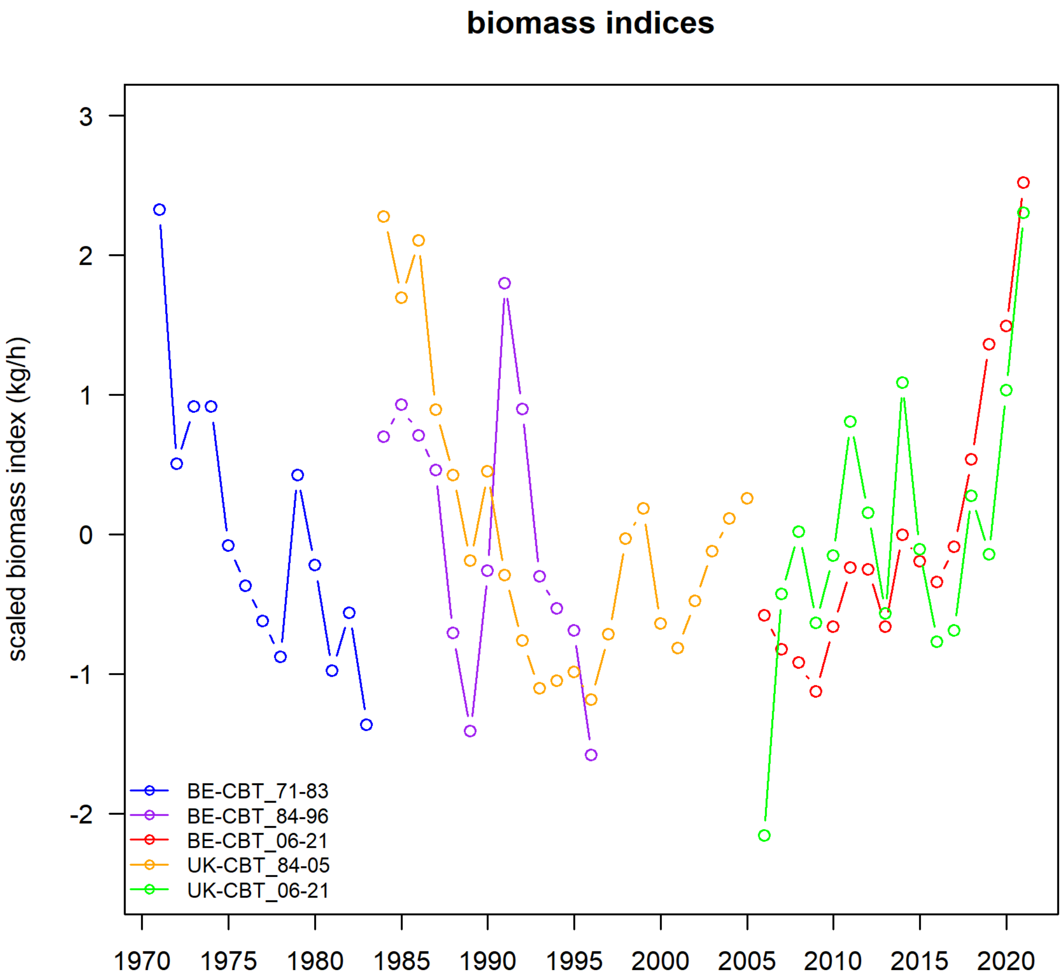

Figure 33.11. Sol.27.7fg - Commercial biomass tuning indices.

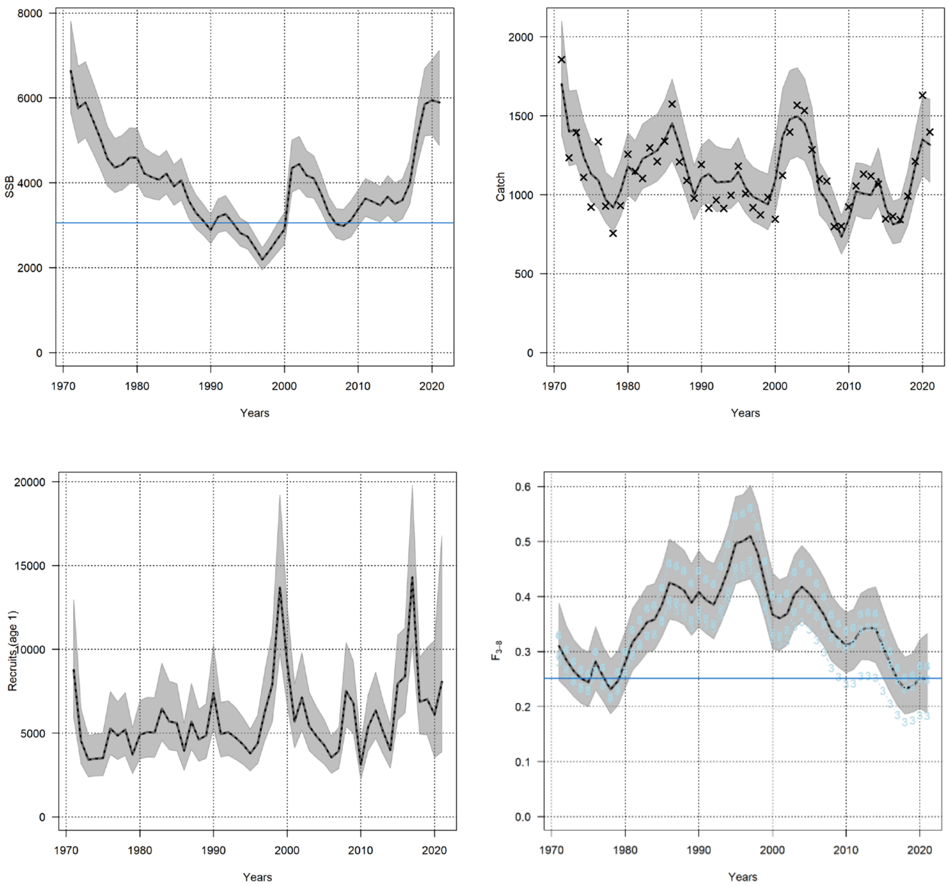

Figure 33.12. Sol.27.7fg - Summary plots.

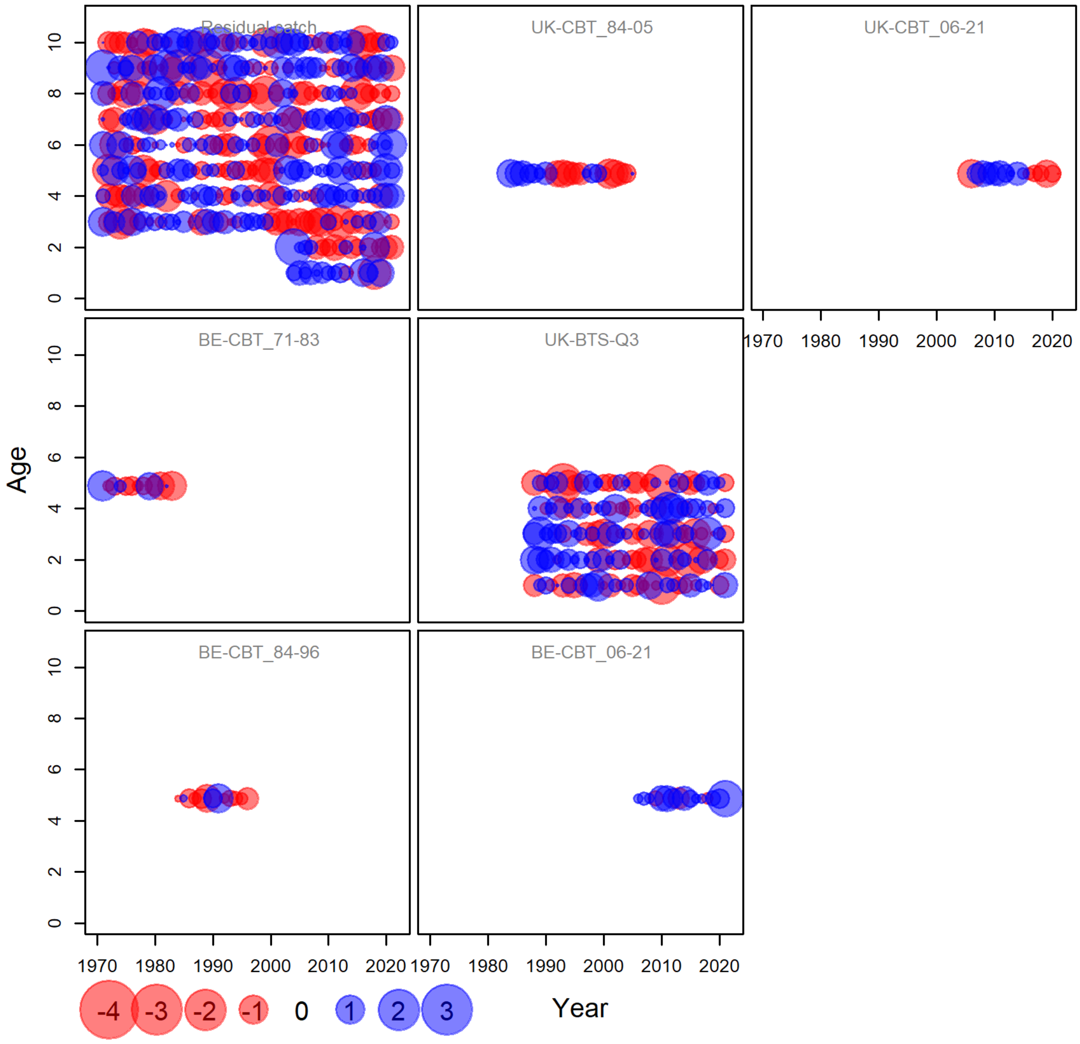

Figure 33.13. Sol.27.7fg - One Step Ahead residuals for the final SAM run.

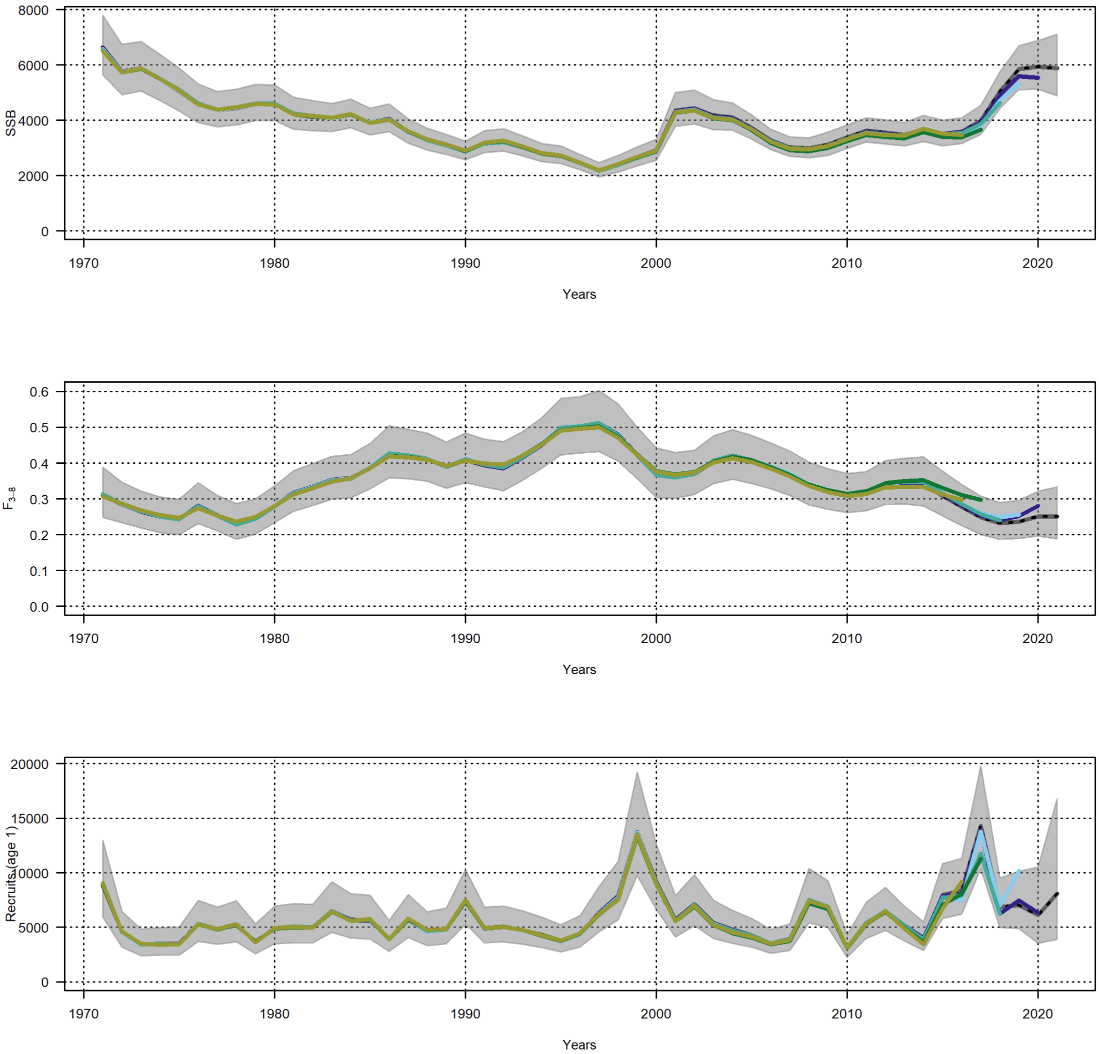

Figure 33.14. Sol.27.7fg - Retrospective analysis.

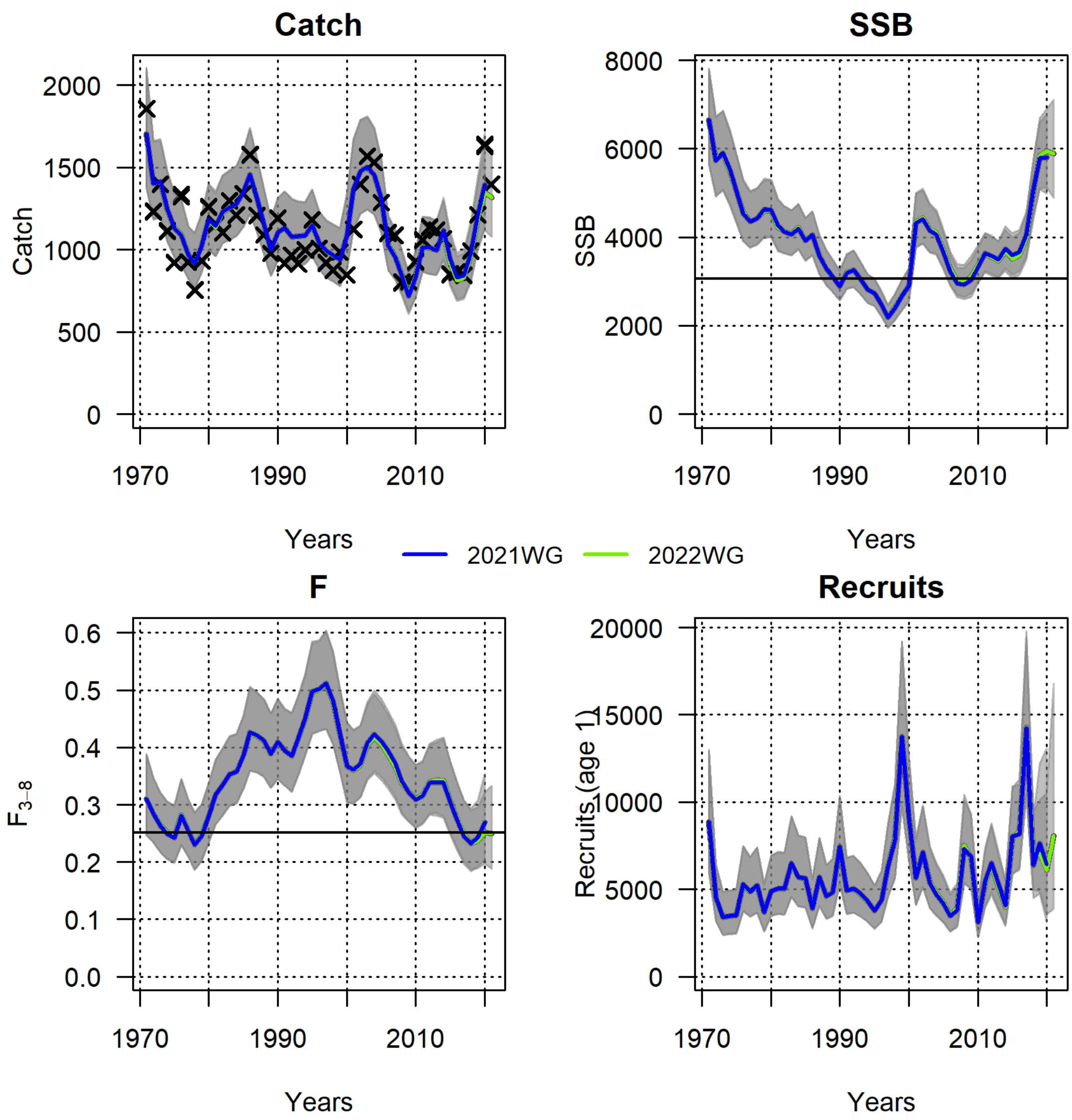

Figure 33.15. Sol.27.7fg - Comparison with last year's assessment.

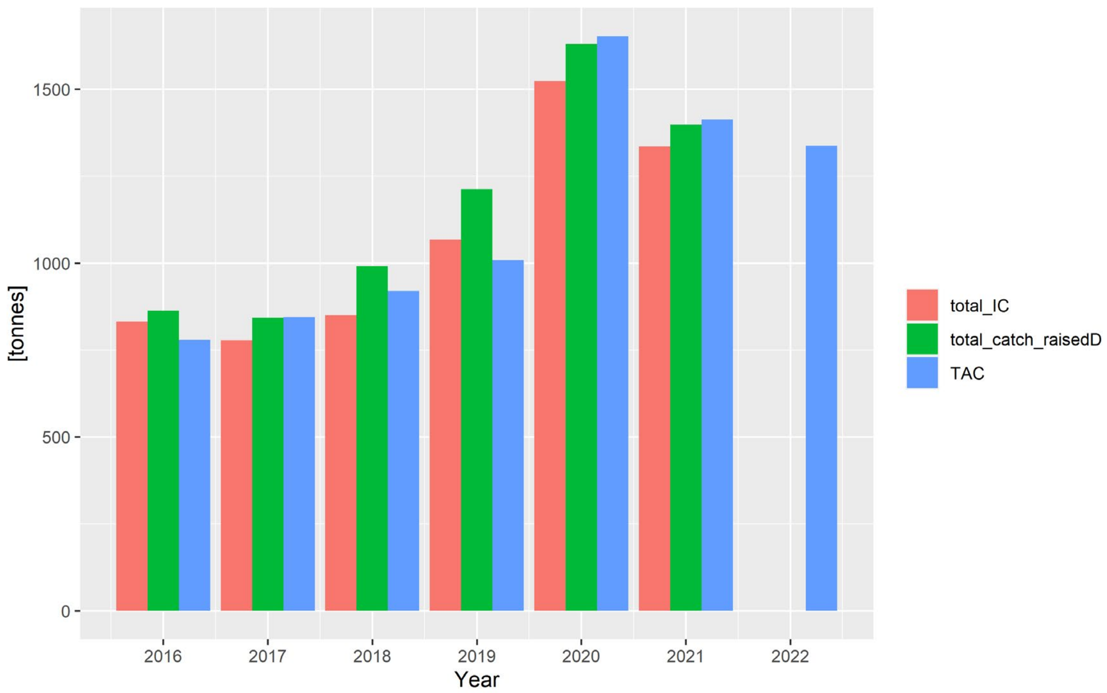

Figure 33.16. Sol.27.7fg - Comparison of international TAC, catch and landings.

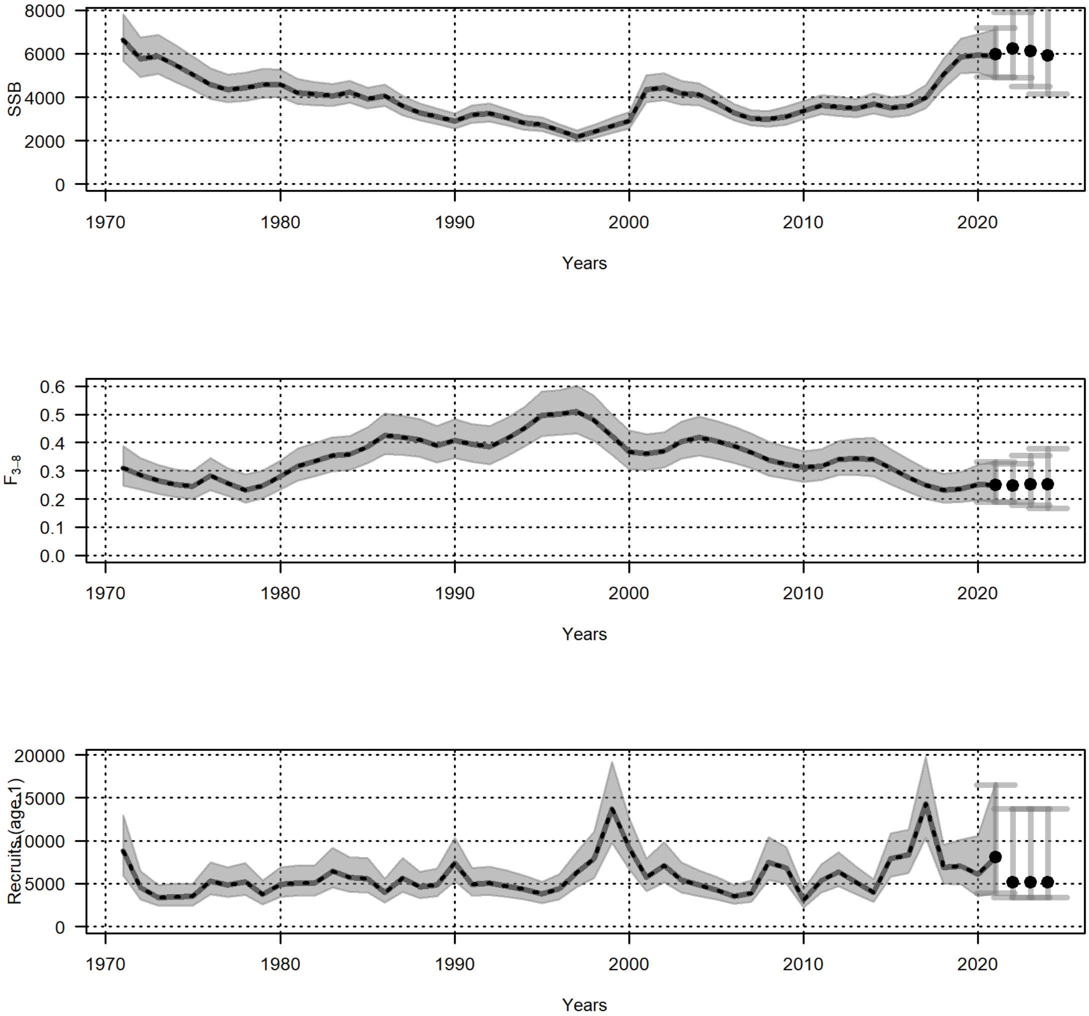

Figure 33.17. Sol.27.7fg - SAM forecast assuming TAC constraint in the intermediate year followed by targeting F_{MSY} in subsequent years.

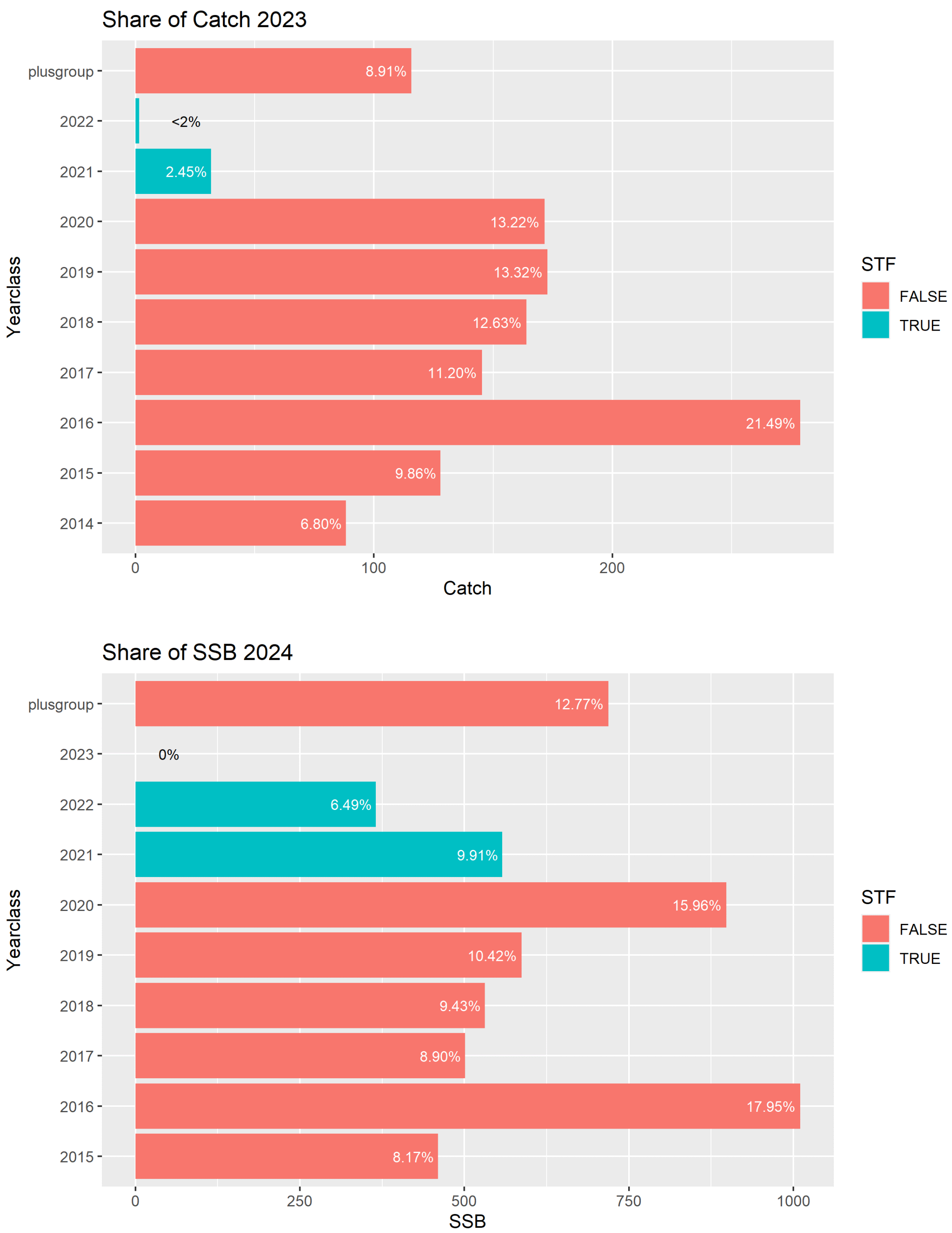

Figure 33.18. Sol.27.7fg - Year-class sources and contributions for the short-term forecast.

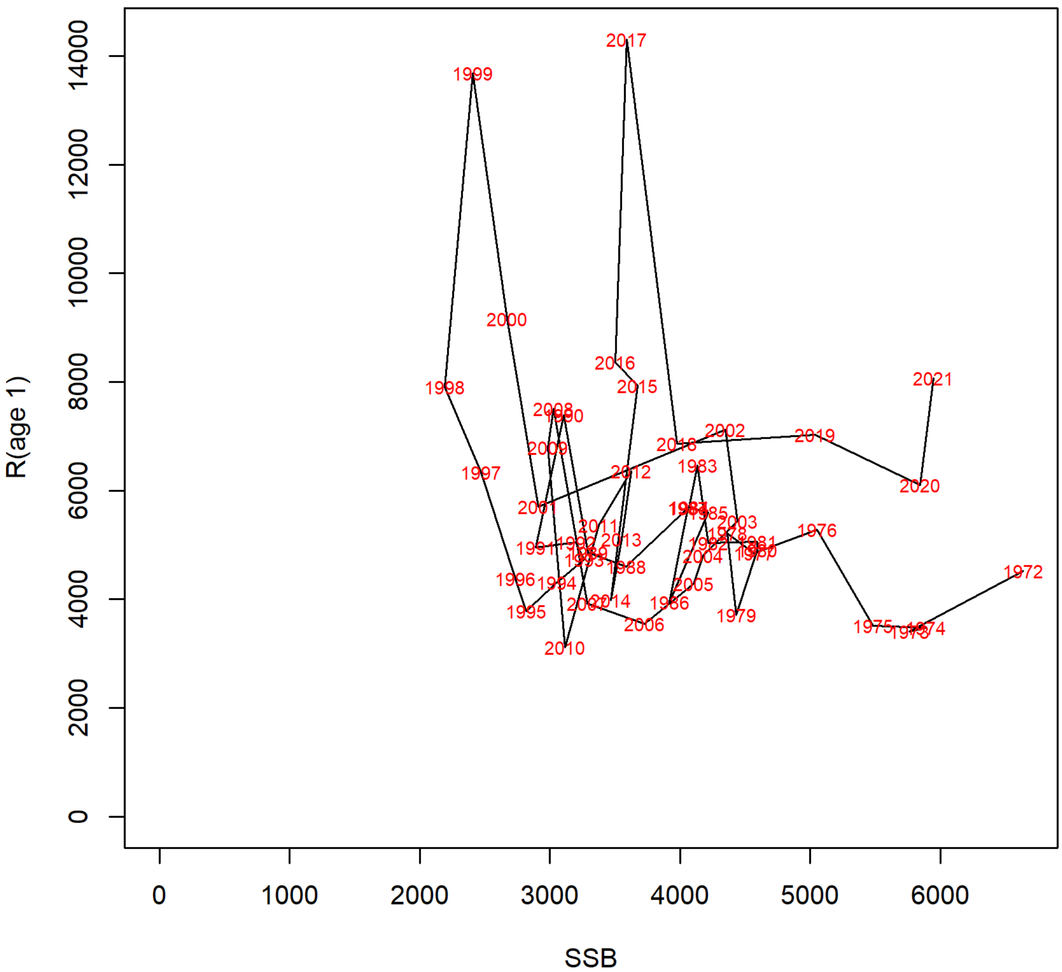

Figure 33.19. Sol.27.7fg – Stock–recruitment plot.

34 Sole (*Solea solea*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)

Type of assessment in 2022

No assessment was performed as this is a category 5 stock. No precautionary buffer was applied as it was applied in 2020. ICES advises that when the precautionary approach is applied, catches in 2023 should be no more than 213 tonnes.

ICES advice applicable to 2021

No assessment was performed as this is a category 5 stock. No precautionary buffer was applied as it was applied last year. Catches in 2022 should be no more than 213 tonnes.

https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2020/2020/sol.27.7h-k.pdf

34.1 General

Stock identity

Sole is a valued, bycatch species in area 27.7hjk and represents a data-limited stock. This stock was benchmarked for the first time in 2020 as part of WKFlatNSCS (ICES, 2020). During the literature review for this benchmark, no information was found on the identity of this stock. A number of different auxiliary data sources were used to determine the geographical spread and behaviour of this fishery, and where possible its life-history parameters.

Landings data submitted to STECF Fisheries Dependant Information (FDI) (https://stecf.jrc.ec.europa.eu/dd/effort) were used to explore trends in the geographical spread and behaviour of fleets targeting sole in 7h–k. Unlike ICES InterCatch data, this data source provides a summary of landings by Member State, gear type, and statistical rectangle. The geographical separation between where the landings in 7h and 7j are taken, suggests that there are two discrete fisheries occurring in the stock area (Figure 34.1). This perception is further supported by the clear variation in the gears used to catch sole within the two ICES divisions. Within 7j, sole is predominantly landed by otter trawls, whereas the 7h fishery is mainly targeted by beam trawls (Figure 34.1 right). This would suggest the two separate assessments are required to effectively manage this fishery.

Due to the data-poor nature of this fishery, there is currently no reliable evidence by which to separate the population of sole in 7h and 7j. However, geographical distribution of the landings data would suggest that the fleets are targeting of two discrete populations. Therefore, it is the recommendation of this group to propose sole in 7h–k to the stock identity working group (SIMWG) for further discussion on the possible separation.

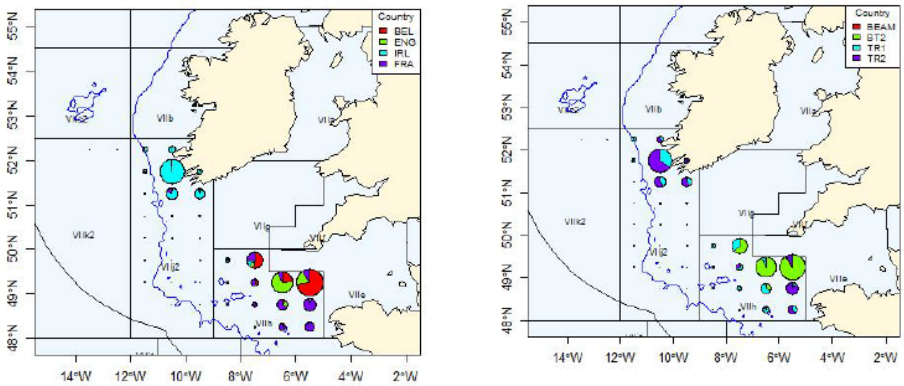

Figure 34.1. The spatial distribution of sole landing as reported to the STECF FDI data call in 2016. The landings are plotted by statistical rectangle and show the relative landings reported by Member State (left) and gear type (right), and weighted by the overall landings of sole in ICES divisions 7hjk in 2016.

Management applicable to 2022

TAC table 2022

Species:	Common sole *Solea solea*	Zone:	7h, 7j and 7k (SOL/7HJK.)
Belgium	18	Precautionary TAC	
		Article 8(2) of this Regulation applies	
France	36		
Ireland	95		
Netherlands	28		
Union	177		
United Kingdom	36		
TAC	213		

Landings obligation

In 2016, the landings obligation was implemented for this stock for the first time. The regulation (EC, 2015) covered vessels where more than 5% of their landings using beam trawls were sole during the reference years (2013 and 2014) in ICES divisions 7.b, 7.c and 7.f–7k will be covered by the Landings Obligation. The landings obligation applied 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.

34.2 Data

34.2.1 Landings and discards

The official and ICES estimates of landings are presented in Table 34.1. The differences between the official and ICES estimated of landing is shown in the unallocated column.

Misreporting is considered to be an issue for this stock but remains difficult to fully quantify. In the past, deviations between official catch statistics and ICES estimates of landings may be due to this misreporting, driven by restrictive TACs in this area (7h–k) and adjoining areas (7e), but also the completeness of data submitted to ICES. Since 2004, these deviations are less due to an improvement in the quality of the data submitted to ICES following on from the introduction of the Data Collection Regulation (EU 2001).

ICES estimates of discards are also provided. Discarding of sole in 7.jk is considered negligible.

34.3 Historical stock development

This stock was benchmarked during WKFlatNSCS in 2020 to address the inclusion of available new landings-at-age data for the Division 7.h component, fishery-independent indices, and to consider stock identity (ICES, 2020a). The benchmark concluded that there was no appropriate method for evaluating the stock status and trends, as the sampling only covers a small part of the total fishery, which is not considered representative of the whole area. Therefore, the benchmark agreed to use category 5 to provide advice for this stock.

Prior to the benchmark sole in h–k was defined as a category 3 stock as was assessed using an XSA model with commercial landings and LPUE from area 27.7j as data inputs. However, during the benchmark, it was concluded that this stock should be assessed as a category 5. The age data from the landings-at-age data were presented and indicated that cohort tracking was relatively poor. Landings data were available, but age information was not available from area 27.7h and precluded using XSA to assess the stock in this area. During previous assessments, it was assumed that the trends in areas 27.7jk were representative of 27.7h. The assessment results from the previous assessment were presented during the workshop. The model resulted in relatively poor fits to the data and severe retrospective variability, although the Mohn's rho was within the range of acceptability.

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.

34.4 References

ICES. 2020. Benchmark Workshop for Flatfish stocks in the North Sea and Celtic Sea (WKFlatNSCS). ICES Scientific Reports. 2:23. 966 pp. http://doi.org/10.17895/ices.pub.5976.

EU. 2001. Commission Regulation (EC) No 1639/2001 of 25 July 2001 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No 1543/2000.

Table 34.1. Sole in divisions 7.h–k. History of official landings by country and ICES estimated landings (tonnes).

Year	Official landings						ICES landings
	Belgium	France	UK	Ireland	Other countries	Total	
1951	21	150	91	56	0	318	
1952	37	220	88	44	0	389	
1953	23	227	100	54	0	404	
1954	13	317	167	75	0	572	
1955	125	634	174	65	0	998	
1956	251	511	98	64	0	924	
1957	454	359	86	67	0	966	
1958	397	605	72	88	0	1162	
1959	241	576	61	101	0	979	
1960	0	506	48	96	0	650	
1961	197	525	61	110	0	893	
1962	144	397	31	123	0	695	
1963	149	502	25	127	0	803	
1964	310	578	34	118	0	1040	
1965	335	1128	15	123	0	1601	
1966	123	0	36	118	0	277	
1967	168	474	20	123	0	785	
1968	113	474	29	116	0	732	
1969	175	633	23	120	0	951	
1970	436	537	19	122	0	1114	
1971	394	1382	4	93	0	1873	
1972	203	1011	11	131	7	1363	
1973	406	390	6	108	4	914	
1974	369	143	5	116	15	648	
1975	210	207	24	97	2	540	

Year	Official landings						ICES landings
	Belgium	France	UK	Ireland	Other countries	Total	
1976	638	19	11	152	33	853	
1977	519	103	12	126	140	900	
1978	290	23	11	73	60	457	
1979	384	29	18	109	0	540	
1980	522	27	42	162	0	753	
1981	576	107	83	195	0	961	
1982	471	104	108	172	0	855	
1983	411	176	129	176	51	943	
1984	474	120	151	156	194	1095	
1985	318	25	200	201	280	1024	
1986	442	38	261	188	3	932	
1987	271	44	193	168	0	676	
1988	254	53	166	182	0	655	
1989	252	84	177	206	0	719	
1990	353	66	144	266	0	829	
1991	358	55	234	306	0	953	
1992	312	43	217	255	0	827	
1993	317	44	214	237	0	812	
1994	338	42	174	184	0	738	
1995	433	47	192	243	0	915	
1996	375	50	148	182	70	825	443
1997	368	58	113	203	0	742	564
1998	346	74	111	221	7	759	423
1999	101	0	97	207	1	406	381
2000	8	78	95	111	10	302	329
2001	13	99	111	124	0	347	325
2002	154	108	124	129	0	515	430
2003	170	133	78	105	0	486	245

Year	Official landings						ICES landings
	Belgium	France	UK	Ireland	Other countries	Total	
2004	157	102	79	111	0	449	454
2005	90	93	112	97	0	392	375
2006	36	99	88	63	1	288	230
2007	31	79	91	77	0	278	232
2008	10	58	80	72	0	220	221
2009	11	79	58	61	0	208	188
2010	20	87	51	71	0	228	206
2011	10	95	54	65	0	224	208
2012	18	85	46	85	0	234	212
2013	4	76	47	85	0	213	204
2014	42	61	54	85	0	242	207
2015	40	74	53	77	0	244	226
2016	91	77	63	99	0	330	269
2017	75	81	39	86	0	281	250
2018	96	91	33	63	0	283	235
2019	75	88	48	55 c	8	274 c	308
2020*	88	102	50	37	7	284	299
2021*	50	128	47	75	16	316	336

*** Preliminary official landings.**

c Incomplete due to part of the data being unavailable under national GDPR clauses.

35 Whiting (*Merlangius merlangus*) in Division 6.a (West of Scotland)

Type of assessment in 2022

This year's assessment is an update of the procedure used last year (SPALY). Following the decision made earlier during the benchmark meeting WKNSEA 2021 (ICES, 2021a), it was carried out using the state-based assessment model (SAM; Nielsen and Berg, 2014) along with catch and survey data. The assessment followed the procedure outlined in the Stock Annex. Due to COVID-19 disruption and reduced discard sampling from the *Nephrops* trawl fleet, the estimates of catch numbers for ages 0 and 1 were excluded from the stock assessment. There were no survey data available for the intermediate year as a result of the research vessel breakdown in quarter 1.

A forecast was conducted with short-term stochastic projections according to model and forecast assumptions agreed upon at the WG meeting. These differ to the assumptions agreed at the benchmark and detailed in the Stock Annex as it was believed to be important to account for the change in discarding which appears to have occurred in the fishery since the full implementation of the landing obligation in 2019 (see further details in Section 35.4).

ICES advice applicable to 2022

"ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 4114 tonnes."

https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2021/2021/whg.27.6a.pdf

Following the benchmark in 2021, the perception of stock status has changed substantially and therefore new advice was issued last year for 2022.

ICES advice applicable to 2021

"ICES advises that when the precautionary approach is applied, there should be zero catches in each of the years 2021 and 2022."

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2020/2020/whg.27.6a.pdf

Although biennial advice was issued in 2020, the advice for 2022 was revised in 2021 (see "ICES advice applicable to 2022" above).

35.1 General

Stock description

General information is presented in the Stock Annex.

Management applicable to 2021 and 2022

The TAC for whiting (in tonnes) is set for ICES subareas 6, 12 and 14 and EU and international waters of ICES Division 5b, for 2022–2020 is shown below.

TAC for 2022

Species:	Whiting *Merlangius merlangus*		Zone:	6; United Kingdom and International waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	9	(1)	Analytical TAC	
France	189	(1)		Article 9 of this Regulation applies
Ireland	462	(1)		Article 3 of Regulation (EC) No 847/96 shall not apply
Union	660	(1)		Article 4 of Regulation (EC) No 847/96 shall not apply
United Kingdom	1 140	(1)		
TAC	1 800	(1)		

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

(Annex IA to Regulation (EU) 2022/109).

TAC for 2021

The agreed TAC was not available.

TAC for 2020

Species:	Whiting *Merlangius merlangus*		Zone:	6; Union and international waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	3	(1)	Analytical TAC	
France	57	(1)	Article 8 of this Regulation applies	
Ireland	273	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply	
United Kingdom	604	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply	
Union	937	(1)		
TAC	937	(1)		

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

(Council Regulation (EU) 2020/123).

Fishery in 2021

A description of the fisheries in the West of Scotland is given in the Stock Annex.

The year 2021 was the third year in a row during which the landing obligation was applied in full force. The overall increase in TAC in 2019–2021 following the introduction of the landing obligation has resulted in an increase in landings.

Total landings (nominal landings, ICES statistics) in 2021 were 851 t, up by 59% from 2020 (Table 35.1). They were the highest in the last 18 years. The majority were landed by Scottish and Irish vessels, and smaller amounts – by French vessels. The UK landings in Division 6.a in 2021 slightly exceeded the quota for the UK, while Ireland used roughly two-thirds of its quota. Total landings in 2021 constituted 91% of the TAC for that year.

The total estimated international catch of all age groups in 2021 was 1114 t, of which 261 t were discards (Table 35.2). Of the discards, 73% were discarded by the trawl fleet targeting crustaceans (*Nephrops*).

Mandatory introduction of larger square mesh panels for the *Nephrops* fleet in 2008 seems not to have had much of an effect in the following years on the discards of whiting in Division 6.a. However, in terms of quantity, the discards in 2021 (all ages) were lower (by 69%) than those in 2020 and they were also below the average in the last decade. In terms of discard rate (discards as a proportion of catch), they were the fifth lowest in the time-series (Table 35.2).

The general perception from fishermen is that large number of whiting are being discarded by the *Nephrops* fleet and that the numbers of smaller whiting have increased substantially in recent years, but mainly in inshore areas.

35.2 Data

Landings

Total landings, as officially reported to ICES, are shown in Figure 35.1 (in 1965–2021) and Table 35.2 (in 1981–2021).

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). However, a review of previously supplied estimates of misreporting and underreporting (ICES, 2012) carried out at WKNSEA (ICES, 2021a) suggested this to have been a relatively minor issue (in the order of ~5% of total landings) in the past (since 2001). Therefore, the benchmark agreed that no catch scaling factor for the period 1995–2006 was required in which it differs from previous analytical assessments of this stock.

During WKDEM 2020, the catch data (landings and discards) for 2003 onwards were revised using InterCatch (ICES, 2020a). The age structure in unsampled landings was estimated from that in sampled landings. This was done separately for the two fleets, TR1 (gadoid fishery) and TR2 (*Nephrops* fishery), on account of the different discard rates observed in them.

The sampling levels in 2021 in the Scottish fleet (taking the majority of the catch), similarly to 2020, were lower compared to the preceding years due to COVID-19. This was particularly the case for discards in the *Nephrops* fleet. The number of primary sampling units (PSU = number of trips sampled) in the area from 2017 to 2021 is shown in the table below:

Year	UK (Scotland)				Ireland			
	Landings		Discards*		Landings		Discards*	
	TR1	TR2	TR1	TR2	TR1	TR2	TR1	TR2
2021	11	0	8	4	80	0	32	0
2020	11	1	12	4	28	0	20	0
2019	16	0	18	23	23	0	28	0
2018	14	1	11	30	28	0	60	0
2017	11	0	13	39	23	0	48	0

*** The number of sampled trips that took place.**

Landings uploaded to InterCatch by métier and country for 2021 are shown in Figure 35.2. As in previous assessments, age distributions were estimated from market samples. Total catch (including landings) by métier for 2021 is shown in Figure 35.3. Catch numbers-at-age (in different catch categories) in 2021 are shown in Figure 35.4. Last year, no landings were recorded for fish at age 1 and this was a consequence of the absence of this age group in the sampled landings. The highest numbers in landings were found for age groups 2–5. Catch numbers-at-age from 2003 onwards are shown in Figure 35.5.

Annual numbers-at-age in the landings are given in Table 35.3. Annual mean weights-at-age in the landings are given in Table 35.6 and shown in Figure 35.6. Last year, they decreased slightly in most age groups. Overall, the mean weights-at-age in the landings have been variable in recent years due to the variability associated with low sample sizes. Efforts to increase sampling in these fisheries are being pursued.

Discards

This WG's estimates of discards have been based on data collected in the Irish and Scottish discard programme and raised by landings. Discard age compositions from Scottish and Irish samples have been applied to unsampled fleets. As agreed at WKDEM 2020, the raising and age allocations for discards were done separately for the TR1 and TR2 fleets (ICES, 2020a).

Discards uploaded to InterCatch by métier and country for 2021 are shown in Figure 35.2.

Annual numbers-at-age in the discards are given in Table 35.4. Due to the low sample numbers in the *Nephrops* fleet, the resulting numbers at age 0 and 1 in discards were considered as unreliable (disproportionately low), especially when compared with previous years (Figure 35.7). This had further consequences for the assessment (see section '35.3 Stock assessment' below).

Annual mean weights-at-age in the discards are given in Table 35.7 and shown in Figure 35.6. Mean weights-at-age 1 in discards were considerable higher compared to previous years, but this was most likely a result of the low number of samples from the *Nephrops* fleet.

Biological

Annual numbers-at-age in the total catch are given in Table 35.5. Annual mean weights-at-age in the total catch are given in Table 35.8 and shown in Figure 35.6.

In previous assessments prior to 2021, mean catch weights-at-age were used as mean stock weights-at-age. Since 2021, the latter has been estimated using the method elaborated at WKNSEA 2021 (ICES, 2021a) that combines catch and survey weights-at-age (see the Stock Annex). Two sets of stock mean weights-at-age are delivered: one to be used as stock weights-at-age input into the SAM stock assessment model to calculate SSB, and one to be used to estimate size-dependent natural mortality-at-age. The estimates from the former (smoothed with a General Additive Model, GAM) are shown in Table 35.9 and Figures 35.6 and 35.8.

In previous assessments of whiting in Division 6.a, natural mortality was assumed to vary and be dependent on fish weight (Lorenzen, 1996). *M* values were time-invariant and were 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 mean stock weight-at-age *a* (in g) and the numbers are the Lorenzen's parameters for fish in natural ecosystems.

During WKNSEA in 2021 it was agreed to first smooth the time-series of stock mean weights-at-age using a GAM and then use these smoothed weights-at-age in the Lorenzen (1996) equation to obtain a time-series of mortality-at-age estimates to be used as input in the stock assessment model (ICES, 2021a).

The time-series of smoothed stock mean weights-at-age obtained from a combination of catch data and survey data from Q1 and Q4 are used in the Lorenzen equation. The smoothed stock mean weights-at-age are shown in Figure 35.6. These estimated natural mortality-at-age is shown in Table 35.10 and Figure 35.9.

In earlier assessments prior to 2021, maturity-at-age was assumed to be knife-edge with the value 0 at age 1 and full maturity-at-age 2+. An analysis of Scottish survey data conducted at WKDEM 2020 and updated at WKNSEA 2021, showed no clear temporal trends in maturity (ICES, 2020a; ICES, 2021a). The analysis provided coefficients of the logistic model (being time-invariant, with data up to 2020): -6.307 (intercept) and 5.228 (slope). The midpoint of the modelled maturity ogive, A50, was estimated to be 1.206 (±0.031) years. The estimated proportions of mature whiting are shown in the table below:

Age	0	1	2	3	4	5	6	7+
Maturity ogive	0	0.254	0.984	1	1	1	1	1

The analysis revealed that considerable proportion of fish at age 1 (a quarter) and nearly all fish at age 2 were mature. There was little variability in the data resulting in relatively narrow confidence intervals (ICES, 2021a).

Surveys

Five research vessel survey series for whiting in 6.a were available to the WG in previous years. They included the two 'old' Scottish surveys:

- Scottish first-quarter west coast groundfish survey (ScoGFS-WIBTS-Q1): all ages 1 and older, years 1985–2010;
- Scottish fourth-quarter west coast groundfish survey (ScoGFS-WIBTS-Q4): all ages including age 0, years 1996–2009.

The Q1 Scottish Groundfish Survey was performed using a repeat station format with the GOV survey trawl together with the west coast groundgear rig 'C'. The Q4 Scottish Groundfish Survey also used 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 breakdown of the research vessel.

In 2011, the Q1 and Q4 Scottish Groundfish Surveys were re-designed. The previous repeat station survey format consisting of the same series of survey trawl positions being sampled at approximately the same temporal period every year is considered a rather imprecise method for surveying both these subareas. Therefore, a move towards some sort of random stratified survey design was judged necessary (see further details of the modified survey design in the Stock Annex). The introduction of the new design initiated two 'new' time-series:

- Scottish first-quarter west coast groundfish survey (UK-SCOWCGFS-Q1): all ages 1 and older, years 2011–2021;
- Scottish fourth-quarter west coast groundfish survey (UK-SCOWCGFS-Q4): all ages including age 0, years 2011–2021.

The distribution and densities of whiting at-age (standardised as CPUE) in the Q1 and Q4 surveys in 2017–2021 are shown in Figure 35.10. The Q4 survey in 2013 was not fully implemented due to adverse weather conditions. It covered only the northern half of Division 6.a and therefore, the index for that year was not used in assessments prior to 2020. Due to vessel breakdown, the Q1 survey was not carried out in 2022. As a result, 11 years of data are currently available in the time-series for the Q1 survey and ten years of data for the Q4 survey (as valid indices).

The Irish Groundfish Survey has partly been conducted in Division 6.a:

- Irish fourth-quarter west coast groundfish survey (IGFS-WIBTS-Q4): all ages including age 0, years 2003–2021.

The distribution and densities of whiting at-age in the two Q4 surveys, UK-SCOWCGFS-Q4 and IGFS-WIBTS-Q4 in 2017–2021 are shown in Figure 35.11 (only the southern part of Division 6.a). The 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. The previous Irish survey (IreGFS), being in operation in 1993–2002 (see the Stock Annex), is not used anymore in the assessment.

Further descriptions of the above five surveys can be found in 'Manual of the IBTS North Eastern Atlantic Surveys' (ICES, 2017) and in the last IBTSWG report (ICES, 2021b).

During WKNSEA 2021, it was agreed to combine all the three Q4 surveys (ScoGFS-WIBTS-Q4, UK-SCOWCGFS-Q4 and IGFS-WIBTS-Q4) into one survey index for use in the stock assessment (ICES, 2021a). The analysis of the combined index was conducted using a GAM-based delta-lognormal model Berg *et al.* (2014) including a number of explanatory variables. The combined index (denoted as Comb-WCGFS-Q4) derived from the model fit is shown in Figure 35.12. The index provides a more complete representation of the population compared to the respective indices used on their own. It simplifies the modelling procedure in the annual assessments of the stock (with three rather than five indices) and provides a longer continuous time-series.

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.

35.3 Stock assessment

In the years 2011–2019, the assessment was done using a Time-Series Analysis (TSA) model (Gudmundson, 1994; Fryer, 2002; Needle and Fryer, 2002). At that time, the stock was classified as category 1. During the benchmark process of WKDEM 2020, it was found that running TSA with the new data and changed survey configuration posed a challenge (ICES, 2020a). Poorly converged optimisation runs (with some parameters being found on the boundary of the assumed parameter space) in conjunction with excessive running times were a major obstacle to complete the assessment successfully. In these circumstances, it was decided *ad hoc* to run the benchmark assessment using an alternative method; namely, a SPiCT model (Pedersen and Berg, 2017). At the same time, the stock was downgraded to category 3 and further to category 5 according to the ICES guidelines for data-limited stocks (ICES, 2019).

In the benchmark process of WKNSEA 2021, it was decided to use SAM as the assessment method (ICES, 2021a). It was agreed that the model should be run over the entire time period for which catch numbers-at-age data were available in order to capture the earliest part of the time-series (during which catches were relatively high). To facilitate this in SAM, it was assumed that catch and discards mean weights-at-age zero between 1981 and 2002, and landings mean weights-at-age zero for the entire modelled time period, were equal to the average of mean weights-at-age zero between 2003 and 2020. In addition, stock mean weights-at-age and natural mortality-at-age between 1981 and 1984 were assumed to equal estimates for the equivalent quantity from the earliest available year (i.e. 1985). Catch numbers-at age zero are only available from 2003 onwards (from the WKDEM data call) and therefore values between 1981 and 2002 were treated as missing and estimated in the assessment model.

Data screening

The diagnostics for commercial catch data and the three indices considered as tuning series (ScoGFS-WIBTS-Q4, UK-SCOWCGFS-Q1 and Comb-WCGFS-Q4) for the assessment are shown in Figures 35.13–35.15).

The log catch curves for the commercial catch and for the surveys in the current assessment are shown in Figure 35.13. In most cases, the curves are relatively linear and not very noisy. They also show a fairly steep and consistent drop in abundance. The curves for the commercial catch have a strong 'hook', especially at age 0 (from 2003 onwards).

The plots of mean standardised catch proportions at age by year (Figure 35.14) demonstrate that there is some general consistency in the estimates of year-class strength across age groups. They indicate strong year classes in recent years (2009 and 2014 year classes), but also markedly weak year classes (2012 and 2017 year classes). A clear year effect can be seen for ages 1+ in 2007 and 2008.

The within-survey correlation plots generally show significant correlations between consecutive age groups (Figure 35.15). There is a general consistency in the estimates of year-class strength across age groups, but the points are more scattered for old age groups.

The three indices used as tuning series in the current assessment are shown in Table 35.11.

Final assessment

Model used: SAM

Software used: stockassessment package in R; stockassessment.org

Input data types and characteristics:

- Catch numbers-at-age: ages 2–7+, 1981–2021; age 1, 1981–2020; age 0, 2003–2019
- Landings fraction at age, ages 0–7+, years 1981–2021,
- Catch weights-at-age: ages 1–7+, 1981–2021; age 0, 2003–2021 (excl. 2020, see below)
- Landings weights-at-age, ages 0–7+, years 1981–2021 (excl. age 1 in 2021, see below),
- Discards weights-at-age: ages 1–7+, years 1981–2021; age 0, 2003–2021 (excl. 2020, see below)
- ScoGFS-WIBTS-Q1, ages 1–6, years 1985–2010,
- UK-SCOWCGFS-Q1, ages 1–6, years 2011–2021,
- Modelled Q4 index, Comb-WCGFS-Q4, fitted to data from ScoGFS-WIBTS-Q4 (G4299), UK-SCOWCGFS-Q4 (G4815), and IGFS-WIBTS-Q4 (G7212); ages 0–7+ with variance estimates; 1996–2021.

No age-0 discards were recorded in 2020. This is assumed to be due to a lack of discard sampling in the *Nephrops* fishery from Q2 onwards and therefore age zero discards are treated as missing in 2020 (as in the years before 2003). Missing catch weights-at-age zero are assumed equal to the average of 2003–2019. There were no age-one fish recorded in the landings in 2021, therefore landings weight-at-age one for 2021 is a three-year average value (2018–2020). Catch numbers-at-age zero and one for 2021 were considered unreliable due to low sampling levels, and were thus removed from the dataset. Unknown/removed catch numbers-at-age values are estimated in the model. Typically, survey indices for UK-SCOWCGFS-Q1 would be available for the assessment year. The index was not calculated in 2022 as there was no survey carried out due to vessel breakdown. The 2022 assessment thus runs up to 2021, deviating from the model configuration agreed in the benchmark.

The assessment of whiting in 6.a was conducted using a SAM model fitted to the updated catch and survey dataseries. Full details of the model implementation are presented in the Stock Annex. The SAM configuration file for the final assessment model run is given in Table 35.12. To summarise the main configuration settings:

- Fishing mortality states processes are uncoupled across all age groups.
- Catchabilities for each survey index are freely estimated with the exception of the two oldest age groups for each index; ages 5 and 6 in ScoGFS-WIBTS-Q1 and UK-SCOWCGFS-Q1, and ages 6 and 7+ in Comb-WCGFS-Q4.
- Catch observation variance parameters are allowed to differ for age 0 and age 7+ while all other age groups are coupled.
- Survey observation variance parameters are coupled across all ages for ScoGFS-WIBTS-Q1 and UK-SCOWCGFS-Q1, whereas for Comb-WCGFS-Q4 observation variance parameters were uncoupled for age zero, and coupled for ages 1 to 4 and ages 5 to 7+.
- The catch, ScoGFS-WIBTS-Q1, and UK-SCOWCGFS-Q1 fleets are modelled with independent covariance structures, whereas the Comb-WCGFS-Q4 fleet is modelled with a first order autoregressive variance structure (AR1) with ages 0 and 1, ages 1 to 6, and ages 6 and 7+ coupled.
- Recruitment is modelled as a random walk.
- $\bar{F}$ was calculated for ages 1 to 3 in order to reflect changes in fishery selectivity, moving from a target fishery in the 1980s and 1990s to a bycatch and discard component of the *Nephrops* trawl fishery from the early 2000s onwards. This is a change from previously accepted analytical assessments of this stock which used an $\bar{F}$ range of ages 2 to 4.

Table 35.13 shows the SAM parameter estimates for the assessment model. Table 35.14 shows the population numbers-at-age estimated in SAM, and estimated F-at-age is shown in Table 35.15. A summary of the full model output is detailed in Table 35.16. The summary plots for the final assessment are shown in Figure 35.16.

The fits of the model to observations (catch and survey indices on a log scale) are shown in Figure 35.17. The fits to the ScoGFS-WIBTS-Q1 appear better at younger ages while for ages five and six some of the trend in the early part of the time-series is not captured. Fits to Comb-WCGFS-Q4 are also generally good, although there is a tendency towards overestimation of age zero individuals for part of the time-series, and some deficiency in tracking the variability of age seven+. The shorter time-series of UK-SCOWCGFS-Q1 makes it more difficult to assess the model fit in terms of trends, but the model seems to fit the observations reasonably well. The model also appears to follow the catch data well for most ages, but perhaps tracks less of the interannual variability for ages 6 and 7+.

The diagnostics of the quality of the model fit were: examination of the residuals; a leave-one-out analysis of the relative influence of indices on model estimates; a retrospective peel analysis. One observation ahead residuals-at-age for catch and survey indices are shown in Figure 35.18. The residuals were not substantially affected by the updates made to the model, showing similar patterns to last year's assessment model. There is an observable trend in the catch residuals from the late 1990s to mid-2000s, particularly between ages two and four, where the fishery shifted from being directly targeted to bycatch. There is some tendency towards negative residuals in the oldest age class of the Q4 survey index, but they are still occasionally interspersed with positive residuals. Otherwise, there are no particularly problematic trends in magnitude or direction.

The model leave-one-out analysis is shown in Figure 35.19. Exclusion of each index in turn results in estimates of SSB, $\bar{F}$ and recruitment which follow very similar trends over time, suggesting generally good agreement between indices. Estimates of SSB in more recent years have a tendency towards being generally lower with the exclusion of ScoGFS-WIBTS-Q1 and Comb-WCGFS-Q4, while remaining reasonable stable with the exclusion of UK-SCOWCGFS-Q1, when compared to the final model. Leave-one-out estimates remain within the confidence interval of full model estimates in all cases. Estimates of $\bar{F}$ in each case diverge the most between 2000 and 2010. Excluding the old Q1 survey (ScoGFS-WIBTS-Q1) results in higher estimates of $\bar{F}$ for much of the time-series from 2000 onwards, while excluding the Q4 index (Comb-WCGFS-Q4) results in generally lower estimates of $\bar{F}$ for the same period.

Retrospective peels for the updated assessment model are shown in Figure 35.20. Retrospective bias in SSB is not substantial, with some downward revision with the addition of new data in recent years. The Mohn's rho values are as follows:

SSB	$\bar{F}$	Recruitment
0.17	-0.14	0.41

The relatively high Mohn's rho value for recruitment is a result of the consistently low recruitment values estimated in recent years. Only one recruitment peel falls outside the confidence interval envelope.

A sensitivity analysis was also carried out to assess the effect of omission of catch-at-age zero and one data from the model. Retrospective fits for the past five years were estimated based on censored datasets, with catch-at-age zero and one values being freely estimated in SAM. These estimates were compared to the retrospective fits for the full model (Figure 35.21). Model estimates appear robust to removal of catch numbers-at-age data for that period, with the only notable divergence being where SAM estimates a lower $\bar{F}$ in 2021 (dotted black line) based on the unreliable catch numbers-at-age zero and one data, when compared to the equivalent value of $\bar{F}$ which was freely estimated in the data censored model (solid black line).

The SAM stock–recruit plot is presented in Figure 35.22 and suggests a relationship which has experienced a number of reasonably distinct phases over time. SSB and recruitments were relatively high, but decreasing, in the early 1980s. At the latest benchmark, it was suggested that this phase was related to the gadoid outburst of the 1960s and 1970s, and the decreasing stock size at the beginning of the modelled period is the time at which the population was returning to its usual size (Holden, 1991; Hislop, 1996). Stock size was then relatively stable for much of the 1990s, but declined in the early 2000s. SSB has shown an increasing trend since ~2010 and average recruitment since then is higher than in the previous ten years.

Comparison with last year's assessment

The 2021 assessment was carried out using SAM, following a benchmark of the stock. The 2021 assessment model was revised in 2022 due to an error in stock mean weights-at-age data inputs which affected SSB estimates, but not the published catch advice.

The revised estimates for last year's assessment are as follows:

$\bar{F}_{(1\text{-}3)}$ in 2020 = 0.065, SSB in 2021 = 30 357 t.

The estimated fishing pressure continued to be very low. The stock biomass was estimated to increase slightly in 2021.

In this year's assessment estimates were updated and remain very similar to last year with some slight revisions (Figure 35.23).

SURBAR analysis

An alternative exploratory assessment conducted using SURBA (Needle, 2015) was presented at the WKNSEA benchmark (ICES, 2021a; WD 5.5 Whiting 6a SURBAR) and WGCSE 2021. Its updated run was presented to the WG this year.

This method requires stock weights-at-age, maturity ogive and survey indices. The smoothed estimates of stock weights-at-age were deployed in the model (those used to calculate SSB and shown in Table 35.9). The same three tuning series were considered for the model for SAM:

- ScoGFS-WIBTS-Q1 for the period 1985–2010;
- UK-SCOWCGFS-Q1 for the period 2011–2021;
- Comb-WCGFS-Q4 for the period 1996–2021.

The model used the following settings:

- Three survey series (as above);
- Reference age for separable model = 3;
- Lambda smoother = 1.0;
- All SSQ weightings and catchabilities q set to 1.0.

The model produced the output given in Figures 35.24. The stock summary plots show rather variable estimates of mean Z being generally lower from the mid-2000s onwards. SSB rose to a peak in the mid-1990s, before returning back down to the levels seen in the late 1980s with a substantial increase in the recent period. Also, it seems to fluctuate more in recent years compared to the historical period. The increase between 2019 and 2021 can be explained by relatively high recruitments in 2018–2019 and very low mean Z (associated with almost flat catch curves between 2019 and 2021 across a number of cohorts in UK-SCOWCGFS-Q1, Figure 35.13). Recruitment (at age 1) between 2005 and 2013 remained on a very low level. In recent years, it has increased markedly.

The assessment with SURBAR shows similar trends to those seen in the SAM runs (Figure 35.25).

State of the stock

The spawning–stock biomass (SSB) in 2022 is estimated to be above MSY $B_{trigger}$. It has increased since 2010 and is now at a level consistent with that estimated for the late 1990s. (Figure 35.26). $\bar{F}$ declined almost continuously since from 2000–2008, and has been below F_{MSY} since 2005. Recruitment was at historically low levels in the mid-2000s, and since around 2014 has been variable around relatively low values. The recruitment in 2021 was estimated to be at the median level of the past decade.

35.4 Short-term projections

The WG conducted a forecast using SAM in the form of short-term stochastic projections. A total of 1 x 10^5 samples was generated from the estimated distribution of survivors. These replicates were then simulated forward according to model and forecast assumptions (see below), using the usual exponential decay equations, but also incorporating the stochastic survival process (using the estimated survival standard deviation) and subject to different catch-options scenarios.

Recruitment in the intermediate year (2022) would typically be assumed to equal the SAM estimate, however, due to a lack of Q1 survey data in 2022, it was assumed to equal the median resampled value from 2012–2021, reflecting recent levels of recruitment. The estimate of recruitment for the forecast year was also assumed to equal the median resampled value from 2012–2021 as per the stock annex.

Fishing mortality in the intermediate year (2022) was taken as a five-year average over 2017 to 2021 (Figure 35.27) of the exploitation pattern rescaled to the 2021 mean F.

The stock has been subject to the landings obligation since 2019, at which point a bycatch TAC of 1112 t was set to allow fisheries with a whiting bycatch component to continue (this represented an increase from the 213 t TAC set for the preceding three years). This increased TAC appears to have resulted in a change in discarding practices since 2019. In Figure 35.28, the observed proportion discarded at-age shows a significant decline in the proportion of discards for ages 3 to 5 between 2019 and 2021, as well as a decline in proportion of discards at age 2 over the same period. For the forecast, total catch is partitioned into landings and discards on the basis of the mean discard proportions-at-age between 2019 and 2021 (rather than the more five-year average agreed at the benchmark and documented in the Stock Annex) with the assumption that this observed change in behaviour will continue in 2022 and 2023.

The observed mean weights-at-age zero and one in the 2021 discard data were considered unreliable due to limited sampling of fleets discarding whiting (COVID-19 pandemic related sampling issue, see Section 35.2 for further details). For the purpose of forecasting, the mean value for those ages should be taken from 2019–2020 data only.

Variable	Value	Notes
$F_{ages\ 1–3}$ (2022)	0.07	$F = F_{average\ (2017-2021)}$ rescaled to F_{2021}
SSB (2023)	28 727	Short-term forecast; Tonnes
$R_{age\ 0}$ (2022-2023)	273 676	Median recruitment, resampled from the years 2012–2021; thousands
Catch (2022)	1 484	Short-term forecast using an F_{2021}; tonnes
Projected landings (2022)	766	Short-term forecast; assuming average landings ratio by age 2019–2021; tonnes
Projected discards (2022)	718	Short-term forecast; assuming average discard ratio by age 2019–2021; tonnes

Under the forecast assumption of status quo F, landings in 2022 are predicted to be 766 t and discards to be 718 t. The SSB in 2023 is forecast to be 28 727 t, which is above B_{lim} and MSY $B_{trigger}$. A summary of the forecast run under different catch scenarios for 2023 is shown in Table 35.17 (the values that appear in the catch scenarios are medians from the distributions that result from the stochastic forecast).

The forecast stock trajectory under the proposed advice for 2023 (4155 t) shows a decrease in SSB in 2024 (Figure 35.29). Figure 35.30 shows the contribution by recruitment year to SSB in 2024 and catch in 2023 (when fished at F_{MSY}). The assumption regarding recruitment in 2022 and 2023 contribute approximately 26% and 9% to the forecast 2024 SSB, and 49% and 6% to the forecast 2023 catch, respectively.

35.5 MSY and biological reference points

The reference points for this stock were updated at WKNSEA 2021 (ICES, 2021a), following the general approach agreed at WKMSYREF4 (ICES, 2016).

The reference points estimated in 2021 are summarised in the table below:

Reference point	WKMSY-REF4 2016	WGCSE 2016	WKNSEA 2021	Rationale (WKNSEA 2021); details
B_{lim}	28 500 t	31 900 t	17 286	Lowest SSB (1999) within period of high recruitment (pre 2000)
B_{pa}	39 900 t	44 600 t	25 597	Blim x exp(1.645 x σ); σ = 0.239 (CV on estimate of SSB2020)
F_{lim}	0.25	0.27	0.31	F giving 50% probability of SSB<Blim in stochastic simulation (EqSim) Uses segmented regression recruitment with breakpoint=Blim (S-R pairs from 1985 onwards).
F_{pa}	0.18	0.19	0.21	Fp.05; the F that leads to SSB ≥ Blim with 95% probability.
F_{MSY}	0.22	0.23	0.21	Fp.05 (FMSY uncapped = 0.23)
F_{MSY} upper	0.34	0.32	0.21	Fp.05 (FMSY upper uncapped = 0.27)
F_{MSY} lower	0.16	0.15	0.173	F resulting in no more than 5% reduction in long-term yield compared with MSY without ICES AR (95 % yield at Fp.05).

35.6 Management plans

There are no specific management objectives or a management plan for this stock, but the EU multiannual plan takes bycatch of this species into account (EU, 2019).

35.7 Uncertainties and bias in the assessment and forecast

Some uncertainties signalled in previous assessments were related to area misreporting of landings. Marine Scotland Compliance have provided estimates based on their surveillance and monitoring programme which suggest area misreporting of whiting to be in the order of 10–15% of reported landings in recent years (ICES, 2012). This issue is thus considered to be of relatively minor importance.

As a result of the 2021 benchmark, the stock was changed from a category 5 stock to a category 1 stock. The assessment, which is now based on SAM, includes revised catch and survey data, updated biological parameters, and accounts for changes in fishery selectivity (rather than changes in survey catchability). These changes have resulted in an improved assessment of the stock status.

The retrospective bias observed for SSB and recruitment is potentially an issue; the Mohn's rho has been found outside the bounds suggested by WKFORBIAS (ICES, 2020b). However, the assessment is deemed to be valid and provide advice based on the WKFORBIAS decision tree.

The lack of an intermediate year survey in Q1 2022 required a change to the recruitment assumptions and this increased the uncertainty of the forecast.

The sampling levels both in 2020 and in 2021 were lower compared to previous years due to COVID-19. As a result, total discards were underestimated for 2021, and the estimates of catch numbers for ages 0 and 1 were excluded from the stock assessment. Sensitivity analyses indicate that these issues are likely to have minimal impact on the assessment.

35.8 Recommendation for next benchmark

Although the combined Q4 index is considered as representative of the population, there is scope for its further improvement. During WKNSEA 2021, the potential need for inclusion of an interaction term between year and geographical coordinates was discussed. Exploratory analysis suggested some temporal changes in the distribution of age groups, but it was found that the inclusion of the interaction term had little effect on the index values or the internal consistency. Additional analyses and careful sense checking of estimated covariates would be necessary to find optimal settings for such an augmented model.

The Q1 indices used in the assessment represent CPUE calculated for age groups. While they integrate information for specific areas or strata, other sources information are thereby ignored. It seems plausible that these indices can be improved by including other explanatory variables, in a similar way as for the Q4 index.

Alternative approaches could be used to estimate stock mean weights. Currently, they are smoothed with a GAM independently in each age group. As a result, two consecutive age groups can occasionally show different trends, which was observed here and which makes such estimates more uncertain.

While a Random Walk on recruitment was selected for the assessment for practical reasons, alternative approaches should be explored in modelling the S–R relationship model with internal calculation of reference points.

35.9 Management considerations

SSB in 2022 is estimated to be above MSY $B_{trigger}$. It has increased since 2010 and is now at a level consistent with that estimated for the late 1990s. Fishing pressure (F) declined almost continuously since around 2000 and is below F_{MSY} since 2005. After a period of somewhat higher recruitment (2014–2019), recruitment in the two last years was estimated to be lower. The first non-zero advice has been given for five years. The SSB is forecast to decline in the following two years in all catch scenarios.

Whiting are caught and heavily discarded in small-meshed fisheries for *Nephrops*. Under the landing obligation (since 2019), discards have considerably reduced. However, they still make up a considerable proportion of the catch (23% in 2021). Reported BMS landings are negligible; they are much lower than ICES estimates of catches below minimum size (i.e. estimated discards at age 0–2).

TAC increased under the landing obligation to allow continuation of mixed fisheries. In response to this, the discard rate declined. The forecast assumes that this behaviour will continue in 2022 and 2023.

It should be noted that TAC have been set for a larger area than Division 6.a. and include areas 6.b, 5.b and international waters of 12 and 14 (Annex IA to Regulation (EU) 2022/109).

Whiting are caught in mixed fisheries with cod and haddock in Division 6.a. There have been several technical conservation measures introduced in the 6.a gadoid fishery in recent years. The increase in mesh size from 100 mm to 120 mm, established under the emergency measures since 2010, and the introduction of large square mesh panels in the *Nephrops* fishery, are likely to have contributed to the observed reductions in fishing mortality.

35.10 References

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Table 35.1. Whiting in Division 6.a. Nominal landings (in tonnes) as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	1	-	+	-	+	+	+	-	1	1	+	-	-	-	-	+	-	-	-	-
Denmark	1	+	3	1	1	+	+	+	+	-	-	-	-	-	+	+	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
France	199	180	352	105	149	191	362	202	108	82	300	48	52	21	11	6	9	7	6	1
Germany	+	+	+	1	1	+	-	+	-	-	+	-	-	-	-	-	-	+	1	-
Ireland	1315	977	1200	1377	1192	1213	1448	1182	977	952	1121	793	764	577	568	356	172	196	56	69
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	1	-	1	2	+	-	2	-	-	-	-	-	-	-
UK (E, W and NI)	44	50	218	196	184	233	204	237	453	251	210	104	71	73	35	13	5	2	1	
UK (Scot.)	6109	4819	5135	4330	5224	4149	4263	5021	4638	3369	3046	2258	1654	1064	751	444	103	178	424	
UK (total)																				370
Total landings	7669	6026	6908	6010	6751	5786	6278	6642	6178	4657	4677	3203	2543	1735	1365	819	289	383	488	441

Table 35.1. Continued.

Country	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*
Belgium	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	2	56	10	-
Faroe Islands	-	+	1	1	-	-	-	-	-	-	-	-	-
France	1	3	+	+	1	1	+	5	3	2	7	10	35
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	125	99	149	96	97	97	88	77	53	72	**	126	161
Netherlands	-	-	-	-	-	-	11	52	19	4	23	4	+
Norway	2	-	-	-	-	-	-	-	-	+	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-	+	-	+
UK (E, W and NI)													-
UK (Scot.)													-
UK (total)	354	247	80	204	116	83	122	98	94	108	241	387	654
Total landings	482	349	230	301	214	181	221	232	169	189	327**	537	851

*** Preliminary.**

**** Incomplete/missing due to part of the data being unavailable under national GDPR clauses.**

+ <0.5 t.

Table 35.2. Whiting in Division 6.a. Landings, discards and catch estimates for 1981–2020, as used by the WG. Values are totals for ages 1 to 7+ (in 1981–2002) and for ages 0 to 7+ (in 2003–2020). Discard and catch values for the years 1981–2002 are revised compared to previous assessments because of a revised method for raising discards (Millar and Fryer, 2005). Landings, discard and catch values for the years 2003–2018 are revised InterCatch estimates (ICES, 2020a) compared to previous assessments.

Year	Landings	Discards	Total	Discard rate (%)
1981	12203	2132	14335	15
1982	13871	5485	19356	28
1983	15970	6294	22264	28
1984	16458	4017	20475	20
1985	12893	4840	17733	27
1986	8454	2669	11123	24
1987	11544	11918	23462	51
1988	11352	8132	19484	42
1989	7531	5876	13407	44
1990	5643	4530	10173	45
1991	6660	4883	11543	42
1992	6004	9249	15253	61
1993	6872	4759	11631	41
1994	5901	3455	9356	37
1995	6076	5771	11847	49
1996	7156	7940	15096	53
1997	6285	5251	11536	46
1998	4631	9216	13847	67
1999	4613	3975	8588	46
2000	3010	13285	16295	82
2001	2438	4263	6701	64
2002	1709	2851	4560	63
2003	1331	1984	3316	60
2004	798	2887	3686	78
2005	335	972	1307	74
2006	378	746	1124	66
2007	481	366	847	43

Year	Landings	Discards	Total	Discard rate (%)
2008	441	156	598	26
2009	480	826	1305	63
2010	345	1091	1436	76
2011	231	630	861	73
2012	300	742	1042	71
2013	215	1172	1387	85
2014	181	745	926	80
2015	221	1458	1679	87
2016	227	1040	1266	82
2017	168	1331	1498	89
2018	189	666	855	78
2019	484	960	1444	66
2020	541	834	1375	61
2021	852	261	1114	23
Min	168	156	598	15
Mean	4524	3650	8174	55
Max	16458	13285	23462	89

Table 35.3. Whiting in Division 6.a. Landings-at-age (thousands).

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	0	3593	24395	11297	4611	1518	452	201
1982	0	2991	5783	29094	6821	2043	803	348
1983	0	3418	7094	8040	22757	6070	1439	540
1984	0	7209	12765	8221	4387	14825	1953	858
1985	0	4139	19520	8574	3351	1997	4764	822
1986	0	2674	14824	9770	2653	532	291	529
1987	0	6430	13935	13988	5442	837	330	259
1988	0	1842	20587	9638	6168	1949	290	207
1989	0	2529	5887	11889	4767	1266	468	71
1990	0	3203	8028	2393	4009	1326	204	37
1991	0	3294	8826	10046	1208	1391	286	51
1992	0	2695	9440	4473	4782	396	373	106
1993	0	1051	10179	6293	2673	2738	163	147
1994	0	909	4889	9158	3607	712	715	69
1995	0	215	4322	6516	5654	1397	376	282
1996	0	990	5410	7675	5052	2461	583	157
1997	0	877	3658	8514	4316	1441	338	106
1998	0	840	3504	4277	3698	1442	338	288
1999	0	1013	6131	4546	2040	1774	355	112
2000	0	484	2952	4211	1570	485	328	89
2001	0	461	3271	2630	1567	401	131	16
2002	0	62	1624	3018	799	227	23	13
2003	0	98	652	1309	1481	414	93	2
2004	0	49	699	544	517	620	74	33
2005	0	26	273	460	145	107	49	5
2006	0	83	135	386	276	67	86	25
2007	0	193	190	294	361	152	31	53
2008	0	3	277	387	335	150	54	25
2009	0	108	255	258	417	107	49	14
2010	0	50	81	150	148	141	43	52
2011	0	0	256	144	94	27	26	8

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2012	0	13	39	374	203	53	16	9
2013	0	4	41	76	269	74	19	6
2014	0	13	26	130	101	101	23	11
2015	0	7	74	56	157	71	73	30
2016	0	19	93	147	77	86	19	28
2017	0	17	37	167	69	52	39	10
2018	0	0	73	89	199	60	8	8
2019	0	23	54	427	255	258	48	5
2020	0	7	309	258	310	156	39	3
2021	0	0	318	674	375	366	67	37

Table 35.4. Whiting in Division 6.a. Discards-at-age (thousands). Previous discard estimates for the years 1978–2003 were replaced by those estimated by Millar and Fryer (2005).

Year	Age	1	2	3	4	5	6	7+
1981	NA	1128	10415	1397	201	27	12	0
1982	NA	19511	3421	12683	1197	187	4	0
1983	NA	21690	6748	2909	5372	158	8	0
1984	NA	34330	2400	909	371	811	73	1
1985	NA	17615	9858	3273	672	205	363	40
1986	NA	6159	9823	1962	185	1	0	10
1987	NA	97611	17427	1763	154	0	0	0
1988	NA	28057	38019	2239	467	11	0	0
1989	NA	31079	5598	8570	223	13	5	0
1990	NA	20952	11176	71	23	3	0	0
1991	NA	23211	7540	7355	266	236	56	0
1992	NA	50665	16729	2810	954	0	0	0
1993	NA	14057	11139	2903	588	431	0	1
1994	NA	12700	6859	3872	1152	189	150	4
1995	NA	21974	21786	3416	484	7	1	1
1996	NA	33621	18625	5086	1535	13	1	20
1997	NA	22422	9632	3806	540	71	2	1
1998	NA	53742	16058	3553	847	177	31	8
1999	NA	7928	17097	1402	503	275	44	0
2000	NA	158913	5254	2238	154	16	41	0
2001	NA	5666	23084	715	172	0	0	0
2002	NA	11055	8531	2428	415	175	9	3
2003	5678	9448	2489	1775	375	25	7	1
2004	10577	14941	5095	1011	660	125	4	2
2005	7873	3246	2298	769	60	22	8	4
2006	5866	4691	528	637	169	29	6	2
2007	1259	1016	966	283	88	38	3	0
2008	840	630	144	114	31	37	4	0
2009	9685	6880	114	66	44	15	4	0
2010	5903	17678	1581	264	37	54	6	16

Year	Age	1	2	3	4	5	6	7+
2011	13306	2047	998	122	7	2	0	0
2012	1434	7810	429	547	94	19	1	0
2013	3188	16415	1578	172	255	8	2	2
2014	6261	9831	51	55	27	30	8	3
2015	17740	7930	909	287	112	18	17	0
2016	3745	5506	1910	268	16	12	4	2
2017	8518	7563	788	889	65	160	2	0
2018	1777	2371	962	469	276	21	5	0
2019	2188	10379	526	413	232	34	0	0
2020	NA	23481	807	59	29	10	3	0
2021	2579	156	467	80	44	89	0	0

Table 35.5. Whiting in Division 6.a. Total catch-at-age (thousands).

	Age							
Year	0	1	2	3	4	5	6	7+
1981	NA	4721	34810	12694	4812	1545	464	201
1982	NA	22502	9204	41777	8018	2230	807	348
1983	NA	25108	13842	10949	28129	6228	1447	540
1984	NA	41539	15165	9130	4758	15636	2026	859
1985	NA	21754	29378	11847	4023	2202	5127	862
1986	NA	8833	24647	11732	2838	533	291	539
1987	NA	104041	31362	15751	5596	837	330	259
1988	NA	29899	58606	11877	6635	1960	290	207
1989	NA	33608	11485	20459	4990	1279	473	71
1990	NA	24155	19204	2464	4032	1329	204	37
1991	NA	26505	16366	17401	1474	1627	342	51
1992	NA	53360	26169	7283	5736	396	373	106
1993	NA	15108	21318	9196	3261	3169	163	148
1994	NA	13609	11748	13030	4759	901	865	73
1995	NA	22189	26108	9932	6138	1404	377	283
1996	NA	34611	24035	12761	6587	2474	584	177
1997	NA	23299	13290	12320	4856	1512	340	107
1998	NA	54582	19562	7830	4545	1619	369	296
1999	NA	8941	23228	5948	2543	2049	399	112
2000	NA	159397	8206	6449	1724	501	369	89
2001	NA	6127	26355	3345	1739	401	131	16
2002	NA	11117	10155	5446	1214	402	32	16
2003	5678	9546	3141	3083	1856	439	100	3
2004	10577	14990	5794	1556	1176	745	78	35
2005	7873	3272	2571	1229	205	129	57	10
2006	5866	4773	663	1023	445	96	93	27
2007	1259	1209	1156	578	449	190	33	53
2008	840	632	421	500	366	187	58	25
2009	9685	6988	370	324	462	123	53	14
2010	5903	17729	1662	414	185	196	49	68
2011	13306	2048	1254	267	101	29	26	8

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2012	1434	7823	469	920	298	72	17	9
2013	3188	16419	1619	247	523	82	21	7
2014	6261	9844	77	185	127	130	31	14
2015	17740	7937	983	343	269	90	90	30
2016	3745	5525	2003	415	92	98	23	30
2017	8518	7580	825	1056	134	212	41	10
2018	1777	2371	1035	557	475	81	13	8
2019	2188	10402	580	840	486	293	48	5
2020	NA	23488	1116	317	339	166	42	3
2021	NA	NA	785	754	419	456	67	37

Table 35.6. Whiting in Division 6.a. Mean weight-at-age (kg) in landings.

	Age							
Year	**0***	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	0.035	0.192	0.228	0.289	0.382	0.409	0.409	0.547
1982	0.035	0.184	0.22	0.276	0.352	0.505	0.513	0.526
1983	0.035	0.216	0.249	0.28	0.34	0.409	0.494	0.51
1984	0.035	0.216	0.259	0.313	0.371	0.412	0.458	0.458
1985	0.035	0.185	0.238	0.306	0.402	0.43	0.461	0.538
1986	0.035	0.174	0.236	0.294	0.365	0.468	0.482	0.499
1987	0.035	0.188	0.237	0.304	0.373	0.511	0.52	0.576
1988	0.035	0.176	0.215	0.301	0.4	0.483	0.567	0.6
1989	0.035	0.171	0.22	0.279	0.348	0.459	0.425	0.555
1990	0.035	0.225	0.251	0.324	0.359	0.417	0.582	0.543
1991	0.035	0.199	0.22	0.291	0.354	0.391	0.442	0.761
1992	0.035	0.193	0.23	0.288	0.349	0.388	0.397	0.51
1993	0.035	0.186	0.242	0.314	0.361	0.412	0.452	0.474
1994	0.035	0.161	0.217	0.29	0.371	0.451	0.482	0.483
1995	0.035	0.19	0.225	0.296	0.381	0.469	0.473	0.528
1996	0.035	0.195	0.245	0.288	0.365	0.483	0.526	0.569
1997	0.035	0.198	0.245	0.297	0.384	0.522	0.629	0.661
1998	0.035	0.215	0.236	0.301	0.364	0.438	0.5	0.646
1999	0.035	0.181	0.225	0.28	0.365	0.44	0.524	0.594
2000	0.035	0.205	0.241	0.298	0.336	0.419	0.488	0.617
2001	0.035	0.173	0.234	0.303	0.37	0.395	0.376	0.595
2002	0.035	0.213	0.257	0.304	0.363	0.464	0.650	0.707
2003	0.035	0.236	0.272	0.301	0.373	0.349	0.409	0.659
2004	0.035	0.189	0.257	0.296	0.342	0.376	0.378	0.305
2005	0.035	0.215	0.253	0.297	0.366	0.426	0.455	0.383
2006	0.035	0.221	0.290	0.321	0.395	0.452	0.496	0.574
2007	0.035	0.215	0.289	0.356	0.416	0.497	0.598	0.667
2008	0.035	0.285	0.245	0.319	0.379	0.516	0.534	0.652
2009	0.035	0.288	0.317	0.406	0.446	0.439	0.444	0.603
2010	0.035	0.286	0.353	0.436	0.540	0.647	0.654	0.575
2011	0.035	0.201	0.356	0.396	0.502	0.571	0.578	0.370

Year	Age 0*	1	2	3	4	5	6	7+
2012	0.035	0.320	0.300	0.374	0.504	0.594	0.665	0.482
2013	0.035	0.225	0.325	0.355	0.441	0.546	0.597	0.770
2014	0.035	0.248	0.295	0.375	0.457	0.528	0.641	0.678
2015	0.035	0.261	0.347	0.447	0.468	0.508	0.596	0.600
2016	0.035	0.137	0.325	0.483	0.509	0.606	0.676	0.664
2017	0.035	0.340	0.352	0.413	0.546	0.497	0.510	0.684
2018	0.035	0.173	0.407	0.396	0.435	0.520	0.472	0.564
2019	0.035	0.244	0.288	0.415	0.506	0.529	0.698	0.879
2020	0.035	0.235	0.406	0.482	0.551	0.597	0.657	1.058
2021	0.035	0.217**	0.301	0.418	0.585	0.577	0.620	0.658

*** For age 0, mean weights-are assumed to be the average for discards in 2003–2019.**

**** For age 1 in 2021, mean weight-is assumed to be the average for age 1 in 2018–2020.**

Table 35.7. Whiting in Division 6.a. Mean weight-at-age (kg) in discards.

	Age							
Year	0	1	2	3	4	5	6	7+
1981	0.035*	0.108	0.16	0.195	0.298	0.286	0.295	NA
1982	0.035*	0.096	0.18	0.209	0.243	0.283	0.44	NA
1983	0.035*	0.141	0.186	0.228	0.237	0.267	0.267	NA
1984	0.035*	0.087	0.199	0.246	0.26	0.259	0.303	0.227
1985	0.035*	0.102	0.191	0.237	0.286	0.326	0.312	0.316
1986	0.035*	0.092	0.17	0.196	0.245	0.258	0.33	0.263
1987	0.035*	0.085	0.182	0.233	0.249	0.225	NA	NA
1988	0.035*	0.076	0.143	0.203	0.227	0.262	NA	NA
1989	0.035*	0.099	0.177	0.205	0.209	0.294	0.305	NA
1990	0.035*	0.124	0.171	0.214	0.219	0.237	0.264	NA
1991	0.035*	0.085	0.169	0.205	0.223	0.226	0.281	NA
1992	0.035*	0.109	0.173	0.219	0.227	NA	NA	NA
1993	0.035*	0.118	0.197	0.225	0.242	0.256	NA	0.436
1994	0.035*	0.087	0.157	0.22	0.283	0.297	0.253	0.299
1995	0.035*	0.075	0.154	0.189	0.246	0.278	0.597	0.493
1996	0.035*	0.095	0.18	0.203	0.229	0.302	0.421	0.26
1997	0.035*	0.112	0.182	0.221	0.235	0.243	0.422	0.819
1998	0.035*	0.098	0.179	0.225	0.254	0.282	0.264	0.245
1999	0.035*	0.077	0.168	0.217	0.205	0.266	0.268	NA
2000	0.035*	0.075	0.164	0.203	0.233	0.282	0.250	NA
2001	0.035*	0.094	0.154	0.196	0.203	0.381	0.000	NA
2002	0.035*	0.073	0.162	0.212	0.245	0.240	0.295	0.276
2003	0.051	0.091	0.161	0.193	0.243	0.209	0.291	0.278
2004	0.020	0.091	0.178	0.223	0.233	0.302	0.343	0.282
2005	0.028	0.074	0.145	0.207	0.188	0.302	0.289	0.368
2006	0.037	0.047	0.195	0.233	0.285	0.311	0.494	0.361
2007	0.042	0.064	0.157	0.232	0.223	0.231	0.787	0.266
2008	0.019	0.076	0.211	0.305	0.350	0.423	0.233	0.289
2009	0.043	0.051	0.283	0.227	0.262	0.250	0.248	NA
2010	0.018	0.040	0.119	0.239	0.360	0.360	0.382	0.224
2011	0.029	0.034	0.136	0.307	0.256	0.228	NA	NA

Year	Age 0	1	2	3	4	5	6	7+
2012	0.042	0.057	0.152	0.292	0.362	0.356	0.386	NA
2013	0.027	0.041	0.209	0.229	0.358	0.385	0.299	0.371
2014	0.040	0.045	0.182	0.289	0.362	0.427	0.422	0.757
2015	0.035	0.072	0.171	0.212	0.336	0.316	0.427	NA
2016	0.050	0.068	0.206	0.276	0.292	0.304	0.261	0.367
2017	0.033	0.066	0.197	0.351	0.409	0.331	0.881	NA
2018	0.054	0.067	0.184	0.250	0.307	0.414	1.107	NA
2019	0.029	0.055	0.199	0.267	0.278	0.436	0.489	NA
2020	0.035*	0.028	0.163	0.254	0.313	0.286	0.255	NA
2021	0.029	0.143	0.236	0.279	0.270	0.236	NA	NA

*** For age 0 in 1981–2002 and 2020, mean weights-are assumed to be the average for 2003–2019.**

Table 35.8. Whiting in Division 6.a. Mean weight-at-age (kg) in total catch.

	Age							
Year	0	1	2	3	4	5	6	7+
1981	0.035*	0.172	0.208	0.279	0.378	0.407	0.406	0.547
1982	0.035*	0.108	0.205	0.256	0.336	0.486	0.513	0.526
1983	0.035*	0.151	0.218	0.266	0.320	0.405	0.493	0.510
1984	0.035*	0.109	0.250	0.306	0.362	0.404	0.452	0.458
1985	0.035*	0.118	0.222	0.287	0.383	0.420	0.450	0.528
1986	0.035*	0.117	0.210	0.278	0.357	0.468	0.482	0.495
1987	0.035*	0.091	0.206	0.296	0.370	0.511	0.520	0.576
1988	0.035*	0.082	0.168	0.283	0.388	0.482	0.567	0.600
1989	0.035*	0.104	0.199	0.248	0.342	0.457	0.424	0.555
1990	0.035*	0.137	0.204	0.321	0.358	0.417	0.582	0.543
1991	0.035*	0.099	0.197	0.255	0.330	0.367	0.416	0.761
1992	0.035*	0.113	0.194	0.261	0.329	0.388	0.397	0.510
1993	0.035*	0.123	0.218	0.286	0.340	0.391	0.452	0.474
1994	0.035*	0.092	0.182	0.269	0.350	0.419	0.442	0.473
1995	0.035*	0.076	0.166	0.259	0.370	0.468	0.473	0.528
1996	0.035*	0.098	0.195	0.254	0.333	0.482	0.526	0.534
1997	0.035*	0.115	0.199	0.274	0.367	0.509	0.628	0.662
1998	0.035*	0.100	0.189	0.267	0.344	0.421	0.480	0.635
1999	0.035*	0.089	0.183	0.265	0.333	0.417	0.496	0.594
2000	0.035*	0.075	0.192	0.265	0.327	0.415	0.462	0.617
2001	0.035*	0.100	0.164	0.280	0.353	0.395	0.376	0.595
2002	0.035*	0.074	0.177	0.263	0.323	0.366	0.550	0.626
2003	0.051	0.092	0.184	0.239	0.347	0.341	0.401	0.516
2004	0.020	0.091	0.188	0.249	0.281	0.364	0.377	0.304
2005	0.028	0.075	0.156	0.241	0.313	0.405	0.432	0.376
2006	0.037	0.050	0.214	0.266	0.353	0.410	0.495	0.557
2007	0.042	0.088	0.179	0.295	0.378	0.444	0.613	0.666
2008	0.019	0.077	0.233	0.316	0.376	0.498	0.514	0.648
2009	0.043	0.054	0.307	0.369	0.429	0.415	0.430	0.603
2010	0.018	0.040	0.130	0.311	0.504	0.567	0.622	0.492
2011	0.029	0.034	0.181	0.355	0.485	0.546	0.578	0.370

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2012	0.042	0.057	0.164	0.325	0.459	0.531	0.643	0.482
2013	0.027	0.041	0.212	0.268	0.401	0.530	0.571	0.679
2014	0.040	0.045	0.220	0.349	0.437	0.505	0.581	0.694
2015	0.035	0.072	0.185	0.250	0.413	0.469	0.565	0.600
2016	0.050	0.068	0.211	0.349	0.472	0.568	0.601	0.649
2017	0.033	0.066	0.204	0.361	0.480	0.372	0.524	0.684
2018	0.054	0.067	0.199	0.273	0.361	0.492	0.731	0.564
2019	0.029	0.055	0.207	0.342	0.397	0.518	0.697	0.879
2020	0.035*	0.028	0.230	0.439	0.531	0.579	0.625	1.058
2021	0.029	0.143	0.262	0.403	0.552	0.510	0.620	0.658

*** For age 0 in 1981–2002 and 2020, mean weights-are assumed to be the average for 2003–2019.**

Table 35.9. Whiting in Division 6.a. Mean weight-at-age (kg) in stock. These are smoothed estimates for use in SSB calculation.

	Age							
Year	0	1	2	3	4	5	6	7+
1981	0.037	0.048	0.153	0.273	0.373	0.48	0.552	0.648
1982	0.037	0.048	0.153	0.273	0.373	0.48	0.552	0.648
1983	0.037	0.048	0.153	0.273	0.373	0.48	0.552	0.648
1984	0.037	0.048	0.153	0.273	0.373	0.48	0.552	0.648
1985	0.037	0.048	0.153	0.273	0.373	0.48	0.552	0.648
1986	0.037	0.048	0.153	0.27	0.369	0.477	0.55	0.642
1987	0.037	0.048	0.153	0.267	0.365	0.472	0.547	0.637
1988	0.037	0.048	0.152	0.264	0.361	0.464	0.545	0.631
1989	0.036	0.048	0.152	0.261	0.358	0.454	0.543	0.624
1990	0.036	0.048	0.151	0.259	0.356	0.442	0.54	0.617
1991	0.036	0.049	0.15	0.256	0.354	0.433	0.538	0.61
1992	0.036	0.049	0.148	0.254	0.353	0.428	0.536	0.603
1993	0.036	0.049	0.146	0.252	0.352	0.431	0.533	0.596
1994	0.035	0.049	0.145	0.25	0.35	0.439	0.531	0.589
1995	0.035	0.049	0.143	0.249	0.349	0.449	0.53	0.582
1996	0.035	0.049	0.141	0.247	0.347	0.457	0.528	0.576
1997	0.035	0.05	0.14	0.246	0.344	0.459	0.527	0.57
1998	0.035	0.05	0.138	0.245	0.341	0.453	0.527	0.565
1999	0.034	0.05	0.138	0.245	0.337	0.44	0.526	0.56
2000	0.034	0.05	0.137	0.245	0.334	0.424	0.526	0.556
2001	0.034	0.05	0.137	0.246	0.331	0.409	0.527	0.553
2002	0.034	0.05	0.137	0.248	0.33	0.398	0.528	0.551
2003	0.034	0.05	0.138	0.25	0.332	0.395	0.531	0.551
2004	0.034	0.051	0.139	0.254	0.337	0.401	0.534	0.552
2005	0.033	0.051	0.141	0.26	0.346	0.415	0.538	0.555
2006	0.033	0.051	0.143	0.266	0.359	0.435	0.543	0.56
2007	0.033	0.051	0.146	0.273	0.374	0.458	0.549	0.566
2008	0.033	0.051	0.148	0.281	0.392	0.483	0.556	0.574
2009	0.033	0.051	0.151	0.289	0.409	0.507	0.564	0.584
2010	0.033	0.051	0.154	0.296	0.425	0.529	0.571	0.594

	Age							
Year	0	1	2	3	4	5	6	7+
2011	0.034	0.052	0.156	0.302	0.438	0.547	0.579	0.606
2012	0.034	0.052	0.158	0.307	0.448	0.558	0.587	0.619
2013	0.034	0.052	0.16	0.31	0.454	0.563	0.595	0.633
2014	0.034	0.052	0.162	0.314	0.456	0.56	0.602	0.648
2015	0.034	0.052	0.163	0.316	0.456	0.553	0.609	0.663
2016	0.035	0.052	0.164	0.319	0.455	0.543	0.616	0.678
2017	0.035	0.052	0.164	0.322	0.454	0.535	0.622	0.694
2018	0.035	0.053	0.163	0.324	0.454	0.529	0.629	0.709
2019	0.036	0.053	0.163	0.327	0.454	0.529	0.635	0.725
2020	0.036	0.053	0.162	0.33	0.455	0.532	0.641	0.74
2021	0.036	0.053	0.161	0.333	0.457	0.538	0.647	0.755

Table 35.10. Whiting in Division 6.a. Natural mortality.

	Age							
Year	0	1	2	3	4	5	6	7+
1981	1.052	1.036	0.713	0.593	0.539	0.501	0.478	0.459
1982	1.052	1.036	0.713	0.593	0.539	0.501	0.478	0.459
1983	1.052	1.036	0.713	0.593	0.539	0.501	0.478	0.459
1984	1.052	1.036	0.713	0.593	0.539	0.501	0.478	0.459
1985	1.052	1.036	0.713	0.593	0.539	0.501	0.478	0.459
1986	1.054	1.015	0.710	0.594	0.541	0.501	0.479	0.460
1987	1.055	0.996	0.708	0.595	0.543	0.503	0.480	0.461
1988	1.057	0.979	0.705	0.597	0.544	0.505	0.482	0.463
1989	1.058	0.963	0.702	0.598	0.545	0.509	0.483	0.464
1990	1.060	0.948	0.699	0.599	0.546	0.513	0.484	0.465
1991	1.062	0.935	0.696	0.600	0.547	0.517	0.485	0.467
1992	1.063	0.921	0.694	0.601	0.548	0.519	0.487	0.469
1993	1.065	0.909	0.691	0.601	0.548	0.518	0.488	0.470
1994	1.066	0.897	0.689	0.601	0.548	0.515	0.489	0.472
1995	1.068	0.885	0.686	0.601	0.548	0.511	0.490	0.473
1996	1.070	0.874	0.683	0.600	0.547	0.507	0.491	0.475
1997	1.071	0.865	0.681	0.599	0.547	0.506	0.492	0.476
1998	1.073	0.857	0.678	0.598	0.548	0.507	0.493	0.478
1999	1.075	0.850	0.675	0.597	0.548	0.511	0.494	0.479
2000	1.077	0.844	0.673	0.595	0.549	0.517	0.495	0.480
2001	1.079	0.840	0.670	0.593	0.549	0.523	0.495	0.481
2002	1.080	0.837	0.668	0.591	0.548	0.529	0.495	0.482
2003	1.082	0.834	0.666	0.589	0.547	0.532	0.494	0.482
2004	1.083	0.833	0.664	0.586	0.545	0.531	0.493	0.482
2005	1.085	0.832	0.661	0.583	0.542	0.528	0.491	0.482
2006	1.085	0.832	0.659	0.580	0.537	0.522	0.489	0.481
2007	1.086	0.832	0.657	0.576	0.532	0.514	0.486	0.480
2008	1.086	0.833	0.655	0.573	0.527	0.506	0.484	0.478
2009	1.085	0.833	0.653	0.570	0.522	0.497	0.481	0.476
2010	1.084	0.833	0.652	0.567	0.517	0.490	0.479	0.474
2011	1.083	0.832	0.650	0.564	0.513	0.484	0.476	0.471

	Age							
Year	0	1	2	3	4	5	6	7+
2012	1.081	0.830	0.648	0.562	0.510	0.480	0.474	0.468
2013	1.080	0.828	0.647	0.560	0.509	0.479	0.471	0.466
2014	1.077	0.825	0.646	0.558	0.508	0.479	0.469	0.463
2015	1.075	0.823	0.644	0.556	0.507	0.481	0.468	0.460
2016	1.073	0.821	0.643	0.555	0.507	0.484	0.466	0.457
2017	1.070	0.820	0.642	0.553	0.507	0.486	0.465	0.454
2018	1.068	0.818	0.641	0.552	0.507	0.488	0.463	0.451
2019	1.065	0.817	0.640	0.550	0.507	0.487	0.462	0.448
2020	1.062	0.817	0.639	0.549	0.506	0.486	0.461	0.445
2021	1.060	0.816	0.638	0.547	0.506	0.484	0.460	0.443

Table 35.11. Whiting in Division 6.a. Survey data made available to the WG. For the Scottish and Irish surveys, numbers are standardised to catch-rate per ten hours. The Scottish surveys from 2011 have been conducted according to the new design and ground gear.

ScoGFS-WIBTS-Q1 – Scottish Groundfish Survey – numbers-at-age/10 h								
Year	Effort	Age						
	(hours)	1	2	3	4	5	6	7
1985	10	3140	1792	380	85	23	156	18
1986	10	1456	1525	403	68	10	9	10
1987	10	6938	1054	584	142	36	2	1
1988	10	567	3469	654	189	42	5	1
1989	10	910	505	586	237	48	3	0
1990	10	1818	571	122	216	61	4	1
1991	10	3203	276	299	22	39	9	1
1992	10	4777	1597	410	517	56	18	0
1993	10	5532	6829	644	91	30	11	2
1994	10	6614	2443	1487	174	56	15	6
1995	10	5598	2831	1160	370	70	17	32
1996	10	9385	2237	635	341	135	30	4
1997	10	5663	2444	1531	355	102	17	4
1998	10	9851	1352	294	195	50	14	1
1999	10	6125	4952	489	103	16	1	0
2000	10	12862	471	152	34	10	11	0
2001	10	4653	1955	242	41	8	1	1
2002	10	5542	1028	964	89	15	1	1
2003	10	6934	746	436	300	32	2	4
2004	10	5887	1566	189	131	44	9	1
2005	10	1308	723	183	35	8	11	2
2006	10	1441	466	282	77	0	3	1
2007	10	614	522	127	75	16	3	2
2008	10	593	127	77	26	8	3	0
2009	10	906	387	103	105	20	9	7
2010	10	3523	340	108	52	40	4	3

Table 35.11. Continued.

UK-SCOWCGFS-Q1 – Scottish Groundfish Survey – numbers-at-age/10 h															
		Index							Variance						
Year	Effort	Age							Age						
	(hours)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2011	10	222	1884	397	64	37	45	12	6431	150861	5654	209	80	133	11
2012	10	3441	293	738	72	14	5	7	600264	8104	18380	184	9	2	3
2013	10	552	1031	302	463	61	7	3	62915	46672	5056	15023	443	7	1
2014	10	5805	125	246	110	74	7	1	2230995	556	2133	657	333	2	0
2015	10	2545	760	285	259	65	58	8	144266	46202	8599	4562	305	352	10
2016	10	3226	3485	576	148	84	42	25	397138	1880448	28776	691	260	95	48
2017	10	4970	1981	1707	203	49	32	5	2335667	309373	227966	2958	172	99	3
2018	10	1960	1827	1069	1142	132	14	2	763992	330295	91346	108990	2138	70	0
2019	10	3231	666	577	191	99	25	0	345197	29689	21447	1786	536	30	0
2020	10	3795	2263	711	572	178	110	27	1369852	699830	68242	27213	3694	1736	415
2021	10	774	1679	703	272	140	24	11	29371	129127	23776	3259	1173	30	10

Table 35.11. Continued.

Comb-WCGFS-Q4 – Combined Scottish and Irish Groundfish Survey – numbers-at-age per hour									
Index									
Year	Effort	Age							
	(hours)	0	1	2	3	4	5	6	7+
1996	1	7924.6	449.5	99.5	30.0	7.9	3.1	0.5	0.0
1997	1	1848.2	701.9	155.3	33.5	10.3	2.3	0.4	0.1
1998	1	551.3	617.9	198.2	20.7	9.0	2.1	0.4	0.7
1999	1	2060.8	218.5	97.1	14.5	4.5	2.1	0.1	0.3
2000	1	2527.0	1035.4	161.4	25.0	1.4	1.2	0.2	0.4
2001	1	258.5	394.9	398.2	30.4	4.7	2.5	0.3	0.1
2002	1	2018.7	273.4	110.4	57.2	4.1	1.2	0.5	0.2
2003	1	558.1	485.5	74.0	32.9	10.3	2.1	0.4	0.2
2004	1	210.2	198.4	74.5	7.6	4.6	3.1	0.2	0.2
2005	1	166.8	68.2	43.3	10.5	1.0	0.4	0.1	0.1
2006	1	128.0	50.5	27.4	11.9	3.2	0.7	0.1	0.0
2007	1	111.7	59.9	39.2	11.3	4.5	2.6	0.3	0.1
2008	1	18.6	41.5	19.1	15.9	4.1	3.0	0.5	0.1
2009	1	1492.7	23.2	16.5	5.1	2.6	0.8	0.4	0.4
2010	1	76.0	317.9	35.2	8.8	2.5	1.1	0.2	0.3
2011	1	428.5	33.4	157.4	20.4	7.1	2.4	1.4	0.4
2012	1	89.3	241.6	50.9	69.7	16.6	2.4	0.7	0.3
2013	1	2140.4	38.3	90.5	27.9	29.7	4.9	0.6	0.1
2014	1	7693.9	243.8	46.2	38.3	10.2	8.1	2.0	0.2
2015	1	804.2	781.8	119.1	27.9	18.7	4.4	2.8	0.2
2016	1	542.8	310.0	288.6	39.8	8.7	10.5	1.6	2.2
2017	1	579.2	162.5	112.7	118.6	18.6	2.6	1.3	0.7
2018	1	2856.0	134.1	94.5	37.6	20.1	2.9	0.1	0.4
2019	1	2833.4	440.5	46.8	22.4	9.4	3.5	0.6	0.1
2020	1	1063.6	426.8	167.1	23.9	12.0	4.0	2.1	0.2
2021	1	1521.8	129.7	157.5	36.1	6.8	4.1	2.1	0.2

Table 35.11. Continued.

Comb-WCGFS-Q4 – Combined Scottish and Irish Groundfish Survey – numbers-at-age per hour									
Variance									
Year	Effort	Age							
	(hours)	0	1	2	3	4	5	6	7+
1996	1	13802654.4	28791.0	1511.8	116.4	7.7	1.2	0.0	0.0
1997	1	503549.8	52750.2	2250.0	88.0	7.5	0.3	0.0	0.0
1998	1	51926.4	41240.3	4136.9	36.9	5.9	0.4	0.0	0.0
1999	1	696436.9	5025.7	904.9	17.2	1.7	0.5	0.0	0.0
2000	1	710042.2	80593.8	2267.5	41.2	0.2	0.1	0.0	0.0
2001	1	9203.0	14074.1	11808.5	49.2	1.2	0.3	0.0	0.0
2002	1	474926.4	5227.6	718.7	183.1	0.8	0.1	0.0	0.0
2003	1	27631.5	12731.6	247.4	38.6	3.0	0.1	0.0	0.0
2004	1	5010.9	2090.7	242.5	2.3	0.8	0.3	0.0	0.0
2005	1	2757.1	251.2	78.5	3.8	0.1	0.0	0.0	0.0
2006	1	2761.4	135.1	30.6	5.0	0.4	0.0	0.0	0.0
2007	1	1053.9	183.5	63.9	4.5	0.7	0.2	0.0	0.0
2008	1	75.6	98.1	18.1	11.5	0.6	0.3	0.0	0.0
2009	1	186968.9	32.7	12.7	1.2	0.3	0.0	0.0	0.0
2010	1	1318.7	10785.8	118.5	6.6	0.9	0.1	0.0	0.0
2011	1	22015.9	64.1	1135.1	14.5	1.6	0.2	0.1	0.0
2012	1	1072.7	3207.9	120.1	156.4	7.8	0.2	0.0	0.0
2013	1	547663.6	105.2	466.5	34.0	31.0	0.9	0.0	0.0
2014	1	5504945.1	2751.6	88.9	52.1	3.3	1.7	0.1	0.0
2015	1	45158.0	29135.7	580.9	31.2	13.6	0.6	0.2	0.0
2016	1	27390.7	4501.4	3657.3	57.9	2.7	3.1	0.1	0.1
2017	1	39781.0	1500.3	643.5	534.3	12.0	0.2	0.1	0.0
2018	1	666403.1	934.4	400.3	58.6	14.0	0.3	0.0	0.0
2019	1	655483.7	9093.9	88.3	19.8	3.3	0.4	0.0	0.0
2020	1	158671.1	9975.1	1333.3	22.8	5.4	0.5	0.1	0.0
2021	1	190708.3	784.4	1033.5	47.0	1.9	0.7	0.1	0.0

Table 35.12. Whiting in Division 6.a. SAM configuration settings for assessment of 6.a whiting agreed at WKNSEA 2021.

Model Setting	Setting name	Configuration & details
Minimum age in model	$minage	0
Maximum age in model	$maxAge	7
Maximum age plus group	$maxAgePlusGroup	Maximum age plus group applies to both the commercial catch data and modelled Q4 survey index
Coupling of the fishing mortality states processes	$keyLogFsta	Uncoupled across all age classes
Correlation of fishing mortality across ages	$corFlag	AR(1) first order autoregressive
Coupling of the survey catchability parameters	$keyLogFpar	WCIBTS.Q1: ages 1 to 4 uncoupled; ages 5 and 6 coupled SCO.Q1: ages 1 to 4 uncoupled; ages 5 and 6 coupled SWC.Q4: ages 0 to 5 uncoupled; ages 6 and 7+ coupled
Density dependent catchability power parameters	$keyQpow	n/a
Coupling of process variance parameters for *log*(F) process	$keyVarF	Coupled across all age classes
Coupling of the recruitment and survival process variance parameters	$keyVarLogN	Age 0 uncoupled; ages 1 to 7+ coupled
Coupling of the variance parameters for the observations	$keyVarObs	Catch: age 0 uncoupled; ages 1 to 6 coupled; age 7+ uncoupled WCIBTS.Q1: ages 1 to 6 coupled SCO.Q1: ages 1 to 6 coupled SWC.Q4: age 0 uncoupled; ages 1 to 4 coupled; ages 5 to 7+ coupled
Covariance structure for each fleet	$obsCorStruct	Catch: Independent (”ID”) WCIBTS.Q1: ”ID” SCO.Q1: ”ID” SWC.Q4: first order autoregressive (”AR1”)
Coupling of correlation parameters for fleet covariance	$keyCorObs	SWC.Q4: ages 0 and 1 coupled; ages 1 to 6 coupled; ages 6 and 7+ coupled
Stock recruitment code	$stockRecruitmentModelCode	0; Plain random walk
Number of years where catch scaling is applied	$noScaledYears	0
Years where catch is scaled	$keyScaledYears	n/a
Matrix specifying the couplings of scale parameters	$keyParScaledYA	n/a
Lowest and highest ages included in $\bar{F}$	$fbarRange	1, 3

Model Setting	Setting name	Configuration & details
Biomass survey configuration	$keyBiomassTreat	n/a
Observational likelihood	$obsLikelihoodFlag	Catch: ”LN” WCIBTS.Q1: ”LN” SCO.Q1: ”LN” SWC.Q4: ”LN”
Observation weighting configuration	$fixVarToWeight	0
Fraction of t(3) distribution used in logF increment distribution	$fracMixF	0
Fraction of t(3) distribution used in logN increment distribution	$fracMixN	0
Fraction of t(3) distribution used in distribution of fleets	$fracMixObs	Catch: 0 WCIBTS.Q1: 0 SCO.Q1: 0 SWC.Q4: 0
Break years between which recruitment is constant	$constRecBreaks	n/a
Coupling of parameters used in a prediction-variance link for observations	$predVarObsLink	n/a

Table 35.13. Whiting in Division 6.a. Parameter estimates from the updated SAM assessment model.

Parameter name	par	sd(par)	exp(par)	Low	High
logFpar_0	-5.904	0.157	0.003	0.002	0.004
logFpar_1	-5.937	0.158	0.003	0.002	0.004
logFpar_2	-6.091	0.161	0.002	0.002	0.003
logFpar_3	-6.199	0.169	0.002	0.001	0.003
logFpar_4	-6.834	0.186	0.001	0.001	0.002
logFpar_5	-5.864	0.239	0.003	0.002	0.005
logFpar_6	-5.677	0.253	0.003	0.002	0.006
logFpar_7	-5.463	0.25	0.004	0.003	0.007
logFpar_8	-5.672	0.26	0.003	0.002	0.006
logFpar_9	-6.289	0.259	0.002	0.001	0.003
logFpar_10	-4.782	0.222	0.008	0.005	0.013
logFpar_11	-5.152	0.183	0.006	0.004	0.008
logFpar_12	-5.142	0.182	0.006	0.004	0.008
logFpar_13	-5.535	0.187	0.004	0.003	0.006
logFpar_14	-5.935	0.206	0.003	0.002	0.004
logFpar_15	-6.221	0.253	0.002	0.001	0.003
logFpar_16	-7.026	0.302	0.001	0	0.002
logSdLogFsta_0	-1.025	0.141	0.359	0.271	0.475
logSdLogN_0	-0.518	0.165	0.596	0.428	0.828
logSdLogN_1	-1.776	0.257	0.169	0.101	0.283
logSdLogObs_0	-0.15	0.205	0.861	0.571	1.297
logSdLogObs_1	-1.033	0.078	0.356	0.304	0.416
logSdLogObs_2	-0.579	0.165	0.56	0.403	0.78
logSdLogObs_3	-0.332	0.066	0.717	0.629	0.818
logSdLogObs_4	0.745	0.099	2.107	1.729	2.567
logSdLogObs_5	0.974	0.15	2.648	1.96	3.576
logSdLogObs_6	0.797	0.133	2.218	1.701	2.893
logSdLogObs_7	1.172	0.101	3.228	2.635	3.954
transfIRARdist_0	3.39	1212.843	29.662	0	Inf
transfIRARdist_1	-0.947	0.301	0.388	0.212	0.709
transfIRARdist_2	1.595	2.195	4.929	0.061	397.639
itrans_rho_0	1.565	0.195	4.785	3.24	7.067

*** The relatively large standard deviation (and associated uncertainty) around the estimate of transfIRARdist_0, the coupled AR1 parameter for ages 0 and 1, indicates a weak to non-existent level of autocorrelation between age groups 0 and 1.**

Table 35.14. Whiting in Division 6.a. SAM estimated population numbers-at-age (thousands).

	Age							
Year	0	1	2	3	4	5	6	7+
1981	792418	193653	467016	80851	22098	6848	2073	1698
1982	816452	270104	70817	208307	35534	9460	2994	1846
1983	1068364	270655	79582	31142	87623	14366	3776	2148
1984	876855	370063	79473	26908	11215	30726	4537	2227
1985	744978	289359	111446	26553	7582	3245	8353	2064
1986	1338213	231131	95963	36063	6987	1626	676	2278
1987	502134	506331	87467	36869	12398	2112	474	1117
1988	752010	145880	157505	31655	11132	3334	501	540
1989	651153	251470	38874	45431	9925	2593	688	291
1990	852259	202756	88564	11157	12736	2876	572	261
1991	1131396	279056	65336	39039	4010	4238	924	305
1992	767342	391116	97846	24148	16014	1436	1343	469
1993	782199	243165	134805	35727	8756	6116	501	715
1994	755541	259288	88621	51249	13297	3096	2157	527
1995	682976	251299	101668	37070	18635	4711	1090	1077
1996	640194	222335	91449	37763	13506	5846	1521	873
1997	654177	198282	66622	32589	11676	3721	1430	840
1998	398209	218410	62625	20507	10947	3214	1015	912
1999	865524	113711	64480	15663	5400	2823	661	661
2000	326837	311800	37386	16690	3439	1235	620	454
2001	204756	92571	87084	11463	3589	833	262	335
2002	274808	62080	33075	26024	3676	1081	231	254
2003	214958	87095	16699	12139	7615	1335	417	219
2004	118957	71387	27011	5176	4062	2768	488	332
2005	109455	35075	20933	8354	1540	1282	957	400
2006	68001	36103	12326	8171	3334	687	626	749
2007	60957	20606	13804	5516	3434	1584	342	787
2008	103708	19403	7553	6661	2560	1739	746	638
2009	303805	35430	8788	3805	3386	1285	914	776
2010	95360	114222	14490	4472	1884	1857	661	1001

	Age							
Year	0	1	2	3	4	5	6	7+
2011	200140	26096	42496	7282	2331	924	1047	887
2012	108065	70825	11253	19228	4603	1137	530	1045
2013	243043	33420	25621	6616	10084	2338	659	911
2014	447703	79396	9898	10977	3909	4805	1347	984
2015	307589	150437	26402	6299	6507	2227	3000	1439
2016	261930	97065	64831	12813	3486	3699	1300	2621
2017	194799	90460	37284	33126	6894	2038	2024	2046
2018	396956	57931	36790	19429	16009	3709	1060	2101
2019	433379	140808	22105	18357	10308	7759	2098	1681
2020	199449	157652	50896	11837	10333	5528	4388	2012
2021	273676	60682	57372	23059	6912	6179	3266	3921

Table 35.15. Whiting in Division 6.a. SAM estimates for F-at-age

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	0.022	0.06	0.128	0.221	0.279	0.318	0.343	0.178
1982	0.033	0.093	0.194	0.315	0.38	0.424	0.454	0.232
1983	0.046	0.135	0.291	0.471	0.565	0.635	0.675	0.335
1984	0.054	0.161	0.364	0.602	0.74	0.835	0.901	0.437
1985	0.058	0.174	0.421	0.714	0.932	1.068	1.171	0.548
1986	0.045	0.132	0.312	0.495	0.643	0.743	0.842	0.393
1987	0.069	0.211	0.455	0.647	0.811	0.938	1.05	0.468
1988	0.083	0.259	0.537	0.719	0.908	1.074	1.177	0.512
1989	0.075	0.232	0.483	0.651	0.801	0.963	1.032	0.439
1990	0.055	0.167	0.333	0.445	0.544	0.641	0.663	0.285
1991	0.055	0.166	0.337	0.452	0.54	0.613	0.611	0.263
1992	0.053	0.16	0.324	0.437	0.515	0.566	0.554	0.241
1993	0.044	0.13	0.272	0.399	0.505	0.57	0.554	0.237
1994	0.04	0.117	0.245	0.37	0.478	0.536	0.518	0.217
1995	0.051	0.155	0.314	0.457	0.575	0.635	0.592	0.241
1996	0.07	0.219	0.424	0.609	0.748	0.82	0.716	0.274
1997	0.071	0.221	0.413	0.586	0.688	0.746	0.627	0.23
1998	0.097	0.311	0.567	0.798	0.901	0.992	0.839	0.289
1999	0.094	0.304	0.559	0.827	0.954	1.022	0.88	0.282
2000	0.11	0.359	0.58	0.849	1.004	0.995	0.836	0.252
2001	0.08	0.255	0.408	0.584	0.71	0.67	0.521	0.15
2002	0.082	0.263	0.371	0.497	0.558	0.483	0.333	0.096
2003	0.079	0.251	0.324	0.439	0.484	0.401	0.264	0.076
2004	0.101	0.323	0.364	0.498	0.53	0.419	0.272	0.083
2005	0.058	0.177	0.167	0.226	0.243	0.193	0.13	0.043
2006	0.052	0.161	0.133	0.189	0.224	0.192	0.139	0.048
2007	0.041	0.131	0.101	0.148	0.19	0.17	0.125	0.046
2008	0.034	0.111	0.074	0.109	0.147	0.135	0.098	0.037
2009	0.049	0.171	0.089	0.118	0.15	0.131	0.09	0.034
2010	0.064	0.229	0.103	0.123	0.147	0.131	0.089	0.034

Year	Age 0	1	2	3	4	5	6	7+
2011	0.039	0.14	0.051	0.056	0.064	0.057	0.038	0.015
2012	0.048	0.186	0.059	0.063	0.071	0.065	0.041	0.015
2013	0.058	0.244	0.065	0.065	0.07	0.063	0.04	0.015
2014	0.03	0.122	0.032	0.035	0.04	0.041	0.027	0.01
2015	0.034	0.138	0.04	0.048	0.053	0.056	0.034	0.013
2016	0.027	0.112	0.033	0.039	0.042	0.046	0.025	0.009
2017	0.027	0.119	0.034	0.043	0.046	0.052	0.026	0.008
2018	0.021	0.094	0.027	0.035	0.038	0.039	0.018	0.006
2019	0.026	0.121	0.034	0.046	0.051	0.051	0.021	0.006
2020	0.026	0.122	0.03	0.04	0.045	0.044	0.017	0.005
2021	0.027	0.13	0.033	0.048	0.061	0.064	0.025	0.007

Table 35.16. Whiting in Division 6.a. Assessment summary with weights in tonnes and recruitment in thousands. 'High' and 'Low' refer to 95% confidence intervals.

Year	Recruitment age 0			SSB			Landings*	Discards*	Fishing mortality ages 1-3		
	Low	Value	High	Low	Value	High			Low	Value	High
1981	459996	792418	1365066	77786	108518	151393	12 194	2 132	0.091	0.136	0.204
1982	498421	816452	1337413	68579	91467	121993	13 880	5 485	0.142	0.201	0.283
1983	657345	1068364	1736379	52550	66838	85011	15 962	6 294	0.217	0.299	0.412
1984	539881	876855	1424156	37862	46702	57605	16 459	4 017	0.275	0.375	0.512
1985	451474	744978	1229290	30455	37889	47137	12 879	4 840	0.324	0.436	0.588
1986	807581	1338213	2217501	25504	32190	40629	8 458	2 669	0.228	0.313	0.428
1987	305224	502134	826076	28783	35679	44227	11 542	11 918	0.328	0.438	0.583
1988	446791	752010	1265733	31030	39873	51236	11 349	8 132	0.381	0.505	0.67
1989	402020	651153	1054675	20737	26023	32657	7 523	5 876	0.335	0.455	0.618
1990	529516	852259	1371717	19138	24796	32126	5 642	4 530	0.229	0.315	0.434
1991	700276	1131396	1827931	21377	27048	34224	6 657	4 883	0.233	0.318	0.434
1992	476492	767342	1235727	25955	32522	40749	6 004	9 249	0.224	0.307	0.421
1993	487073	782199	1256149	29801	37808	47966	6 871	4 759	0.193	0.267	0.368
1994	474415	755541	1203255	28991	36153	45084	5 900	3 455	0.176	0.244	0.338
1995	431387	682976	1081293	29491	36487	45144	6 078	5 771	0.227	0.309	0.42
1996	403631	640194	1015406	27181	33447	41156	7 158	7 940	0.31	0.417	0.561
1997	419932	654177	1019088	21653	26670	32849	6 291	5 251	0.3	0.407	0.551
1998	251844	398209	629639	18297	22542	27771	4 628	9 216	0.417	0.559	0.747
1999	547489	865524	1368304	14208	17817	22344	4 613	3 975	0.418	0.563	0.759
2000	207196	326837	515561	12326	15340	19091	3 011	13 285	0.445	0.596	0.798
2001	123439	204756	339642	13389	17587	23100	2 439	4 263	0.298	0.416	0.579
2002	172978	274808	436584	10429	13606	17752	1 768	2 851	0.26	0.377	0.548

Year	Recruitment age 0			SSB			Landings*	Discards*	Fishing mortality ages 1-3		
	Low	Value	High	Low	Value	High			Low	Value	High
2003	138692	214958	333162	7411	9806	12976	1 331	1 987	0.224	0.338	0.511
2004	75301	118957	187922	6531	8857	12011	799	2 889	0.252	0.395	0.621
2005	69310	109455	172852	5175	7333	10389	335	971	0.121	0.19	0.299
2006	42299	68001	109321	4684	6631	9386	378	748	0.105	0.161	0.248
2007	37923	60957	97979	4489	6399	9120	481	367	0.082	0.127	0.195
2008	63495	103708	169388	4067	5848	8409	441	156	0.063	0.098	0.152
2009	182966	303805	504451	4093	5870	8419	480	826	0.082	0.126	0.193
2010	56780	95360	160152	5395	7753	11143	338	1 094	0.097	0.152	0.237
2011	121253	200140	330352	7755	11738	17766	229	631	0.051	0.082	0.134
2012	63597	108065	183626	8077	12242	18557	304	772	0.063	0.103	0.169
2013	143857	243043	410615	8647	13389	20730	216	1 225	0.073	0.125	0.214
2014	266623	447703	751764	7749	11995	18569	181	748	0.037	0.063	0.106
2015	182614	307589	518092	9838	15192	23458	223	1 457	0.045	0.075	0.125
2016	156219	261930	439172	14014	22004	34551	226	1 038	0.036	0.061	0.104
2017	111597	194799	340036	15845	24777	38744	178	1 326	0.039	0.065	0.11
2018	232604	396956	677437	15732	24363	37728	190	648	0.031	0.052	0.088
2019	248326	433379	756332	14861	22780	34917	502	925	0.04	0.067	0.113
2020	102183	199449	389299	16902	26085	40258	544	826	0.036	0.064	0.113
2021	93253	273676	803174	18547	29141	45786	873	262***	0.036	0.07	0.139
2022	108065	273676**	447703	17660	29167	47163					

*** Calculated using Sum of Products from the catch numbers-at-age and mean weights-at-age. Pre-2003 Discards are estimated for ages 1+ only.**

**** Median resampled recruitment (2012–2021).**

***** Underestimate due to reduced discard sampling from the *Nephrops* fleet.**

Table 35.17. Whiting in Division 6.a. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2023)	Projected landings * (2023)	Projected discards ** (2023)	F_{total} (2023)	$F_{projected\ landings}$ (2023)	$F_{projected\ discards}$ (2023)	SSB (2024)	% SSB change ***	% Advice change^
MSY approach = F_{MSY}	4 155	2 081	2 074	0.21	0.043	0.167	25 692	-10.6	1
F = 0	0	0	0	0	0	0	30 665	6.7	-100
$F_{MSY\ lower}$	3 472	1 735	1 737	0.173	0.036	0.137	26 463	-7.9	-15.6
$F_{MSY\ upper}$	4 155	2 081	2 074	0.21	0.043	0.167	25 692	-10.6	1
F_{pa}	4 155	2 081	2 074	0.21	0.043	0.167	25 692	-10.6	1
F_{lim}	5 907	2 978	2 929	0.31	0.064	0.25	23 765	-17.3	44
SSB (2023) = B_{lim}	12 447	6 432	6 015	0.77	0.158	0.61	17 286	-40	200
SSB (2023) = B_{pa}	4 241	2 124	2 117	0.22	0.044	0.171	25 597	-10.90	3.1
SSB (2023) = MSY $B_{trigger}$	4 241	2 124	2 117	0.22	0.044	0.171	25 597	-10.90	3.1
SSB (2024) = SSB (2023)	1 547	766	781	0.074	0.0153	0.059	28 727	0	-62
F = F_{2022}	1 468	728	740	0.070	0.0145	0.055	28 825	0.34	-64

*** Marketable landings, assuming recent discard rate.**

**** Including BMS landings (EU stocks), assuming recent discard rate.**

***** SSB 2024 relative to SSB 2023.**

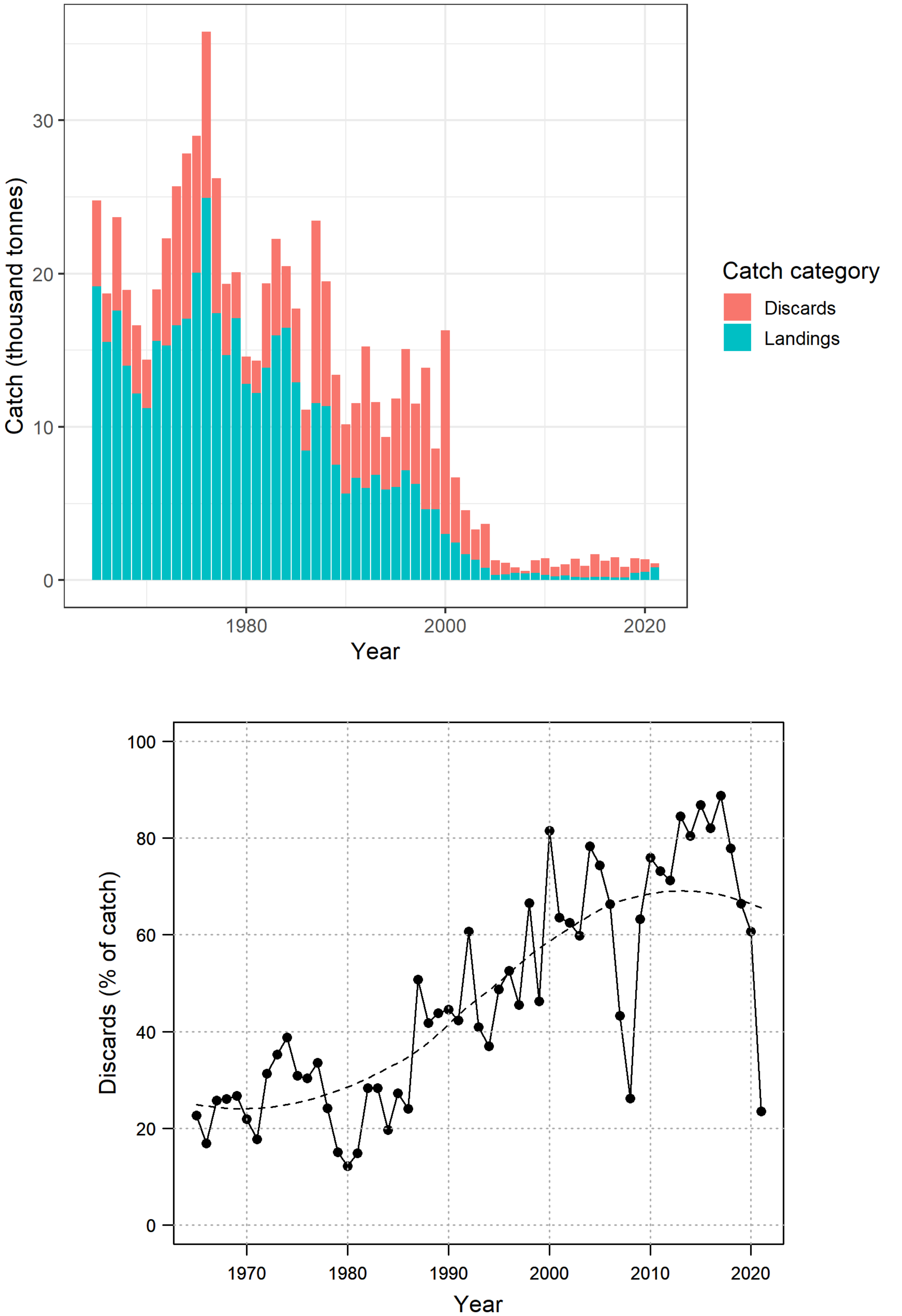


Figure 35.1. Whiting in Division 6.a. Landings and discards (in thousand tonnes) as officially reported to ICES (upper panel) and discards (as % of catch, lower panel). Pre-2003 discards are estimated for ages 1+ only; from 2003 onwards, they are estimated for all ages.

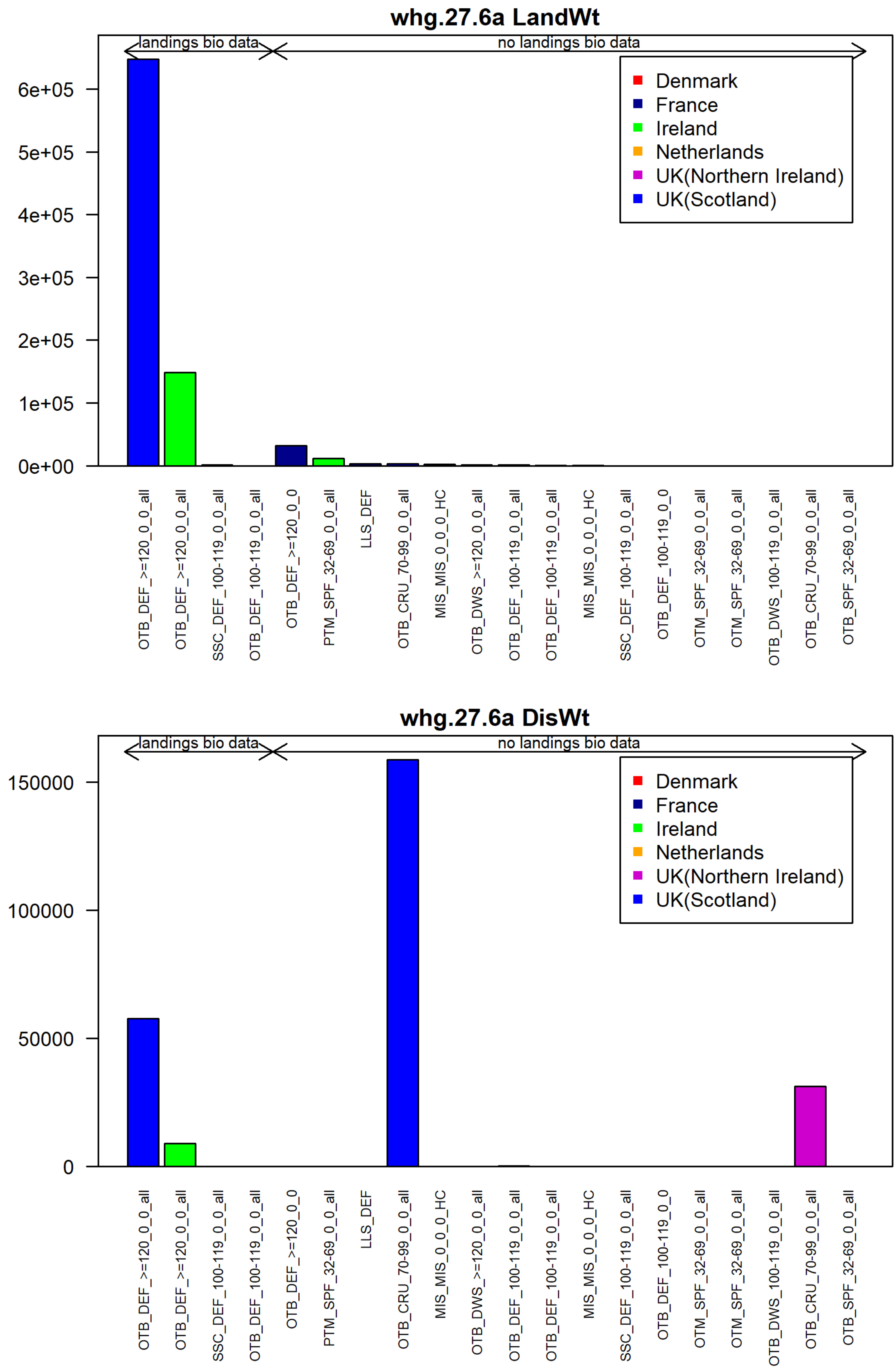


Figure 35.2. Whiting in Division 6.a. Landings (upper panel) and discards (all ages, lower panel) by métier (kg) in 2019 as entered into InterCatch.

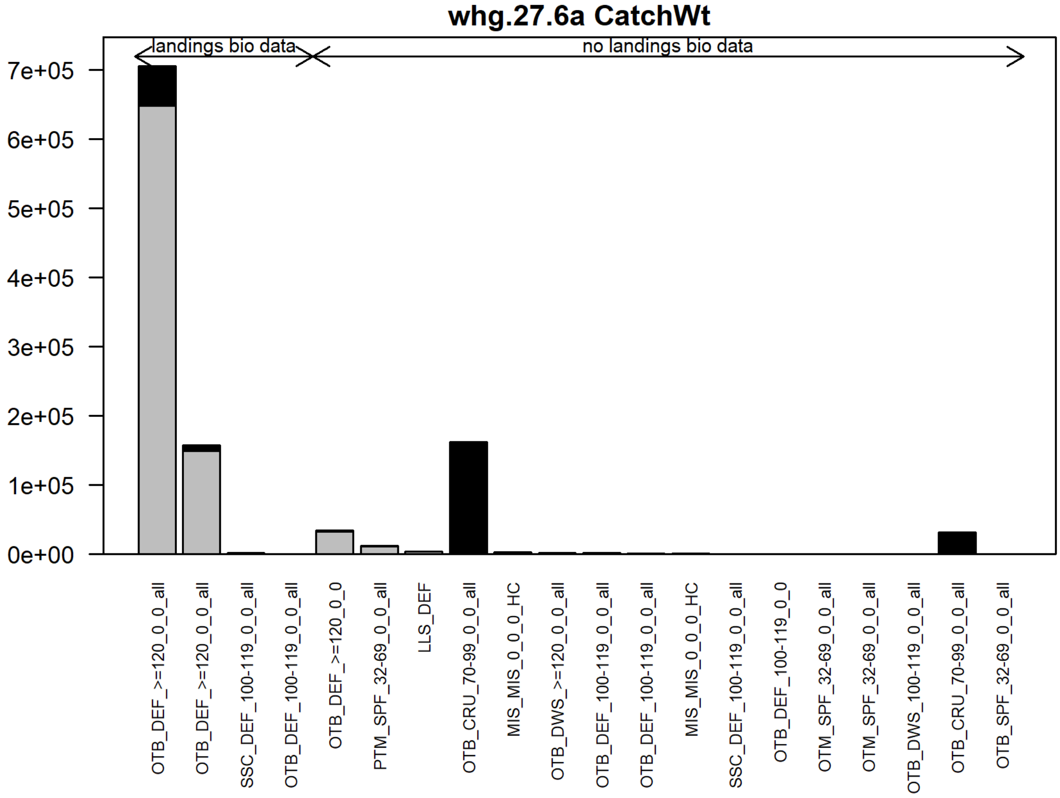


Figure 35.3. Whiting in Division 6.a. Landings (sampled and unsampled, in grey), sampled discards (in black) and raised unsampled discards (in red) after allocations within InterCatch.

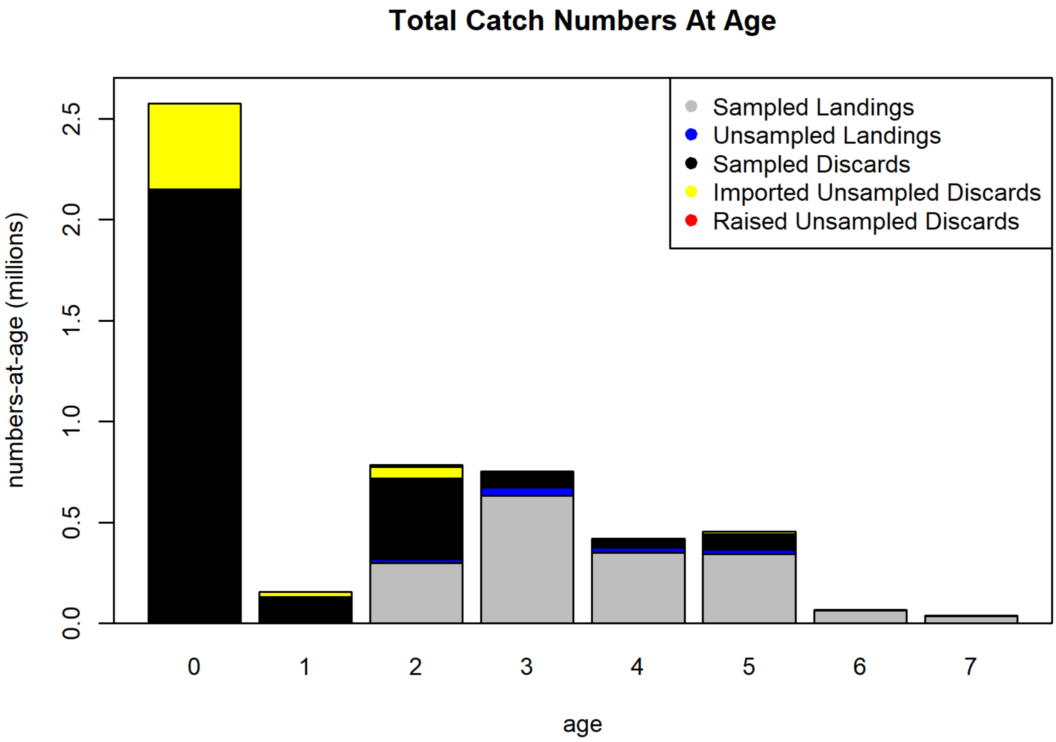


Figure 35.4. Whiting in Division 6.a. Catch numbers-at-age by sampled and unsampled landings and sampled and raised (unsampled) discards, after allocations within InterCatch.

Figure 35.5. Whiting in Division 6.a. Catch numbers-at-age by year.

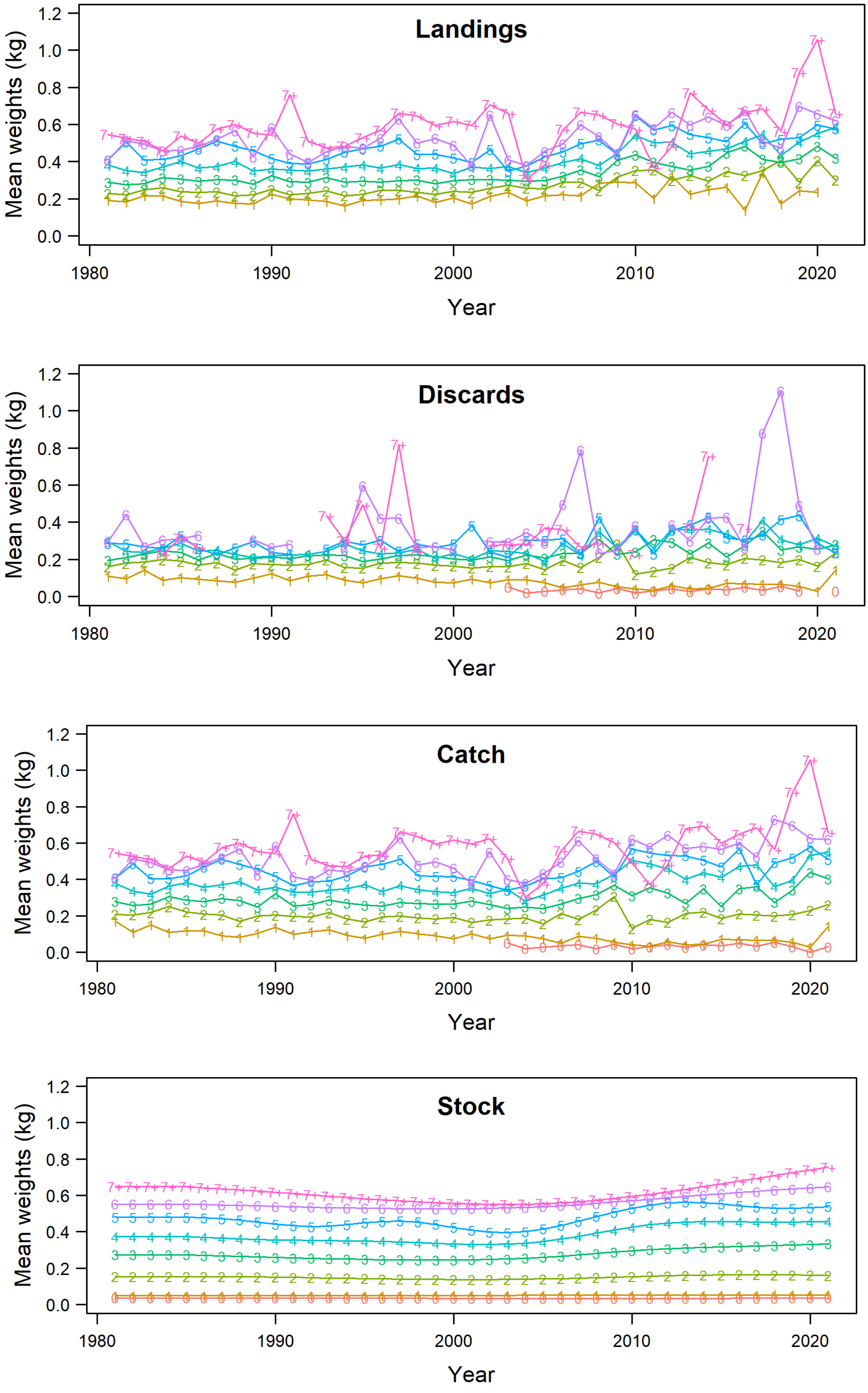


Figure 35.6. Whiting in Division 6.a. Mean weight-at-age in the landings, discards, catch and stock.

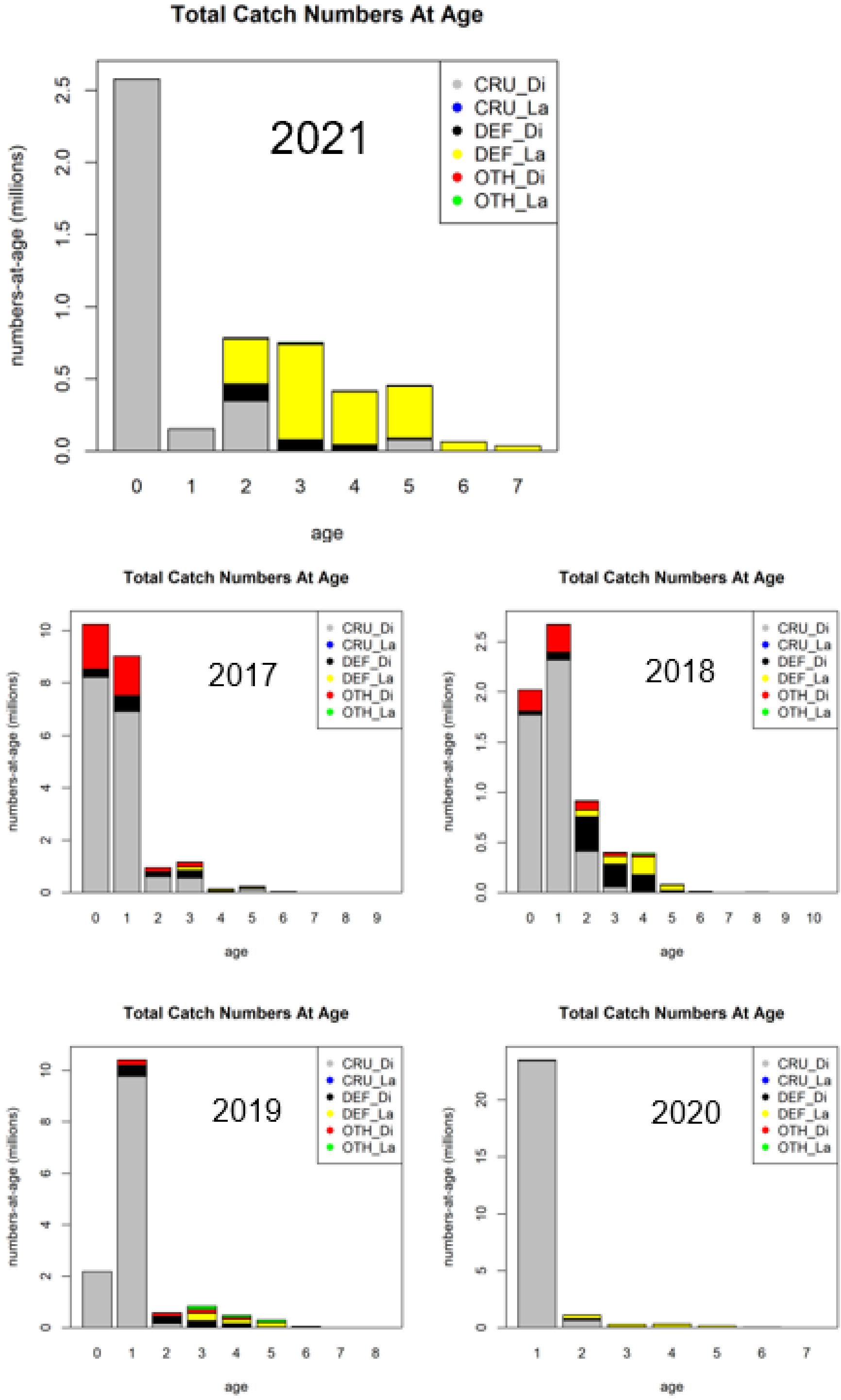


Figure 35.7. Whiting in Division 6.a. Catch numbers-at-age by sampled and un-sampled landings and sampled and raised (unsampled) discards, after allocations within InterCatch, in 2021 and in recent years 2017–2020.

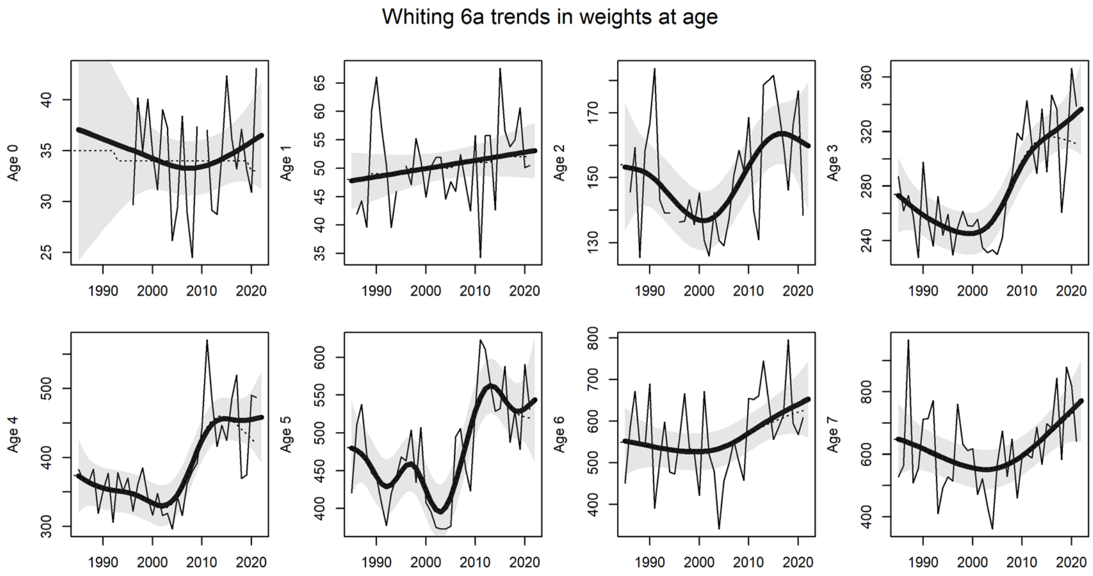


Figure 35.8. Whiting in Division 6.a. Combined Q1 and Q4 survey weights-at-age time-series for 6a whiting, together with catch weights-at-age time-series. Only Q4 surveys contain data for the zero age class. The smoothed estimates were used for M calculation.

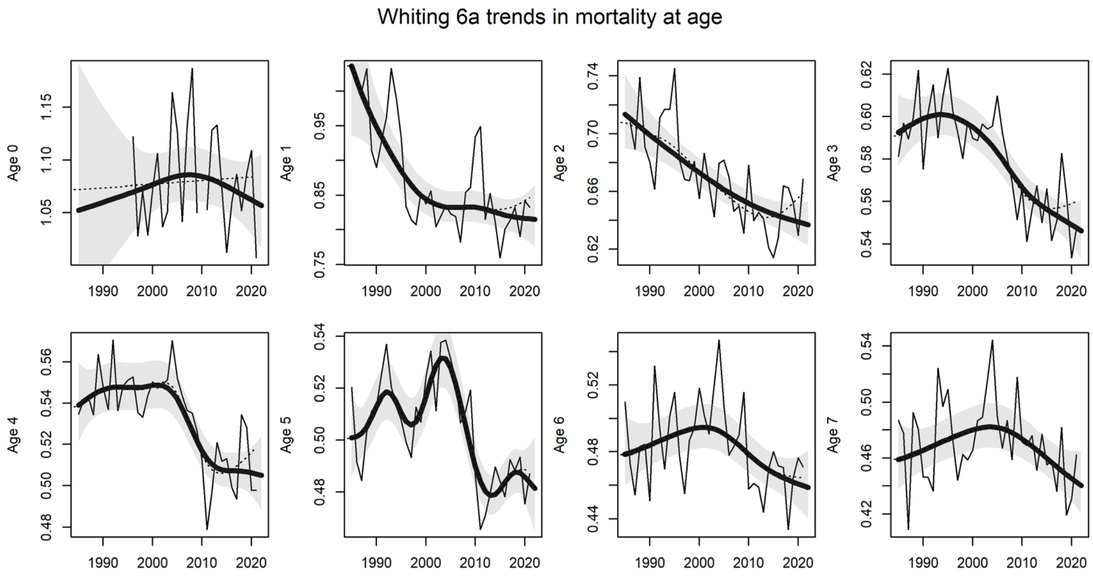


Figure 35.9. Whiting in Division 6.a. Time-series of natural mortality-at-age estimated with Lorenzen's (1996) model. The thick black line shows the natural mortality obtained with the smoothed weights-at-age with the corresponding 95% confidence interval shown in grey. The thin black line shows the natural mortality obtained with unsmoothed weights-at-age, for comparison.

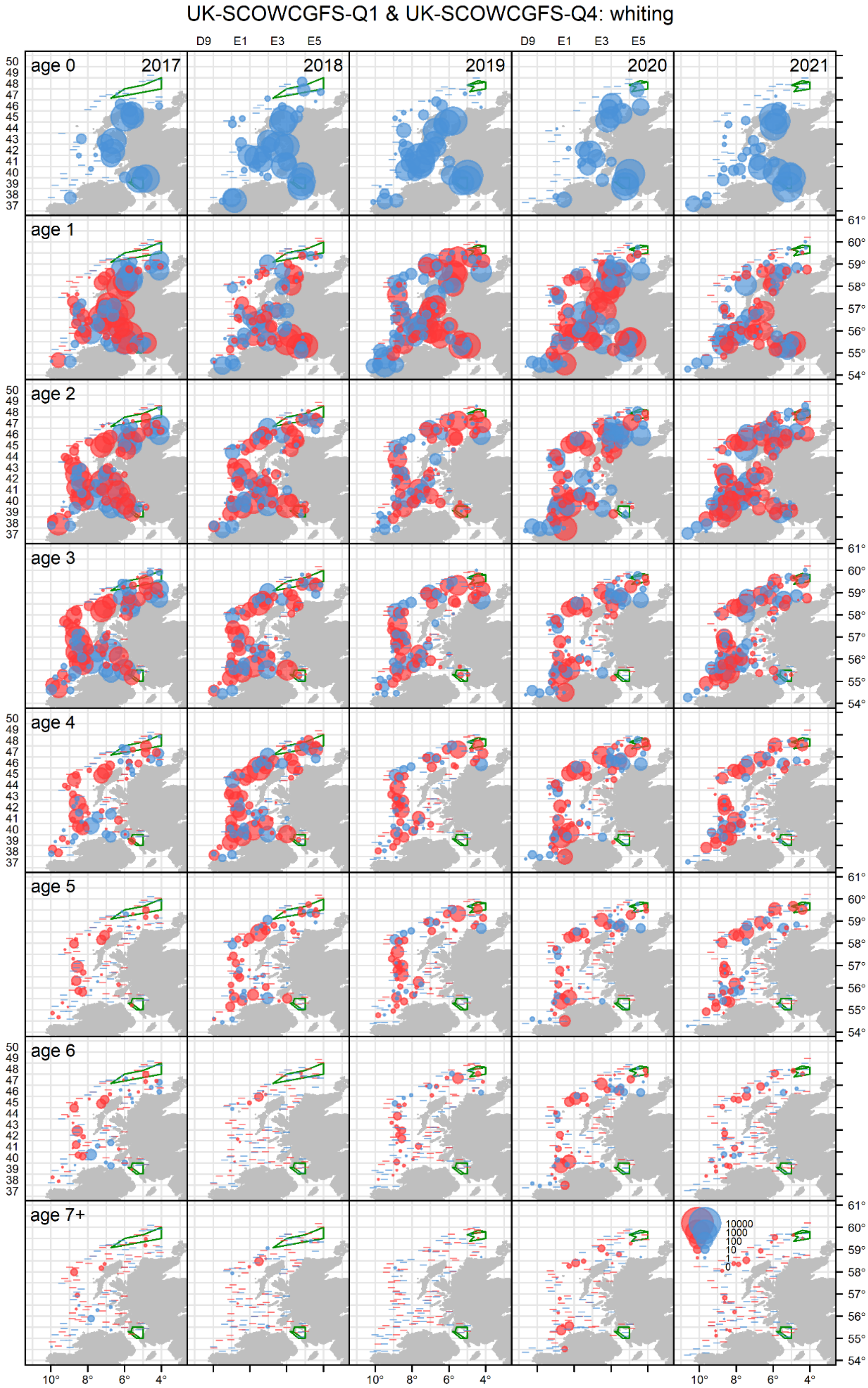


Figure 35.10. Whiting in Division 6.a. CPUE from the Scottish first quarter west coast groundfish survey (UK-SCOWCGFS-Q1, in red) and the Scottish fourth quarter groundfish survey (UK-SCOWCGFS-Q4, in blue) in 2017–2021. Numbers are standardised to 30 minutes towing. The closed areas, the Windsock and West Shetland Shelf in the north, and the Clyde in the south, are shown as green polygons.

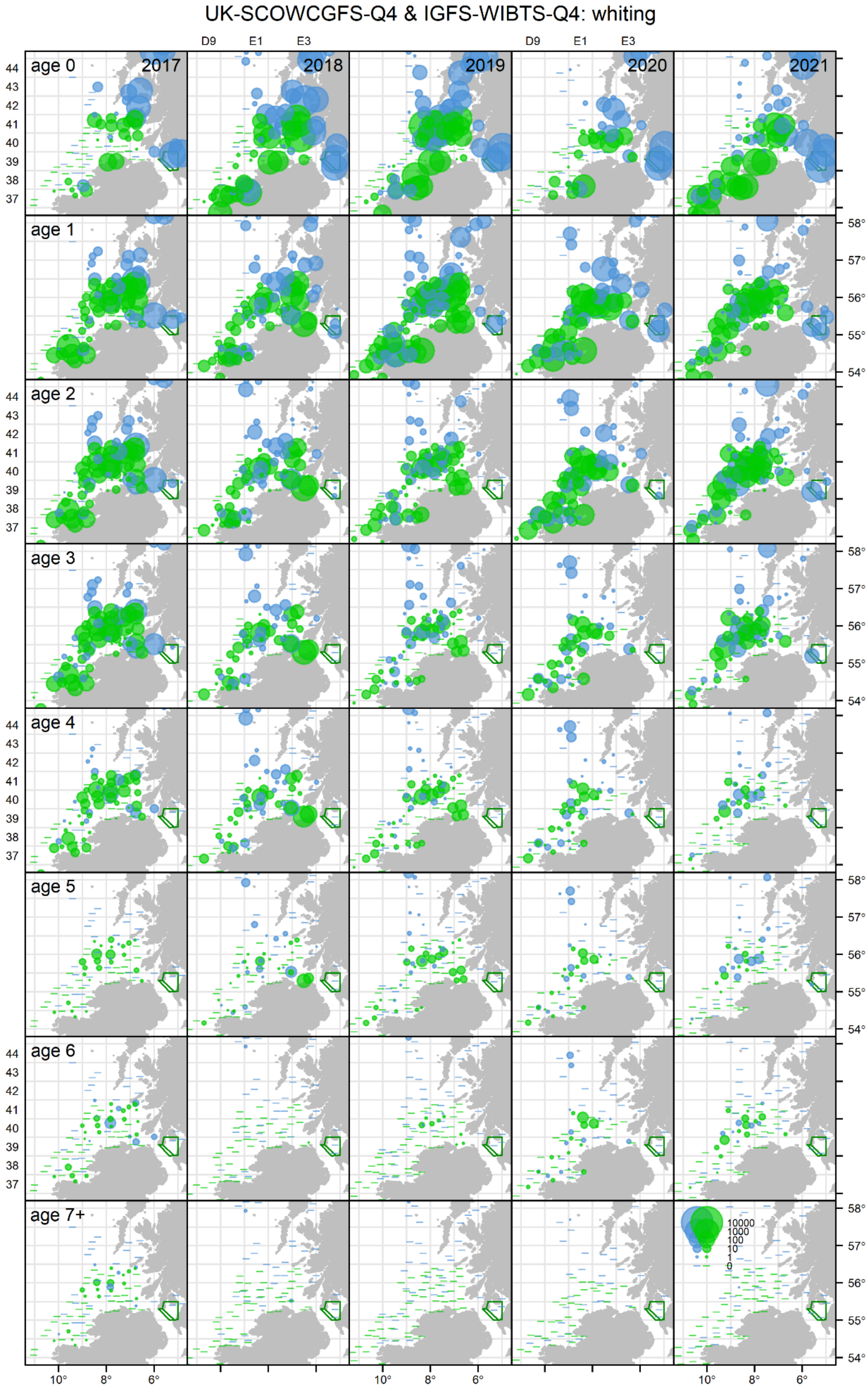


Figure 35.11. Whiting in Division 6.a. CPUE from the Scottish fourth quarter west coast groundfish survey (UK-SCOWCGFS-Q4, only the southern part of the survey area, in blue) and the Irish fourth quarter groundfish survey (IGFS-WIBTS-Q4, in green) in 2017–2021. Numbers are standardised to 30 minutes towing. The Clyde closed area is shown as a green polygon.

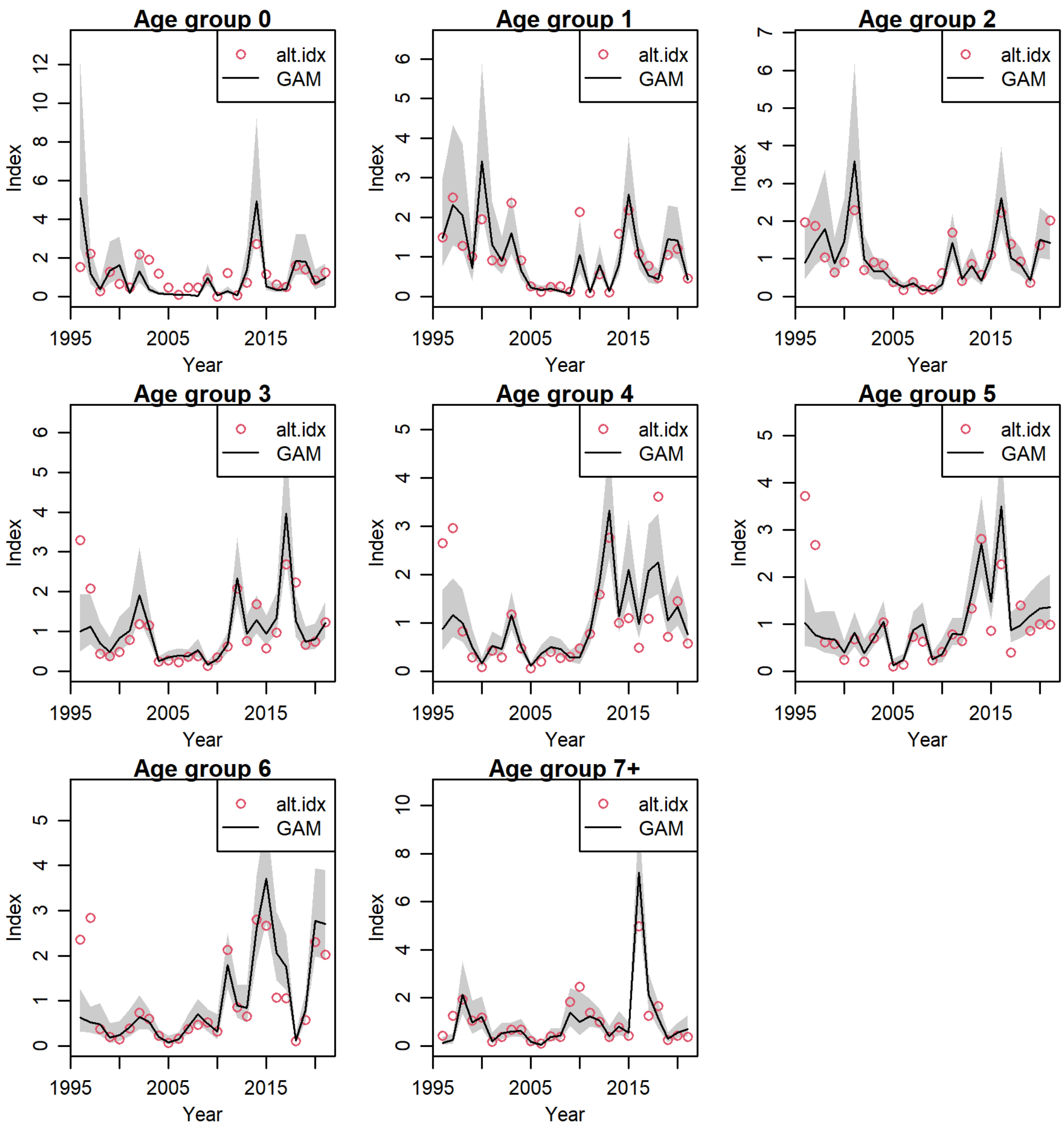


Figure 35.12. Whiting in Division 6.a. The combined index derived from a delta-GAM model fit to data from the three Q4 surveys (black line) with 95% confidence limits (in grey). Indices are derived by summing model predictions on a spatial grid. The survey index calculated using the stratified mean method for ICES statistical rectangles as strata are shown as red points. The indices are mean-standardised.

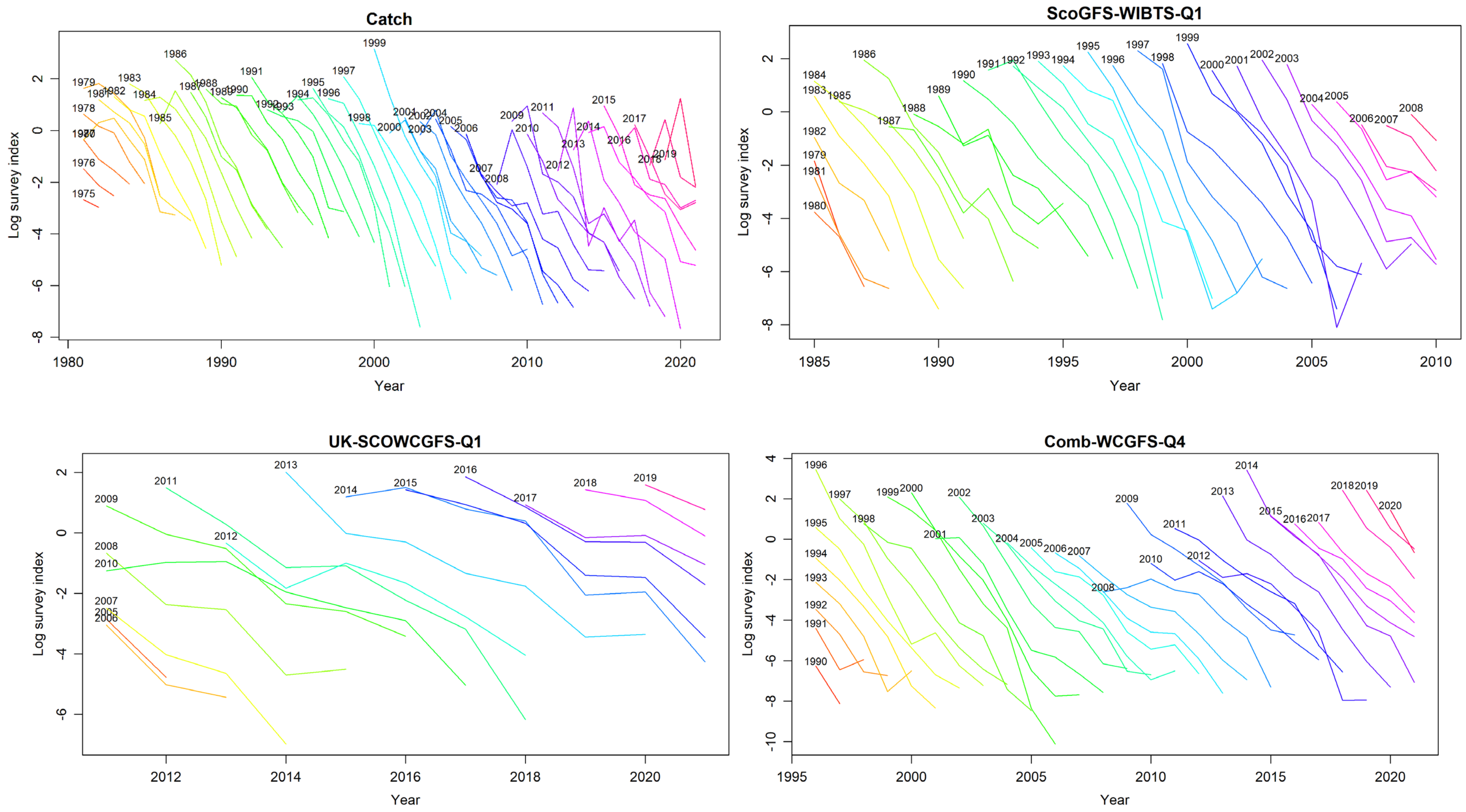


Figure 35.13. Whiting in Division 6.a. Log abundance indices by year with a line for each cohort, for catch and the three survey series. The spawning year of each cohort is indicated at the start of each line. Note the age range 1–7+ in 1981–2002 and 0–7+ in 2003–2021 for the catch data.

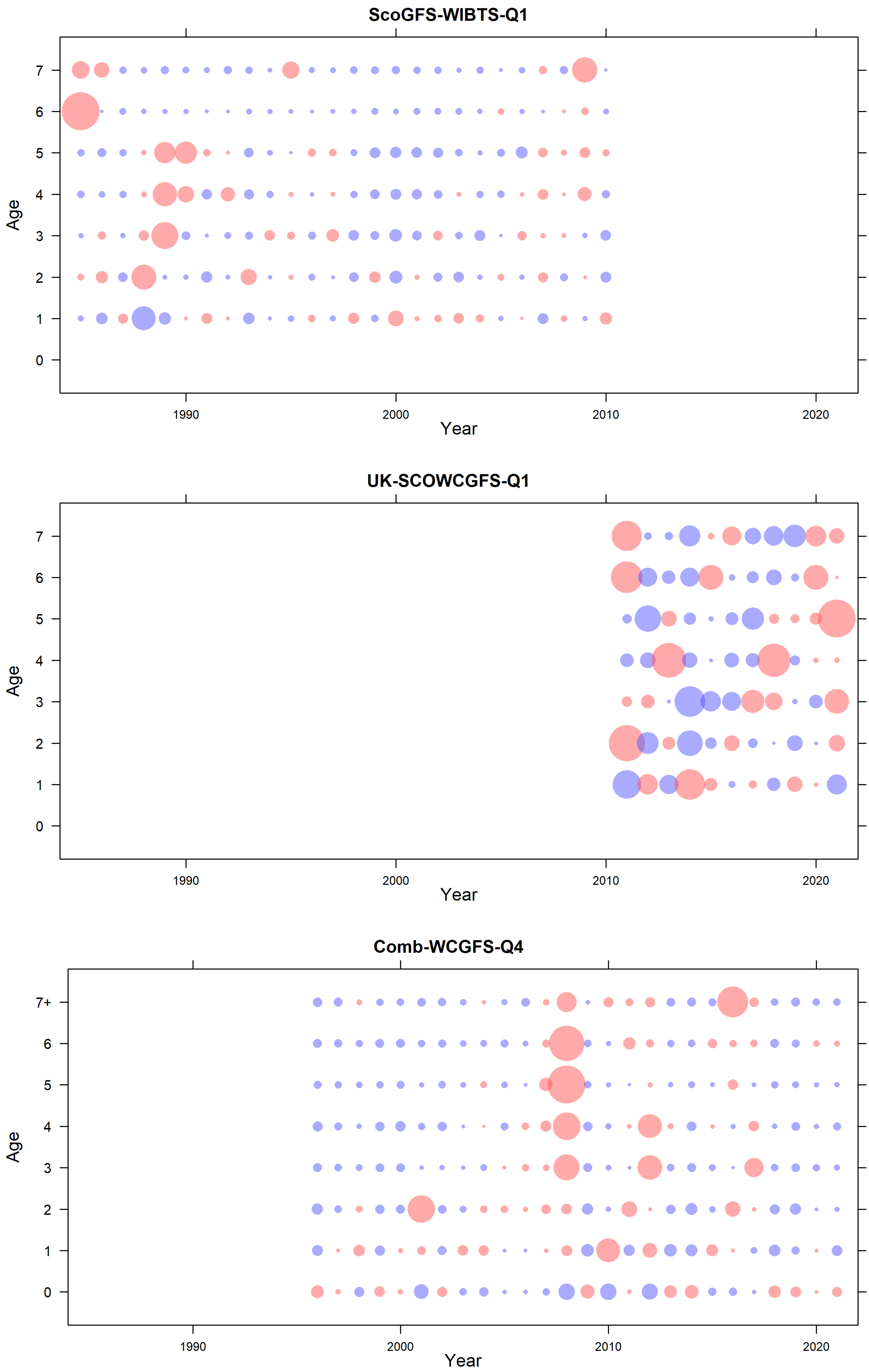


Figure 35.14. Whiting in Division 6.a. Standardised proportions-at-age per year ("spay") for the three survey series. The positive values are shown in red, the negative values are shown in blue.

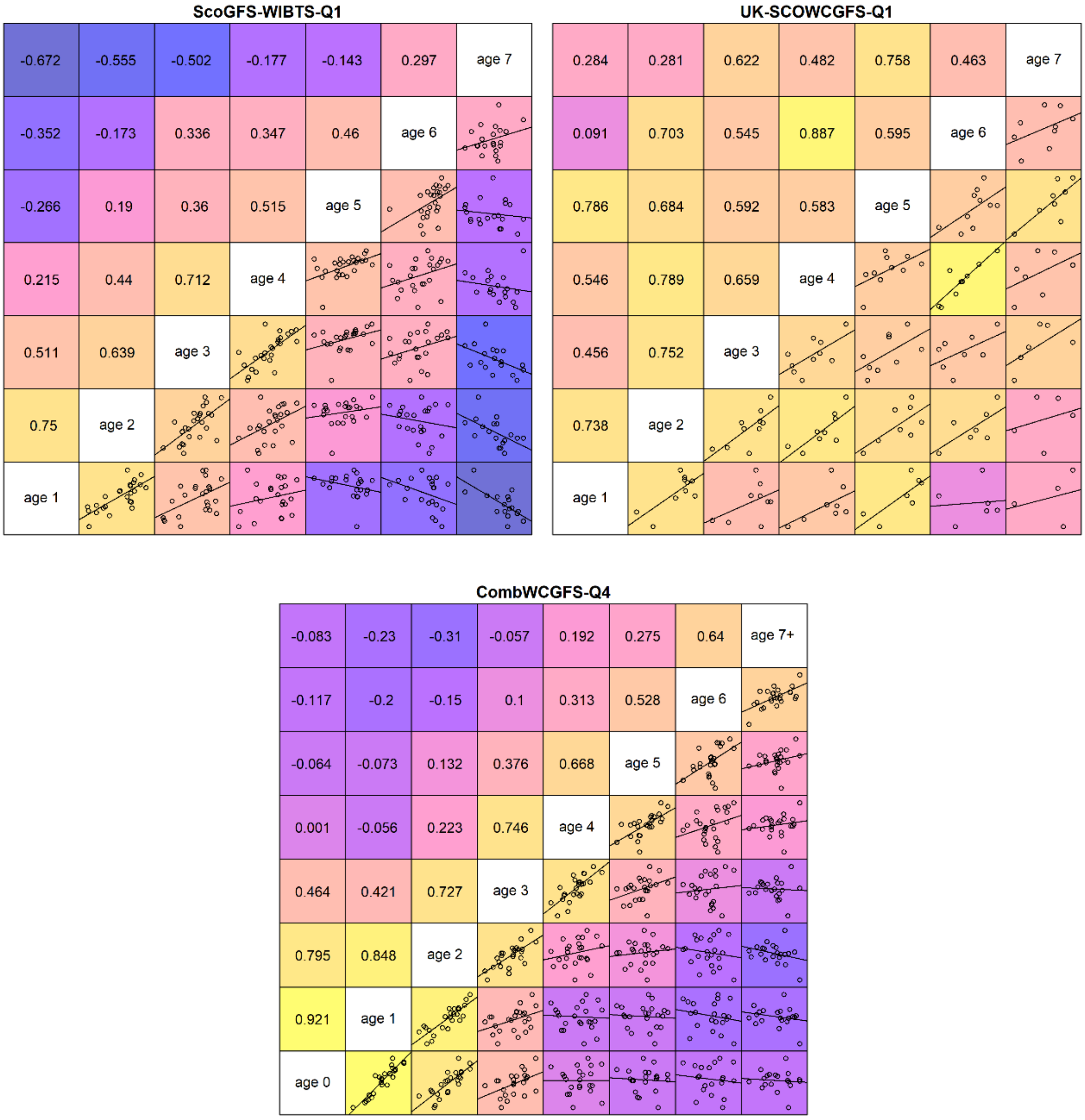


Figure 35.15. Whiting in Division 6.a. Within-survey correlations comparing index values at different ages for the same year classes for the three survey series. The straight line is a linear regression.

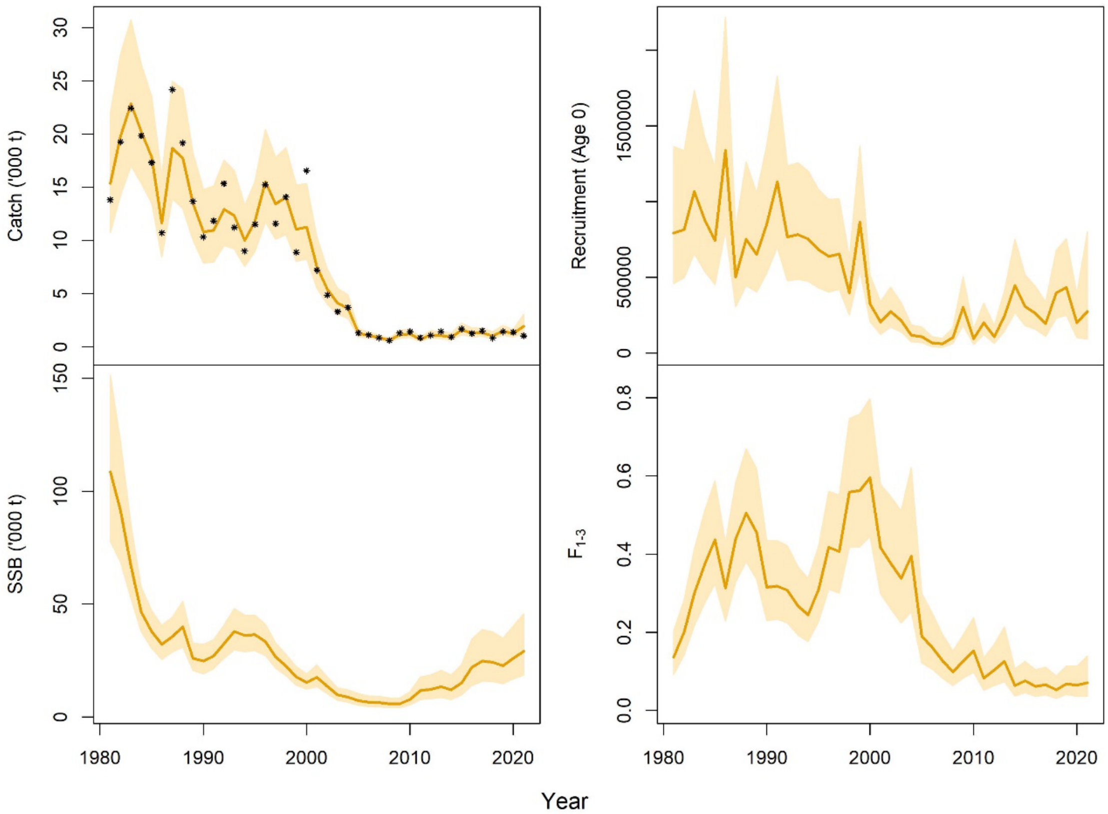


Figure 35.16. Whiting in Division 6.a. Summary of the SAM assessment model estimates (orange line) with 95% confidence intervals (yellow polygon).

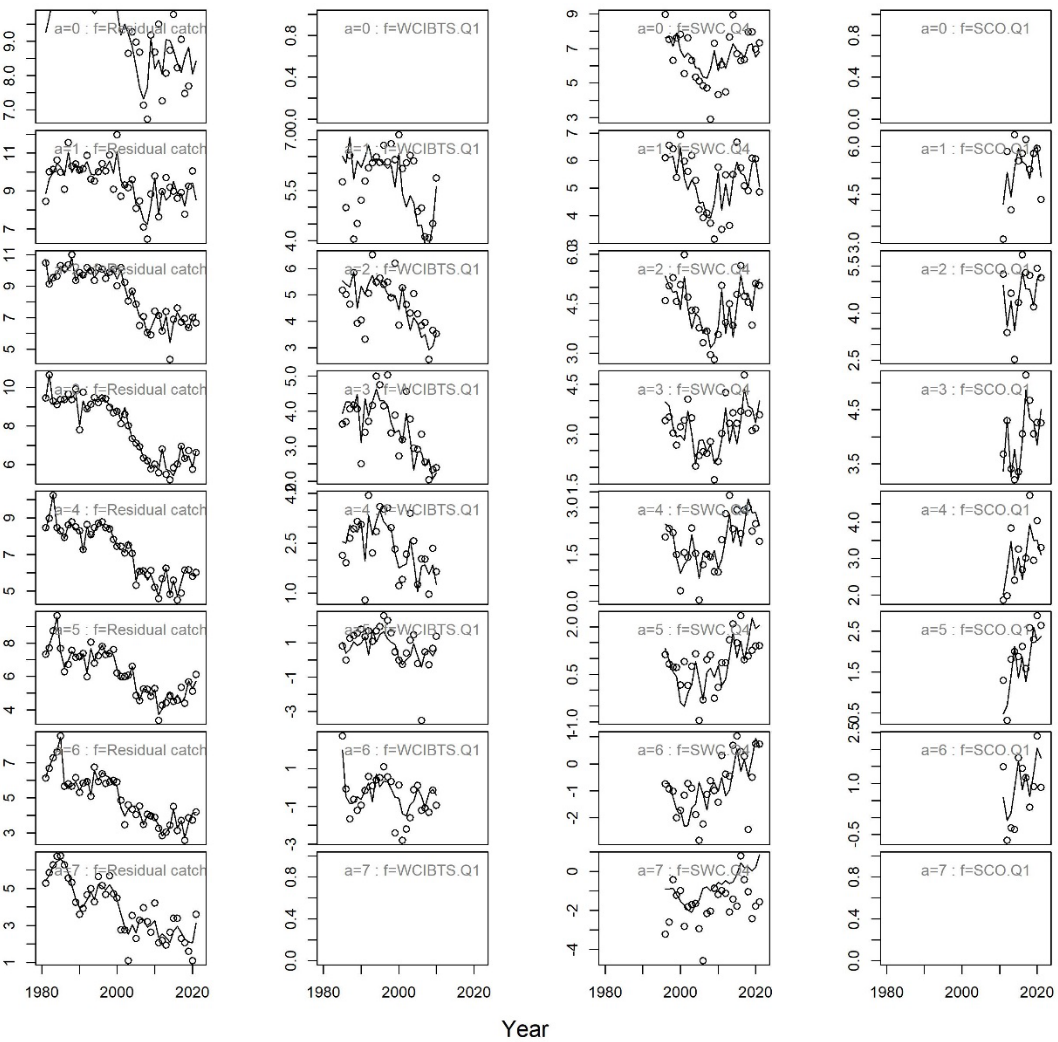


Figure 35.17. Whiting in Division 6.a. Comparison of the SAM assessment model estimates with observed log catch numbers-at-age (first column of panels) and observed log survey indices-at-age for ScoGFS-WIBTS-Q1 (second column), Comb-WCGFS-Q4 (third column), and UK-SCOWCGFS-Q1 (fourth column).

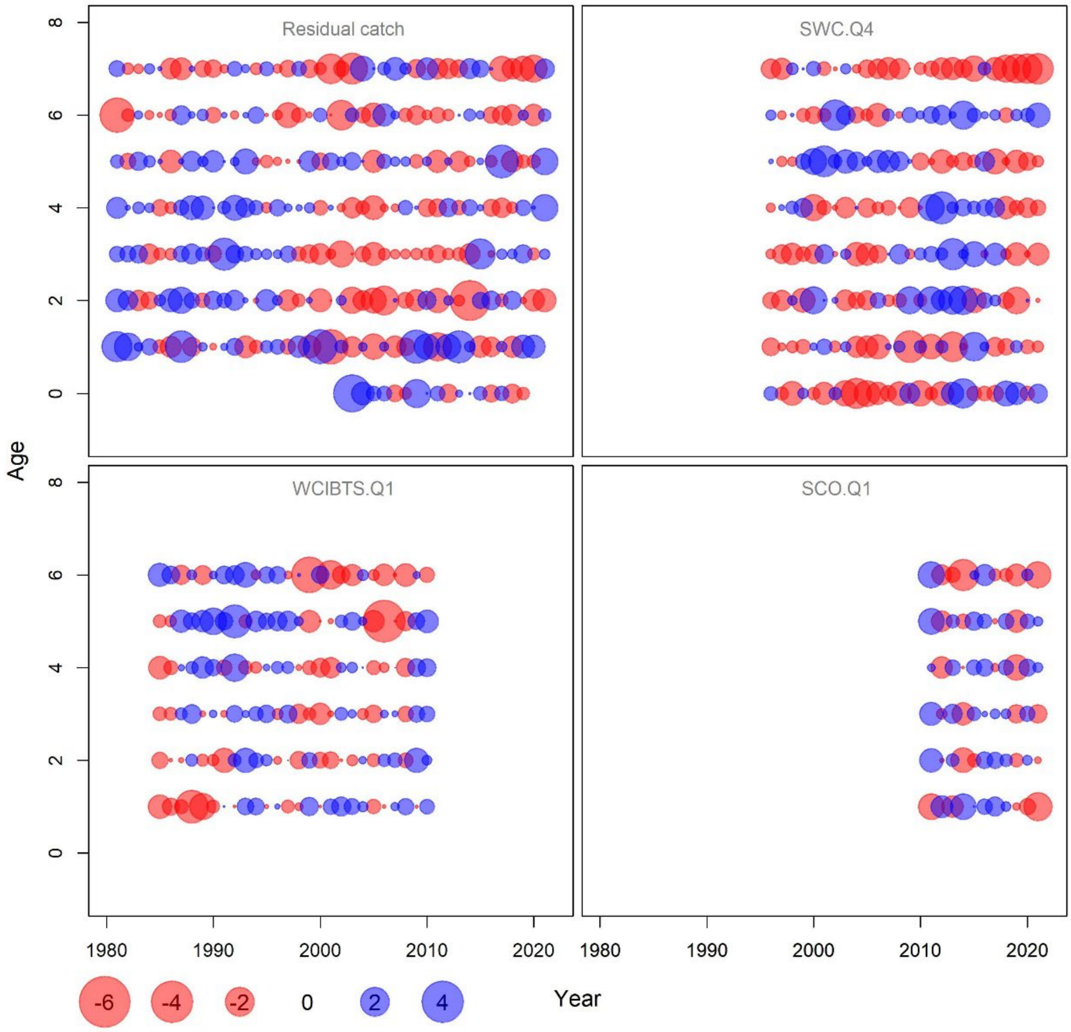


Figure 35.18. Whiting in Division 6.a. Standardized one-observation-ahead residuals-at-age by fleet from the SAM assessment model: catch (top left), ScoGFS-WIBTS-Q1 (bottom left), UK-SCOWCGFS-Q1 (bottom right), and Comb-WCGFS-Q4 (top right).

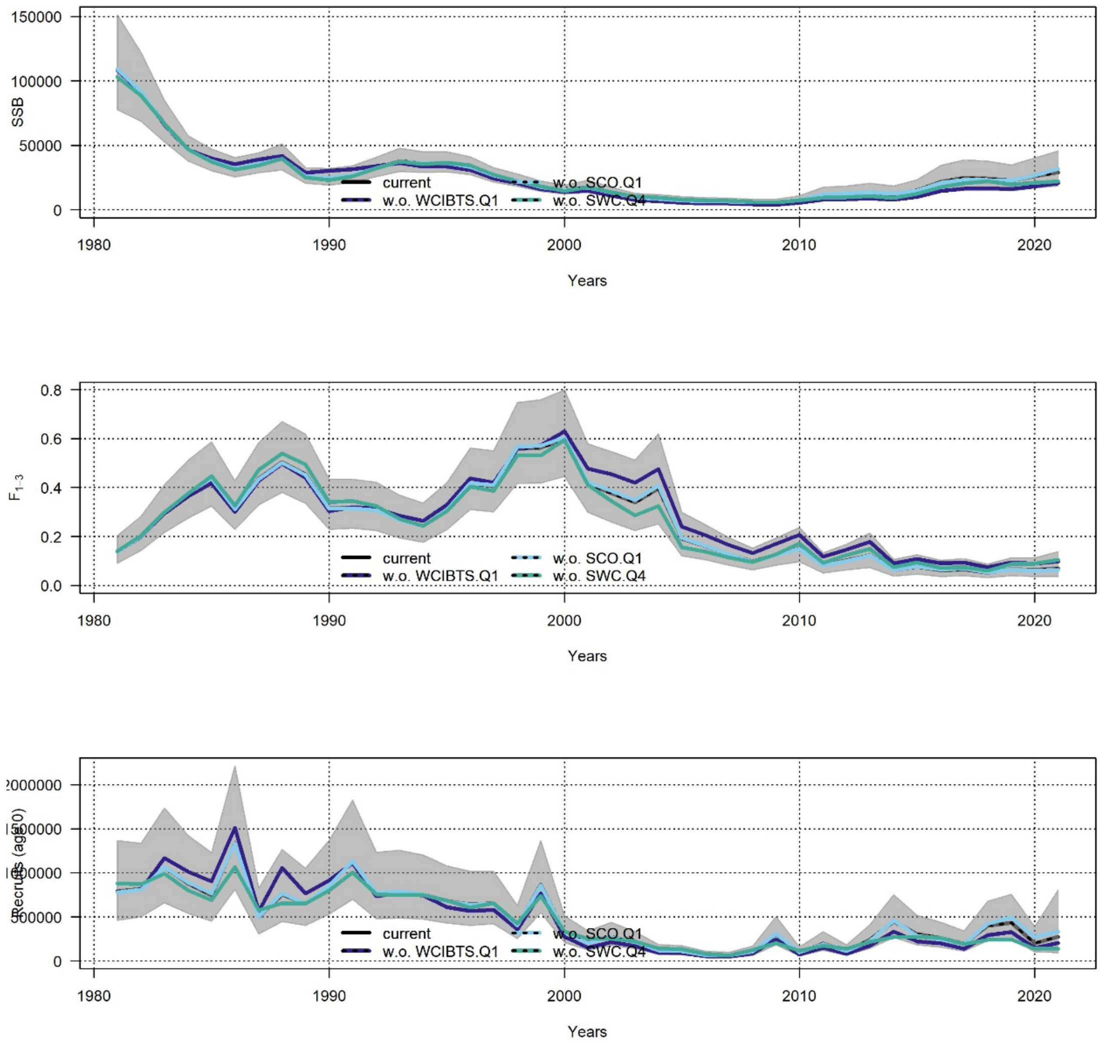


Figure 35.19. Whiting in Division 6.a. Leave-one-out sensitivity analysis of the SAM assessment model.

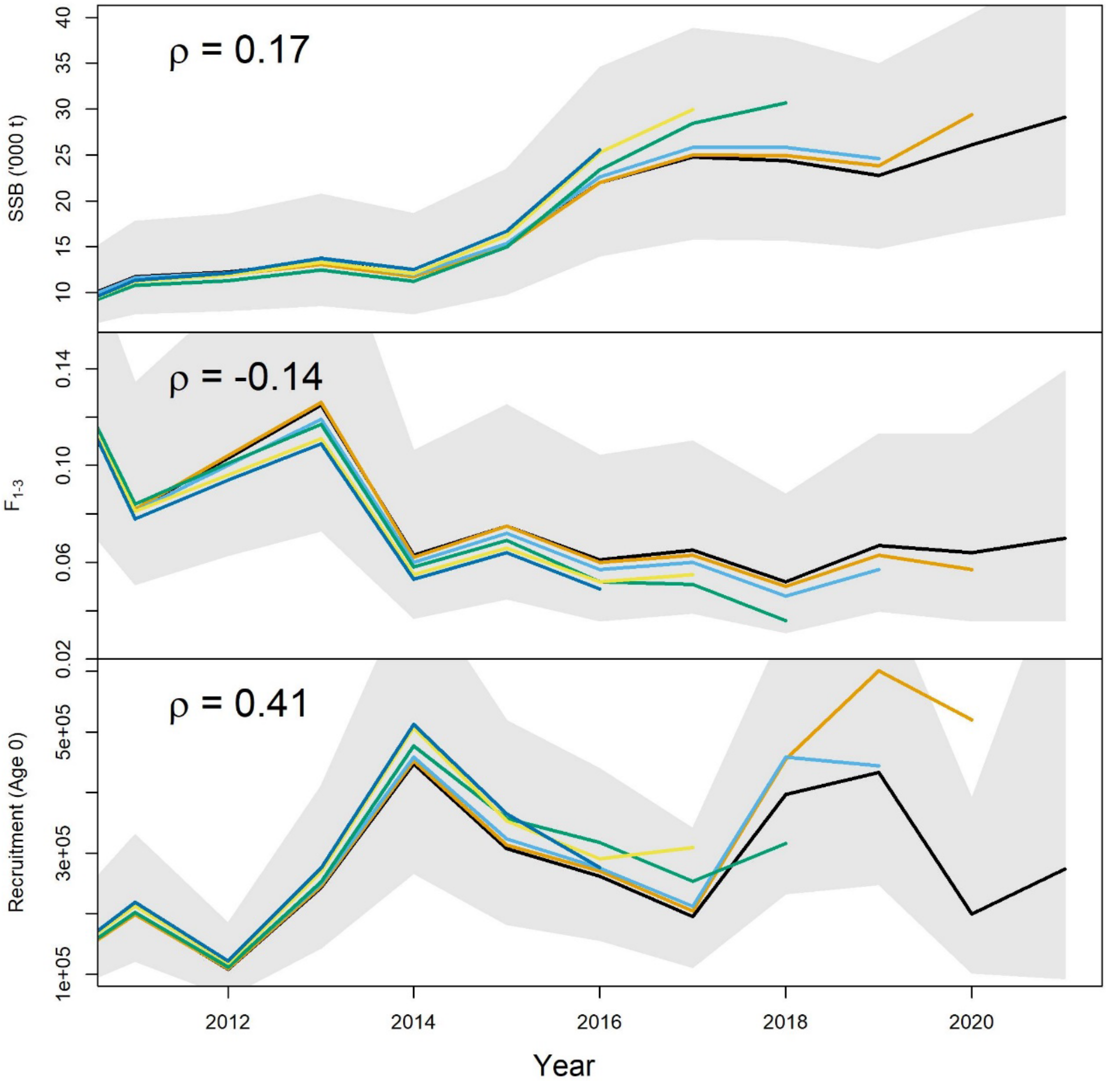


Figure 35.20. Whiting in Division 6.a. Retrospective patterns for the SAM assessment model.

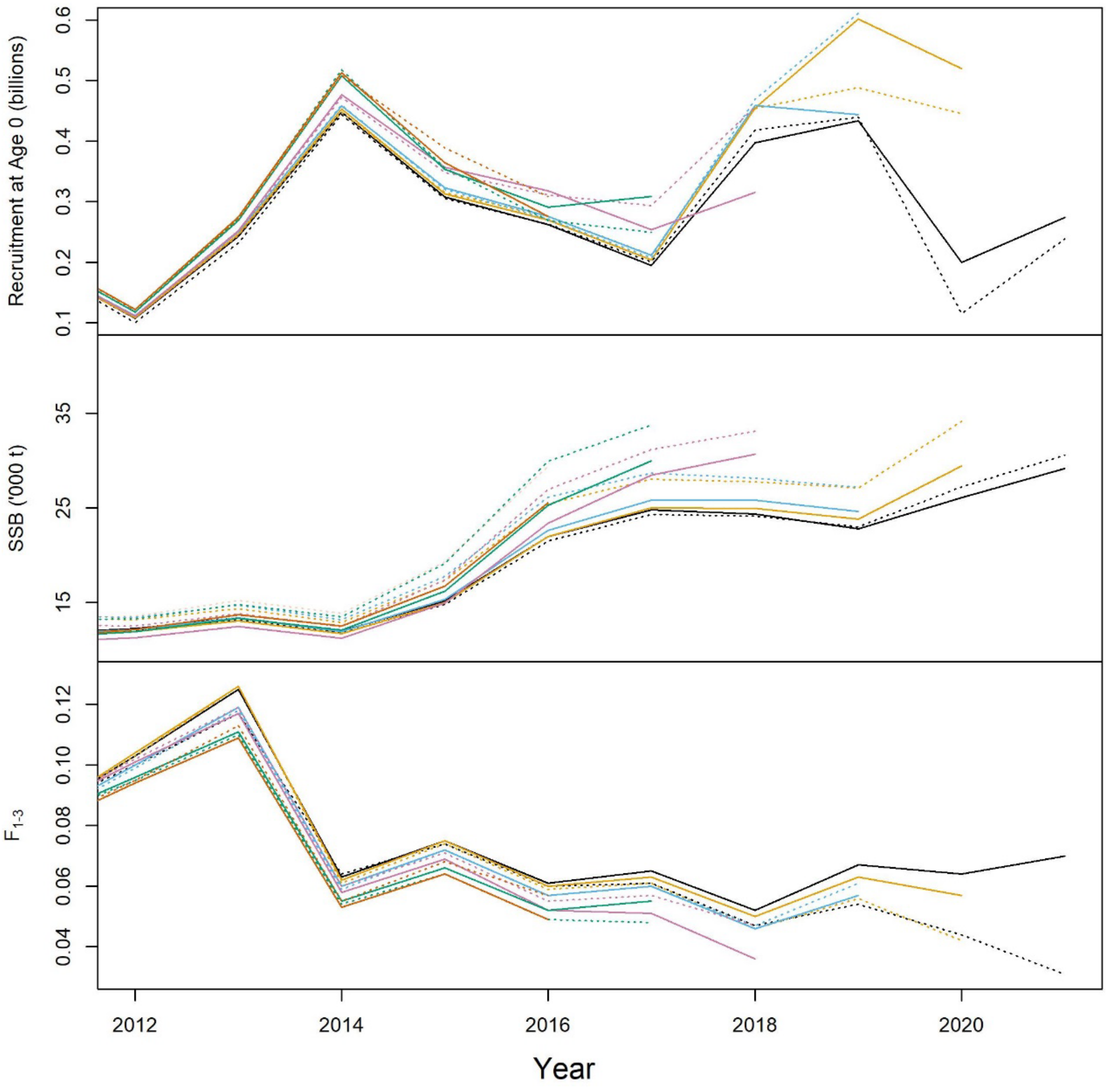


Figure 35.21. Whiting in Division 6.a. Sensitivity analysis investigating the effect of missing catch numbers-at-age zero and one value in the terminal year (solid lines), when compared to the full model retrospective fits (dotted lines).

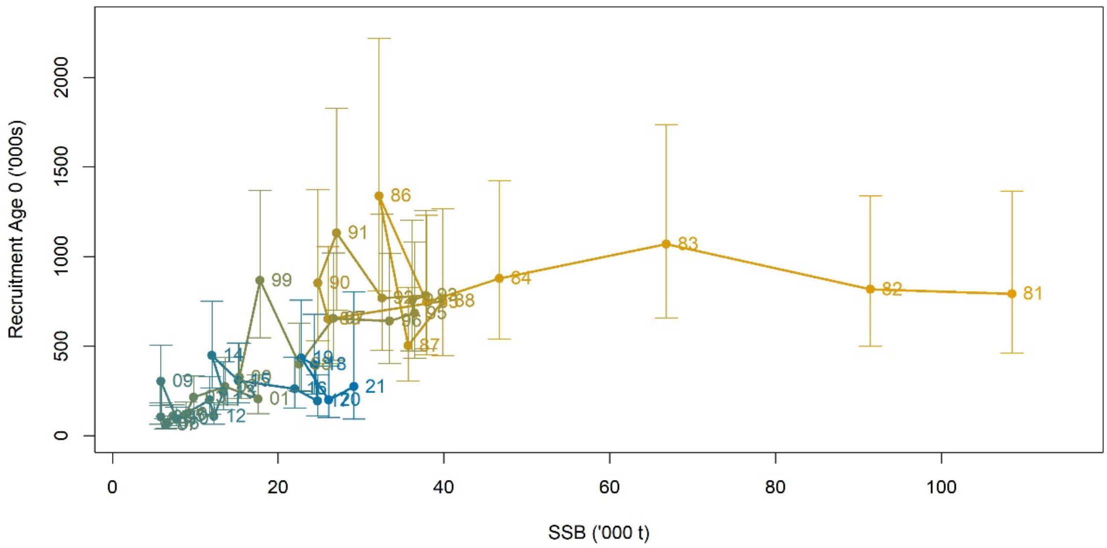


Figure 35.22. Whiting in Division 6.a. The SAM assessment model Stock–Recruit relationship.

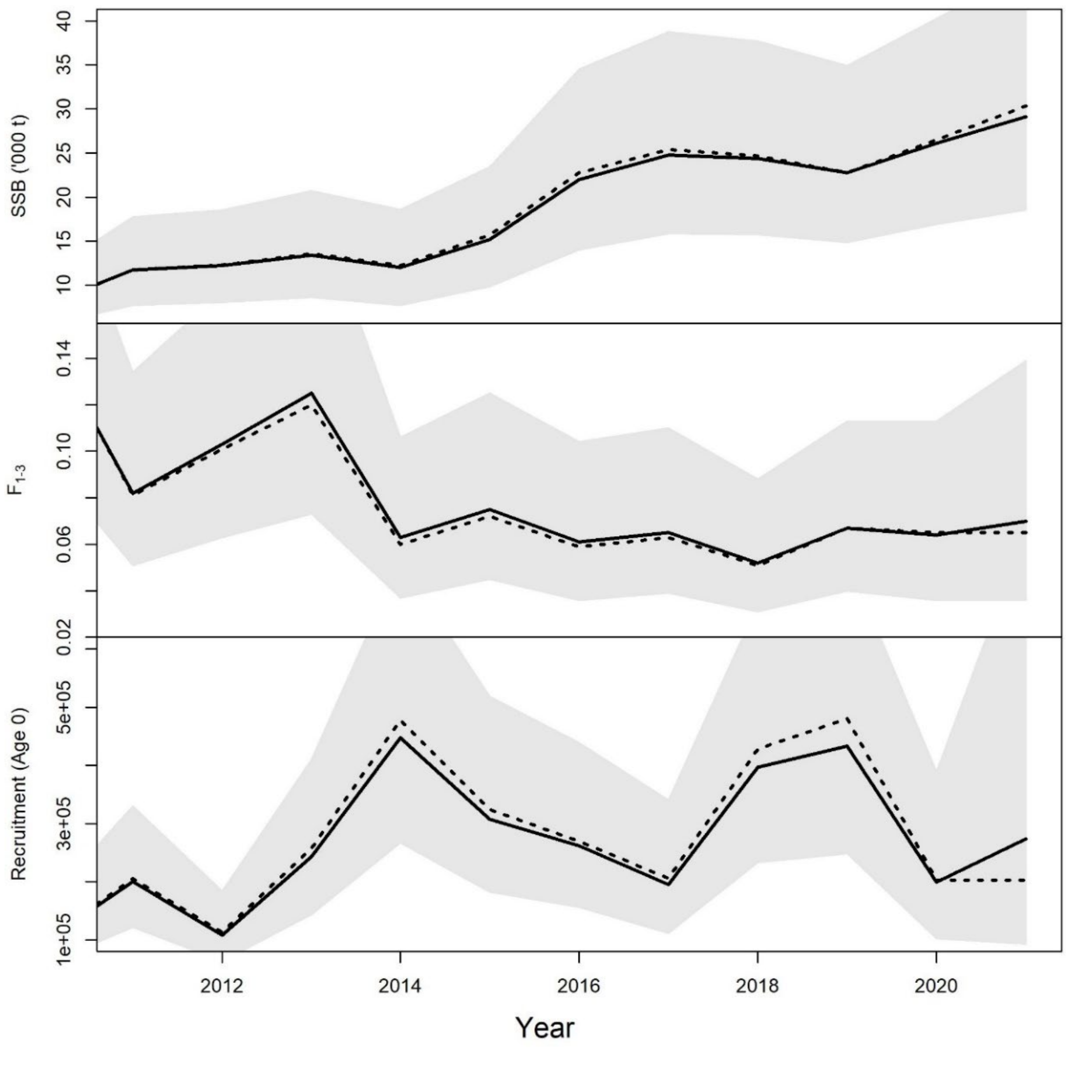


Figure 35.23. Whiting in Division 6.a. Comparison of 2022 SAM assessment estimates (solid lines) with revised 2021 SAM assessment estimates (dotted lines).

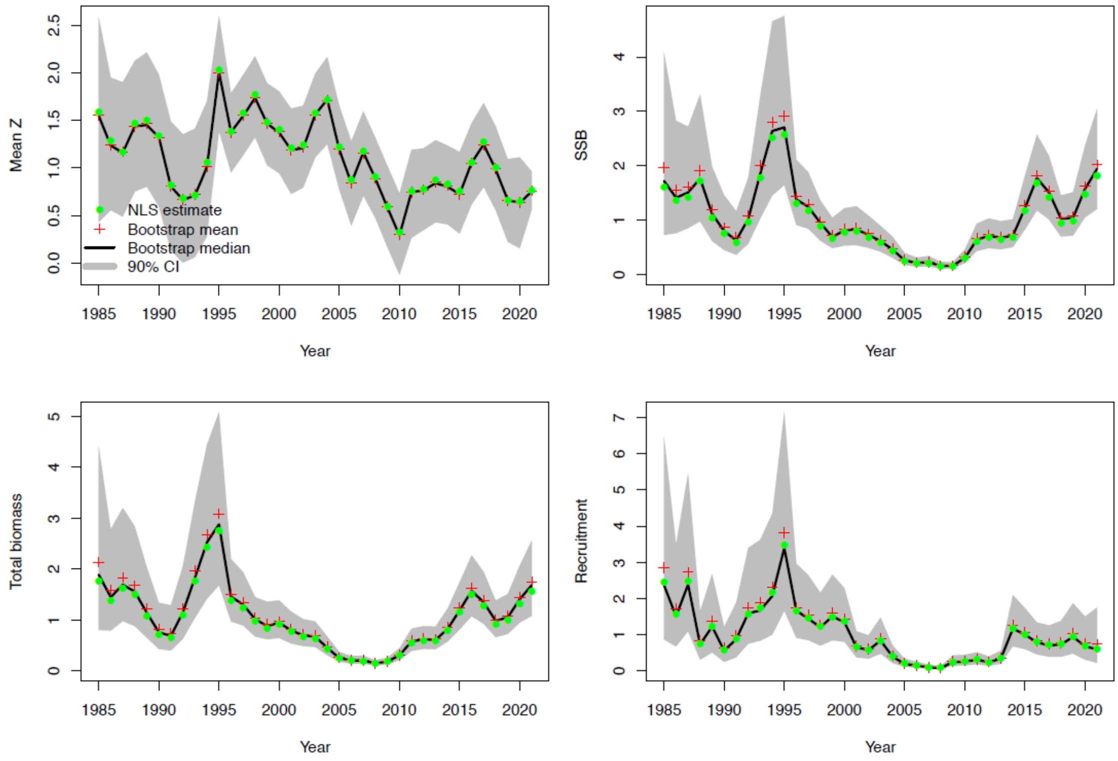


Figure 35.24. Whiting in Division 6.a. Results of SURBAR analysis (see legend on mean Z plot for details). SSB, TSB and recruitment are relative estimates.

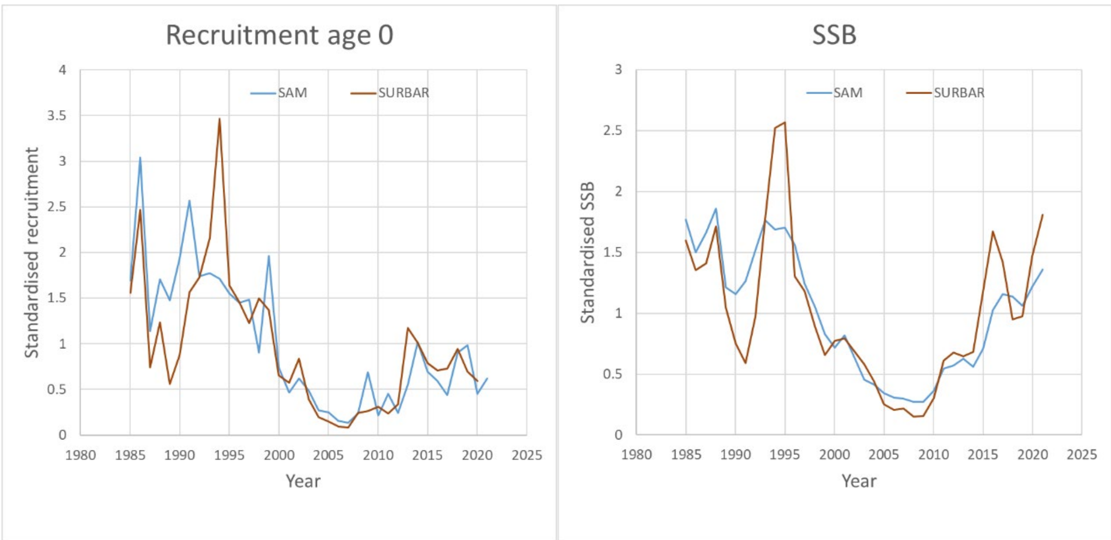


Figure 35.25. Whiting in Division 6.a. Comparison of the Recruitment and SSB estimates by SAM and SURBAR (the run with three tuning series).

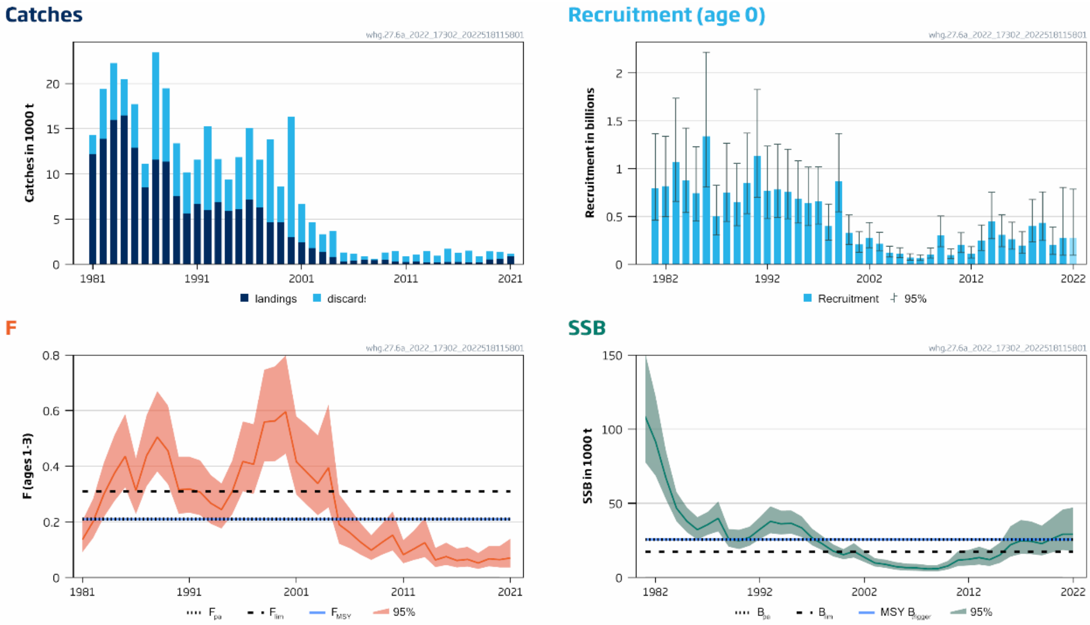


Figure 35.26. Whiting in Division 6.a. ICES Standard Graphs for the SAM assessment.

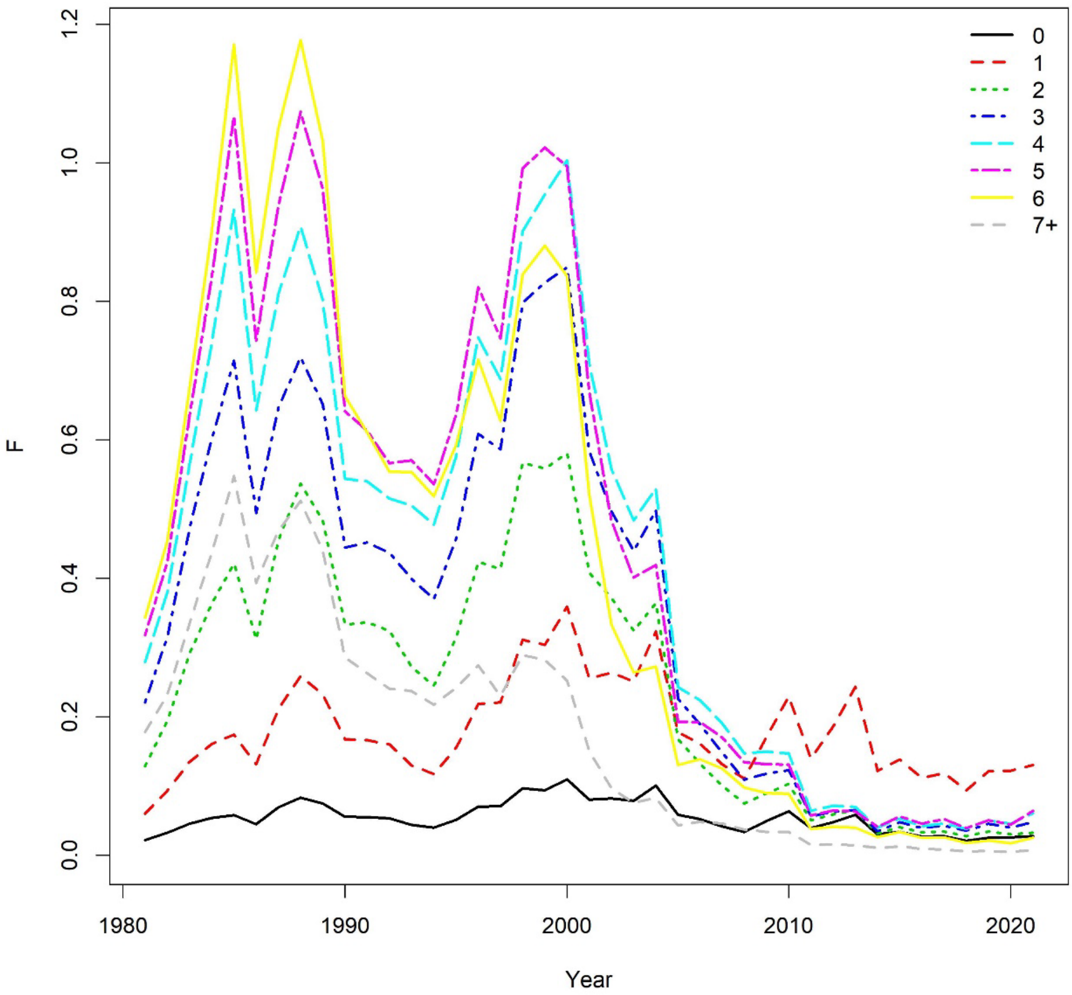


Figure 35.27. Whiting in Division 6.a. The SAM assessment model estimated F-at-age.

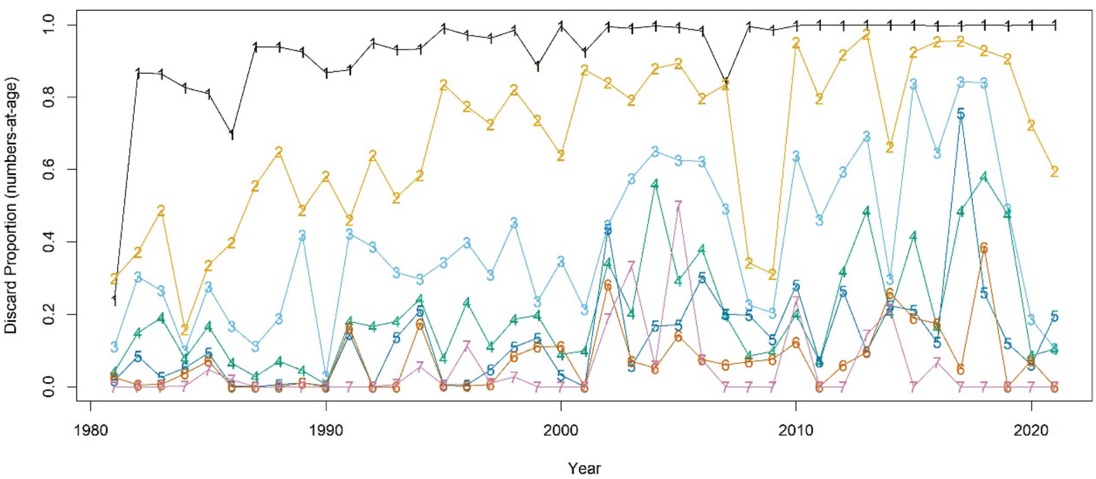


Figure 35.28. Whiting in Division 6.a. Proportion of catch discarded-at-age, from SAM landing fraction input file.

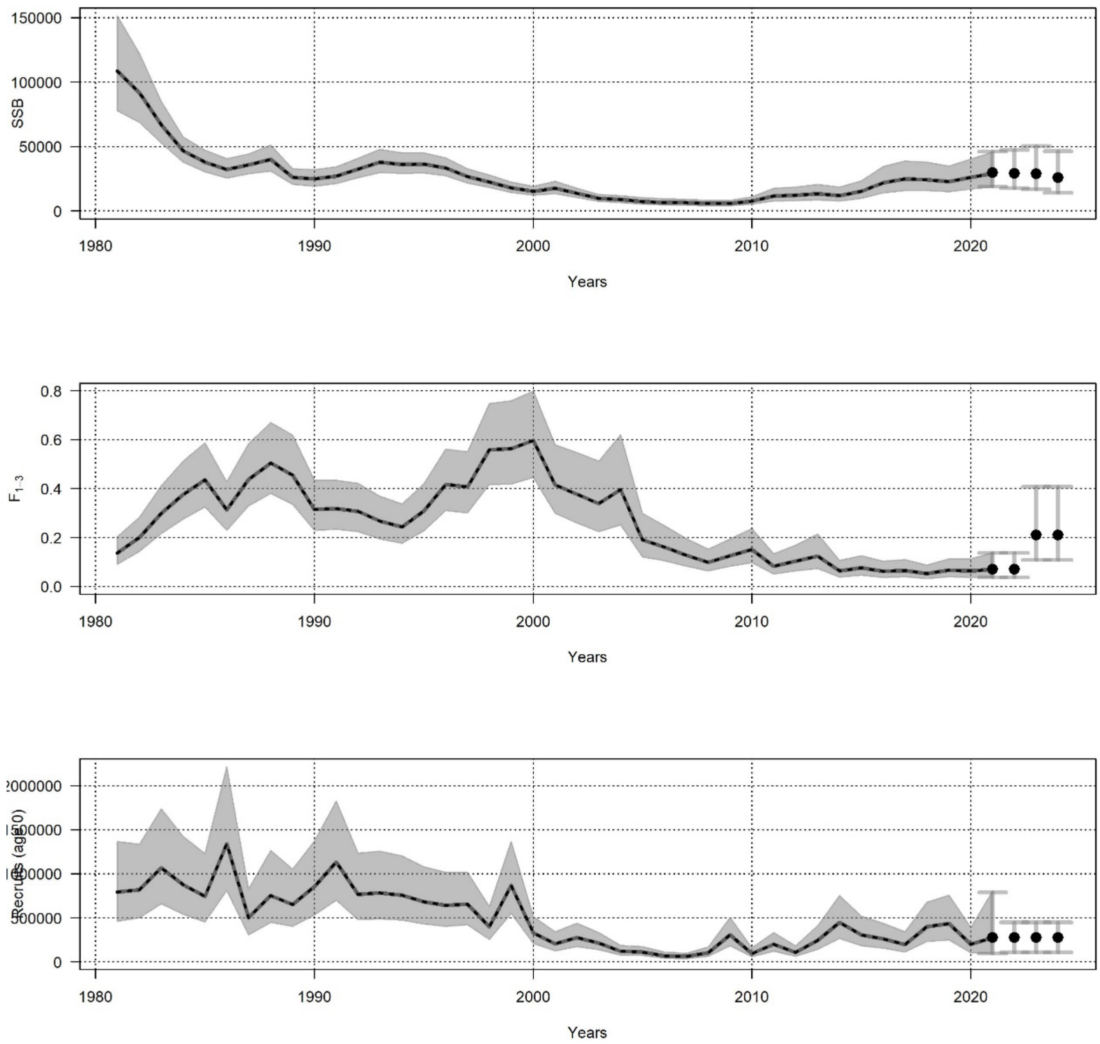


Figure 35.29. Whiting in Division 6.a. SAM forecast in the intermediate year followed by F_{MSY} (the proposed advice) in subsequent years.

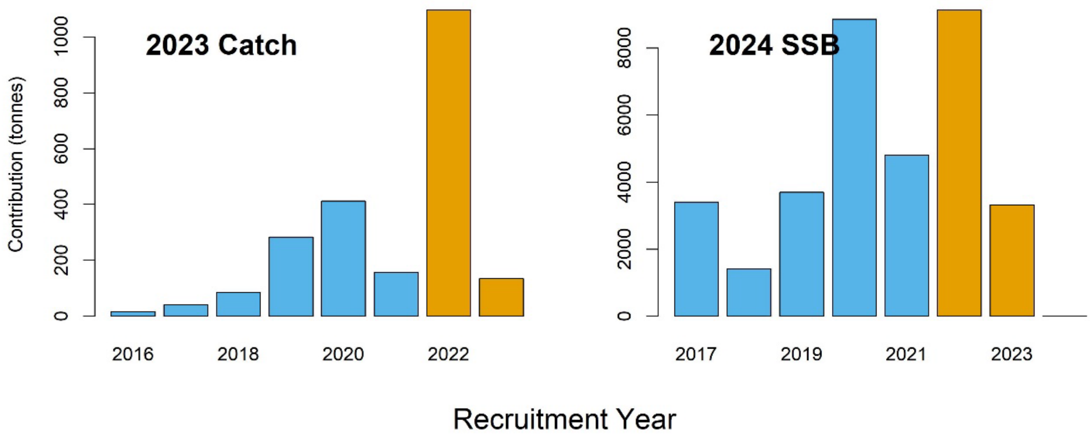


Figure 35.30. Whiting in Division 6.a. Contribution of recruitment years to projected 2022 catch and 2023 SSB under an F_{MSY} catch scenario.

36 Whiting (*Merlangius merlangus*) in Division 6.b (Rockall)

Type of assessment in 2022

No assessment was performed in 2021.

ICES advice applicable to 2022

In 2021, ICES provided multiyear advice:

"ICES advises that when the precautionary approach is applied, landings should be no more than 7 tonnes in each of the years 2022, 2023, 2024. ICES cannot quantify the corresponding total catches."

https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2021/2021/whg.27.6b.pdf

ICES advice applicable to 2021

In 2018, ICES provided multiyear advice:

"ICES advises that when the precautionary approach is applied, wanted catches should be no more than 9 tonnes in each of the years 2019, 2020, and 2021. ICES cannot quantify the corresponding total catches."

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/whg.27.6b.pdf

36.1 General

Stock description

There is an absence of information on whiting stock structure in this region and whiting caught at Rockall may potentially be part of the adjacent 6.a stock.

Management applicable to 2021 and 2022

The TAC for whiting (in tonnes) is set for ICES subareas 6, 12 and 14 and EU and international waters of ICES Division 5b, for 2022–2020 is shown below.

TAC for 2022

Species:	Whiting *Merlangius merlangus*		Zone:	6; United Kingdom and International waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	9	(1)	Analytical TAC	
France	189	(1)		Article 9 of this Regulation applies
Ireland	462	(1)		Article 3 of Regulation (EC) No 847/96 shall not apply
Union	660	(1)		Article 4 of Regulation (EC) No 847/96 shall not apply
United Kingdom	1 140	(1)		
TAC	1 800	(1)		

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

(Annex IA to Regulation (EU) 2022/109).

TAC for 2021

The agreed TAC was not available.

TAC for 2020

Species:	Whiting *Merlangius merlangus*		**Zone:**	6; Union and international waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	3	(1)	Analytical TAC	
France	57	(1)	Article 8 of this Regulation applies	
Ireland	273	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply	
United Kingdom	604	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply	
Union	937	(1)		
TAC	937	(1)		

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

(Council Regulation (EU) 2020/123).

Fishery in 2021

No specific information is available for 2021. Whiting at Rockall are taken as a bycatch in fisheries for other species such as haddock and anglerfish.

36.2 Data

Landings data for whiting in 27.6.b are shown by nation in Table 36.1 and Figure 36.1. Total officially reported landings were 17 t in 2021, of which 11 t were reported by the UK and 6 t by Ireland. In the past, official landings have shown very high interannual variation and it is not known whether these are a true reflection of removals.

Both landings and discards have been uploaded to InterCatch for 2021 (Figure 36.2). No information on the age composition in landings was available and some discard age compositions (based on three sampled trips) were uploaded to InterCatch. All the landings and discards were from the Scottish TR1 fleet. The discard rate was 23%. The data available in InterCatch are shown below.

Country	Landings(tonnes)	Discards (tonnes)	Total (tonnes)
Ireland	5.8	0.6	6.4
UK (Scotland)	11.1	4.4	15.5
Grand total	16.9	5.0	21.8

Survey catch rates of whiting at Rockall are extremely low (Table 36.2) 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.

36.3 Target category

In 2012, advice was provided using the DL approach for category 6; 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 information in Section 36.2 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.

36.4 Management considerations

Rockall whiting is managed under a TAC for the combined Divisions 6.a and 6.b and therefore cannot be effective in limiting catches in Rockall.

Table 36.1. 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	2017	2018	2019	2020*	2021*
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	+	-	-	-	-	-	-	-	-	-	-	-	+	+	-
Ireland	16	23	4	2	3	-	+	6	6	9	7	9	24	13	6
Norway	-	-	-	-	-	-	-	-	-	1	-	+	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E, W & NI)	-	-	-	-	-	-	-	-							
UK (Scotland)	1	8	12	16	6	1	3	23							
UK (all)									46	22	32	34	65	25	11
Total	17	31	16	18	9	1	3	29	52	33	40	43	89	38	17

* Preliminary.

\+ < 0.5 t.

Table 36.2. Whiting in Division 27.6.b. Survey data made available to the WG: Scottish Q3 groundfish survey (UK-SCORoc-Q3). Catch rates are given as number per ten hours.

UK-SCORoc-Q3 – Scottish Groundfish Survey – numbers at age/10 h									
Year	Effort	Age							
	(hours)	0	1	2	3	4	5	6	7
2011	10	0	0	0	0	0	0	0	0
2012	10	33.279	0	0.358	0	0	0	0	0
2013	10	6.687	1.924	0	0	0	0	0	0
2014	10	17.425	3.426	0.838	0.307	0	0	0	0
2015	10	8.853	0.559	0.559	0.55	0	0	0	0
2016	10	250.012	0.782	0	0.223	0.447	0	0	0
2017	10	23.147	10.84	0	0	0	0	0	0
2018	10	0.531	0.754	0.894	0	0	0.307	0	0
2019	10	0.144	0.169	0.175	0	0	0.094	0	0
2020	10	9.388	0	0	0	0	0	0	0
2021	10	26.112	0.902	0	0	0	0.223	0	0

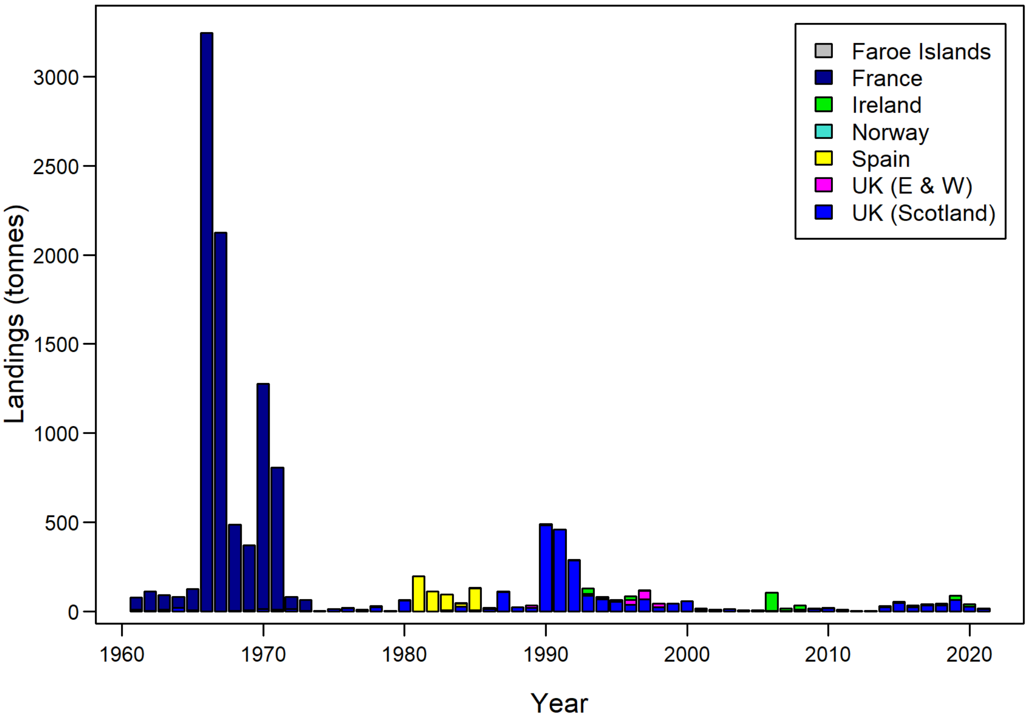


Figure 36.1. Whiting in Division 27.6.b. Official landings of whiting in 27.6.b by nation.

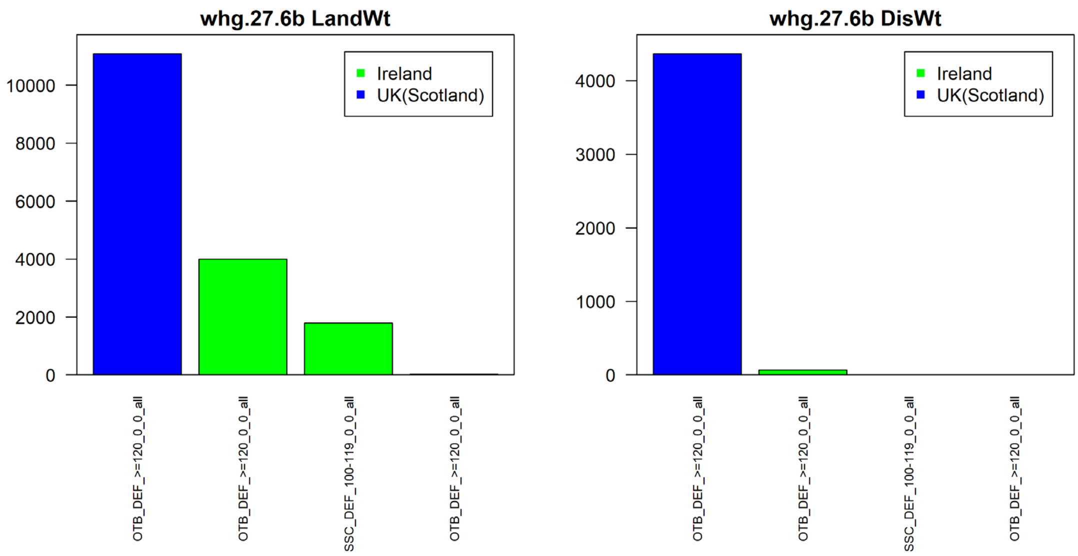


Figure 36.2. Whiting in Division 27.6.b. Landings (left panel) and discards (right panel) by métier (kg) in 2021 as entered into InterCatch.

37 Whiting in 7.a (Irish Sea)

2020 Assessment and advice

WGCSE 2022 updated the assessment with 2021 data. The advice for this stock is biennial so advice does not change; however, a short-term forecast was run to update the data.

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.

The advice for this stock was updated in October 2018 following a special request to ICES to update the advice based on the most recent discard estimates. Furthermore, in response to an EC request for advice on the removal of TACs for certain stocks ICES advised that removing the EU TAC for Whiting in ICES Division 7.a may generate a high risk of the stock being unsustainably exploited. However, ICES notes that the TAC is not currently controlling exploitation. http://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=34726.

Type of assessment

SPALY update of ASAP assessment.

ICES advice applicable to 2022 and 2023

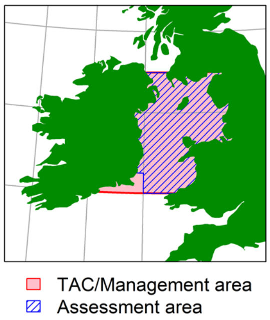
ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catches in 2022 and 2023.

https://doi.org/10.17895/ices.advice.5224

37.1 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 2022 and 2023

The minimum conservation reference size of whiting is 27 cm. This stock is subject to the landings obligation as part of the Commission Delegated Regulation (EU) 2018/2034.

In 2022, the TAC was set at 721 t.

In 2021, there was no agreed TAC until mid-year when it was set at 721 t.

In 2020, the TAC was set to 721 t. This followed an ICES technical service that examined the likely catches in 2020 for specific bycatch stocks that have zero catch advice.

https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2019/Special_Requests/eu.2019.23.pdf

In 2019 the TAC was set to 727 t. This TAC was later increased to 1246 t following from ICES advice in March 2019.

https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2019/Special_Requests/eu.2019.02.pdf

Official landings as reported to ICES in 2021 were 149 t, an increase from 102 t in 2020.

TAC 2021

Species: Whiting *Merlangius merlangus*		Zone: 7a (WHG/07A.)
Belgium	2 (1)	Analytical TAC
France	22 (1)	Article 9 of this Regulation applies
Ireland	280 (1)	Article 3 of Regulation (EC) No 847/96 shall not apply
The Netherlands	0 (1)	Article 4 of Regulation (EC) No 847/96 shall not apply
Union	305 (1)	
United Kingdom	416 (1)	
TAC	721 (1)	

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

TAC 2022

Species: Whiting *Merlangius merlangus*		Zone: 7a (WHG/07A.)
Belgium	2 (1)	Analytical TAC
France	22 (1)	Article 9 of this Regulation applies
Ireland	274 (1)	Article 3 of Regulation (EC) No 847/96 shall not apply
Netherlands	1 (1)	Article 4 of Regulation (EC) No 847/96 shall not apply
Union	299 (1)	
United Kingdom	422 (1)	
TAC	721 (1)	

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

Fishery in 2021

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

The fishery in 2021 was prosecuted by the same fleets and gears as in recent years.

The majority of catches are discards are from *Nephrops* directed fleets. The main fleets landing whiting are fin-fish directed fleets from Ireland and Northern Ireland. In recent years landings were submitted for the PTM_SPF métier. These are likely from trips targeting herring where whiting was a bycatch.

Figure 37.2 shows the contribution of catch by fleet.

Table 37.1 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 37.2. In recent years the values provided to the WG are very similar to officially reported landings. Ireland, Belgium and UK(NI) submitted discard estimates for 2021. Total discard estimates were to be 1571 t in 2021.

No BMS landings or logbook registered discards were submitted to ICES for 2021.

The closure of the western Irish Sea to whitefish fishing from mid-February till the end of April, designed to protect cod, was continued in 2021 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 2021 catches by main gear types is presented below.

Catch (2021)	Landings			Discards	
1662 tonnes	Finfish-directed otter trawls	*Nephrops*-directed otter trawls	Other gears	*Nephrops*-directed otter trawls	Other gears
	96.5%	0.9%	2.6%	97.6%	2.4%
	91 tonnes			1571 tonnes	

37.2 Information from the Industry

There was no information on the whiting stock from the industry.

37.3 Data

Data were provided by all countries according to the data call.

For WGCSE (2022) all data have been updated where possible. To allow an age-based assessment, catch numbers-at-age, catch weights-at-age, stock weights-at-age have all be constructed since 2003 (WGCSE, 2017). These updates are documented in the Stock Annex.

Fishery landings

Working Group estimates of catch available since 1980 are illustrated in Figure 37.1 and indicate the declining trend since the start of the time-series. In 2021, there was a slight increase in landings from 88 t to 91 t.

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 (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.

f Average IR-OTB discards (2017–2019).

Table 37.3).

Fishery discards

Discard estimates are available from Northern Ireland and Belgian fleets. Raising methods used are described in the stock annex for 7.a whiting.

Landings-at-age data

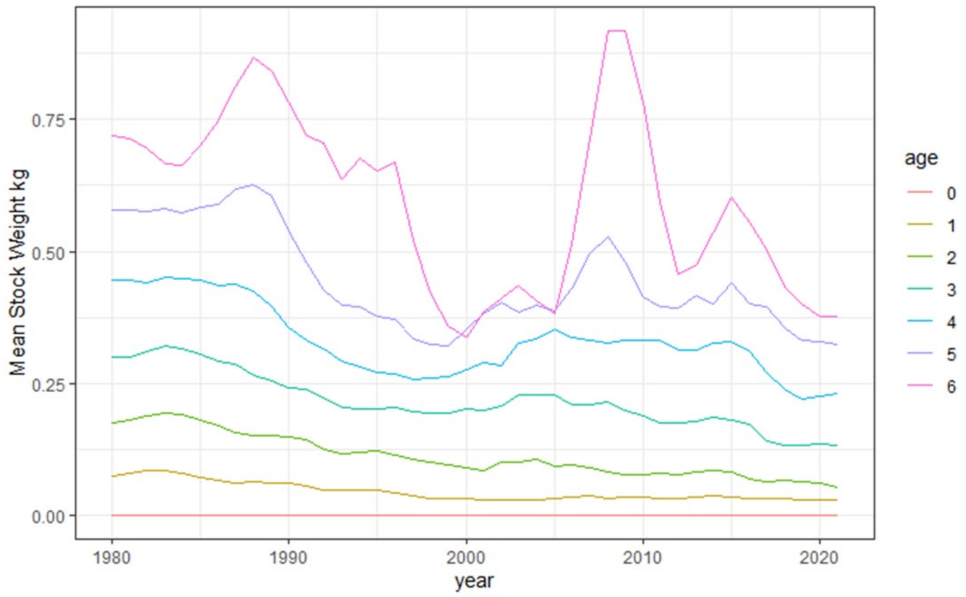
Landings numbers-at-age are given in Table 37.4. For the 2003 data onwards, the catch and mean weight-at-age are estimated using combined UK (NI) and Irish quarterly length–weight relationships and age–length keys. These data are raised to the international catch data provided to ICES. Typically, quarterly landings are provided by the UK (Scotland), Belgium and France and annual landings are provided by UK (IOM). The quality of the landings-at-age data has been declining in recent years due to reduced sample numbers commensurate with the decline in landings. In 2021, landings at-age were provided by Ireland and Northern Ireland.

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.

Discards numbers-at-age data

In 2021, discard sampling numbers at age were available from Northern Ireland and Ireland.

Discard number at age are given in **Error! Reference source not found.**. Discarding of whiting is high within the Irish Sea. Discard Numbers at age were combined for ages 0 to 6+ and then raised to the international discards. 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 (



).

The length frequency of discards of national sampled fleets in 2019 is given in Figure 37. This information has not been updated for 2021. 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 37. 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 37.5 describes the survey data made available to the Working Group.

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.

The three surveys used in the assessment are NIGFS-WIBTS-Q1 (G7144), NIGFS-WIBTS-Q4 (G7655), and NI MIK (I9826).

The 2019 UK (E&W)-BTS-Q3: Corystes Irish Sea Beam-Trawl Survey data were revised for WGCSE 2022. The 2019 data were updated from 340 to 307 for age 0 and 207 to186 for age 1.

Figure 37. shows the log standardized indices by cohort of the tuning fleets used in the assessment. There are very little cohort signals in any of the indices. The survey data show a major change in the age structure of the stock around the mid-2000s. The two NI surveys show that older fish disappear around 2003 in the Q1 survey and around 2004 in the Q4 survey. This is mainly due to a decline whiting catches in the Eastern Irish Sea stratum which was explored in detail at WKIrish.

37.4 Historical Stock Development

Model used: ASAP

Software used: ASAP V3.0.17 NOAA Fisheries toolbox (http://nft.nefsc.noaa.gov)

FLR with R version 3.6.1 (64-bit) with packages FLEDA 2.5.2, FLCore 2.6.15, FLAssess 2.6.3, and Flash (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 37.6 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 exception to this is the CV of 0.3 used for catch numbers-at-age for 2020.

Figure 37. 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 37.7 shows the model estimates.

The observed and predicted index CPUE values are shown in Figure 37.. There is poor fit to the Northern Irish groundfish survey indices in the first half of the series but it improves in recent years.

The observed and predicted catches are shown in Figure 37.. 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.

Figure 37. shows the retrospective analysis. The predicted catch shows no obvious retrospective pattern. The recruitment shows a slight underestimate in the last year. There is some deviation in the early part of the time-series when the surveys were first introduced. However, recent estimates of SSB and F are consistent with no apparent bias.

A Mohn's rho analysis was conducted based on the ASAP stock assessment results, i.e. the last data year (2020) was used as the final year for comparison of SSB, F and recruitment and based on a five-year retrospective analysis. The results from the Mohn's rho analysis are shown in the following table:

	SSB	F (ages 1-3)	recruitment
Mohn's rho value	0.187	-0.121	0.27

The Mohn's rho values for this assessment are below the threshold imposed by ICES of 20% for recruitment and 15% for fishing mortality.

The state of the stock

Table 37.8 shows the estimated fishing mortality-at-age and Table 37.9 shows the stock numbers-at-age. The stock summary is given in Table 37.10 and Figure 37.

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 with a slight increase in recent years. Large variations in fishing mortality estimates have been observed in recent years. F has been well above F_{lim} since the early 1990s.

37.5 Short-term predictions

Short-term projections were performed using FLR libraries. Recruitment for 2022–2024 was estimated at 119 242 (GM 2000–2020:thousands). As the retrospective pattern shows an underestimate of recruitment, the terminal year was excluded from the GM for the WGCSE, 2022 assessment. Three year averages (2019–-2021) were used for F (unscaled) and weights-at-age.

Input data for the short-term forecast are given in Table 37.11. The single-option output is given in Table 37.12 , Table 37.13 and Table 37.14 gives the management options.

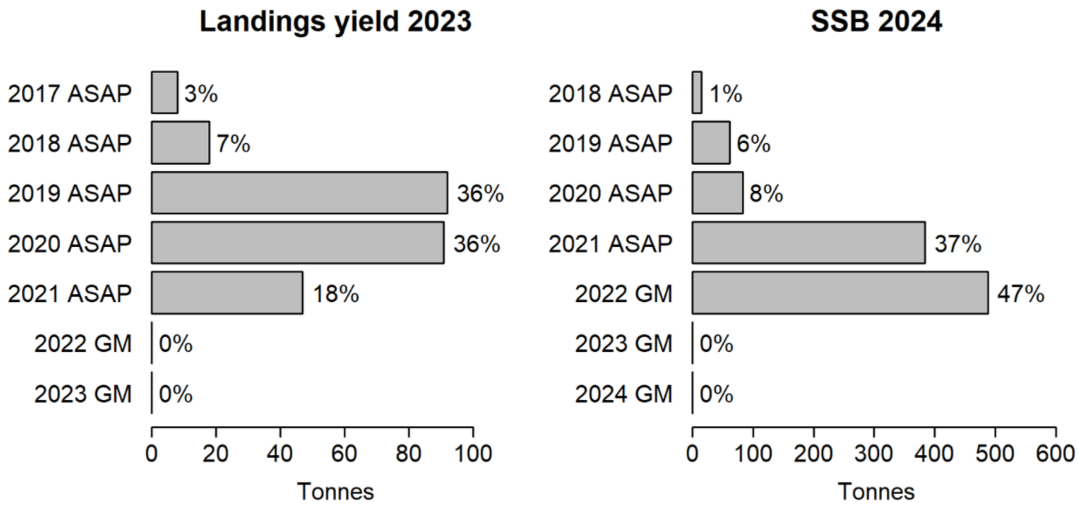


Figure 37.. The 2019–2020 year class estimates from ASAP accounts for 72% of the projected landings in 2023. The 2022 GM assumption contributes considerably to the estimated SSB in 2024 as does the 2021 ASAP assessment.

37.6 Medium-term projection

There is no analytical assessment for this stock.

37.7 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	B_{pa}
Approach	F_{MSY}	0.22	Median point estimates of EqSim with combined SR
	$F_{MSY\ lower}$	0.158	Median point estimates of EqSim with combined SR
	$F_{MSY\ upper}$	0.294	Median point estimates of EqSim with combined SR
	Blim	10 000 t	Below 10 000 t recruitment is impaired
Precautionary	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	$F_{p.05}$; the F that leads to SSB ≥ B_{lim} with 95% probability

In 2021, ICES updated the basis for F_{pa} as "the F that leads to SSB ≥ B_{lim} with 95% probability", ICES (2021). Prior to this, it was based on "F_{lim} combined with the assessment error", ICES (2017). The F_{pa} value of 0.22 remains unchanged.

37.8 Management plans

No management plan has been agreed or proposed.

37.9 Uncertainties and bias in assessment and forecast

This stock was benchmarked in January 2017. The result of the benchmark was that the stock was elevated from a category 3 stock (trend-based assessment) to a category 1 stock (analytical assessment). The assessment includes information from the commercial fishery, including both landings and discards, and takes into account selectivity changes that have occurred in 1995. Three survey series are used within the assessment. Natural mortality parameters were updated to reflect current stock dynamics. The highly fluctuating estimates of fishing mortality in recent years (2002–present) are likely to be the result of variability in the sampling data and discard estimates. Despite this inherent uncertainty, it is clear from the assessment and additional information from surveys that the stock remains extremely low.

Stock status classification relative to MSY proxies is given below. This has not been updated for WGCSE, 2022.

	Fishing pressure					Stock size				
		2018	2019	2020			2019	2020	2021	
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

37.10 Recommendations for next benchmark assessment

This stock was benchmarked in 2017 as part of the WKIrish process. A number of recommendations for future work were made and these are listed below. Given the current stock status there is no urgency to schedule another benchmark for this stock in the short term.

Assessment method

Currently a single fleet ASAP with fixed selection assumption is used. Exploring alternative modelling frameworks which allow for changes in selection should be investigated. There is 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.

Biological parameters

New natural mortality estimates from the Irish Sea EWE model should be included in the assessment. The stock shows very strong changes in weights-at-age over time (they can change by a factor of up to 2). This is likely to affect the natural mortality. Further information to support this would be very useful for future benchmarks.

Discards

Discards data remain highly uncertain for this stock. This probably contributes to the variable F patterns observed. Partitioning catch data into landings and discards or by fleet with different CVs may help smooth out some of this variability.

Life-history parameters

Mean weights show trends which are currently smoothed. This should be explored further with a view to improving the approach and possibly using it in forecasts.

Other issues

Stock identity is assumed to be appropriate but there are east–west differences in population structure and in the past there has been speculation about emigration to 7g.

Sampling

Discard sampling should be improved for this stock since discards account for the vast majority of the catch in number. Despite various management initiatives discarding remains sporadic and high in the *Nephrops* fishery.

Tuning series

Currently calculated survey CVs are not used in ASAP. It might be worth exploring the impacts of using actual values instead of an assumed fixed CV in future assessment models.

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.

37.11 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 and the full implementation of the landings obligation in 2019, the discards estimates still remain high, ca. 1089 t. This stock is a major 'choke species' for the 7.a *Nephrops* fishery in the context of the landing obligation.

Effort limitations are in force within the Irish Sea as a result of the cod long-term management plan. These effort limitations have not significant reduced mortality on whiting.

Whiting has a low market value, which is likely to contribute to discarding rates.

Technical measures applied to this stock include a minimum conservation reference size (≥27 cm), whiting now mature well below this MCRS.

37.12 References

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37.13 Tables

Table 37.1. Official landings (t) of Whiting in Division 7.a as reported to ICES.

Year	Belgium	France	Ireland	Netherlands	UK(NI, Engl. & Wales)	Spain	UK (Isle of Man)	UK (Scotland)	UK	Total human consumption
1988	90	1,063	4,394		5,823		15	107		11,492
1989	92	533	3,871		6,652		26	154		11,328
1990	142	528	2,000		5,202		75	236		8,183
1991	53	611	2,200		4,250		74	223		7,411

1992	78	509	2,100		4,089		44	274		7,094
1993	50	255	1,440		3,859		55	318		5,977
1994	80	163	1,418		3,724		44	208		5,637
1995	92	169	1,840		3,125		41	198		5,465
1996	80	78	1,773	17	3,557		28	48		5,581
1997	47	86	1,119	14	3,152		24	30		4,472
1998	52	81	1,260	7	1,900		33	22		3,355
1999	46	150	509	6	1,229		5	44		1,989
2000	30	59	353	1	670		2	15		1,130
2001	27	25	482		506		1	25		1,066
2002	22	33	347		284		1	27		714
2003	13	29	265		130	85	1	31		554
2004	11	8	96		82		1	6		204
2005	10	13	94		47			<0.5		164
2006	4	4	55		22			<0.5		85
2007	3	3	187		3		1	<0.5		197
2008	2	2	68		11		1			84
2009	2		78		20					100
2010	5	3	97		16		<0.5			121
2011	4	3	95		16		<0.5			118
2012	5	1	58		10			1	11	86
2013	2	<0.5	44				<0.1	2	20	68
2014	2	<0.5	60		11		<0.1			73
2015	1	<0.5	49		8					59
2016	1	<0.5	44		5		<0.1			50
2017	2	<0.5	32		17		<0.1			50
2018	1		44		19		<0.5			63
2019	4		129		63		<0.1			196
2020	5	<0.1	56		42		<0.1			102
2021	2	<0.1	109		38					149

* **Preliminary.**

Table 37.2. ICES estimates of discards, landings and catch of whiting in Division 7.a.

Year	Discards by Country/Fleet					Discards	Landings	Catch
	Nephrops fishery [b]	IR-OTB fleet[ce]	NI *Nephrops* fishery[d]	Belgium	UK (E&W) fleet			
1988	1,611					1,611	10,245	11,856
1989	2,103					2,103	11,305	13,408
1990	2,444					2,444	8,212	10,656
1991	2,598					2,598	7,348	9,946
1992	4,203					4,203	8,588	12,791
1993	2,707					2,707	6,523	9,230
1994	1,173					1,173	6,763	7,936
1995	2,151					2,151	4,893	7,044

1996	3,631					3,631	4,335	7,966
1997	1,928					1,928	2,277	4,205
1998	1,304					1,304	2,229	3,533
1999	1,092					1,092	1,670	2,762
2000	2,118					2,118	762	2,880
2001	1,012					1,012	733	1,745
2002	740					740	747	1,487
2003		480				480	517	996
2004		905				905	133	1,038
2005		272				272	125	397
2006		1,580	193			1,773	64	1,837
2007		725	787			1,512	35	1,547
2008		693	476			1,169	37	1,206
2009		688	633			1,321	39	1,360
2010		240	914			1,154	30	1,184
2011		330	616			946	31	977
2012		257	1,065	17	1	1,339	60	1,399
2013		95	833	17	3	948	33	981
2014		263	1,645	15	28	1,951	23	1,974
2015		438	1,074	9	1	1,521	28	1,549
2016		173	589		3	765	15	780
2017		122	544		1	667	36	703
2018		98	754		<0.5	853	46	899
2019		86	897	20	87	1,089	172	1,261
2020		102[f]	906	22	Na	1,030	88	1,118
2021		431	1,118	22		1,571	81	1,662

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.

f Average IR-OTB discards (2017–2019).

Table 37.3. 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	

Year	Official landings	ICES landings	ICES Discards	ICES catch	Landings taken or reported in rectangles 33E2 and 33E3
1994	5,637	6,763	1,173	7,936	
1995	5,465	4,893	2,151	7,044	
1996	5,581	4,335	3,631	7,966	
1997	4,472	2,277	1,928	4,205	
1998	3,355	2,229	1,304	3,533	
1999	1,989	1,670	1,092	2,762	
2000	1,130	762	2,118	2,880	
2001	1,066	733	1,012	1,745	
2002	714	747	740	1,487	
2003	554	517	480	996	159
2004	204	133	905	1,038	51
2005	164	125	272	397	33
2006	85	64	1,773	1,837	22
2007	197	35	1,512	1,547	161
2008	84	37	1,169	1,206	44
2009	100	39	1,321	1,360	63
2010	121	30	1,154	1,184	91
2011	118	31	946	977	75
2012	86	60	1,339	1,399	43
2013	68	33	948	981	33
2014	73	23	1,951	1,974	50
2015	59	28	1,521	1,549	34
2016	50	15	765	780	40
2017	50	36	667	703	20
2018	63	46	853	899	18
2019	196	172	1,089	1,261	24
2020	102	88	1,030*	1,118	14
2021	149	91	1,571	1,662	59

***this includes the ICES estimate of 102 t for IR-OTB discards.**

Table 37.4. Whiting7.a. Landings numbers-at-age.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1980	0	14520	21811	6468	2548	350	0
1981	0	11203	29011	16004	2596	821	0
1982	41	5427	18098	19340	6108	813	0
1983	0	4886	9943	9100	4530	1165	321
1984	0	18254	12683	5257	2571	1045	402
1985	0	15540	35324	8687	996	0	675
1986	0	6306	16839	10809	1877	285	0
1987	0	10149	21563	6968	1943	242	0
1988	0	6983	25768	6989	1513	396	0
1989	0	11645	14029	13011	3645	490	0
1990	0	9502	17604	4734	1477	318	0
1991	102	7426	18406	5829	993	0	311
1992	0	8380	21907	7959	1374	462	0
1993	38	2742	21468	7327	932	0	135
1994	0	3245	6983	18509	1801	208	0
1995	0	1124	10095	3020	4444	233	0
1996	129	1652	6162	7432	1263	1082	135
1997	0	610	4239	2567	1795	87	79
1998	0	329	3287	4727	888	261	95
1999	1	341	2806	2607	741	160	119
2000	0	319	1364	1002	299	115	15
2001	0	111	1189	1006	171	53	20
2002	0	67	748	1480	376	48	41
2003	0	89	1051	606	199	0	0
2004	0	0	17	117	150	17	0
2005	0	0	101	216	95	21	3
2006	0	34	41	88	39	9	1
2007	0	24	41	32	10	3	0
2008	0	38	66	25	5	1	0

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
2009	0	65	44	22	4	1	0
2010	0	18	83	11	3	0	0
2011	0	1	17	59	15	3	0
2012	0	4	29	80	60	9	1
2013	8	81	36	20	5	1	1
2014	0	2	25	24	11	1	1
2015	0	2	25	24	11	1	1
2016	0	0	6	21	10	3	0
2017	0	0	9	50	43	5	1
2018	0	1	14	70	38	19	2
2019	0	0	146	181	72	45	23
2020	0	0	58	138	93	18	10
2021	0	0	32	119	62	42	6

Table 37.5. 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

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
2009	6622	27448	1176	0	0	0	0
2010	3946	15102	2810	64	1	0	0
2011	25982	8197	658	314	0	0	0
2012	6637	31020	790	37	1	3	0
2013	8493	11945	613	4	0	0	0
2014	13467	27553	2425	259	10	0	0
2015	3883	23595	2603	223	1	0	0
2016	4509	5780	4804	294	15	0	0
2017	3559	5870	4385	240	14	0	0
2018	6523	7386	2557	614	92	10	0
2019	6429	14041	3986	571	57	7	0
2020	11987	26870	978	50	3	0	0
2021	4272	18880	6496	396	18	4	0

Table 37.5. Whiting in 7.a. Survey data available.

NIGFS-WIBTS-Q1: Northern Ireland March Groundfish Survey

1993	**2021**					
1	1	0.21	0.25			
1	6					
1	665.6	710.3	81.2	11.7	4.3	0.8
1	1804.6	262.1	299.2	44.7	11.9	8.1
1	1688.9	635.7	174.2	88.4	22.0	6.3
1	1468.4	334.0	213.0	35.1	37.2	5.4
1	1406.1	1536.4	156.0	52.8	4.5	13.7
1	1485.0	754.4	415.4	29.7	7.4	1.8
1	1369.4	373.2	111.2	41.5	3.7	1.0
1	2302.4	410.9	181.8	26.6	3.7	0.0
1	1065.7	696.5	124.6	13.7	5.9	2.7
1	2307.7	686.7	175.3	52.9	11.2	1.4
1	1495.1	905.2	130.2	10.9	1.6	0.1
1	1609.8	231.7	61.4	2.7	1.3	0.2
1	689.3	124.0	28.5	12.3	2.8	0.1
1	959.8	235.6	30.3	6.0	0.1	0.1
1	905.0	158.6	14.9	2.7	0.2	0.0
1	756.7	347.0	45.0	2.8	0.3	0.4
1	1062.3	281.1	36.3	1.8	0.2	0.1
1	739.4	545.8	51.6	4.7	6.4	0.0
1	586.4	156.5	36.0	3.9	0.6	0.0
1	972.2	354.4	42.3	5.9	1.2	0.0
1	629.6	649.3	66.7	3.5	0.5	0.0
1	922.1	367.6	67.0	4.3	0.2	0.1
1	2797.3	469.3	18.8	2.3	0.0	0.0
1	1409.1	924.8	38.7	1.5	0.1	0.1
1	888.1	831.8	142.2	11.2	0.7	0.1
1	431.4	296.8	119.4	17.9	2.3	0.0
1	568.0	831.9	347.2	43.2	6.2	0.5
1	1573.5	583.4	127.3	9.2	0.3	0.6
1	569.4	951.5	86.2	9.9	2.9	0.6

NIGFS-WIBTS-Q4: Northern Ireland October Groundfish Survey

1993	2021						
1	1	0.83	0.88				
0	6						
1	714.0	1040.5	475.9	67.5	8.2	3.1	0.3
1	1113.1	1320.0	208.6	150.7	33.9	2.3	0.5
1	3124.4	477.3	166.5	30.6	35.6	5.4	1.2
1	2306.2	591.2	134.4	52.4	10.5	7.0	1.3
1	2626.5	676.6	497.6	61.0	18.2	4.6	4.5
1	2863.5	466.8	153.8	72.8	6.2	2.2	0.1
1	2478.4	1079.7	192.0	51.7	43.3	3.7	1.8
1	2374.3	1084.7	126.0	20.0	16.9	6.0	2.7
1	6356.4	658.3	270.8	28.9	4.9	2.3	0.0
1	2692.4	1322.5	268.3	41.6	4.5	1.2	0.0
1	4431.0	1572.3	921.1	74.8	16.8	1.5	0.0
1	4457.1	699.6	268.3	113.8	4.4	1.9	0.0
1	2377.2	487.8	183.3	15.8	1.5	0.4	0.0
1	2849.2	144.8	46.8	7.9	1.8	0.0	0.0
1	2163.1	957.6	149.1	16.7	4.8	4.3	0.2
1	4884.6	1312.6	114.3	3.8	0.2	0.0	0.0
1	2246.5	510.8	71.7	7.5	1.6	0.0	0.2
1	2274.4	312.1	259.6	8.2	0.7	0.2	0.0
1	3534.1	348.4	139.7	26.3	3.5	0.9	0.0
1	1330.9	402.5	134.7	19.5	6.2	0.1	0.0
1	7135.8	354.7	155.9	31.1	1.5	0.5	0.9
1	4504.0	507.7	135.5	8.8	0.7	0.0	0.0
1	2802.4	891.0	115.2	6.3	0.7	0.0	0.0
1	2718.7	859.3	203.5	31.7	3.5	0.4	0
1	3011.1	714.1	368.4	78.4	4.2	0.0	0.1
1	4424.7	897.5	367.6	23.4	8.3	0.2	0.04
1	5613.5	643.2	148.5	27.4	3.2	0.3	0.00
1	2416.2	1157.8	98.4	16.0	0.2	0.5	0.00
1	5376.7	1018.7	143.1	25.6	4.9	0.0	0.1

NIMIK: Northern Ireland MIK Net Survey

1994	**2019**		
1	1	0.46	0.5
0	0		
1	778	1994	
1	225	1995	
1	397	1996	
1	205	1997	
1	59	1998	
1	91	1999	
1	40	2000	
1	167	2001	
1	19	2002	
1	148	2003	
1	101	2004	
1	135	2005	
1	118	2006	
1	82	2007	
1	99	2008	
1	173	2009	
1	78	2010	
1	122.2	2011	
1	123.9	2012	
1	197.6	2013	
1	54.9	2014	
1	59.5	2015	
1	6.7	2016	
1	175.45	2017	
1	90.74	2018	
1	164.42	2019	
1	N/A`	2020	
1	108.4	2021	

UK (E&W)-BTS-Q3: Corystes Irish Sea Beam-Trawl Survey - Prime stations only – Effort and numbers-at-age (per km towed)

1988	2019		
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

1988	2019		
1	261	113	2014
1	211	112	2015
1	666	213	2016
1	489	230	2017
1	662	380	2018
1	307	186	2019
1	N/A	N/A	2020
1	340	132	2021

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 37.6. Whiting 7.a. ASAP input data.

ASAP VERSION 3.0
Irish Sea Whiting
#
ASAP GUI 15 AUG 2012
#
Number of Years
42
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
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
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 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	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
0.02	0.048	0.125	0.256	0.401	0.375	0
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
0.028	0.032	0.075	0.198	0.362	0.432	0.5
0.021	0.045	0.104	0.161	0.24	0.319	0.408
0.02	0.033	0.104	0.175	0.268	0.436	0.433
0.019	0.027	0.067	0.166	0.27	0.358	0.367
0.026	0.045	0.084	0.187	0.311	0.398	0.342

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	0.0308	0.068	0.1713	0.3104	0.4016	0.555
0	0.0306	0.0625	0.1401	0.2712	0.3946	0.505
0	0.0301	0.0658	0.133	0.2375	0.3551	0.4336
0	0.029	0.0641	0.1307	0.2187	0.3307	0.3992
0	0.0252	0.062176	0.1371	0.2185	0.3257	0.3888
0	0.0275	0.06	0.1337	0.2251	0.3284	0.3758

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
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
0	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
4509	5780	4809	315	25	3	0	780
3559	5871	4394	290	57	5	1	704
```

6523 7386 2571 684 129 29 2 899
6429 14041 4132 752 129 52 23 1261
11987 26870 1036 188 96 18 10 1118
11479 23168 9450 1175 199 58 24 1662
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
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0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
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
0	0	0	0	0	0	0
0	0	0	0	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
2017 1874 0.3 0 0.474 0.444 0.076 0.006 0.001 0 50
2018 868 0.3 0 0.497 0.342 0.138 0.021 0.003 0 50
2019 1797 0.3 0 0.316 0.463 0.193 0.024 0.003 0 50
2020 2294 0.3 0 0.686 0.254 0.055 0.004 0 0 50
2021 1620 0.3 0 0.351 0.587 0.053 0.006 0.002 0.002 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
```

2017	4176	0.3	0.721	0.171	0.088	0.019	0	0	0	50
2018	5722	0.3	0.774	0.157	0	0.064	0	0	0	50
2019	6436	0.3	0.872	0.1	0.023	0.004	0	0	0	50
2020	3689	0.3	0.655	0.314	0.027	0.004	0	0	0	50
2021	6569	0.3	0.818	0.155	0.022	0.004	0.001	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
2017	175.4	0.5	0	0	0	0	0	0	0	0
2018	90.74	0.5	0	0	0	0	0	0	0	0
2019	164.4284624	0.5	0	0	0	0	0	0	0	0
2020	0	0.5	0	0	0	0	0	0	0	0
2021	108.4	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
2017	489	0.5	0	0	0	0	0	0	0	0
2018	661.75	0.5	0	0	0	0	0	0	0	0
2019	307	0.5	0	0	0	0	0	0	0	0
2020	0	0.5	0	0	0	0	0	0	0	0
2021	340	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
2017	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0

2020 0 0 0 0 0 0 0 0 0 0
2021 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
1
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
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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
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Discard Total CV by Year and Fleet
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Catch Effective Sample Size by Year and Fleet
10
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Discard Effective Sample Size by Year and Fleet

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# 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
2022
Projection Data by Year
2022 -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 37.7. Whiting 7.a. Selectivity of the catches and indices.

Age	Catch	NI-Q1	NI-Q4	NI-MIK
0	0.115	0.000	0.669	1.000
1	0.841	0.478	0.760	0.000
2	0.995	1.000	1.000	0.000
3	1.000	1.000	1.000	0.000
4	1.000	1.000	1.000	0.000
5	1.000	1.000	1.000	0.000
6	1.000	1.000	1.000	0.000

Table 37.8. Whiting 7.a Fishing mortality- (F) -at age.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1980	0.024	0.17	0.409	0.472	0.478	0.479	0.479
1981	0.029	0.207	0.497	0.573	0.582	0.583	0.583
1982	0.033	0.239	0.575	0.663	0.673	0.674	0.674
1983	0.034	0.248	0.596	0.687	0.697	0.698	0.698
1984	0.041	0.297	0.715	0.825	0.837	0.838	0.838
1985	0.05	0.359	0.865	0.997	1.011	1.013	1.013
1986	0.039	0.281	0.677	0.78	0.791	0.792	0.793
1987	0.041	0.296	0.712	0.821	0.833	0.834	0.834
1988	0.035	0.252	0.607	0.7	0.71	0.711	0.711
1989	0.049	0.355	0.854	0.985	0.999	1.001	1.001
1990	0.042	0.303	0.729	0.841	0.853	0.854	0.854
1991	0.043	0.307	0.74	0.853	0.866	0.867	0.867
1992	0.07	0.506	1.217	1.403	1.424	1.426	1.426
1993	0.056	0.403	0.97	1.118	1.134	1.136	1.136
1994	0.058	0.418	1.007	1.161	1.178	1.179	1.179
1995	0.103	0.758	0.898	0.902	0.902	0.902	0.902
1996	0.112	0.824	0.975	0.979	0.979	0.979	0.979
1997	0.098	0.717	0.849	0.853	0.853	0.853	0.853
1998	0.138	1.01	1.195	1.201	1.201	1.201	1.201
1999	0.109	0.797	0.943	0.948	0.948	0.948	0.948
2000	0.141	1.036	1.226	1.232	1.232	1.232	1.232
2001	0.115	0.841	0.995	0.999	1	1	1
2002	0.157	1.151	1.362	1.368	1.368	1.368	1.368
2003	0.078	0.575	0.681	0.684	0.684	0.684	0.684
2004	0.22	1.612	1.908	1.917	1.917	1.917	1.917
2005	0.06	0.437	0.517	0.519	0.519	0.519	0.519
2006	0.193	1.418	1.679	1.686	1.686	1.686	1.686
2007	0.152	1.118	1.323	1.329	1.329	1.329	1.329
2008	0.124	0.907	1.073	1.078	1.078	1.078	1.078

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
2009	0.14	1.026	1.215	1.22	1.22	1.22	1.22
2010	0.146	1.074	1.271	1.277	1.277	1.277	1.277
2011	0.11	0.805	0.952	0.957	0.957	0.957	0.957
2012	0.145	1.063	1.258	1.263	1.264	1.264	1.264
2013	0.084	0.613	0.726	0.729	0.729	0.729	0.729
2014	0.191	1.401	1.658	1.666	1.666	1.666	1.666
2015	0.124	0.913	1.08	1.085	1.085	1.085	1.085
2016	0.071	0.519	0.614	0.617	0.617	0.617	0.617
2017	0.057	0.415	0.491	0.493	0.493	0.493	0.493
2018	0.057	0.414	0.49	0.493	0.493	0.493	0.493
2019	0.093	0.682	0.807	0.81	0.811	0.811	0.811
2020	0.091	0.669	0.792	0.795	0.795	0.795	0.795
2021	0.099	0.728	0.862	0.866	0.866	0.866	0.866

Table 37.9. Whiting 7.a Stock Numbers-at-age (start of year) ('1000).

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1980	543303	406806	132581	22541	7971	1082	1911
1981	317076	180565	153764	42954	7658	2839	1104
1982	281004	104844	65792	45607	13181	2460	1312
1983	881826	92499	36982	18048	12790	3864	1145
1984	632618	289933	32352	9940	4944	3661	1485
1985	513219	206571	96500	7717	2373	1231	1326
1986	872068	166145	64613	19821	1550	496	553
1987	472746	285395	56194	16020	4947	404	283
1988	484038	154396	95116	13447	3838	1236	178
1989	593233	159045	53755	25286	3637	1085	414
1990	516210	192163	49963	11157	5141	769	328
1991	665548	168424	63587	11752	2620	1259	278
1992	230445	217013	55482	14796	2726	634	385
1993	212078	73102	58637	8012	1980	377	146
1994	183038	68243	21891	10846	1426	366	100
1995	339009	58772	20123	3901	1850	252	85
1996	202658	104021	12334	4000	862	431	82
1997	171146	61633	20452	2270	818	186	115
1998	167120	52808	13475	4267	527	200	76
1999	208186	49551	8619	1989	699	91	50
2000	109678	63544	10005	1637	420	156	32
2001	192438	32402	10101	1431	260	70	33
2002	79684	58389	6263	1822	287	55	23
2003	121206	23176	8277	782	252	42	12
2004	94124	38131	5841	2043	215	73	16
2005	106078	25706	3407	423	164	18	8
2006	154477	34009	7441	991	137	56	9
2007	103890	43320	3689	677	100	15	7
2008	148979	30352	6345	479	98	15	3

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
2009	92763	44796	5490	1058	89	19	4
2010	92375	27442	7191	795	170	15	4
2011	151247	27150	4200	984	121	27	3
2012	78928	46116	5440	790	206	27	7
2013	161013	23234	7139	754	122	33	6
2014	196488	50394	5638	1685	198	34	11
2015	123220	55230	5561	524	173	22	5
2016	81525	37021	9933	921	96	34	5
2017	103030	25846	9872	2621	271	30	13
2018	107633	33131	7649	2947	872	95	15
2019	214378	34613	9808	2285	981	306	40
2020	107078	66471	7843	2135	553	251	92
2021	196382	33260	15257	1733	525	143	92
2022	119242	60507	7194	3143	397	127	59

Table 37.10. Whiting 7.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	16777.68	65098.12	35279.22	0.318856	543303.1	0.352142	0.350178	0.319952
1981	18267	3064	21331	21260.44	60560.46	46386.09	0.240546	317076.1	0.425481	0.425772	0.292762
1982	17167	801	17969	17869.68	43451.88	34644.96	0.273053	281003.5	0.446187	0.492646	0.332003
1983	10577	1829	12405	12315.84	29595.21	21732.78	0.352274	881825.6	0.25352	0.510116	0.391793
1984	11619	3380	14999	14698.42	37551.51	14646.8	0.421607	632618.3	0.314123	0.612299	0.353879
1985	15525	2644	18169	17939.59	36881.93	22483.94	0.297368	513218.8	0.344648	0.74031	0.324985
1986	10063	2066	12129	12067.14	28711.32	18028.21	0.325739	872068.1	0.262285	0.579194	0.350435
1987	10411	3859	14270	14058.48	33127.54	16060.94	0.341842	472746.4	0.347163	0.609553	0.323548
1988	10245	1611	11856	11796.65	29932.84	20406.6	0.281277	484038.1	0.323115	0.519509	0.326943
1989	11305	2103	13408	13392.93	26552.4	16898.37	0.309355	593233.1	0.267113	0.731426	0.32207
1990	8212	2444	10656	10633.81	24215.74	12532.24	0.330763	516210.1	0.250499	0.624308	0.305843
1991	7348	2598	9946	9911.575	22671.57	13492.49	0.263406	665548.1	0.168403	0.633543	0.252974
1992	8588	4203	12791	12555.59	21940.34	11523.71	0.210731	230444.8	0.151741	1.041951	0.182648
1993	6523	2707	9230	6749.623	12706.2	9321.555	0.151584	212078.4	0.130277	0.83005	0.166388
1994	6763	1173	7936	4983.258	8518.981	5366.164	0.159371	183037.6	0.136398	0.861892	0.173015
1995	4893	2151	7044	4536.276	6647.761	3867.851	0.16208	339008.6	0.117761	0.852515	0.168255
1996	4335	3631	7966	4376.071	7042.328	2673.437	0.185084	202658.5	0.128018	0.925821	0.146303
1997	2277	1928	4205	3001.332	5191.624	2929.691	0.150122	171146	0.13877	0.806479	0.164046
1998	2229	1304	3533	2885.702	4122.945	2422.512	0.158984	167119.8	0.129697	1.135113	0.16357
1999	1670	1092	2762	2246.251	2981.87	1430.936	0.196543	208186.5	0.127266	0.895955	0.175087
2000	762	2118	2880	2354.155	3388.852	1406.278	0.189066	109678	0.13846	1.164767	0.150657
2001	733	1012	1745	1619.083	2191.775	1242.383	0.171936	192438.2	0.130016	0.944997	0.180667
2002	747	740	1487	1888.927	2801.794	1108.518	0.193556	79683.62	0.135574	1.293595	0.154592
2003	517	480	996	1278.184	1765.711	1114.463	0.170001	121206.1	0.148153	0.646684	0.234411
2004	133	905	1038	2065.423	2282.334	1184.153	0.196199	94124.07	0.123805	1.812313	0.161633
2005	125	272	397	508.3343	1307.047	476.7326	0.256412	106078.1	0.137889	0.490919	0.275015
2006	64	1773	1837	2567.899	2106.984	981.298	0.215694	154476.8	0.125462	1.594417	0.177927
2007	35	1512	1547	1521.477	2043.839	518.9917	0.270544	103889.6	0.130456	1.256744	0.165539

Year	Lan	Dis	Cat	CatPred	Tsb	Ssb	SsbCv	Recr	RecrCv	Fbar	FbarCv
2008	37	1169	1206	1284.081	1607.203	663.2622	0.206766	148978.8	0.124407	1.019516	0.189031
2009	39	1321	1360	1496.776	2158.052	675.3145	0.212731	92762.62	0.133211	1.153808	0.171502
2010	30	1154	1184	1450.439	1653.5	758.9044	0.19121	92374.78	0.127546	1.207466	0.184154
2011	31	946	977	979.999	1402.276	552.4963	0.22963	151247	0.125338	0.904552	0.193787
2012	60	1339	1399	1433.416	2101.441	625.7129	0.211854	78928.24	0.134502	1.194523	0.167598
2013	33	948	981	1036.867	1541.642	765.628	0.196989	161012.6	0.139679	0.68917	0.219032
2014	23	1951	1974	2639.152	2727.158	867.623	0.21061	196488.1	0.117564	1.575067	0.172063
2015	28	1521	1549	1736.563	2484.049	611.7477	0.251313	123219.9	0.115493	1.026047	0.175304
2016	15	765	780	818.2394	2019.811	879.5625	0.179828	81525.18	0.12617	0.583254	0.200581
2017	36	668	704	697.6882	1866.634	1075.751	0.162919	103030.4	0.122207	0.466113	0.212453
2018	46	853	899	876.8681	2139.994	1142.747	0.167832	107632.6	0.138471	0.465702	0.210078
2019	172	1089	1261	1419.745	2262.81	1259.039	0.16592	214378.1	0.135569	0.766307	0.226476
2020	88	1030	1118	1223.628	2693.506	1018.429	0.220133	107077.7	0.173239	0.751817	0.265065
2021	91	1571	1662	1674.597	2261.635	1346.999	0.209926	196381.9	0.237435	0.818499	0.295761
2022*	NA	NA	NA	NA	NA	991.7084	NA	119242	NA	0.778874	NA

Table 37.11. Whiting 7.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.

2022										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	119242	1.078	0	0	0	0	0	0	0.094	0.022
1	60507	0.803	0	0	0	0.028	0.072	0.062	0.621	0.035
2	7194	0.718	1	0	0	0.059	0.342	0.256	0.478	0.084
3	3143	0.608	1	0	0	0.132	0.598	0.335	0.226	0.134
4	397	0.554	1	0	0	0.225	0.751	0.358	0.073	0.178
5	127	0.518	1	0	0	0.328	0.807	0.43	0.017	0.146
6	59	0.518	1	0	0	0.384	0.814	0.381	0.009	0
2023										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	119242	1.078	0	0	0	0	0	0	0.094	0.022
1	36917	0.803	0	0	0	0.028	0.072	0.062	0.621	0.035
2	13558	0.718	1	0	0	0.059	0.342	0.256	0.478	0.084
3	1545	0.608	1	0	0	0.132	0.598	0.335	0.226	0.134
4	751	0.554	1	0	0	0.225	0.751	0.358	0.073	0.178
5	100	0.518	1	0	0	0.328	0.807	0.43	0.017	0.146
6	49	0.518	1	0	0	0.384	0.814	0.381	0.009	0
2024										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	119242	1.078	0	0	0	0	0	0	0.094	0.022
1	36917	0.803	0	0	0	0.028	0.072	0.062	0.621	0.035
2	8272	0.718	1	0	0	0.059	0.342	0.256	0.478	0.084
3	2912	0.608	1	0	0	0.132	0.598	0.335	0.226	0.134
4	369	0.554	1	0	0	0.225	0.751	0.358	0.073	0.178
5	189	0.518	1	0	0	0.328	0.807	0.43	0.017	0.146
6	39	0.518	1	0	0	0.384	0.814	0.381	0.009	0

Table 37.12 Whiting 7.a. Single-option output of the short-term forecast (F = mean F 2019–2021). Numbers in thousands, weights in tonnes.

2022										
Age	F (lan)	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.094	6635	144	119242	0	0	0
1	0.072	0	0	0.621	21745	761	60507	1700	0	0
2	0.342	97	25	0.478	2915	244	7194	424	7194	424
3	0.598	553	186	0.226	823	110	3143	414	3143	414
4	0.751	136	49	0.073	41	7	397	89	397	89
5	0.807	53	23	0.017	4	1	127	42	127	42
6	0.814	27	10	0.009	0	0	59	23	59	23
Total	0.337	866	293	0.442	32163	1267	190669	2692	10920	992
2023										
Age	F (lan)	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.094	6635	144	119242	0	0	0
1	0.072	0	0	0.621	13267	464	36917	1037	0	0
2	0.342	183	47	0.478	5493	460	13558	799	13558	799
3	0.598	272	91	0.226	405	54	1545	204	1545	204
4	0.751	258	92	0.073	78	14	751	169	751	169
5	0.807	42	18	0.017	3	0	100	33	100	33
6	0.814	22	8	0.009	0	0	49	19	49	19
Total	0.337	777	256	0.442	25881	1136	172162	2261	16003	1224
2024										
Age	F (lan)	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.094	6635	144	119242	0	0	0
1	0.072	0	0	0.621	13267	464	36917	1037	0	0
2	0.342	111	28	0.478	3352	280	8272	488	8272	488
3	0.598	513	172	0.226	763	102	2912	384	2912	384
4	0.751	127	45	0.073	38	7	369	83	369	83
5	0.807	80	34	0.017	6	1	189	62	189	62
6	0.814	18	7	0.009	0	0	39	15	39	15
Total	0.337	849	286	0.442	24061	998	167940	2069	11781	1032

Table 37.13. Whiting 7.a. Management options table. Weights in tonnes.

Fmult	Catch23	Land23	Dis23	Basis	FCatch23	FLand23	FDis23	SSB24	dSSB	dTac
0	0	0	0		0	NA	NA	2211	80.79%	-100%
0.1	181	35	146		0.078	0.0119	0.066	2048	67.46%	-75.04%
0.2	350	67	283		0.156	0.024	0.132	1897	55.11%	-51.73%
0.3	510	97	413		0.23	0.036	0.198	1758	43.75%	-29.68%
0.4	660	125	535		0.31	0.048	0.26	1629	33.20%	-9.02%
0.5	801	151	650		0.39	0.06	0.33	1509	23.39%	10.40%
0.6	934	175	758		0.47	0.072	0.4	1398	14.31%	28.71%
0.7	1059	198	861		0.55	0.083	0.46	1296	5.97%	46.05%
0.8	1177	219	958		0.62	0.095	0.53	1201	-1.80%	62.28%
0.9	1288	238	1049		0.7	0.107	0.59	1113	-8.99%	77.53%
1	1393	257	1136		0.78	0.119	0.66	1031	-15.70%	92.09%
1.1	1492	273	1218		0.86	0.131	0.73	956	-21.83%	105.83%
1.2	1586	289	1296		0.93	0.143	0.79	886	-27.56%	118.72%
1.3	1674	304	1370		1.01	0.155	0.86	821	-32.87%	130.93%
1.4	1758	318	1441		1.09	0.167	0.92	761	-37.78%	142.58%
1.5	1838	330	1508		1.17	0.179	0.99	705	-42.36%	153.54%
1.6	1914	342	1571		1.25	0.191	1.06	654	-46.53%	163.94%
1.7	1985	354	1632		1.32	0.2	1.12	606	-50.45%	173.79%
1.8	2053	364	1689		1.4	0.21	1.19	562	-54.05%	183.22%
1.9	2118	374	1744		1.48	0.23	1.25	521	-57.40%	192.23%
2	2180	383	1797		1.56	0.24	1.32	483	-60.51%	200.69%
2.1	2238	392	1847		1.64	0.25	1.39	448	-63.37%	208.74%
2.2	2294	400	1895		1.71	0.26	1.45	415	-66.07%	216.51%
2.3	2348	407	1941		1.79	0.27	1.52	385	-68.52%	223.86%
2.4	2399	414	1985		1.87	0.29	1.58	357	-70.81%	230.93%
2.5	2447	421	2027		1.95	0.3	1.65	331	-72.94%	237.73%

Table 37.14. Whiting 7.a. Management options Advice table. Weights in tonnes.

Catch23	Land23	Dis23	Basis	FCatch23	FLand23	FDis23	SSB24	dSSB	dTac
481	92	389	FMSY	0.22	0.034	0.185	1783	45.79%	-33.70%
39	8	32	FMSY x SSB(2023)/MSY Btrigger	0.0164	0.0025	0.0139	2175	77.84%	-94.59%
0	0	0	F = 0	0	0	0	2211	80.79%	-100%
1393	257	1136	F = Fsq	0.78	0.119	0.66	1031	-15.70%	92.09%
767	145	622	F = Flim	0.37	0.057	0.31	1538	25.76%	5.69%
481	92	389	F = Fpa	0.22	0.034	0.185	1783	45.79%	-34%
355	68	287	Min FMSY	0.158	0.024	0.134	1893	54.78%	-51.04%
28	5	23	Min FMSY x SSB(2023)/MSY Btrigger	0.0119	0.00181	0.01	2185	78.66%	-96.12%
481	92	389	Max FMSY	0.22	0.034	0.185	1783	45.79%	-33.70%
39	8	32	Max FMSY x SSB(2023)/MSY Btrigger	0.0164	0.0025	0.0139	2175	77.84%	-94.59%
1149	214	935	Stable SSB	0.6	0.092	0.51	1223	0%	58.39%
850	160	690	SSB * 1.2	0.42	0.064	0.35	1468	20.03%	17.20%
616	117	499	-15% TAC	0.29	0.044	0.24	1666	36.22%	-14.98%
721	136	585	Stable TAC	0.35	0.053	0.29	1573	28.62%	0%
834	157	677	+ 15% TAC	0.41	0.062	0.35	1481	21.10%	14.98%

37.14 Figures

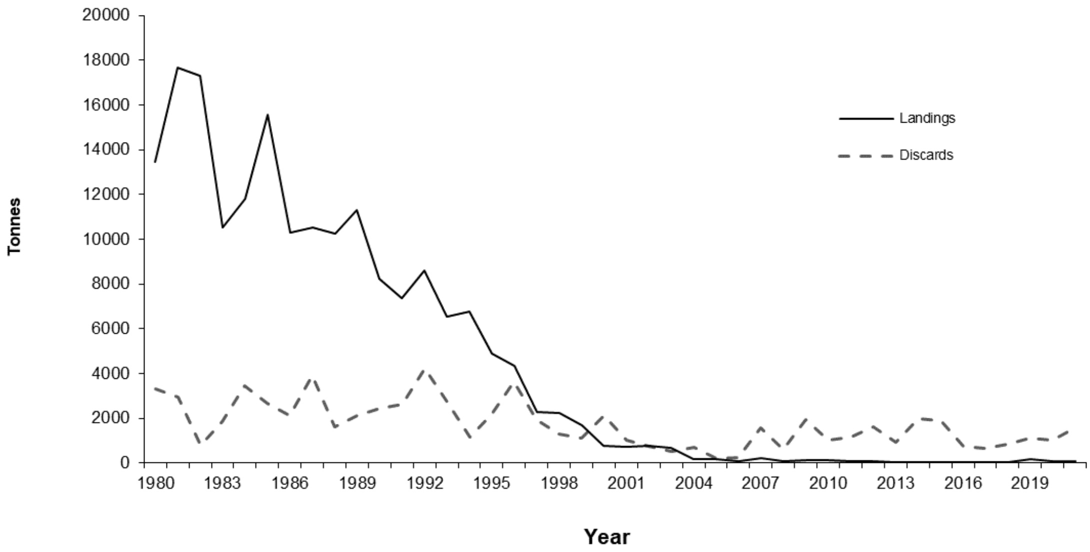


Figure 37.1. Whiting 7.a. Working group estimates of International landings and discards.

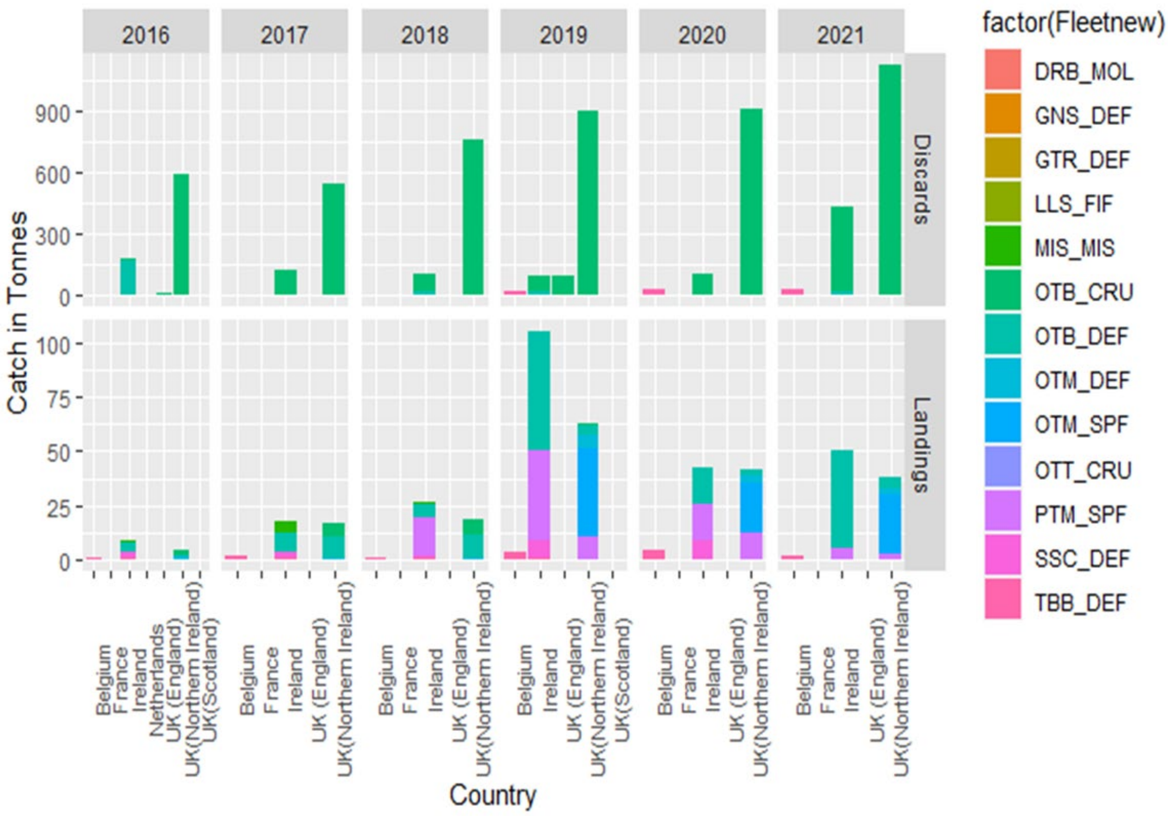


Figure 37.2. Whiting 7.a. Landings and discards by fleet.

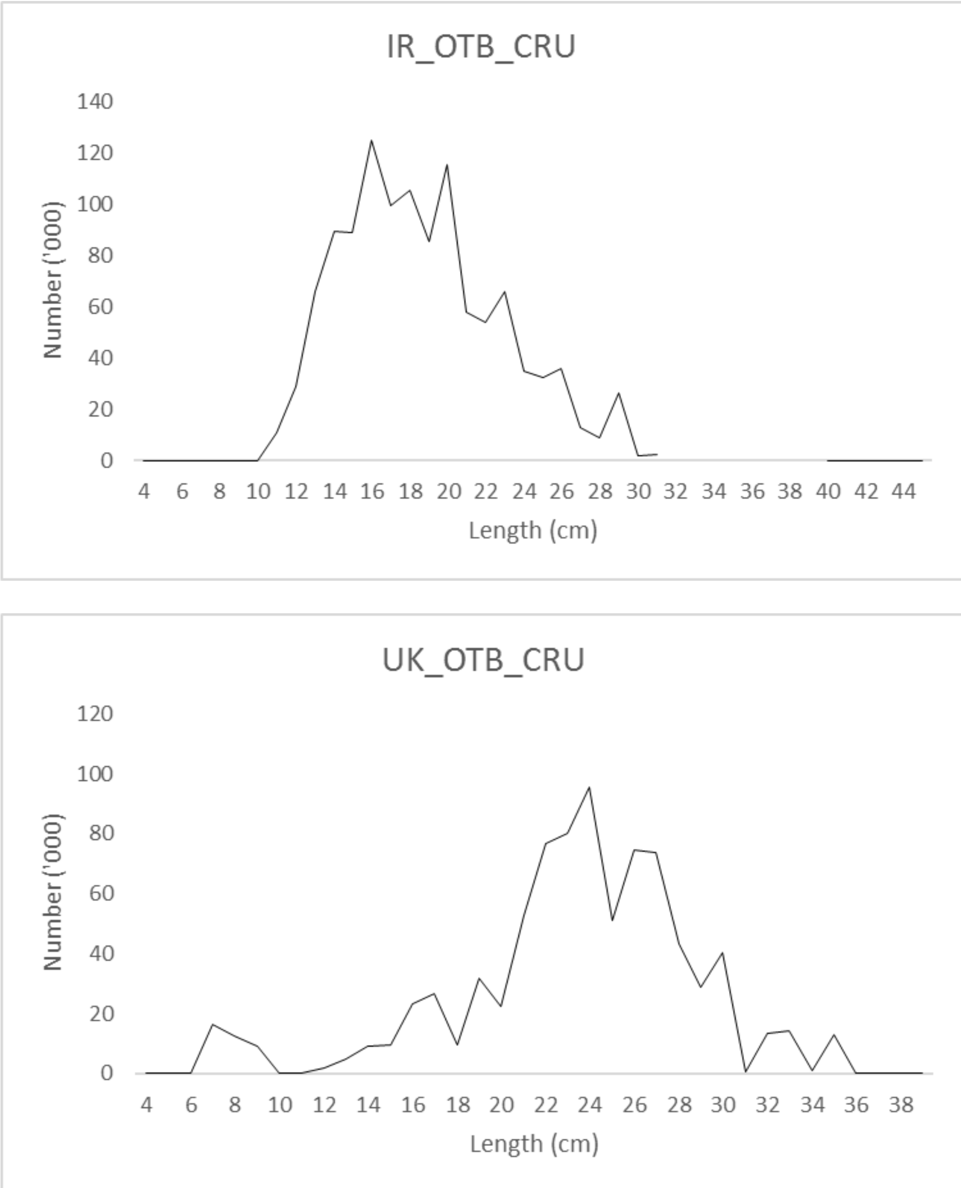


Figure 37.3. Whiting 7.a. discard length–frequency by national fleets for the OTB_CRU métier. Note due to low levels of retained catch, and hence low sampling, these data are not presented. Not updated at WGCSE, 2021.

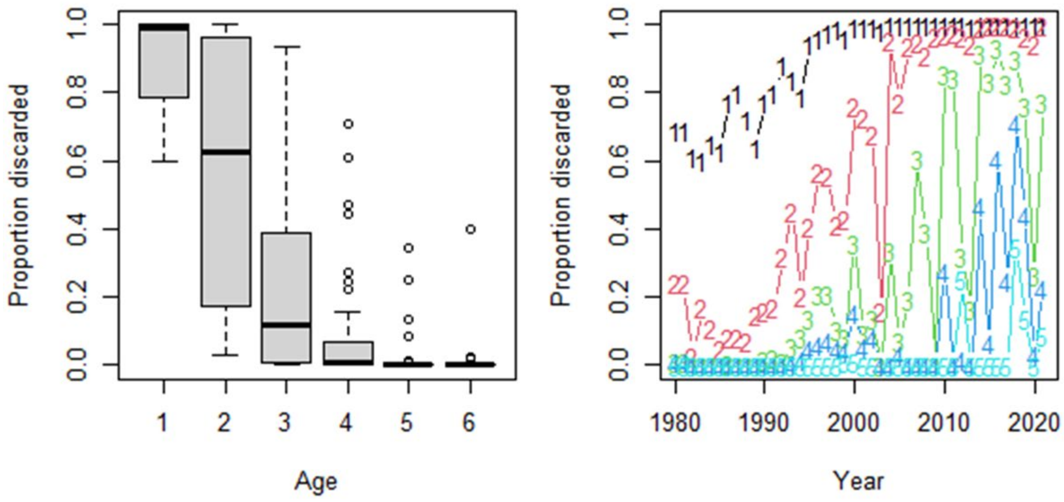


Figure 37.4. Whiting 7.a. Proportion of discards by age (left) and year (right).

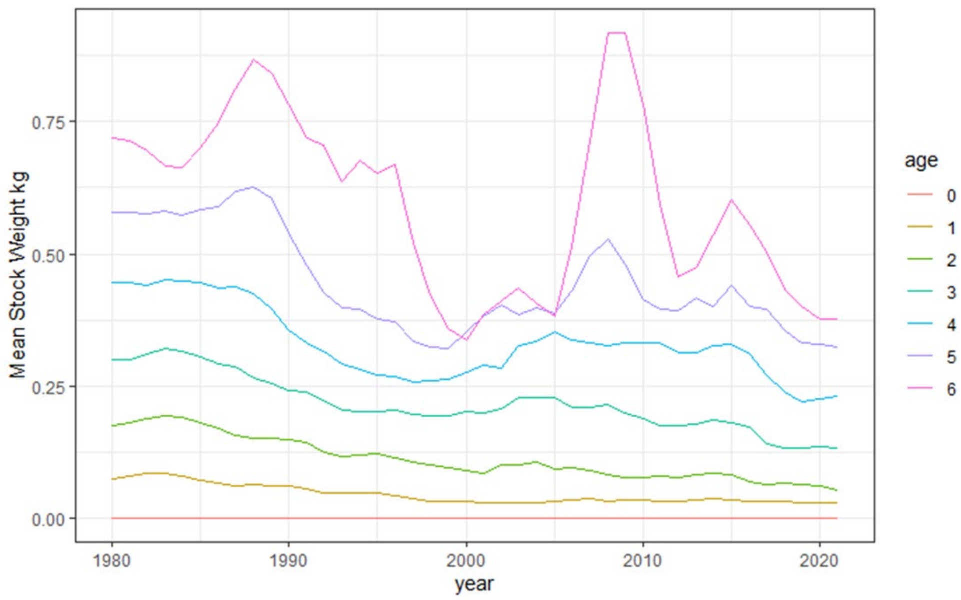


Figure 37.5. Whiting 7.a. Smoothed Stock Weights (Three year running average).

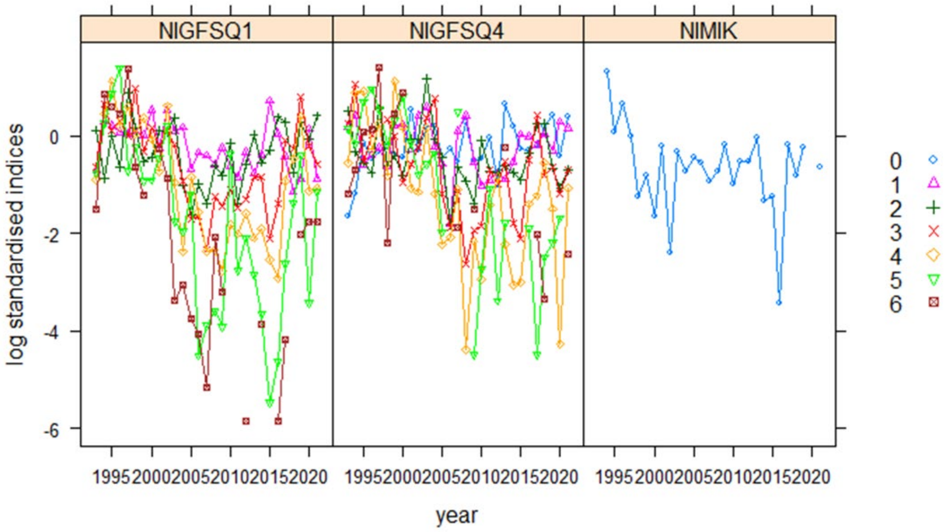


Figure 37.6. Whiting 7.a. Log Standardized indices of tuning fleets by cohort.

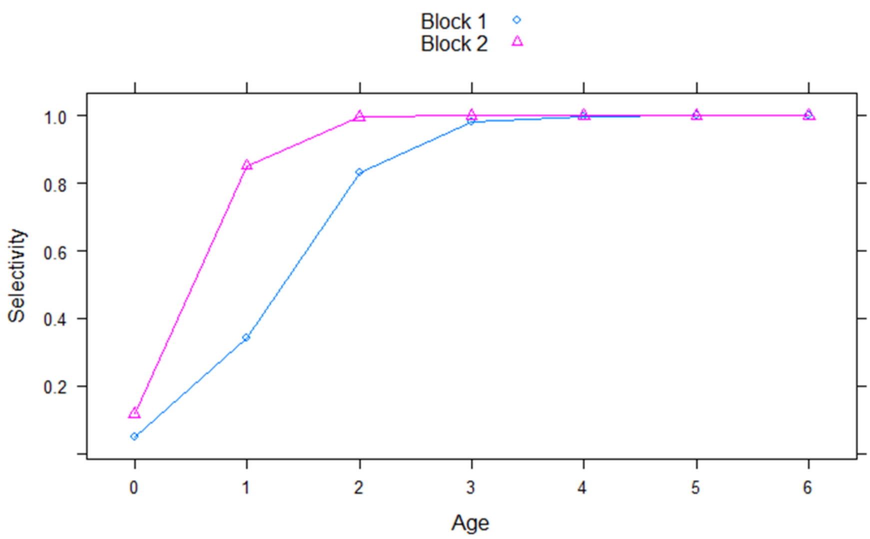


Figure 37.7. Whiting 7.a. Selectivity-at-age in the Catch.

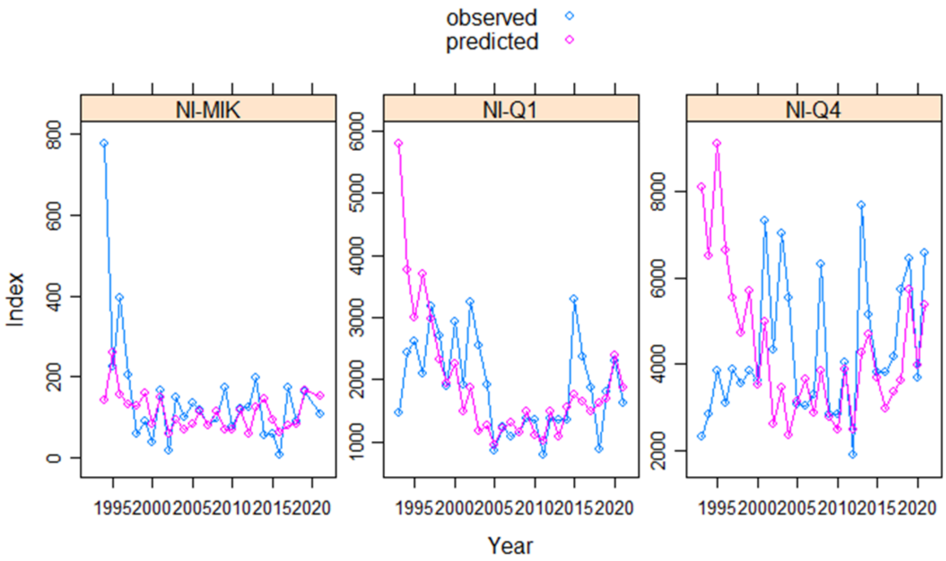


Figure 37.8. Whiting 7.a. Observed and Predicted index CPUE.

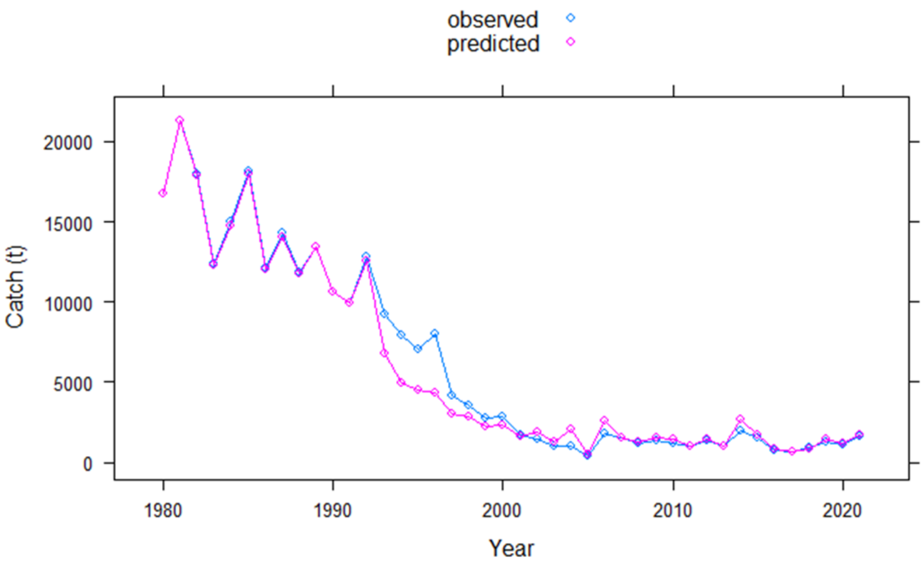


Figure 37.9. Whiting 7.a. Observed and Predicted catch.

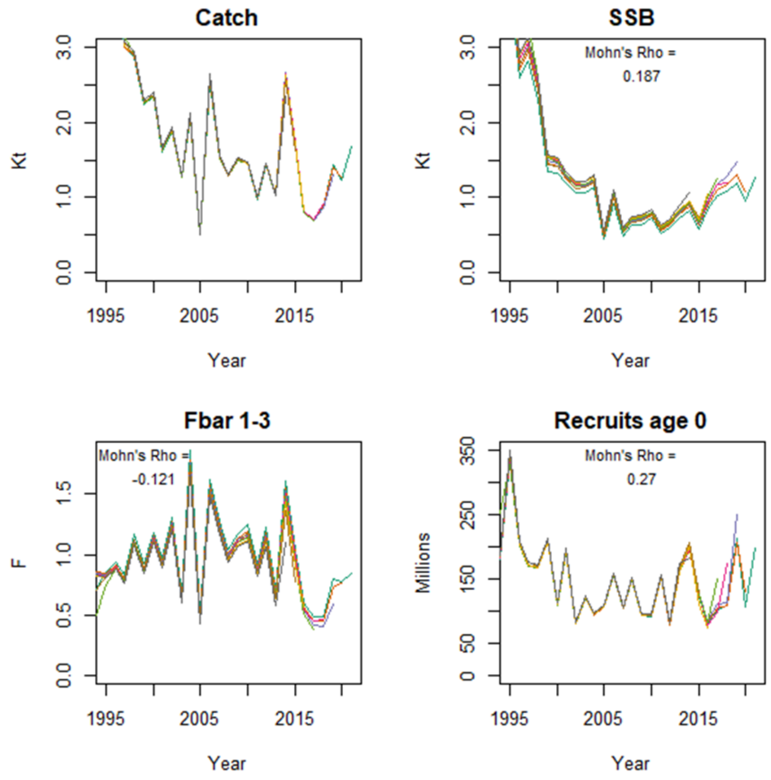


Figure 37.10. Whiting 7.a. Retrospective analysis of the final ASAP run with Mohn's Rho calculation. Image shows >5 peels but calculation is based on five peels only.

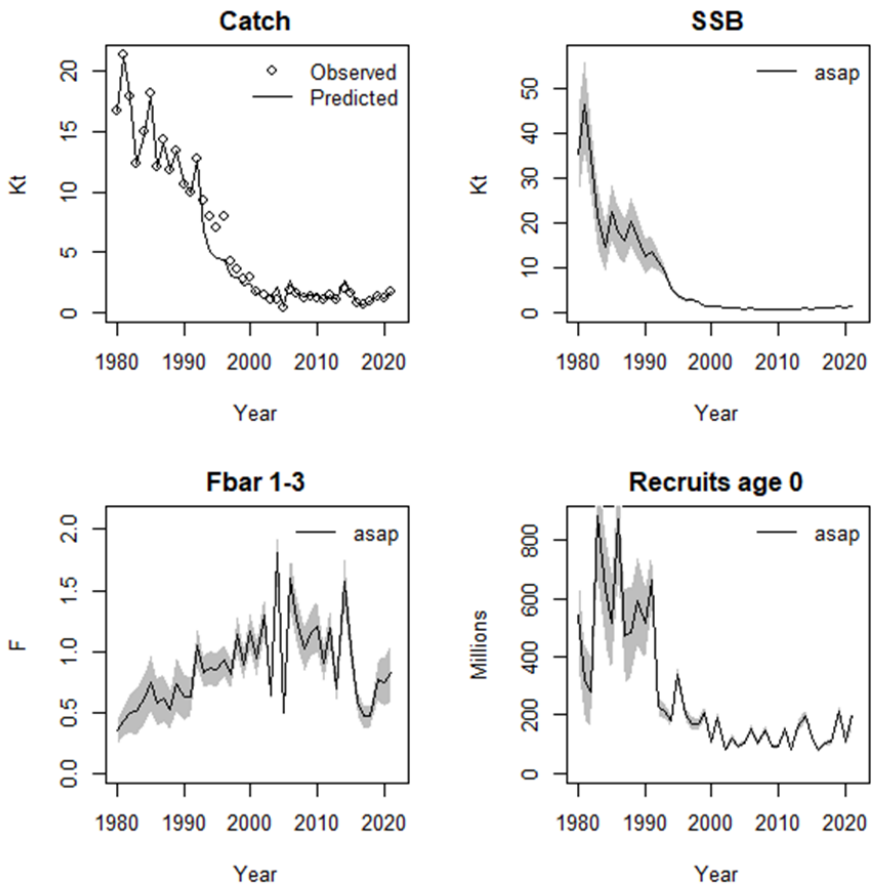


Figure 37.11. Whiting 7.a. Stock Summary Plot. The thick black line represents the ASAP assessment. Standard deviations from ASAP are shaded grey. The thick black line in the catch plot represents the predicted catch from ASAP.

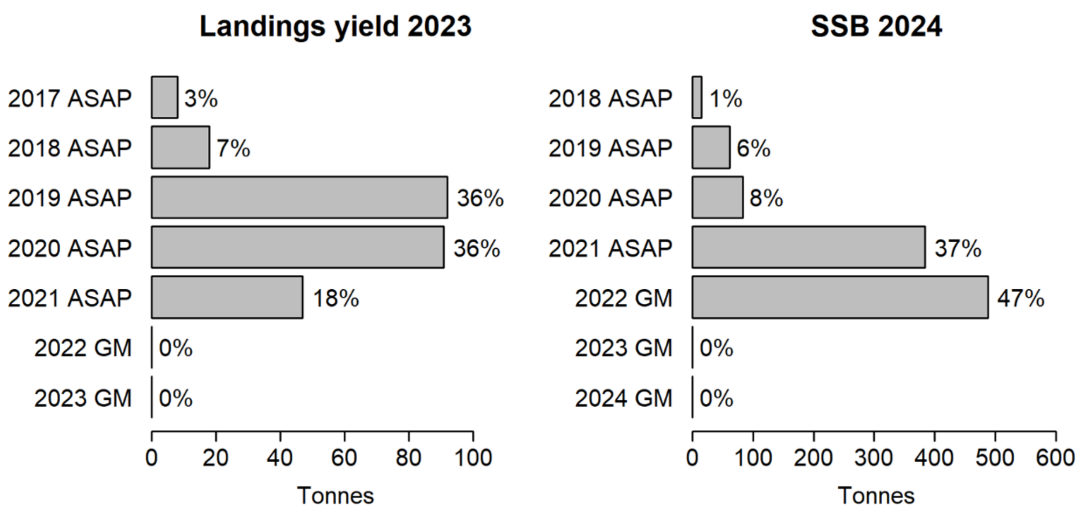


Figure 37.12. Whiting 7.a. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

38 Whiting (*Merlangius merlangus*) in divisions 7.b–c and 7.e–k (southern Celtic Seas and eastern English Channel)

Type of assessment in 2022

This stock assessment was benchmarked in 2020 (ICES, 2020). The model has been changed to a stochastic State–Space Assessment Model (SAM) and detailed in the Stock Annex. An inter-benchmark was also carried out for this stock in 2021 (ICES, 2021). The model input data were updated with additional discard data, re-estimated weights-at-age, and a revision to the allocation of sampling across catch. Reference points were revised accordingly.

ICES advice applicable to 2022

ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 4452 tonnes.

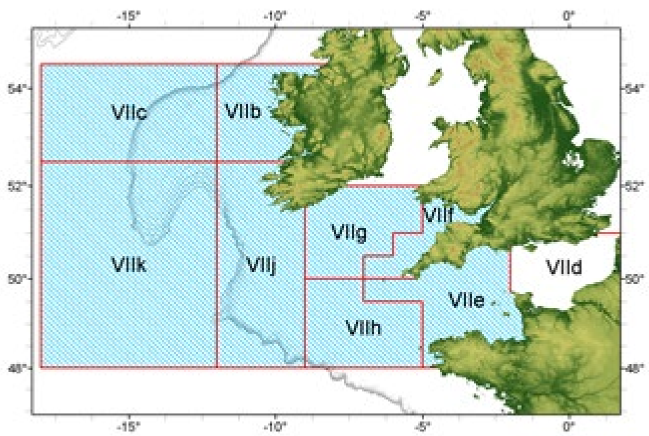
ICES advice applicable to 2021

ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2021 that correspond to the F ranges in the MAP are between 4458 tonnes and 5261 tonnes.

38.1 General

Stock description and management units

The TAC for whiting is set for divisions 7.b, 7.c, 7.d, 7.e, 7.f, 7.g, 7.h, 7.j and 7.k. The assessment area does not correspond to the TAC area. Since the 2014 Benchmark (WKCELT), Whiting in 7.b,c are now assessed as part of 7.bc, e–k, while whiting in 7.d remain part of the WGNSSK assessment of the North Sea stock. Any management measures implemented for this stock should be consistent with the assessment area.



Red Boxes-TAC/Management Areas Blue Shading-Assessment Area.

The TAC for whiting 7.bc, e–k decreased from 19 184t (2019) to 8352t (2022). ICES official landings for whiting 7.bc, e–k in 2022 are 6153 t and estimated catch of 7197 t. Thus, the current TAC for whiting catches in the 7.b–ce–k stock area is not restrictive in the 7.bc, e–k assessment area.

TAC in 2022/109

Species:	Whiting *Merlangius merlangus*	Zone:	7b, 7c, 7d, 7e, 7f, 7g, 7h, 7j and 7k (WHG/7X7A-C)
Belgium	63	Analytical TAC Article 7[1] of this Regulation applies	
France	3 959		
Ireland	3 328		
Netherlands	33		
Union	7 383		
United Kingdom	969		
TAC	8 352		

Landings obligation

Since 2017 the landings obligation (LO) has applied to this stock in accordance with Delegated Regulation (EC, 2016) superseded by (EU) 2019/2239[1]. This implies that all catches of whiting in the Celtic Sea and Western Channel by those vessels must be landed. However, a 6% *de minimus* applies to bottom trawls using a mesh size of ≥80 mm, as well as pelagic trawls and beam trawls using 80–119 mm mesh. There are also three specific technical measures in operation for vessels using bottom trawls or seines in the Celtic Sea Protection Zone.

A significant proportion of unwanted catch is above the Minimum Conservation Reference Size (MCRS = 27 cm) in whiting, although discards are assessed by ICES to have reduced in 2019 to 14% from 48–17% for 2016–2018 respectively. Whiting is also the least limiting stock for most fleets in a mixed-fishery context for the Celtic Sea, where cod is most commonly considered the choke species. In this context it is difficult to accurately predict the impact of the LO on Celtic Sea whiting.

38.2 The fishery in 2021

ICES officially reported landings for divisions 7.b-ce–k and landings as used by the Working Group are given in Tables

Table 1 1. In addition, landings for 7.d are included for comparison to the 7.b–k TAC (i.e. management area).

The 7.bc, e–k whiting stock is primarily targeted by otter trawlers and to a lesser extent Scottish seines and beam trawls. An overview of landings by fleet is given in Table 2 and more generally effort trends in fleets catching whiting in the Celtic Sea is provided by STECF (STECF, 2018).

The spatial distribution of international otter trawl effort by country 2014–2018 is given in Figure 1. Irish OTB effort is primarily from within 7.g (the Smalls fishing grounds gadoid fishery) and

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R2239

to a lesser extent 7.j and the Porcupine Bank (*Nephrops* fishery). In previous years, French landings have exhibited similar spatial and temporal focus around the Smalls.

38.3 Data

Catch

A general data handling approach was agreed during the WKCELTIC 2020 preparatory data workshop and reviewed again during IBPCSWhiting (ICES, 2021) following an error in the data and codesed to allocate sampling to un-sampled catch data. Data is submitted to Intercatch (IC) by France, Ireland, Belgium, UK, Spain and the Netherlands. A standardized approach to international catch data exploration and QC is taken across the cod, haddock and whiting stocks in the form of a shared R markdown document[2]. In so far as is possible, the allocation of sampling to un-sampled métiers is likewise standardized across stocks using the same R markdown template and editing only where necessary.

Fishery-dependent data are therefore collated in InterCatch, but raised and documented outside of InterCatch using these shared open source R Markdown documents.

Raising of un-sampled catches to International CNAA is implemented using a simple hierarchy for available samples where priority was given to the same:

i. Country & Season & Year
ii. Season & Year
iii. Year

With gears into to either: GNS_DEF, OTB_CRU, OTB_DEF, TBB_DEF and MIS_MIS.

Discard raising is likewise implemented where samples were missing by estimating ratios at three levels:

i. Year, country and gear
ii. Year and gear
iii. Year

The international catch numbers-at-age are given in Table 3 and Figure 2. It is possible to track the strong 1999 and 2013 year classes, but the strong 2009 recruitment is only apparent at some older ages. Generally, the proportion of un-sampled catch that requires raising is minimal Figure 3, this inevitably increased somewhat during Covid-19, but was still deemed moderate compared to historic data for many stocks. The age distribution has remained similar over time with the exception of periods where strong year classes pass through older ages. Discarding of age 2 and above highlights significant fishing mortality above the minimum conservation reference size (MCRS – 27 cm).

While poorly represented in the survey data, the 0-group age class is incorporated into the assessment data to allow inclusion of 0-group indices, although catches at this age are not minimal in most years. Catch weights-at-age and mean weights-at-age in the catch are given in Table 4 and 5 respectively. Rivard corrected stock weights (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, but 0–5 yr old corrected weights are relatively stable. There is a notable increase in the 0-group stock weight from the previous year and drop in 1-

[2]https://community.ices.dk/ExpertGroups/benchmarks/2019/wkceltic/2014%20Meeting%20docs/02.%20Background%20documents/WHG/aggregate_IC_data_whg.27.7b-ce-k_Oct_2020.html

group so they appear to overlap. This not so apparent in the mean weights-at-age, but a down-weighting of the 1-group fish in the Rivard correction process due to a low value in 2020. In contrast 0-group fish have returned to a more average value.

Discards

The time-series of discard data was revised by WKCELTIC and are included in the assessment. Procedures for raising discards to international catch-at-age are summarised above and detailed in the stock annex. More accurate national data, and for more Member States, are now available through InterCatch. Historically, Irish and French OTB discards were simply raised to international landings to produce an estimate of discards-at-age.

A summary of discarding rates-at-age for the time-series 2003–2021 available in InterCatch is presented in Figure 5. The two main fleets exploiting whiting, FRA_OTB and IRL_OTB, have shown some downward trend in discarding in recent years. The remaining lesser métiers have remained largely constant over time. Numbers and weights by age and country for the most recent data year (2021) are given in Table 7 for both landings and discards.

Figure 6 presents the proportion of landings and discards. The data indicate that the proportion of young being landed, versus discarded, has increased significantly in the last four years suggesting a distinct shift towards landing more fish around the MCRS.

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.

Mortality Ogive

Age	0	1	2	3	4	5	6	7+
Proportion Mature	1.22	0.86	0.65	0.50	0.43	0.40	0.38	0.36

Maturity was historically knife-edge at age 2, but has been replaced at the Benchmark to a revised maturity ogive based on survey data.

Maturity Ogive

Age	0	1	2	3	4	5	6	7+
Proportion Mature	0	0.61	0.94	0.97	0.97	1	1	1

Surveys

Two IBTS Q4 surveys, FR-EVHOE and IE-IGFS, have been combined to provide the survey index for the assessment of Celtic Sea whiting since the previous benchmark in 2014.

Issues with survey data gaps in particular, highlighted by WGCSE for review by the benchmark, led to significant work being undertaken to implement a modelling approach to survey index calculation. The approach selected was the VAST (Vector Autoregressive Spatio-Temporal) model (www.github.com/james-thorson/VAST).

Internal consistency is >47% for all age classes above 0-group and ca. 70% for ages 2:3 (Figure 7). However, following evaluation with different survey age ranges during assessment model fitting, the survey index was truncated to 0–2 (Table 8).

Log mean standardised indices are given in Figure 8. Plot by cohort the index has got quite noisy in recent years. Plotting by years shows a marked downward trend since 2015 across age classes.

Commercial lpue

An updated French commercial tuning fleet for whiting was made available (Table 9). The Working Document Laviale et al 2019[3] details the issues raised by the old commercial tuning fleet and the work done to provide the updated French commercial tuning index. In summary, the list of species and the threshold used to select trips has been modified to better account for the fact that cod is no longer a target of these fisheries, but more a bytcatch of whiting and haddock directed fisheries. Moreover, the commercial tuning now accounts for both landings and discards. While the French otter trawl fleet generally accounts for ca. 45% of the landings it is ostensibly concentrated around the 7.d Channel area and eastern Celtic Sea.

38.4 Historical stock development

A State–space (SAM) assessment is used for this stock applying the settings as agreed at WKCELTIC. Runs are available at Stockassessment.org. The full time-series was used (1999–2021) with one survey index (VAST) and one commercial index (FRA-OTB-lpue). The settings are detailed within the stock annex.

Data screening

The methodology agreed at WKCELTIC is implemented and documented as an R Markdown document and available on the WGCSE[4] SharePoint site. For consistency, routine exploratory analysis was carried out in parallel as in previous years using FLR under R version 4.0.5. The packages FLCore 2.6.18, and FLXSA 2.6.4 and FLEDA 2.5 were used.

Final update assessment

The final assessment was run as per https://www.stockassessment.org/setStock.php?stock=whg.7b-ce-k_WGCSE22_RevRec.

Final model inputs and settings were:

[3] https://community.ices.dk/ExpertGroups/benchmarks/2019/wkceltic/2014%20Meeting%20docs/04.%20Working%20documents/WD_03_WKCELTIC%20-%20French%20commercial%20tuning%20fleets_Final_2020.pdf

[4] https://community.ices.dk/ExpertGroups/wgcse/2022%20Meeting%20Documents/06.%20Data/whg-7b-ce-k/aggregate_IC_data_whg.27.7b-ce-k_Sept_2022.html

• *Full time-series of catch data(1999 to 2021, ages 0 to 7+)*
• *Model-filled discards for ages 5–7+ in 1999–2002*
• *VAST Model index for ages 0–2 from IGFS:EVHOE 2003–2020*
• *French Commercial biomass index in Kg/Hr for 2000–2020*
• *Fishing mortality states were bound for ages 6+*
• *Catchability for ages 1+ were bound for the survey index*
• *Default settings for remaining configuration*
• *Observation error on the first age in the survey was estimated separately from the older ages (i.e. ages 1–2 were bound).*

Fishing mortality-at-age and stock numbers-at-age are presented in Tables 10 and 11 respectively. Summary plots for SSB, Fbar and Recruitment are given in Figure 9. The last small pulse in recruitment in 2013 resulted in a small rise in SSB as harvestable 2-year olds in 2015. With poor recruitment since there has been little to bolster the stock or fishery since 2016.

Model fits to the data are presented in Figure 10. The overall fit to catch data are reasonably good and the IBTS survey observations are also oscillating around the SAM model. Fit for the commercial biomass index is less predictable however, possibly due in part to spatial coverage. The same patterns are reflected in the residuals presented in Figure 11 with 0–2yr old indices slightly higher than predicted for last year and catch observations conversely appearing slightly lower for 0-group and ages 4+.

Comparison with previous assessments

Preliminary runs showed improving precision over the previous year's assessment, but with a continuing retrospective bias highlighted by the Mohn's Rho values (Figure 11). Spawning–stock biomass being somewhat over estimated annually and fishing mortality being consistently revised upwards. The positive residual patterns for the FRA-OTB biomass index was discussed and exploratory runs presented excluding this index, but felt a significant deviation to implement outside a benchmark process.

State of the stock

Trends in landings, $F_{(2–5)}$, SSB, and recruitment are presented in Table 12. For the recent time-series, SSB displays a peak biomass in 2010 following relatively strong recruitment from the 2008–2009 year classes. Again in 2014–2015 following the 2013 recruitment.

Fishing mortality (F_{bar}) increased between 2012 and 2016, but is now assessed to be just below F_{lim} but above F_{MSY}. SSB is estimated to be increasing slowly, but still below agreed reference points.

38.5 Short-term projections

The short-term projections were carried out in SAM (stockassessment.org) as described in the stock annex. However, given the apparent bias a revision to the recruitment assumption was used span only the recent seven years from 2015–2021 rather than starting in 2010. This would remove the moderately high 2013 recruitment point producing a more conservative estimate of recruitment and therefore SSB in the forecast.

Whiting in the Celtic Sea, as with many gadoid fisheries, is heavily reliant on younger age classes and therefore recruitment. Recruitment is highly sporadic and thus the span over which a mean or median recruitment assumption is taken for the intermediate year is important. Historically this was taken as GM for the time-series minus the last year. Following discussion at WKCELTIC, and further the ADG, this was revised to median since 2010 which covers the more modern history of the stock. The median resampled recruitment then from 2010–2021 in 000s was estimated as 507 319 and with the final 2015–2021 year range as 400 108. This was used as 0-group numbers in the forecast for 2022–2023.

Table 13 gives the management options table. Given the probability of SSB being below B_{lim} of >50% for all scenarios other than zero catch, F=0 is advised. Fishing at 0 gives a 40% likelihood of being below B_{lim} with a spawning–stock biomass forecast of 38 ,109 t. The assumed recruitment in 2022 and 2023 used in the forecast constitutes a significant part (49.1%) of the projected SSB in 2024 (Figure 13).

The basis for the catch forecast is given in Table 14. Whiting is aligned with the other benchmarked species (cod and haddock) in this mixed fishery. A catch constraint is generated by taking the whiting catch predicted by Mixed Fish (9240 t) for F at Haddock F_{MSY}. The resulting Fmix (0.571) was then used as the F assumption in the intermediate year (2022).

38.6 MSY evaluations and Biological reference points

ICES carried out an evaluation of MSY and PA reference points for this stock at IBPCSWhiting (ICES, 2021). The results are summarised below:

Reference points

Reference Point	IBPCSWhiting 2021 Value	WKCELTIC 2020 Value	Rationale
MSY $B_{trigger}$	50 818 t	47 963 t	B_{pa}
F_{msy}	0.375	0.4	From EqSim with segmented regression and fixed break-point (B_{lim}) capped to $F_{p0.5}$.
$F_{msyLower}$	0.315	0.332	Median lower point estimates of (F_{05})
$F_{msyUpper}$	0.375	0.4	$F_{p.05}$
B_{lim}	36 571 t	34 516 t	B_{loss}; lowest observed SSB (2008) from which stock recovery was observed.
B_{pa}	50 818 t	47 963 t	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.20$ (default setting)
F_{lim}	0.64	0.89	F with 50% probability of SSB less than B_{lim}

38.7 Management plans

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

38.8 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. Revised time-series data for 2002–2021 are now included in the assessment with sampling from more countries which should give greater accuracy. While the overall SOP checks have invariably been ≤3%, any difference in the sampled catch-at-age going into the assessment vs those coming out will cause concern. Rather than correct the national data provided, a SOP correction is applied as part of the revised raising procedures outlined above and the stock annex.

Ageing

Cohort tracking in the landings-at-age matrix appears consistent up to age 6. Tracking deteriorates at older ages.

Discards

Discarding has been major feature of most fleets catching whiting in the Celtic Sea. Sampling coverage of discarding has improved over time particularly since 2004. Discard estimates for the UK and Belgium are now included along with those of Ireland and France.

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.

Surveys

The survey indices for whiting are prone to some year effects. However, cohort tracking for the 1+ fish is consistent and has improved further using the VAST modelling approach. There is a noticeable downward trend since 2016 in the indices plotted by year and higher noise when plotted by cohort (Figure 8).

Misreporting

The level of misreporting for this stock is not known. Underreporting has previously been considered unlikely to be a significant source of unaccounted mortality in the assessment because the TAC has been in excess of recent catches.

38.9 Recommendation for next benchmark

The survey indices were truncated from 0–5 year olds down to 0–2 year olds as part of model fit optimization. This should be revisited again to ensure the model is not over fitting to the catch data. Commercial tuning was only available from France at the recent benchmark, whose fleet have a different spatial extent to that of Ireland, the other main country involved in the fishery. Potential to extend the coverage of the commercial tuning index should be examined otherwise whether the SAM fit to the LPUE index is reasonable.

38.10 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 third highest in the time-series. These contributed to catches and SSB in the short term but the upturn in catches and SSB was short lived as recruitment is episodic and SSB is now below all reference points.

Discarding in this stock for different fleets is substantial and highly variable depending on gear and year-class strength. High levels of discarding for a species like whiting reduce the longer term yields one might expect so efforts to improve selection and reduce discards in the mixed fishery should be encouraged. ICES notes the introduction of square-mesh panels in all trawl fisheries operating in ICES divisions 7.fg. It is important that these measures are fully implemented and their effectiveness in reducing discards and the impact on commercial catches is monitored and evaluated. Further gear modifications to increase the likelihood of small whiting passing through the gear, such as introduction of larger minimum mesh sizes, separator panels, or grids may be needed.

Ireland has the only directed fishery for whiting which is part of mixed fishery throughout the Celtic Sea, as well as bycatch within *Nephrops* fisheries. Discard rates are high as a consequence of the low market value of the species, particularly at smaller sizes. High-grading above the MCRS to some extent is also prevalent in most fisheries.

From the 1 February to the 31 March fishing activity has been prohibited within ICES rectangles: 30E4, 31E4, 32E3 (excluding within six nautical miles from the baseline) annually since 2005 to protect the cod stock.

There have been major changes in fleet dynamics over the period of the assessment. Effort in the French gadoid fleet has been declining since 1999, but the effort has fluctuated in recent years due to the way the effort series is derived. Irish otter-trawl effort in 7.b–k has also declined slightly over the time-series.

The full impact of the Landings Obligation is complex and unknown as yet and will depend on whether there is a measurable impact on discarding behaviour or whether variable practices continue and simply data becomes more reliable (for a summary of issues see http://www.discardless.eu/media/results/Celtic_Sea_Year2.pdf).

38.11 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.

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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.

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38.12 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	-	-	-	-		
1999[a]	448	16418	6013	1354	27	24260	4082	20178	5420	25598	31401	
2000	194	9186	5358	1255	39	16032	387	15645	4400	20045	26117	
2001	171	7317	5365	948	31	13832	640	13192	9877	23070	29684	
2002	149	7548	5718	847	35	14297	657	13640	7336	20977	26338	
2003	129	5989	4516	763	21	11418	321	11097	3559	14656	21661	
2004	180	4874	4350	587	132	10123	-66	10189	6481	16670	21953	
2005	218	5913	5774	482	136	12523	312	12211	6700	18911	23812	
2006	128	4710	4570	413	129	9951	291	9660	12031	21691	25440	
2007	127	3574	4864	576	86	9226	139	9087	8456	17543	20934	19900
2008	121	3072	2406	620	35	6255	395	5860	2880	8740	11933	19900
2009	87	2814	2798	827	25	6551	38	6513	4101	10614	17183	16950
2010	102	3463	4330	798	85	8779	191	8588	3008	11596	17729	14407
2011	100	4312	4752	740	174	10077	593	9484	1954	11438	16902	16658
2012	170	3710	5841	764	141	10627	439	10188	2449	12637	16234	19053

	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
2013	226	4006	6888	907	92	12119	188	11931	2512	14443	18700	24500
2014	222	4928	6874	1062	35	13121	274	12847	3977	16824	19954	19162
2015	152	5634	6437	828	97	13149	-25	13174	6101	19275	19954	17742
2016	186	6294	7700	892	39	15110	-69	15179	7278	22457	26187	22778
2017	102	5256	6296	607	32	12293	600	11693	4505	17098	17780	27500
2018	103	3666	4628	592	31	9019	246	8773	1495	10268	12625	22213
2019	73	3203	2599	487	126	6488	946	5542	752	6294	9393	19184
2020*	82	2669	2650	336	90	5827	104	5931	1266	7197	1970	10863
2021*	82	2666	2915	352	66	6082	71	6153	1224	7377	2454	12259

[*]Provisional data.

[a]French Official landings not available, not updated.

Table 2. Whiting in Divisions 7.b-ce-k. Landings (t) by fleet.

LANDINGS	Others	OTB	SSC	TBB	Total	%
BEL	0	14	1	65	81	1%
FRA	120	2561	0	0	2681	44%
IRL	36	1884	1014	38	2973	48%
UK	39	240	10	65	354	6%
Others	1	1	63	0	65	1%
Total	196	4700	1088	168	6153	100%
	3%	76%	18%	3%	100%	

Table 3. Whiting in divisions 7.bc,e–k. The strong 1999 year class is distinct in both the catch and landings data, with evidence of the strong 2009 and 2013 year classes appearing at older ages. Catch numbers-at-age ('000).

1999	**2021**						
0	7						
1							
5370.0	20744.1	25957.7	14662.4	8744.8	8987.8	6670.2	1498.7
8176.3	26561.7	26303.7	12529.9	6122.5	2605.9	2100.9	2424.3
8795.0	26105.8	51390.6	13715.2	5317.1	2049.0	763.1	627.3
4568.6	13387.4	34319.6	24356.6	5968.2	1057.6	291.6	111.0
13563.8	20962.0	34625.2	14881.0	15187.9	2698.4	369.8	4.2
35663.6	20301.8	60277.3	30276.2	15671.1	6833.3	541.1	77.0
5540.3	33978.7	44751.0	18055.2	8245.2	6434.5	2651.8	126.4
13472.7	16455.6	8974.9	9465.6	4559.3	2821.7	4419.0	634.9
926.1	10977.9	29863.4	22446.5	6347.2	2601.3	821.3	1016.0
1430.2	10540.5	14640.9	10936.2	3775.9	865.0	220.4	89.7
809.6	6124.2	17584.6	10350.5	3958.6	1266.2	248.0	78.2
495.8	12773.2	15669.6	14991.2	4803.2	1207.5	283.2	104.8
559.8	4153.3	15044.6	12540.0	6502.9	1626.1	375.8	102.2
3798.5	6573.8	9025.6	15864.1	7519.9	2653.6	605.5	134.1
770.0	3346.0	8808.5	7320.9	12392.4	4809.3	1054.1	294.5
133.9	14770.7	6808.8	7768.4	6684.4	7574.4	1746.7	301.5
4647.2	5651.8	32558.2	7710.9	6203.1	2815.4	3111.9	650.8
2074.9	10980.8	13651.0	33791.0	5935.6	3085.0	1079.9	1193.1
933.6	2840.6	12286.9	7615.0	11764.8	2010.4	771.2	282.8
1803.3	2888.6	8804.0	7711.5	3749.0	3979.7	575.2	219.5
93.0	3025.8	4713.2	4371.8	3044.0	1017.7	745.5	75.3
1417.2	3684.5	8679.1	3972.3	1534.9	758.1	219.9	126.2
48.7	4556.3	5814.8	8063.6	1688.6	422.1	124.2	34.9

Table 4. Whiting in divisions 7.bc,e–k. Catch weights-at-age (Tons).

1999	**2021**						
0	7						
1							
603.1	2588.8	6681.7	4496.2	6085.5	1416.0	250.9	2.5
748.8	3135.3	10982.9	7433.9	4674.5	2629.2	204.7	32.8
229.2	3989.7	8773.7	5791.2	3439.3	2739.9	1143.7	66.1
467.9	2433.0	2529.3	3491.9	2416.2	1601.7	1673.4	392.8
42.6	1403.4	5695.9	6364.0	2407.3	1230.4	374.8	345.0
54.0	1298.9	3080.3	3088.6	1658.0	424.3	159.9	76.6
54.7	844.6	3662.2	3466.6	1780.3	838.7	147.6	60.2
20.4	1932.4	3935.0	5696.2	2404.7	684.4	183.8	59.5
17.7	716.1	3557.8	4520.9	3559.4	1104.6	263.8	94.0
217.0	677.7	2014.9	6407.2	4094.8	1945.2	462.3	130.5
35.2	493.6	1860.8	2657.4	6926.6	3052.4	905.4	225.0
6.5	2046.5	1742.6	3076.4	3667.0	5455.4	1365.1	295.4
258.3	682.6	7744.0	2961.8	3345.0	2059.2	2125.4	461.4
89.3	1355.3	2896.0	12098.1	3279.0	2093.7	777.7	871.1
39.6	409.9	2885.4	3015.1	6421.4	1450.4	689.8	256.3
98.4	364.0	1742.9	2878.6	2260.6	3064.2	516.5	221.3
5.8	496.3	1608.6	2056.9	1890.0	794.9	625.9	80.2
27.4	609.7	2686.0	2080.6	964.8	536.8	174.2	117.3
2.3	413.3	1672.8	3742.6	1092.5	327.2	88.5	37.0

Table 5. Whiting in divisions 7.bc,e–k. Mean catch weights-at-age (kg).

	Age							
		1	2	3	4	5	6	7+
1999	0.0271	0.1331	0.2216	0.3412	0.4274	0.4402	0.4963	0.623
2000	0.0314	0.069	0.2204	0.3955	0.5053	0.563	0.5804	0.5868
2001	0.0315	0.1116	0.1853	0.3778	0.5293	0.6335	0.76	0.7775
2002	0.0272	0.0965	0.1966	0.3506	0.5315	0.7069	0.8249	1.0133
2003	0.0445	0.1235	0.1930	0.3021	0.4007	0.5248	0.6786	0.6038
2004	0.0210	0.1544	0.1822	0.2455	0.2983	0.3848	0.3783	0.4263
2005	0.0414	0.1174	0.1961	0.3207	0.4171	0.4258	0.4313	0.5232
2006	0.0347	0.1479	0.2818	0.3689	0.5300	0.5676	0.3787	0.6186
2007	0.0460	0.1278	0.1907	0.2835	0.3793	0.4730	0.4563	0.3395
2008	0.0377	0.1232	0.2104	0.2824	0.4391	0.4905	0.7256	0.8543
2009	0.0675	0.1379	0.2083	0.3349	0.4497	0.6624	0.5952	0.7689
2010	0.0411	0.1513	0.2511	0.3800	0.5007	0.5668	0.6489	0.5674
2011	0.0316	0.1724	0.2365	0.3605	0.5474	0.6793	0.7019	0.9197
2012	0.0571	0.1031	0.2232	0.4039	0.5445	0.7331	0.7635	0.9731
2013	0.0457	0.1475	0.2113	0.3630	0.5589	0.6347	0.8589	0.7641
2014	0.0484	0.1386	0.2559	0.3960	0.5486	0.7202	0.7815	0.9798
2015	0.0556	0.1208	0.2379	0.3841	0.5392	0.7314	0.6830	0.7089
2016	0.0431	0.1234	0.2121	0.3580	0.5524	0.6787	0.7201	0.7301
2017	0.0424	0.1443	0.2348	0.3959	0.5458	0.7214	0.8945	0.9065
2018	0.0546	0.1260	0.1980	0.3733	0.6030	0.7700	0.8980	1.0080
2019	0.0625	0.1640	0.3413	0.4705	0.6209	0.7811	0.8396	1.0646
2020	0.0193	0.1655	0.3095	0.5238	0.6286	0.7081	0.7922	0.9297
2021	0.0473	0.0907	0.2877	0.4641	0.6470	0.7751	0.7123	1.0611

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	0.01700	0.10340	0.16590	0.28040	0.37240	0.38340	0.46740	0.62300
2000	0.01670	0.04320	0.17130	0.29600	0.41520	0.49050	0.50550	0.58680
2001	0.01800	0.05920	0.11310	0.28860	0.45750	0.56580	0.65410	0.77750
2002	0.01280	0.05510	0.14810	0.25490	0.44810	0.61170	0.72290	1.01330
2003	0.02390	0.05800	0.13650	0.24370	0.37480	0.52810	0.69260	0.60380
2004	0.00890	0.08290	0.15000	0.21770	0.30020	0.39270	0.44560	0.42630
2005	0.02190	0.04970	0.17400	0.24170	0.32000	0.35640	0.40740	0.52320
2006	0.01810	0.07820	0.18190	0.26900	0.41230	0.48660	0.40160	0.61860
2007	0.02810	0.06660	0.16790	0.28260	0.37410	0.50070	0.50890	0.33950
2008	0.01970	0.07530	0.16400	0.23210	0.35280	0.43130	0.58580	0.85430
2009	0.04510	0.07210	0.16020	0.26540	0.35640	0.53930	0.54030	0.76890
2010	0.02010	0.10110	0.18610	0.28130	0.40950	0.50490	0.65560	0.56740
2011	0.01750	0.08420	0.18920	0.30090	0.45610	0.58320	0.63070	0.91970
2012	0.03550	0.05710	0.19620	0.30910	0.44300	0.63350	0.72020	0.97310
2013	0.02620	0.09180	0.14760	0.28460	0.47510	0.58790	0.79350	0.76410
2014	0.03060	0.07960	0.19430	0.28930	0.44630	0.63440	0.70430	0.97980
2015	0.03730	0.07650	0.18160	0.31350	0.46210	0.63340	0.70140	0.70890
2016	0.02360	0.08280	0.16010	0.29180	0.46060	0.60490	0.72570	0.73010
2017	0.02460	0.07890	0.17020	0.28980	0.44200	0.63130	0.77920	0.90650
2018	0.03150	0.07310	0.16900	0.29610	0.48860	0.64830	0.80490	1.00800
2019	0.03840	0.09460	0.20740	0.30520	0.48140	0.68630	0.80400	1.06460
2020	0.00890	0.10170	0.22530	0.42280	0.54380	0.66310	0.78660	0.92970
2021	0.05350	0.04180	0.21820	0.37900	0.58210	0.69800	0.71020	1.06110

Table 7. Whiting in divisions 7.e–k. Summary of landings and discard data for 2021 provided to the Working Group.

weight in tonnes										
Discards	**Country**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**	**Grand Total**
	Belgium	0.1	25.8	41.9	24.2	3.9	0.2	0.2	0.0	96.4
	France	1.7	177.2	334.0	198.5	22.1	0.9	1.4	0.0	735.9
	Ireland	0.0	83.5	112.1	65.9	14.9	0.6	1.0	0.0	277.9
	UK (England)	0.4	9.8	33.1	13.8	1.4	0.4	0.1	0.0	59.1
	Other	0.1	14.5	23.6	13.8	2.1	0.1	0.1	0.0	54.3
	Total	2.3	310.7	544.8	316.3	44.4	2.3	2.8	0.0	1223.6
Landings	**Belgium**	**0.0**	**1.2**	**14.5**	**45.3**	**13.7**	**4.2**	**1.1**	**0.5**	**80.6**
	France	0.0	92.4	725.2	1428.0	327.2	87.0	18.7	2.1	2680.6
	Ireland	0.0	3.4	315.8	1742.6	623.6	200.8	56.0	30.6	2972.8
	UK (England)	0.0	5.2	62.2	166.0	67.8	27.2	8.4	3.3	340.0
	Other	0.0	0.4	10.3	44.4	15.8	5.7	1.5	0.5	78.6
	Total	0.0	102.6	1128.0	3426.3	1048.1	324.9	85.7	37.0	6152.5
Number in 000's										
Discards	Country		1	2	3	4	5	6	7	Grand Total
	Belgium	2.9	370.7	213.6	92.3	12.9	1.1	0.7	0.0	694.3
	France	34.1	2124.7	1542.6	733.7	72.4	5.5	3.9	0.0	4517.0

weight in tonnes										
	Ireland	0.0	1377.3	622.7	257.8	50.1	4.4	2.8	0.0	2315.2
	UK (England)	9.6	71.1	171.9	52.2	3.5	0.8	0.2	0.0	309.4
	Other	2.0	204.1	118.5	52.2	6.8	0.6	0.4	0.0	384.6
	Total	48.7	4147.9	2669.3	1188.2	145.7	12.5	8.0	0.1	8220.4
Landings	Belgium	0.0	4.7	40.4	91.3	20.2	5.4	1.6	0.5	163.9
	France	0.0	368.7	2106.6	2851.3	451.8	90.4	21.9	4.1	5894.9
	Ireland	0.0	11.2	765.9	3466.1	948.6	272.1	81.2	27.2	5572.3
	UK (England)	0.0	22.1	201.5	377.6	100.2	35.4	9.6	2.6	749.0
	Other	0.0	1.7	31.0	89.1	22.0	6.4	1.9	0.4	152.5
	Total	0.0	408.3	3145.4	6875.4	1542.8	409.6	116.2	34.8	12532.7

Table 8. Whiting in divisions 7.bc,e–k. Combined (IE-IGFS and FR_EVHOE) VAST recruitment survey index for age groups 0–2 (No/Km²).

IGFSEVHOE No/Hr			
	Age		
		1	2
2003	46205.02	40655.983	12533.098
2004	157691.534	28393.568	7434.628
2005	37035.107	31625.849	5542.815
2006	73694.246	19836.628	7491.025
2007	231611.031	27207.135	4406.281
2008	161259.028	38695.505	9387.597
2009	231100.591	62799.181	10512.46
2010	21900.202	45146.326	19875.118
2011	63739.781	15863.561	24673.54
2012	39744.354	17373.611	9713.187
2013	236267.312	11165.44	7168.082
2014	29265.971	38110.41	6455.985
2015	72084.394	14574.46	16569.482
2016	73908.284	18872.027	10601.144
2017	71216.312	8958.637	4255.448
2018	84964.539	5825.47	2431.677
2019	52307.438	21968.034	3260.777
2020	41224.611	7403.799	4252.018
2021	47267.467	17694.33	6953.716

Table 9. Whiting in divisions 7.bc,e–k. FRA-OTB commercial biomass index (Kg/Hr).

	Kg/Hr
2000	38.10363867
2001	20.72032437
2002	19.72791635
2003	15.04609422
2004	15.08119522
2005	24.65779777
2006	24.11897529
2007	14.66450994
2008	11.05968544
2009	11.14466828
2010	14.68285952
2011	13.01333083
2012	10.45746782
2013	13.16969924
2014	19.60473794
2015	20.3091624
2016	25.69082281
2017	25.06670645
2018	22.20498986
2019	22.43714973
2020	18.57563875
2021	16.47383047

Table 10. 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+
1999	0.009	0.096	0.425	0.656	0.944	1.189	1.573	1.573
2000	0.008	0.091	0.389	0.627	0.968	1.240	1.756	1.756
2001	0.008	0.088	0.361	0.581	1.047	1.555	2.354	2.354
2002	0.008	0.076	0.288	0.403	0.703	1.094	1.903	1.903
2003	0.009	0.090	0.330	0.384	0.601	0.978	1.547	1.547
2004	0.014	0.156	0.619	0.694	0.697	0.865	1.303	1.303
2005	0.012	0.149	0.601	0.786	0.790	0.852	1.316	1.316
2006	0.006	0.074	0.280	0.549	0.744	1.041	1.574	1.574
2007	0.007	0.101	0.484	1.026	1.358	1.744	2.126	2.126
2008	0.004	0.058	0.276	0.626	0.841	1.034	1.246	1.246
2009	0.003	0.045	0.220	0.528	0.785	1.001	1.175	1.175
2010	0.002	0.038	0.176	0.436	0.673	0.849	1.008	1.008
2011	0.002	0.033	0.141	0.324	0.540	0.719	0.881	0.881
2012	0.002	0.037	0.153	0.298	0.480	0.675	0.832	0.832
2013	0.002	0.037	0.158	0.300	0.498	0.713	0.876	0.876
2014	0.002	0.039	0.170	0.331	0.563	0.766	0.953	0.953
2015	0.003	0.057	0.249	0.435	0.660	0.877	1.125	1.125
2016	0.004	0.076	0.345	0.631	0.864	1.105	1.393	1.393
2017	0.004	0.072	0.351	0.636	0.884	1.113	1.413	1.413
2018	0.003	0.072	0.383	0.755	1.060	1.348	1.680	1.680
2019	0.002	0.048	0.266	0.656	1.013	1.279	1.556	1.556
2020	0.002	0.042	0.225	0.576	0.915	1.240	1.486	1.486
2021	0.001	0.032	0.174	0.459	0.701	0.911	1.085	1.085

Table 11. Whiting in divisions 7.b, c, e–k. Stock number-at-age ('000).

	0	1	2	3	4	5	6	7+
1999	2027897	291554	94860	37192	17484	14771	9914	2519
2000	1701339	606549	111836	31802	11652	4466	2993	1793
2001	1421549	498264	238876	39555	9914	2851	888	573
2002	1267864	412764	193577	90478	13543	2194	392	96
2003	998197	375735	162050	77773	38110	4332	507	48
2004	871785	292860	145356	62250	36758	13870	1025	81
2005	749519	244099	106380	40407	18132	13568	3999	206
2006	826353	219843	81238	29472	10970	5145	4453	775
2007	1020649	236347	86603	35050	10171	3388	1172	750
2008	1218297	300794	86509	27784	7770	1685	387	158
2009	1278262	363220	117262	33160	8845	2207	408	108
2010	652585	395419	141166	48649	11743	2594	539	110
2011	624387	192617	166946	59400	18401	3859	746	163
2012	579921	185721	81198	78604	25616	6696	1261	259
2013	1205680	160105	76808	36487	37398	10450	2232	455
2014	545184	391306	64226	34708	16660	15588	3404	764
2015	507319	160542	175051	28967	15365	6018	4993	1104
2016	330789	148074	64806	75519	11911	5242	1671	1364
2017	293206	91972	55229	22804	24183	3382	1167	519
2018	504093	80182	34322	19539	7271	6424	760	283
2019	400108	152847	30350	11503	5484	1658	1110	133
2020	494034	117017	60296	11918	3418	1255	313	180
2021	353025	149859	49413	25825	4057	875	237	77

Table 12. Whiting in divisions 7.b, c, e–k. Summary table.

Year	Recruitment age 0			SSB			Landings	Discards	F ages 2–5		
	Value	Low	High	Value	Low	High			Value	Low	High
1999	2027897	3019160	1362089	54302	61100	48260	20180	5420	0.80	0.94	0.69
2000	1701339	2486760	1163986	52501	60164	45815	15644	4400	0.81	0.94	0.69
2001	1421549	1930257	1046908	61432	73583	51288	13196	9877	0.89	1.03	0.76
2002	1267864	1703340	943722	70799	84286	59469	13640	7336	0.62	0.75	0.52
2003	998197	1346874	739785	68985	78939	60286	11788	10337	0.57	0.69	0.47
2004	871785	1180819	643630	65094	73768	57440	10321	19522	0.72	0.85	0.61
2005	749519	1007845	557406	46453	52199	41340	12575	13598	0.76	0.88	0.65
2006	826353	1135740	601247	41147	46292	36574	9908	5098	0.65	0.79	0.55
2007	1020649	1374910	757667	39139	44757	34226	9424	8439	1.15	1.34	0.99
2008	1218297	1640683	904652	37123	42658	32306	6080	3760	0.69	0.83	0.58
2009	1278262	1870293	873636	46729	53865	40539	6574	4281	0.63	0.77	0.52
2010	652585	881377	483184	68742	79815	59205	9570	5346	0.53	0.66	0.43
2011	624387	836391	466120	67898	78585	58664	10084	3750	0.43	0.54	0.34
2012	579921	788972	426262	61381	70051	53784	10834	5116	0.40	0.50	0.32
2013	1205680	1940367	749170	55194	62296	48902	12131	4026	0.42	0.52	0.34

Year	Recruitment age 0			SSB			Landings	Discards	F ages 2–5		
	Value	Low	High	Value	Low	High			Value	Low	High
2014	545184	730884	406667	60670	69406	53033	12983	4672	0.46	0.56	0.38
2015	507319	692155	371843	61195	69360	53992	13110	6528	0.56	0.66	0.47
2016	330789	493952	221522	49278	56528	42957	15201	8259	0.74	0.87	0.63
2017	293206	434204	197994	33504	37662	29806	12377	2791	0.75	0.87	0.64
2018	504093	707837	358994	23130	26061	20529	9007	2139	0.89	1.04	0.75
2019	400108	571894	279923	22862	27150	19251	6588	970	0.80	0.99	0.65
2020	494034	781842	312172	27954	34842	22428	5931	1266	0.74	1.06	0.51
2021	353025	731427	170388	26600	35064	20180	6153	1224	0.56	1.01	0.31
2022	400108*	507319	293206	32346	46048	22581					

*** Median resampled (2015–2021).**

Table 13. Whiting in divisions 7.b, c, e–k. Management options table.

Basis	Total catch (2023)	Projected landings (2023)	Projected discards (2023)	F_{total} (2023)	$F_{projected\ landings}$ (2023)	$F_{projected\ discards}$ (2023)	SSB (2024)	% SSB change*	% advice change **	% Probability of being below B_{lim} in 2024
ICES advice basis										
MSY and precautionary considerations: F = 0	0	0	0	0.000	0.000	0.000	38109	26	-100	40
Other options										
MSY approach: $F_{MSY} \times SSB_{2023}/MSY\ B_{trigger}$	4030	3542	488	0.224	0.199	0.025	34568	14	-9.5	62
EU MAP^^: $F_{MSY} \times SSB_{2023}/MSY\ B_{trigger}$	4030	3542	488	0.224	0.199	0.025	34568	14	-9.5	62
EU MAP^^: $F_{MSY\ lower} \times SSB_{2023}/MSY\ B_{trigger}$	3441	3026	415	0.188	0.167	0.021	35065	16	-23	59
$F = F_{MSY} = F_{pa}$	6322	5532	790	0.375	0.333	0.042	32641	8	42	72
$SSB_{2024} = B_{lim}$	1715	1512	203	0.090	0.079	0.011	36571	21	-61	50
$SSB_{2024} = B_{pa} = B_{trigger}$ ^										
$F = F_{2022}$	10376	9013	1363	0.701	0.622	0.079	29323	-3	133	86
$SSB_{2024} = SSB_{2023}$	9108	7939	1169	0.590	0.523	0.067	30343	0	105	82

Input units are thousands and kg, outputs in tonnes.

Table 14. Whiting in divisions 7.b, c, e–k. Basis for the catch forecast scenarios.

Variable	Value	Notes
Fages 2–5 (2022)	0.701	F based on catch of 9240 tonnes for 2022
SSB (2023)	30 343	Short-term forecast fishing at F = 0.571; in tonnes
Recruitment age 0 (2022–2023)	400 108	Median resampled (2015–2021); in thousands
Catch (2022)	10 741	Catch based on mixed fisheries considerations (ICES, 2021a) when haddock is fished in 2022 at F = 0.582; in tonnes
Projected landings (2022)	9228	Short-term forecast assuming average 2019–2021 landings pattern; in tonnes
Projected discards (2022)	1513	Short-term forecast assuming average 2019–2021 discard pattern; in tonnes

Input units are thousands and kg output in tonnes.

38.13 Figures

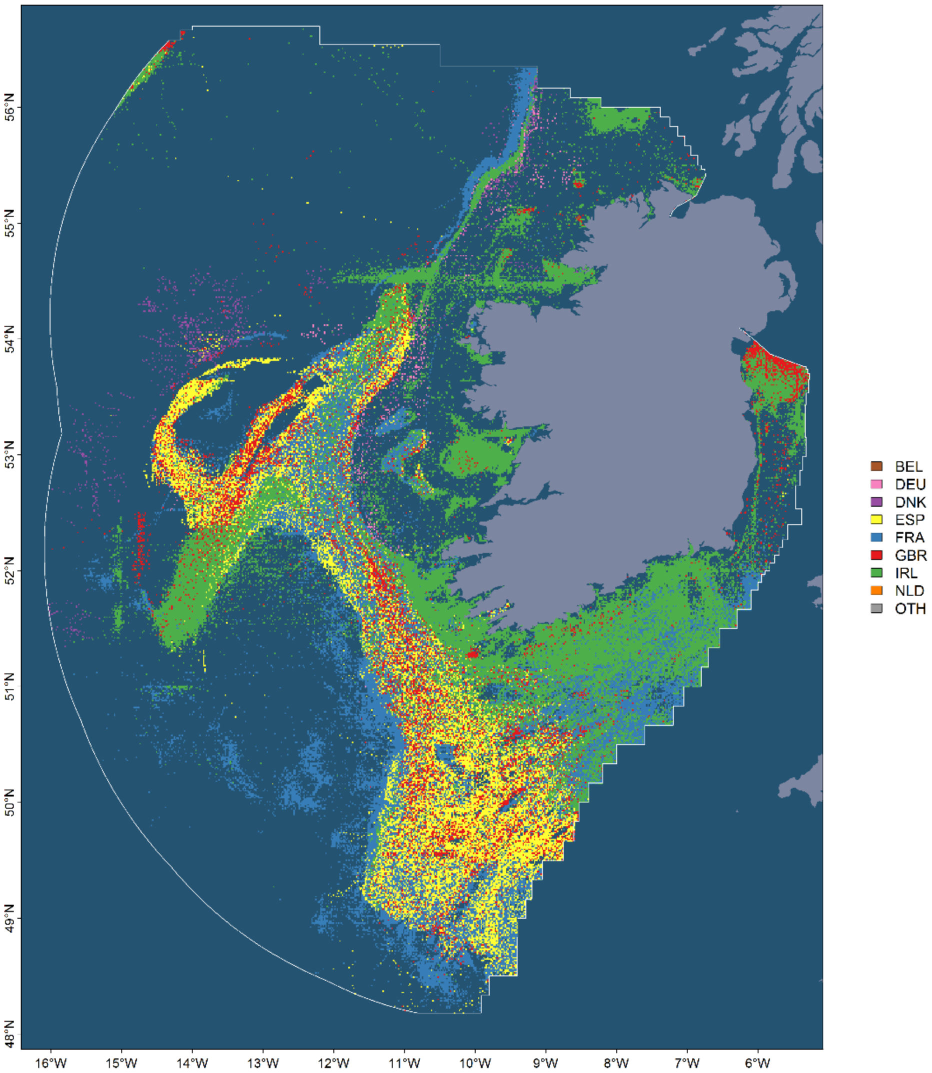


Figure 1. Distribution of international OTB effort within the Irish EEZ 2014–2018.

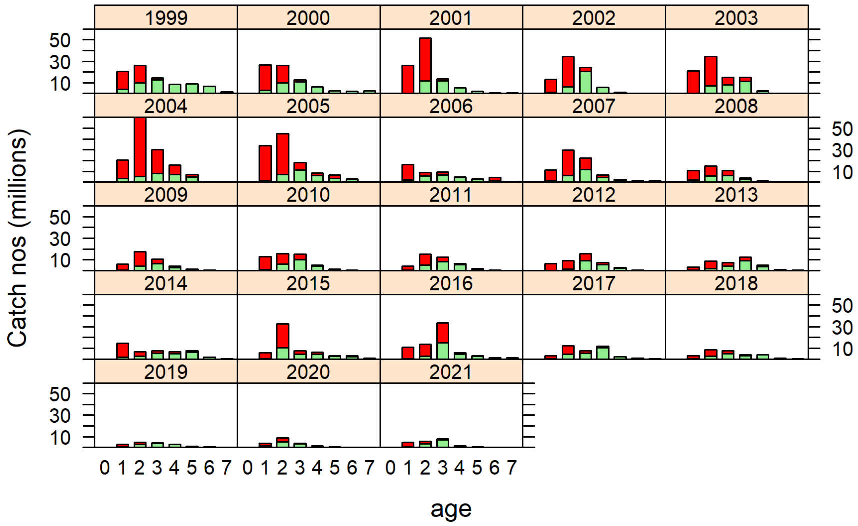


Figure 2. Whiting in 7.b-ce–k (Celtic Sea), annual Landings (Green) and Discards- (red) at-age.

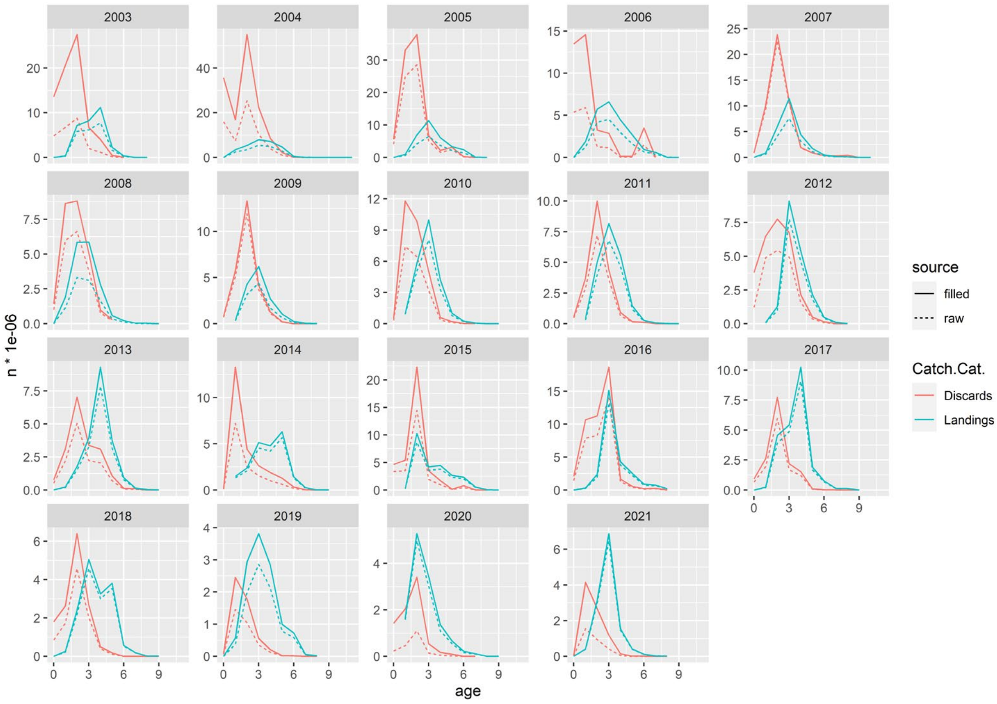


Figure 3. Whiting in 7.b-ce–k (Celtic Sea), annual Landings- (Blue) and Discards- (red) at-age. Dashed lines give revised data uploaded to InterCatch. Solid lines show the final raised International Catch Numbers-at-Age used in the assessment.

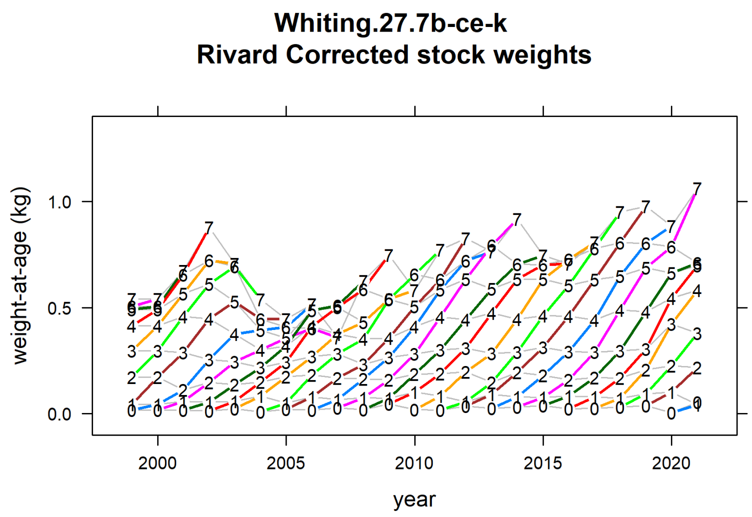


Figure 4. Whiting in 7.b, c, e–k (Celtic Sea). Rivard corrected stock weights-at-age.

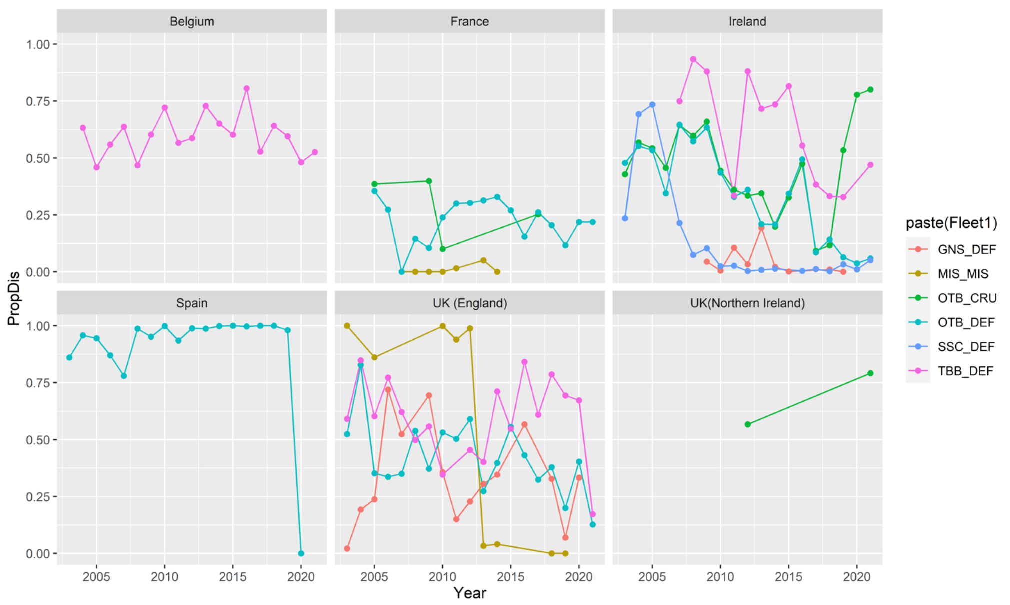


Figure 5. Annual proportions of Discarding (by weight) for the Celtic Sea whiting revised time-series (2003–2021).

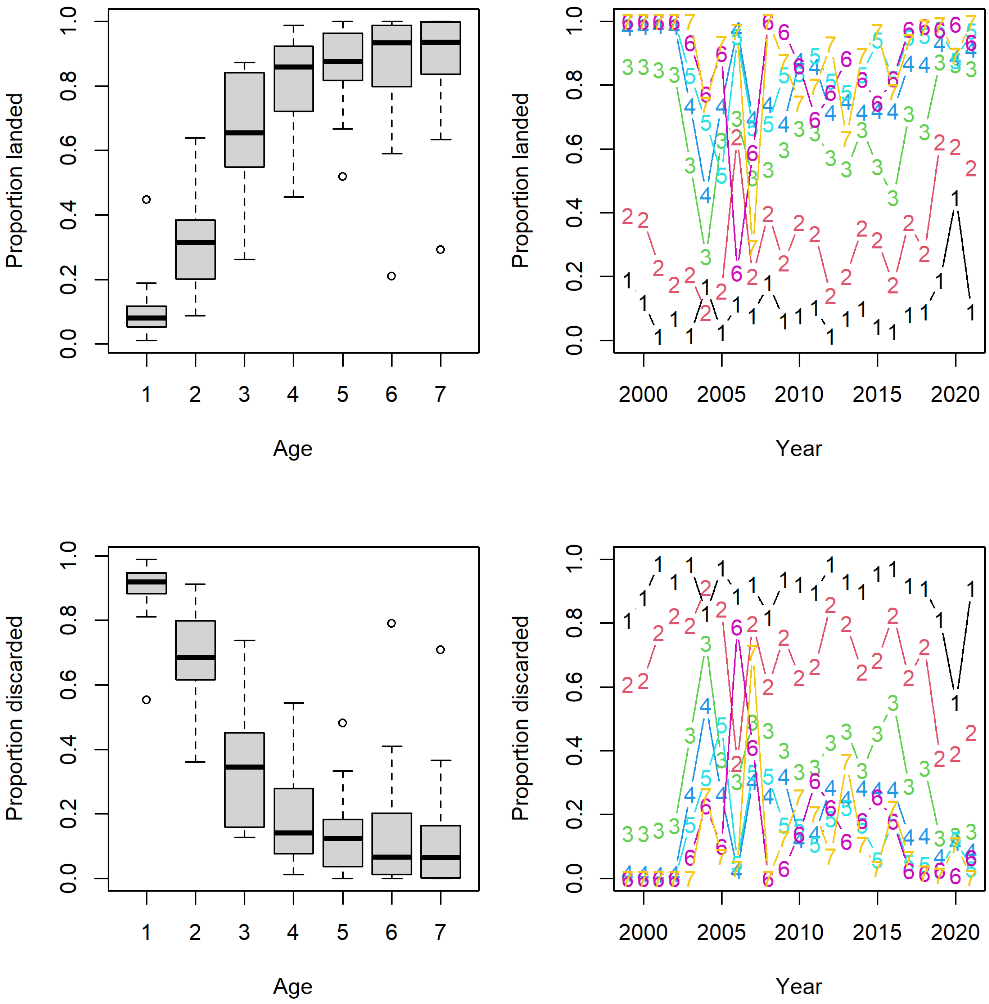


Figure 6. Proportion of landings (upper panels) and discards (lower panels) for Celtic Sea whiting (2003–2021).

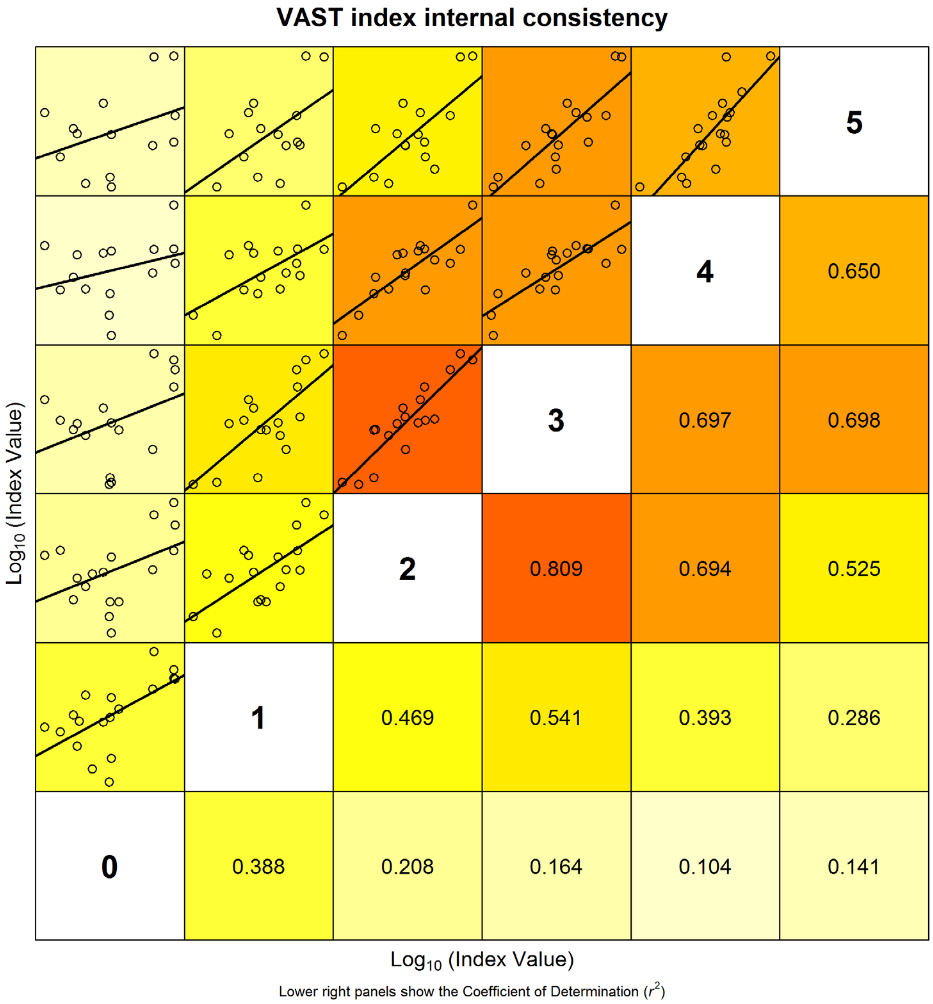
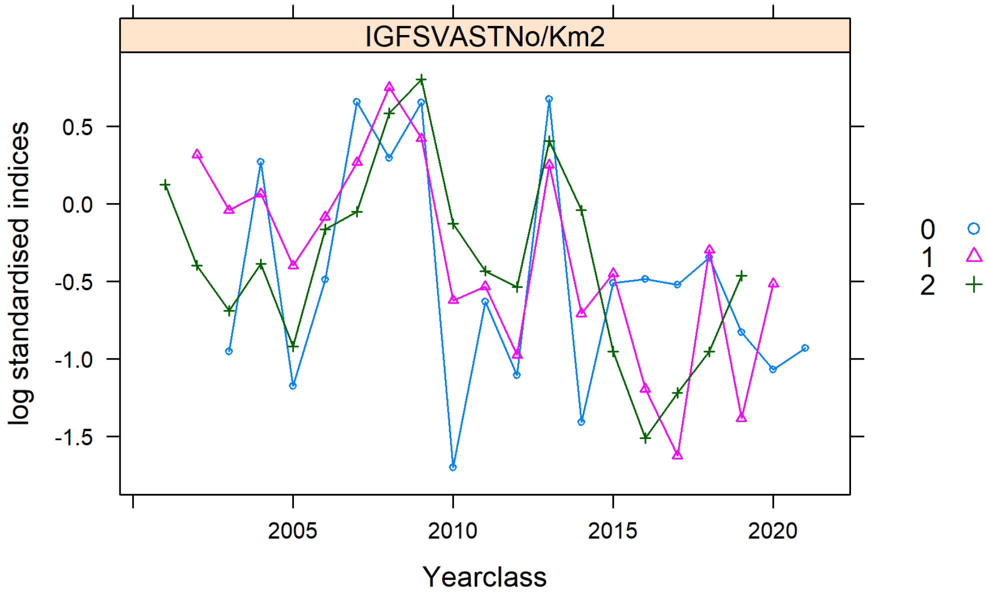


Figure 7. Whiting in 7.b, c, e–k (Celtic Sea). Pairwise scatterplots for the log numbers-at-age for the VAST combined survey index.



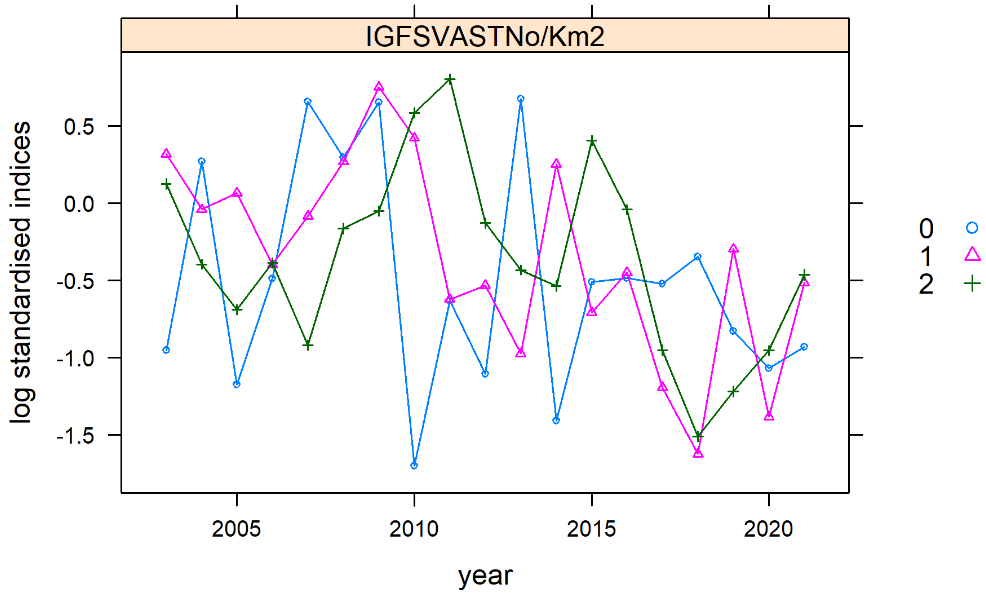


Figure 8. Whiting in 7.e–k (Celtic Sea). Mean log standardized plots of combined IE-IGFS & FR-EVHOE indices by year class (top panel) and by year (lower panel). Only age 0–2 is included in the assessment.

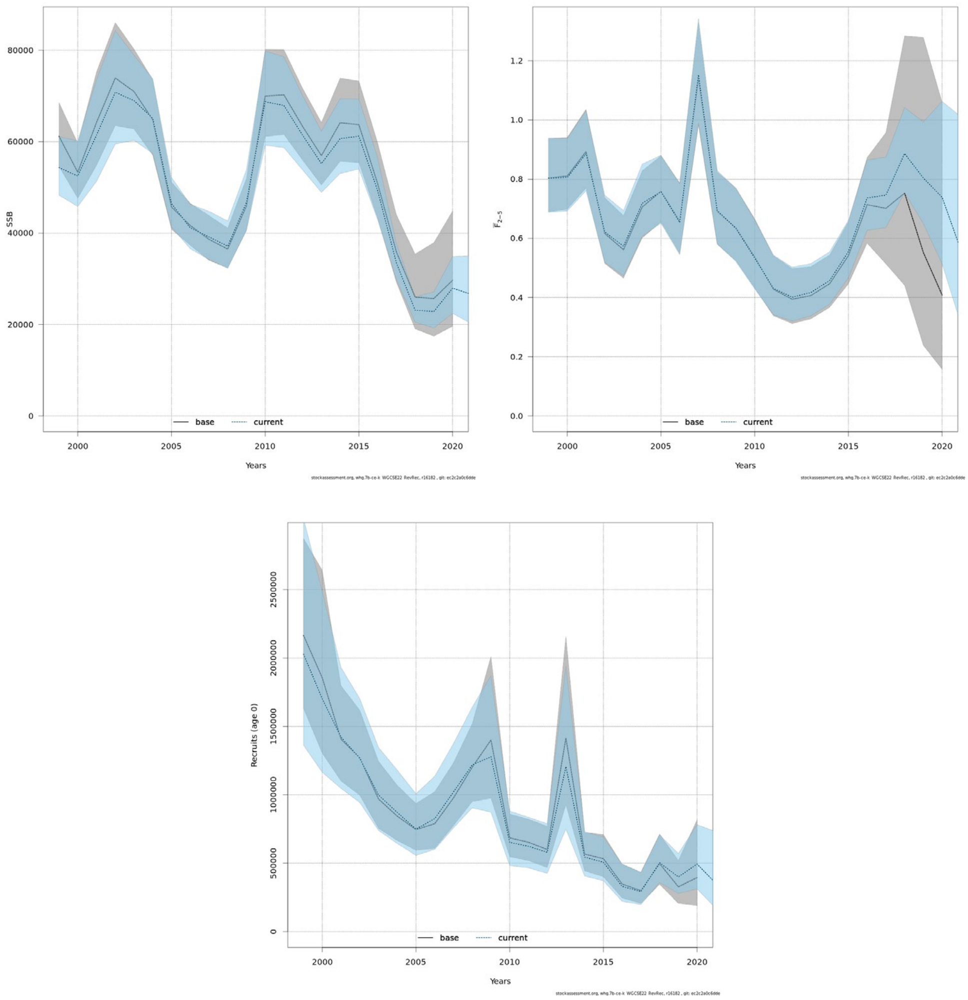
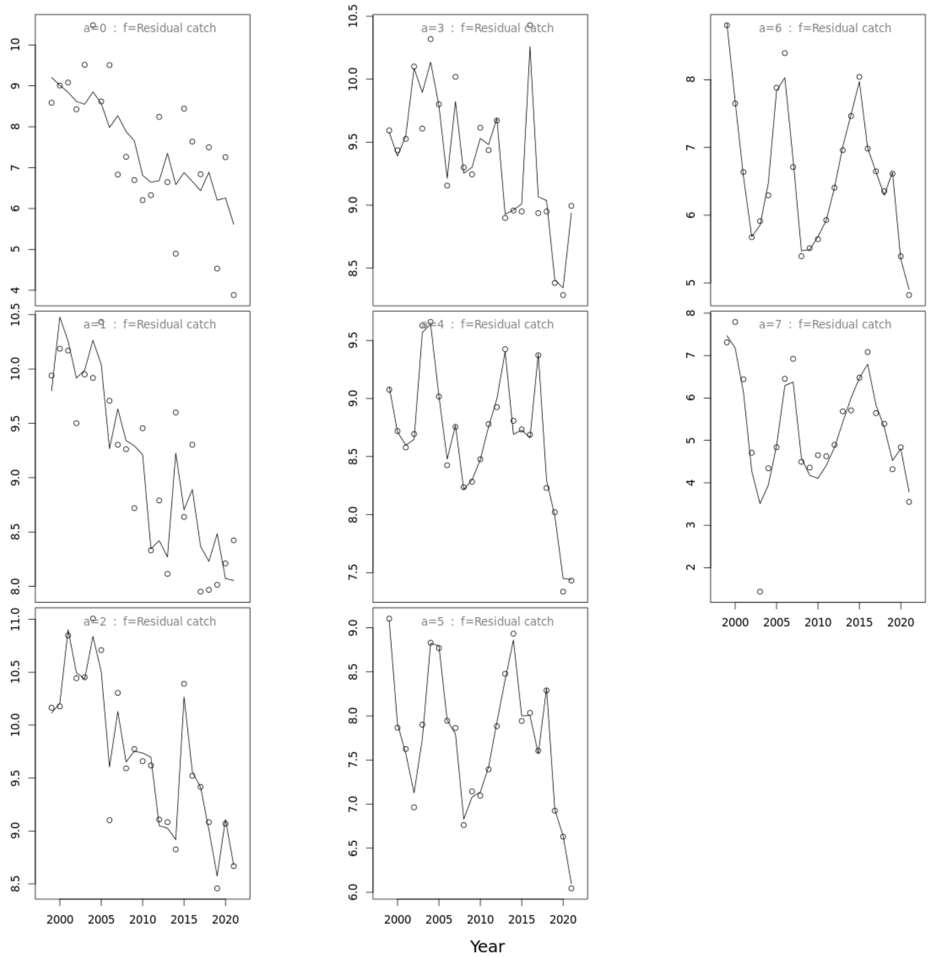
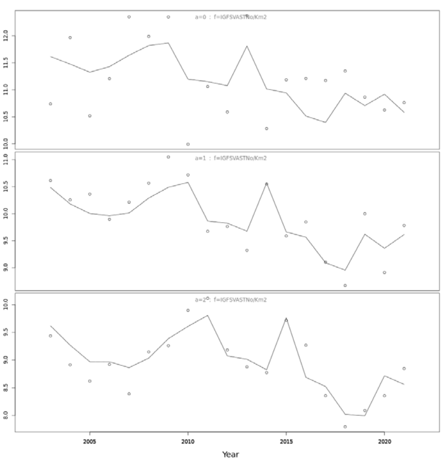


Figure 9. Whiting in 7.b, c, e–k (Celtic Sea). SAM assessment summary plots of SSB (top left), $F_{bar2–5}$ (top right) and recruitment (bottom left) at Age 0. Grey line and shaded area indicate the previous year's assessment. An overall downward trend in biomass and recruitment since the last small pulse in 2013 is evident and followed by a significant drop in fishing effort as that biomass was removed.





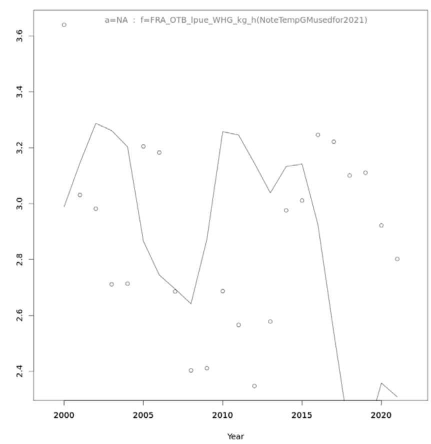


Figure 10. Fit to the catch-at-age data (top) and VAST index (bottom left) for final SAM assessment run. Model fits for commercial biomass index are given in lower right panel. Point observations are presented along with model prediction lines.

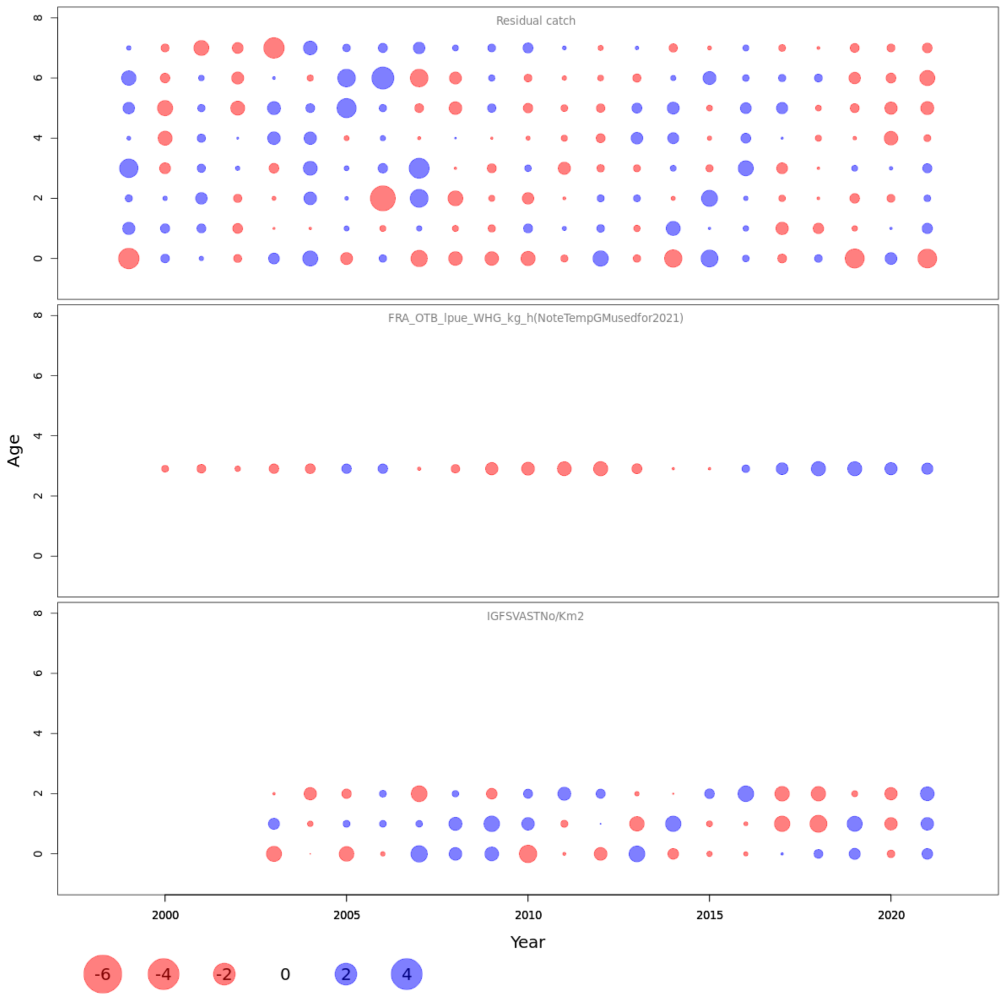


Figure 11. Residual patterns for the catch at age data (top), commercial biomass index (middle) and VAST IBTS index (bottom) for final SAM assessment run.

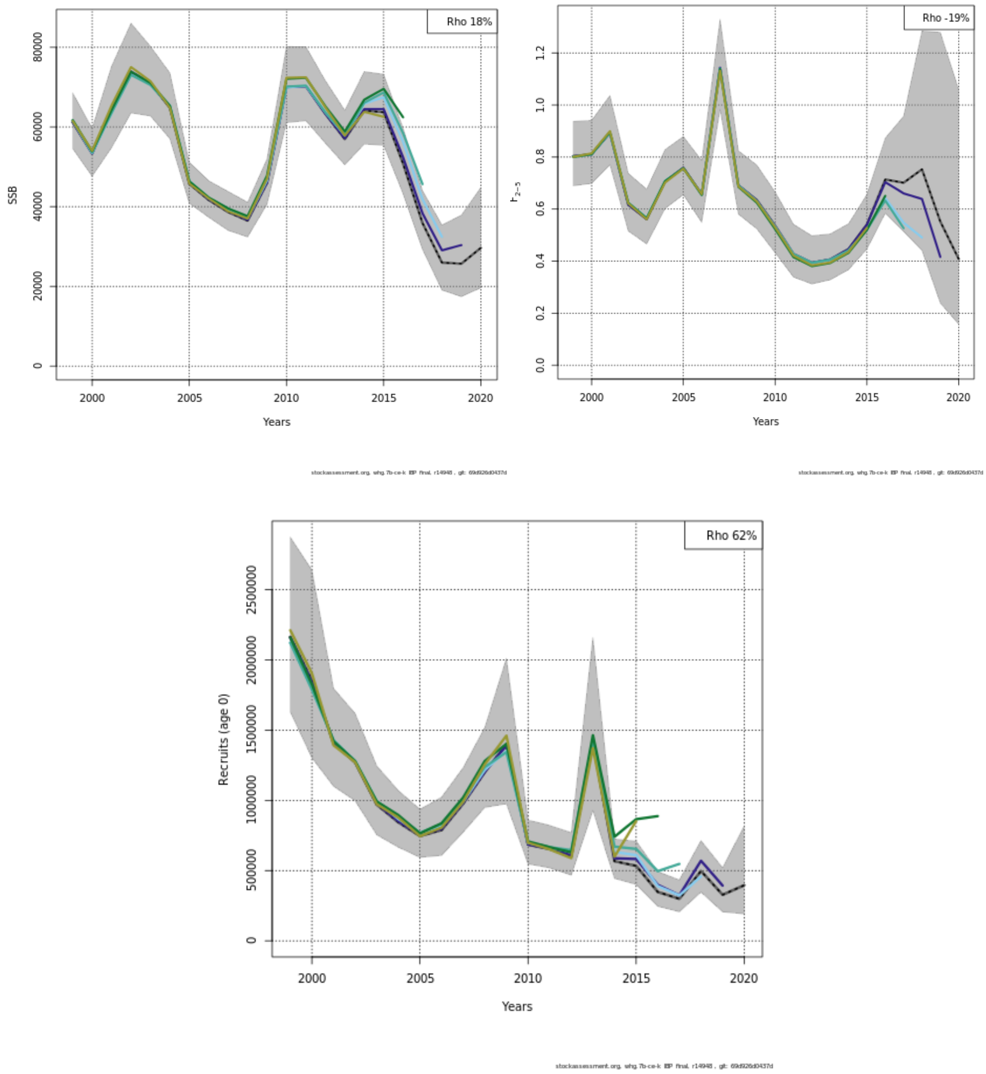


Figure 12. Retrospective patters and Mohn's Rho calculations for SSB (top left), F_{bar} (top right) and recruitment (bottom left).

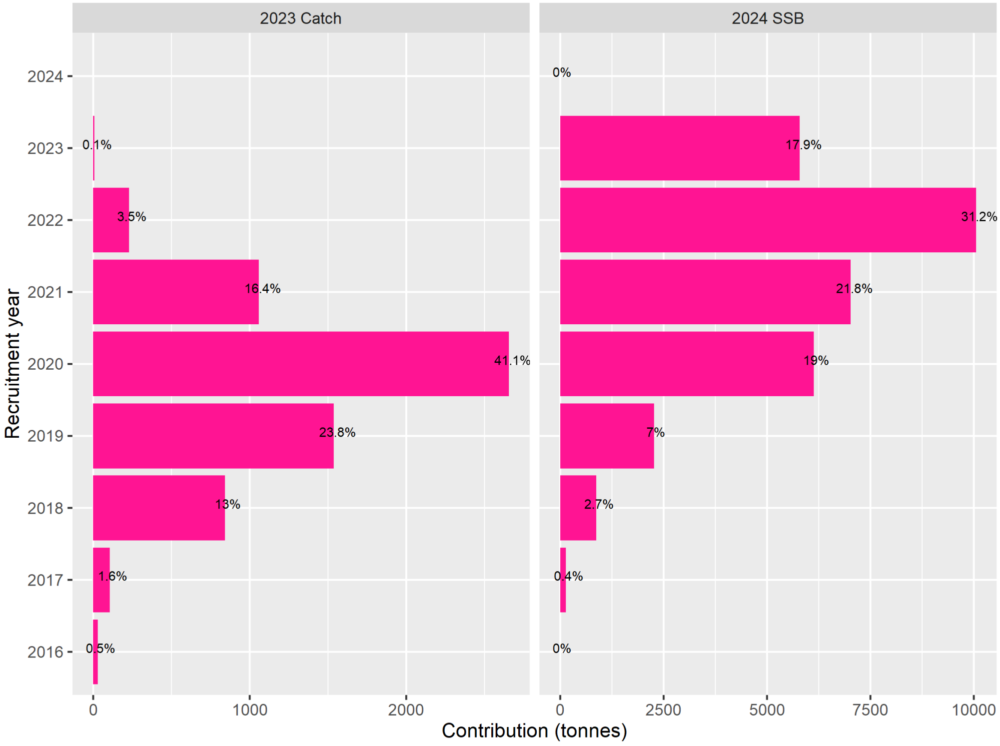


Figure 13. Contribution to advised catch and Spawning–Stock Biomass (SSB) of the recruitment assumption used in the short term forecast.

Annex 1: List of participants

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Annex 2: Stock Annexes

The table below provides an overview of the WGCSE Stock Annexes. Stock Annexes for other stocks are available on the ICES website Library under the Publication Type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion*, *species,* and *acronym* of the relevant ICES expert group.

Stock ID	Stock name	Last updated	Link
anf.27.3a46	Anglerfish (*Lophius budegassa*, *Lophius piscatorius*) in subareas 4 and 6, and in Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat)	October 2019	Anglerfish 3.a46
bss.27.4bc7d–h	Seabass (*Dicentrarchus labrax*) in divisions 4.b–c, 7.a, and 7.d–h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel, and Celtic Sea)	May 2020	Sea bass 47
cod.27.7e–k	Cod (*Gadus morhua*) in divisions 7.e–k (eastern English Channel and southern Celtic Seas)	October 2020	Cod 7.e–k
cod.27.7a	Cod (*Gadus morhua*) in Division 7.a (Irish Sea)	February 2022	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)	May 2022	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)	June 2021	Haddock 7.a
had.27.6b	Haddock (*Melanogrammus aeglefinus*) in Division 6.b (Rockall)	May 2020	Haddock 6.b
lez.27.4a6a	Megrim (*Lepidorhombus* ssp.) in divisions 4.a and 6.a (northern North Sea, West of Scotland)	June 2021	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

Stock ID	Stock name	Last updated	Link
nep.fu.13	Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 13 (West of Scotland, the Firth of Clyde and Sound of Jura)	May 2017	*Nephrops* FU13
nep.fu.14	Norway lobster (*Nephrops norvegicus*) in Division 7.a, Functional Unit 14 (Irish Sea, East)	September 2018	*Nephrops* FU14
nep.fu.15	Norway lobster (*Nephrops norvegicus*) in Division 7.a, Functional Unit 15 (Irish Sea, West)	May 2018	*Nephrops* FU15
nep.fu.16	Norway lobster (*Nephrops norvegicus*) in divisions 7.b–c and 7.j–k, Functional Unit 16 (west and southwest of Ireland, Porcupine Bank)	March 2013	*Nephrops* FU16
nep.fu.17	Norway lobster (*Nephrops norvegicus*) in Division 7.b, Functional Unit 17 (west of Ireland, Aran grounds)	May 2016	*Nephrops* FU17
nep.fu.19	Norway lobster (*Nephrops norvegicus*) in divisions 7.a, 7.g, and 7.j, Functional Unit 19 (Irish Sea, Celtic Sea, eastern part of south-west of Ireland)	October 2019	*Nephrops* FU19
nep.fu.2021	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h, functional units 20 and 21 (Celtic Sea)	October 2019	*Nephrops* FU2021
nep.fu.22	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.f, Functional Unit 22 (Celtic Sea, Bristol Channel)	May 2018	*Nephrops* FU22
nep.fu.2324	Norway lobster (*Nephrops norvegicus*) in divisions 8.a and 8.b, functional units 23–24 (northern and central Bay of Biscay)		Not available
ple.27.7bc	Plaice (*Pleuronectes platessa*) in divisions 7.b–c (West of Ireland)	April 2013	Plaice 7.bc
ple.27.7h–k	Plaice (*Pleuronectes platessa*) in divisions 7h–k (Celtic Sea South, southwest of Ireland)	May 2021	Plaice 7.h–k
ple.27.7fg	Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)	May 2022	Plaice 7.fg
ple.27.7e	Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel)	May 2022	Plaice 7.e
ple.27.7a	Plaice (*Pleuronectes platessa*) in Division 7.a (Irish Sea)	June 2021	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 2020	Sole 7.h–k
sol.27.7fg	Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)	May 2022	Sole 7.fg

Stock ID	Stock name	Last updated	Link
sol.27.7e	Sole (*Solea solea*) in Division 7.e (western English Channel)	June 2021	Sole 7.e
sol.27.7a	Sole (*Solea solea*) in Division 7.a (Irish Sea)	May 2022	Sole 7.a
whg.27.7b–ce–k	Whiting (*Merlangius merlangus*) in divisions 7.b–c and 7.e–k (southern Celtic Seas and eastern English Channel)	September 2020	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)	June 2022	Whiting 6.a

Annex 3: Working documents

The following working documents were presented to WGCSE in spring 2022. They are found in full in the following pages:

WD1: Maturity-at-age estimates for Irish Demersal Stocks in 6.a and 7.b–k between 2004–2021. Sara-Jane Moore and Hans Gerritsen.

WD2: Reducing uncertainty and assessing Bias in estimates of *Nephrops norvegicus* population size. Niall G. Fallon.

WD3: Development of Reference Points for the assessment of Celtic Sea Plaice Divisions 7.f and 7.g. Timothy Earl, Vladimir Laptikhovsky, Mathieu Lundy, Jonathan White.

Working document X

ICES Working Group for the Celtic Seas Ecoregion
4–13 May 2022
By Correspondence

ICES Working Group for the Assessment of the Bay of Biscay and the Iberic waters Ecoregion
2–13 May 2022
By Correspondence

Maturity-at-age estimates for Irish Demersal Stocks in 6.a and 7.b-k between 2004-2021

Sara-Jane Moore and Hans Gerritsen
Marine Institute
Galway
Ireland

Introduction

This document provides maturity-at-age estimates for stocks assessed by the WGCSE and WGBIE. All data are obtained on surveys and commercial sampling carried out by the Marine Institute.

Methods

Data was used from the Marine Institute Q1 Biological sampling programme (2010-2021), At-Sea Observer programme (2010-2021), Irish Anglerfish and megrim survey (2016-2021), the Irish beam trawl Ecosystem survey (2016-2018) and the MI Biological sampling survey (2004-2009). Sampling levels were reduced in 2021 as a result of COVID 19 and diminished access to at-sea samples and also port samples. Proportions mature-at-age were estimated by constructing a matrix containing the sample numbers by age, sex and maturity state (mature/immature) at each length class. Unsexed individuals (usually small fish with undeveloped gonads) were assigned in equal numbers to both sexes. This Age-Sex-Maturity-Length Key (ASMLK) was applied to the length-frequency data to estimate the proportions mature-at-age for either sex and both sexes combined. Any gaps in the ASMLK were filled in using a multinomial model (Gerritsen *et al.*, 2006).

Results

Because overall there was no clear evidence of trends in maturity over time for any stock, data from all years (2004-2021) were combined. Overall, the perception of age at maturity has not changed from previous years working documents. Figure 1 shows that for most stocks there are no clear trends in the L_{50} over time. Estimates for cod in area 7e-k varied from around 40cm to 60cm, however the sample sizes for this stock were generally very low at the start of the time-series. In the last 3 years, L_{50} estimates are consistent with an average of 48 cm. Sole in area 7 shows variable estimates in recent years. Plaice in area 7 shows two outlying estimates in 2013 and 2019 but these was estimated with low precision. There is a slight decrease L_{50} estimates from 30cm in 2020 to 24cm in 2021. Whiting in 7b-k shows a decline in L_{50} in 2019 but the data is based on low sample levels. In 2020 and 2021 the L_{50} increased to an average of 21cm.

Table 1(a) shows the estimated proportions mature-at-age. “All” sexes is a weighted maturity ogive and included unsexed individuals most likely to be immature. For Megrim 7&8, maturity at age is slightly lower than that used by WGBIE. Estimated proportions mature for plaice and sole were also slightly lower than those used by the working group. Whiting and Haddock estimates for 6a are variable over time.

Discussion

Some (relatively minor) differences were found between the ogives used by the working groups and the current findings. Because Irish sampling generally does not cover the full extent of the stocks, it is difficult to determine whether the Irish estimates are unbiased. It is possible that the lack of full spatial coverage can explain some of the differences.

References

Gerritsen, H.D., Armstrong, M.J., Allen, M., McCurdy, W.J. and Peel, J.A.D., 2003. Variability in maturity and growth in a heavily exploited stock: whiting (Merlangius merlangus L.) in the Irish Sea. J. Sea Res., 49(1): 69-82.

Gerritsen, H.D., McGrath, D. and Lordan, C., 2006. A simple method for comparing age-length keys reveals significant regional differences within a single stock of haddock (Melanogrammus aeglefinus). ICES J. Mar. Sci., 63(3): 1096-1100.

ICES, 2018. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 9-18 May, 2018, ICES CM 2018/ACOM:13

ICES, 2020. Report of the Working Group for the Celtic Seas Ecoregion (WKCELTIC), 10-14 February, 2020, ICES CM 2020/ACOM: TBC

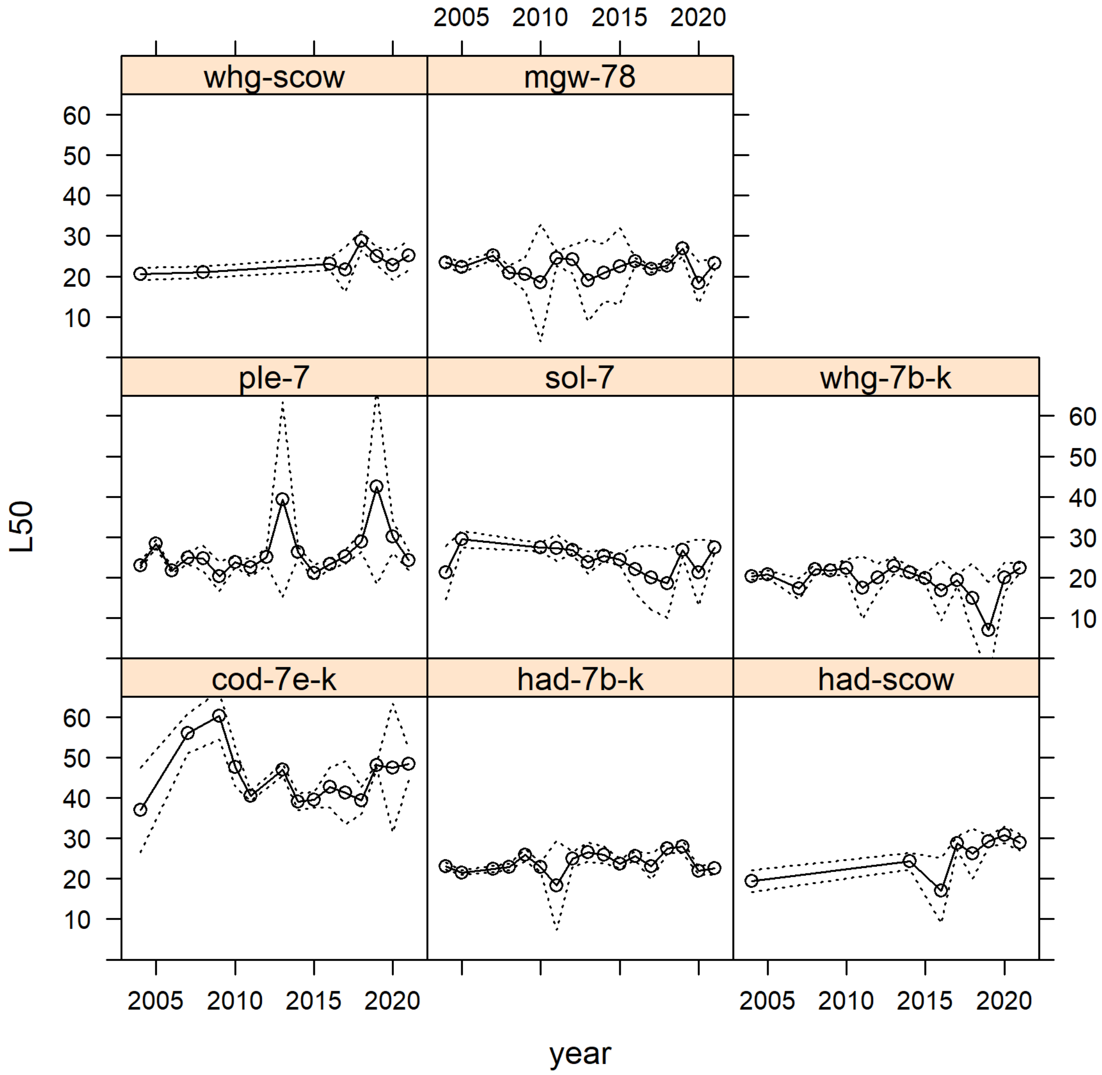

Figure 1. Length at 50% maturity (L50; cm) for females by stock and year.

Table 1 (a). Estimated proportions mature (sample numbers in table below) by stock, sex and age. Maturity ogives used by the WG are also given.

Stock	Sex/WG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
cod-7e-k	**All**	0	0.39	0.83	1	1	1	1											
	F	0.02	0.47	0.91	1	1	1	1											
	M	0.01	0.57	0.97	1														
	WKCELTIC	0	0.54	0.93	1	1	1	1	1	1	1								
had-7b-k	**All**	0.21	0.83	0.93	0.95	0.97	0.96	0.98	1	1	1	1	1						
	F	0.01	0.91	0.97	0.98	0.97	0.99	0.98	1	1	1	1							
	M	0.28	0.82	0.91	0.91	1.0	0.92	0.95	1	1			1						
	WKCELTIC	0.04	0.91	0.97	0.98	1	1	1	1										
had 6.a	**All**	0.07	0.56	0.57	0.73	0.69	0.77	0.75	0.86	0.81	1								
	F	0.03	0.78	0.75	0.81	0.85	0.89	0.80	1	0.90	1								
	M	0.10	0.65	0.59	0.70	0.45	0.40	0.68	0.33	0.42									
	WGNSSK	0	0	1	1	1	1	1	1	1	1								
mgw-78	**All**	0.30	0.31	0.57	0.74	0.75	0.76	0.76	0.84	0.85	0.86	0.90	0.88	0.93	0.92	0.93	0.94	1	1
	F	0.11	0.29	0.65	0.86	0.86	0.86	0.81	0.82	0.86	0.87	0.88	0.86	0.92	0.90	0.93	0.95	1	1
	M	0.62	0.35	0.54	0.69	0.72	0.77	0.84	0.88	0.87	0.82	0.84	0.93	1	1	1	1		
	WGBIE	0.04	0.21	0.6	0.9	0.98	1	1	1	1	1								
ple-7	**All**	0	0.27	0.50	0.66	0.76	0.87	0.87	0.87	0.89	0.95	0.68	0.87						
	F	0	0.14	0.44	0.65	0.77	0.89	0.89	0.83	0.83	0.91	0.86	0.78						
	M	0	0.33	0.59	0.73	0.82	0.88	0.84	0.92	0.86	1	1	1						
ple 7.a	**WGCSE**	0	0.24	0.57	0.74	0.93	1	1	1	1	1								
ple 7.fg	**WGCSE**	0	0.26	0.52	0.86	1	1	1	1	1	1								
sol-7	**All**	0	0.15	0.39	0.52	0.79	0.79	0.83	0.73	0.82	0.89	0.89	0.89	0.93	0.88	0.75	0.97	0.97	0.98
	F	0	0.14	0.46	0.63	0.85	0.92	0.95	0.97	0.95	0.96	0.95	0.95	0.94	1	0.90	1	1	1
	M	0	0.22	0.40	0.49	0.56	0.71	0.70	0.75	0.68	0.71	0.86	0.73	0.75	0.67	0.52	0.78	0.68	0.70
sol 7.fg	**WGCSE**	0	0.14	0.45	0.88	0.98	1	1	1	1	1								
whg 7b-k	**All**	0.50	0.90	0.96	0.91	0.87	1	1	1										
	F	0.29	0.96	0.98	0.98	1	1	1	1										
	M	0.49	0.83	0.95	0.85	0.80	1	1	1										
	WKCELTIC	0.61	0.94	0.97	0.97	1	1	1											
whg 6.a	**All**	0.40	0.70	0.65	0.80	0.88	0.81	0.93	1										
	F	0.43	0.88	0.93	0.92	0.96	1	1	1										
	M	0.47	0.59	0.50	0.64	0.58	0.38	0.78	1										
	WGCSE	0	1	1	1	1	1	1	1										

Table 1 (b). Sample numbers by stock, sex and age for associated maturity in Table 1(a) above.

Stock	Sex/WG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
cod-7e-k	**All**	1646	1881	172	25	2	2	3											
	F	734	849	82	14	2	2	3											
	M	837	1015	89	11														
had-7b-k	**All**	1228	2172	1603	540	269	167	105	44	17	4	1	1						
	F	490	1220	947	320	167	113	70	27	13	4	1							
	M	579	944	654	220	101	54	35	17	4			1						
had-scow	**All**	143	535	499	310	291	193	130	48	32	8								
	F	58	281	305	207	202	140	95	37	25	7								
	M	66	250	194	103	89	53	35	11	7									
mgw-78	**All**	57	1268	2114	1571	970	672	413	260	191	156	140	114	60	53	44	30	24	9
	F	34	622	1301	1081	699	463	257	178	153	133	135	107	58	53	44	29	24	9
	M	22	640	801	489	271	209	156	82	38	23	5	7	2			1		
ple-7	**All**	28	525	1375	1058	730	348	192	141	57	33	21	9						
	F	13	233	793	628	491	230	131	94	42	25	19	8						
	M	14	267	556	417	233	118	60	46	15	8	2	1						
sol-7	**All**	2	75	649	972	693	472	333	235	168	93	70	62	52	28	14	12	12	8
	F	2	46	537	823	584	327	202	114	90	45	24	28	27	12	8	8	5	5
	M		24	111	148	108	144	130	121	77	46	45	34	25	16	5	4	7	3
sol 7.fg																			
whg-7b-k	**All**	1300	1360	904	381	127	28	4	2										
	F	601	773	510	212	70	12	2	1										
	M	642	584	394	169	56	16	2	1										
whg-scow	**All**	200	416	472	281	153	59	17	3										
	F	95	224	265	177	112	38	7	2										
	M	103	192	207	104	41	21	10	1										

Working Paper: Reducing uncertainty & assessing Bias in estimates of *Nephrops norvegicus* population size

Niall G. Fallon

Stock Assessment and Modelling Group

Marine Scotland Science

Introduction

The fishery for *Nephrops norvegicus* is one of the most valuable in Scotland (£86m in 2019), representing ~15% of the value of all vessels' landings. The South Minch *Nephrops* Functional Unit (FU 12), found off the northwest coast of Scotland (Fig. 1, *inset*) has been surveyed on an annual basis since 1995. The total abundance of *Nephrops* is estimated using burrow density data collected during a research vessel based underwater television survey (UWTV) (ICES, 2021). Estimates of stock size derived from UWTV survey sample data are subject to uncertainty arising from measurement error (i.e. sampling uncertainty). Minimising measurement error is essential to the calculation of survey quantities with a level of uncertainty which allows for the evaluation of trends in stock dynamics.

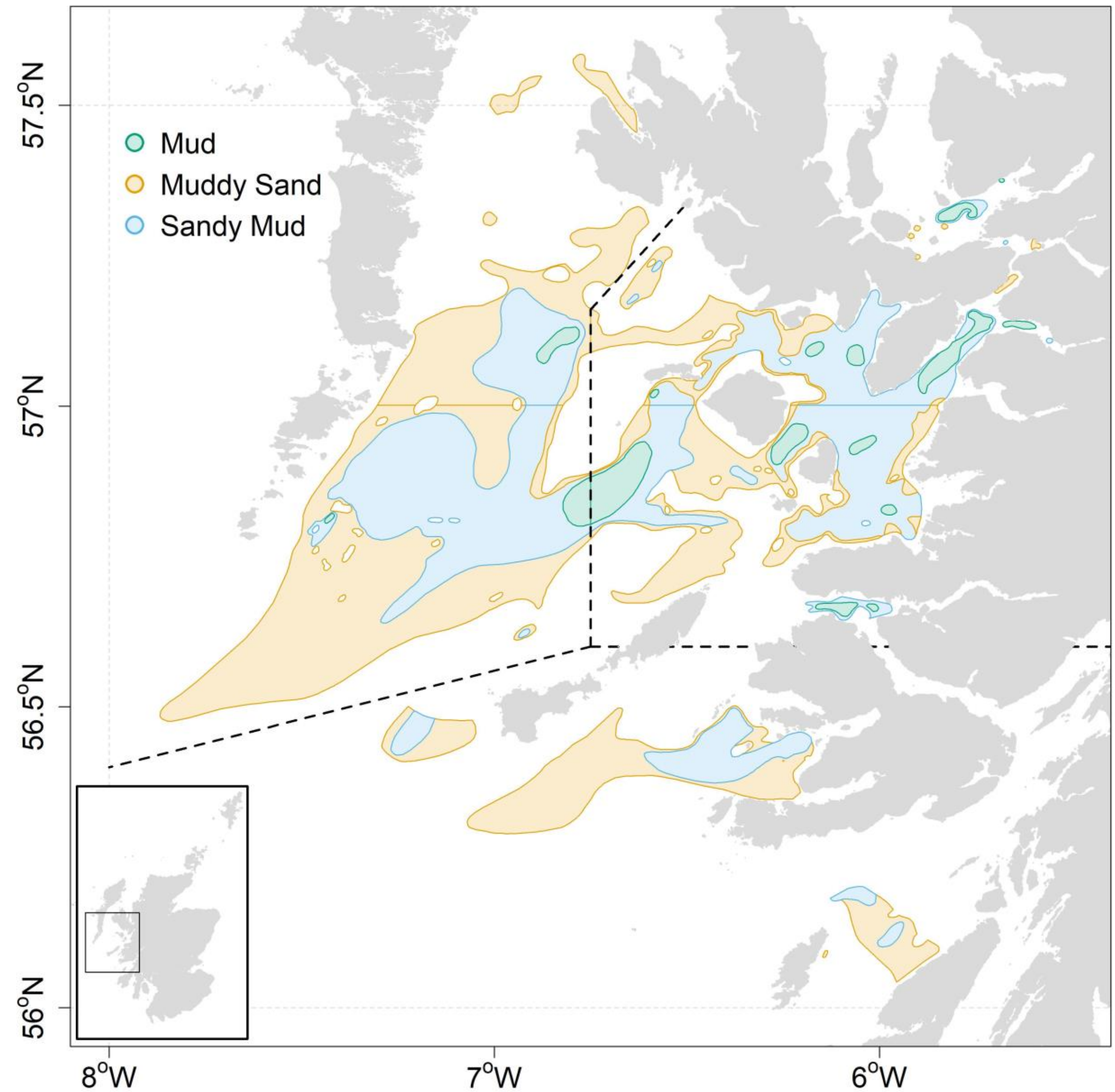

Figure 1. FU 12 is divided into three areal strata (East, South, and West), and three sediment strata (Mud *green*, Sandy Mud *blue*, and Muddy sand *yellow*), for UWTV sample allocation purposes.

The current sampling scheme for FU 12 is stratified across three sediment types (muddy sand, sandy mud and mud, following the Folk sediment classification) with fixed proportions of sampling effort in each of three areas (East, South and West; Fig. 1). Data from UWTV surveys of FU 12 are characterised by relatively high sample variance due to variability in burrow density within and between sediment types, when compared with the other Scottish *Nephrops* functional units. Estimates of abundance derived from FU 12 survey data using the current method (“standard method”, “standard abundance estimates”), a stratified mean estimator, therefore have relatively high uncertainty, affecting the precise detection of temporal trends in abundance. In addition, until 2021 UWTV survey samples were not allocated in direct proportion to area in the case of two strata, Eastern Sandy Mud and Western Muddy Sand, and samples were not always collected in the Western Mud stratum, along with some other less substantial temporal inconsistencies (Fig. 2). Burrow counts in the Eastern Sandy Mud stratum are notable for being relatively high (between ~0.6 and 1 burrow per m^2), particularly in recent years, and thus their over-representation in the sample set may have been problematic. Although the disparities in proportionate allocations are seemingly low (<10%), the sample allocation scheme could potentially have been introducing a bias to abundance estimates. In 2021, a sample allocation scheme was implemented in which sample numbers per stratum were as close to proportionate to sediment areal coverage as sample size and logistics would allow.

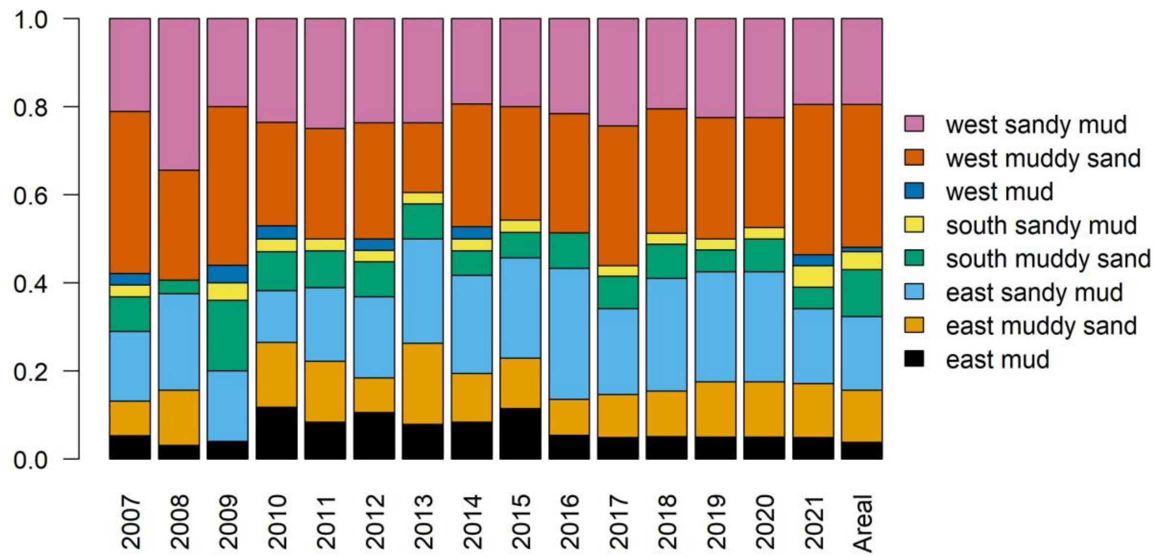

Figure 2. Proportionate sample allocations by stratum 2006-2021.

The aim of this study is to identify an abundance estimation method for FU 12 *Nephrops* which has lower uncertainty when compared to the standard method, and to determine whether bias was being introduced to abundance estimates by the UWTV survey sample allocation method. Kriging is used here to generate estimates of *Nephrops* abundance, and these estimates and associated uncertainty measures are compared to those derived using the standard method. In order to evaluate the bias (if any) in abundance estimates that may have been introduced due to disproportionate sample allocations, a resampling routine is used to generate estimates based on the standard method, where samples are taken in direct proportion to the area of each survey stratum.

Methods

Geostatistical analyses were implemented in RGeostats (MINES ParisTech / ARMINES, 2020) to generate spatially explicit kriged surfaces of FU 12 *Nephrops* burrow densities based on UWTV survey data from 2006-2021 (*See* Petitgas *et al*. 2017 for detailed descriptions of geostatistical methods), as well as globally kriged mean density estimates to be raised to total abundance. The first step in kriging involves characterising the spatial structure of the variable of interest (*Nephrops* burrow density) using variography (Rivoirard et al., 2000): i.e. the calculation and modelling of variability in density as a function of sample separation distance. Experimental variograms were calculated from the survey density data, to which exponential variogram models were fitted (Fig. 3).

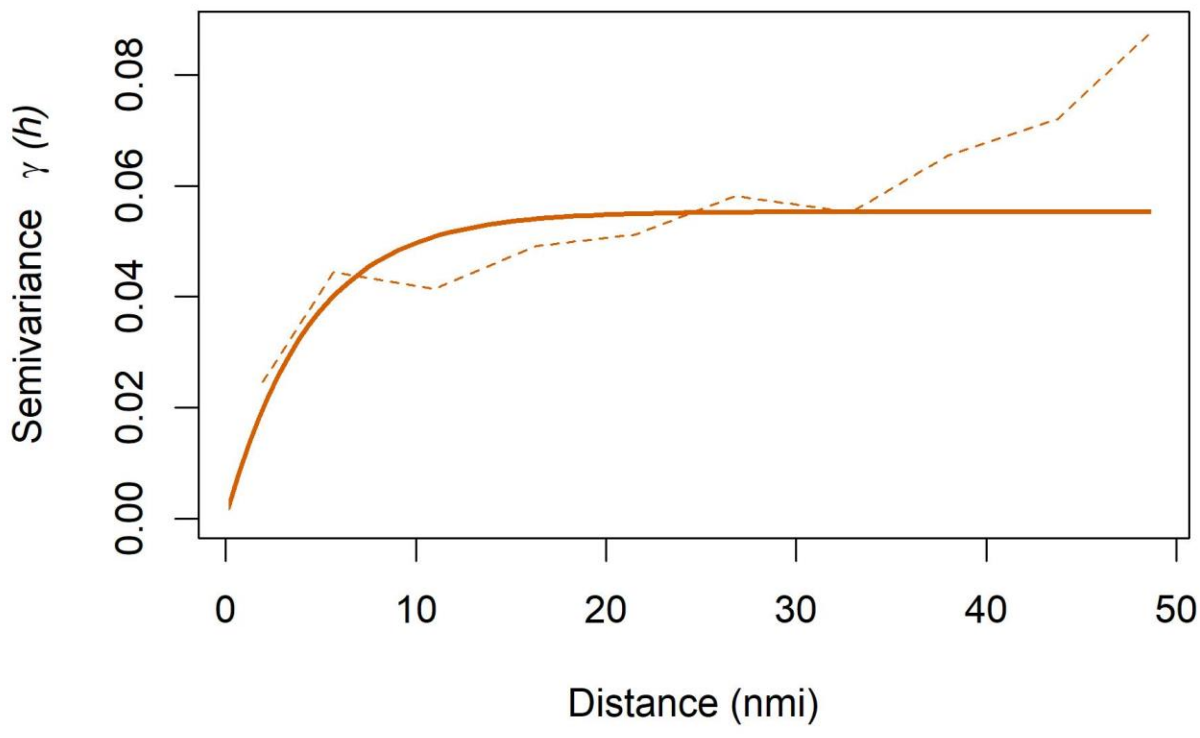

Figure 3. Variogram calculated for FU 12 *Nephrops*, from 2021 UWTV survey data. The experimental variogram of burrow density is represented by the dashed orange line. The model variogram is represented by the solid orange line.

Once an acceptable variogram model was fitted, kriged surfaces of burrow densities across the estimation area were generated. Here, a grid size of 500 x 500 metres was used. A globally kriged mean abundance (numbers per m^{-2}) was calculated, and raised to the total area of the main sediment patch (Fig. 4), with 95% confidence intervals calculated from the coefficient of variation. The abundance of *Nephrops* across the remaining, smaller sediment patches was calculated using the standard method, and added to the kriged total abundance. Sensitivity of estimates to grid size and variogram parameters were tested.

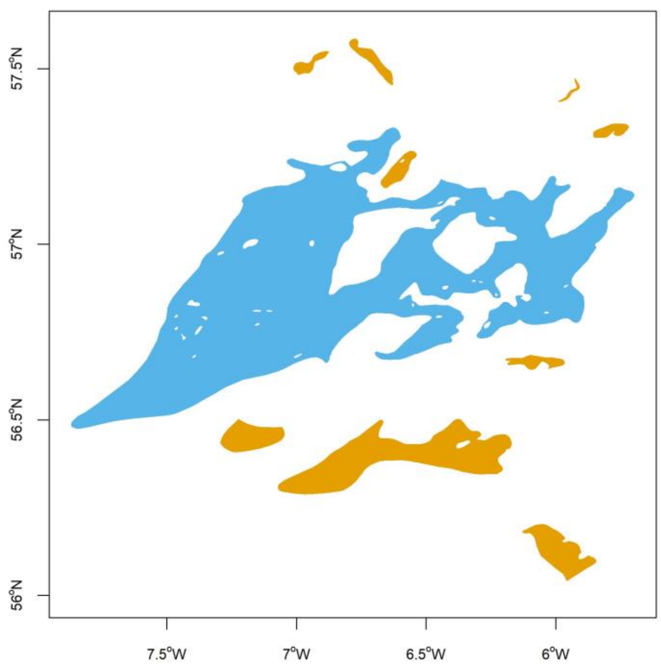

Figure 4. Sediment patches in FU 12 used in the calculation of *Nephrops* abundance. The main (*blue*) patch is the area across which kriging was carried out. *Nephrops* abundance across the remaining (*orange*) smaller patches was calculated using the standard method, and a total abundance was then summed across all sediment patches. The main sediment patch accounts for 82% of the survey domain by area.

In order to evaluate potential bias in UWTV survey standard abundance estimates, a resampling routine was implemented whereby a bootstrapped distribution of abundance estimates (n = 1000) was generated for each survey year using the standard method. Each estimate was derived based on a sample set which had a number of samples per stratum approximately proportionate to relative areal coverage of each stratum.

Results

Kriging provides illustrative maps of the spatial distribution of *Nephrops* within the main sediment patch of FU 12 (e.g. Fig. 5).

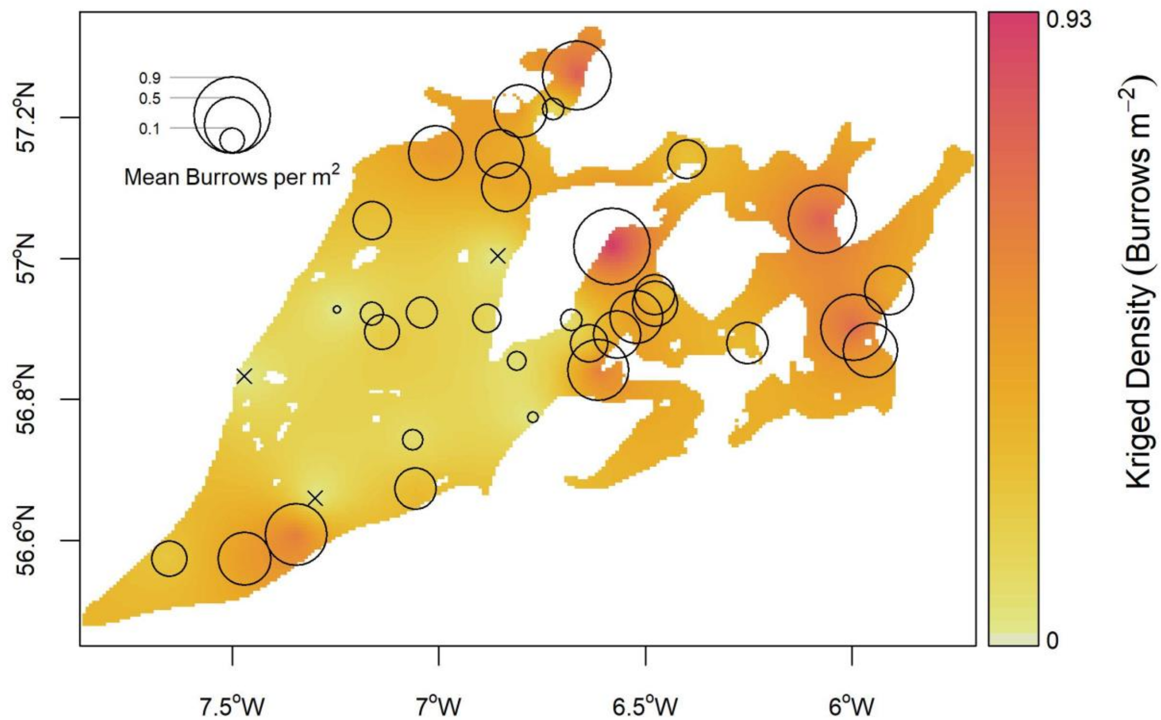

Figure 5. Kriged *Nephrops* burrow density distribution for FU 12, calculated using 2011 UWTV burrow density data (overlaid as a *black* bubble plot where bubble area is proportional to burrow density, the *black* **x** symbols represent zero density observations). Darker *red* pixels represent areas of higher estimated *Nephrops* burrow density, and lighter *yellow* pixels represent areas of lower estimated density.

Kriged estimates of mean abundance were significantly lower than the estimates using the current method (Fig. 6; $F_{(2, 42)} = 5.8$, $p < 0.01$). The resampling-based mean abundance estimates tended to be closer to (but were also generally lower than) standard estimates, and followed the same overall temporal trend. There was no significant difference between the resample-based estimates and those derived using the standard method ($F_{(2, 42)} = 5.8$, $p = 0.36$). The 2021 resample-based estimate had the fourth lowest percentage deviation (1.54 %) from its equivalent standard estimate across the time series.

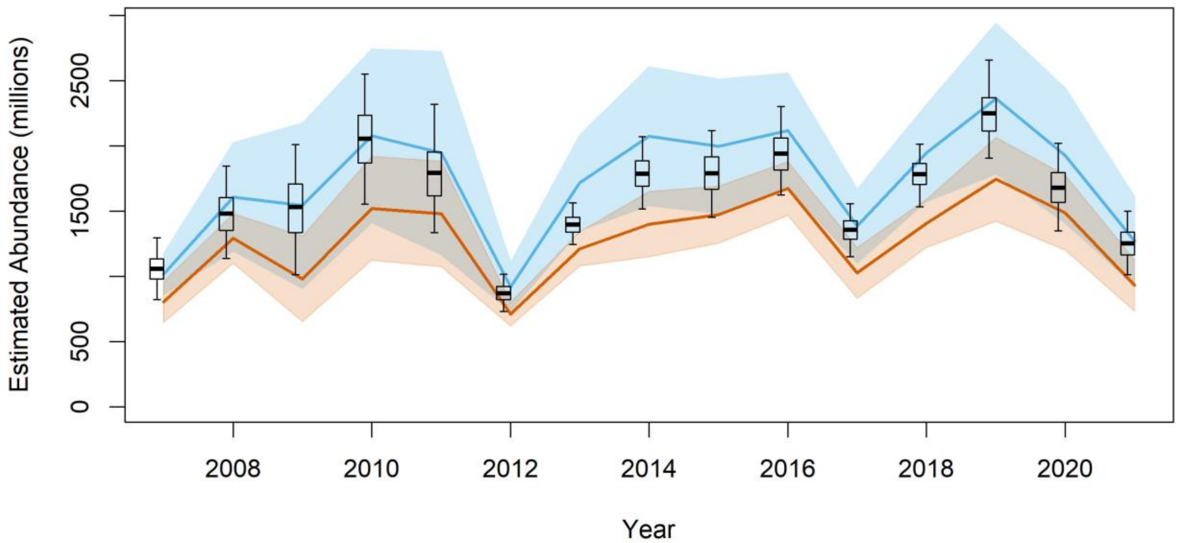

Figure 6. Time series estimates of FU 12 *Nephrops* abundance with 95% CIs using the standard method (*blue line and polygon*) overlaid with kriged estimates of mean total abundance with 95% CIs (*orange line and polygon*), and resample estimates (*black boxplots*; the centre line is the mean, the whiskers are at the 95% quantiles of the bootstrap distribution).

Differences in magnitude aside, the three time series were highly correlated (pairwise Pearson correlation coefficients > 0.95), suggesting generally good agreement between the trends observed across methods (Fig. 7). Compared to the standard method, there was a mean reduction of 34% in coefficient of variation using kriging (Fig. 8).

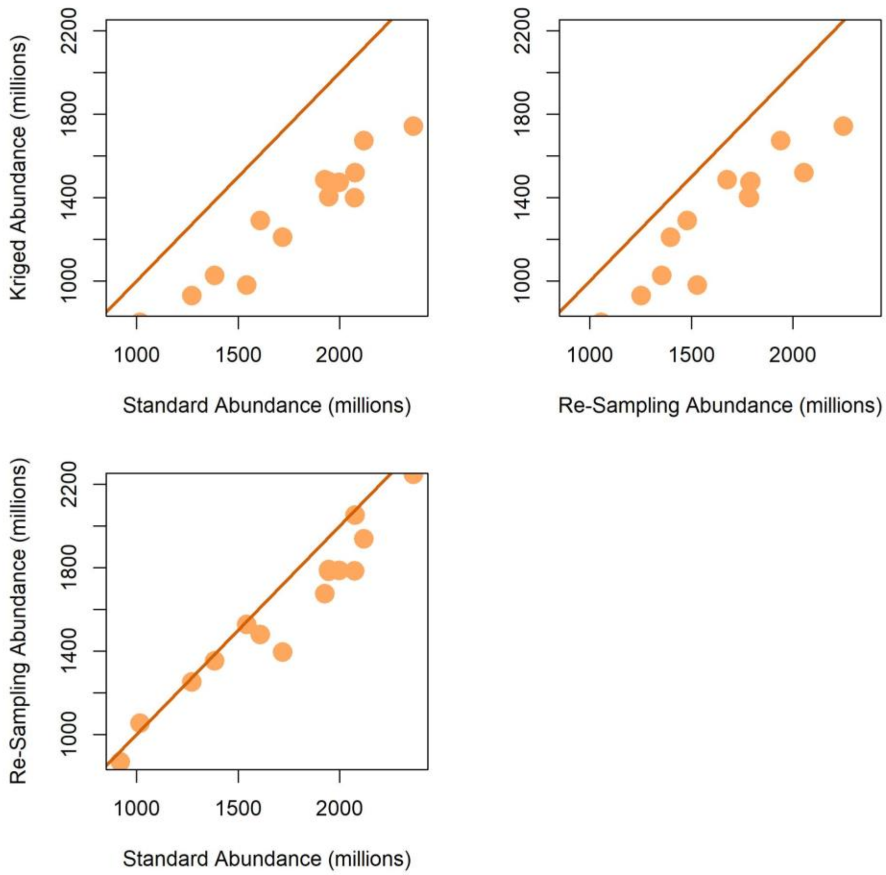

Figure 7. Pairwise comparisons of mean abundance estimates derived using kriging, the resampling routine, and the standard method. Each plot panel includes a *red* 1:1 line to aid in comparison of time series.

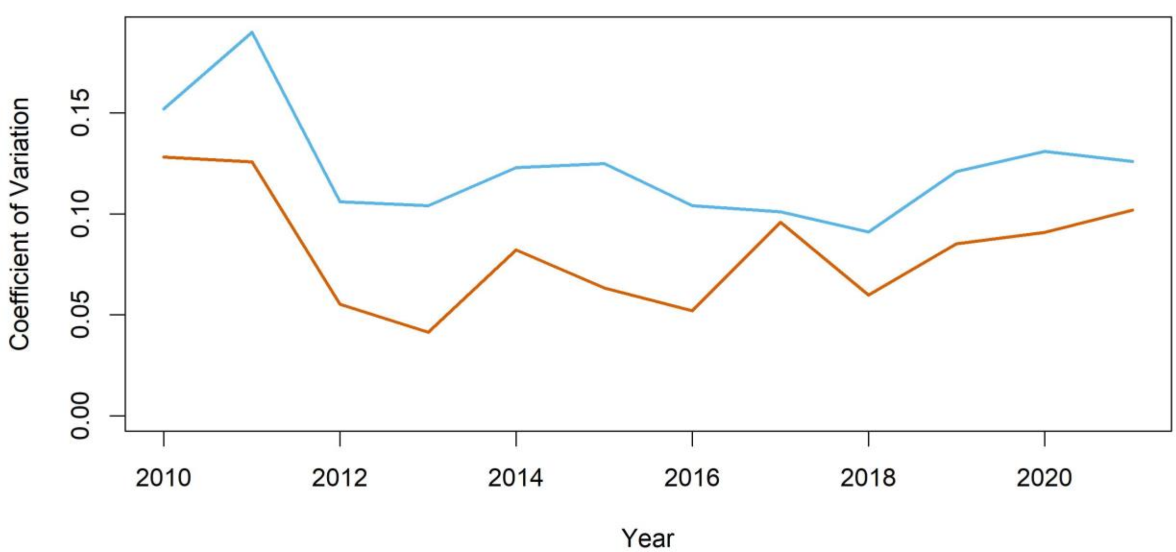

Figure 8. Time series of coefficients of variation for standard (*blue line*) and kriged (*orange line*) estimates of FU 12 *Nephrops* abundance.

Abundance estimates showed little sensitivity to changes in kriging grid size (Fig. 9) and variogram lag distances (Fig. 10).

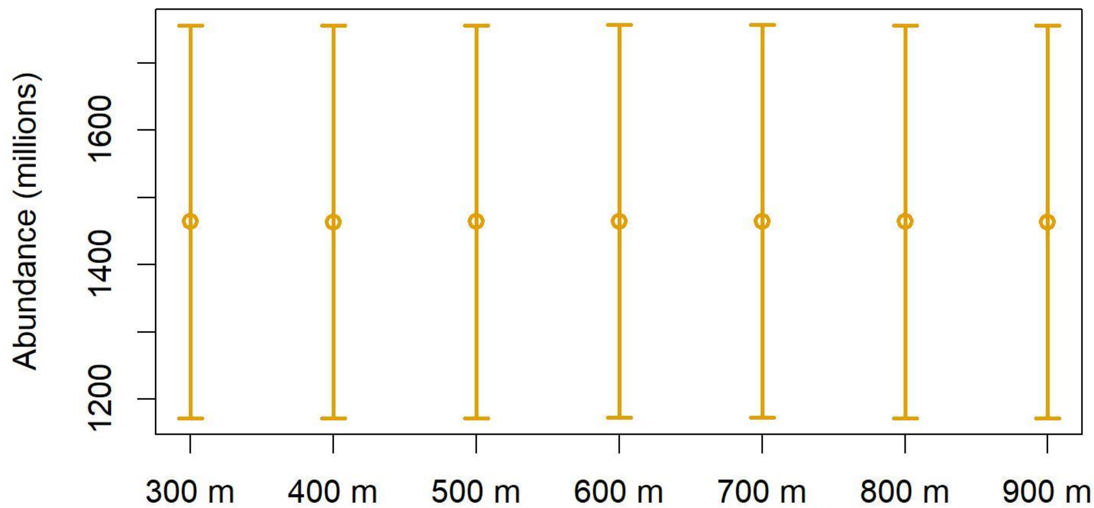

Figure 9. FU 12 *Nephrops* kriged abundance estimates with 95% CIs calculated using a range of grid sizes.

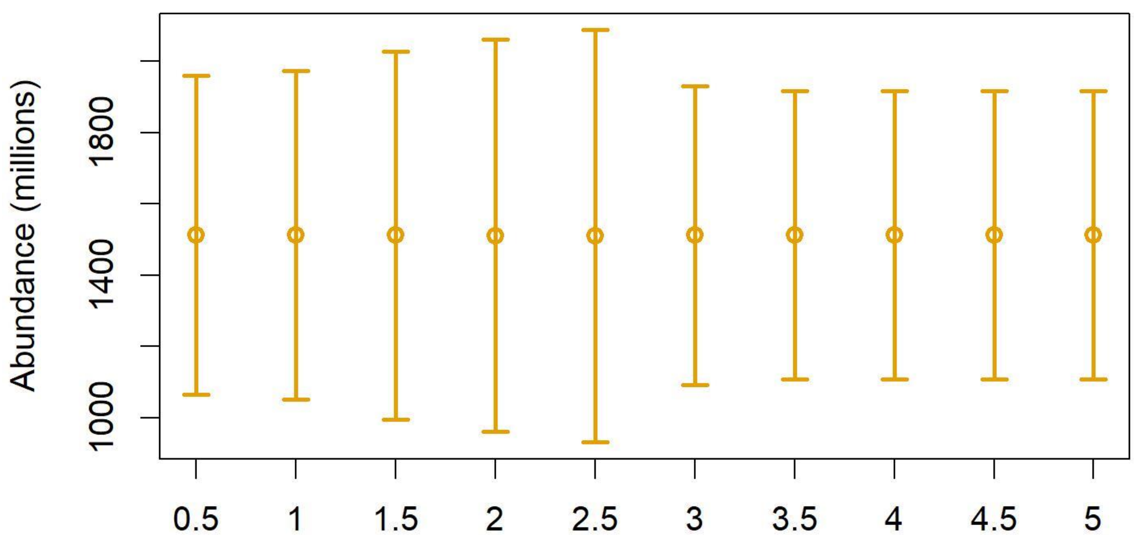

Figure 10. FU 12 *Nephrops* kriged abundance estimates with 95% CIs calculated using a range of variogram lag distances.

Discussion

Kriging can provide estimates of *Nephrops* abundance for FU 12 with reduced uncertainty when compared to the standard method, while being of a comparable magnitude and following similar historical trends. As such, kriging may offer a solution to the long-standing issue of highly uncertain abundance estimates for that management area. Ultimately, the outcome of the method relies heavily on the ability to fit a representative variogram model. It is thus important to fully explore the sensitivity of the variogram model fits to the assumptions applied in the calculation of the empirical variogram (e.g. distance lag). It may be useful to expand this analysis to multiple Scottish FUs to assess the performance of the kriging estimation method against the standard method in different scenarios.

Given the non-significant difference between the resampling-based method and the standard method, it does not appear that substantial bias has been introduced to the assessment due to the UWTV sample allocation method. Regardless, it would be favourable to correct the minor discrepancies in proportionate sample allocations for future surveys.

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Post WKNSCS WD

Development of Reference Points for the assessment of Celtic Sea Plaice Divisions 7.f and 7.g

v. 2.0 Post review update 20th April, 2022

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Introduction

The Benchmark meeting WKNSCS reviewed and developed a SAM assessment for Plaice in the Celtic Sea Divisions 7 f-g. The assessment is accessible on Stockassessment.org as "plaice7fg_001". The details of the assessment are available in the WKNSCS report, section "Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)" under subsection "Suggested assessment"

Following review of the proposed assessment model during WKNSCS, reference points were developed (ICES 2021a). These were initially explored during WKNSCS and found to suggest a marked change in perception of stock status compared to the most recent qualitative assessment of the stock (ICES 2021b). A sub-group was tasked to review the proposed reference point formulation to understand the driver for the change.

The WKNSCS Benchmark meeting reviewed:

Benchmark Model 1 (BM1): a SAM model incorporating natural mortality estimates taken from the plaice assessment in the Irish Sea, Division 27.7a (ple.27.7a) (Stockassessment.org as "plaice7fg_001").

Subsequent to the WKNSCS Benchmark meeting, a second model and reference points derived from it were reviewed:

Benchmark Model 2 (BM2): A SAM model variant on BM1, using natural mortality estimates from the assessment of plaice in the English Channel (ple.27.7d), calculated using the Gislason equation, which were notably higher (Stockassessment.org as "Ple.7fg_disc").

The two different estimates of natural mortality were used, as stock-specific data were considered not appropriate for the Celtic Sea (27.7fg) stock because they were lacking older ages. In both model variants, natural mortality was specified for each of the modelled age classes (1 to 10 year olds) and fixed across the full time series. Figure 1 compares the two different sets of natural mortality.

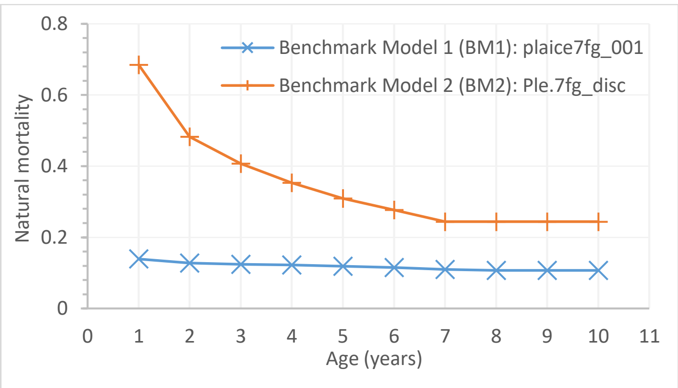


Figure 1. Comparison of natural mortalities of Benchmark Models 1 and 2.

The model variant focus, to develop reference points in this WD, is BM1, which is the model reviewed by the WKNSCS using natural mortalities taken from the plaice assessment in the Irish Sea, Division 27.7a.

Method

Reference points were estimated following ICES Technical Guidelines (ICES, 2021) and WKMSYREF4 (ICES, 2017). In order to optimise for wanted catch in the reference point estimation, it was assumed that ages 1 and 2 have been unwanted and all other ages wanted, as age 2 corresponds with the Minimum Conservation Reference Size (MCRS) in this plaice stock.

Following review of an initial estimation of reference points, and following reviewer's recommendations, reference point estimation R-scripts were re-run in with the following settings:

Error settings were defined as:

Fbar (ple7fg)
sigma_m = sd(log(Fbar))
Fcv = standard deviation (Fbar) / mean (Fbar)
Fphi = 0.423 = default value (ICES, 2017)
SSBcv = 0.20 = default value (ICES, 2017)

Following further reviewer comments:

- F_{MSY} ranges were checked against F_{p05}, which resulted in no changes.
- The lower 5%ile biomass was considered from fishing at F_{MSY} for the second reference points (derived from BM2), but this was lower than B_{pa}, and so should not be used.

Results

From plotting of Stock-Recruitment points, stock characteristics were taken as being of Type 5, "Stocks with no evidence that recruitment has been impaired or with no clear relation between stock and recruitment (no apparent S-R relationship)". For these stocks B_{loss} is defined as a candidate value of B_{lim}, below which the dynamics of the stock are unknown. With B_{loss} taken from a stable part of the assessment and not from recent years. B_{lim} then acts for the basis of estimation of "Precautionary Approach" and "MSY" reference points (ICES, 2021).

Reviewing the S-R data, the segmented regression inflection point is very close to this point and presents as a stable point from which to define B_{loss}, at 1344 tonnes. Following external review recommendation, the inflection point of the segmented regression was set to the B_{loss} point. Appendix 1 sets out the R-Markdown of the described estimation.

PA reference points:

B_{pa} may be calculated as = $B_{lim} \times \exp(1.645 \times \sigma)$, with σ estimated from the assessment uncertainty in SSB in the terminal year (σ is the estimated standard deviation of ln(SSB) in the final assessment year). If σ is unknown, 1.4 can be used as a default for "exp(1.645 × σ)", equivalent to σ = 0.20 ("SSBcv" in the above listed Error settings).

While F_{lim} may be estimated by simulating a stock with a segmented regression S-R relationship, with the point of inflection at B_{lim} (as detailed above, set as B_{loss} at 1344 tonnes) thus determining the F = F_{lim} which, at equilibrium, yields a 50% probability of SSB > B_{lim}. This is may be done by running EqSIM to implement this simulation (ICES, 2021). F_{lim} is calculated with Fcv and Fphi both set to zero (ICES 2021).

MSY reference points:

To define F_{MSY} it is necessary to determine yield from the fishery, in the case of this plaice stock this is defined as the catch above Minimum Conservation Reference Size, and taken as wanted catch, aged above 2 year olds. Following the procedures set out in ICES (2021), F_{MSY} was set to the median yield curve versus

F: the value of F that maximises yield. MSY $B_{trigger}$, is set to safeguard against undesirable or unexpected low SSB when fishing at F_{MSY}, as the 5th percentile on the distribution of SSB when fishing at F_{MSY}.

Following this process, through application of the R package and process "EqSIM" (set out in Appendix 1), derives reference points in Table 1. These, relative to the stock status (SSB) and fishing pressure (F) from the SAM assessment over time are shown in Figure 2 and Figure 3 respectively.

Table 1. BM1 - Estimated reference points for plaice 7.fg.

Reference Point	Value	Rationale
MSY Btrigger	1882t	Bpa
Fmsy	0.147	Stochastic simulations with segmented regression & Beverton-Holt
FmsyLower	0.099	Median lower point estimates of Stochastic simulations
FmsyUpper	0.230	Median upper point estimates of Stochastic simulations
Blim	1344t	Lowest observed SSB
Bpa	1882t	Blim combined with the assessment error
Flim	1.275	F with 50% probability of SSB less than Blim
Fpa	0.592	F with a probability of less than 5% of falling below Blim

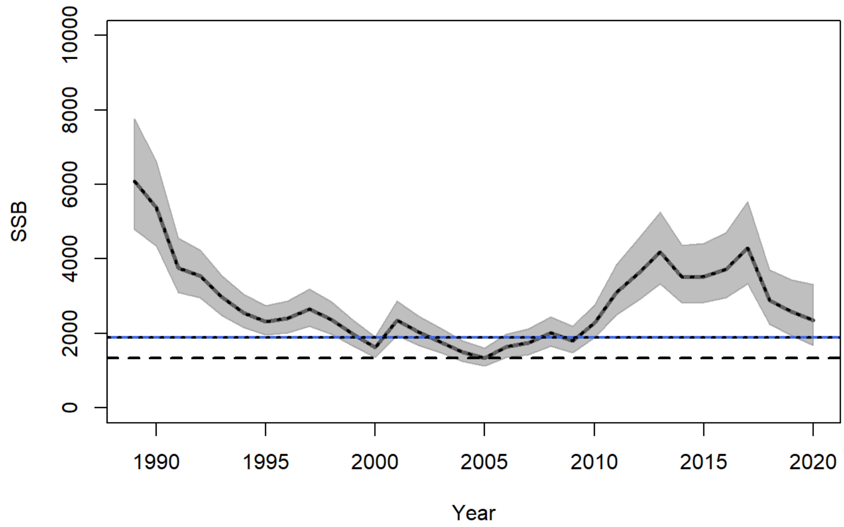


Figure 2. BM1. SSB from the developed SAM model and associated, derived Biomass reference points MSY $B_{trigger}$ (1,882 tonnes, in blue), B_{pa} (1,882 tonnes, dotted line) and B_{lim} (1,344 tonnes, dashed line).

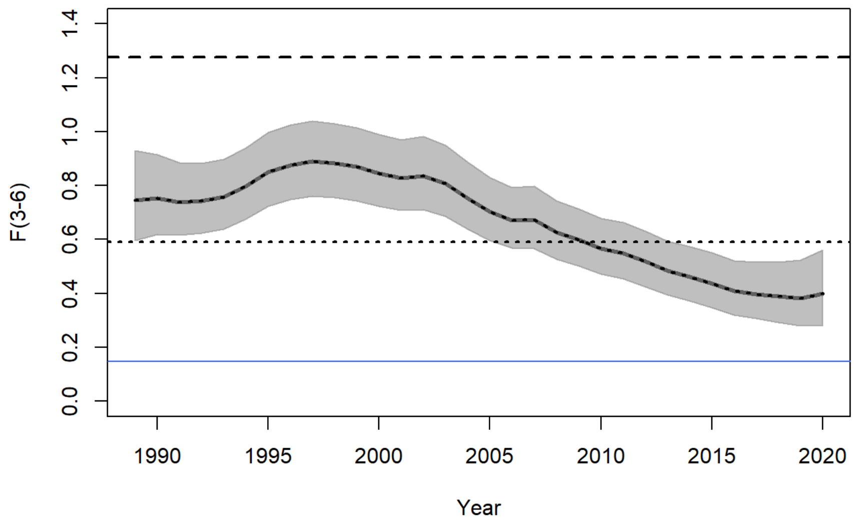


Figure 3. BM1. Fishing pressure from the developed SAM model and associated, derived F reference points F_{MSY} (0.147 in blue), F_{pa} (0.592, dotted line) and F_{lim} (1.275, dashed line).

For comparison purposes, running the same exercise on the BM2 SAM model of the plaice stock, provides different reference point estimates. Beginning with B_{loss} defined at 2061 tonnes (Appendix 2, Table 2, Figures 4 and 5).

Table 2. BM2 - Estimated reference points for plaice 7.fg.

Reference Point	Value	Rationale
MSY Btrigger	2885t	Lower 5th percentile of BMSY; in tonnes
Fmsy	0.479	Stochastic simulations with segmented regression & Beverton-Holt
FmsyLower	0.263	Median lower point estimates of Stochastic simulations
FmsyUpper	0.480	Median upper point estimates of Stochastic simulations
Blim	2061t	Lowest observed SSB
Bpa	2885t	Blim combined with the assessment error
Flim	1.649	F with 50% probability of SSB less than Blim
Fpa	0.480	F with a probability of less than 5% of falling below Blim

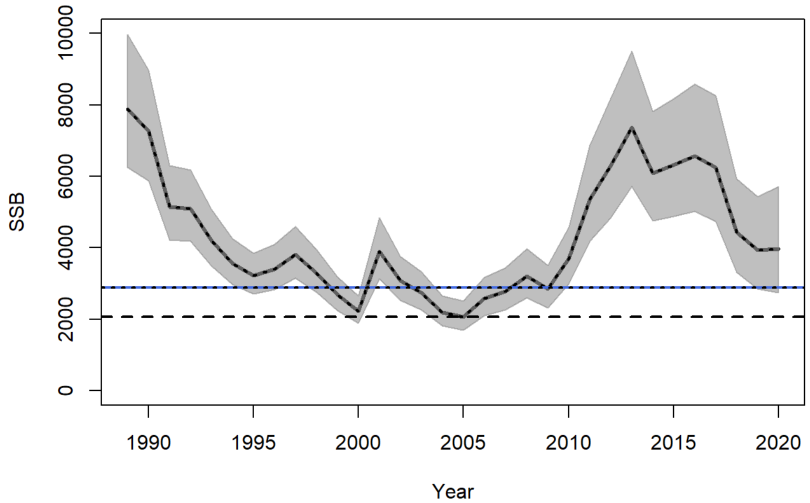


Figure 4. BM2. SSB from the developed SAM model and associated, derived Biomass reference points MSY $B_{trigger}$ (2,885 tonnes, in blue), B_{pa} (2,885 tonnes, dotted line) and B_{lim} (2,061 tonnes, dashed line).

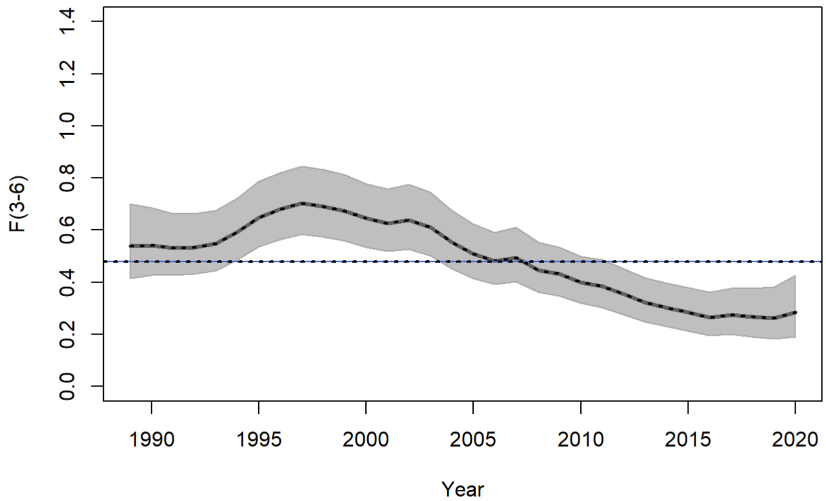


Figure 5. BM2. Fishing pressure from the developed SAM model and associated, derived F reference points F_{MSY} (0.479 in blue), F_{pa} (0.480, dotted line) and F_{lim} (1.649, off scale).

Conclusions

There is clearly a notable influence coming from the choice of natural mortality in the estimation of reference points. For the BM1 model seen by the benchmark process WKNSCS, the MSY $B_{trigger}$ reference point is notably higher, while B_{lim} and $B_{trigger,}$ lower than BM2. F reference points are all lower.

The premise for this is that BM1, with lower natural mortality values taken from the Irish Sea, a higher proportion of total mortality in the SAM assessment model is being attributed to fishing pressure and therefore suggest that F has been relatively high and has been limiting stock development. It suggests if fishing pressure were reduced a large development of the stock would result, and a high yield even at a much lower F than is currently observed.

The larger impact on the advice is therefore the much lower estimate of F_{MSY} in BM1, which comes directly from the lower natural mortality assumption and creates a significantly more pessimistic estimate of F-based stock status than BM2.

BM2, with higher natural mortality estimates, attributes a greater proportion of total mortality to natural mortality than fishing mortality, and therefore suggest that F is not limiting the stock, with F below F_{MSY} since around 2007. To maximise yield it would be necessary to increase fishing pressure to the levels seen pre 2005, for a landing yield of around 1000t (similar to what has been achieved). The perception of this secondary model is much closer to the recent year's perception (Figure 5; ICES 2021b).

The selection of natural mortality values is evidently important on the calculation of reference points. The two SAM assessments, BM1 and BM2, both give potential assessments, with BM2 giving better retrospective patterns, with lower variability. This may be justification for BM2 over BM1. More work is recommended however, on the choice of natural mortalities. This should include comparison of similar plaice stocks, further review of stock-specific raw data and review of any ecosystem modelling pertaining to fish natural mortalities.

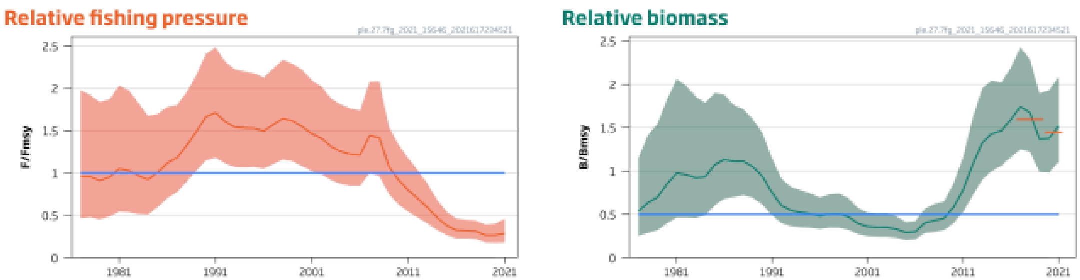


Figure 5. 2021 perception of stock status for plaice in divisions 7.f and 7.g (ICES 2021). Fishing pressure on the stock was below F_{MSY} and biomass above MSY $B_{trigger}$. The short orange lines in the relative biomass plot indicate the average values of the respective years (2017 to 2019 and 2020 to 2021; ICES 2021b).

References

ICES (2017). 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 (2021). ICES Technical Guidelines Published 1 March 2021. 16.4.3.1. ICES fisheries management reference points for category 1 and 2 stocks. ICES Advice 2021 https://doi.org/10.17895/ices.advice.7891

ICES (2021b). Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea). In Report of the ICES Advisory Committee, 2021. ICES Advice 2021, ple.27.7fg. https://doi.org/10.17895/ices.advice.7823

Appendix 1. Reference point calculation R-Markdown – from Base Stock assessment

File: CS_PLE_RePt_WKNSCS_3_updated.html

CS_PLE_RePt_WKNS
CS_3_updated.html

Appendix 2. Reference point calculation R-Markdown – from developed Stock assessment

File: CS_PLE_RePt_WKNSCS_4_updated.html

CS_PLE_RePt_WKNS
CS_4._updated.html

Response to further Review of Reference Points for Celtic Sea Plaice Divisions 7.f and 7.g

Reference points are presented for two assessments with differing natural mortalities:

(1) *M*s from the Irish Sea plaice assessment (plaice7fg_001) and

(2) *M*s from the English Channel plaice assessment (Ple.7fg_disc).

The first set of reference points correspond to the assessment put forward by the WKNSCS benchmark but the second (based on higher Ms) correspond better to the previous perception of the stock (based on a SPiCT assessment). It is not clear which set of reference point are being proposed, and no reasoning is presented regarding the choice of M.

This document therefore reviews only the reference point calculations, although it is important to ensure the same set of Ms are used for both assessment and calculation of reference points.

> **Response:** Review of the reference points post Benchmark revealed the issue around choice of natural mortality in estimating reference points. Both situations are presented in this WD to detail the issue and the effect of the choice. Work is ongoing to determine the choice of *Ms* for application in assessment and advice.

***Reference point calculations*:**

B_{lim}: The classification as Type 5 seems appropriate, with B_{lim}=B_{loss} as specified in the guidelines.

B_{pa}: B_{pa} is calculated assuming the default σ=0.2, in accordance with the guidelines. This seems appropriate given the standard deviation of ln(SSB) < 0.2 for both assessments.

F_{MSY}: Biological parameters are derived by default from the last 10 years of data. Selectivity is derived from the last 5 years, which is justified due to trends in recent years. Assessment error parameters are taken as F_{cv}=0.212 and F_{phi}=0.423. These are stated as ICES defaults although this should be checked as default values are not given in the ICES guidelines.

> **Response:** Fcv in the reference points presented in this updated WD are now calculated as sd(fbar)/mean(fbar). Fph=0.423 commonly used in Celtic Sea, e.g cod 7a and Haddock 7a. Comes from ICES, 2017: WKMSYREF4:
> ICES. 2017. 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.

Stock recruitment is taken as a mixture of a segmented regression (with breakpoint estimated close to B_{lim} and within the range of observed SSBs) and Beverton-Holt. F_{MSY} and the F_{MSY} range have not been checked against $F_{P.05}$ (i.e., it has not been evaluated that P(SSB < B_{lim}) ≤ 5% when applying the ICES AR).

> **Response**: This has now been checked, and does not change reference points.

MSY $B_{trigger}$: For the first set of reference points (based on plaice7fg_001) the stock has not been fished at or below F_{MSY}. MSY $B_{trigger}$ is therefore taken as B_{pa} as specified in the guidelines. For the second set of reference points (based on Ple.7fg_disc) MSY $B_{trigger}$ is also taken as B_{pa}, although in this case *F* has been below F_{MSY} since around 2007 so the 5th percentile of B_{MSY} could be considered.

> **Response**: This biomass is less than Bpa, so should not be used.

F_{lim}: Stock recruitment was taken as a mixture of a segmented regression with breakpoint estimated and a Beverton-Holt. This is not in accordance with the guidelines which specify that a segmented regression with the point of inflection at B_{lim} should be used (although the BP is estimated close to B_{lim}).

Response: Now corrected to use Hockeystick with breakpoint at Blim for the estimation of Flim. Slightly increases Flim and Fpa

Assessment and advice error were (correctly) not included, and all other settings were the same as for F_{MSY}.

F_{pa}: F_{pa} was derived as ~F_{lim}/1.4 using the Fpa() function in the icesAdvice package. This appears to be a legacy function from the previous guidelines as Table 16.4.3.1.1 now specifies that F_{pa} should be taken as $F_{P.05}$ (i.e., the F that would lead to P(SSB ≥ B_{lim})=95% in the ICES AR).

Annex 4: Audits

Audit of Cod (*Gadus morhus*) in Division 6.a (West of Scotland)

Reviewer: Dave Stokes 4/6/2022

General

For single-stock summary sheet advice:

1. **Assessment type:** Benchmarked in 2020. The current assessment is in line with the stock annex.
2. **Assessment:** Analytical age-based SAM assessment.
3. **Forecast:** Short-term stochastic forecast carried out in SAM.
4. **Assessment model:** SAM assessment with catch data tuned with five survey series.
5. **Data Issues:** Q1 survey data not available for interim recruitment; low sampling from OTB-CRU resulting in biased estimates for ages 1–2 so removed from assessment for 2021; VMS data unavailable so misreporting estimated from Marine Scotland Compliance data.
6. **Consistency:** Other than data issues above, recruitment assumption reduced to five years rather than ten years, otherwise assessment is consistent.
7. **Stock status:** SSB is estimated to be below all reference points and F estimated to be above.
8. **Management plan:** There is no agreed shared management plan with UK for this stock, and ICES provides advice according to ICES MSY approach – zero catch advice.

General comments

The report is comprehensive and easy to follow with only a few minor comments. The assessment itself has some updates driven by missing data as well as some noise in tuning indices for older ages and recent years in particular. Overall however, the assessment is consistent with the stock annex and guidelines for retrospective bias and therefore accepted by WGCSE 2022.

Technical comments

Inclusion of survey variance in the assessment is interesting and uncommon so some description in the stock annex on how it was introduced and how it is used, etc. would be useful as well as listing in the inputs to SAM in SA/Advice sheet.

Check minor comments Tables 6,7 & 9 in advice sheet.

Conclusions

The assessment is well presented, supported by the data and the report, and appears to have been carried out either as prescribed or as documented by the stock coordinator in the report and advice sheet.

Audit of Cod (*Gadus morhua*) in Division 7.a (Irish Sea)

Reviewer: Sara-Jane Moore

General

For single-stock summary sheet advice:

1. **Assessment type:** stock was benchmarked in February 2022. Assessment run based on the benchmark but without recreational removals.
2. **Assessment:** age-based.
3. **Forecast:** yes, as short-term stochastic projections.
4. **Assessment model**: SS3.
5. **Consistency:** last year's assessment was based on Survey trends using the biomass index of the NIGFS-WIBTS-Q1 survey. Last year stock was Category 3.
6. **Stock status:** Fishing pressure on the stock is below F_{MSY} and spawning–stock size is below MSY $B_{trigger}$, B_{pa}, and B_{lim}.
7. **Management plan:** No agreed management plan.

General comments

The assessment was benchmarked in 2022 and changed from category 3 to category 1 (ICES, 2022b), therefore historical assessments are not comparable. Additional information included an updated natural mortality M, inclusion of multiple survey indices, commercial catch and catch-at-age information and recreational removals. Owing to uncertainty around calculations of the recreational removals and selectivity pattern, all recreational removals have been excluded in the 2022 assessment. This makes minor changes to the perception of the stock.

Technical comments

- Catch SOP check for 2020 is low (0.74525). when you multiply lnaa by lwaa get 265 581 tonnes not 181 tonnes as in landings Lowestoft file.
- Get Mohns rho of -0.14 for F.
- Fleet 2 (NIGSQ1) has an error of 0.96 in 2002, this seems quite large.

  What was the basis of the S–R relationship? It does not look appropriate from SS3 plots.

Conclusions

Depending on input values corrections to be checked, the stock assessment appears to have been done correctly. If current Lowestoft files are used for forecast, then the forecast will have to be re-run. The perception of the stock is unlikely to change however.

Minor edits suggested for report.

Audit of Cod (*Gadus morhua*) in divisions 7.e–k (eastern English Channel and southern Celtic Seas)

Date: 20/05/22

Auditor: Paul Bouch

General

ICES advises for zero catch in 2023. Fishing pressure is above F_{MSY} and F_{pa} and spawning–stock size is below all relevant reference points. The TAC for 2021 was significantly overshot with discards estimated to be 54%.

For single stock summary sheet advice:

1. Assessment type: update.
2. Assessment: analytical.
3. Forecast: presented.
4. Assessment model: SAM - tuning using a VAST index (combining EVHOE and IRGFS) and the FR-OTDEF commercial index.
5. Data issues: No issues.
6. Consistency: Similar to last year's assessment. Mohn's Rho values are high but similar in magnitude to previous years.
7. Stock status: SSB continues to be below B_{pa}, B_{lim} and $B_{trigger}$. Fishing pressure declined slightly to drop below F_{lim} since last year, but it remains well above F_{pa} and F_{MSY}.
8. Management Plan: ICES recommends zero catch advice. Mixed fisheries advice will be provided later in the year.

General comments

The assessment is available on stockassessment.org and is in agreement with what is specified in the stock annex.

Technical comments

No issues were identified.

Conclusions

The assessment has been performed correctly. The stock assessment for this stock has been audited internally within WGCSE, and no issues were found.

Audit of Haddock (*Melanogrammus aeglefinus*) in Division 7.a (Irish Sea)

Date: 31/06/2022

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 2022 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. 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 at relatively high levels in the time-series and above MSY $B_{trigger}$. but it has declined in recent years. Fishing mortality (F) has been below F_{MSY} since 2012. The stock is characterized by highly variable recruitment. Recent recruitment has been low (and below the time-series mean).
7. **Man. Plan**: There is no specific management plan for the stock.

General comments

The assessment was conducted correctly and it followed the methods detailed in the stock annex.

Technical comments

ASAP analysis was correctly performed.

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**

Audit of Haddock (*Melanogrammus aeglefinus*) in divisions 7.b–k (southern Celtic Seas and English Channel)

Date: 03/06/2020

Auditor: Ruth Kelly

General

This stock was benchmarked by WKCELTIC in 2020, and assessment methods have been updated according to guidance from this benchmark assessment as detailed in the stock annex.

For single stock summary sheet advice:

1. Assessment type: Update.
2. Assessment: Analytical.
3. Forecast: Presented.
4. Assessment model: State–Space Assessment Model (SAM).
5. Data issues: Due to COVID-19 catch sampling of this stock was disrupted in 2020. Catch sampling in 2021 increased compared to 2020 and is considered sufficient to describe the stock.
6. Consistency: This assessment follows the assessment method (SAM) that is described in the 2020 WKCELTIC benchmark of this stock, and has been applied since 2021.
7. Stock status: Fishing pressure on the stock is below F_{MSY} and spawning–stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.
8. Management Plan: EU multiannual management plan (MAP) for the Western Waters (EU, 2019).

General comments

Assessment is well documented in advice sheet, report and stock annex.

Technical comments

Data have been provided via ICES SharePoint, and SAM assessment based on VAST modelled time-series are available on stockassessment.org.

Conclusions

Report, advice sheets and analysis are available, and analysis appears to have 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 this been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? Yes
- 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

Audit of Megrim (*Lepidorhombus* spp.) in divisions 4.a and 6.a (northern North Sea, West of Scotland)

Reviewer: Simon Fischer, 24/05/2022

General

The assessment and forecast for megrim in 4.a and 6.a are complex but reproducible.

Short description of the assessment:

1. Assessment type: Update.
2. Assessment: Accepted.
3. Forecast: Accepted.
4. Assessment model: Custom Bayesian surplus production (Schaefer) model with six survey indices, some of them from delta-gamma GLMs. Discards before 2013 are estimated but used as input for the assessment model.
5. Consistency: High consistency of estimates relative to MSY reference points. Absolute values (used for forecast) more variable.
6. Stock status: B > MSY $B_{trigger}$ and F < F_{MSY}.
7. Management plan: EU multiannual plan (MAP) for Western Waters and adjacent waters, using F_{MSY} ranges and MSY $B_{trigger}$.

General comments

The report is concise and could benefit from more detailed descriptions of the assessment and forecast procedure and outcomes.

The Stock Annex (SA) would benefit from a rewrite and update. There is a lack of model specifications for the assessment model, and the description for the short-term forecast is extremely short and does not give details about how to perform it.

The stock assessment method (a Schaefer surplus production model) is used as a category 1 data-rich stock assessment model since 2012. Since then, the ICES system has changed and such an assessment would likely be considered as a category 2 or 3 data-limited approach nowadays. It is unknown if this assessment configuration would meet the strict acceptance criteria for a category 2 surplus production model.

Technical comments

The assessment is run with a Bayesian model in WinBUGS, which is very slow, particularly for a surplus production model. Also, the forecast takes >0.5 hour to run. The assessment is conducted with numerous R/Markdown scripts and appears overly complex with several versions run concurrently, which makes auditing this stock challenging. The assessment would benefit from cleaning the assessment procedure, e.g. by creating an R package for the model, which would also remove the possibility of accidentally introducing mistakes.
The assessment could be reproduced.

The forecast is conducted by running a wide range of discrete catch options and then selecting them based on catch, F, biomass, or risk considerations. The forecast is stochastic with many thousand iterations, but metrics such as biomass or F are reported as the mean (not median) of the distributions. There is no documentation (SA or report) on how to derive the scenarios shown in the advice sheet from the numerous catch scenarios. The derivation of the final forecast is somewhat intransparent but follows the same procedure as in previous years.

Conclusions

The assessment is complex but consistent with the approach used in previous years. Full compliance with the stock annex cannot be evaluated because the stock annex is vague and does not give comprehensive details about the data, assessment and forecast procedures.

Audit of Plaice (*Pleuronectes platessa*) in Division 7.a (Irish Sea)

Reviewer: Claire Moore, 01/06/2022

General

The assessment and forecast were performed correctly.

Short description of the assessment:

1. Assessment type: Update.
2. Assessment: Accepted.
3. Forecast: Accepted.
4. Assessment model: SAM assessment: landings + discards + three survey indices.
5. Consistency: Same approach as in previous years; downscaling in SSB in retro.
6. Stock status: Fishing pressure below F_{MSY} and spawning–stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.
7. Management plan: Bycatch stock within EU MAP, no agreed management plan with UK.

General comments

None.

Technical comments

Intersessional work should look into the fact that an increasing proportion of the catch is contained in the plus group, which may be increasing the uncertainty in the SSB of the model. 47% of catch in last five years has been contained in 8+ group.

Future work should also consider the increasing evidence of substock structure within the population, which would include growth rates and mortality considered within the model.

Conclusions

The assessment and forecast for plaice in 7.a could be reproduced and were performed correctly. The report was well written, and concise, with very little feedback to address.

Audit of Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel)

Reviewer: Vladimir Laptikhovsky

General

The 7.e plaice is relatively data-rich for an ICES category 3 data-limited stock. There are no major concerns for this stock to provide advice following category 3 methods. However, the stock might be upgraded in the future.

For single-stock summary sheet advice.

Short description of the assessment as follows:

1. Assessment type: update of the annual assessment.
2. Assessment: accepted.
3. Forecast: not presented.
4. Assessment model: choice of rfb rule was based on the new ICES technical guidelines for stocks in categories 2 and 3 and supported by expert group. This harvest control rule accounts for life-history parameters and the previously advised catch. Legacy XSA assessment and exploratory SAM assessment were carried out but not considered.
5. Consistency: last year assessment used the 2 over 3 rule and was based on the SSB estimate of a landings' only XSA assessment. This assessment is not used anymore for the ICES advice because the rfb rule is applied to empirical data.
6. Stock status: $L_{mean} < L_{MSY\ proxy}$, Biomass index > MSY $B_{trigger}$.
7. Management plan: ICES is aware of the multiannual management plan which has been adopted by the EU for this stock and which ICES considers to be precautionary. There is no agreed shared management plan with UK for this stock, and ICES provides advice according to ICES MSY approach.

General comments

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 the spawning period in 7.d.

Technical comments

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 assessment results depend on the mixing rate assumption estimated from historical tagging data that apply a spawning migration correction that reallocates 15% of Q1 landings for the mature proportion of the catch from 7.d to 7.e.

Conclusions

The 2021 stock assessment for this stock has been audited internally within WGCSE, and no issues were found.

Audit of Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)

Reviewer: Claire Moore, 30/05/2022

General

The assessment was performed correctly, there are some checks required on the forecast.

Short description of the assessment:

1. Assessment type: Cat3 rfb rule.
2. Assessment: Accepted.
3. Forecast: Not applicable.
4. Assessment model: RFB rule – using a survey biomass index for trends.
5. Consistency: Benchmark model (ICES 2022) rejected due to error in some model assumptions.
6. Stock status: The stock is above F_{MSY} proxy and below MSY $B_{trigger}$.
7. Management plan: EU MAP, but no agreed management plan with the UK.

General comments

A number of updates have been requested to the report (see comments) and the stock annex before publication.

Technical comments

The rfb rule has been applied correctly, the advice sheet follows the code provided.

Conclusions

The assessment for ple in 7.fg could be reproduced and were performed correctly.

Audit of Plaice (*Pleuronectes platessa*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)

Reviewer: Vladimir Laptikhovsky

General

The 7.h–k plaice is an ICES category 3 data-limited stock. There are no major concerns for this stock to provide advice following category 3 methods.

For single-stock summary sheet advice

Short description of the assessment as follows:

1. Assessment type: update of the annual assessment.
2. Assessment: accepted.
3. Forecast: not presented.
4. Assessment model: choice of rfb rule was based on the new ICES technical guidelines for stocks in categories 2 and 3 and supported by expert group. A survey biomass index was produced using VAST biomass index of the VAST model and applied as an indicator of stock development. The advice is based on the recent advised catches, multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard, and a precautionary multiplier. The stability clause was considered and applied since the new catch advice was more than 20% higher than the recent advised catches.
5. Consistency: last year assessment is based on the rfb rule to provide MSY advice. A survey combined biomass index was used as an indicator of stock development. The advice is based on the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), multiplied by the recent catches, a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard, and a precautionary multiplier. The stability clause was considered and applied.
6. Stock status: $L_{mean} > L_{MSY\ proxy}$, Biomass index > MSY $B_{trigger}$.
7. Management plan: The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters applies to bycatches of this stock. There is no agreed shared management plan with UK for this stock, and ICES provides advice according to ICES MSY approach.

General comments

The stock unit (divisions 7.h–k is consistent with the assessment area. However, to date no stock identification studies (including tagging) have been conducted on plaice in 7h–k, which is on the southwestern margins of the species distribution. There is evidence in other areas to suggest that plaice is a highly mobile species, and therefore it is possible that ple.27.7.h–k might be an extension of larger adjoining populations, but tagging and genetic would need to be completed to determine this.

Technical comments

The discard rates for this stock are highly variable over time being mean 42% in 2004–2019. This stock should be considered for the next SPiCT workshop to assess if it can be moved to a category 2 stock.

Conclusions

The 2022 stock assessment for this stock has been audited internally within WGCSE, and no issues were found.

Audit of Pollack (*Pollachius pollachius*) in subareas 6–7 (Celtic Seas and the English Channel)

Reviewer: Pia Schuchert, 31/05/2022

General

For single stock summary sheet advice:

1. **Assessment type:** update from last year assessment.
2. **Assessment:** depletion corrected average catch.
3. **Forecast**: No.
4. **Assessment model**: DCAC from NOAA toolbox for category 4 stocks.
5. **Data issues:** The available data consist purely of commercial landings, which is also reflected in the fact that the stock is in a data-limited category. In previous years, exploitation has been consistently below the DCAC 95% confidence interval in both management areas.
   The amount and impact of a recreational fishery is currently not included, but efforts are made to include this in the future.
6. **Consistency**: Same approach as last year.
7. **Stock status**: The available information on the stock is insufficient to evaluate the exploitation rate and stock trends for Pollack.
8. **Management Plan**: The European Parliament and the Council have published a multi-annual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including pollack in ICES subareas 6 and 7. ICES advises on the precautionary basis. There is no agreed shared management plan with UK for this stock.

General comments

The report contained the expected information in a clear manner and is very thorough.

The advice is on precautionary basis as under the ICES framework for data-limited stocks.

Technical comments

None.

Conclusions

The assessment has been performed correctly.

Audit of Sole (*Solea solea*) in Division 7.a (Irish Sea)

Reviewer: Simon Fischer, 24/05/2022

General

The assessment and forecast were performed correctly.

Short description of the assessment:

1. Assessment type: Update.
2. Assessment: Accepted.
3. Forecast: Accepted.
4. Assessment model: XSA (in FLR) – tuning by one survey index.
5. Consistency: Same approach as in previous years; some rescaling is appearing.
6. Stock status: SSB has been increasing and is just above MSY $B_{trigger}$ in 2022; F has also been increasing and is now above F_{MSY} and F_{pa}.
7. Management plan: None.

General comments

None.

Technical comments

Discards are not used in the assessment (but considered in the advice) and have been increasing recently (~12% in 2021). Future benchmarks should consider the inclusion of discards into the assessment, particularly because of the recent changes in the discarding behaviour.

Some of the characteristics seen in this year's assessment (rescaling of SSB in recent years, estimated number of age 8+ fish in the stock in 2020 being higher than the combined numbers for ages 7 and 8+ in 2019) are likely a feature of XSA and its formulation. Using an alternative stock assessment model, such as the state–space model SAM, might help to avoid this behaviour and should be considered in a future benchmark.

Conclusions

The assessment and forecast for sole in 7.a could be reproduced and were performed correctly.

Audit of Sole (*Solea solea*) in divisions 7.b and 7.c (West of Ireland)

Section currently missing

Audit of Sole (*Solea solea*) in Division 7.e (western English Channel)

Reviewer: Sofie Nimmegeers, 30/05/2022

General

The assessment and forecast were performed correctly.

Short description of the assessment:

1. Assessment type: Update.
2. Assessment: Accepted.
3. Forecast: Accepted.
4. Assessment model: XSA (in FLR) – tuning by four tuning fleets (two fishery-independent surveys: UK-FSP and Q1SWBeam; and two commercial lpue time-series: UK-CBT-late and UK-COT).
5. Consistency: Same approach as in previous years; The retrospective has been increasing slightly in recent years; however, this does not cause concerns because the SSB is usually underestimated while the fishing mortality is overestimated.
6. Stock status: SSB has been increasing and is well above MSY $B_{trigger}$, ,B_{pa} and B_{lim} (highest value of the time-series in 2022); F has also been increasing and is now at F_{MSY}.
7. Management plan: EU MAP, but not accepted by all clients

General comments

The report is well-structured and contains a series of very informative graphs.

A few small comments:

*please adjust the last column of the table with the XSA assessment settings used at the last three working groups. It should be referring to 'WGCSE 2022' instead of 'WGCSE 2021'

*In Section 32.9: Uncertainties in assessment and forecast – discards, it is stated that 'Discarding is considered negligible in the sole fishery, averaging only 0.44% of the total international catch weight in 2021.' The 0.44% is the average discard rate of 2019–2021 and not of 2021.

Technical comments

Discards are not used in the assessment (but considered in the advice). As discards are low (average discard rate of 2019–2021 = 0.44%), due to the implementation of the landing obligation in 2016, it is unlikely to become a problem in the future. Nevertheless, as the time-series on discards increases, a future benchmark might look into estimating historical discards.

The current XSA assessment has a "taper range" of 15 years, which means all survey data older than 15 years are ignored and data from 7–15 years ago are strongly down-weighted. The scientific survey index time-series are increasing in length and early years are being cut off due to the taper range. Therefore a re-evaluation of assessment parametrisation should be considered in a future benchmark. The inclusion of commercial tuning indices should also be questioned.

Conclusions

The assessment and forecast for sole in 7.e could be reproduced and were performed correctly.

Audit of Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)

Reviewer: Timothy Earl, 27/05/2022

General

The assessment was performed correctly, there are some checks required on the forecast.

Short description of the assessment:

1. Assessment type: Update.
2. Assessment: Accepted.
3. Forecast: Accepted.
4. Assessment model: SAM using landings and discards, tuned using one survey at-age and five biomass commercial LPUE series.
5. Consistency: Since the benchmark in 2020, the current assessment has shown good consistency.
6. Stock status: The stock is above MSY $B_{trigger}$. Fishing mortality is at F_{MSY}.
7. Management plan: EU MAP, but not accepted by all clients.

General comments

None.

Technical comments

The stock is described (correctly) as being at F_{MSY} because the numbers are the same to two significant figures. If this departure from the standard ICES description is not acceptable, it is also correct to say F_{2021} (0.2504) is below F_{MSY} (0.251).

Some of the other advice sheets are presenting the MAP range as just the lower/upper point, so "0.136–0.251" would be written as ""0.136".

Some of the inputs to the short-term forecast don't seem to match between the advice sheet and the file "stf_input.csv". From this file the sum of products of the N, Mat and stock weight give SSBs of 6095 in 2022, and 5896 in 2023. The corresponding number in the advice sheet are 6221 in 2022 (Table 9) and 6120 (Table 1).

Conclusions

The assessment for sole in 7.fg could be reproduced and were performed correctly. There are minor issues in the forecast to review.

Audit of Sole (*Solea solea*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)

Reviewer: Timothy Earl, 27/05/2022

General

The assessment was performed correctly.

Short description of the assessment:

1. **Assessment type:** No assessment, category 5 advice.
2. **Assessment:** N/A.
3. **Forecast:** N/A.
4. **Assessment model:** N/A.
5. **Consistency:** Same approach as in last year. No change to advice.
6. **Stock status:** Unknown.
7. **Management plan:** EU MAP applies, but not relevant to category 5.

General comments

None.

Technical comments

Due to poor knowledge of the stock identity, poor sampling from Division 7.h and potential issues with historic misreporting, this stock is categorised as category 5 (catch data only). Discards are low (less than 1%).

The report section on the Landings Obligation is written referring to its future implementation, it may be worth reviewing this paragraph to reflect how it has affected the fishery.

By providing advice on based only on the catch trends, it seems to me that we are ignoring potentially important data on the abundance of sole in this area that could be used to provide more robust advice. I suggest that the stock assessor consider applying the VAST survey methodology in a similar way to the assessment of plaice in this area for consideration at future Working Groups, along with reviewing whether recent length data sampling is sufficient for the `rfb` approach to be applied.

Conclusions

The advice for sole in 7.h–k could be reproduced and was performed correctly.

Audit of Whiting (*Merlangius merlangus*) in Division 6.a (West of Scotland)

Reviewer: Emilie Le Luherne, 25/05/2022

General

For single stock summary sheet advice:

1. **Assessment type:** update from last year assessment.
2. **Assessment:** analytical age-based.
3. **Forecast**: Presented, in form of short-term stochastic projections.
4. **Assessment model**: SAM with catch and survey data, SURBA assessment for comparison.
5. **Data issues:** Total landings (nominal landings, ICES statistics) in 2021 were the highest in the last 18 years and constituted 91% of the TAC for that year. The sampling levels in 2021 in the Scottish fleet (taking the majority of the catch), similarly to 2020, were lower compared to previous years due to COVID-19. This WGs estimates of discards have been based on data collected in the Irish and Scottish discard programme and raised by landings. Mean weights-at-age 1 in discards were considerable higher compared to previous years, but this was most likely an effect of the low number of samples from the *Nephrops* fleet.
6. **Consistency**: Same approach as last year. The 2022 assessment thus runs up to 2021, deviating from the model configuration agreed in the benchmark. The 2021 assessment model was revised in 2022 due to an error in stock mean weights-at-age data inputs which affected SSB estimates, but not the published catch advice (the revised estimates for last year's assessment are as follows: F (1–3) in 2020 = 0.065, SSB_{2021} = 30 357 t). The residuals were not substantially affected by the updates made to the model, showing similar patterns to last year's assessment model. The retrospective patterns show a downward revision of SSB and recruitment, and upward revision of F. Both SSB and F remain in their respective envelopes and SSB is above MSY $B_{trigger}$ and F consistently below F_{MSY}.
7. **Stock status**: SSB is considered to be close to the 1990s state and above MSY $B_{trigger}$, increasing in recent years. Fishing mortality has been consistently below F_{MSY} since 2005.
8. **Management Plan**: There is no agreed shared management plan with UK for this stock, and ICES provides advice according to ICES MSY approach. The EU map takes discards of this stock into account.

General comments

The report contained the expected information in a clear manner and is very thorough. A complementary assessment in SURBAR is provided, which supports the findings from the SAM assessment.

The advice is on MSY basis for the second time after years of precautionary advice.

Technical comments

None.

Conclusions

The assessment has been performed correctly.

Audit of Whiting (*Merlangius merlangus*) in divisions 7.b–c and 7.e–k (southern Celtic Seas and eastern English Channel)

Reviewer: Helen Dobby 27/05/2022

General

For single stock summary sheet advice:

1. **Assessment type:** There was an IBP in 2021. This year's assessment follows the approach agreed at the IBP (although stock annex not updated following IBP, so difficult to verify this).
2. **Assessment:** analytical age-based.
3. **Forecast**: Presented, in form of short-term stochastic projections.
4. **Assessment model**: SAM with catch and survey data.
5. **Data issues:** No major data issues.
6. **Consistency**: Assessment follows approach agreed at IBP although some discussion of removal of LPUE which results in improved diagnostics (retro bias/Mohn's rho), but considered too significant to change out with a benchmark. Forecast assumptions of recruitment modified to shorter resampling period (2015 onwards, rather than 2010) due to apparent reduction in recruitment in recent years.
7. **Stock status**: SSB is considered below reference points and F above reference points. SSB in forecast very sensitive to assumption regarding recruitment. Short-term resampled recruitment implies stock is below B_{lim} in forecast and therefore zero catch advice.
8. **Management Plan**: There is no agreed shared management plan with UK for this stock, and ICES provides advice according to ICES MSY approach – zero catch advice.

General comments

There was no up to date Stock Annex available for this stock so it was quite difficult to ascertain whether the assessment had been conducted correctly (as agreed). The audit therefore consisted of cross-checking report tables with data in SA.org, re-running the assessment and cross-checking output from SA.org with the WG report and advice sheet. ('RevRec' stock assessment on SA.org and whg.27.7b–ce–k_DS.doc advice sheet were checked).

The report was concise, well-written and easy to follow. It would be useful to present additional data in the report – such as mean weights-at-age in landings and discards, and also the landings fraction (or landings and discard numbers-at-age) since these quantities are used in SA.org in the forecast.

The assessment is borderline acceptable in terms of retro bias/Mohn's rho with significant revisions in SSB and F occurring with the addition of extra years of data.

Technical comments

There were a number of discrepancies between the WG report and the assessment data in SA.org which need to be checked by the stock assessor:

- Table 6: stock weights (see WG report for details) mismatch in 2019, 2020 and 2021 missing from WG report.
- Natural mortalities also differ between WG report and SA.org.

In addition, some numbers in the forecast need to be corrected (in both the WG report and advice sheet) and/or checked:

- The intermediate year/forecast assumptions table needs to be updated to account for the shortened recruitment time-series assumption

- The $F=F_{2022}$ and $SSB_{2024}=SSB_{2023}$ options in SA.org appear to have different intermediate year F assumptions to the other options (perhaps TAC constraint and/or F_{sq} rather than F_{mix}).

Conclusions

The stock assessment appears to have been done correctly (at least the WG report/advice sheet is consistent with SA.org). However, some of the assessment input data require checking (as above) and in addition some of the forecast options in SA.org appear to be incorrect.

Annex 5: Technical Minutes of the Stony Brook University Review Group for the Advice Drafting Group for Biology and Assessment of the Celtic Sea Fisheries Resources

The following review was done by the Review Group of Data-limited Stocks (RGDLS) on June 3, 2022.

Technical Minutes of the Stony Brook University Review Group for the Advice Drafting Group for Biology and Assessment of the Celtic Sea Fisheries Resources

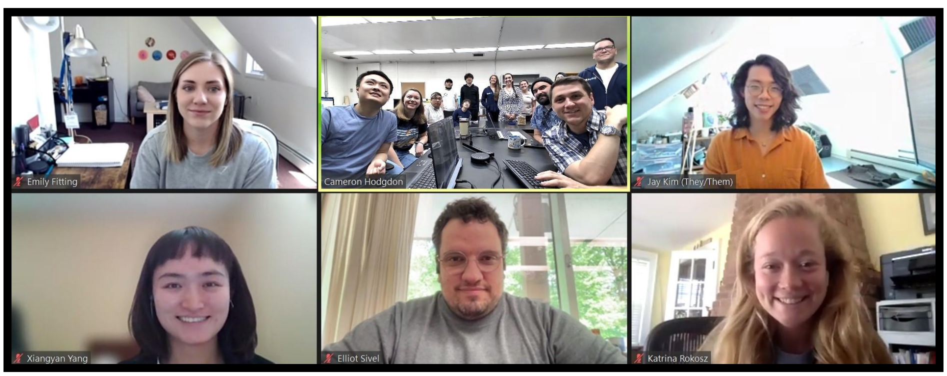
May 17 - June 6, 2022
Stony Brook University, Stony Brook, New York, USA

Reviewers:
Dr. Cameron Hodgdon (Co-Chair), Dr. Ming Sun (Co-Chair), Dr. Hsiao-Yun Chang, Nathan Willse, Noah Khalsa , Jaeheon Kim (UMaine), Emily Fitting (UMaine), Patricia Woodruff, Katrina Rokosz, Qingqiang Ren, Tatum Eigenberger, Dr. Yunzhou Li, Xiangyan Yang, Elliot Sivel, Robyn Linner, Xindong Pan, Farrah Leone, Claire Ober, Stephanie Arsenault, & Allegra Ervin

Faculty Advisor:
Dr. Yong Chen (Professor, School of Marine and Atmospheric Sciences, Stony Brook University)

ICES Secretariat:
Anne Cooper

Review Process



The Stony Brook University Review Group (SBU RG) met on May 17th, 2022 to examine the review materials, discuss the review process, and assign individuals to a subgroup of 4 reviewers focusing on particular stocks. The relevant materials were distributed to each RG subgroup on the ICES SharePoint website. Reviews were carried out after the working group (WG) completed the final report for the WGCSE stocks. In general, the ICES guidelines for review groups (RG) were followed. The RG focused on the consistency between the WG report and the stock annex, i.e., checking whether the assessment, calculation of biological reference points (BRPs), and forecast were carried out in accordance with the stock annex, Terms of reference (ToRs), and RG guidelines. Furthermore, the RG examined the data quantity and quality, assessment method, assumptions, technical measures, uncertainty, presentations, and BRPs for each reviewed stock to ensure that management measures are based upon the best scientific information available. The RG finalized their reports on June 1st to determine the status of each group's report as well as their final decision of accepting or rejecting the assessment, and discussed any remaining issues. Table 1 lists the stocks reviewed by the SBU RG along with the suggestion (accept, accept with caveats, or reject).

Table 1. List of stocks reviewed by the SBU RG.

Stock code/ draft advice link	**Assessment Type**	**Data category**	**Expert group**	**RG suggestion**
ple.27.7e	WKLIFE X approach *rfb* rule	3	WGCSE	Accept
ple.27.7fg	WKLIFE X approach *rfb* rule	3	WGCSE	Accept
ple.27.7hk	WKLIFE X approach *rfb* rule	3	WGCSE	Accept with Caveats

Table of Contents

General Comments

The RG identified some common issues regarding the reports, data, and methods among the stocks, and they are summarized as follows:

The RG understands that the recent WKLIFE document outlines new methodology in the form of a flowchart that WGCSE must follow. In most cases, this was not appropriately outlined in the individual assessment reports. Discussion of this in the context of deviations from the respective stock annexes is necessary for all assessment reports.

This year is the first time that WKLIFE was applied to the data-limited bycatch species. Compared to the assessment models used in previous assessment, WKLIFE approaches have a more explicitly defined roadmap directing different rules based on available data and life history traits. However, the RG believes that performance of WKLIFE approaches are hard to evaluate without quantitative diagnostics such as retrospective analysis or relative errors. As uncertainty due to climate change, lack of knowledge in stock structure, and variations in spatio-temporal distribution are detected for the assessed stocks, it is currently unclear how robust the WKLIFE approaches are. The RG suggests further considerations of uncertainty should be introduced to the WKLIFE approaches to ensure better management effects. Overall, the RG believes the WKLIFE flowchart for assessment is too rigid and does not allow individual stock flexibility.

The RG recommends exploratory analyses of various data-limited-methods concerning WGCSE stocks currently with empirical assessments. The RG has included a list of data-limited-methods resources in the References section.

Stock Specific Issues

The RG suggested the following stocks to be accepted as long as certain suggestions are considered ("Accept with Caveats"). These stocks and suggestions are:

ple.27.7hk

- Discussion of any exploratory SPiCT use is discussed or the lack of use is further justified.
- Because of the lack of an annex, discussion of previous management and assessment practices is necessary for the report.
- The additional general and technical comments are addressed.

Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel) (ple.27.7e)

1. **Assessment Type:**
    - Update
    - Last benchmark: 2015

2. **Assessment:**
    - Accept

3. **Forecast:**
    - None.

4. **Assessment Model:**
    - WKLIFE X: *rfb* rule is used for advice
    - SPiCT, XSA, and SAM assessments are explored, but results are not used for advice.

5. **Consistency:**
    - The natural mortality and the maturity ogives were the same as previous assessments in Division 7.a and 7.fg. The natural mortality is from Division 7.a, which has been changed recently, but the origin values are still used in Division 7.e.
    - The landing-only XSA has been updated but not used for advice anymore.
    - The SAM assessment is still used this year for exploratory purposes only without a benchmark.
    - The stock in Division 7.e had a joint TAC with the plaice stock in 7.d in previous year's management until 2021. This year the stock in 7.e has an individual TAC.

6. **Stock Status:**
    - Length-based indicators show the stock was overfished ($L_{Mean} < L_{F=M}$) during 2014-2021.
    - The SAM assessment indicates strong overfishing ($F > F_{MSY}$), but it's not used for advice purposes.
    - The biomass from the FSP survey has been decreasing since 2014 and had the first increase in 2021 since then.
    - The total international landings of Division 7.e were 1373 t in 2020 and 1403 t in 2021 after the migration correction.

- The landings have decreased since 2017.

7. **Management Plan:**
   - There are no specific management objectives except for the EU multiannual plan for the region.
   - The recommended TAC for years 2023 and 2024 is 1219 tonnes each year.
   - Some technical measures are applicable in 2021 and 2022, including a minimum 80 mm mesh size and a minimum 27 cm landing size.

8. **General Comments:**
   - The WG report is well written and follows the stock annex. The data and data issues are well documented and discussed at length.
   - The WG has thoroughly considered the issues in the connectivity between stocks 7.d and 7.e. Landings were corrected based on the understanding of migration which makes the results of the assessment acceptable.
   - The WG has successfully applied the rfb rule in the assessment following the WKLIFE approach and reliable catch advice is given. Discards were included in the SAM assessment and an even worse overall overfishing situation was identified compared with XSA assessment.
   - Most figures and tables in the reports were well organized and visualized.

9. **Technical Comments**
   - Table 25.2 is not clear.
   - It’s difficult to read the numbers in Figures 25.11 and 25.12.
   - Figure 25.14 is in low resolution and difficult to read.

10. **Conclusions**
    - The assessment of Plaice in division 7.e appears well written with no large errors.
    - The RG recommends that the assessment is accepted.

Plaice (*Pleuronectes platessa*) in divisions 7.f–g (Celtic Sea Plaice) (ple.27.7fg)

1. **Assessment Type:**
   - Benchmark

2. **Assessment:**
   - Accept

3. **Forecast:**
   - None.

4. **Assessment Model:**
   - WKLIFE: *rfb* rule is used for advice
   - SPiCT was applied for 2022 with high uncertainty and generally rejected for management use.
   - SAM (State-Space Assessment) was suggested in the 2022 benchmark assessment. However, it resulted in a strong retrospective pattern with high Mohn's Rho and provided contradictory conclusions. Therefore, the *rfb* rule was applied.

5. **Consistency:**
   - Commercial abundance indices from the different fisheries provided inconsistent trends due to varying discarding practice from 2011 onwards. The situation began to return to normal after 2018 when most fish of commercial size were retained.
   - The SPiCT model was used as the basis for advice in 2021. However, the SPiCT model converged with very large uncertainty and with unsatisfactory diagnostics.

6. **Stock Status:**
   - The fishing pressure was below $F_{MSY\ proxy}$. However, the stock size was below $I_{trigger}$.
   - Total landings from 2021 were equal to 846 t, which was 56.7% lower than the TAC of 1911 t. The stock has declined to close to the lowest observed from 2016-2021, and the advised TAC was reduced to 1735 t.
   - Plaice is primarily a bycatch species in the targeted sole fishery and nephrops fishery. Discards are a large proportion of total catch (44.6% in 2021), and highly variable among years). 2019-2021 was the first time that landings exceeded discards

7. **Management Plan:**
    - There is a TAC for Celtic Plaice, and a mean length reference point for a comparison with MSY_{proxy} to guide management.
    - TAC is divided into national quotas.
    - Beyond TAC there is no further management plan.

8. **General Comments:**
    - The justification for implementation of the previous modeling methodologies is well presented, giving the rationale for the current modeling methodology and describing the data limitations for this species.
    - The abundance decreased significantly since the 2010s, and this stock appeared to make strong year classes occasionally. The RG suggests investigating the relationship between recruitment and environmental conditions as well as examining if the decline in abundance was associated with environmental variability or overfishing.
    - The landings weight-at-age have decreased since the 2000s especially for large age groups (age 6+ older). The RG suggests the WG evaluate the impacts of decreased weight-at-age on the productivity of this population and explore the possible reasons for the decline in weight-at-age.
    - The plaice stock in 7fg is considered primarily a bycatch of the targeted sole fishery. Although its ecological importance in the ecosystem, the discards rates have been high due to mismatch of gear selectivities as well as low market value. The fishing mortality on plaice has been highly impacted by changes in fishing effort in the targeted sole fishery. The RG encourages the WG to consider using multispecies assessment methods for this stock.

9. **Technical Comments:**
    - Consider putting more contrasting color within Figure 28.1 and zooming into the field space. It is currently difficult to see points with smaller values. Also, how much space does each square on the grid represent?
    - Figure 28.1 is missing a general area description or latitude/longitude values to give spatial reference.
    - Figure 28.11 missing a legend for associated fishing mortality at age
    - Country order of TACs and Quotas table should be consistent
    - Figure 28.4 and 28.13, axis labels are small and difficult to read.
    - Figure 28.8 is cut off by page format.
    - Table 28.5: The unit should be “Numbers 10^3”, spelling errors in figure description.
    - Table 28.6: Please specify the term “SOPCOFAC” in the table.

- Table 28.10: Please add column names and row names.

10. **Conclusions**
    - The WG report is well-written and organized. The concerns and limitations of available data were documented and discussed in the report. The RG appreciates the WG's efforts to address the issues in the data and historical model configurations.
    - The RG recommends the assessment to be accepted.

Plaice (*Pleuronectes platessa*) in divisions 7h–k (Celtic Sea South, southwest of Ireland) (ple.27.7hk)

1. **Assessment Type:**
    - Update
    - Last Benchmark: 2021 (not found in report, but found in separate document)

2. **Assessment:**
    - Accept with Caveats

3. **Forecast:**
    - None.

4. **Assessment Model:**
    - WKLIFE X: *rfb* rule.

5. **Consistency:**
    - No stock annex was provided for plaice in divisions 7h-k.
    - This is the second year that the current methodology is being used.
    - Stock identification of plaice is not based on tagging or genetic studies.

6. **Stock Status:**
    - Relative fishing mortality is below the F_{MSY} proxy in 2020.
    - Relative biomass is above the reference B_{MSY} * 0.5 proxy in 2020.
    - Spawning biomass has remained high and stable since 2004.
    - Fishing mortality has been below F_{MSY} since 2004, and is now at the lowest point in the time-series.
    - Official landings in 2021 (46 tonnes) were 31% lower than the 2021 TAC (67 tonnes).

7. **Management Plan:**
    - 2022 TAC = 114 tonnes
        - TAC for 2021 was 67 tonnes
    - The management advice for each of the years 2023 and 2024 when the MSY approach is applied:
        - Catches should not exceed 132 tonnes.
    - Reference points:
        - MSY $B_{trigger\ proxy}$ = 150 mt
        - $F_{MSY\ proxy}$ = 1

8. **General Comments:**

- The RG commends the WG on a well written assessment.
- The WG does a very good job explaining the effects that COVID-19 had on sampling and data collection.
- The RG suggests inclusion of more justification on why VAST was applied to combine the indices, rather than using individual indices. Also including when and why the indices started to be combined using VAST for the assessment would be beneficial.
- The WG should include justification on why no temporal autocorrelation was included in VAST. While the residuals do not show concerning patterns, the WG should consider trying multiple models with different formulations, and then comparing their performance to pick the best one. As part of these explorations, inclusion of environmental covariates in the model, especially considering the influence of climate change in the North Atlantic would be beneficial.
- For the calculation of the *rfb* index, L_C and L_{mean} are calculated as a mean over the time series. Are these estimated from all data over the time series 2004-2021 or as a mean estimated from each year's data? This is an important distinction and justification of which one was used is needed.
    - Additionally, given the values of L_C and L_{mean} in the Figures (29.16 and 29.17), it appears that these values have a temporal trend with early time series values being lower and later time series values being higher (in general). Why then is the entire time series 2004 - 2021 used for these calculations? Temporal shift of these yearly estimations may mean that current values of L_C and L_{mean} are underestimations. More justification is needed.
- The WG should consider including a section detailing the nature of the biomass indices. Consider comparing the individual indices to the combined index, and quantifying uncertainties in the indices.
- The RG recommends including a table in section 29.3.4 that includes all of the calculated values and their summary statistics.
- The WG should include more discussion on why this stock should be considered for SPiCT in section 29.1. Additionally, the WG has no mention of previous exploratory use of SPiCT as is outlined by the WKLIFE X flowchart. If these exploratory assessments were completed, information and any results (even if not used) should be included.
- After communications with the WG, the RG understands the reason for lack of an annex for the current assessment. The RG will not fault the current assessment for this, but requests an annex be made before the next update and requests further

elaboration on previous management and assessment methods to be included in the current report. This will greatly increase understanding and readability in the absence of an annex.

9. **Technical Comments**

- The years of the last update and benchmark assessments should be included in the report.
- Discussion of the landings obligation (section 29.2.2) is not clear and the term “survivability exemption” is not defined.
- There is no discussion of how Ay is calculated. If it is a TAC from a previous year, it does not match the TAC of 2022 (114) or 2021 (67).
- Section 29.4.2 needs rewording for clarification.
- The WG should check the numbering of tables/figures throughout the assessment. For instance, in section 291.3.4, Figure 29.18 is referenced for the mean length in observed catch, but that figure is the length-age relationship.
- The tables in section 29.4.1 and 29.4.3 need table captions.
- The TAC tables in section 29.2.3 need captions, and the units need to be included.
- Generally, all figures have small font sizes and are difficult to read.
- Figure 19.1 is blurry.
- Figures 29.2 and 29.3 color variations between countries lead to poor readability, especially colors chosen for the Netherlands, Spain, and UK (England).
- Figure 29.8 color variation between the surveys leads to poor readability.
- Figures 29.11a and b are blurry and colors are indistinguishable from each other. Additionally, the range of the scales for each plot should be reevaluated.
- Figure 29.12 is missing an X axis label.
- In section 29.3.4, paragraph 2, sentence 7, “was found to be” is repeated twice.
- In section 29.3.4, paragraphs 3 and 4, “von Bertalanffy” is spelled incorrectly.
- Figures should have consistency in colors for labels for different counties.
- Figures 29.16 and 19.17 could use greater description of figures in captions.
- In general, all Figure captions should be expanded for further clarification.

10. **Conclusions**

- The assessment of plaice in divisions 7h-k is well done and well written.
- The RG agrees with the WG and also recommends further research on tagging and genetics in future benchmarks so as to further justify stock boundaries.
- After communications with the WG, the RG understands the reason for lack of an annex for the current assessment. The RG will not fault the current assessment for this, but requests an annex be made before the next update and requests further

elaboration on previous management and assessment methods to be included in the current report.

- The RG recommends the assessment of plaice in divisions h-k to be accepted under the following caveats:
    - Discussion of any exploratory SPiCT use is discussed or the lack of use is further justified.
    - Because of the lack of an annex, discussion of previous management and assessment practices is necessary for the report.
    - The additional general and technical comments are addressed.

References

Carruthers, T.R., and Hordyk, A. 2018. The Data-Limited Methods Toolkit (DLMtool): An R package for informing management of data-limited populations. Methods Ecol Evol. 2018;1–8.

Carruthers, T.R., Kell, L.T., Butterworth, D.D.S., Maunder, M.N., Geromont, H.F., Walters, C., McAllister, M.K., Hillary, R., Levontin, P., Kitakado, T., and Davies, C.R. 2016. Performance review of simple management procedures. ICES Journal of Marine Science, 73 (2): 464-482.

Carruthers, T.R., Punt, A., Walters, C., MacCall, A., McAllister, M., Dick, E.J., Cope, J., 2014. Evaluating methods for setting catch limits in data-limited fisheries. Fisheries Research, 153: 48–68.

Newman, D., Carruthers, T.R., MacCall, A., Porch, C., Suatoni, L. 2014. Improving the Science and Management of Data-Limited Fisheries: An Evaluation of Current Methods and Recommended Approaches, Natural Resources Defense Council.